STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
4601 N Monroe Street • Spokane, Washington 99205-1295 • (509)329-3400

November 18, 2011

Ms. Barbara Greene
Boundary Relicensing Project Manager
Seattle City Light
P.O. Box 34023
Seattle, WA 98124-4023

Dear Ms. Greene:

RE: Boundary Hydroelectric Project Certification-Order No. 8872 (FERC No. 2144)

The request for the certification under Section 401 of the Clean Water Act (33 USC § 1341) for the relicensing of the Boundary Hydroelectric Project (FERC No. 2144) in Pend Oreille County, Washington has been reviewed. On behalf of the State of Washington, the Department of Ecology (Ecology) certifies that reasonable assurance exists that the Boundary Project, subject to and limited by the conditions stated by the enclosed Order No. 8872, will comply with applicable provisions of 33USC §§ 1311, 1312, 1313, 1316, 1317 and other appropriate requirements of State law.

This certification shall be deemed withdrawn if the Federal Energy Regulatory Commission does not issue a license for Boundary Hydroelectric Project within five (5) years of the date of this issuance. This certification may be modified or withdrawn by Ecology prior to the issuance of the license based upon new information or changes to the March 29, 2010 Settlement Agreement, water quality standards or appropriate requirements of state law. If the certification is withdrawn, the applicant will then be required to reapply for certification under Section 401 of the Clean Water Act.

This certification is subject to the conditions contained in the enclosed Order. Please contact Marcie Mangold (Certification Manager) at (509) 329-3450, by email at dman461@ecy.wa.gov or at the mailing address above if you have any questions. The enclosed Order may be appealed by following the procedures described in the Order.

Sincerely,

James M. Bellatty
Water Quality Section Manager
Eastern Regional Office

JMB:DMM:slt

CERTIFIED MAIL (7010 0290 0003 5678 9243)

Enclosure
cc: Kimberly D. Bose, FERC Secretary
FERC Service List for Boundary Hydroelectric Project (FERC No. 2144)
Joan Marchioro, State of Washington Office of Attorney General
Marcie Mangold, Department of Ecology
Chad Brown, Department of Ecology

401 Certification-Order

Boundary Hydroelectric Project Certification Order No. 8872 FERC License No. 2144

November 18, 2011

WASHINGTON STATE
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401 Certification-Order

Boundary Hydroelectric Project Certification Order No. 8872 FERC License No. 2545

By

Marcie Mangold
Water Quality Program
Eastern Regional Office/Ecology
4601 N. Monroe Street
Spokane, WA 99205

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Acronyms

401	Section 401 of the Clean Water Act
7Q10	Seven-day, consecutive low flow with a ten year return frequency
BMP	Best Management Practice
CFR	Code of Federal Regulation
cfs	Cubic feet per second
CWA	Clean Water Act
DO	Dissolved Oxygen
EMD	Emergency Management Division
ERO	Eastern Regional Office of the Department of Ecology
ESHB	Engrossed Substitute House Bill
FAWG	Fish and Aquatic Work Group
FERC	Federal Energy Regulatory Commission
FWPCA	Federal Water Pollution Control Act
hp	Horse power
HPA	Hydraulic Project Approval
ICS	Incident Command System
ILP	Integrated Licensing Process
IWWPP	In Water Work Protection Plan
kcfs	Thousand cubic feet per second
MW	Mega watt
NAVD 88	North American Vertical Datum of 1988, vertical control datum establish for vertical control surveying in the United States of America
NPDES	National Pollution Discharge Elimination System
NRC	National Response Center
NTU	Nephelometric Turbidity Unit
PCB	Polychlorinated Biphenyls
PLP	Preliminary Licensing Proposal
PM&E	Protection, Mitigation and Enhancement
QAPP	Quality Assurance Project Plan
RCW	Revised Code of Washington
RM	River Mile
SCL	Seattle City Light
SDCC	Spill Deterrent Control & Countermeasure Plan
SPCC	Spill Prevention Control & Countermeasure Plan
SWPPP	Stormwater Pollution Prevention Plan
TDG	Total Dissolved Gas
TDG Subgroup	Total Dissolved Gas Subgroup, a subgroup of the WQWG
TMDL	Total Maximum Daily Load
USC	United States Court
USGS	United States Geological Survey
WAC	Washington Administrative Code
WDFW	Washington State Department of Fish and Wildlife
WDOE	Washington State Department of Ecology
WQAP	Water Quality Attainment Plan
WQPP	Water Quality Protection Plan
WQWG	Water Quality Work Group

DEPARTMENT OF ECOLOGY

IN THE MATTER OF GRANTING A	)	**CERTIFICATION**
WATER QUALITY CERTIFICATION TO:	)	**ORDER NO. 8872**
Seattle City Light	)	Licensing of Boundary Hydroelectric
in accordance with 33 U.S.C. § 1341	)	Project (FERC No. 2144),
FWPCA § 401, RCW 90.48.120, RCW 90.48.260	)	Pend Oreille County, Washington
and WAC 173-201A	)	

TO: **Barbara Greene**
Boundary Relicensing Program Manager
Seattle City Light
PO Box 34023
Seattle, WA 98124-4023

On September 3, 2010, the Department of Ecology (Ecology) received an application for a Clean Water Act (CWA) Section 401 certification, 33 U.S.C. § 1341, from Seattle City Light (SCL), for the Boundary Dam hydropower project, Federal Energy Regulatory Commission (FERC) License No. 2144. As the one year deadline provided by Section 401 approached SCL withdrew that application at Ecology's request, and reapplied on July 25, 2011. SCL filed its Preliminary Licensing Proposal (PLP) with FERC on April 30, 2009, and filed its License Application (LA) on September 20, 2009. In March, 2010, SCL entered into the Boundary Hydroelectric Project Relicensing Settlement Agreement (Settlement Agreement, SCL 2010a), that represents five years of consultation and negotiations with state and federal resource agencies, Native American tribes, local governments, non-governmental organizations, and members of the public under the Commission's Integrated Licensing Process (ILP) and a two-year, coordinated mediation process involving many of the same parties. The Settlement Agreement contains proposed License Articles that included provisions for fish passage, fish and wildlife habitat enhancement and protection, water quality, fish supplementation, recreation, cultural properties, and other matters. SCL filed the Settlement Agreement with FERC on March 29, 2010 along with Addenda to the LA that incorporate the provisions of the Settlement Agreement. FERC published a Draft Environmental Impact Statement (EIS) on the Boundary Project in April 2011, and published the Final EIS in September 2011 (FERC 2011). SCL adopted the FERC EIS for purposes of compliance with the State Environmental Policy Act (SEPA) (SCL 2011). The proposed License Articles and the LA as amended by the LA Addenda and evaluated in the FERC Final EIS are reflected in this 401 Certification.

1 NATURE OF THE PROJECT

The Boundary Project (FERC No. 2144) (Project), owned and operated by SCL, is located on the Pend Oreille River, in Pend Oreille County, Washington. The Project was constructed in the mid 1960s and operates under a license administered by the FERC. The present license for the Project expires on September 30, 2011. For the relicensing of the Project, SCL used the FERC ILP to provide the framework for its consultation with agencies, tribes, and other relicensing participants during the period leading up to the filing of the License Application.

1.1 Location

The Project is located on the Pend Oreille River in northeastern Washington and is 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 (RM) 17.0 on the Pend Oreille River. The upstream end of the Project reservoir (Boundary Reservoir) is located immediately downstream of the Box Canyon Dam. Land ownership in the Project vicinity is shown in Figure 1. Specific facility characteristics and layout are listed in Table 1.

Figure 1: Seattle City Light - Project Facilities and Use Areas

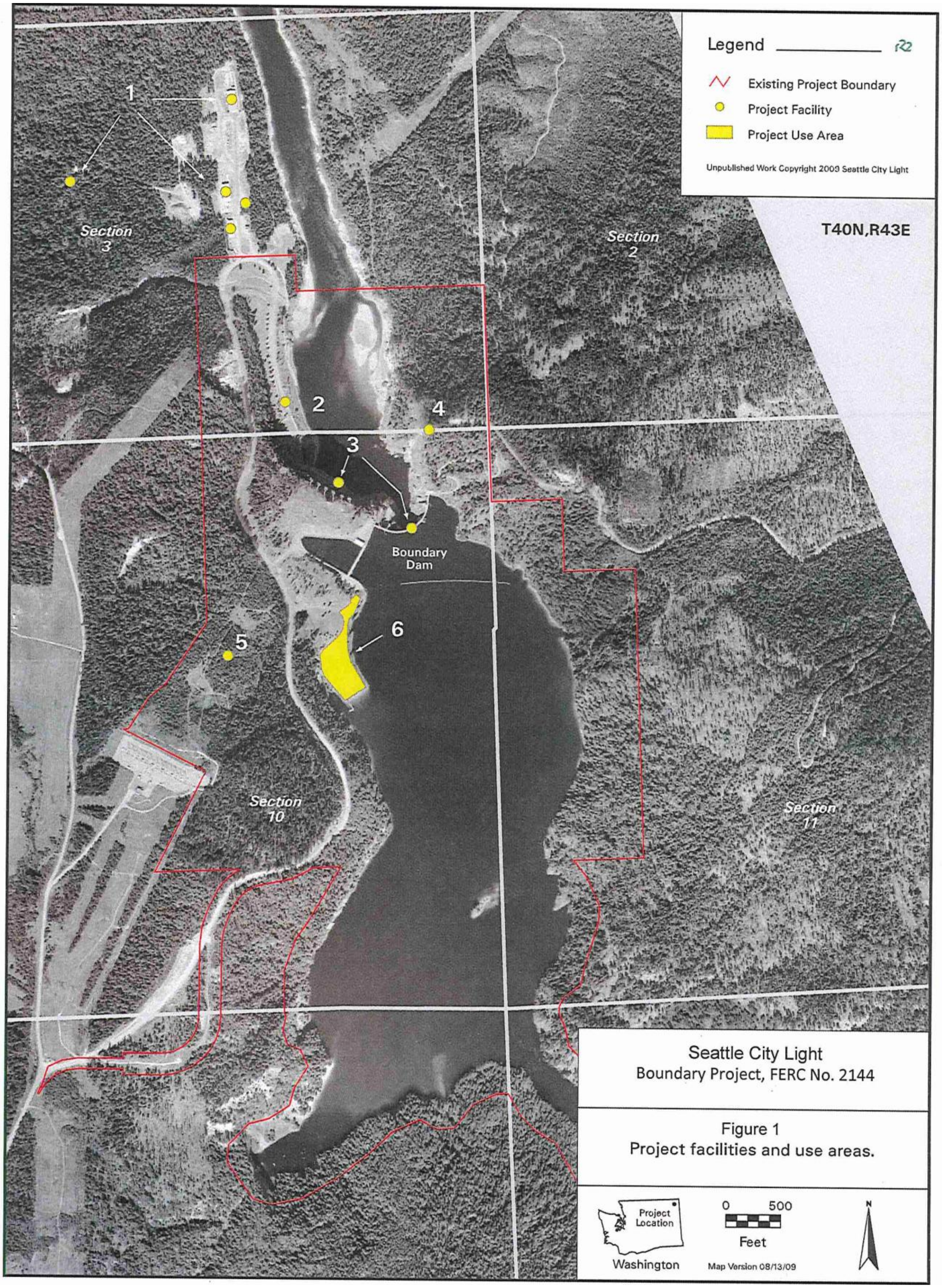

Table 1: Project Facilities and Use Areas

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 miscellaneous 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.

1.2 Dam Characteristics

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), as measured in the forebay.

The Project power plant comprises an underground machine hall, six turbine-generator units, draft tubes, and transformer bays. The machine hall was excavated within the massive rock forming the left abutment of the dam. The machine hall is 76 feet wide, 172 feet high and 477 feet long housing six (6) generating units. 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 (SCL 2009, Exhibits A and B).

Project 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. 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. The Project's total authorized installed capacity is 1,003,253 kW based on total turbine ratings with a total generator capacity of 1,039.8 megawatts (MW) (1,040 MW) based on an assumed peak efficiency of 95 percent. By 2008, SCL conducted actual performance tests that produced a peak efficiency of approximately 90 percent resulting in a revised total installed capacity of 981,518 kW based on turbine ratings and total generator capacity of 1,039.8 MW (1,040 MW). Future maintenance and changes such as turbine upgrades and generator rewinds will be as approved by FERC (SCL 2010b, Exhibit B Addendum).

1.3 Impoundment and Reservoir Storage

Completed in 1967, Boundary Dam forms the 17.5-mile-long reservoir that has a surface area of approximately 1,794 acres, a shoreline length of roughly 47 miles, and maximum depth in the forebay of approximately 270 feet (SCL 2009, Exhibit A).

Table 2 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 its usable storage capacity is approximately 40,843 acre-feet (elevation 1,954 feet NAVD 88 to elevation 1,994 feet NAVD 88) (SCL 2009, Exhibit A). Maximum residence time is less than four days, but more typically the residence time is less than two days (Pickett 2004).

Table 2: Boundary Reservoir Data (SCL 2009)

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

2 AUTHORITIES

In exercising authority under Section 401 of the Clean Water Act (33 U.S.C. § 1341) and Revised Code of Washington (RCW) RCW 90.48.120 and 90.48.260, Ecology has investigated this proposal for:

Conformance with all applicable water quality based, technology based, toxic or pretreatment effluent limitations as provided under the Federal Water Pollution Control Act Sections 301, 302, 303, 306 and 307 and 33 U.S.C. §§ 1311, 1312, 1313, 1316, and 1317.

Conformance with the state water quality standards as provided for in Chapter 173-201A WAC and by Chapter 90.48 RCW, and with other appropriate requirements of state law; and, conformance with all known, available and reasonable methods to prevent and control pollution of state waters as required by RCW 90.48.010.

3 CONDITIONS

In view of the foregoing and in accordance with Section 401 of the Clean Water Act (33 U.S.C. 1341), RCW 90.48.260 and WAC Chapter 173-201A, Ecology finds reasonable assurance that implementation of the compliance schedule and adaptive management strategy contained in the proposed license will result in the attainment and compliance with state and federal water quality standards and other appropriate requirements of state law provided the following conditions are met. Accordingly, through this Order issued and enforceable under RCW 90.48, Ecology grants Section 401 water quality Certification to SCL for the Boundary Dam Hydroelectric Project (FERC No. 2144) subject to the following conditions. This Order will hereafter be referred to as the "Certification".

3.1 General Requirements

(a) The Project shall comply with all water quality standards (currently codified in WAC 173-201A), ground water standards (currently codified in WAC 173-200), and sediment quality standards (currently codified in WAC 173-204) and other appropriate requirements of state law that are related to compliance with such standards, as all such standards are applied in this Certification.

(b) Pursuant to RCW 90.48.080, discharge of any solid or liquid waste to the waters of the state of Washington is prohibited.

(c) In the event of changes or amendments to the state water quality, ground water, or sediment standards, or changes in or amendments to the state Water Pollution Control Act (RCW 90.48), or changes in or amendments to the Federal Clean Water Act, Ecology may by Administrative Order incorporate such provisions, standards, criteria or requirements into this Certification and any attendant agreements, orders or permits, to the fullest extent permitted by law.

(d) SCL shall notify Ecology before undertaking any change to the Project or Project operations that might significantly and adversely affect the water quality (including impairment of designated uses) or compliance with any applicable water quality standard (including designated uses) or other appropriate requirement of state law. If, following such notification, Ecology determines that such a change would violate state water quality standards or other appropriate requirements of state law; Ecology reserves the right to condition or deny such Project change by Administrative Order.

(e) This Certification does not exempt compliance with other statutes and codes administered by any other federal, state, and local agency.

(f) The Washington State Department of Fish and Wildlife (WDFW) require a Hydraulic Project Approval (HPA) under ch. 75.55 RCW for work in waters of the State. SCL shall obtain an HPA from WDFW for any in water activity that may affect water quality or designated uses, prior to the beginning of those activities, and must comply with all conditions of the applicable WDFW HPA.

(g) Ecology retains the right by Administrative Order to require additional monitoring, studies, or measures if it determines there is likelihood or probability that violations of water quality standards or other appropriate requirements of state law have or may occur, or insufficient information exists to make such a determination.

(h) Ecology reserves the right to issue Administrative Orders, assess or seek penalties, and to initiate legal actions in any court or forum of competent jurisdiction for the purposes of enforcing the requirements of this Certification.

(i) Ecology retains the right by Administrative Order to modify schedules and deadlines provided under this Certification or provisions it incorporates.

(j) If a conflict or inconsistency arises between this Certification and the Settlement Agreement for the Boundary Project, or any part thereof, the terms of this Certification shall govern.

(k) If five or more years elapse between the date this Certification is issued and issuance of the new FERC license for the Project, Ecology reserves the right to issue an Administrative Order declaring that this Certification shall be deemed to be expired and denied at such time, and instructing SCL to send Ecology an updated 401 application that reflects the current conditions, regulations and technologies. This provision shall not be construed to otherwise limit the reserved authority of Ecology to withdraw, amend, or correct the Certification before or after the issuance of a FERC license.

(l) Ecology reserves the right to amend this Certification by further Administrative Order if it determines that the provisions hereof are no longer adequate to provide reasonable assurance of compliance with applicable water quality standards or other appropriate requirements of state law.

Such determination shall be based upon provisions in the new FERC license or new information or changes in: (i) the construction or operation of the Project; (ii) characteristics of the water; (iii) water quality criteria or standards; (iv) Total Maximum Daily Load (TMDL) requirements; (v) effluent limitations; or (vi) other applicable requirement of state law. Amendments of this Certification shall take effect immediately upon issuance, unless otherwise provided in the Administrative Order containing the amendment. Ecology shall transmit such amending orders to FERC as notice to FERC of the current Certification conditions.

(m) Copies of this Certification and associated permits, licenses, approvals and other documents shall be kept on site and made readily available for reference by SCL, its contractors and consultants, and Ecology.

(n) SCL shall allow Ecology access to inspect the Project and Project records required by this Certification for the purpose of monitoring compliance with the conditions of this Certification. Access will occur after reasonable notice, except in emergency circumstances.

(o) SCL shall, upon request by Ecology, fully respond to all reasonable requests for materials to assist Ecology in making determinations under this Certification and any resulting rulemaking or other process.

(p) The conditions of this Certification should not be construed to prevent or prohibit SCL from either voluntarily or in response to legal requirements imposed by a court, the FERC, or any other body with competent jurisdiction, taking actions which will provide a greater level of protection, mitigation, or enhancement of water quality or of existing or designated uses.

(q) If an action required under or pursuant to this Certification requires as a matter of federal law that the FERC approve the action before it may be undertaken, SCL shall not be considered in violation of these requirements to the extent that FERC refuses to provide such approval, provided that SCL diligently seeks such approval and so notifies Ecology of FERC's refusal.

(r) Any work that is out of compliance with the provisions of this Certification, or conditions that result in distressed, dying or dead fish, or any unpermitted discharge of oil, fuel, or chemicals directly or indirectly into state waters, is prohibited. In the event of such an occurrence, SCL shall immediately take the following actions:

1. Cease work at the location of the violation to the extent such work is causing or contributing to the problem.
2. Assess the cause of the water quality problem and take appropriate measures to correct the problem and/or prevent further environmental damage.
3. Notify Ecology of the failure to comply. Spill events shall be reported immediately to Ecology's 24-Hour Spill Response Team at 509-329-3400. Other non-compliance events shall be reported to Ecology's permit manager, or to Ecology's ERO Certification Manager.
4. Within two weeks of an event described in paragraph 3.1(r), SCL shall submit a detailed written report to Ecology that describes the nature of the event, corrective action taken and/or planned, steps to be taken to prevent a recurrence, results of any samples taken, and any other pertinent information.

Compliance with these requirements does not relieve SCL from responsibility to maintain continuous compliance with the terms and conditions of this Certification or the resulting liability from failure to comply.

(s) Submittals required by this Certification are summarized in Appendix A. Unless indicated otherwise, submittals shall be sent to the Certification manager at the Department of Ecology, Eastern Regional Office, Water Quality Section, 4601 North Monroe, Spokane, Washington 99205-1295.

(t) This Certification does not authorize any Project related work that may impact water quality (e.g. hatcheries, riparian habitat restoration projects, etc.) beyond those activities specifically identified in this Certification. To the extent that SCL or its agents seek to undertake such work, appropriate permits and/or Certifications shall be obtained prior to commencement of such work.

SCL shall consult with Ecology to determine whether a specific activity requires additional permits, a new CWA Section 401 Certification, or other authorization under ch. 90.48 RCW.

(u) All information prepared or collected as a requirement of this Certification (e.g. plans, reports, monitoring results, meeting minutes, and raw data) shall be made available to the public on SCL's website or other readily accessible means unless otherwise restricted by law (e.g., FERC Critical Energy Infrastructure Information). Where data or quantitative analysis is involved, it shall be provided in a format that allows others to efficiently validate and analyze data and results.

(v) Where this Certification refers to "reasonable and feasible" actions and measures, Ecology retains the authority to ultimately determine if an action or measure qualifies as "reasonable and feasible".

(w) Within this Certification, Ecology has required the use of an Adaptive Management process to meet a number of state water quality standards. As used in this Certification, Adaptive Management means an iterative and rigorous process used to improve decision-making and achieve objectives in the face of uncertainty. It is intended to improve the management of natural resources affected by the Project in order to achieve desired objectives as effectively and efficiently as possible.

(x) Ecology acknowledges that SCL reserves the right to appeal to the Pollution Control Hearings Board pursuant to RCW 43.21B, or to any court or other forum of competent jurisdiction pursuant to applicable law, any Administrative Order or civil penalty issued by Ecology relating to this Certification.

3.2 Aquatic Resources

3.2.1 General Conditions

SCL shall comply with all applicable water quality standards. Waters of the state are assigned designated uses under WAC 173-201A-200(1). Designated uses for this section of the Pend Oreille River and tributary streams include, but are not limited to, the uses described in Table 3 below.

For aquatic life uses, it is also required that all indigenous fish and non-fish aquatic species be protected in waters of the state in addition to the key species described below.

Table 3: Designated Uses

Pend Oreille River Reach Description	Designated Uses
Pend Oreille River from Canadian border (river mile 16.0) to Idaho border (river mile 87.7)[1]	• Aquatic Life Uses – Salmonid spawning, rearing, and migration. The key identifying characteristics of the use is salmon or trout spawning and emergence that only occurs outside of summer season (September 16 – June 14). Other common characteristic aquatic life uses for waters in this category include rearing and migration by salmonids. • Recreation – Primary contact • Water Supply – Domestic, Industrial, Agricultural, and Stock Watering. • Misc. Uses – Wildlife Habitat, Harvesting, Commerce and Navigation, Boating and Aesthetics.
Sullivan Creek	• Aquatic Life Uses – Char spawning and rearing. The key identifying characteristics of this use are spawning or early juvenile rearing by native char (bull trout and Dolly Varden), or use by other aquatic species similarly dependent on such cold water. Other common characteristic aquatic life uses for waters in this category include summer foraging and migration of native char; and spawning, rearing, and migration by other salmonid species. • Recreation – Extraordinary primary contact. • Water Supply – Wildlife Habitat, Harvesting, Commerce and Navigation, Boating and Aesthetics.
Slate Creek from mouth to headwaters (including tributaries)	• Aquatic Life Uses – Char spawning and rearing. The key identifying characteristics of this use are spawning or early juvenile rearing by native char (bull trout and Dolly Varden), or use by other aquatic species similarly dependent on such cold water. Other common characteristic aquatic life uses for waters in this category include summer foraging and migration of native char; and spawning, rearing, and migration by other salmonid species. • Recreation – Extraordinary primary contact. • Water Supply – Wildlife Habitat, Harvesting, Commerce and Navigation, Boating and Aesthetics.
[1]Temperature shall not exceed a 1-DMax of 20.0ºC due to human activities. When natural conditions exceed a 1-DMax of 20.0ºC, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3ºC; nor shall such temperature increases, at any time, exceed t=34/(T+9).	

Numeric water quality criteria applicable to the designated uses in Table 3-1 are found in WAC 173-201A-200 and WAC 173-201A-602, Table 602. These include criteria for TDG, pH, dissolved oxygen (DO), fecal coliform, turbidity and temperature. Criteria for these parameters specific to the Pend Oreille River and its tributaries are identified in Table 4 below.

Table 4: Water Quality Standards

Parameter	Water Quality Standard
Temperature	**Pend Oreille River**: Temperature shall not exceed a 1-DMax of 20.0ºC due to human activities. When natural conditions exceed a 1-DMax of 20.0ºC, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3ºC; 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
Dissolved Oxygen	**Pend Oreille River**: Lowest 1-day minimum of 8.0 mg/L
	Sullivan Creek (above Harvey Creek & its tributaries) and Slate Creek and its tributaries (Char spawning/rearing): Lowest 1-day minimum of 9.5 mg/L
Turbidity	**Pend Oreille River**: 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.
	Sullivan Creek (above Harvey Creek & its tributaries) and Slate Creek and its tributaries (Char spawning/rearing): Same as above.
Total Dissolved Gas	**Pend Oreille River**: Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.
	Sullivan Creek (above Harvey Creek & its tributaries) and Slate Creek and its tributaries (Char spawning/rearing): Same as above.
pH	**Pend Oreille River**: pH shall be within the range of 6.5 to 8.5, with a human caused variation within the above range of less than 0.5 units.
	Sullivan Creek (above Harvey Creek & its tributaries) and Slate Creek and its tributaries (Char spawning/rearing): pH shall be within the range of 6.5 to 8.5, with a human caused variation within the above range of less than 0.2 units.
Bacteria Indicator	**Pend Oreille River**: Fecal coliform organism levels must not exceed a geometric 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: Fecal coliform organism levels must not exceed a geometric 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.

Other numeric criteria or narrative standards may apply to the Pend Oreille River in addition to the criteria listed in Table 4.

3.3 Aquatic Invasive Species Control and Prevention

SCL shall implement all elements of its 2010 Aquatic Invasive Species Control and Prevention Plan (Boundary AISCPP) developed for the Project. Specifically, SCL shall implement the following provisions of the Boundary AISCPP (Appendix B).

- Macrophyte Suppression
- 3.1 Verification Mapping
- 3.2.1 Bottom Barrier Locations
- 3.2.2 Boat Ramp Macrophyte Control Locations
- 3.2.3 Additional Potential Macrophyte Control Locations
- 3.3 Bottom Barrier Material and Deployment Methods
- 3.4 Timing of Bottom Barrier Installation
- 3.5 Permits
- 3.6 Monitoring Macrophyte Response to Control Measures
- 3.7 Other Potential Macrophyte Control Measures
- 4.1 Monitoring for Zebra and Quagga Mussels
- 4.1.1 Substrate Sampling
- 4.1.2 Tow Sampling
- 4.2 Monitoring for New Zeland Mudsnails
- 4.3 Other Invasive Aquatic Species
- 4.4 Rapid Response and Coordination
- 5 Interpretation and Education Program
- 6 Water Quality Workgroup
- 7 Adaptive Management
- 8 Implementation Schedule

3.4 Total Dissolved Gas

3.4.1 General Conditions

The Project shall not cause any exceedance of the Total Dissolved Gas (TDG) water quality criteria as specified in WAC 173-201A-200 (1)(f) and WAC 173-201A-510(5). In March 2008, the Environmental Protection Agency (EPA) approved a TDG Total Maximum Daily Load (TMDL) for the Pend Oreille River (Ecology 2007). The TMDL stated that allocations would be met primarily through a TDG abatement or attainment plan. SCL shall implement its 2011 Total Dissolved Gas Attainment Plan (Boundary TDGAP) developed for the Project. Specifically, SCL shall implement the following provisions of the Boundary TDGAP (Appendix B).

- 4.1.1.1 Development of CFD Model
- 4.1.1.2 Testing Structural Alternatives
- 4.1.1.3 Development of Numerical TDG Predictive Tool
- 4.1.2.1 Physical Model Testing
- 4.1.3 Engineering Studies
- 4.2.1 Field Studies and Monitoring
- 5 TDG Attainment Plan
- 5.2.2 Annual Reports
- 5.2.3 TDG Attainment Plan Compliance Schedule

3.4.2 7Q10 Exceedance Flow

Compliance with the 110 percent TDG criterion does not apply when flows exceed the rate equivalent to the 7Q10 flows as defined in WAC 173-201A-200(1)(f)(i). The 7Q10 exceedance flow for the Pend Oreille River is 108.3 kcfs, above which the 110 percent TDG criterion does not apply.

3.5 Temperature

The Project shall not cause any exceedance of the temperature water quality criteria as specified in WAC 173-201A-200 (1)(c), WAC 173-201A-602, Table 602 and WAC 173-201A-510(5). SCL shall implement its 2011 Temperature Attainment Plan (Boundary TAP) developed for the Project. Specifically, SCL shall implement the following provisions of the Boundary TAP (Appendix B).

- 4.1.2 Pend Oreille Watershed Aquatic Habitat Improvement Projects
- 4.2.1 Mainstem and Tributary Temperature Monitoring
- 4.2.2 QAPP
- 4.2.3 Tributary Aquatic Habitat Improvement Monitoring
- 4.3 Compliance Schedule
- 4.4 Annual Attainment Measure Implementation Reports

SCL has developed other tributary habitat improvements in their 2010 Fish and Aquatics Management Plan (FAMP) as measures to address Project water quality impacts on fish and aquatic resources. SCL shall implement the following provisions of its FAMP (Appendix B).

- 5.4.6 Culvert Replacements and LWD Placement in Tributaries to Boundary Reservoir
- 5.4.7 Riparian Planting, Culvert Replacement and Channel Reconstruction in Linton Creek RM 0.00 to RM 0.24
- 5.4.8 Riparian and Channel Improvements in Sweet Creek RM 0.0 to RM 0.6

3.6 Dissolved Oxygen

The Project shall not cause any exceedance of the dissolved oxygen water quality criteria as specified in WAC 173-201A-200 (1)(d) and WAC 173-201A-510(5). SCL shall implement its 2010 Dissolved Oxygen Attainment Plan (Boundary DOAP) developed for the Project. Specifically, SCL shall implement the following provision of the Boundary DOAP (Appendix B).

- 3.1 Dissolved Oxygen Monitoring
- 3.2 Monitoring Design
- 3.3 Monitoring Methods
- 3.4 Evaluating Monitoring Results and Potential Secondary Actions
- 3.5.2 Schedule

3.7 Toxics

SCL shall implement its 2010 Fish Tissue Sampling Plan developed for the Project. Specifically, SCL shall implement the following provisions of the Plan (Appendix B).

- 2.1 Sample Site Locations
- 2.2 Fish Collection and Processing
- 3 Laboratory Analysis
- 4 Reporting of Results
- 5 Implementation Schedule

3.8 Spills

SCL shall comply with its most recent approved version of the Spill Prevention Control and Counter Measure (SPCC) Plan for the project and shall continue to provide Ecology, Eastern Region Office, Spills and Water Quality Programs, with copies of its most up-to-date versions.

3.8.1 General Oil Spill Prevention & Control Conditions

(a) SCL shall not discharge oil, fuel or chemicals into waters of the State, or onto land with a potential for entry into waters of the State as prohibited by Chapter 90.56 RCW and Chapter 90.48 RCW.

(b) SCL shall contain wash water with oils, grease or other hazardous materials resulting from wash down of equipment or working areas for proper disposal, and shall not discharge these contaminated waters into waters of the State.

(c) Any visible floating oils released from Project operation, maintenance activities or construction shall be contained and removed from the water.

(d) In the event of a discharge of oil, fuel or chemicals in waters of the State, or onto land with a potential for entry into waters of the State, SCL shall immediately begin and complete containment and clean-up efforts of the spilled material. Cleanup work shall take precedence over normal work and shall include proper disposal of any spilled material and used clean-up materials.

(e) Spills into waters of the State and spills onto land with a potential for entry into waters of the State, or other significant water quality impacts, must be reported immediately (within one hour) to the Department of Ecology, Eastern Regional Office at 509-329-3400 (24-hour phone number).

(f) SCL shall participate in the Incident Command System whenever a Unified Command is established in response to a spill incident that involves or potentially impacts one or more Projects.

(g) SCL employees and its agents shall be familiar with and trained on use of oil spill cleanup materials. In the event of a spill, properly dispose of used/contaminated materials and oil, and as soon as possible restock new supplies. Include records of proper disposal in the oil consumption records and keep copies of disposal records of contaminated cleanup supplies on-site and available for inspection by Ecology.

(h) SCL shall install, or have on-site to deploy, staircases, ladders, harnesses, etc., which will allow oil spill response personnel to safely reach areas that could, in the event of an oil spill, need to be accessed to deploy sorbent pads, boom material or other cleanup equipment.

(i) Following all spills into waters of the State, or onto land with a potential for discharge to waters of the State, SCL shall provide a written report to Ecology's Eastern Regional Office within 15 days of the incident. The report shall include a description of the incident, response actions taken and any spill prevention measures taken or recommended to prevent similar spills.

3.8.2 Turbine Pits

Every effort shall be made to keep oil and grease from discharging to the turbine pits.

(a) Sorbent material deployed in the turbine pits shall be removed before the sorbent pads reach their capacity to absorb oil or grease and then shall be properly disposed or reconditioned.

(b) Any oil that may leak into the turbine pits from the turbines' upper bearings will either be absorbed on sorbent pads or will enter the path of seal water channeled to the sump system designed specifically to capture residual oil.

3.8.3 Sumps

(a) SCL shall visually inspect sumps weekly or immediately if an oil leak is suspected, such as in the event of an oil sump high level alarm or other visual indications that oil could reach the sump. An oil skimmer in the sump manages removal of any day-to-day oil that may enter the sump. In the event the Powerhouse Operator receives a low-oil-level alarm from oil-filled equipment at the Project, this equipment will be visually checked immediately and may trigger emergency response procedures found in Sec. 3 (Emergency Recognition &Communication) of the Boundary Emergency Response Plan (BERP). SCL shall immediately repair oil leaks that are of sufficient volume to reach the sump and that cannot be contained by placing a container underneath the leak.

(b) SCL shall provide water-proof lighting in the sump or spotlights adequate to observe oil sheens on the surface of the water in the sumps.

(c) SCL shall initiate cleaning of the sump to remove all oil and oil residue from walls, piping and other structures in contact with sump water as necessary based on the results of weekly inspections and the volume of effluent in the sump. Oil cleanup and removal of effluent shall follow the procedure defined in Section 10 (Decontamination & Disposal) of the Boundary Emergency Response Plan (BERP).

3.8.4 Transformers

(a) SCL shall verify that the transformer containment system is functioning as designed and will contain oil spills.

(b) SCL shall inspect the transformer containment areas during routine plant rounds.

(c) SCL shall obtain prior approval from Ecology before breaching containment areas for reasons other than containment area maintenance.

(d) SCL shall conform to industry standards, use BMPs or utilize other control measures for protecting water quality and preventing and containing oil spills when conducting in-place maintenance work on transformers, transporting transformers and transferring transformer oil.

3.8.5 Stormwater Pollution and Containment Area Management

(a) SCL shall use Best Management Practices (BMPs) or other control measures to prevent any oil-contaminated stormwater on the Project site from entering state waters.

(b) Transformer and oil-filled operating equipment containment areas exposed to stormwater shall be monitored for the presence of oil. If oil is present, the oil shall be removed and properly disposed of prior to draining the containment area.

(c) Discharge of non-contaminated stormwater from containment areas shall be recorded. Records of all stormwater removed or discharged from containment areas shall be kept on-site and available for inspection by Ecology.

(d) Snowy or icy conditions require thorough and at least daily inspection of containment areas and containment drains. Remove any observed stormwater pooling in containment areas and dispose of such water appropriately.

3.8.6 Other

(a) SCL shall maintain site security at the Project to reduce chance of oil spills.

(b) SCL shall coordinate spill response planning and response efforts with other oil-handling facilities and spill response agencies on the Pend Oreille River.

(c) Compliance with these conditions does not relieve SCL from responsibility to maintain continuous compliance with terms and conditions of this Certification or resulting liability from any further failure to comply.

3.9 Construction Projects, Miscellaneous Discharges and Habitat Modifications

The following applies to all over-water or near-water work related to the Project that may impact surface or ground water quality. This includes, but is not limited to, construction, operation, and maintenance of fish collection structures, generation turbines, penstocks, transportation facilities, portable toilets, boat ramps, transmission corridors, structures, and staging areas. This also includes emergencies for all activities related to Project operation.

3.9.1 Water Quality Protection Plans

If water quality exceedances are predicted as being unavoidable during construction or maintenance of a project, a short term water quality modification must be applied for in writing to Ecology at least three (3) months prior to project initiation.

If any project has a long term impact on a regulated water quality parameter, characterization monitoring must be performed for the impacted parameter(s), and a monitoring plan must be outlined in the Water Quality Protection Plan (WQPP) discussed below. This may require additional management practices to minimize impacts of the license period.

A WQPP shall be prepared, and followed for all Project related work that is in or near water that has the potential to impact surface and/or ground water quality. The WQPP shall include control measures to prevent contaminants from entering surface water and groundwaters, and shall include, but not be limited to, the following elements:

(a) A Stormwater Pollution Prevention Plan (SWPPP) shall specify the BMPs and other control measures to prevent contaminants entering the Project's surface water and groundwaters. The SWPPP shall address the pollution control measures for SCL's activities that could lead to the discharge of stormwater or other contaminated water from upland areas. The SWPPP must also specify the management of chemicals, hazardous materials and petroleum (spill prevention and containment procedures), including refueling procedures, the measures to take in the event of a spill, and reporting and training requirements.

(b) An In Water Work Protection Plan (IWWPP), consistent with SWPPP, shall be prepared and shall specifically address the BMPs and other control measures for SCL's activities that require work within surface waters.

Turbidity and dissolved oxygen shall be monitored upstream of the location where in-water construction is taking place and at the point of compliance (as defined in WAC 173-201A-110) during construction. Samples shall be taken at a minimum of once each day during construction in or adjacent to any water bodies within the Project area that may be affected by the construction. The IWWPP shall include all water quality protection measures consistent with a HPA for the Project.

(c) The WQPP shall include procedures for monitoring water quality, actions to implement should water quality exceedances occur, and procedures for reporting any water quality violations to Ecology. The WQPP shall include all water quality protection measures consistent with a HPA for the Project. The WQPP shall be submitted to Ecology for review and approval at least three months prior to Project initiation and a copy of the WQPP shall be in the possession of the on-site construction manager and available for review by Ecology staff whenever construction work is under way.

(d) When a construction project meets the coverage requirements of the National Pollutant Discharge Elimination System (NPDES) permit and State Waste Discharge General Permit for Stormwater Discharges associated with construction activity, SCL shall, at Ecology's discretion, either apply for this permit and comply with the terms and conditions of the permit or apply for and comply with the terms of an individual NPDES permit.

3.9.2 Best Management Practices (BMPs)

(a) Work in or near the reservoir, water within the dam, the river, or any wetlands shall include all reasonable measures to minimize the impacts of construction activity on waters of the state.

(b) Water quality constituents of particular concern are turbidity, suspended sediment, settleable solids, oil and grease, and pH. These measures include use of BMPs to control erosion and sedimentation, proper use of chemicals, oil and chemical spill prevention and control, and clean up of surplus construction supplies and other solid wastes.

(c) During construction, all necessary measures shall be taken to minimize the disturbance of existing riparian, wetland, or upland vegetation.

(d) All construction debris shall be properly disposed of on land so that the debris cannot enter a waterway or cause water quality degradation to state waters. Retention areas or swales shall be used to prevent discharging of water from construction placement areas.

(e) SCL shall ensure that any fill materials that are placed for the proposed habitat improvements in any waters of the State do not contain toxic materials in toxic amounts.

3.10 Water Quality Monitoring

3.10.1 Quality Assurance Project Plan

SCL shall prepare a water quality monitoring and quality assurance project plan (QAPP) for each parameter to be approved by Ecology as specified in each WQAP or other Plan. SCL shall coordinate with Ecology in establishing its monitoring locations prior to the development of the QAPP.

The QAPPs shall follow the Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies (July 2004 Ecology Publication Number 04-03-030) or its successor.

The QAPPs shall contain, at a minimum, a list of parameter(s) to be monitored, a map of sampling locations, and descriptions of the purpose of the monitoring, sampling frequency, sampling procedures and equipment, analytical methods, quality control procedures, data handling and data assessment procedures, and reporting protocols.

SCL shall review and update the QAPPs called for in the aquatic invasive species, total dissolved gas, temperature and dissolved oxygen plans annually based on a yearly review of data and data quality. Ecology may also require future revisions to the QAPP based on monitoring results, regulatory changes, changes in project operations and/or the requirements of TMDL.

Implementation of the monitoring program shall begin as soon as Ecology has provided SCL with written approval of the QAPP. Changes to the QAPP need written approval by Ecology before taking effect. Ecology may unilaterally require implementation of the QAPP.

3.11 Penalties and Appeals

You have the right to appeal this Order. To appeal this you must:

1. File your appeal with the Pollution Control Hearings Board within 30 days of the "date of receipt" of this document. Filing means actual receipt by the Board during regular office hours.

2. Serve your appeal on the Department of Ecology within 30 days of the "date of receipt" of this document. Service may be accomplished by any of the procedures identified in WAC 371-08-305(10). "Date of receipt" is defined at RCW 43.21B.001(2).

Be sure to do the following:

1. Include a copy of this document that you are appealing with your Notice of Appeal.

2. Serve and file your appeal in paper form; electronic copies are not accepted.

A. To file your appeal with the Pollution Control Hearings Board

Mail appeal to:		Deliver your appeal in person to:
The Pollution Control Hearings Board PO Box 40903 Olympia WA 98504-0903	**OR**	The Pollution Control Hearings Board 4224 – 6th Ave SE Rowe Six, Bldg 2 Lacey WA 98503

B. To serve your appeal on the Department of Ecology

Mail appeal to:		Deliver your appeal in person to:
The Department of Ecology Appeals & Application for Relief Coordinator PO Box 47608 Olympia WA 98504-7608	**OR**	The Department of Ecology Appeals & Application for Relief Coordinator 300 Desmond Dr. SE Lacey WA 98503

C. And send a copy of your appeal to:

James M. Bellatty
ERO Water Quality Program
4601 N. Monroe
Spokane, WA 99205-1295

For additional information visit the Environmental Hearings Office Website: http://www.eho.wa.gov. To find laws and agency rules visit the Washington State Legislature Website: http://www.leg.wa.gov/CodeReviser

Your appeal alone will not stay the effectiveness of this Order. Stay requests must be submitted in accordance with RCW 43.21B.320. These procedures are consistent with Chapter 43.21B RCW.

DATED this 18 day of November, 2011 at Spokane, Washington

James M. Bellatty
Water Quality Section Manager
Eastern Regional Office
Department of Ecology

4 REFERENCES

Federal Energy Regulatory Commission, 2011. Final Environmental Impact Statement: Application for Hydropower License for the Boundary Hydroelectric Project, FERC Project No. 2144-038, Washington, and Application for Surrender of Hydropower License for the Sullivan Creek Project, FERC Project No. 2225-015, Washington, Publication Number FERC/FEIS – 0239F.

Pickett, P.J. 2004. Draft Pend Oreille River Temperature Total Maximum Daily Load Technical Study. Washington State Department of Ecology, Environmental Assessment Program, Olympia, WA.

Washington State Department of Ecology, 2011. Pend Oreille River Temperature Total Maximum Daily Load, Publication Number 10-10-065.

Washington State Department of Ecology. 2007. Pend Oreille River, Total Dissolved Gas Total Maximum Daily Load Water Quality Improvement Report, Publication Number 07-03-003.

Washington State Department of Ecology. 2006. Water Quality Standards for Surface Waters of the State of Washington Chapter 173-201A WAC, Publication Number 06-10-091.

Washington State Department of Ecology, 2004. Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies, Publication Number 04-03-030.

Seattle City Light, 2011. Adoption of Existing Environmental Document (SEPA Adoption Notice).

Seattle City Light, 2010a. Boundary Hydroelectric Project Relicensing Settlement Agreement FERC Project No. 2144 (including Proposed License Articles and Management Plans).

Seattle City Light, 2010b. License Application Addenda for the Boundary Hydroelectric Project FERC No. 2144.

Seattle City Light. 2009. License Application for the Boundary Hydroelectric Project FERC No. 2144. Volume 1 and 2.

5 APPENDIX A

Summary of Studies and Reports Required by this Certification

Plans and Reports Due
Under this Certification

Note: This list may not be all inclusive

Product Type	Description	Due Date	Section of Certification or WQAP
Aquatic Invasive Species Control and Prevention Plan			
Mapping	To verify or revise the macrophyte distribution, abundance, and species composition obtained during 2007	Two years following license issuance	3.1 AISCPP
Specify bottom barrier location	Confirm or revise in consultation with the WQWG and the FAWG	Immediately following the mapping exercise	3.1 of the AISCPP
Bottom barrier installation	Install at locations identified in Section 3.2 of the AISCPP	After spring runoff of the third year following licensing issuance	8 of the AISCPP
Annual surveys at barrier locations	Annual surveys from a boat to monitor site conditions and, in consultation with the WQWG and FAWG and subject to agreement by Ecology determine whether macrophytes have reestablished to a degree requiring implementation of suppression measures	In the third year following the completion of the boat launch modifications	3.2.2 of the AISCPP
Annual sampling	Deploy artificial substrates for Zebra and Quagga Mussels	First April following Ecology approval of QAPP	8 of the AISCPP
Tow sampling	Horizontal and vertical zooplankton tow net sampling for Zebra and Quagga Mussels	First June, July and August following Ecology approval of QAPP	4.1.2 of the AISCPP
Annual sampling	New Zealand Mudsnails	First April following Ecology approval of QAPP	8 of the AISCPP
QAPP	Quality Assurance Project Plan, which will include a schedule for conducting macrophyte verification mapping to Ecology for approval	Within six months of the new license issuance	8 of the AISCPP
Interpretation and Education	Will develop the final details of the I&E program	During the first three years of the new license term	8 of the AISCPP and 4.6.1 of the RRMP
Toxics			
QAPP	Quality Assurance Protection Plan for Ecology's approval	Within six months of license issuance.	5 of the Fish Tissue Sampling Plan
Sampling	Fish tissue collection for lead and zinc according to the approved QAPP by Ecology.	Once during the first summer (July – August) following Ecology approval of QAPP	5 of the Fish Tissue Sampling Plan
Table	Table of results of tissue sampling for each fish at each sampling site provided to Ecology and WDOH	Within 90 days of receiving final results from the laboratory	5 of the Fish Tissue Sampling Plan
Total Dissolved Gas			
QAPP	Update annually based on data review	Update annually based on data review	3.10.1 of 401 Certification
TDG monitoring	Ongoing monitoring	Continuous	4.2.1 of TDG

Product Type	Description	Due Date	Section of Certification or WQAP
			attainment plan
Construct 1st choice prototype	Construct the first choice on prioritized structural alternative list for prototype development and build prototype, annual report, and consultation with Ecology, TDG Subgroup, and FAWG	Year one after license issuance	5.2.3 of TDG attainment plan
Field testing and data gathering from 1st choice prototype	Field testing, gather operational and performance data for implemented designs, analyze results, recalibrate predictive tool, annual report, and consultation with Ecology, TDG Subgroup, and FAWG	Year two after license issuance	5.2.3 of TDG attainment plan
Develop design for next choice on prototype	Develop design (plans and specifications) for next choice on prioritized alternative list for prototype development – build prototype, field testing, gather operational and performance data, analyze results, recalibrate predictive tool, annual report, and consultation with Ecology, TDG Subgroup, and FAWG	Year three after license issuance	5.2.3 of TDG attainment plan
Field testing and data gathering from 2nd choice prototype	Field testing, gather operational and performance data, analyze results, recalibrate predictive tool, annual report, and consultation with Ecology, TDG Subgroup, and FAWG	Year four after license issuance	5.2.3 of TDG attainment plan
Develop design for next choice on prototype	Develop design (plans and specifications) for next choice on prioritized alternative list for prototype development – build prototype, field testing, gather operational and performance data, analyze results, recalibrate predictive tool, annual report, and consultation with Ecology, TDG Subgroup, and FAWG	Year five after license issuance	5.2.3 of TDG attainment plan
Repeat field testing and develop design prototype as necessary	Repeat years 4 and 5 as necessary, evaluate potential combinations of gate operations to optimize TDG reduction	Years six to ten	5.2.3 of TDG attainment plan
Monitor and evaluate progress	Monitor and evaluate progress of the attainment program and results of implementation of the preferred alternatives.	Year 10	5.2.3 of TDG attainment plan
Temperature			
Mill pond dam removal and stream channel restoration	Mill pond dam and the associated log crib dam removal, manage sediment, restore the stream channel, implement site restoration measures, and conduct short-term monitoring and maintenance in the Mill Pond Affected Area.	Within five years of FERC's issuance of the Sullivan Creek Project License Surrender Order	4.1.2.1.1 of the TAP
Tributary and stream	Stream and riparian improvements in Sullivan	Within ten years of	4.1.2.1.1 of

Product Type	Description	Due Date	Section of Certification or WQAP
channel improvements	Creek RM 2.3 to RM 3.0 and North Fork Sullivan Creek	FERC's issuance of the new Boundary license	the TAP
LWD placement and road improvements in Sullivan Creek	LWD placement and road improvements in Sullivan Creek and selected tributaries upstream of the confluence with Outlet Creek	By year 10 of the new license term	4.1.2.1.1 of the TAP
Habitat protection, riparian improvement, and stream channel enhancement in Sullivan Creek	Habitat protection, riparian improvement, and stream channel enhancement in Sullivan Creek RM 0.30 to RM 0.54	Within 10 years of license issuance	4.1.2.1.1 of the TAP
Mainstem LWD at tributary deltas	Mainstem LWD at tributary deltas; two at Sullivan, one at Sweet, Slate, and Linton Creeks	Will take place within the first 10 years following license issuance, except in the Sullivan Creek delta, which at the direction of the FAWG, may take place after the tenth year, depending on the influence of Mill Pond Dam removal	4.1.2.3.1 and 4.3 of the TAP
Cold Water Release Structure at Sullivan Dam	SCL shall fund its share of the cost of design, permitting, construction, monitoring, operation, and maintenance of the cold water facility as required under the Cold Water Release MOA.	Within three years of FERC's issuance of the Sullivan Creek Project License Surrender Order	4.1.2.2 of the TAP
Mainstem monitoring	Continuous temperature data monitoring collected annually	Beginning the first June after new license issuance and through October, and every June through October thereafter	4.2.1 of the TAP
QAPP	Submit a Temperature QAPP to Ecology for approval. The QAPP shall be reviewed and updated annually	Within six months of FERC's issuance of a new license.	4.2.2 of the TAP
Tributary Aquatic Habitat Improvement Monitoring	Protocols for collecting compliance information will be developed by the FAWG as part of implementation planning.	Within one year following implementation of tributary habitat improvement measures	4.2.3 of the TAP
Effectiveness monitoring	SCL will conduct effectiveness monitoring to assess the tributary improvement measure's condition.	Beginning in the eighth year following implementation and every eighth year after	4.2.3 of the TAP
Annual reports	SCL will provide tables of summarized annual temperature monitoring data from Boundary reservoir mainstem, deltas of Sullivan, Sweet, and Linton Creeks and at locations within Sullivan Creek. The report will summarize implementation of the aquatic habitat measures as discussed in Section 4.4 of the TAP.	Beginning the first year after license issuance and then every year after on March 31	4.3 of the TAP

Product Type	Description	Due Date	Section of Certification or WQAP
Dissolved Oxygen			
Monitoring	Temp, DO, pH	June-Sept beginning one year following license issuance and every year after for five years	3.5.2 of DO Plan
Annual reporting	Annual reporting	Every Dec. after the first monitoring period	3.3 of DO Plan
QAPP	Quality Assurance Project Plan	Within six months following license issuance	3.5.2 of DO Plan
Consultation	Consult with Ecology to determine if any further actions are needed	After 5 years	3.4 of DO Plan

6 APPENDIX B

Water Quality Plans

Exhibit 6

Boundary Hydroelectric Project (FERC No. 2144)

Aquatic Invasive Species Control and Prevention Plan

Seattle City Light

March 2010

TABLE OF CONTENTS

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List of Acronyms and Abbreviations

AISCPP	Aquatic Invasive Species Control and Prevention Plan
ANSC	Washington State Aquatic Nuisance Species Management Plan
ANSTF	U.S. Federal Aquatic Nuisance Species Task Force
Ecology	Washington Department of Ecology
GPS	Global Positioning System
I&E	Interpretation and education
FERC	Federal Energy Regulatory Commission
PAD	Pre-Application Document
Project	Boundary Hydroelectric Project
PRM	project river mile
SCL	Seattle City Light
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WNWCB	Washington State Noxious Weed Control Board

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Aquatic Invasive Species Control and Prevention Plan
Boundary Hydroelectric Project (FERC No. 2144)

1 INTRODUCTION

This document describes Seattle City Light's (SCL) proposed Aquatic Invasive Species Control and Prevention Plan (AISCPP) for the Boundary Hydroelectric Project (Project), Federal Energy Regulatory Commission (FERC) No. 2144. The AISCPP will direct the implementation of measures undertaken to suppress the abundance and control the spread of introduced invasive aquatic submerged macrophytes (mainly Eurasian watermilfoil) at targeted sites in the Project area. This AISCPP also describes how SCL will implement a monitoring and prevention program for zebra and quagga mussels, New Zealand mudsnails, and any other newly listed aquatic nuisance species that are identified by the State of Washington. The Washington Department of Ecology (Ecology) recognizes the need to develop long-term management measures for the aforementioned aquatic nuisance species in the region (RCW 77.08.010, 77.60.130[1]), including the Project area. This AISCPP describes the interpretation and education (I&E) program that SCL will undertake in consultation with the Water Quality Workgroup (WQWG) and Fish and Aquatics Workgroup (FAWG) to educate the public on practices that reduce the risk of dispersing invasive aquatic species.

2 BACKGROUND

On April 12, 2005, SCL met with Ecology at its Spokane offices to discuss issues related to Section 401 water quality certification of the Project (Item 81, Appendix 6-1 of SCL's Pre-Application Document [PAD] [SCL 2006]). During this pre-relicensing consultation meeting, Ecology identified Eurasian watermilfoil (*Myriophyllum spicatum)*, currently found in the Project area, and zebra mussels (*Dreissena polymorpha)*, which have the potential to be introduced to the State of Washington, as the two invasive species of concern for the Project area. Ecology specifically identified boat ramps and the dam structure as two locations where zebra mussels could become an issue if they were to be introduced.

The quagga mussel (*D. rostriformis bugensis*), a species similar to the zebra mussel, and the New Zealand mudsnail (*Potamopyrgus antipodarum*) are also invasive species of concern in the State of Washington; like zebra mussels, neither of these mollusk species has been found in the Project area to date. Curly pondweed (*Potamogeton crispus*), an introduced aquatic macrophyte species of concern to resource agencies, is present in the Project area and will respond to measures implemented primarily for the suppression of Eurasian watermilfoil. Over the course of the new Project license, additional invasive species of concern may be identified in the State of Washington. SCL will work with the WQWG and FAWG to determine appropriate monitoring, control, and prevention measures for any such species, as necessary.

2.1. Aquatic Invasive Species of Concern

2.1.1. Eurasian Watermilfoil

Eurasian watermilfoil (referred to henceforth as milfoil), an aquatic plant native to Europe, Asia, and North Africa, was first collected from a pond in the District of Columbia during the fall of 1942. By 1985, it had been found in 33 states, the District of Columbia, and the Canadian provinces of British Columbia, Ontario, and Quebec (Ecology 2007). Milfoil was first documented in the State of Washington in 1965, and in spite of efforts to stop its spread, it dispersed through the Okanogan Lakes and into the Okanogan and Columbia rivers in 1974 (Duke 2001).

Milfoil is highly adaptable, tolerating a variety of environmental conditions. It is a rooted plant that grows in water depths from 1 to 10 meters (3 - 33 feet), can survive under ice, and can grow under a wide range of temperatures (Ecology 2007). Milfoil exhibits an annual growth pattern, with shoots beginning to proliferate rapidly as water temperatures approach 15 ˚C (59 ˚F) in the spring. When plants near the surface, shoots branch out, often forming a dense canopy (Ecology 2007). Plants flower at the surface and die back to root crowns in the fall, which sprout again in the following spring. Vegetative reproduction is the primary means of milfoil dispersal; during the growing season the plant undergoes fragmentation, and these fragments have the potential to develop into new plants (Ecology 2007). Milfoil can adversely impact aquatic ecosystems by outcompeting native submerged aquatic macrophytes and when abundant can affect aquatic habitat and water quality. It can also impact power generation by clogging intake structures and can interfere with recreational activities.

Milfoil is classified as a class B noxious weed by the Washington State Noxious Weed Control Board (WNWCB 2007), and is designated for control in Pend Oreille County. Class B noxious weeds are introduced species of limited distribution in Washington State. Milfoil is also identified as a nuisance species in the Washington State Aquatic Nuisance Species Management Plan (ANSC 2001).

2.1.2. Curly Pondweed

Curly pondweed, a native of Eurasia, is thought to have been first introduced into the United States in the mid 1800s (Stuckey 1979). Prior to 1900, the species occurred only in the northeastern United States, but by 1930 it had spread west of the Great Lakes. Since that time it has spread across much of the United States, presumably dispersed by migrating waterfowl, intentional planting for waterfowl and wildlife habitat, and incidental introduction in water used to transport fish and fish eggs (Stuckey 1979).

Curly pondweed life history is unusual in that it flowers, fruits, and produces turions (a scaly shoot developed from an underground bud) in late spring and early summer, and then shortly after that the plants begin to decay. The turions germinate in late summer or fall and produce small overwintering plants that can survive under the ice in lakes and reservoirs (Stuckey et al. 1978). When water begins warming in spring the plants begin to grow. Dense colonies of curly pondweed can restrict access to docks and other facilities and can adversely affect angling and other forms of recreation.

2.1.3. Zebra and Quagga Mussels

Zebra and quagga mussels are freshwater, bivalve mollusks that are native to Eurasia. Both species were introduced into the Great Lakes in ballast water discharged from transoceanic ships. Zebra mussels were first found in North America in the mid-1980s, and quagga mussels were first found in 1989 (USFWS 2007). The two species are closely related, with subtle morphological differences. The North American distribution of these species has been concentrated in the Great Lakes region, although zebra mussel distribution extends into the southern and mid-western states. Despite measures to prevent their westward expansion, quagga mussels have been found in Lake Mead and other reservoirs serving southern California. Currently, zebra and quagga mussels are not found in Washington (Benson 2009a, 2009b) (Figure 2.1-1).

Zebra and quagga mussels can spawn throughout the year if conditions are favorable, but peak spawning generally occurs in spring and fall. Fecundity is high, with a few individuals having the ability to produce millions of gametes (USFWS 2007). After fertilization, microscopic larvae, called veligers, develop, and these planktonic larvae are transported by currents for three to four weeks until settling on suitable substrate. Adults generally attach to hard surfaces (although quagga mussels can live in soft sediments) but can detach and move if conditions become unfavorable. Both species tolerate a wide range of water temperatures (1-30 ˚C; 32-86 ˚F) and low water velocities (< 2 meters/second; 6.5 feet/second) (USFWS 2007). Zebra mussels are typically found just below the water's surface to depths of about 12 meters (≈ 40 feet), and quagga mussels can live at greater depths if oxygen is available (USFWS 2007).

Zebra and quagga mussels may be introduced through several pathways, including transport into the system attached to recreational boats, or simply drift from upstream areas. Once introduced, both zebra and quagga mussels can clog water intake structures such as pipes and screens, thereby interfering with hydropower generation and water treatment. Recreation facilities, such as docks, breakwaters, and buoys, are also susceptible to colonization (USGS 2007).

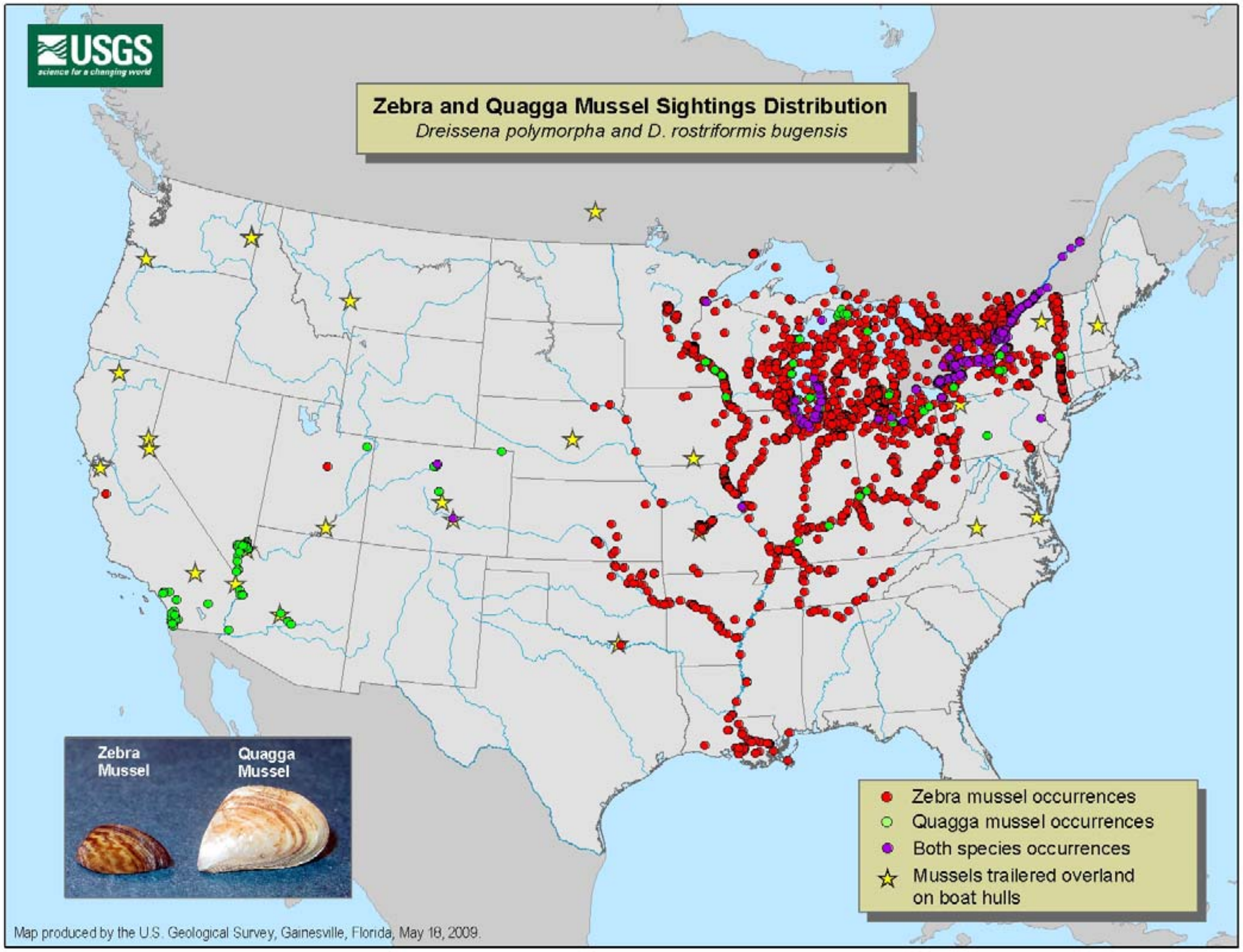


Figure 2.1-1. Current (May 2009) distributions of zebra and quagga mussels in the continental United States (Benson 2009a, 2009b).

2.1.4. New Zealand Mudsnail

New Zealand mudsnails are small (3 - 6 millimeter [≈ ⅛ inch]) snails with brown or black cone-shaped shells with five whorls. This snail reproduces quickly and can occur in densities up to 500,000/square meter (ANSTF 2009). Resource agencies are concerned about proliferation of the mudsnail in western streams, where their presence could adversely affect macroinvertebrates that provide food for native trout (ANSTF 2009).

New Zealand mudsnails were first found in the Snake River, Idaho in 1987, and in 1994 were found in the Madison River near Yellowstone National Park (ANSTF 2009). Subsequent investigations documented the rapid spread of this exotic species to the Firehole and lower Gibbon rivers. The New Zealand mudsnail is currently distributed widely throughout the western United States, with documented occurrences in the Columbia River and in Kalispell Creek, a tributary to Priest Lake (Benson 2009c).

New Zealand mudsnails are able to withstand desiccation, a wide range of temperatures, and are small enough to be inadvertently transported to aquatic systems where they have not yet been introduced (ANSTF 2009). The mudsnail tolerates siltation and thrives in disturbed watersheds. It occurs among macrophytes and prefers the littoral zones of lakes or slow streams but can tolerate high-flow environments. Mudsnails have been found at depths ranging from 4 to 45 meters (13 to 148 feet).

There is concern about this species' ability to disperse because of its asexual reproduction and ability to tolerate harsh conditions. Because mudsnails reproduce asexually, a single individual is capable of populating an aquatic system once introduced (ANSTF 2009). The New Zealand mudsnail has no natural predators or parasites in the United States, which has contributed to its successful dispersal. Control of this species depends on vigilant cleaning of boats and other equipment to avoid its introduction into unaffected areas (ANSTF 2009).

2.2. Submerged Macrophyte Surveys in the Project Area

Mapping surveys of submerged aquatic macrophytes in the Project area were conducted in August 2007, i.e., during the period of peak macrophyte growth (Mainstem Aquatic Habitat Modeling [SCL 2009a]). The entire shoreline from Box Canyon tailrace to Boundary Dam was surveyed for the presence of macrophytes. A Global Positioning System (GPS) point was taken every 1,000 meters (3,281 feet) or when macrophytes were encountered. When macrophytes were present, GPS points were taken at the boundaries of the macrophyte beds and every 100 meters (≈ 325 feet) along the outside of the beds. A sufficient number of points were recorded to clearly define the limits of each bed. At each GPS point within the beds, species present and their respective percent cover were recorded. If dewatered and dry macrophytes were encountered, the species identification and their respective percent cover were estimated.

For the purpose of conducting relicensing studies in 2007 and 2008, the Project area was divided into the following reaches. Results of macrophyte surveys are reported below for each of these reaches.

- The Tailrace Reach, which extends from Boundary Dam downstream to the US-Canada border, 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.

- The Forebay Reach, which extends from Boundary Dam upstream to the lower end of Z-Canyon, is wide and deep, with steep-walled banks, and water depths to approximately 260 feet. There is little shallow littoral habitat in this area.

- The Canyon Reach, which extends from the downstream end of Z-Canyon to Metaline Falls, is predominantly narrow with steep rock walls. A few large embayments and backwater channels provide localized shallow habitats, and areas of rock outcroppings provide habitat complexity. Depths in this reach are typically 80 to 100 feet.

- The Upper Reservoir Reach, which extends from Metaline Falls to Box Canyon Dam, is relatively wide and shallow, with a combination of silt, sand, and hard substrates, and water depths typically ranging from 10 to 25 feet.

Submerged macrophyte species found in the Project area are listed in Table 2.2-1. Eurasian watermilfoil and coontail (*Ceratophyllum demersum)* were the dominant macrophyte species, although curly pondweed appeared to be invading areas of established milfoil beds, displacing both milfoil and coontail in some areas.

Table 2.2-1. Macrophyte species in Boundary Reservoir during 2007 surveys.

Scientific Name	Common Name	Status
Myriophyllum sibericum	northern milfoil	Native
Myriophyllum spicatum	Eurasian watermilfoil	Non-native
Ceratophyllum demersum	coontail	Native
Elodea canadensis	common waterweed	Native
Potamogeton crispus	curly pondweed	Non-native
Potamogeton pectinatus	sago pondweed	Native
Potamogeton vaginatus	sheathing pondweed	Native
Potamogeton richardsonii	Richardson's pondweed	Native
Potamogeton zosteriformis	flat-stem pondweed	Native
Ranunculus aquatilis	white water buttercup	Native

In 2007, 33 macrophyte beds existed in the Upper Reservoir Reach, 27 in the Canyon Reach, 12 in the Forebay Reach, and zero in the Tailrace Reach (Table 2.2-2). Macrophyte beds covered 20.7 acres in the Canyon and Forebay reaches and 202.5 acres in the Upper Reservoir Reach.

Aerial photographs showing the extent, density, and species composition of macrophyte beds in Boundary Reservoir, based on 2007 surveys, are provided in Appendix 1.

Table 2.2-2. Number and size of macrophyte beds in the Project area during 2007.

Reservoir Zone	Number of Macrophyte Beds	Macrophyte Bed Size Range (acres)	Total Macrophyte Area (acres)
Upper Reservoir Reach	33	0.02-61.7	202.5
Canyon Reach	27	0.001-7.9	12.3
Forebay Reach	12	0.001-8.4	8.4
Tailrace Reach	0	0	0
		Total	**223.2**

3 MACROPHYTE SUPPRESSION

During Project relicensing, concerns regarding the spread of invasive aquatic macrophytes inside and outside the Project area were raised by relicensing participants. SCL will implement a targeted suppression program, with the goal of reducing potential adverse effects associated with invasive aquatic macrophytes, Eurasian watermilfoil in particular. The objectives of the program are to: 1) reduce the risk of fish stranding and trapping and/or the potential for macrophyte interference with recreational boating at four target locations where thick macrophyte cover likely increases stranding and trapping rates and macrophytes come into contact with boats, 2) reduce potential macrophyte interference with recreational boating at the Boundary Forebay and Metaline Waterfront Park boat ramps, as needed, and 3) suppress the abundance of invasive aquatic macrophytes at up to three additional locations (for a maximum total area of 50,000 square feet) in the Project area where they are likely to increase fish stranding and trapping or interfere with recreational boating, as determined appropriate by the WQWG and FAWG following license issuance. During the term of the license, the WQWG and FAWG may also choose to discontinue suppression at the seven locations referenced in number 1 and 3 above, in favor of other similarly-sized locations, if deemed appropriate by the WQWG and FAWG following license issuance. Reducing the extent of contact between boats and invasive aquatic macrophytes will reduce the risk of dispersing these macrophytes, both within and outside of the Project area.

SCL identified bottom barriers as the best treatment method to address the objectives identified above. The locations of bottom barrier deployment discussed below were identified based on relicensing studies and the objectives described above. Exact locations of bottom barrier placement may be adjusted following verification mapping and consultation with the WQWG and FAWG after issuance of the new Project license (see sections 3.1 and 3.6).

The plan outlined below describes: (1) verification mapping to confirm that conditions at the treatment locations identified in Section 3.2 have not changed significantly by the time the plan is implemented, and if there have been changes, to guide adjustments to the treatment locations; (2) the proposed locations of bottom barrier installation and approximate areal extent to be treated; (3) the expected interval of barrier reinstallation; (4) methods and materials to be used;

(5) assessment of effectiveness, (6) adaptive management, and (7) an implementation schedule. Although the locations of bottom barrier installations are identified in this plan, specific treatment locations will need to be verified in consultation with the WQWG and FAWG, based on verification mapping, following license issuance. Waiting until after license issuance to confirm the exact locations of barrier placement is necessary because the species composition and distribution of macrophyte beds could change between the writing of this AISCPP and the time that macrophyte suppression is first implemented.

Bottom barriers kill aquatic macrophytes by compressing them and reducing or blocking their supply of light. Installation of a bottom barrier immediately creates an area of open water. In most instances, the barriers can be easily installed by hand–either by wading or diving–around boat launches, recreation areas, or other small-scale, targeted locations. When properly installed, bottom barriers can eliminate up to 100 percent of the aquatic macrophytes in the area covered.

There are, however, some drawbacks associated with the use of bottom barriers. Because they reduce available habitat by covering the substrate, they are only suitable for localized macrophyte control, and for safety and performance reasons they must be regularly inspected and maintained. Without regular maintenance, aquatic macrophytes can colonize the upper surface of bottom barriers. Fishing gear, propeller backwash, and boat anchors can damage or dislodge bottom barriers, and improperly anchored barriers can create safety hazards for boaters and swimmers. Anchoring bottom barriers can be challenging in deep water with soft substrate. Depending on their placement, barriers can interfere with fish spawning, benthic productivity, and productivity of epibenthic invertebrates living on the leaves of macrophytes. By opening up lanes into macrophyte beds, bottom barriers can increase feeding opportunities by sportfish on prey species, which can be either desirable or undesirable, depending on the species interactions in question.

Finally, the method is not species-specific, because the barrier covers all plants, whether native or introduced, in the area of installation. However, areas dominated by native macrophytes can be avoided when placing the barriers.

3.1. Verification Mapping

In the second year following issuance of the new Project license, SCL will undertake mapping to verify or revise the macrophyte distribution, abundance, and species composition information obtained during mapping conducted in 2007 as part of relicensing studies (see Appendix 1 of this AISCPP for maps of macrophyte distribution). Following the mapping exercise, SCL will confirm or revise the specific locations of bottom barrier deployment in consultation with the WQWG and FAWG. The general locations identified below for bottom barrier installation are not expected to change significantly, although given the dynamic nature of macrophyte growth and species composition, slight changes may need to be made.

3.2. Macrophyte Suppression Locations

SCL will 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).

3.2.1. Bottom Barrier Locations

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

- Everett Island side channel (Project river mile [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. The bottom barrier will be placed to create and maintain a 30-foot wide swath extending about 650 feet (19,500 square feet) to the mainstem channel to a depth of up to 1,974 feet NAVD 88[1] (Figure 3.2-1). The Everett Island side channel has a high ridge in the middle, and if high flows were to dislodge the barrier, it would likely wash downstream and catch on this ridge, thereby reducing the risk of it moving downstream and interfering with the dam or forebay intake facilities. The open channel provided by the barrier is also expected to improve angler access to fish habitat in this area.
- 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 (Figure 3.2-2). This area was identified by the field crews that conducted relicensing studies as a location where boats commonly come in contact with macrophytes. The exact location of the barrier within the location identified in Figure 3.2-2, or at an alternative location, will be determined in consultation with the WQWG and FAWG following license issuance (estimated area = 200 x 100 feet = 20,000 square feet). When the exact placement location is determined, the potential for the barrier to become dislodged will be assessed before deploying the barrier in an area so near the thalweg. Appropriate measures will be applied to ensure that the barrier remains in place.
- 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. The barrier will be placed in a 20-foot wide swath covering about 700 linear feet (14,000 square feet) on the downstream side of side channel where velocities during high flow conditions would be low (Figure 3.2-3). Not only will the open area created by the bottom barrier provide 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. The open channel provided by the barrier is also expected to improve angler access to fish habitat in this area.

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

- 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 a 20-foot wide swath that will extend about 400 feet (8,000 square feet) through the middle of the trapping pool and end at the upper end of the narrow channel that drains the trapping pool (Figure 3.2-4). 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. The open channel provided by the barrier is also expected to improve angler access to fish habitat.

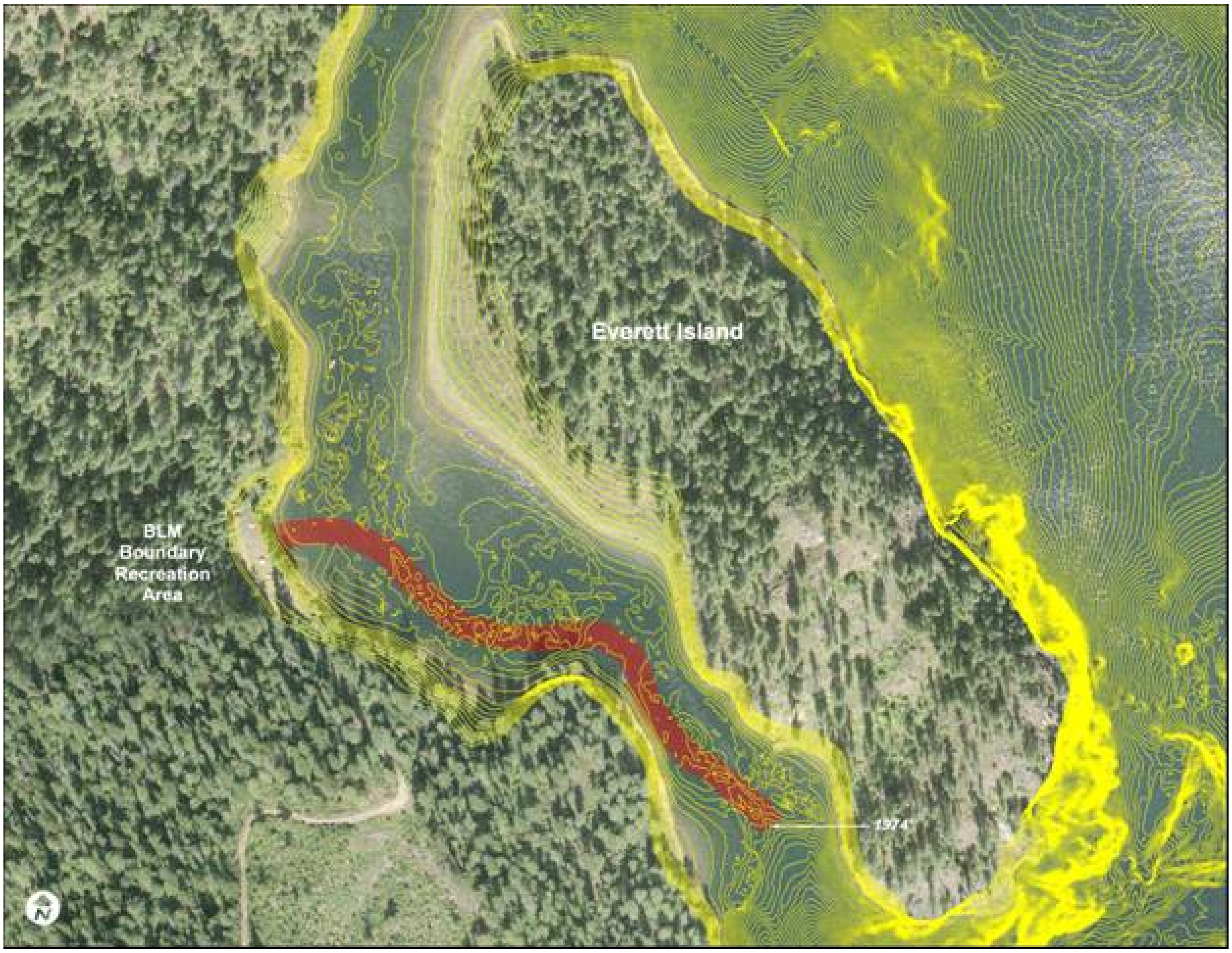


Figure 3.2-1. Proposed location of macrophyte bottom barrier in the Everett Island side channel (PRM 19.4). Area shown in red indicates the proposed location of the bottom barrier.

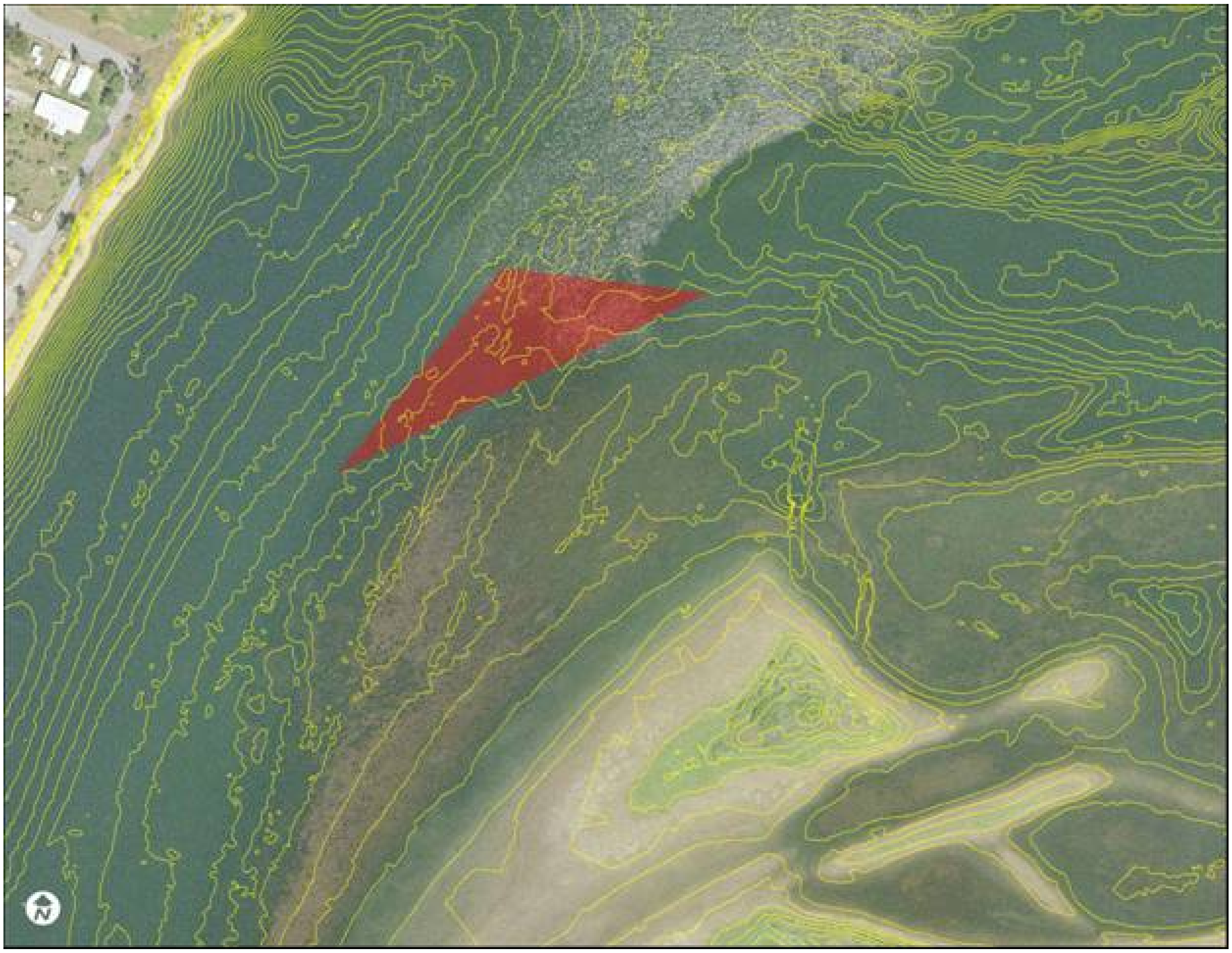


Figure 3.2-2. Proposed location of macrophyte bottom barrier in the Metaline Pool, across from the Town of Metaline (PRM 28.7). Area shown in red indicates the location within which bottom barrier could be installed.

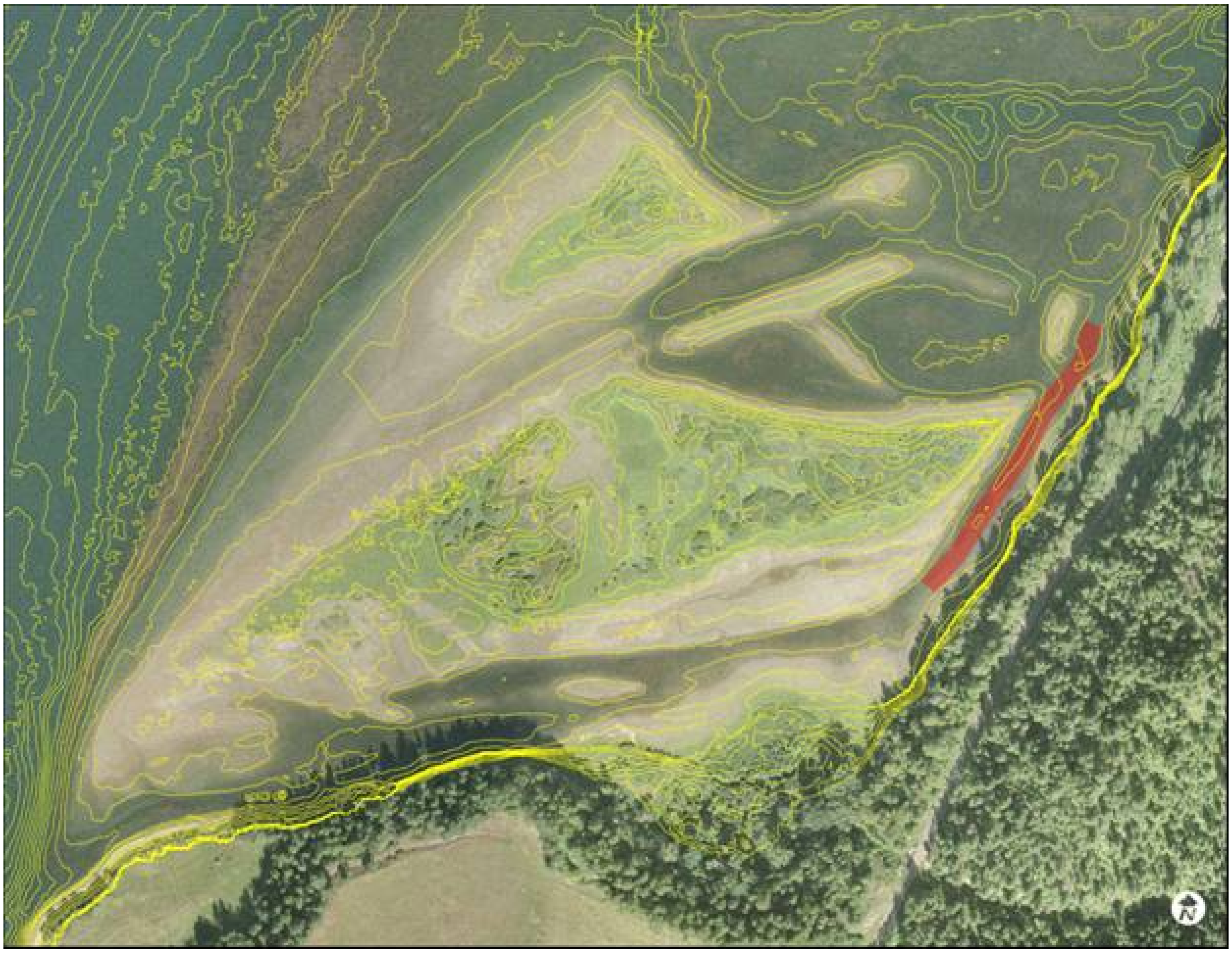


Figure 3.2-3. Proposed location of macrophyte bottom barrier Fish Stranding and Trapping Region 9 (PRM 28.8). Area shown in red indicates the proposed location of the bottom barrier.

Figure 3.2-4. Proposed location of macrophyte bottom barrier Fish Stranding and Trapping Region 11 (PRM 30.3). Area shown in red indicates the proposed location of the bottom barrier.

3.2.2. Boat Ramp Macrophyte Control Locations

In addition to the sites identified in Section 3.2.1, SCL will evaluate whether macrophyte suppression is needed at the Forebay Recreation Area and/or the Metaline Waterfront Park boat launches following proposed modifications to these areas, as outlined in SCL's Recreation Resources Management Plan (RRMP). In the third year following the completion of boat launch modifications at these sites, SCL will conduct annual surveys from a boat to monitor site conditions and, in consultation with the WQWG and FAWG, and subject to agreement by Ecology, determine whether macrophytes have reestablished to a degree requiring implementation of suppression measures. The approximate areas to be surveyed (and treated, as necessary) in the Forebay Recreation Area and the Metaline Waterfront Park boat launches are identified in Figures 3.2-5 and 3.2-6. Reestablishment of any non-native invasive macrophytes will trigger implementation of suppression measures as described in Section 3.6. If suppression measures are necessary at the Metaline Waterfront Park boat launch, bottom barriers will be used. Because of the risk of a dislodged bottom barrier becoming impinged on the forebay trashrack or being entrained into the power plant unit intakes, bottom barriers will not be installed at the Forebay Recreation Area. Measures to be considered for use in the Forebay Recreation Area include hand pulling or mechanical harvest and removal.

3.2.3. Additional Potential Macrophyte Control Locations

In addition to the four target locations (Section 3.2.1) and the Boundary Forebay and Metaline Waterfront Park boat ramps (Section 3.2.2), SCL will suppress the abundance of invasive aquatic macrophytes at up to three additional locations (for a maximum total area of 50,000 square feet) in the Project area where they are likely to increase fish stranding and trapping or interfere with recreational boating, as determined appropriate by the WQWG and FAWG following license issuance. During the term of the license, the WQWG and FAWG may also choose to discontinue suppression at any of the seven locations identified in Section 3.2.1 and in this section, in favor of other locations of the same approximate area, if deemed appropriate by the WQWG and FAWG. Macrophyte suppression methods to be applied at the three potential additional locations would consist, at least initially, of bottom barriers.

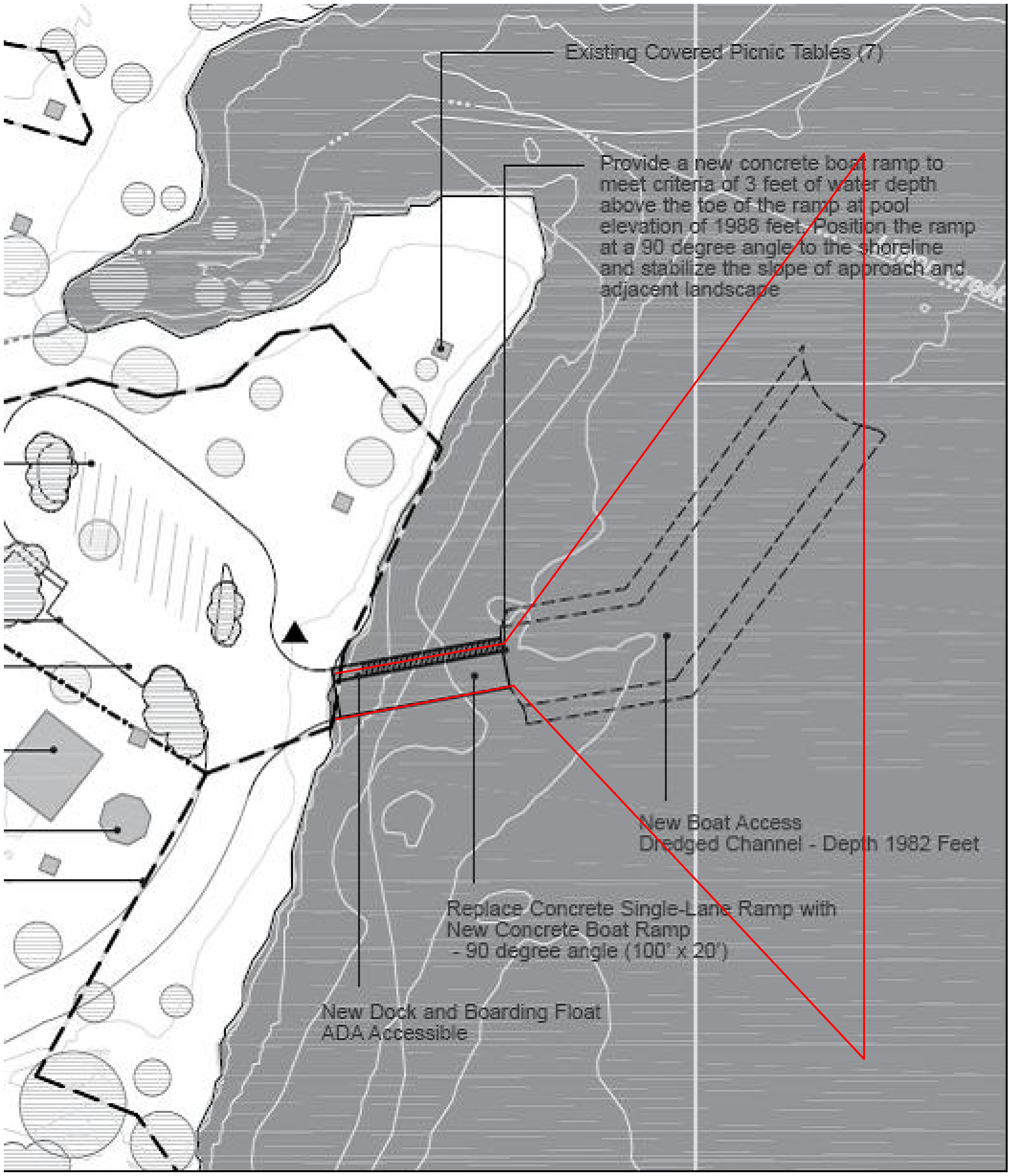


Figure 3.2-5. Proposed milfoil survey and potential treatment location for the Metaline Waterfront Park boat ramp area.

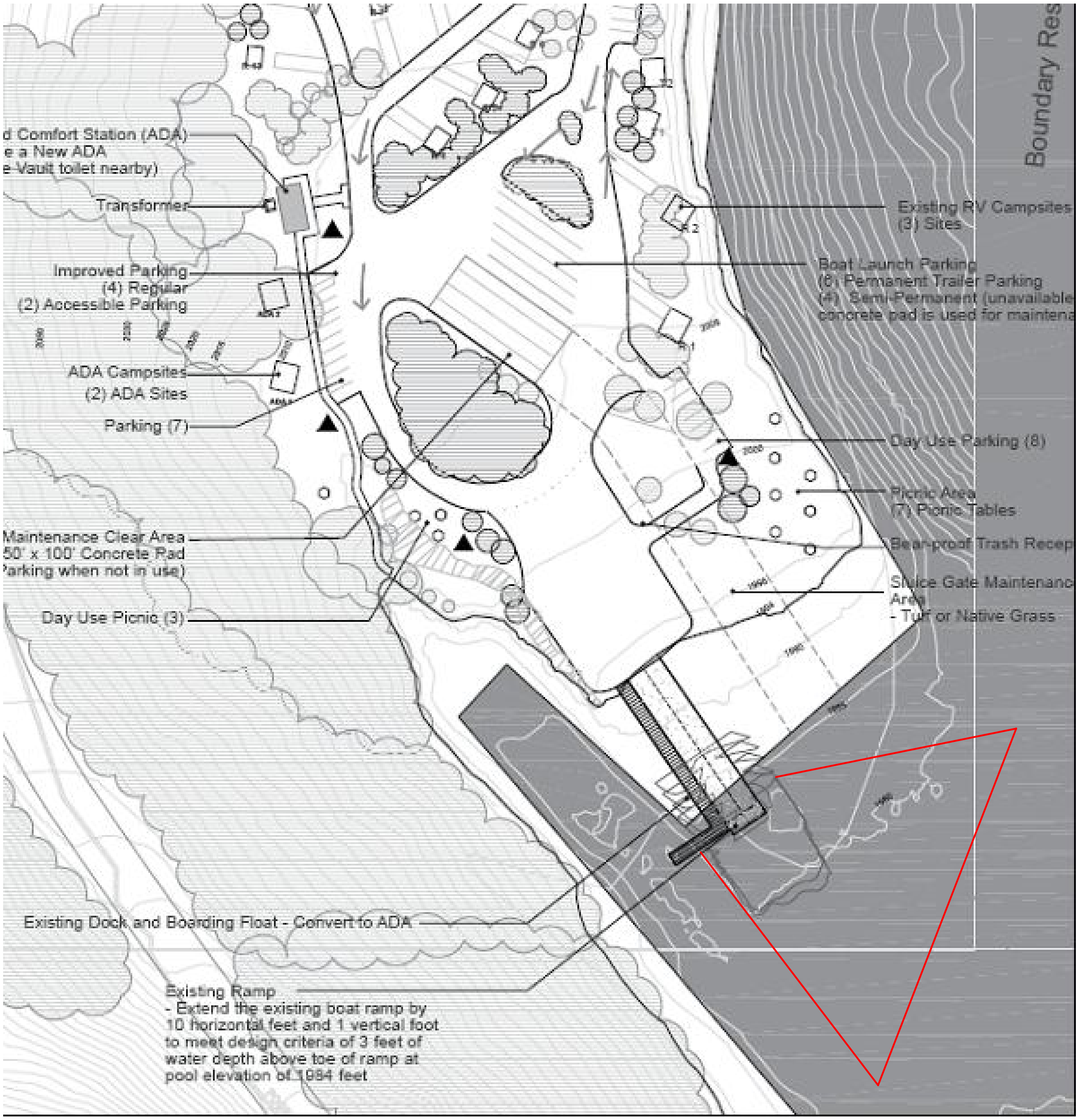


Figure 3.2-6. Proposed milfoil survey and potential treatment location for the Forebay Recreation Area boat ramp.

3.3. Bottom Barrier Material and Deployment Methods

SCL plans to use burlap as the bottom barrier material. Burlap is preferable to commercially available vegetation barrier material, which will not degrade and must be actively removed. Burlap will be effective during the first two years following installation, partially effective in the third and fourth years, and then require replacement after five years (Harry Gibbons, personal communication, June 2009). Bottom barriers will be replaced as soon as feasible if and when monitoring results exceed thresholds identified in Section 3.7. Because burlap is porous, it will allow fluids and gases to escape and rise to the surface, thereby reducing the degree to which gases produced by decomposing macrophytes will accumulate under the barrier and cause it to "balloon" upwards. Burlap is available in 20-foot-wide rolls that can be placed by hand (wading or diving), without the use of equipment.

Bottom barriers will be deployed in identified areas when reservoir levels are drawn down as part of daily operations, either by crews unrolling the material from shore or by divers in areas too deep to allow for shore-based installation. The maximum depth of installation will likely be about 20 feet, although actual depth will be determined by the goal of the placement and site conditions.

It is critical that bottom barriers be anchored securely to the reservoir bottom, because poorly secured barriers not only lose their effectiveness by allowing plant growth to take place, they can also create navigation hazards and be dangerous to swimmers. The barriers will be weighted down with sandbags made of burlap tied with natural fiber twine. Barriers will be oriented to reduce the risk of their being lifted during higher flows and transported downstream. Barriers will be checked monthly to ensure that they remain securely anchored to the reservoir bottom. If observer safety could be compromised due to reservoir or weather conditions, or the reservoir's surface in the area of the barrier is iced over for the entirety of a given month, checking the bottom barrier could be postponed until the following month.

3.4. Timing of Bottom Barrier Installation

Bottom barriers will be installed following spring runoff. The goal will be to install the bottom barriers as soon as possible after runoff, given ambient conditions, to reduce the amount of organic matter decomposition that occurs beneath the barriers. The greater the amount of organic matter breakdown, the more gas is produced under the barriers (King County 2003); the less plant material present prior to barrier installation, the more successful the barrier will be in staying in place (although burlap will allow for the escape of gas, see Section 3.3). Barriers will not be removed but will be allowed to breakdown (See Section 3.3). Barriers will be replaced as soon as feasible if and when monitoring results exceed thresholds identified in Section 3.7.

3.5. Permits

Installation of bottom barriers in the State of Washington requires applicable permit approvals. SCL will file a Joint Aquatic Resources Permits Application (JARPA) prior to installation of bottom barriers.

3.6. Monitoring Macrophyte Response to Control Measures

Verification of barrier effectiveness will begin during the first year that barriers are installed and continue for the duration of the license term. It is anticipated that macrophyte suppression will be nearly complete beneath the bottom barriers. At the four bottom barrier sites identified in Section 3.2.1, the criterion for evaluating success will be a 70 percent reduction in the abundance of macrophytes and appropriate fish passage, assessed by estimating the area of macrophytes on top of or protruding through a barrier. Redeployment of a bottom barrier will be undertaken if submerged aquatic macrophytes cover more than the 30 percent of the surface area of the barrier (either growing on top of or through the barrier), or if macrophyte coverage is less than 30 percent of the surface area of the barrier and macrophytes growing on or through the barrier surface have reached the water surface at any pool elevation and are present in a density that is impeding fish passage.

At boat ramp locations identified in Section 3.2.2, the target for evaluating success will be a 100 percent reduction in the abundance of non-native invasive macrophytes, assessed by estimating the area of macrophytes within the areas identified in Figures 3.2-5 and 3.2-6 adjacent to the boat ramps during annual surveys. Surveys will occur following the establishment of macrophytes (March/April) and the cessation of spring runoff. The particular area of treatment will be determined through consultation with the WQWG and the FAWG and subject to approval by Ecology. Elimination of non-native invasive macrophytes will occur once per year immediately following the annual survey, if these macrophytes cover any of the surface area surveyed.

New barriers will be placed on top of old barriers, which, because they will be burlap, will decompose in the reservoir. Barriers will only be removed if treatment is no longer deemed necessary at a given location. Effectiveness monitoring will be accomplished during the barrier maintenance trips identified in Section 3.3.

3.7. Other Potential Macrophyte Control Measures

Suppression of invasive submerged aquatic macrophytes will be addressed adaptively. Adaptive management will allow for changes in the way in which bottom barriers are deployed or, possibly, the integration and use of alternative methods of macrophyte control in the areas designated in Section 3.2. At annual meetings of the WQWG (see Section 6), SCL, in consultation with WQWG and FAWG participants, will assess the success of bottom barrier deployment and the potential use of other macrophyte control technologies, including harvesting, if barrier performance is deemed inadequate. Alternative measures will be considered at the sites identified in Section 3.2 only if they are feasible from the standpoint of safety and logistics and do not have the potential to permanently or significantly jeopardize fish and aquatic resources or water quality. In addition, SCL will remain apprised of any advances in macrophyte suppression methods by participating in information exchanges and regional efforts to coordinate the monitoring, prevention, and control of invasive aquatic macrophytes.

4 MONITORING FOR INVASIVE AQUATIC SPECIES

As noted in Section 2.1, zebra and quagga mussels are not currently found in the state of Washington (Benson 2009a, 2009b), and although New Zealand mudsnails have been introduced to the Columbia and Snake rivers, as well as Kalispell Creek, their presence has not yet been documented in the Pend Oreille River. The goals of the monitoring program will be to provide early detection whether any of these mollusk species becomes established in the Project area, so that an appropriate response can be planned in coordination with Ecology and other resource agencies.

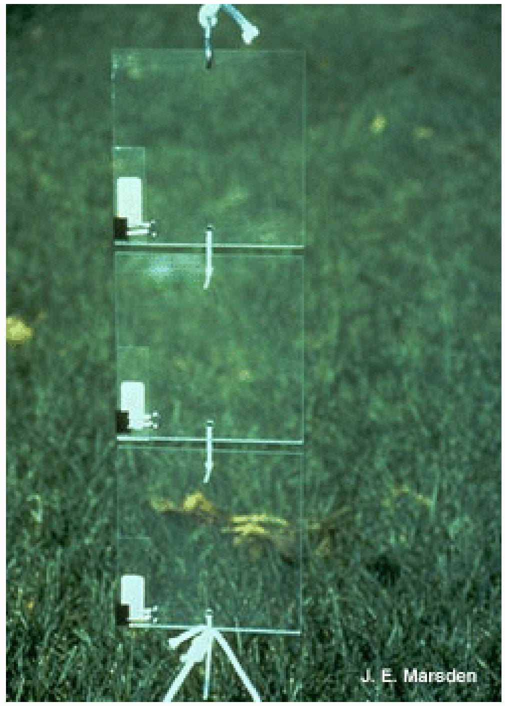
4.1. Monitoring for Zebra and Quagga Mussels

4.1.1. Substrate Sampling

The objective of this component of the monitoring program will be to detect zebra and quagga mussels if they become established in the Project area. To achieve this objective, SCL will install artificial substrate samplers at two 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 WQWG and FAWG, will coordinate with the Center for Lakes and Reservoirs at Portland State University to ensure that the proposed number of samples (up to two additional substrate sampling sites may be added, following license issuance, if deemed appropriate by the Center for Lakes and Reservoirs at Portland State University), design, placement, and monitoring regime associated with the artificial substrate samplers is appropriate. Figure 4.1-1 shows an artificial substrate used to sample for zebra mussels; a similar design, or one slightly modified to accommodate local conditions, will be used in Boundary Reservoir.

Artificial substrates will be concealed to prevent vandalism and located so that they do not interfere with boat traffic or other recreational activities. SCL will deploy the artificial substrates in April and retrieve them in October of each year. Samplers will be checked once per month during this period for signs of mussel colonization. Any sessile bivalves attached to the artificial substrate will be placed in a plastic bag and stored in the refrigerator. Specimens will be sent to the Center for Lakes and Reservoirs, Portland State University for identification.

In addition to data gathered from the artificial samplers, field crews will opportunistically inspect, during the monthly checks of the artificial substrates, hard structures in the vicinity of the boat launches, including, if present, floats, buoys, ropes, anchors, rocks, and logs. Again, any sessile bivalves attached to these surfaces will be placed in a plastic bag and stored in the refrigerator. Specimens will be sent to the Center for Lakes and Reservoirs at Portland State University for identification.



ZM-S28.	Plexiglass 15 cm square plates used to sample settling zebra larvae.
Photo Credit:	J. Ellen Marsden
Organization:	Lake Michigan Biological Station

Figure 4.1-1. Example of an artificial substrate for monitoring zebra/quagga mussel colonization.

4.1.2. Tow Sampling

SCL will conduct horizontal and vertical zooplankton tow net sampling for zebra and quagga mussel veligers. The goal of this sampling effort is early detection of zebra or quagga mussels in the Project area. The horizontal tow samples will be collected at three locations in the Project to represent inflow (below Box Canyon dam, PRM 34.3), outflow (Boundary forebay, PRM 17.6), and mid-reservoir (Metaline Pool area, PRM 28.7) locations. Samples will be taken once in each of the following months: June, July, and August (i.e., when conditions are suitable for mussel spawning and larval dispersal). Sampling will be conducted each year for the term of the new license, beginning in Year 1.

Sampling methods will follow those recommended by WDFW and Ecology as described by Grant PUD in its Priest Rapids Aquatic Invasive Species Control and Prevention Plan (Grant County PUD 2009). These methods include use of a Wisconsin plankton net (363μ mesh net) that is towed horizontally for a distance of 40-100 feet at a depth of approximately 20 feet at each location. The plankton net will be thoroughly rinsed and all sample material transferred into a 250 ml Teflon bottle and preserved immediately with 70 percent isopropyl alcohol. The samples will then be shipped to a certified laboratory for analysis and determination of veliger presence or absence.

SCL will also collect vertical tows that will sample the entire water column at each site. Methods for collecting vertical tow samples are almost identical to the horizontal tow sampling method as described above, except that samples will be taken from 3 feet above the bottom of the river up through the entire water column without drifting.

4.2. Monitoring for New Zealand Mudsnails

SCL will conduct New Zealand mudsnail surveys in the vicinities of two public 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, i.e., monthly from April through October of each year.

During each survey month, personnel (anticipated to be a single person) will locate an area of cobble/boulder substrate, wade along a 100-foot transect at a depth of approximately 2 feet, and at 10-foot intervals pick up five rocks ranging in size from 6 to 12 inches. All gastropods attached to the rocks, including the undersides of the rocks, will be collected. Three grab samples will also be taken from sand/silt substrate in the vicinity of each of the boat launches. The samples will be examined in the field for the presence of mudsnails. If any gastropods appear to be New Zealand mudsnails (the field person will have training so that he or she can ascertain whether a snail may be a mudsnail), they will be preserved in ethanol and sent to an approved laboratory for analysis (laboratory to be selected in consultation with Ecology and other members of the WQWG and FAWG).

4.3. Other Invasive Aquatic Species

Monitoring for invasive aquatic species will be addressed adaptively, that is, SCL will monitor for newly listed aquatic invasive species identified by Ecology or other appropriate invasive species committees. At annual meetings (see Section 6), WQWG and FAWG participants will have the opportunity to propose additional invasive aquatic species (beyond zebra and quagga mussels and New Zealand mudsnails) for monitoring. If these species are officially recognized as invasive aquatic species in the vicinity of the Project, and Ecology believes that monitoring for these species is warranted, SCL will develop appropriate monitoring protocols in consultation with the WQWG and FAWG, and SCL will implement the protocols, provided they are considered safe, cost effective, and logistically feasible, and do not have the potential to jeopardize fish and aquatic resources or water quality. In addition, SCL will remain up to date on aquatic invasive species introductions and developments associated with the methods of detecting and controlling such species by participating in information exchanges and regional efforts to coordinate monitoring, prevention, and control activities associated with invasive aquatic species. Should zebra or quagga mussels or New Zealand mudsnails or any other newly listed invasive species become established and problematic as determined by the WQWG and FAWG, SCL will consult with the workgroups to determine potential management strategies, which would include additional monitoring and reasonable and feasible control measures implemented by SCL consistent with regional control programs.

4.4. Rapid Response and Coordination

Through this AISCPP, SCL will implement monitoring programs that will help detect new aquatic invasive species infestations as soon as possible. In the event of identification of new invasive species within the Project area, SCL will conduct the following response activities:

- Immediate notification to Ecology (for plants) or WDFW (for animals) of possible new invasive species identified during monitoring. Digital photographs will be taken and sent to Ecology or WDFW for assistance in identification.

- SCL will coordinate with Ecology or WDFW to confirm aquatic invasive species identification.

- Upstream (Box Canyon Dam) and downstream (Seven Mile Dam) operators will be notified immediately if aquatic invasive species not previously identified in the Pend Oreille River system (e.g., zebra or quagga mussels) are found.

- If zebra or quagga mussels or New Zealand mudsnails are discovered in the Project area, SCL will evaluate potential control methods in coordination with regional invasive species control programs and in consultation with the WQWG and FAWG.

- SCL will coordinate with Ecology and WDFW to develop appropriate press releases to alert the public of any new aquatic invasive species.

- SCL will take reasonable and feasible steps, as determined in consultation with the WQWG and FAWG, to manage and/or contain the new aquatic invasive species, including providing assistance as needed for Ecology or WDFW site visits to confirm presence and determine extent of infestation, and coordinate with Ecology and WDFW to develop a further response, e.g., boat launch closures at launches under SCL's jurisdiction, if deemed necessary by Ecology and WDFW. Although SCL does not have the authority to deny entry to or exit from the reservoir by potentially infested boats or trailers, SCL will implement appropriate I&E measures to curtail the potential transfer of any new aquatic invasive species from the Project area to other waterbodies.

- SCL will conduct effectiveness monitoring to determine the success of aquatic invasive species management/containment actions implemented; coordinate with the WQWG and FAWG on monitoring results and discuss appropriate next steps to determine long-term monitoring and reasonable and feasible control efforts in coordination with the WQWG and FAWG during the annual workgroup meeting.

Figure 4.4-1 provides a summary of the rapid response steps in the event of an introduction of a new aquatic invasive species. The designated contacts are the Ecology 401 Certification lead and the WDFW Project Lead. A full list of contacts is provided in Table 4.4-1.

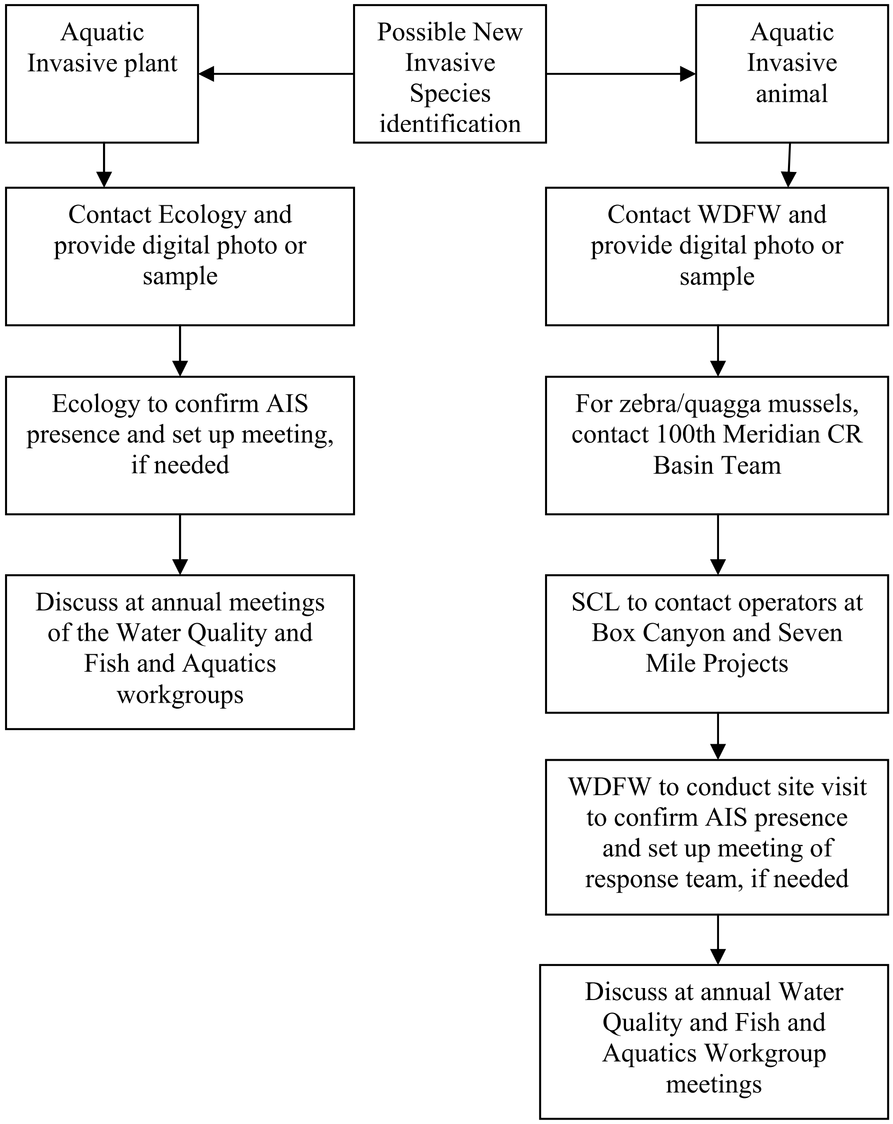


Figure 4.4-1. Aquatic invasive species rapid-response flowchart.

Table 4.4-1. Designated contacts in the event that a new aquatic invasive species is detected in the Project area.

Organization	Position	Address and Phone Number
Ecology	401 Certification Lead	Eastern Regional Office 4601 N. Monroe Spokane, WA 99205-1295 (509) 329-3529
	Aquatic Invasive Species Lead	Headquarters Office PO Box 47600 Olympia, WA 98504-7600 (360) 407-6000
WDFW	WDFW Project Lead	Eastern Regional Office 2315 North Discovery Place Spokane Valley, WA 99216-1566 (509) 892-1001
Pend Oreille County Noxious Weed Control Board	Noxious Weed Coordinator	PO Box 5085 Newport, WA 99156-5085 (509) 447-2402
100th Meridian Initiative: Columbia River Basin Team	Invasive Species Hotline	1-877-786-7267
Pend Oreille County PUD	Environmental Specialist	PO Box 190 130 N. Washington Newport, WA 99156 (509) 447-3137
BC Hydro	Environmental Specialist	6911 Southpoint Drive Burnaby, BC V3N 4X8 Canada (604) 224-9376

5 INTERPRETATION AND EDUCATION PROGRAM

SCL will implement an I&E program aimed at reducing the potential for the spread of invasive macrophyte and mollusk species (zebra and quagga mussels and New Zealand mudsnails). The goals and objectives of the I&E program and a description of how it will be administered are provided in SCL's RRMP).

The locations of I&E facilities and other media are critical to the success of the program. Specific sites within the Project area will be finalized based on their ability to support interpretation of the Project’s identified theme, subthemes, and messages. Preliminary I&E sign/kiosk sites are identified in the RRMP, Appendix 4, concept site plans. Signs or kiosks providing information on reducing the risk of invasive species dispersal will be installed at Project boat launches at the Forebay Recreation Area and Metaline Waterfront Park. Other media related to invasive species, i.e., brochures and possibly maps, will be available at the Vista House, Tailrace, and Forebay recreation areas, community information centers in Metaline and

Metaline Falls, and possibly at regional tourism/information centers and Scenic Byway portal sites. I&E costs are addressed in the RRMP.

The design and content of the signs, including exact wording, will be finalized by SCL following issuance of the new license in consultation with the WQWG, the FAWG, and the Pend Oreille County Noxious Weed Control Board. Potential text for I&E signs related to preventing dispersal of invasive species is provided below. In addition to the following recommendations, the sign should include photographs of zebra and quagga mussels, New Zealand mudsnails, and Eurasian watermilfoil, possibly including a boat hull or other piece of equipment infested with mussels.

- Please take precautions to avoid the dispersal of invasive species between and within water bodies.
  - Your actions can help prevent the introduction of invasive zebra mussels, quagga mussels, and New Zealand mudsnails to the Pend Oreille River.
  - Please take precautions to avoid dispersing Eurasian watermilfoil within Boundary Reservoir and transporting it to other locations where it has not yet become established.
- When removing your boat from the water from any water body/before launching it in any other water body:
  - Inspect all exposed surfaces - small mussels feel like sandpaper to the touch.
  - Wash the hull of each watercraft thoroughly.
  - Remove all plant and animal material from your boat, trailer, fishing gear, or any other equipment.
  - Drain all water and dry all areas.
  - Drain and dry the lower outboard unit.
  - Clean and dry all live-wells.
  - Empty and dry any buckets.
  - Dispose of all bait in the trash.
  - Keep watercraft dry between launches into different fresh waters.
  - Report suspected mussels or mudsnails to the Washington Department of Fish and Wildlife 1-888-933-9247
- While in the water:
  - Avoid breaking up milfoil with boat propellers or other gear, as fragments of the plant can colonize areas where milfoil is not yet established.
  - Be particularly cautious operating jet skis in shallow or slow-water areas where milfoil tends to grow.

6 WATER QUALITY WORKGROUP

Administering the AISCPP is expected to require one meeting per year of the Water Quality Workgroup, to discuss the outcome of the year's field activities and plan the following spring's activities. In addition to the meetings, site visits may be needed at times. Preparation for meetings will include conducting verification mapping in areas where bottom barriers are to be installed or reinstalled, summarization of any relevant field data, and photography needed to document progress or difficulties being encountered in the field. Each year, SCL, in consultation with the WQWG and FAWG, will determine whether any changes to the AISCPP may be warranted. If changes are agreed to by SCL and Ecology, SCL will revise the AISCPP and submit it to the workgroup before the spring implementation efforts occur. Representatives of the FAWG will be invited to attend meetings of the Water Quality Workgroup and review sections of the AISCPP that pertain to the control of invasive submerged macrophytes.

7 ADAPTIVE MANAGEMENT

This AISCPP describes adaptive management provisions to be implemented in coordination with the WQWG as summarized below:

- SCL will hold one meeting a year with the WQWG and FAWG to discuss the outcome of the year's field activities and plan for the following spring's field efforts.
- Verification monitoring of macrophyte beds will occur within two years following the license to confirm exact placement of bottom barriers in the four general areas identified in Section 3.2.1 in consultation with the WQWG and FAWG.
- Once bottom barriers are placed, monthly monitoring will occur, with reports on effectiveness provided annually to the WQWG and FAWG.
- Annual monitoring and macrophyte control measures at the boat launch locations identified in Section 3.2.2 will be implemented three years following completion of boat launch upgrade construction activities identified in the RRMP.
- At the annual meeting, SCL, in consultation with the WQWG and FAWG, will determine whether any changes to the AISCPP may be warranted.
- Site visits with the WQWG and FAWG will be conducted as necessary to review effectiveness and/or issues with treatment locations or methods identified in this AISCPP.
- The Rapid Response and Coordination Protocol described in Section 4.4 will be used in the event that new invasive species are identified through monitoring efforts in the Project area.

8 IMPLEMENTATION SCHEDULE

Within six months of the issuance of the new Project license, SCL will submit a Quality Assurance Project Plan (QAPP), which will include a schedule for conducting macrophyte verification mapping, to Ecology for approval.

Bottom barriers will be installed at the locations identified in Section 3.2 after spring runoff of the third year following license issuance, following completion of verification mapping. Barriers will be maintained and replaced, as described in sections 3.3 and 3.4, over the term of the new license or until their use is discontinued by Ecology and the WQWG and the FAWG.

Monitoring for zebra and quagga mussels and New Zealand mudsnails will commence during April of the first year following Ecology's approval of the QAPP and continue for the term of the new license or until discontinued by Ecology and the WQWG and FAWG.

The implementation schedule for the I&E program is provided in the RRMP.

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Appendix 1: Maps of Macrophyte Bed Locations

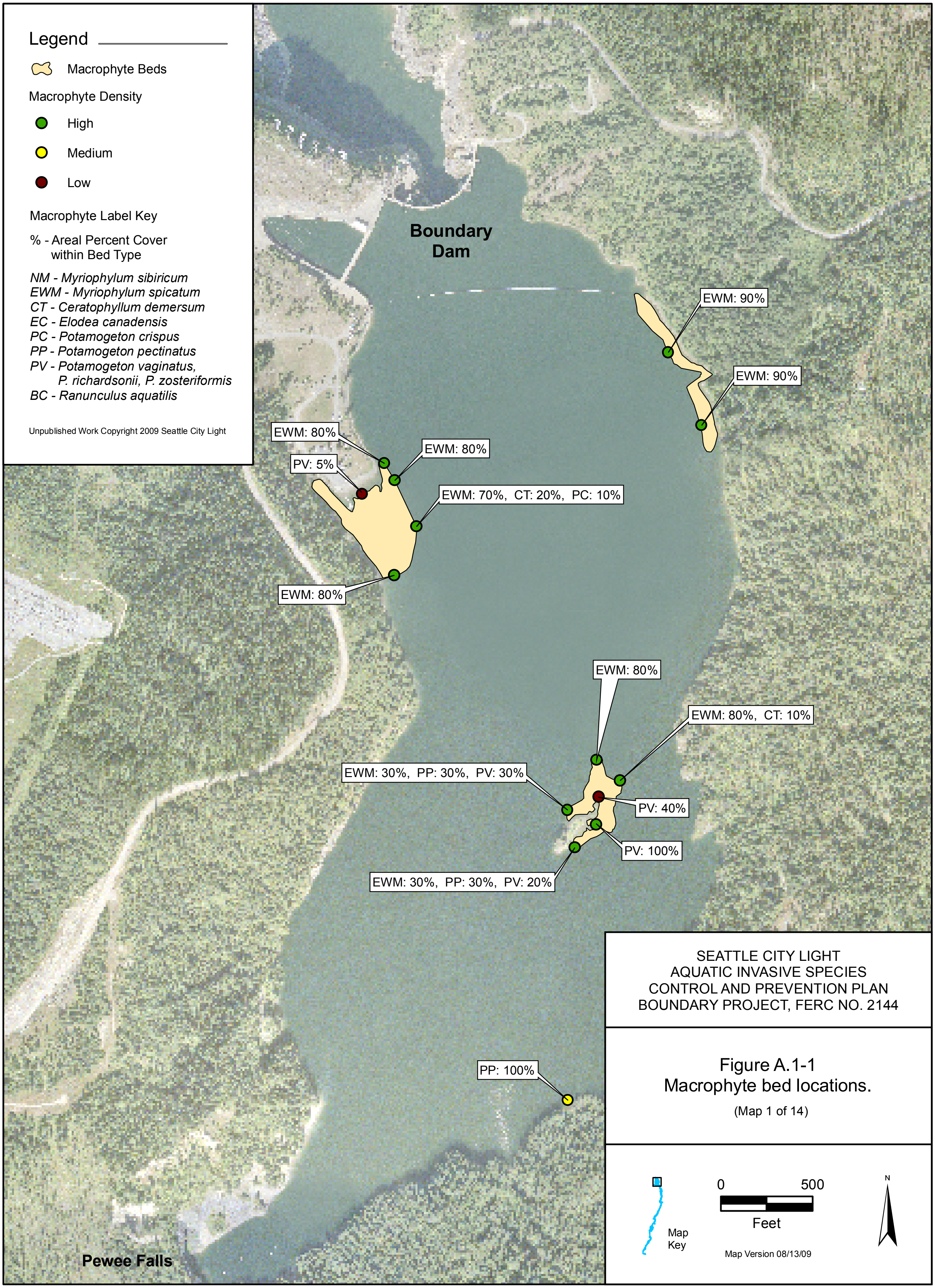
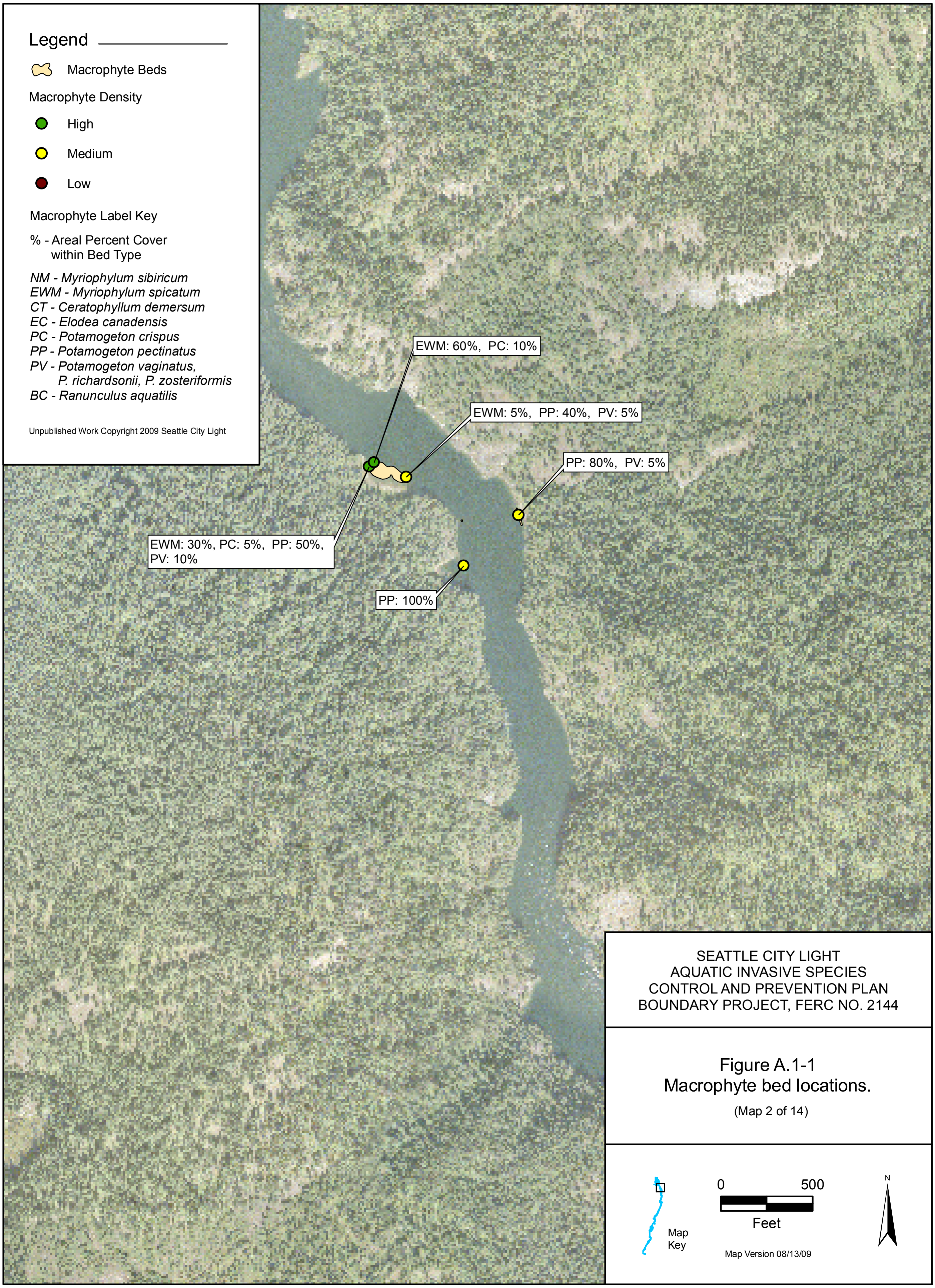


Figure A.1-1
Macrophyte bed locations.
(Map 1 of 14)



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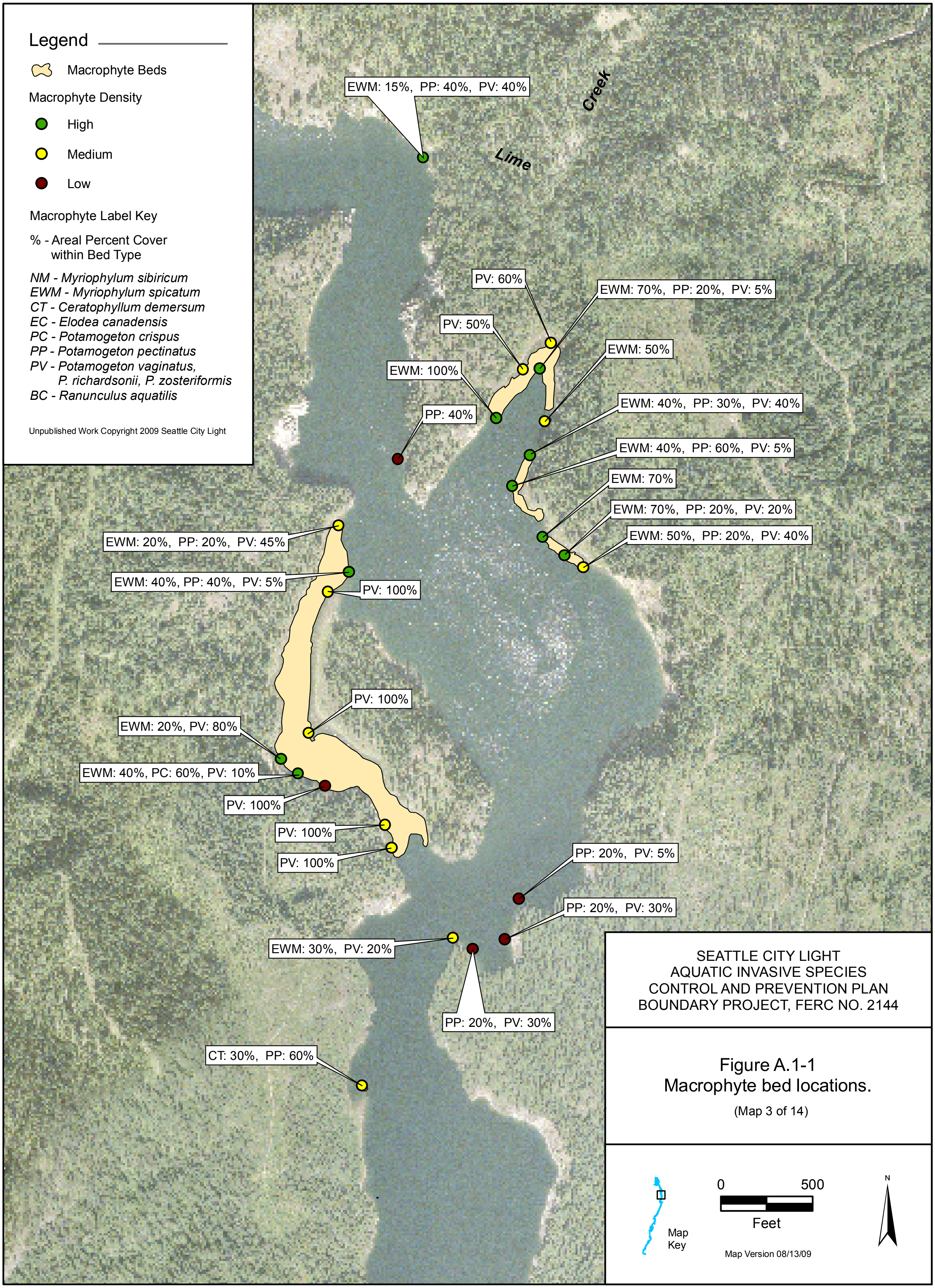
(Map 2 of 14)



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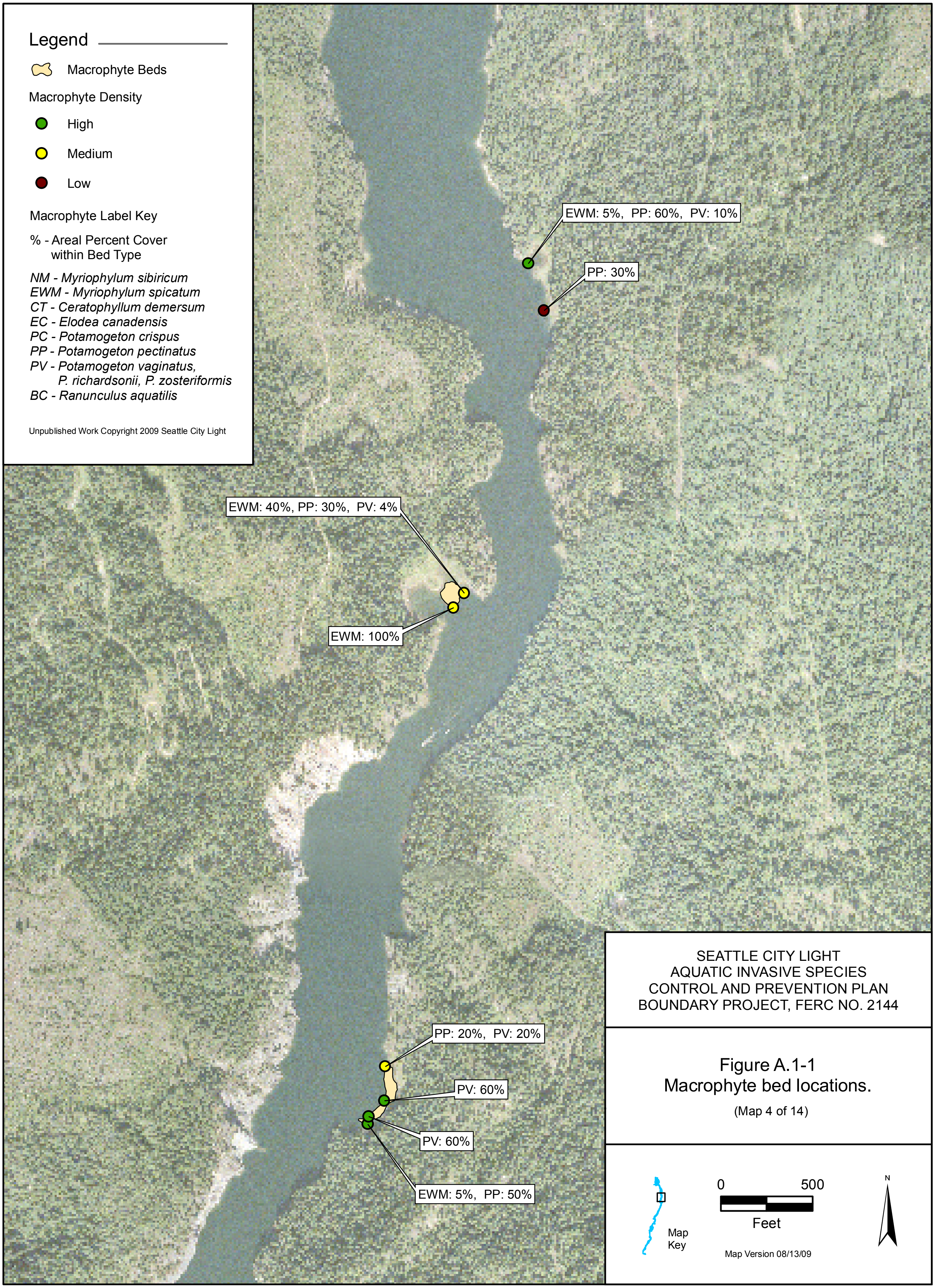
(Map 3 of 14)



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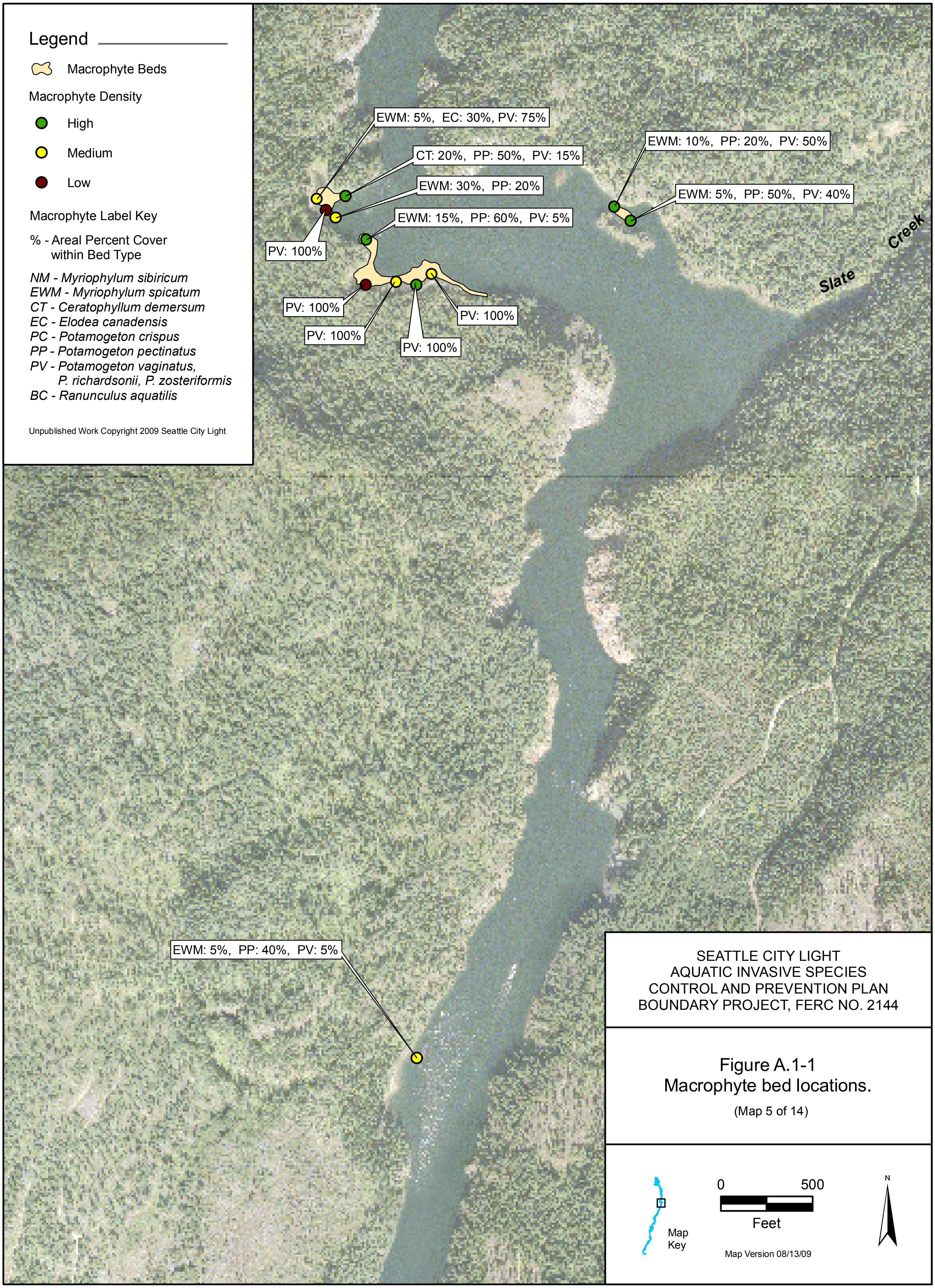
(Map 4 of 14)



SEATTLE CITY LIGHT
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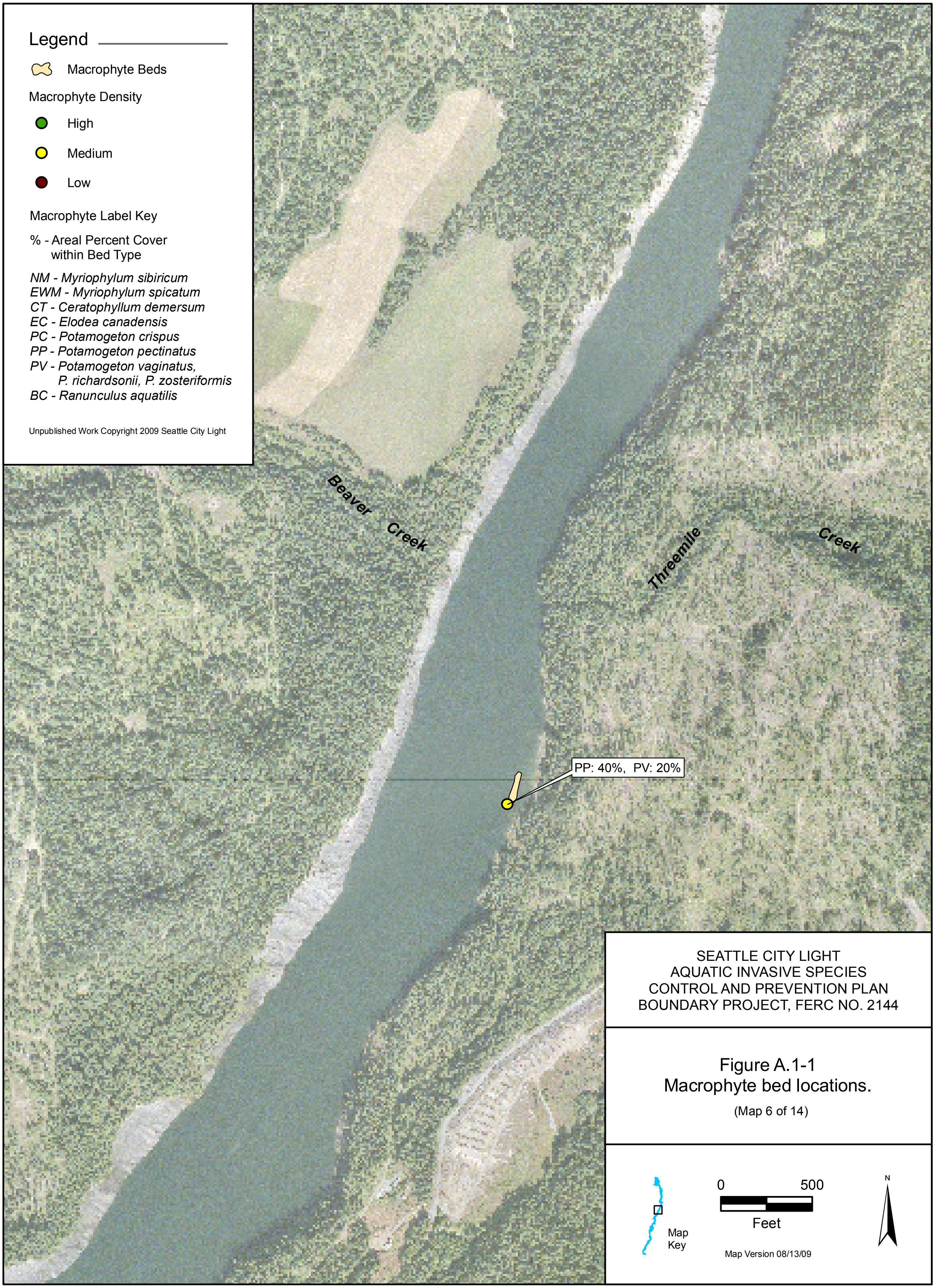
Figure A.1-1
Macrophyte bed locations.
(Map 5 of 14)



Legend
Macrophyte Beds
Macrophyte Density
High
Medium
Low
Macrophyte Label Key
% - Areal Percent Cover within Bed Type
NM - Myriophylum sibiricum
EWM - Myriophylum spicatum
CT - Ceratophyllum demersum
EC - Elodea canadensis
PC - Potamogeton crispus
PP - Potamogeton pectinatus
PV - Potamogeton vaginatus, P. richardsonii, P. zosteriformis
BC - Ranunculus aquatilis
Unpublished Work Copyright 2009 Seattle City Light
Beaver Creek
Threemile Creek
PP: 40%, PV: 20%
SEATTLE CITY LIGHT
AQUATIC INVASIVE SPECIES
CONTROL AND PREVENTION PLAN
BOUNDARY PROJECT, FERC NO. 2144
Figure A.1-1
Macrophyte bed locations.
(Map 6 of 14)
Map Key
0
500
Feet
Map Version 08/13/09
N

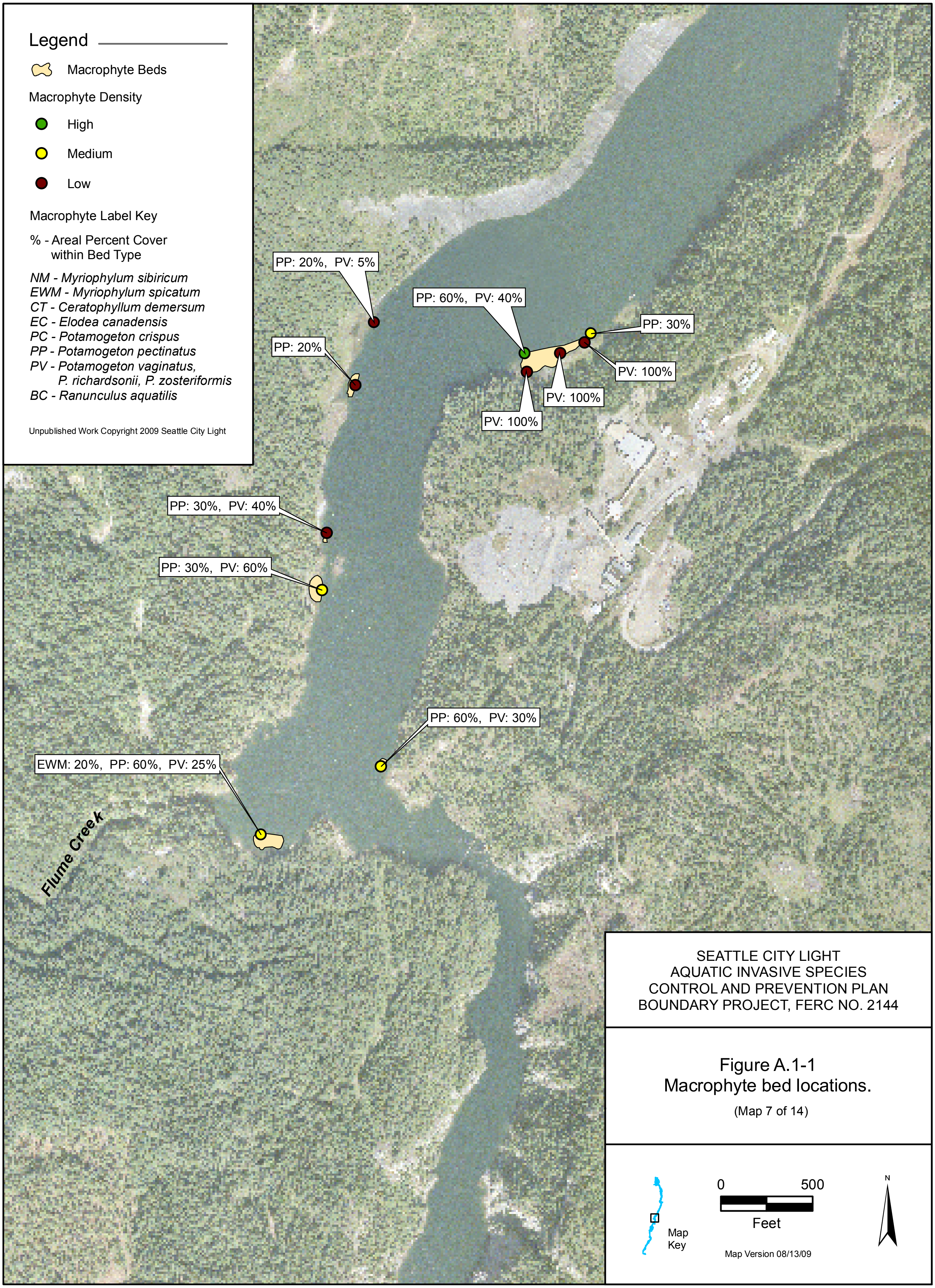
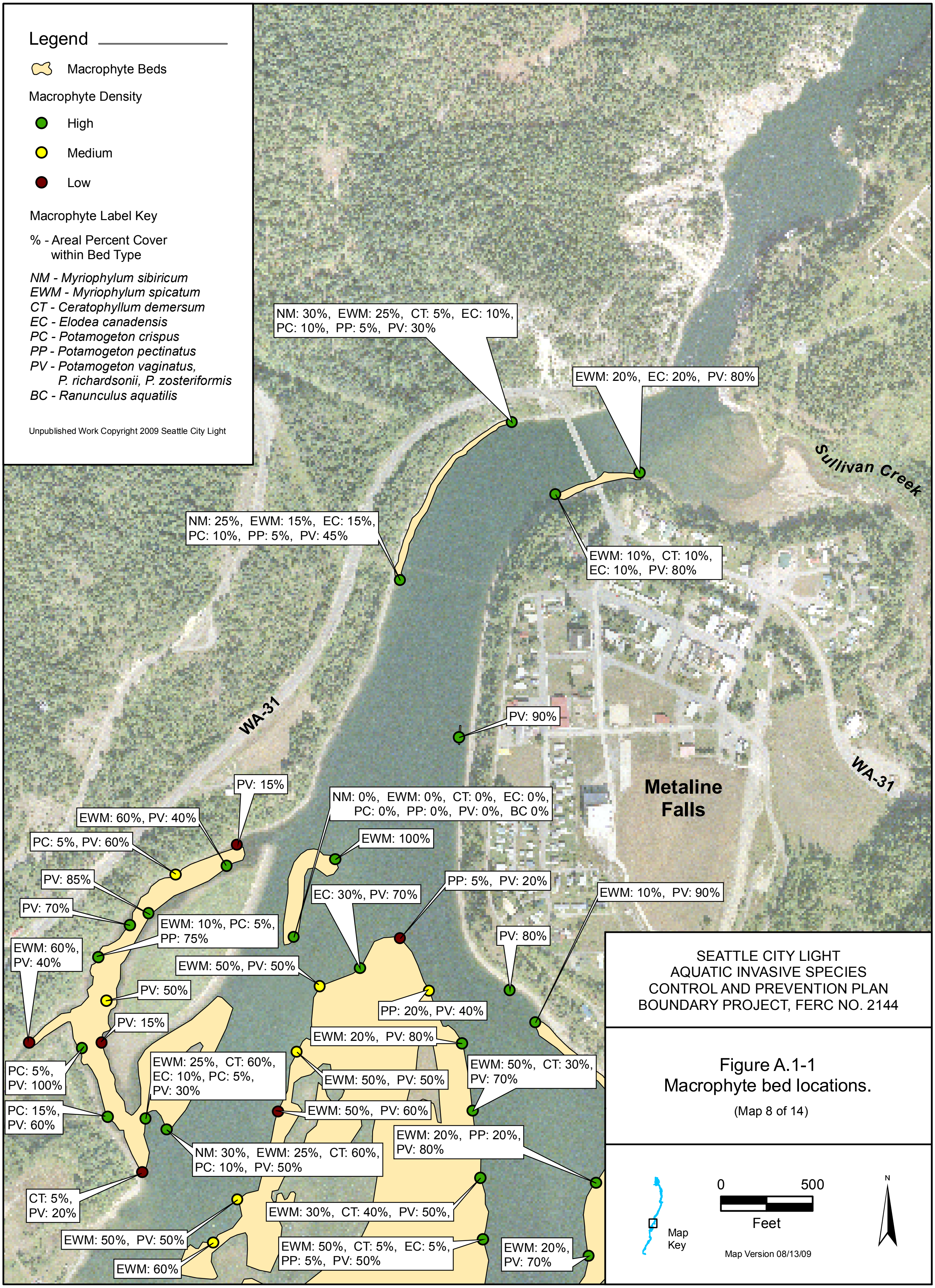


Figure A.1-1
Macrophyte bed locations.
(Map 7 of 14)



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CONTROL AND PREVENTION PLAN
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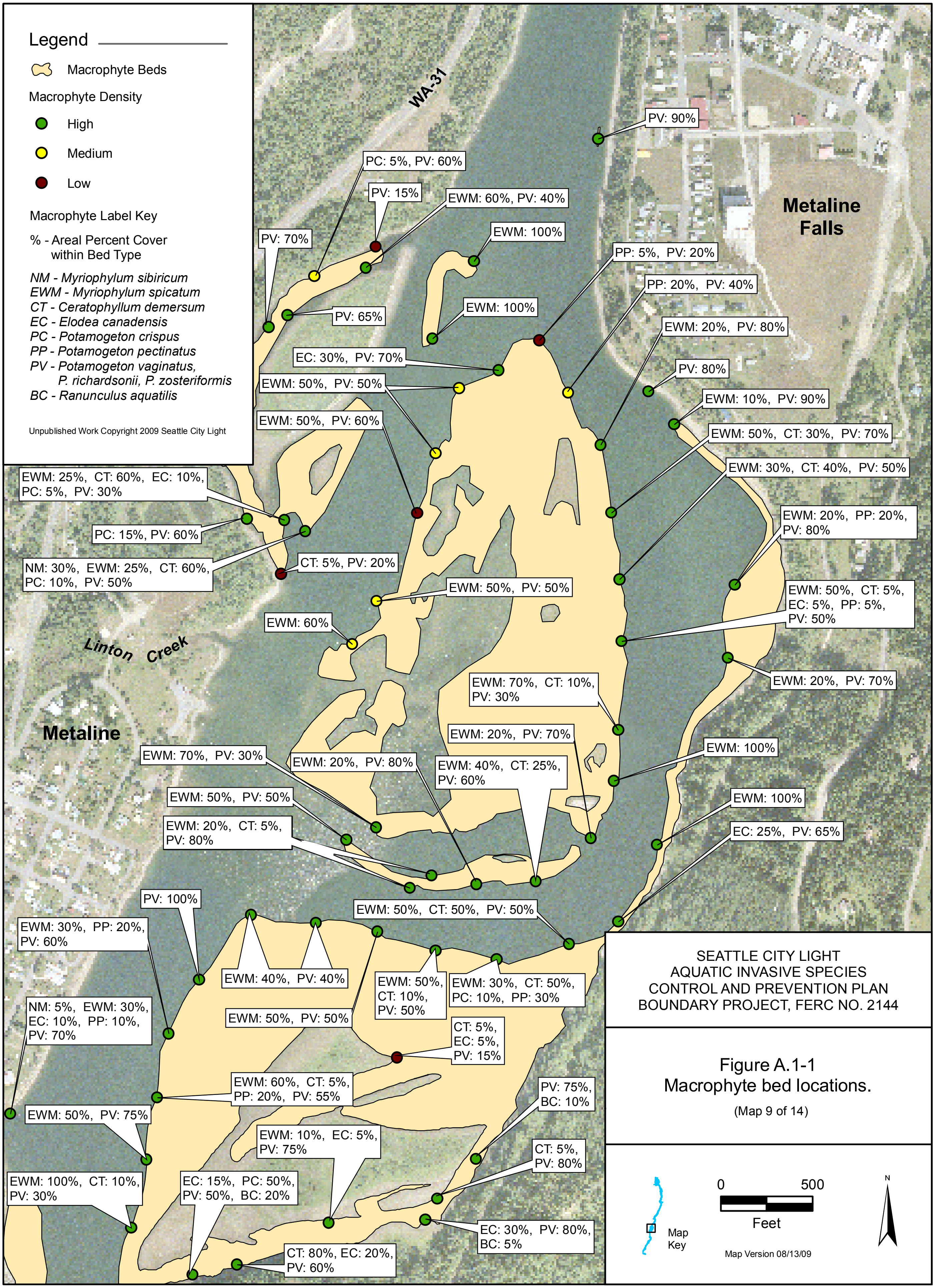
Figure A.1-1
Macrophyte bed locations.
(Map 8 of 14)



SEATTLE CITY LIGHT
AQUATIC INVASIVE SPECIES
CONTROL AND PREVENTION PLAN
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Figure A.1-1
Macrophyte bed locations.
(Map 9 of 14)

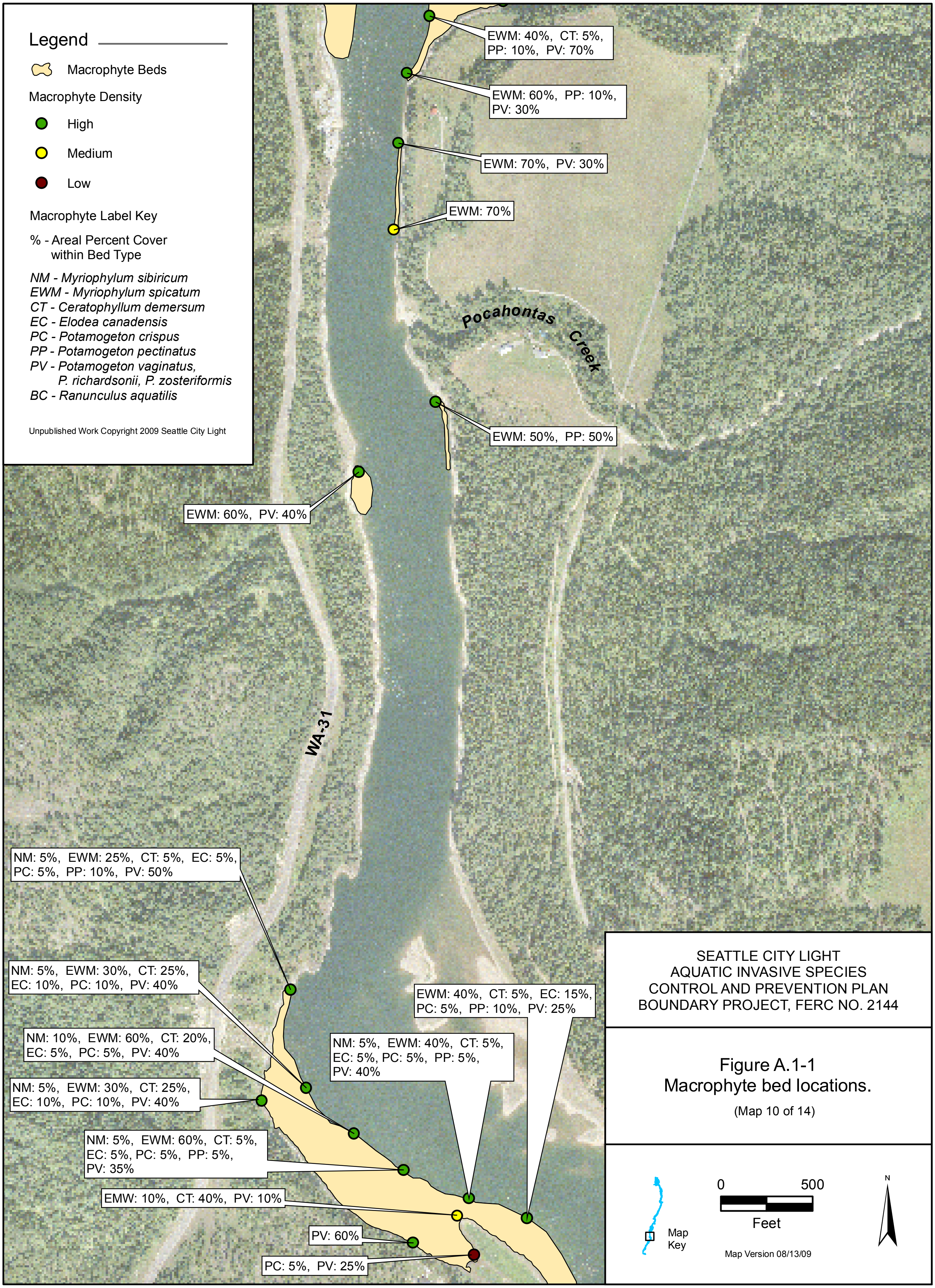

Figure A.1-1
Macrophyte bed locations.

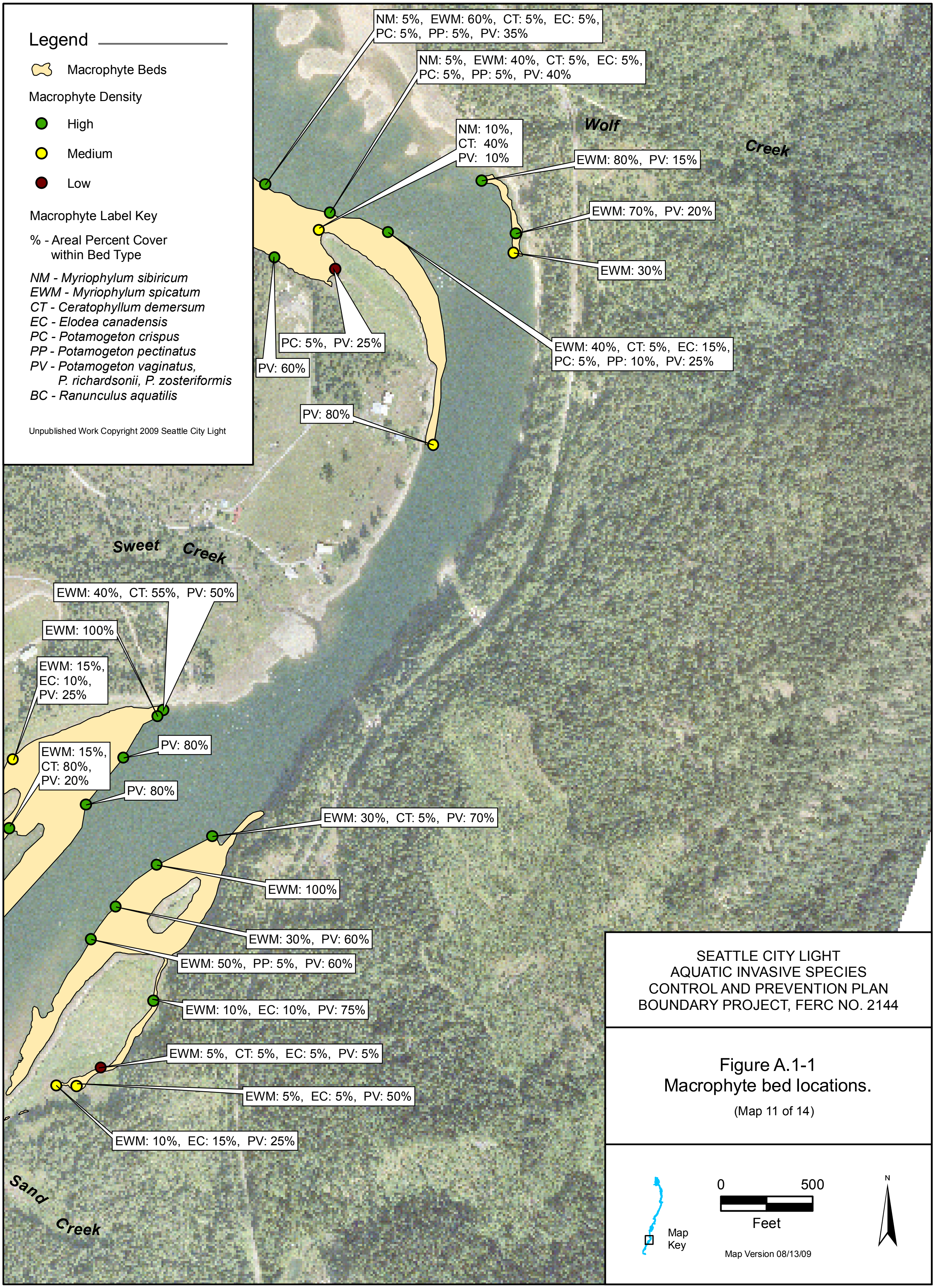

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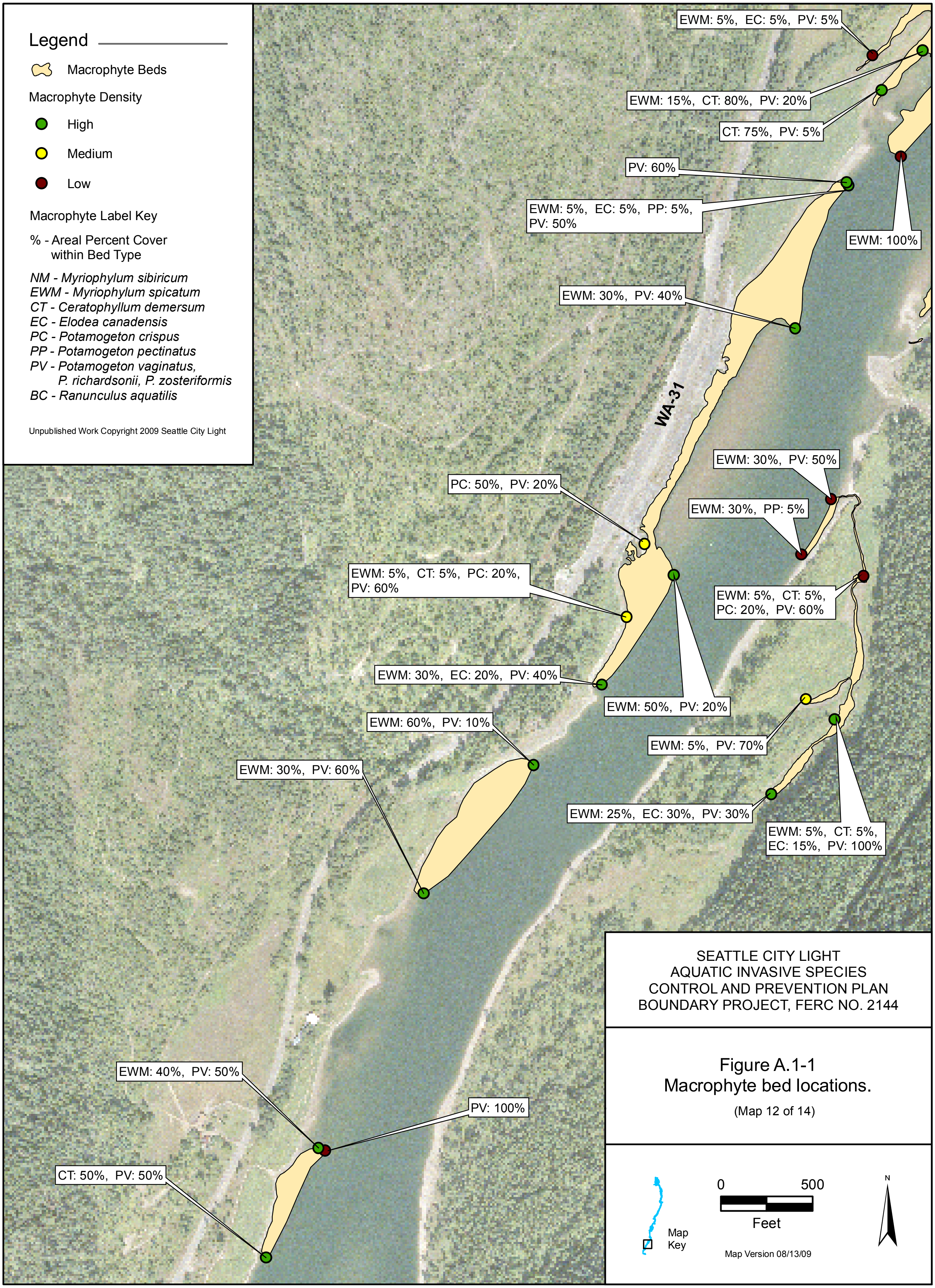
Figure A.1-1
Macrophyte bed locations.
(Map 11 of 14)



SEATTLE CITY LIGHT
AQUATIC INVASIVE SPECIES
CONTROL AND PREVENTION PLAN
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Figure A.1-1
Macrophyte bed locations.
(Map 12 of 14)

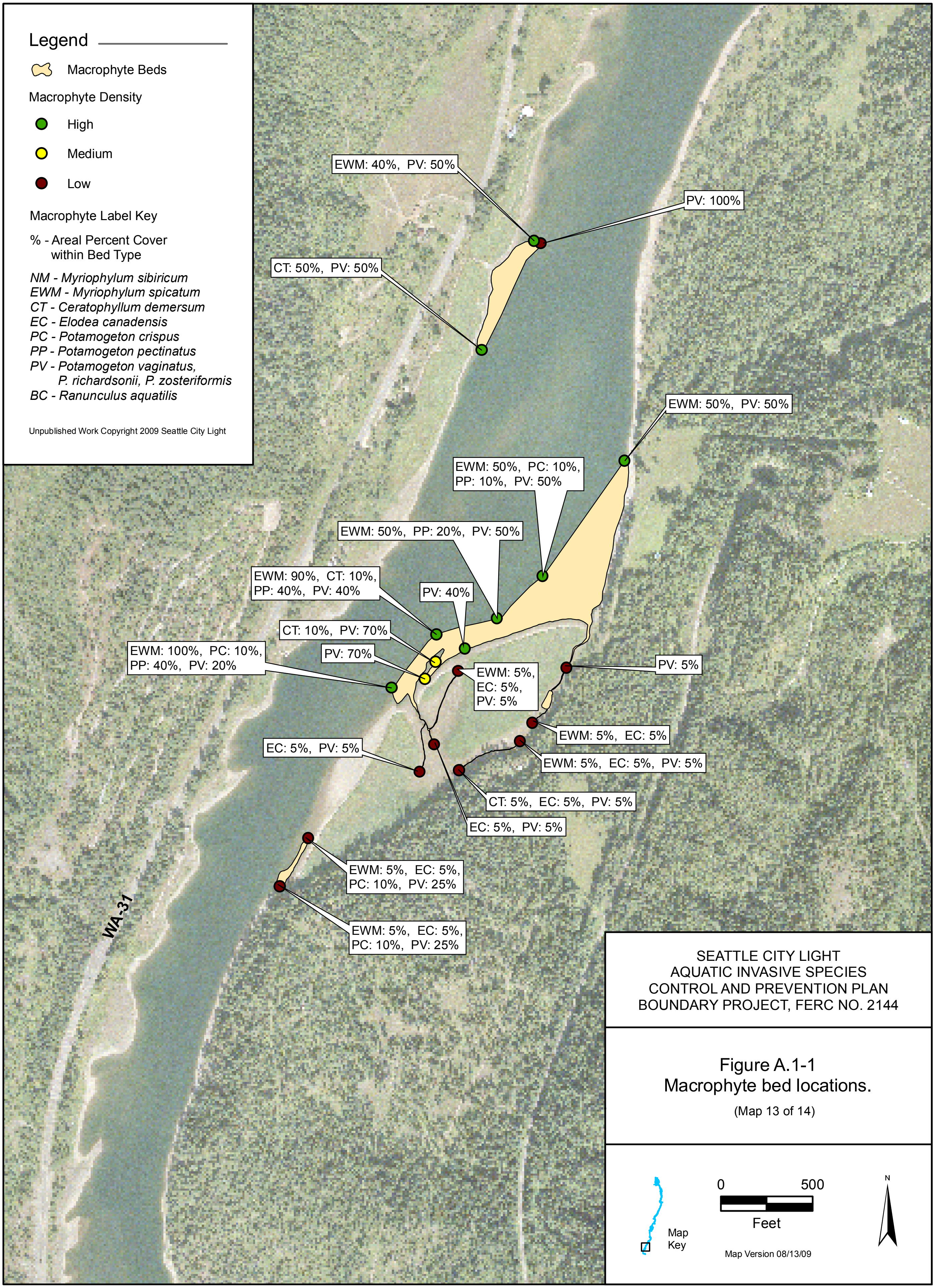
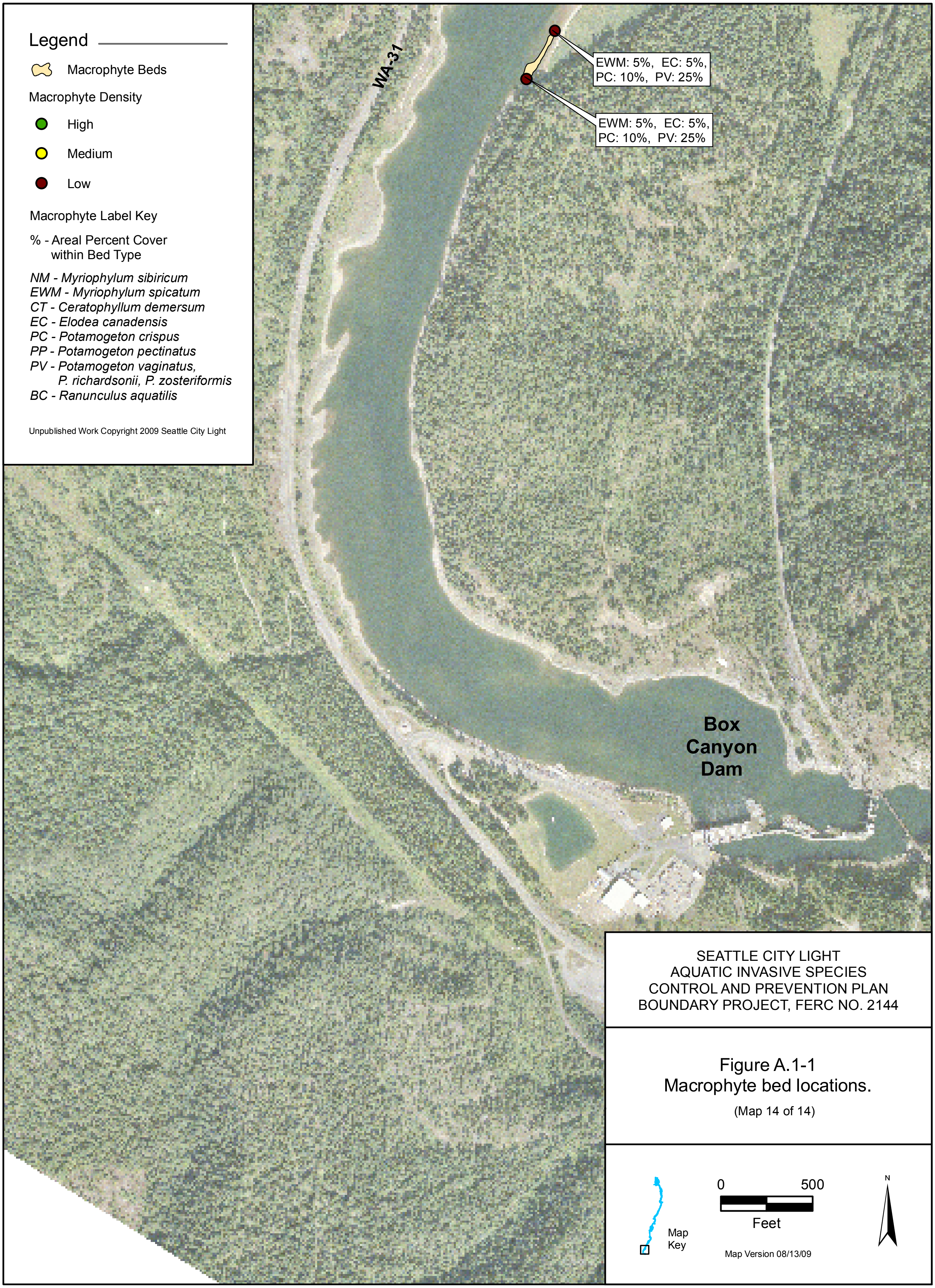


Figure A.1-1
Macrophyte bed locations.
(Map 13 of 14)


Legend
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BC - Ranunculus aquatilis
Unpublished Work Copyright 2009 Seattle City Light
WA-31
EWM: 5%, EC: 5%, PC: 10%, PV: 25%
EWM: 5%, EC: 5%, PC: 10%, PV: 25%
Box Canyon Dam
SEATTLE CITY LIGHT
AQUATIC INVASIVE SPECIES
CONTROL AND PREVENTION PLAN
BOUNDARY PROJECT, FERC NO. 2144
Figure A.1-1
Macrophyte bed locations.
(Map 14 of 14)
0
500
Feet
Map Key
Map Version 08/13/09
N

Boundary Hydroelectric Project (FERC No. 2144)

Total Dissolved Gas Attainment Plan

Seattle City Light

August 2011

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List of Acronyms and Abbreviations

7Q10	Average peak annual flow for 7-consecutive-days with 10-year recurrence interval
ADV	Acoustic Doppler Velocimeters
CEII	Critical Energy Infrastructure Information
cfs	cubic feet per second
CFD	Computational Fluid Dynamics
CWA	Clean Water Act
Ecology	Washington Department of Ecology
FERC	Federal Energy Regulatory Commission
FMS	Fixed Monitoring Station
O&M	Operations and Maintenance
PMF	Probable Maximum Flood
RSP	Revised Study Plan
SCL	Seattle City Light
STI	Supporting Technical Information
TDG	Total Dissolved Gas
TMDL	Total Maximum Daily Load
USGS	U.S. Geological Survey
WAC	Washington Administrative Code

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Attainment Plan for Total Dissolved Gas
Boundary Hydroelectric Project (FERC No. 2144)

1 INTRODUCTION

1.1. Regulatory Requirement

As part of the new license for the Boundary Hydroelectric Project (Project) FERC No. 2144, Seattle City Light (SCL) has this Total Dissolved Gas Attainment Plan (TDGAP) incorporated into the Washington Department of Ecology (Ecology) water quality certification. SCL's requirement under the water quality certification is "Identification of all reasonable and feasible improvements that could be used to meet standards, or if meeting the standards is not attainable, then to achieve the highest attainable level of improvement" (Ecology 2006). The state of Washington's water quality standard is 110 percent TDG saturation; however the standard is waived for conditions where incoming TDG is greater than that leaving the Project and for average peak annual flow exceeding the 7-consecutive-day, 10-year recurrence interval event (7Q10 event), which is approximately 108,300 cubic feet per second (cfs) for the Project (Ecology 2006).

The 7Q10 event can be put into context using the Pend Oreille River Annual Flow Duration (U.S. Geological Survey [USGS] gaging station 12396500), showing percent exceedance of approximately 0.5 percent (R2 Resource Consultants 2008) for the 7Q10 flow, which corresponds to an average occurrence of approximately 1.9 days per year based on the 1987 through 2005 period of record.

This document describes the attainment plan for TDG at the Project. SCL has been conducting spill tests and studies of TDG at the Project since 1999. These studies include a review of alternatives to determine potentially reasonable and feasible structural and operational improvements, and include actions already taken by SCL to test and implement TDG improvement measures. The results of efforts to date are reported in detail in the Evaluation of Total Dissolved Gas and Potential Abatement Measures (TDG Evaluation) Final Report (SCL 2009) and in the 2010 TDG Annual Report (SCL 2011). The next steps to be taken toward meeting the Ecology TDG standard include the following:

- Develop engineering plans to identify possible reasonable and feasible structural and operational improvements to meet standards;
- Use calibrated computer and physical models to test identified improvements;
- Select preferred improvement(s) for detailed design;
- Construct and implement prototype modifications at the Project;
- Monitor and test to assess success toward meeting predicted TDG performance goals;
- Refine ability to predict TDG performance of improvement(s); and,
- Implement additional possible structural and operational measures until TDG standard is met, or until all reasonable and feasible alternatives have been tested and implemented as appropriate.

Washington water quality standards allow a maximum of ten (10) years after issuance of the new Federal Energy Regulatory Commission (FERC) license and 401 water quality certification to achieve compliance.

Actions and TDG reduction goals described in this attainment plan will continue to progress and be implemented consistent with the Pend Oreille Total Dissolved Gas Total Maximum Daily Load (TMDL) Water Quality Improvement Report (Ecology 2007).

1.2. Phases of TDG Activities

The history and future of TDG activities at the Project can be summarized as follows:

- TDG analysis prior to 2007 initiation of relicensing studies
- Relicensing Studies (TDG Evaluation Final Report [SCL 2009])
  - Literature search
  - Field studies
  - Comparative analysis of possible alternatives, resulting in a short list of three preferred alternatives
- 2010 TDG Annual Report (SCL 2011) describes recent use of engineering tools and other considerations to study specific alternatives:
  - Physical model
  - Computational Fluid Dynamics (CFD) computer model
  - Engineering Studies
  - Dam safety and operation and maintenance considerations
  - TDG predictive tools
  - Consideration of potential effects on other resources
  - Preparation of design drawings and specifications for each preferred alternative
- Incremental implementation of TDG alternatives to evaluate effectiveness of measures
  - Implement prototype of most promising concepts
  - Confirm performance
  - Use results to improve prediction of performance of subsequent concept
  - Consider results and implement the next most promising alternative

2 ANALYSIS PRIOR TO 2007

The historic analysis sets the stage for understanding the TDG challenges at the Project and identified additional data needs over the 10-year TDGAP time period.

2.1. Historic Analysis

TDG data has been gathered at the Project since 1999. Historic data analysis at the Project was focused on characterizing existing conditions and, until about 2005, was a separate exercise from assessing potential structural improvement alternatives. A review of the Project TDG studies, along with the Project TDG studies and other TDG studies conducted by the scientific community and at other projects where TDG is an issue, provides an understanding of the information developed to date. An annotated bibliography of reference information (review), including its relevance to the Project, was developed and is part of the TDG Evaluation Final Report (SCL 2009).

The review focused on the goal of achieving compliance with the TDG water quality standard. The historic data was analyzed to relate TDG levels in the tailrace of the Project to upstream conditions and operations of the Project.

2.2. Results of Historic Analysis

At higher flows, the Project forebay TDG level is closely linked to upstream TDG levels from Box Canyon and Albeni Falls dams. Spill from these upstream projects causes relatively high Project forebay TDG at inflow near and slightly above the Project power plant total release of approximately 56,000 cfs. The Project tailrace TDG levels begin to increase slightly above the forebay TDG levels when spill from the Project is greater than approximately 15,000 cfs, which corresponds to an average occurrence of approximately 7.4 days per year. At inflow greater than approximately 80,000 cfs, the incoming TDG levels to the Project decrease due to removal of the spillway gates at Box Canyon Dam and corresponding reduction in TDG production at upstream projects at these higher river flows (SCL 2009).

Low volume of spill flowing through either spill gates or sluice gates at the Project does not increase tailrace TDG above that in the forebay. At present river conditions, this low volume of spill is approximately 15,000 cfs or less. As upstream projects improve their TDG compliance and the TDG levels at the Project forebay decrease, the ability to pass low volumes of spill without raising tailrace TDG levels above Project forebay levels will become more difficult. When Project forebay TDG levels are improved, the corresponding tailrace TDG levels may become dominated by the TDG performance of the Project spill gates and not the incoming TDG level to the Project (SCL 2009).

As discussed in the 2010 TDG Annual Report (SCL 2011), TDG production is related to the depth of plunge and the residence time of bubbles at depth, so a 30% - 50% reduction in plunge is roughly estimated to correspond to a 30% - 50% reduction in TDG production. For example, if a 26,000-cfs flow over the current spillway configuration results in a 152% TDG level just below the spillway, then the modified spillway with the roughness elements to reduce plunge would be estimated to result in a 126% -135% range of TDG levels at 26,000-cfs.

The ongoing refinement of the Spillway alternative and further development of the analytical estimate of TDG will improve our ability to estimate TDG reduction at the Project. However, actual TDG performance will not be known until after installation of a full scale prototype is completed at the Project and tested as part of the 10-year attainment plan efforts.

2.2.1. Voluntary Actions Taken to Reduce TDG

Changes to Project power plant operations were introduced in September 2003 for the Project's largest generating units (Units 55 and 56), resulting in a significant reduction in TDG levels at the USGS-Fixed Monitoring Station (FMS) compliance monitoring site in the Project tailrace, to the point that there is minimal addition of TDG by the Project power plant. In fact, at releases less than the Project power plant capacity of approximately 56,000 cfs, the Project tends to slightly reduce TDG below forebay levels. The analysis of historic data indicates that, with the Project power plant operational changes initiated in 2003, TDG exceeds the regulatory limit in the Project tailrace for flows between approximately 70,000 cfs and 108,300 cfs (which corresponds to spill flow of approximately 15,000 cfs to 53,300 cfs). These flow conditions correspond to an occurrence of approximately 7.4 days per year based on the 1987 through 2005 period of record.

Table 2.2-1 defines the days the Project provides a benefit to the Pend Oreille River by reducing the TDG from the forebay to the tailrace. This historical data indicate that the Project reduces river TDG approximately nine (9) days per year on average for spill flows up to approximately 15,000 cfs.

Table 2.2-1. Project spill influence on TDG under current Project operation**.** (SCL 2009)

Spill (cfs)	Days/Year	% TDG Stripped (Reduced) or Added
>0–15,000	8.9	7% reduced to 0% change
>15,000–53,300	7.4	0% change to 24% added
53,300 +	1.9	110% TDG standard not applicable as flow is greater than 7Q10 flow

7Q10 – 7-day, 10-year frequency flood
cfs – cubic feet per second

The analysis of data indicates that the Project adds TDG to the river approximately seven (7) days per year on average, and for approximately two (2) days per year the river flows exceed the 7Q10 river flow, at which time the TDG regulatory requirement of 110 percent is not applicable.

Figure 2.2-1 shows a plot of the average flow as well as the 80th percentile flows (based on average of 1987 – 2005 period of record). This plot illustrates some of the current challenges associated with TDG at the Project. TDG stripping occurs up to river flows of 70,000 cfs, a modest increase in added TDG occurs between 70,000 and 80,000 cfs, and there is a significant increase in TDG above 80,000 cfs.

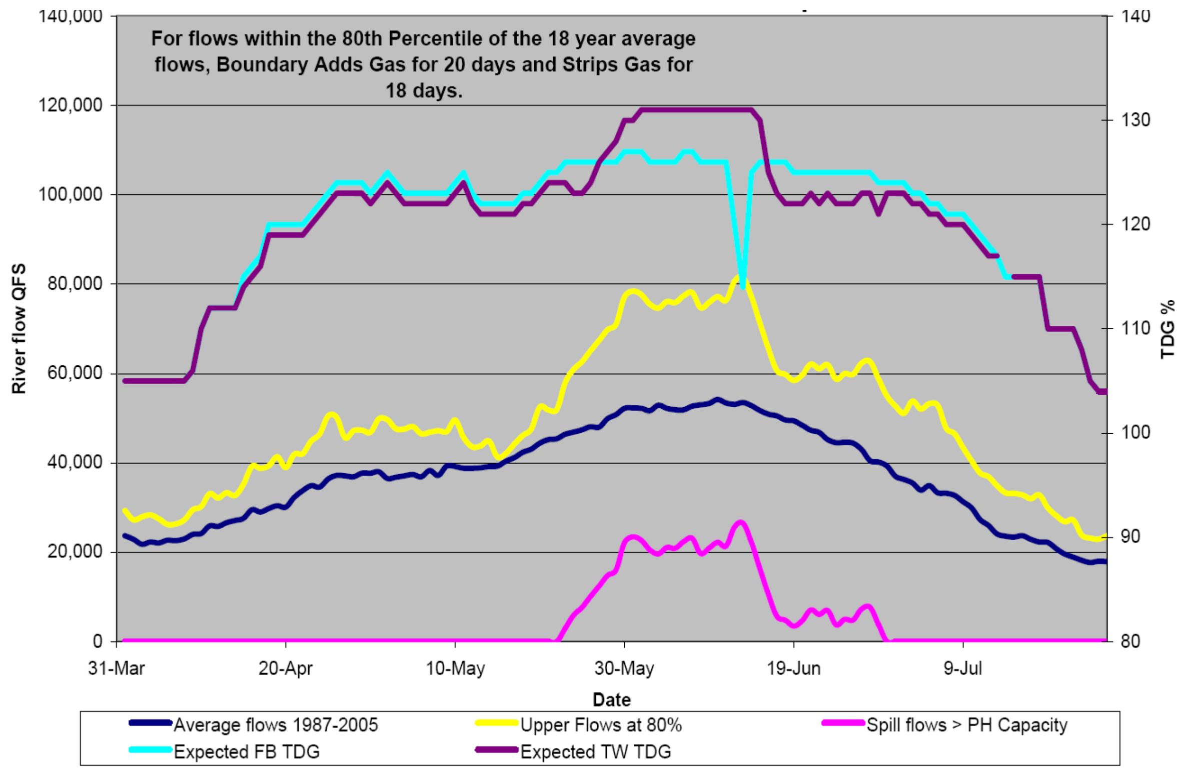

Figure 2.2-1. Average and 80th percentile flows (based on average of 1987 – 2005 hydraulic record).

3 RELICENSING STUDIES

3.1. Literature Search

Over 70 documents were collected and assembled in a Project TDG reference library. An annotated bibliography was developed that includes a complete document reference, summary, and each article's relevance to the TDG evaluation. These documents are presented in Appendix 1 of the TDG Evaluation Final Report (SCL 2009). Additionally, documents that are part of the FERC Part 12 inspection Supporting Technical Information (STI) have been gathered to provide technical background information on Project features (SCL 2005). STI information is covered by FERC's Critical Energy Infrastructure Information (CEII) restrictions.

3.2. Field Studies

In 2007, two different types of field data were collected in support of the TDG studies: (1) hydrodynamic data for use in calibration of future hydrodynamic models of the Project tailrace and (2) TDG data to provide further insights into the effects of spill operations on TDG production.

The hydrodynamic data consisted of water surface profile measurements from three gages along either bank of the tailrace and velocity measurements at eleven (11) fixed stations on three (3) transects in the tailrace at varying distances downstream from the Project power plant.

TDG data were acquired using a total of nine (9) meters. One (1) was installed on the Project forebay trash rack, four (4) on a transect just downstream of the extent of the frothy gas transfer zone downstream from the Project power plant, three (3) on a transect at the location of the USGS tailrace FMS, and one (1) below a riffle in the river channel just across the U.S.-Canada border.

The results of the 2008 field program are summarized as follows:

- Developed an understanding of the Project TDG performance during conditions with low forebay TDG levels
- Confirmed previous spill gate tests and developed further understanding of effects of spill gate operation on TDG
- Examined the distribution of TDG in the river at different flows:
    - No spill flow—little variation in TDG across the river
    - <u>Less than 10,000 cfs spill</u>—the USGS meter read highest of all meters along the same transect
    - <u>Greater than 15,000 cfs spill</u>—the USGS meter read lowest of all meters along the same transect
    - <u>Between approximately 10,000 and 15,000 cfs spill</u>—the USGS and transect meters recorded TDG levels that transitioned from the left to the right bank (i.e., transitioned between the patterns observed during less-than-10,000-cfs-spill and greater-than-15,000-cfs-spill conditions described above)

The following additional field activities have also been performed to date:

- 2009 TDG field studies—Extended the program developed during previous years, which allowed refined analysis of the effects of gate operations (SCL 2009).

- 2010 TDG field studies—Continued development of the program from previous years (SCL 2011).

3.3. Workshops

The process of examining operational and structural alternatives has been progressing for several years in a systematic manner, starting with a large number of alternatives and weeding out those less likely to be effective. This process resulted in six (6) structural alternatives, which were presented in relicensing study plan reports (SCL 2007 and SCL 2009) after a series of meetings between SCL and an expert panel. Two workshops were conducted in 2007 and 2008 in order to focus on the most promising alternatives and develop conceptual designs. The main items discussed at the two workshops (Workshop 1 – October 2007 and Workshop 2 – June 2008) are summarized below. The workshops are noteworthy in that they are significant milestones in the evaluation and direction for future steps in development of potential operational and structural alternatives. The third and fourth workshops were conducted in September 2009 and April 2011 with the expert panel and focused on sluice gate engineering analyses, physical and CFD model calibrations, spillway alternative evaluations (primarily using the physical hydraulic model), and CFD modeling comparisons as informed by the TDG predictive tool (SCL 2011).

3.3.1. Workshop 1 – October 2007

Six (6) structural alternatives were presented in the Revised Study Plan (RSP) by SCL (SCL 2007). These were the result of a series of meetings between SCL and an expert panel[1]. A group of experts was convened on October 1 and 2, 2007, to conduct a workshop for considering additional alternatives, evaluate various aspects of engineering and geology, and discuss issues relevant to potential TDG alternatives. Items discussed included:

- Spatial layout
- Preliminary design
- TDG performance
- Cost estimate
- Dam safety

Prior to the 2007 workshop, an evaluation matrix was developed for reviewing the feasibility of potential alternatives. During the workshop, the matrix was further refined and an initial evaluation of alternatives was completed. After the workshop, further work was performed to fill in technical details and provide further detail on the feasibility of the alternatives. The alternatives were ranked, and the most promising ones were selected based on the results of the evaluation. The criteria for evaluation are summarized in Section 3.4 of this document, and discussed in detail in the TDG Evaluation Final Report (SCL 2009).

More advanced analysis continues to be used to further develop spillway and sluiceway designs, which informs the future development and priority for implementation of preferred measures that, after more detailed evaluation, are determined to be reasonable and feasible. These analyses involve:

- A physical hydraulic model
- Computational fluid dynamic (CFD) modeling

3.3.2. Workshop 2 – June 2008

A workshop was conducted June 8, 2008, including a meeting summary (SCL 2009), with the following objectives:

[1] The expert panel that developed the six structural alternatives included in the RSP included the following individuals: Henry Falvey (hydraulic engineering and TDG production), Glenn Tarbox (dam safety and civil design), and Ken Bates (fisheries). On October 1-2, 2007, a group of experts attended a workshop to further review the potential TDG alternatives at the Project. Attendees included Keith Moen (Hatch Consultants Associates (HCA)), John Gulliver (Univ. of Minnesota), Chick Sweeney (AECOM), Kim deRubertis, (Independent Consultant), Joe Groeneveld (HCA), Christopher May (HCA), Paul Oblander (HCA), Jim Rutherford (HCA), Bill Fullerton (Tetra Tech), Kim Pate (SCL), Dan Kirschbaum (SCL), and Paul Carson (Currents Consulting).

- Show team members the Boundary site during spill for a variety of spill conditions.
- Develop a common understanding of the scope of work.
- Introduce team members to each other in person.
- Brainstorm concepts for modifications to spill operations that will reduce TDG.
    - Spillway modifications (aeration of flow, flip buckets)
    - Explored concept of baffle blocks with the goal to minimize the "break up length" (the distance required for the jet coming off the spillway to break up into individual packets of water)
    - Turbulence in all three dimensions is desirable. Flare and block elements to dissipate energy are a viable approach to modify spillway channels. Turbulence elements are easy to prototype and construct, test one year, and demonstrate progress.
- Sluice gate modifications (flip buckets, gate modifications)
- Concept developed with cantilevered triangular block that intercepts flow on downstream lip just below invert. The goal of this element is to break up core and spread it laterally. It is undesirable to force flow towards the gate slot. Half the depth of flow needs to be deflected to change flow angle and dissipate flow.
- It is desirable to find balance with deflector and flow to avoid forcing water into gate slots.

3.3.3. Workshop 3 – September 2009

A workshop was conducted September 21 and 22, 2009 (SCL 2009) with the following objectives:

- Review baseline and calibration results for physical and computational hydraulic models; initial performance of alternatives and progress to date.
- Review geotechnical concerns associated with alternative concept of expanding the spillway into left abutment rock which contains post-tensioned anchors.
- Consider dam safety/constructability of alternatives.
- Revisit matrix criteria (SCL 2007) and review fisheries considerations of alternatives.
- Determine next steps.

3.3.4. Workshop 4 – April 2011

A workshop was conducted in two meetings on April 14, 2011 and April 28, 2011 (SCL 2011). These meetings had the following objectives:

- Summarize 2010 TDG Efforts.
- Physical model update.
- CFD model update.
- Predictive tool update.
- Determine next steps.

3.4. Evaluation

Six (6) structural TDG alternatives were short-listed by SCL in the RSP (SCL 2007). The six (6) TDG alternatives identified in the RSP for further evaluation during relicensing studies included:

- Throttle Sluice Gates
- Roughen Sluice Flow
- Right Abutment Tunnel with Submerged Discharge
- Open Existing Diversion Tunnel and Add Control Structure
- Penstock Draft Tube By-pass
- New Left Abutment Tunnel Next to Unit 51 Intake

This shortlist was further developed and evaluated by knowledgeable experts in geology, dam construction, hydraulics, TDG issues, gate design, and structural design, and an additional promising alternative (Spillway Flow Splitter/Aerator) was included. A full description of each alternative and the subsequent evaluation of the alternatives' feasibility are included in the TDG Evaluation Final Report (SCL 2009). The experts' qualitative evaluation included the following criteria for alternative selection:

- Low risk of fish injury
- High likelihood of improving TDG conditions downstream
- Technically feasible for construction and permitting;
- Minimal dam safety concerns
- Lower cost for implementation
- Maintenance and access are not impaired
- Existing Project operations are not impacted
- Ability to prototype concept
- Concept can be phased and adjusted

Based on the evaluation of the above criteria, three (3) alternatives were selected for more detailed examination and implementation in order to meet TDG implementation goals:

- Throttle Sluice Gates (Option 1-3), which involves operation of sluice gates in partially open positions
- Roughen Sluice Flow (Option 3-2), which entails modification of the sluice gate outlets to break up and spread flow
- Spillway Flow Splitter/Aerator (Option 2 – New), which entails modifying the spillways to aerate, break up and spread flow

These three (3) gate alternatives all involve spilling flow through existing outlets (the seven sluice gates and two spillway gates) into the plunge pool and rely on reduction in TDG production by spreading the flow and limiting plunging effects of the confined jets. The historical performance of these outlets at small gate openings indicates the potential for successfully reducing tailwater TDG levels. The four alternatives not selected for more detailed analysis at this time all employ various tunnel configurations with submerged outlets or surface jets outside the plunge pool.

The majority of 2010 modification concepts were developed under the basic premise that spreading the energy of outlet jets over larger areas (increasing the impact area) should decrease the depth of plunge, and should therefore reduce dissolved gas production. Approaches other than spreading flow with deflectors or spillway shaping were considered, including adding roughness to the outlet surfaces and the brute force method of limiting plunge depth using an apron located below the sluices. The use of roughness elements was influenced by a study performed by the USBR in which the cavitation potential in the Folsom Auxiliary Spillway Stilling Basin was evaluated (Frizell, 2009). This concept entails promoting boundary layer development (adding turbulence), via the addition of roughness elements, to facilitate jet break-up as it falls to the plunge pool (SCL 2011).

4 ENGINEERING STUDIES

4.1. Study of Preferred Alternatives

Resolution of many of the hydraulic design issues relies heavily on the results of both physical and numerical hydraulic models. Both models are used in complementary roles to maximize their particular strengths. The greatest strength of the numerical model is the capability it offers designers to explore, develop, and compare various design concepts relatively quickly and easily. Modifications can be made quickly in a "numerical flume," and tested to ensure that a proposed design alteration performs as expected. The numerical hydraulic model will continue to be used to assist in predicting the relative TDG performance of each of the preferred alternatives.

4.1.1. Computational Fluid Dynamics Modeling

The numerical hydraulic model or computational fluid dynamic (CFD) model continue to support the evaluation of operational and structural alternatives and are:

- Used to analyze, in conjunction with the physical model, modifications to the sluices and spillways to provide greater dispersion of the jets and lower jet momentum entering the tailwater;
- Verified versus physical model results; and
- Preliminarily incorporated into an overall model of the plunge pool area and downstream river to provide the hydrodynamic framework for the overall TDG predictive model for the Project.

4.1.1.1. Development of CFD Model

In 2008, the far-field CFD model was developed for the entire Project area, along with a more detailed near-field model of the sluice gate area using the FLOW-3D software. The CFD model of the sluice gate was compared to the original physical model results (Washington State 1963) and found to be consistent.

The near field models are developed and a series of runs calibrated and validated the CFD model results during years 2009 and 2010. Ideally, prototype data from actual gate operations are desirable. However, the Project plunge pool is a challenging location for data collection and thus, limits prototype data in the plunge pool to qualitative observations and photos taken during historical operation of the sluiceways/spillways. While it is important to compare the CFD model against this type of data, a more detailed comparison was made by replicating actual physical model study tests, and performing a more in-depth comparison between the CFD and physical model results in 2010. With this in mind, validation of the CFD model was carried out in 2010 using a two-phased approach:

- The CFD model replicates a known discharge condition for a single sluice gate or spillway gate.
- The model results were compared to prototype observations to ensure a reasonable match (with the far field CFD model as a base to ensure compatibility of results).

SCL will continue development of the physical and CFD models as modifications are constructed, tested, and monitored on the prototype during the 10-year TDGAP time period. Physical model test runs will continue in order to better determine the implementation priority among the three gate alternatives. Physical model test results were compared directly to the CFD model results to validate the CFD model (SCL 2011). These validation tests were performed for a single operating spillway bay. The CFD model was translated into the physical hydraulic model scale to ensure complete compatibility with the physical model results, and then both models were run for identical tests of discharge flow (cfs). For the sluiceway, the test involves the partial opening of a single bay to provide a flow of 4,400 cfs. For the spillway, the test involves the operation of a single spillway with a discharge of 10,300 cfs.

Both models have been run and more rigorous comparisons made between model results. The comparisons include the following:

- Downstream flow patterns and velocities
- Jet trajectory measurements
- Dimensions of jet impact area
- Qualitative observations of depth and extent of air entrainment

As required, pertinent CFD model parameters were adjusted to achieve a better match with those of the physical model as necessary. Once a suitable match was obtained, both models were rerun at a prototype scale to identify and document any scaling effects in moving to the larger, actual size prototype dimensions. These results will continue to be compared to prototype observations to ensure a continuation of a good fit between the CFD and prototype results.

Suitable matches were obtained, and the models have been validated. The final model results form the "baseline" for operation of a single sluiceway and single spillway bay. These runs will form the baseline data against which the performance of other modifications will be compared.

Resolution of many of the hydraulic design issues for the Project relied heavily on the results of both physical and numerical hydraulic models (SCL 2009, SCL 2011). Both were used in complementary roles to maximize their particular strengths (SCL 2011).

The goal of CFD modeling analyses in 2010 was to continue development of the models of sluices and spillways that can be:

- Used to analyze, in conjunction with the physical model, modifications to the sluices and spillways to provide greater dispersion of the jets;
- Verified in comparison to physical model results; and
- Incorporated into an overall model of the plunge pool area and downstream river at a later date to provide the hydrodynamic framework for an overall TDG predictive model for the project.

For the spillway component of the model study, the following tasks were performed in 2010:

- Validation of the spillway model against velocity data measured in the physical model. Two spillway operating scenarios were considered: a) Spillway 1 discharging 13 kcfs, and b) Spillways 1 and 2 with a combined flow of 13 kcfs.
- Upgrading Spillway 2 model to include roughness elements or super-cavitating blocks for breaking up the spillway plunging jet, as investigated in the physical model. During the study period, two configurations of super-cavitating blocks were analyzed and plunge depth and jet trajectories were compared.

4.1.1.2. Testing Structural Alternatives

Following completion of the baseline and validation runs in 2010, the CFD and physical models were changed to include the structural modifications proposed for potential TDG structural measures at the sluiceway and spillway structures. The initial designs were based on the conceptual designs described in the TDG Evaluation Final Report (SCL 2009), but modified as required to optimize overall hydraulic design and improve TDG performance goals. CFD analysis continues to be performed iteratively with the design team to test the performance of various concepts.

Initial runs involved a single gate test and will develop into multiple spillway and sluice gate tests as the evaluation progresses. At the completion of each run, comparisons are made with the baseline runs to determine the overall impacts on jet trajectory, impact area, and calculated air entrainment. These comparisons are used to rank various alternative designs in the search for the potential TDG reduction modification(s).

It should also be noted that as a continued validation exercise, these CFD test results will continue to be compared with results emerging from the concurrent physical model evaluation.

4.1.1.3. Development of Numerical TDG Predictive Tool

One of the key components of the numerical modeling exercise is the application of the CFD models to help predict the final TDG performance associated with each of the proposed modifications.

Two separate approaches are promising to achieve prediction of TDG performance. The first approach involves application of the CFD and physical models to perform TDG calculations independently of the actual FLOW3D code. The second allows for the continuous computation of TDG directly within the FLOW3D model. This second approach requires some customization of the FLOW3D software. SCL will assess both approaches to compare results, check sensitivity, and, ultimately, ensure compatibility and consistency between the approaches; however, the first approach appears to be more achievable in providing predictive values.

Each of the two approaches is described in more detail below. Potential improvements in TDG performance for each proposed measure, when evaluated for implementation, will be reported in annual reports to Ecology (see Section 5.2.2).

4.1.1.3.1. Approach 1 – Use of Discrete Particle Tracking

The first approach is considerably simpler in nature, and similar to a technique developed and used on other studies to simulate TDG transfer, that has provided reasonable estimates of TDG performance.

This technique involves the “sprinkling” of a representative number of history particles within the air entraining area of a jet. These particles are given a buoyancy equivalent to a standard air bubble, and then their position is tracked as they move throughout the computational domain. The CFD model tracks time, pressure, air entrainment fraction, and velocities experienced by these “bubbles” as they move through the mesh.

This information is then exported from the CFD model, and imported into a special spreadsheet model to estimate gas transfer. This spreadsheet estimates the amount of gas transfer which might occur for each bubble based on the pressure and velocity hydrographs experienced by each. The gas transfer associated with each bubble is then integrated to determine a total TDG percentage for the main flow field.

4.1.1.3.2. Approach 2 – Numerical Modeling of TDG

The CFD models will be modified to predict the TDG contribution of the Project. Source/sink terms are incorporated in the mass transport algorithm of FLOW3D to simulate TDG. These source and sink terms represent the generation of TDG and also the escape of excess TDG at the free surface. FLOW3D's existing capabilities will be utilized to determine the volume of entrained air, shear stress, and pressure in the water phase.

The simulation of TDG within the water column will be accomplished by implementing the following steps:

- Determine the number and size of air bubbles and their corresponding surface area in each computational cell as a function of shear stress and volume of entrained air;
- Determine the transfer of air mass to the dissolved phase as a function of pressure, temperature, air/water interface area, and initial (background) TDG concentration;
- Apply a boundary condition on the free surface to allow release of excess dissolved air into the atmosphere; and
- Utilize the existing transient capability of FLOW3D to transport TDG throughout the flow field by: i) solution of an advection-diffusion equation; and ii) simple "mass" transport.

Hydraulic equations relating flow characteristics with the number and size of bubbles transfer of air from bubbles to water, and subsequent release of dissolved gas into the atmosphere, will be obtained from the work performed by Professor Gulliver as reported by Urban et al. (2008). No new research work will be involved in developing source/sink terms. However, incorporation of these processes into a transient three-dimensional CFD model will represent significant improvements over currently available methods.

4.1.2. Physical Model

The physical hydraulic modeling is performed using the 1:25 scale model that was completed in early 2009.

The goal of the physical model studies is to:

- Provide a tool that tests various sluice and spill gate operational scenarios and visualizes the resulting jet interactions, water surface impact areas, and subsurface flow conditions and mixing in the plunge pool (The operational testing and interpretation is more readily accomplished using a physical model than using a CFD model); and
- Provide a basis for verification of CFD models of the Project outflow release structures.

4.1.2.1. Physical Model Testing

Relative performance of the varying gate operations and modifications of the outlets is primarily judged on the depth and amount of air entrainment and the distance downstream that carries entrained air. Air entrainment and transport is usually reduced by maximizing the surface area of the spill volume prior to jet impact in the plunge pool. To a large degree, the relative performance is judged on the basis of qualitative observations, however, there will be some quantifiable data collected as well.

At a minimum, the following information is collected for each test:

- Metered inflow using orifice flow meters in supply piping;
- Flow through each gate outlet (sluice and spillway gate based on ratings for each developed in the model);
- Water levels and wave action using point gauges and capacitance wire probes;
- Jet trajectories documented through point gauge measurements, photography, and video;
- Jet impact zones on water surface through visual assessment, photography, and video;
- Air entrainment through visual assessment, photography, and underwater video; and
- Selected velocities using Acoustic Doppler Velocimeters (ADV) and miniature propeller current meters.

The structural configurations to be tested in the physical model include:

- Existing (to provide a baseline for comparison of modifications);
- Modified spillway gates (to provide greater aeration and dispersion of the flow);
- Roughened sluices (to provide better dispersion of flow); and
- Other configurations suggested by test results.

These configurations will continue to be tested in an iterative manner to develop the best final configuration for reducing TDG at the Project (SCL 2009, SCL 2011).

4.1.3. Engineering Studies

The engineering study goals are to further develop the understanding of the structural improvement alternative using standard engineering analysis. These studies support the analysis described above to provide a comparative basis and foundation for decision making as the TDG attainment plan progresses. The engineering studies continue to examine the feasibility of actual construction and implementation of structural and operational changes at the Project in consideration of the elements described further below.

4.1.3.1. Design Development

The design development includes several subtasks including:

- Analyze hydraulic capacity of structural improvements including sluice gate and spill gate alternatives,

- Conceptual and feasibility analysis of alternatives including geotechnical/geologic, structural, and mechanical (gates) quantitative analyses at a feasibility level to further the qualitative analyses, and

- Develop design details of favored alternatives including potential interactions with existing features of the Project (existing structural components of dam, dam abutments, dam safety instrumentation/reinforcement, sluice gates and spillway).

4.1.3.2. Effects of Operational Change

Evaluation of the effects of operational changes continued with sluice gate reinforcements and analysis of the existing sluice gate hoist mechanism to determine potential detrimental effects of a modified operational procedure associated with more frequent use of sluice gates. The analysis continues to examine the winches, cables, and other subsystems of the gates to satisfy dam safety concerns (SCL 2011).

4.1.3.3. Cost Estimates for Design and Construction

The development of more detailed drawings will provide better conceptual understanding and basis for cost estimates, and develop more detailed cost estimates and construction sequencing for favored alternatives.

4.1.3.4. Sluice Gate Deflector Design

Deflectors are in the design phase for installation within the sluice gate water passage to improve operation during throttled gate operation. They consist of steel constructions attached to the existing steel liner. They serve to constrict the flow in the lower portion of the sluice gate to prevent the jet from entering the gate slot.

The sluice gate deflector design process includes:

- CFD analysis to refine the shape of the deflector and provide water pressures to develop loading;

- Structural design of the deflectors includes means of transferring the loads to the surrounding structure and welding details to transition between the existing liner and the new deflector resulting in a package of design calculations;

- Design drawings and technical specifications stamped by a Washington State Professional Engineer (PE) to allow fabrication of the deflectors (the assumption is that the fabrication may be undertaken by the SCL metal shop); and,

- Submittal of design and construction Quality Control Inspection Program (QCIP) to the FERC Portland Regional Office for review by 2012.

4.2. Development of Prioritized Implementation

4.2.1. Field Studies and Monitoring

Monitoring TDG will continue using the USGS gaging station located in the Project forebay and at the USGS-FMS compliance monitoring site in the Project tailwater. (The compliance monitoring site was identified in the Pend Oreille River TDG TMDL, and is located at the upstream end of the TDG compliance area for the Project [Ecology 2007].) If the hydrologic conditions allow, SCL takes advantage of opportunities to fill in gaps in data records to continue to build a better understanding of the operational influences on TDG production at the Project.

Once operational changes are formally implemented or a prototype alternative has been installed at the Project, the TDG data will continue to be collected and evaluated for actual performance and critically compared to the predicted performance to assess potential improvements.

Following implementation of each program of TDG improvement measure(s), SCL will conduct biological sampling in the Project tailrace area within two days of a spill event or at a time that is safe to access the tailrace. SCL will use boat electrofishing to sample along five 200 meter transects in the tailrace during each sampling period once per year in years following installation of a new TDG measure. (Sampling methods are described in the Fish and Aquatics Management Plan in the Boundary license.) Fish captured will be examined for injury and indications of gas bubble trauma. Sampling will not be conducted during spill due to concerns regarding the safety of field crews in the tailrace.

4.2.2. Engineering Efforts

Results of physical and numerical modeling leads to structural improvement configurations that can be further developed into design concepts. Design concepts will be evaluated and ranked for a range of criteria including:

- Details of alternatives and interactions with other Project features;
- Evaluation of the concept with regard to operating mechanisms for the sluice gates and spillway;
- Changes to hydraulic capacity of the Project;
- Effects of selected alternative on other resources; and
- Dam safety considerations.

The evaluation results in a ranked order of development for prototype concepts. All historic Project reports collectively serve as a living document, which describe the iterative process of developing alternatives and testing prototypes that in turn, influences future development.

5 TDG ATTAINMENT PLAN

5.1. Steps to Meet TDG Standards

To summarize, SCL's TDG attainment approach consists of both operational and structural improvement components as follows.

Existing operational modifications:

- Voluntary sequencing of Units 55 and 56 (last on, first off operation), which began in 2003 and is formalized in the new license.
- Spill gate operational sequence (preferred use of spill gate no. 2); implementation tested in 2008 through 2011
- Modification of sluice gates to allow use of sluice gates after dam safety requirements are met, and operational constraints are identified (ongoing)

During the new license term, SCL will upgrade equipment at the Project power plant. Future upgrades to Units 55 and 56 may reduce or eliminate the conditions that in the past have led to TDG production during non-spill operations. When the turbine upgrades are completed, SCL will reevaluate the need for the unit sequencing identified above and adjust the approach to, or eliminate, the sequencing restrictions as appropriate.

Implementation of all reasonable and feasible alternatives will use an iterative evaluation and implementation approach to determine the most effective configuration of operational and structural changes to the nine gates (seven sluice gates and two spillway gates) as an adaptive management approach. Each gate alternative or combination of alternatives is evaluated using the following steps:

- Develop engineering plans to identify possible structural and operational improvements to meet standards;
- Identify improvement(s) and implementation schedule;
- Implement prototype modifications;
- Monitor and test to assess success based on predicted TDG performance and dam safety goals;
- Refine ability to predict TDG performance; and
- Evaluate and implement additional possible structural and operational measures until the TDG standard is met, or until all reasonable and feasible alternatives have been tested and implemented as appropriate.

5.2. Schedule

According to Washington Administrative Code (WAC) 173-201A-510(5), the compliance schedule for dams is not to exceed ten years. SCL will continue to refine tools and collect spill data during the new FERC license. SCL will complete the following during the first year of license issuance:

- TDG predictive tool for analysis of TDG alternatives
- Prioritized list indicating the order in which the preferred TDG alternatives will be evaluated and implemented in 2012 and 2013, as appropriate

This information will continue to be updated and provided to Ecology in annual reports (See section 5.2.2).

5.2.1. Considerations that Influence the Plan Schedule

The following elements were considered in developing this schedule and planning:

- The Sluice Maintenance Gate (a traveling gate upstream of the existing seven sluice gates that allows dewatering of the sluice gate water passage) is currently in repair and rehabilitation:
  - Removed in September 2010 and expect reinstallation by late 2011, which will permit safe access to and use of the sluice gates;
  - Once completed, the program will enhance safety for future alternative or prototype installation.
- Dam safety issues to consider:
  - Arch dam structure and any potential interaction that could cause additional stress on the arch structure, instrumentation, and reinforcements;
  - Potential effect of changing flow patterns on rock abutments and foundations;
  - Hydraulic capacity of the Project and ability of Project to continue to pass the Probable Maximum Flood (PMF).
- Operation and maintenance (O&M):
  - Increase hoist operational frequency may add stress to components;
  - Increased use will increase gate seal wear;
  - The new alternatives will have their own O&M requirements.
- Effects on other resources:
  - Fish entrainment – effect during passage (strike, shear, impacts on fish);
  - Coordination of activities with upstream fish passage development;
  - Coordination with mitigation plans for other resources.

5.2.2. Annual Reports

Annual reports will contain TDG monitoring data, engineering analysis and prototype design(s) for alternative(s) (as appropriate), modeling results of predicted TDG performance of alternative(s), and a schedule for the following year's activities as finalized and approved by Ecology on or before March 31st. SCL will submit draft annual reports on or before January 31st to Ecology, the Total Dissolved Gas Subgroup of the Water Quality (WQWG) and Fish and Aquatics Workgroups (FAWG) for review and discussion.

5.2.3. TDG Attainment Plan Compliance Schedule

The TDG activities and schedule will be implemented as described below and per WAC 173-201A-510(5) since a compliance schedule must not exceed ten years. Actions described below will be implemented consistent with the Pend Oreille TDG TMDL (Ecology 2007), as approved by the EPA in March 2008, and approved CWA Section 401 water quality certification.

- **Year one –** Construct the first choice on prioritized structural alternative list for prototype development and build prototype, annual report, and consultation with Ecology, WQWG, and FAWG;
- **Year two –** Field testing, gather operational and performance data for implemented designs, analyze results, recalibrate predictive tool, annual report, and consultation with Ecology, WQWG, and FAWG;
- **Year three –** Develop design (plans and specifications) for next choice on prioritized alternative list for prototype development – build prototype, field testing, gather operational and performance data, analyze results, recalibrate predictive tool, annual report, and consultation with Ecology, WQWG, and FAWG;
- **Year four –** Field testing, gather operational and performance data, analyze results, recalibrate predictive tool, annual report, and consultation with Ecology, WQWG, and FAWG;
- **Year five –** Develop design (plans and specifications) for next choice on prioritized alternative list for prototype development – build prototype, field testing, gather operational and performance data, analyze results, recalibrate predictive tool, annual report, and consultation with Ecology, WQWG, and FAWG;
- **Years six to ten –** Repeat years 4 and 5 as necessary; evaluate potential combinations of gate operations to optimize TDG reduction.
- **Year ten -** Monitor and evaluate progress of the attainment program and results of implementation of the preferred alternatives. Once an optimum combination of potential sluice and spill gate alternatives are implemented, evaluate compliance with Washington water quality standards. Determine whether additional TDG reduction is required and, if necessary, determine if additional measures are available, and evaluate their feasibility.

The Section 401 water quality certification of the Project authorizes a compliance period not to exceed 10-years from the date of license issuance to achieve TDG standards. Consistent with WAC 173-201A-510(5), if TDG standards are not met by the end of the compliance period, SCL will complete a feasibility analysis within one year. The feasibility analysis will identify the reasonable and feasible methods to achieve compliance. Following review of this analysis by the TDG Subgroup, a subgroup of the WQWG, Ecology would either issue an order that includes additional compliance actions, or, if appropriate, evaluate whether modifications of the application of the TDG standard are warranted.

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Boundary Hydroelectric Project (FERC No. 2144)

Temperature Attainment Plan

Seattle City Light

Revised
July 2011

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Boundary Hydroelectric Project (FERC No. 2144)

1 INTRODUCTION

As part of the relicensing of the Boundary Hydroelectric Project (Project), Federal Energy Regulatory Commission (FERC) No. 2144, Seattle City Light (SCL) must obtain Clean Water Act (CWA), Section 401 water quality certification from the Washington Department of Ecology (Ecology). This document describes SCL's Temperature Attainment Plan (Plan) for the Project in support of Ecology's issuance of a Section 401 certification.

The Pend Oreille River is listed on Ecology's 303(d) list as being impaired for temperature. Ecology has prepared a Temperature Total Maximum Daily Load (TMDL) for the river (Ecology 2011). As required by WAC 173-201A-510(5)(c), SCL must address the temperature load allocations identified in the TMDL as part of the 401 certification of the Project.

The following sections include a summary of temperature modeling and analyses conducted for the Project area by SCL as part of relicensing and by Ecology during development of its Temperature TMDL. Following the discussion of analyses is a description of SCL's approach to temperature attainment, monitoring, and evaluation of success in achieving attainment. SCL commits to implement the terms of the Plan as set forth below.

2 REGULATORY CONTEXT

2.1. Washington Water Quality Standards

Ecology adopted use-based standards in 2003 that were approved by the U.S. Environmental Protection Agency (EPA) in 2006. These uses are defined in WAC 173-201A-200. Designated beneficial 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

The applicable temperature standard for the Pend Oreille River from Canada to the Idaho border is for protection of the designated Aquatic Life Use (Ecology 2006). In the Temperature TMDL, the standard has two parts: Part 1, which applies when natural temperatures are over 20 ˚C, and Part 2, which applies when temperatures are under 20 ˚C. Ecology defines parts 1 and 2 of the temperature standard on page 7 of the Temperature TMDL (Ecology 2011) as follows:

"Part 1: Temperature shall not exceed a 1-day maximum (1-DMax) of 20.0˚C due to human activities. When natural conditions exceed a 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;

"Part 2: Nor shall such temperature increases, at any time, exceed t = 34/(T + 9) where:

t = the allowable temperature increase; and

T = the background temperature measured at a point unaffected by the discharges. The Pend Oreille River is affected by discharges from dams in both Washington and Idaho, so the modeled natural condition, which represents the unaffected river, is used to define T in this TMDL."

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. During development of the Pend Oreille River Temperature TMDL, Ecology and SCL produced CE-QUAL-W2 models[1] to estimate natural temperature conditions by removing all known human heat influences ("Natural Condition"). Temperatures throughout the Pend Oreille River can reach 25 ˚C in the summer months, in excess of the numeric standard of 20 ˚C. During the period when natural conditions are above 20 ºC, the natural conditions provision is the applicable water quality standard (i.e., numeric criteria is Natural Condition + 0.3 ˚C). Accordingly, modeled temperatures were used to evaluate summer temperature conditions in the Pend Oreille River relative to the Natural Condition (Khangaonkar et al. 2009, Ecology 2011). In addition to the analysis of summer temperature conditions, Ecology's TMDL also includes an analysis of fall temperature conditions under Part 2 of the standard. A discussion of these analyses is provided in Section 3 of this Plan.

2.2. Pend Oreille River Temperature TMDL

Analysis of the Existing Condition relative to the Natural Condition temperatures was applied in developing the Temperature TMDL and evaluating compliance with Part 1 and Part 2 of the water quality standard. Using the CE-QUAL-W2 model, data from representative years[2] (2004-2005) were also used to simulate and compare summer temperatures under the modeled Natural Condition and the modeled Existing Condition without Boundary Project. The TMDL indicates that daily maximum temperatures in areas of the Boundary Reservoir are not in compliance with the water quality standard for temperature, and that at times the Boundary Project contributes to impaired temperature conditions in the Pend Oreille River. Based on these analyses, Ecology formulated temperature load allocations for the Boundary Project under Part 1 and for the Boundary reaches under Part 2 (see Section 3 of this Plan for a discussion of the analyses and load allocations contained in the TMDL).

[1] Ecology developed a CE-QUAL-W2 model for the reach of the Pend Oreille River from the Washington / Idaho state line to Box Canyon Dam forebay, and SCL developed a CE-QUAL-W2 model for the reach from the tailrace of the Box Canyon Dam to Boundary Dam tailrace.

[2] 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.

SCL's actions under this attainment plan will help to achieve the temperature allocations assigned to SCL in the TMDL. If the TMDL targets and water quality criteria are not met by the end of this compliance period, Ecology and SCL will follow WAC 173-201A-510(5)(g) to identify further necessary actions.

3 TEMPERATURE ANALYSIS

Modeling (CE-QUAL-W2) shows that Existing Condition summer temperatures in Boundary Reservoir are frequently within the range of the modeled Natural Condition or cooler (Table 3-1). Greater detail can be found in Section 4.5.2.2.2 of SCL's License Application Exhibit E and in Khangaonkar et al. (Temperature Modeling and Alternative Operations Analyses for Boundary Hydroelectric Project – Clean Water Act 401 Certification Support, 2009), which are incorporated herein by reference (see Appendix 1).

Four modeling conditions examined in support of SCL's License Application and the Pend Oreille River Temperature TMDL are described (Table 3-2 and Khangaonkar et al. 2009). In order to determine whether water quality standards are met in the Pend Oreille River, Ecology compared the Natural and Existing model-predicted temperatures conditions. As a part of its License Application and 401 Application, SCL provided analyses comparing the Existing Condition and the Existing Condition without the Boundary Project in order to determine the temperature contribution of the Boundary Project to the existing summer temperature condition in the Pend Oreille River (Section 5 of Khangaonkar et al. [2009]). Finally, SCL compared an operations alternative (1,974-foot Run of River Condition) to the Existing Condition (see Section 4.1.1 below and Section 6 of Khangaonkar et al. 2009).

Table 3-1. Summary of SCL's frequency analysis results regarding the summer temperature effects at the Metaline Pool, Boundary Forebay, and Boundary Tailrace stations.

Frequency Analysis Results	Surface[3] 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) (License Application Exhibit E, Figure E.4-24).
	Boundary Forebay Existing Condition difference is between -0.35 ºC (lower than Natural) and +0.76 ºC (higher than Natural) (License Application Exhibit E, Figure E.4-24).
	Boundary Tailrace Existing Condition difference is between -1.15ºC (lower than Natural) and +0.19 ºC (higher than Natural) (License Application Exhibit E, 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 -0.32 ºC (lower than Existing without Boundary Dam) and +0.07 ºC (higher than Existing without Boundary Dam) (License Application Exhibit E, Figure E.4-28).
	Boundary Forebay Existing Condition is between +0.01 ºC and +0.58 ºC (all higher than Existing without Boundary Dam) (License Application Exhibit E, Figure E.4-28).
	Boundary Tailrace Existing Condition difference is between -0.14 ºC and -0.88 ºC (all lower than Existing without Boundary Dam) (License Application Exhibit E, Figure E.4-28).

[3] The term “surface” in SCL’s analysis refers to the top layer of the CE-QUAL-W2 model. At Metaline Pool, Boundary Forebay and Boundary Tailrace, the top layer is 1m, 2m and 1m thick, respectively. SCL’s analyses of temperature effects considered both surface temperatures and flow-weighted temperatures (Khangaonkar et al. 2009 at 10).

Table 3-2. Model conditions for temperature analyses (Khangaonkar et al. 2009).

Model Condition	Pend Oreille River Dams	Point Sources	Shade
Existing Condition	All	All	Existing
Natural Condition	None	None	Potential Natural Vegetation
Existing Without Boundary Project Condition	Albeni Falls, Box Canyon, Seven Mile	All	Existing
Run-of-River 1,974-foot Condition	All	All	Existing

Ecology's analysis for the TMDL indicates that daily maximum temperatures in areas of the Boundary Reservoir are not in compliance with Part 1 and Part 2 of the water quality standard for temperature, and that at times the Boundary Project contributes to impaired temperature conditions in the Pend Oreille River.

The TMDL states that in the Boundary Dam forebay, Part 1 of the temperature standard was exceeded by an average (2004, 2005) of 0.59 ˚C. For Part 2 of the standard, Ecology analyzed temperatures between 20 ˚C and 12 ˚C, with the 12 ˚C lower limit applied because bull trout use the river for migration in the early fall and are sensitive to temperatures above that level. During the period associated with these temperatures (September - October), the TMDL finds that Part 2 of the standard was exceeded for all of the Boundary Project reaches, with the level of maximum exceedance increasing longitudinally from 0.14 ˚C at Metaline to 0.53 ˚C at the Boundary Dam tailrace (see Table 11 of the TMDL for an account of Part 1 and Part 2 exceedances as identified by Ecology).

When natural condition river temperatures are greater than 20 ˚C (July and August), Ecology's load allocation for the Boundary Project has been set at 0.12 ˚C above the natural temperature condition (an equivalent allocation was assigned to the Box Canyon Project). The TMDL states that the magnitude of the allocations reflects the interrelationship of the Box Canyon and Boundary projects' temperature impacts and associated cumulative impacts in the watershed. The temperature reduction required to achieve the load allocation for the Boundary Project is 0.88 ˚C, based on 2004 modeling results. This reduction applies during July and August in the forebay, which is the area of maximum temperature impairment. When river temperatures are under 20 ˚C in late summer and early fall (September through October), the TMDL identifies the following allocations for the Boundary Project reaches: Metaline, 0.14 ˚C; Slate, 0.24 ˚C; Boundary forebay, 0.61 ˚C; and Boundary tailrace, 0.53 ˚C (see Table 15 of the TMDL for a list of Part 1 and Part 2 load allocations, by reach, for hydroelectric facilities on the Pend Oreille River).

The TMDL identifies load allocations by Project to address Part 1 of the temperature standard, whereas for Part 2 of the standard, allocations are identified by reach. For Part 2, all activities completed to reduce water temperatures will cumulatively help achieve the reductions. Because of their cumulative interrelated effects, the Box Canyon and Boundary Projects are required to "equally share" the temperature allocations identified to achieve compliance with Part 2 of the standard in the four Boundary reaches (TMDL at p. 79).

4 TEMPERATURE ATTAINMENT PLAN

As noted above, Ecology has stated in its Temperature TMDL for the Pend Oreille River (Ecology 2011) that areas of the Pend Oreille River in the Boundary Project area are not in compliance with the water quality standard for temperature, and that at times the Boundary Project contributes to impaired temperature conditions. SCL's analysis of three locations in the Project area (Boundary Tailrace, Boundary Forebay, and Metaline Pool) shows that modeled summer surface daily maximum temperatures are the same or cooler with the Project than without it at the Boundary Tailrace and Metaline Pool stations. The model analysis also shows that the Existing Condition temperatures at times are higher at the Forebay station than the modeled temperatures for the Existing Condition without Boundary Project Condition (see Table 3-1).

Under WAC 173-201A-510(5)(b), dams contributing to a violation of the water quality standards must develop a water quality attainment plan that provides a detailed strategy for achieving compliance. To meet commitments under the Boundary Relicensing Settlement Agreement, SCL has prepared this Temperature Attainment Plan (TAP) that summarizes analyses completed and outlines actions that will be implemented during the first ten years of the new license term that will contribute to temperature improvement goals in the Pend Oreille watershed to address the temperature effects in the Boundary Reservoir. This TAP meets the requirements of WAC 173-201A-510(5)(b). Ecology has suggested that riparian plantings and fish habitat improvements in tributaries to the reservoir, including enhancing and protecting thermal refugia in the Reservoir's tributary delta areas and erosion control measures and associated riparian plantings on the mainstem Pend Oreille River (see Section 4.1.2), will help meet the temperature improvement goals for the Pend Oreille River.

4.1. Reasonable and Feasible Improvements

This Plan evaluates potential operational and non-operational approaches to addressing temperature effects in the Boundary Reservoir. The results of an alternative operations analysis (see Section 4.1.1 below) indicate that during summer, rather than reducing or eliminating the daily maximum temperature effect observed, the most extreme change in operations possible consistent with physical Project constraints ("run-of-river" at lower forebay elevation) would marginally worsen surface temperature conditions. There do not appear to be operational changes that could lower daily maximum temperatures in the Boundary Reservoir during this period (Khangaonkar et al. 2009). Accordingly, implementation of non-operational measures to improve aquatic habitat conditions (see Section 4.1.2 below) are the only reasonable and feasible improvements identified for implementation in this Plan.

4.1.1. Operations Analysis

Due to the daily maximum temperatures seen at the Boundary Dam Forebay station, Ecology requested that SCL investigate whether there were operational changes that could lower daily maximum temperatures (for greater detail, see 4.5.2.2.2 of SCL's License Application Exhibit E and Khangaonkar et al. [2009]). 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 ("1,974-foot Run-of-

River Condition")[4]. The 1,974-foot Run-of-River Condition is the most extreme variant on current operations possible given the 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 1,974-foot Run-of-River Condition 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.

There is no significant difference between the Existing Condition and the 1,974-foot Run-of-River Condition for modeled surface daily maximum temperatures at Metaline Pool or Boundary Tailrace. The only difference between the two conditions was warming of summer surface[5] daily maximum temperatures at the Boundary Forebay station under the 1974-foot Run-of-River Condition relative to the Existing Condition. These results indicate that, rather than reducing or eliminating the limited 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 marginally worsen conditions at the Forebay. Accordingly, the modeling results indicate that summer daily maximum temperatures in the Boundary Reservoir cannot be lowered using operational changes.

4.1.2. Pend Oreille Watershed Aquatic Habitat Improvement Projects

As noted above, the water quality standard for temperature in the Pend Oreille River was established to protect the aquatic life designated beneficial use. The Fish and Aquatics Management Plan (FAMP) outlines measures to be taken to protect and improve aquatic habitat in tributaries to Boundary Reservoir (SCL 2010a). The settlement parties reviewed all available information on fish use and habitat in the mainstem Pend Oreille River, and its tributaries (Section 4.5.3 of the License Application Exhibit E summarizes Fish and Aquatics Resources information). The parties identified the suite of tributary measures identified in this section of the Temperature Attainment Plan as the most effective combination of measures intended to address Project water quality impacts on fish and aquatic resources.

Included in these tributary measures are plans to be implemented pursuant to agreements between SCL and the Pend Oreille PUD for removal of the Mill Pond Dam on Sullivan Creek and related habitat restoration, and cold water release from Sullivan Lake. Both of these measures are expected to improve temperature and other aquatic habitat conditions in Sullivan Creek and its delta in the Boundary Reservoir. Other tributary aquatic habitat measures include riparian plantings that will increase tributary shade, which should thereby reduce stream temperatures. Tributary measures also include physical habitat modifications designed to improve habitat for salmonids, which could improve temperatures by creating pools (i.e., deeper water that may experience lower diel fluctuations in temperature than the shallow water habitats currently present). These tributary habitat improvements would also have a direct positive effect on designated beneficial uses, i.e., salmonid spawning and rearing. Finally, reductions in tributary temperature could improve the quality of thermal refugia at the mouths of tributaries in

[4] The exact operational parameters used for this scenario are described in Khangaonkar et al. (2009).
[5] For the Boundary Forebay location "surface" refers to the top layer of the CE-QUAL-W2 model, which is 2m thick at this location.

Boundary Reservoir, which could improve salmonid habitat in the reservoir at the tributary deltas during summer. In addition to tributary habitat measures, several erosion sites on the mainstem Pend Oreille River were identified for stabilization and associated riparian planting.

4.1.2.1. Tributary Aquatic Habitat Improvements, Including Riparian Plantings

As required under the FAMP, and in coordination with the Fish and Aquatics Work Group (FAWG), aquatic habitat improvements will be conducted following issuance of the new Project license in the tributary reaches described below, or as modified by the FAWG and described in the FAMP annual reports. Mill Pond dam removal and habitat restoration is described in Section 4.1.2.1.1, and the Sullivan Lake cold water release is described in Section 4.1.2.2 below. Riparian plantings will also be conducted during the first 10 years following issuance of the new Project license in several tributary reaches, as detailed Section 4.1.2.1.1. Riparian plantings will increase tributary shade, which should thereby reduce stream temperatures. Reductions in tributary temperature could improve the quality of thermal refugia at the mouths of tributaries in Boundary Reservoir, which could improve salmonid habitat at the tributary deltas during summer. Other physical habitat modifications that are designed to improve habitat for salmonids, and could improve temperatures by creating pools (i.e., deeper water that may experience lower diel fluctuations in temperature than the shallow water habitats currently present), would also have a direct positive effect on designated beneficial uses, i.e., salmonid spawning and rearing.

These measures will be implemented in coordination with other fish and aquatics Protection, Mitigation, and Enhancement measures detailed in the FAMP. The timelines for implementation presented below were established to reflect the inter-related nature of implementation.

4.1.2.1.1. Tributary Habitat Improvements

<u>Mill Pond Dam Removal and Stream Channel Restoration</u>

As part of the proposed surrender of its license for the Sullivan Creek Project, within five years of FERC's issuance of the License Surrender Order, the Pend Oreille County Public Utility District (POPUD) will remove Mill Pond Dam and the associated log crib dam, manage sediment, restore the stream channel, implement site restoration measures, and conduct short-term monitoring and maintenance in the Mill Pond Affected Area (see Mill Pond Decommissioning Plan [POPUD 2010a]). The Affected Area shall include the stream channel, floodplain, and upland areas, from immediately downstream of Mill Pond Dam to Outlet Creek, and shall include any areas impacted by restoration or construction activity. These measures will increase the extent of habitat connectivity for native salmonids and improve aquatic habitat and water quality in Sullivan Creek, the largest tributary to Boundary Reservoir. Through an Interlocal Agreement for Mill Pond Decommissioning between SCL and the POPUD, SCL will implement the Mill Pond Decommissioning Plan. SCL will perform this work as the contractor of the PUD for the time period when the facilities and area are subject to the PUD's Sullivan Creek Project license.

Specific measures related to site restoration at the Mill Pond site as described in the Mill Pond Dam Removal and Restoration: Alternatives Analysis and Evaluation of Recommended Alternative Report (McMillen 2010) are designed to meet the following objectives:

- Restore the Mill Pond reservoir inundated area. Restoration shall include revegetation of the inundated area to plant communities consistent with the site and surrounding vegetation. The inundated area is defined as the area when the water surface elevation is 2,520 feet NAVD 88, i.e., the average water surface elevation when the concrete dam was completed.
- Restore the Affected Area, to a self-functioning system consistent with the Sullivan Creek channel upstream and downstream of Mill Pond. The restored stream channel, floodplain, and upland area will be designed to function up to, and including a flood event having a 100-year flood recurrence interval.
- Provide for the prevention, suppression, containment, eradication and/or control of invasive, non-native plant species in the Affected Area.
- Stabilize sediment left in place within the Affected Area.
- Deposit sediment material removed during site restoration in locations and at elevations to avoid mobilization and transport into the restored stream channel during flows up to, and including a flood event having a 100-year flood recurrence interval. Permanently dispose of sediment not left in place or utilized in restoration efforts at a non-National Forest Service (NFS) site.
- Implement floodplain and upland area restoration measures to prevent erosion and run-off of sediment materials into the restored stream channel during large rain events.
- Initiate stream restoration activities as soon as practicable after the start of dam removal activities so that the restoration and removal activities occur concurrently.
- Restore Sullivan Creek between Mill Pond and the confluence with Outlet Creek in a downstream direction.
- Remove Mill Pond dam and the associated crib dam in dry conditions behind the coffer dam.
- Restore the Affected Area, including any wetland areas receiving temporary direct impacts from equipment trampling. These areas shall be planted with native vegetation and restored to their pre-construction condition upon completion of restoration activities.

Following completion of the restoration effort described in the Mill Pond Decommissioning Plan, and after FERC jurisdiction over the site through the Sullivan Creek Project license ends, SCL will continue to monitor and maintain the Mill Pond area (see Section 4.2.3).

Stream and Riparian Improvements in Sullivan Creek RM 2.3 to RM 3.0 and North Fork Sullivan Creek

This measure will be implemented in Sullivan Creek, within 10 years of license issuance, from approximately 265 feet downstream of the confluence of Sullivan Creek and North Fork Sullivan Creek (RM 2.3) to RM 3.0 and consists primarily of streambank and channel enhancement but also includes riparian planting. The objectives are to decrease bank erosion on the right bank, provide instream structure to create pools and enhance deposition and retention of spawning gravel, decrease the channel width-to-depth ratio, and promote the riparian buffer along the right bank. If permitting or other issues prevent implementation of this measure over portions of the reach within 10 years after license issuance, funds equivalent to what would have been expended will be allocated to other measures in tributaries to Boundary Reservoir as determined in consultation with the FAWG and subject to the approval of the USFS for activities that occur on NFS lands.

A brief site visit that included biologists and engineers from the USFS and the SCL relicensing team suggested that the objectives could be achieved through road relocation/reconstruction or stream channel diversion. Stream channel diversion could be accomplished through the addition of log jam structures, rock barb structures, and LWD. The log jam and the barbs are anticipated to move the thalweg of Sullivan creek at least 10 feet towards the center of the channel and create at least a 10-feet wide vegetative riparian zone. This action would promote deposition of stream sediment along the existing bank; thus, reducing bank angles and providing a low lying bench appropriate for natural regeneration or riparian planting of willows and other native woody plants. SCL shall undertake additional post-license planning to add substance and detail to the conceptual plan developed in the field and to ensure that modifications do not cause adverse downstream impacts. This plan will be developed in consultation with the FAWG and subject to approval of the USFS. Implementation of this plan will result in completion of the following activities within 10 years after license issuance between RM 2.3 and 3.0:

- Design and construction of seven engineered LWD jams (1,100 cubic feet volume each)
- Placement of 10 to 20 boulders (average of 3 feet in diameter)
- Channel modifications
- Riparian plantings
- Streambank modifications at two locations (475 feet long and 317 feet long) where Sullivan Lake Road is hydrologically connected to the creek. Modifications will include decreasing the bank angle through flow redirection, structural techniques, and/or biotechnical techniques.
- Either road relocation/reconstruction or stream channel diversion at one site on Sullivan Creek (County Road 9345 in SCL Segment 4; RM 2.5-3.0).

Boulders will primarily be placed in clusters, but could also be used to anchor LWD pieces. Selection of specific structural elements and their placement will be determined as part of post-

license planning and design work, will generally follow WDFW guidelines in Saldi-Caromile et al. (2004), and will require approval of the FAWG prior to implementation.
SCL will also replace the culvert at the Sullivan Lake Road stream crossing of North Fork Sullivan Creek and place LWD in North Fork Sullivan Creek from the mouth to the North Fork Sullivan Creek Dam (RM 0.25) by License Year 15. Instream LWD placement will include 70 pieces of LWD. Of these pieces, at least 6 shall be 12 inches or greater in diameter and a minimum of 35 feet in length. The final number and size of LWD to be placed into North Fork Sullivan Creek will be approved by the FAWG and consider site-specific conditions.

Large Woody Debris Placement and Road Improvements in Sullivan Creek and Selected Tributaries Upstream of the Confluence with Outlet Creek

This measure will be implemented in Sullivan Creek and select tributaries upstream of the confluence with Outlet Creek at RM 5.3. SCL will place LWD in Sullivan Creek by Year 10 of the new license term in the amounts listed below:

- Outlet Creek to Rainy Creek – 681 pieces, of which 136 will be greater than or equal to 12 inches in diameter and 35 feet in length.
- Rainy Creek to Gypsy Creek – 330 pieces, of which 46 will be greater than or equal to 12 inches in diameter and 35 feet in length.
- Gypsy Creek to the end of fish bearing waters – 728 pieces, of which 76 will be greater than or equal to 12 inches in diameter and 35 feet in length.

Engineered log jams will account for a portion of LWD. The number of LWD jams will be determined as part of post-license planning and subject to approval by the FAWG.

SCL will implement the following road improvements along the 12 miles of Sullivan Creek Road between the mouth of Outlet Creek and Leola Creek:

- Sullivan Creek Road – Approximately 6.5 miles of road (described in Table 5.4-5) shall be reconstructed, including resurfacing with 4 inches of gravel, re-grading to divert storm water to the inside ditch, and the replacing of deficient/adding up to 35 new storm water ditch relief culverts including sediment traps or energy dissipaters as needed to reduce delivery of road-related erosion to streams. Two cutslope slides located approximately 1.5 and 1.7 miles, respectively from the junction with Sullivan Lake Road (MP 12) (described in Table 5.4-5), shall be stabilized by removing slumped material installing drainage, re-vegetating, and installing retaining structures while maintaining road width.
- Kinyon Creek – Replace FS Road 2220 culvert with a fish passable structure.
- Stony Creek – Replace FS Road 2200 culvert with a fish passable structure.
- Unnamed creek downstream of Cascade Creek– Replace culvert with a multi-plate arch structure.

Table 5.4-5 of the FAMP identifies road lengths using GIS. Preliminary estimates identify 34,190 feet of road to be regarded. This estimate will be verified during implementation planning.

SCL will implement the following road and habitat improvements in the Sullivan Creek basin upstream of Outlet Creek:

- Johns Creek – Remove the FS Road 505 culvert and implement streambank restoration within the road imprint. Replace FS Road 500 culvert with a fish-passable structure.
- Rainy Creek – Remove fish barrier at the mouth of the creek.
- Streambank stabilization near Cascade Creek – Create three engineered LWD jams from LWD currently causing bank instability; supplement with boulders and rock barbs/vanes.
- Channel and weir rehabilitation near the mouth of the unnamed creek downstream of Cascade Creek – Augment existing log weirs and redirect flows to the thalweg of the channel.

Habitat Protection, Riparian Improvement, and Stream Channel Enhancement in Sullivan Creek RM 0.30 to RM 0.54

This measure consists of two components, riparian improvement and stream channel enhancement, that will be implemented in Sullivan Creek between RM 0.3 to RM 0.54 within 10 years of license issuance. If permitting, landowner permission, or other issues prevent implementation of this measure over portions of the reach, funds equivalent to what would have been expended will be allocated to tributary measures as determined in consultation with the FAWG and subject to the approval of the USFS if they occur on NFS lands.

Riparian improvements will be implemented along the left bank for up to 1,200 feet of stream to improve shade, potential instream LWD, and erosion control. Activities in some sections of the reach would depend on obtaining easements from non-SCL landowners. Selection of specific plant species and planting locations will be determined as part of post-license planning and design work to be approved by the FAWG and following WDFW guidelines.

Stream channel enhancement will improve instream spawning and rearing habitat and channel conditions along 1,200 feet of stream via LWD (> 4 inches in diameter and > 6.6 feet long) placement (15 to 20 pieces), large boulder placement (5 to 10 boulders), and channel modification. Addition of structural elements will contribute to pool formation, retention of LWD, and retention of coarse sediment suitable for salmonid spawning. Structural elements along the left bank will help stabilize the streambank, protecting downstream property owners and decreasing bank erosion. Selection of specific structural elements and their placement will be determined as part of post-licensing implementation planning, be subject to approval by the FAWG, USFS, and Ecology, and generally follow WDFW guidelines. LWD replenishment will occur on an eight-year basis throughout the term of the license.

4.1.2.2. Cold Water Release Structure at Sullivan Dam

The POPUD and SCL have jointly examined the feasibility to utilize cold water releases from Sullivan Lake to cool water temperatures in Sullivan Creek and provide cooler water input to the Pend Oreille River and have evaluated some of the physical and potential biological effects of such withdrawals on Sullivan Lake. The evaluation demonstrates that, in conjunction with the Mill Pond Dam Removal and Stream Channel Restoration described in Section 4.1.2.1.1, a gravity water supply 48 inches in diameter, with fish screens at the inlet and using an existing low-level outlet from Sullivan Dam, is an effective method to cool water temperatures and improve native salmonid habitat conditions in Outlet and lower Sullivan creeks and provide cooler water input to the Pend Oreille River while minimizing adverse effects on Sullivan Lake (see Cold Water Release Facility Plan [POPUD 2010b]).

The cold water release facility described in the Cold Water Release Facility Plan (POPUD 2010b) is intended to address beneficial uses for Outlet and lower Sullivan Creeks by improving native salmonid habitat conditions relative to existing conditions and condition projected in the future without the cold water release and the removal of Mill Pond Dam. The projected temperature improvements (Snyder 2009) from the cold water release from June 1 through the time Sullivan Lake de-stratification (turnover) occurs address the biological requirements for some of the life stages of bull trout that are expected to occur in lower Sullivan Creek. The projected temperature improvements from the cold water release also address the needs of life stages of westslope cutthroat trout in lower Sullivan Creek that occur during the above time-periods.

SCL shall fund its share of the cost of design, permitting, construction, monitoring, operation, and maintenance of the cold water facility described in McMillen 2010 as required under the Cold Water Release Memorandum of Agreement between SCL and POPUD. It is anticipated that construction work for the cold water release will be completed within three years of FERC’s issuance of the Sullivan Creek Project License Surrender Order.

4.1.2.3. Mainstem Habitat Improvement

The settlement parties reviewed all available information on fish use and habitat in the mainstem Pend Oreille River and its tributaries (Section 4.5.3 of the License Application Exhibit E as revised March 2010). As described above, settlement parties identified tributary habitat improvements as the most effective non-operational actions to address Project effects to fisheries resources and found limited non-operational opportunities for habitat improvements on the mainstem Pend Oreille River. However, many of the measures identified in Section 4.1.2.1 occur in the tributary deltas in the Reservoir and directly benefit the mainstem. In addition, during relicensing, SCL conducted a detailed survey of the riparian plant and shrub community along the mainstem shoreline areas of Boundary Reservoir (Inventory of Riparian Trees and Shrubs Final Report, SCL 2009). The measures identified in Section 4.1.2.3.2 are the opportunities for riparian planting along the mainstem that were identified and would be consistent with habitat management and improvement goals.

4.1.2.3.1. Mainstem Large Woody Debris at Tributary Deltas

As detailed in the FAMP, SCL will enhance tributary delta habitat by providing additional cover for salmonids holding in coldwater refugia at tributary mouths. LWD jams will be placed and maintained in the thalweg in the upper delta regions of four tributaries to Boundary Reservoir. Two LWD jams will be placed at the Sullivan Creek delta and one LWD jam will be placed at the deltas of Sweet, Slate, and Linton creeks (total of 5 LWD jams)[6]. The Sullivan Creek logjams will have a total volume of not less than 1,700 cubic feet, while each LWD jam in Slate, Sweet, and Linton creeks will have a volume of not less than 530 cubic feet.

The specific location and design of the LWD jams will be determined during implementation planning by SCL, in consultation with the FAWG and subject to approval by the FAWG. LWD jams will be located in the upper ends of tributary deltas to minimize use by non-salmonids. Orientation and construction of each LWD jam will be based on site-specific hydraulic and channel conditions.

4.1.2.3.2. Mainstem Erosion Control Measures and Riparian Plantings

The following measures, including revegetation, will be implemented to reduce ongoing erosion along the shoreline of Boundary Reservoir. Greater detail regarding the analysis of the Boundary Reservoir for erosion and selection of these sites for improvement action is provided in the Erosion Study Final Report (SCL 2009). More detail on the implementation of these measures, and ongoing erosion monitoring in the Project area, is provided in the Terrestrial Resources Management Plan (SCL 2010b).

- *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. Controlling surface erosion from the recreation area will also reduce future bank erosion. 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

[6] Placement of LWD dams in deltas will take place within the first 10 years following license issuance, except in the Sullivan Creek delta, which at the direction of the FAWG, **may** take place after the tenth year, depending on the influence of Mill Pond Dam removal (see page 39 of the FAMP).

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.

4.2. Monitoring

4.2.1. Mainstem and Tributary Temperature Monitoring

SCL will use a hobo-temp (or similar device) to collect continuous mainstem temperature data from June through October at the locations shown in Table 4.2-1 (mainstem locations cited in the table correspond approximately to original monitoring stations used to calibrate the CE-QUAL-W2 temperature model). Mainstem temperature data collection will complement data collected by Ecology at its Metaline Falls station. Temperature data collection will be conducted at depth intervals in the Boundary Forebay. Due to safety concerns, SCL will work with Ecology to confirm the location of the Boundary tailrace monitoring station. The final tailrace location will be identified in the QAPP. SCL will collect data annually unless the frequency is modified through the annual QAPP review described in Section 4.2.2. These data will be provided to Ecology.

Table 4.2-1. Mainstem temperature monitoring locations in the Project area.

Site	Project River Mile
Metaline Pool	28.4
Slate Creek Pool	22.5
Boundary Dam Forebay	17.0
Boundary Dam Tailrace	16.1

SCL will also conduct continuous temperature monitoring (with a hobo-temp or similar device) at one location in each of the following tributary deltas: Sullivan Creek, Sweet Creek, and Linton Creek. The specific locations of temperature monitoring within these deltas will be determined during discussions with the WQWG and FAWG following issuance of the new Project license. Data will be collected annually from June through October, unless the frequency is modified through the annual QAPP review described in Section 4.2.2.

SCL will share equally (with the POPUD) the cost of monitoring associated with the cold water release structure at Sullivan Dam (Section 4.1.2.2). Continuous water temperature monitoring stations will be installed and maintained at two locations on Sullivan Creek: upstream of its confluence with Outlet Creek and at least 300 feet downstream of the confluence with Outlet Creek.

SCL will conduct monitoring of water and air temperatures at a single location in lower Sullivan Creek, i.e., downstream of the current location of Mill Pond but upstream of the delta. The specific location to be monitored will be determined during discussions with the WQWG and FAWG following issuance of the new Project license. Data will be collected annually from June through October, unless the frequency is modified through the annual QAPP review described in Section 4.2.2.

4.2.2. QAPP

Within six months of the issuance of the new Project license, SCL will submit a Temperature Monitoring Quality Assurance Project Plan (QAPP) to Ecology for approval. The QAPP shall follow the Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies (July 2004 Ecology Publication Number 04-03-030) or its successor.

The QAPP shall contain, at a minimum, a list of parameter(s) to be monitored, a map of sampling locations, and descriptions of the purpose of the monitoring, sampling frequency, sampling procedures and equipment, analytical methods, quality control procedures, data handling and data assessment procedures, and reporting protocols.

SCL shall review and update the QAPP annually based on a yearly review of data and data quality. Ecology may also require future revisions to the QAPP based on monitoring results, regulatory changes, changes in project operations and/or the requirements of Total Maximum Daily Load. Implementation of the monitoring program shall begin as soon as Ecology has provided the Licensee with written approval of the QAPP. Changes to the QAPP need written approval by Ecology before taking effect. Ecology may unilaterally require implementation of the QAPP.

4.2.3. Tributary Aquatic Habitat Improvement Monitoring

Compliance monitoring will occur within one year following implementation of measures identified in Section 4.1.2.1 and any repairs that are needed during the term of the license. Protocols for collecting compliance information will be developed by the FAWG as part of implementation planning. At a minimum, compliance monitoring will include documentation collected during implementation of the measure, such as survey data, records of purchased materials (LWD pieces, ballast, etc), and photographs of each site before and after measures or repairs are implemented.

SCL will conduct effectiveness monitoring beginning in the eighth year following implementation and every eight years thereafter. The purpose of the effectiveness monitoring will be to assess the tributary improvement measure’s condition to determine if structural repairs, log replenishment, additional plantings, or non-native plant removal is needed to maintain the measure’s designed functions. Criteria for determining whether a measure needs remediation will be determined during post-license planning and is subject to approval of the FAWG. The results of the effectiveness monitoring will be used to support adaptive management and adjustments to the measure at eight-year intervals. If a treatment falls below established success levels, SCL will develop a plan for remediation within 60 days, for approval of the FAWG, to correct the deficiencies. SCL shall begin implementing these remediation measures within 30-days of permit approval or as determined appropriate by the FAWG. Subsequent compliance monitoring will occur as determined by the FAWG.

SCL will monitor the Mill Pond Dam site and maintain the site to remediation design specifications following completion of dam removal and restoration efforts. SCL will monitor the Mill Pond Dam site to assess stream channel, floodplain, and upslope conditions to determine if any structures or plantings fall below the success levels established during implementation planning for the decommissioning of Mill Pond Dam (SCL 2010a). In consultation with the FAWG, SCL will adaptively manage the site and adjust and implement stream restoration components to maintain remediation benefits.

4.3. Compliance Schedule

The following table summarizes the actions to occur in this attainment plan.

Table 4.3-1. Timeline of Activities**.**

Activity	Schedule
Mill Pond Dam Removal and Stream Channel Restoration	Within five years of license issuance of the License Surrender Order for the Sullivan Creek Project
Stream and Riparian Improvements in Sullivan Creek RM 2.3 to RM 3.0 and North Fork Sullivan Creek	Within 10 years of license issuance
LWD placement and Road improvements in Sullivan Creek and Selected tributaries upstream of the confluence with Outlet Creek	By year 10 of the new license term
Habitat protection, riparian improvement, and stream channel enhancement in Sullivan Creek RM 0.30 to RM 0.54	Within 10 years of license issuance
Cold Water Release Structure at Sullivan Dam	Within three years of the issuance of the License Surrender Order for the Sullivan Creek Project
Mainstem LWD at tributary deltas; two at Sullivan, one at Sweet, Slate, and Linton Creeks	Will take place within the first 10 years following license issuance, except in the Sullivan Creek delta, which at the direction of the FAWG, may take place after the tenth year, depending on the influence of Mill Pond Dam removal (see page 39 of the FAMP).
Mainstem erosion control measures and riparian plantings	Year 7 following license issuance.

The current schedule for riparian plantings and aquatic habitat improvements is described in Section 4.1.2. Greater detail regarding the timeline and approach for implementing these measures can be found in the FAMP.

In its annual reports to Ecology, SCL will provide a table of summarized annual temperature monitoring data from sites in the Boundary Reservoir mainstem, from the deltas of Sullivan, Sweet, and Linton creeks, and at locations within Sullivan Creek (see Section 4.2.1). In addition, the annual report will summarize implementation of the aquatic habitat measures as discussed in Section 4.4.

As discussed in Sections 4 and 4.1, the Pend Oreille watershed aquatic habitat improvement measures described in this Plan are the only reasonable and feasible improvements that have been identified for addressing the Project's limited temperature effects in the Boundary Reservoir. At the end of the 10-year compliance period, SCL will have completed all the actions outlined in Section 4.1. Although implementation of all reasonable and feasible improvements as outlined above may not result in significant changes in daily maximum temperatures in the Boundary Reservoir, SCL anticipates that their implementation will result in significant improvements in aquatic habitat within tributaries, at the select erosion stabilization sites, and at tributaries' mouths in Boundary Reservoir, and therefore improve conditions for the aquatic life designated beneficial uses.

4.4. Annual Attainment Measure Implementation Reports

SCL will provide Ecology with annual reports, beginning after license issuance, as required by its 401 certification from Ecology. Annual reports will detail the implementation of riparian plantings, erosion stabilization, and other aquatic habitat enhancement measures, as well as monitoring associated with these measures.

5 REFERENCES

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SCL. 2009. Updated Study Report for the Boundary Hydroelectric Project (FERC No. 2144). Seattle, Washington. March 2009. Available online at: http://www.seattle.gov/light/news/issues/bndryRelic/br_document.asp.

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Snyder, J. 2009. Sullivan Lake Dam Outflow Temperature Impacts Model. EES Consulting, Kirkland, WA. November 2009.

Appendix 1: Temperature modeling and alternative operations analyses for Boundary Hydroelectric Project - CWA 401 Certification Support

Date:	**August 19, 2009**	Project No.:	**57415**
To:	**Christine Pratt / Seattle City Light**	Internal Distribution:	**File/LB**
From:	**Tarang Khangaonkar, Stephen Breithaupt, and Taeyun Kim**		
Subject:	**Temperature Modeling and Alternative Operations Analyses for Boundary Hydroelectric Project - CWA 401 Certification Support**		

1.0 Introduction

Seattle City Light (SCL) is currently engaged in a relicensing effort for the Boundary Hydroelectric Project. The Boundary Project is located on the Pend Oreille River in northeastern Washington State. The Project is owned and operated by SCL and was first licensed in 1961 by the Federal Energy Regulatory Commission (FERC). The existing license (FERC No. 2144) expires in 2011. SCL has adopted the Integrated Licensing Process (ILP) and has completed studies in preparation for the development of supporting documentation for its proposed operations. The studies focused on determining and evaluating the impacts of the Project and ultimately will be used to develop proposed protection, mitigation and enhancement measures to address impacts as the Project continues to operate under a new license. SCL will file its License Application with FERC on September 30, 2009.

The potential effect of hydropower on water quality is of importance to FERC as well as the Washington State Department of Ecology (Ecology). The FERC process relies on the Clean Water Act (CWA) Section 401 Water Quality Certificate to ensure that the regulatory requirements in connection with water quality compliance will be met. The 401 Water Quality Certificate is issued by Ecology and is a FERC requirement prior to the issuance of a new license for any hydropower project. The purpose of the 401 Water Quality Certificate process is to assess any water quality impacts of the Project and its continued operations and assure its compliance with Washington's water quality standards. Although several water quality variables are of interest on the Pend Oreille River, temperature is the water quality variable evaluated in this memorandum.

For the Pend Oreille River in Washington, the numerical temperature criterion is a daily maximum temperature of 20˚C, unless the temperature would be above 20˚C under Natural Conditions, in which case the criterion is Natural Conditions + 0.3˚C. Temperatures have been observed above the 20°C criterion at several locations in the Pend Oreille River. Consequently, the river was included in the CWA Section 303(d) list as impaired for temperature subject to further analysis of the Natural Condition. Ecology is currently developing a total maximum daily load (TMDL) (heat load limit) for the main stem of the river from the Idaho border to the international boundary with Canada, exclusive of waters within the Kalispel Reservation, to further assess compliance and, as necessary, to bring river temperatures into compliance with Washington Water Quality Standards. SCL has participated in the TMDL development process as a partner, conducting temperature modeling in the Boundary Reach of the Pend Oreille River, through a contract with Battelle–Pacific Northwest Division.

As part of the Pend Oreille River TMDL for temperature, Ecology has conducted the modeling for the Pend Oreille River upstream of Box Canyon Dam to the Idaho border. Ecology is coordinating with the Idaho Department of Environmental Quality (IDEQ), the Kalispel Tribe and the EPA to address the interstate and tribal temperature TMDL for the Pend Oreille River in Washington, including the Kalispel Reservation, and in Idaho. SCL developed a predictive model of temperature (using the model CE-QUAL-W2) for the Boundary Reservoir and the Pend Oreille River from the tailrace of Box Canyon Dam to the international boundary downstream of the Boundary Dam (Breithaupt and Khangaonkar 2007).[1]

This memorandum presents the results of a temperature impact assessment using the aforementioned Pend Oreille River and Boundary Reservoir temperature models, in support of the relicensing and the 401 certification processes for Boundary Dam. To assess the impact of the Boundary Project on temperature, the temperature model was first applied to establish the current temperature condition (Existing Condition). Next it was used to compare these temperature conditions to a modeled case simulating the Natural Condition in the Pend Oreille River. The Natural Condition and Existing Condition temperatures were then compared to a modeled case simulating the Existing Condition without Boundary Project. Finally, at Ecology's request, SCL investigated whether there were operational changes that could lower surface daily maximum temperatures in Boundary Reservoir. To do so, SCL evaluated the temperature effects of the most extreme operational modification possible consistent with operational constraints in order to provide an outer bound on possible alternative operational scenarios relative to current operations. The alternative operations analysis involved modeling of temperature conditions assuming run-of-river operations at a forebay elevation of 1974 feet NAVD 88 during summer months. For each condition analyzed, SCL evaluated temperature conditions at three locations within the Boundary Project: at the Metaline Pool station, which is located in the upper reservoir above Metaline Falls; at the Boundary forebay station, which is located just upstream of the dam; and at the Boundary tailrace station, which is located just downstream of the dam.

Collectively, the simulations described above are consistent with what SCL understands Ecology to be examining as part of its temperature TMDL assessment and what SCL understands Ecology will examine in its 401 assessment.[2] In this memorandum, the predicted temperatures are compared to the Existing Condition to assess any differences from current condition, as well

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[1] Breithaupt, S.A. and T. Khangaonkar. September 2007. Temperature Modeling of the Pend Oreille River, Boundary Hydroelectric Project CE-QUAL-W2 Model Calibration Report. Prepared for Seattle City Light by Battelle—Pacific Northwest Division.

[2] July 28, 2009 letter from D. Marcie Mangold (Ecology) to Barbara Greene (SCL) re: Boundary Hydroelectric Project No. 2144; Response to July 1, 2009 Letter Operations Analysis to Accompany Final Application for Section 401 Certification.

as compared to the Natural Condition temperatures to assess compliance with the temperature standard.[3]

SCL is utilizing a frequency analysis approach for assessing the effect of different scenarios on temperature because it is a better indicator of actual changes in stream temperature than comparison of instantaneous temperature results (i.e., comparing temperatures at the same day/time). A comparison of instantaneous temperature results between two scenarios could lead to erroneous conclusions about changes in the stream temperatures. Using an instantaneous comparison, it would not be possible to determine whether flow through the system was truly heated, or whether instead this was simply due to differences in travel times. In contrast, the frequency analysis approach used here looks at peak 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 recognizes that hydropower operations are not necessarily a heat source in the literal sense but can cause a redistribution of heat within the system. A detailed description and justification of the frequency analysis method is provided in Section 2 of this memorandum.

SCL is also analyzing daily maximum temperatures throughout the water column using flow weighting. The flow-weighted approach is more representative of temperatures throughout the water body because it takes into account conditions found in the entire water column, rather than using only temperatures from the water surface. A detailed description and justification of the flow-weighted approach is provided in Section 3 of this memorandum.

This memorandum is organized as follows:

- Section 2 describes the frequency analysis methodology utilized by SCL for the assessment of temperatures in the Boundary Reach of the Pend Oreille River.
- Section 3 presents the flow-weighted approach for assessing the daily maximum temperatures in the Boundary Reach.
- Section 4 presents and compares the model runs for the Existing Condition (with all dams and point sources present on the Pend Oreille River) for 2004 through 2005 and the Natural Condition (without dams or point sources) for the same 2004 through 2005 period.
- Section 5 presents the model run for the Existing Condition without Boundary Project. This describes the effects of the Existing condition with the Albeni Falls, Box Canyon and Seven Mile Dams present but with the Boundary Project removed from the model. Comparisons are made to the Natural and Existing Conditions.
- Section 6 presents the alternative operations analysis, including evaluation of an alternative operations scenario consisting of run-of-river operations with a drawdown to 1974 feet NAVD 88 elevation during the summer.
- Section 7 presents the conclusion of all the above evaluations.

[3] 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 Existing Condition temperatures were > 20ºC. During this period the applicable temperature criteria was Natural River temperature +0.3˚C

2.0 Frequency Analysis Approach for Temperature Assessment

The water quality criterion for temperature in the Pend Oreille River (WRIA 62, WAC 173-201A-602, Table 602, WRIA 62, Pend Oreille River, note 1) is as follows:

> *Temperature shall not exceed a 1-DMax of 20.0°C due to human activities. When natural conditions exceed a 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 . . .*

In other words, when the natural temperatures exceed 20˚C, the applicable criterion is the natural temperature + 0.3˚C. Natural conditions are estimated using numerical models applied to stream conditions simulated without human influence.

Assessments of compliance with the criterion have sometimes been done by direct comparisons between existing and natural temperatures for a specific day and at a specific location. This approach is appropriate for systems in which the hydrologic regime has not been altered and river flow and stage in the existing and natural conditions may be assumed to be the same (e.g., for an industrial or other point-source discharge that does not alter flow). However, in the case of systems like the Pend Oreille River, the placement of dams for hydropower generation has regulated the hydrologic response of the system, such that flows through the river system are different from the natural condition; the peak flow is earlier and larger in the Natural Condition than in the Existing Condition. The Boundary Project also operates in a peaking mode. Peaking mode operations have daily variation in flow with the highest flow during peak-electricity demand in the day and near-zero flow at night. This pulsing of discharge produces fluctuating velocities and water levels throughout the Boundary Reservoir, which alter the travel time of flow. Comparing the temperature of the Existing Condition of the Boundary Reach at a specific location and time with the Natural Condition at that same location and time results in comparison of two different parcels of water because of a significant travel time difference referred to as *lag time*.

When we compare temperatures under the Natural Condition to those under the Existing Condition, we observe this lag time effect; it is the result of two separate phenomena, travel time lag and thermal inertia. A natural river is typically shallow and well mixed and has high velocities resulting in relatively short travel or residence times. In contrast, impounded systems are deeper, of slower velocity, less well mixed vertically, and have longer residence times. In the Boundary Reservoir, this effect is illustrated with the simulation of a pulse test conducted for low summer flow conditions of approximately 11,400 cfs. Figure 2-1 shows the lag time of flow through the system, with the tracer depicting the time for a pulse to travel through the Boundary Reach for the unimpounded river (Natural) and the impounded river (Existing).[4] For the Boundary Reach, the Natural Condition has a short travel time (around 0.5 day), while the

[4] Similar results would be observed in a comparison of the Existing without Boundary Condition to the Existing Condition.

Existing Condition has a longer travel time (around 3 days). Therefore, a parcel of water leaving the Box Canyon Dam, with Boundary Dam in place (Existing Condition), lags behind that in the unimpounded river (Natural Condition) by about 2.5 days (3.1 – 0.5 = 2.6) due to the difference in travel time.

Temperature response in a reservoir also lags that in a natural river due to *thermal inertia*. A reservoir holds a considerably larger mass of water relative to a natural stream of the same length. As a result, an unimpounded river heats up much faster in response to an atmospheric forcing while a reservoir takes longer to reach the equilibrium temperature. This is illustrated in Boundary Reservoir with the help of a heat wave simulation (Figure 2-2). A hypothetical atmospheric heat pulse was applied to the existing and natural systems for a period of 7 days. The existing system with the Boundary Reservoir in place responds slowly to the atmospheric temperature increase relative to the natural system. The effect is also notable after the heat pulse is removed and the atmospheric temperatures return to the previous values. The Existing Condition takes longer to heat up and longer to recover. Figure 2-2 shows the results of this heat pulse analysis for surface water temperatures in the Pend Oreille River system at the Boundary Dam forebay location (RM 17.5). The thermal inertia lag in the Boundary Reservoir for the summer low-flow conditions is about 4.5 days. Note that in the Natural Condition, the daily temperature amplitude is much larger than in the Existing (impounded) Condition; this also reflects the thermal inertia differences.

During low-flow summer conditions, the lag effect due to a combination of travel time lag (2.5 days) and thermal inertia lag (4.5 days) is about 7 days.[5] Therefore, a comparison of instantaneous temperature values would be comparing two parcels of water separated by 7 days. This would provide an incorrect estimate of any true increase or decrease in temperature caused by heating or cooling of water. By failing to account for lag time and thermal inertia, a comparison of recorded daily maximum temperatures in the Existing Condition with the temperatures from the same days in the Natural Condition would result in an exaggerated apparent change in temperature. In reality, the corresponding peak temperature in the Natural Condition during the same period is found to reach about the same peak temperature as under the Existing Condition, it just occurs on a different day. Added complexity is induced by the fact that the lag effect is a function of daily flow rate, which not only fluctuates on a day-to-day basis, but also includes diurnal fluctuations due to the peaking mode operation of Boundary Dam.

Frequency analysis is an effective approach that has been used to address this lag time effect when comparing temperature data for different hydrologic scenarios. This approach pools all data during the period when natural temperatures exceed the numeric water quality criterion. This generally corresponds to the peak summer months of June, July, August, and September. The justification for this approach is that during the summer period, water temperatures higher than the numeric criteria occur naturally. Temperatures in the Existing Condition in Boundary Reach also exceed the 20˚C criterion, although, the timing of these peak temperatures is slightly altered from the Natural Condition due to the lag effects described above. To assess actual

[5] Note that the lag time of 7 days derived through this numerical experiment corresponds to a specific Pend Oreille River flow of 11,400 cfs. The lag time would likely vary as a function of river flow and is unrelated to the metric of 7-day average of daily maximum temperatures (7-DADM) used in temperature compliance analysis in other parts of Washington.

temperature changes under these circumstances, it is more informative and meaningful to evaluate whether the high temperatures in the Existing Condition were higher or lower due to Project operations or whether they occurred more or less frequently compared to the Natural Condition.

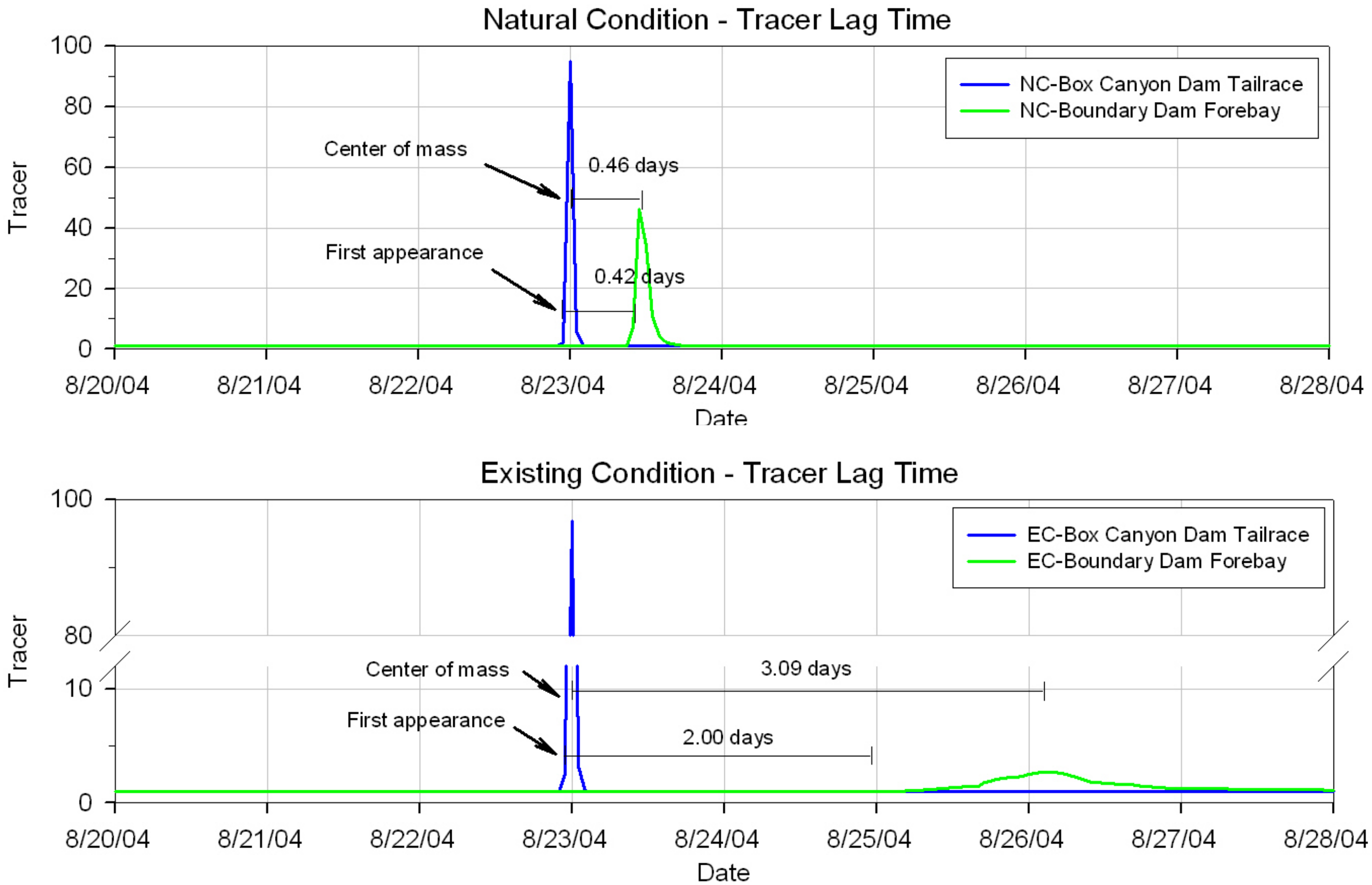
The frequency analysis approach for assessing temperature impairment has been used by the Oregon Department of Environmental Quality (ODEQ) on the Willamette River.[6] Figure 2-3 shows an example analysis conducted along a reach of the Willamette River using flow-weighted temperatures over a stated period. Instead of being plotted as a time series of temperature, the data are represented as a cumulative frequency plot of exceedance temperatures along with their percentile frequencies. Both the project and no-project conditions are shown, and the differences in the temperatures at each quantile are shown. In Washington, frequency analysis technique was used successfully by U.S. EPA to show that temperatures at Bonneville Dam exceed the 20˚C criterion more frequently (impounded) than in Natural Conditions (unimpounded).[7]

To provide a more reliable comparison of temperatures under different scenarios and to address the lag effects inherent in such a comparison, the temperature analyses in Boundary Reservoir were conducted using a frequency analysis approach.

The frequency analysis of temperature data was conducted using the following steps:

1. The daily maximum temperatures for the periods July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005, when observed temperatures were above 20 ˚C, were sorted from highest to lowest. This was done for the Existing and Natural Conditions, as well as for the alternative scenarios consisting of the Existing Condition without Boundary Project and the alternative operations analysis (run-of-river operations with a drawdown to 1974 feet elevation). The cases were developed using identical periods so they all would have the same number of daily maximum temperature values.
2. A rank value was assigned to each temperature value. The highest value was assigned the number 1 and the lowest the number N (the total number of values in the period).[8]
3. A percentage of the rank value based on the total number of values in the given time period was computed. This is the frequency of occurrence of the value (sometimes referred to as percentile or quantile).
4. To find the difference in temperature at each frequency value, the temperature of the reference scenario was subtracted from the case under consideration.
5. The maximum positive and negative difference between the cases being compared was noted.

[6] ODEQ. September 2006. *Willamette Basin TMDL*. Chapter 4 – Temperature Mainstem TMDL and Subbasin Summary.
[7] U.S. EPA. October 18, 2001. Problem Assessment for the Columbia/Snake River Temperature TMDL. *Preliminary Draft.*
[8] For example, the Existing Condition at the Boundary Reservoir forebay N is 118 for the 2004 through 2005 period.



Notes:

1. A tracer pulse is applied at the Box Canyon tailrace, tracked through the reservoir, and sampled at the Boundary Dam Forebay.
2. Parcels of water at the Forebay station for the Natural Condition arrive 2 to 3 days sooner than for the Existing Condition. At any time in the Forebay, the parcels of water for the Natural and Existing Condition are not the same.

Figure 2-1

Travel-Time Lag Through the Boundary Reservoir Reach

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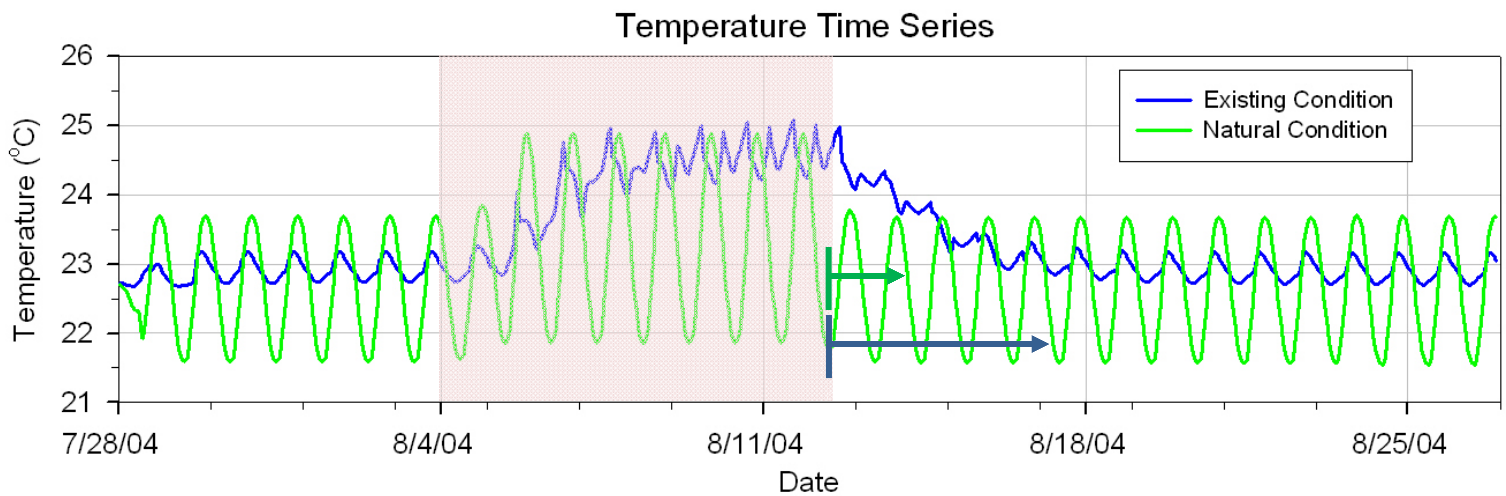

Notes:

1. This plot is a demonstration of the thermal lag (inertia) of Boundary Reservoir with the longer response time of the Existing Condition (as indicated by the blue arrow).
2. Constant inflow temperature from Box Canyon Dam was input. Variation in meteorological data was the same for each day.
3. An atmospheric heat pulse (from increased solar radiation) was applied after 7 days (8/4) to the whole system. After 7 more days (8/11), the atmospheric conditions were returned to the previous condition, thus shutting off the heat pulse. The duration of the pulse is shown by the shading.
4. Daily variations for the Natural Condition are larger than for the Existing Condition in which Boundary Reservoir dampens the daily variation.
5. The Natural Condition (as a river) responds within 1 day (green arrow), while the Existing Condition (as a reservoir) takes approximately 4 to 5 days to respond (blue arrow).

Figure 2-2

Surface Temperatures with a Hypothetical Heat Pulse at the Forebay Station of the Boundary Reach for the Existing and Natural Conditions

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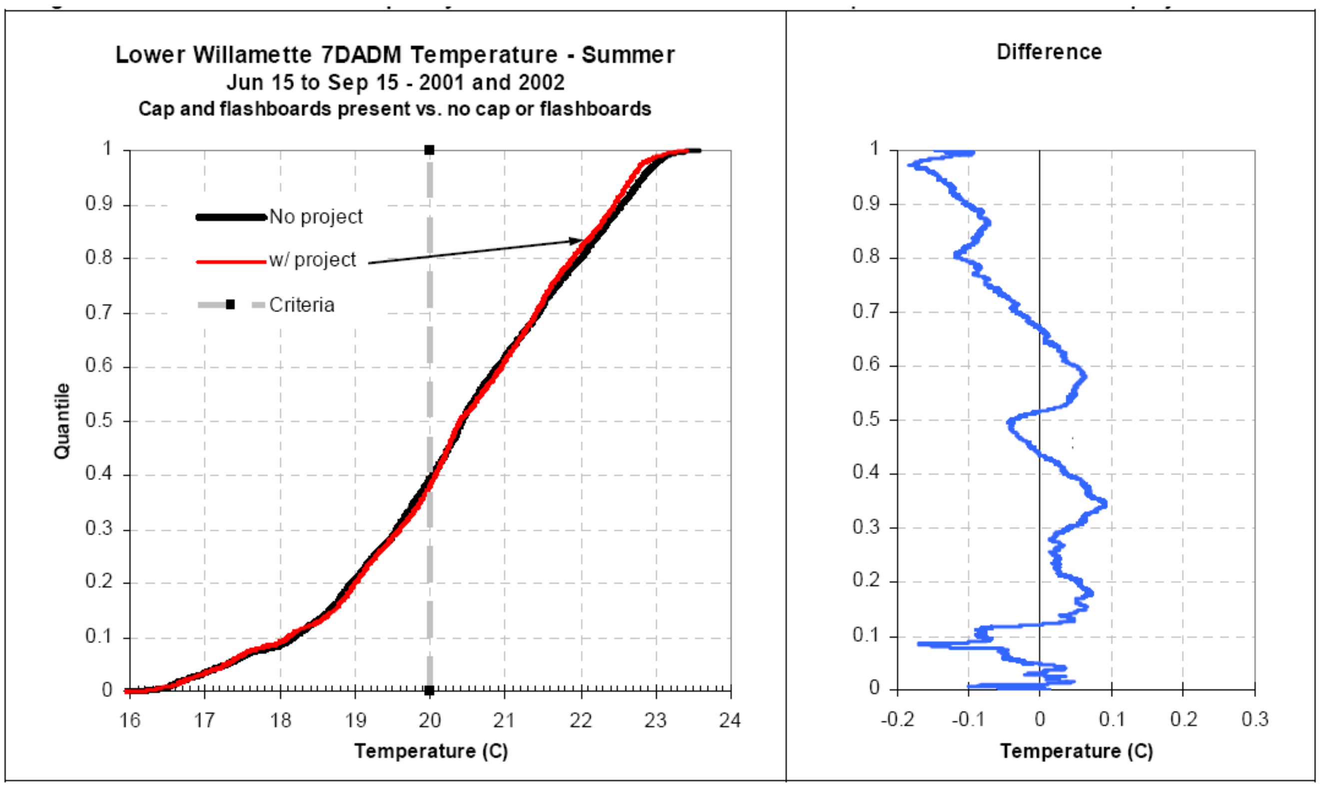

Notes:

1. The frequency is indicated by the term quantile. The flow-weighted temperatures are pooled over time (June 15 through September 15 and over length (Lower Willamette River, OR).
2. The difference in temperature at each frequency is obtained by subtracting the No Project values from the w/ Project values.
3. The figure was taken from the Willamette Basin TMDL Chapter 4 - Temperature-Mainstream TMDL and Sub-Basin Summary (ODEQ September, 2006). Cap and flashboards refers to the use of structures used to raise the water levels.

Figure 2-3

Example of Temperature Frequency Analysis from the Willamette River Total Maximum Daily Load

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3.0 Flow-Weighted Approach for Temperature Assessment

Ecology has indicated in the TMDL process that it expects to use the approach of considering only surface temperatures for compliance assessment in the Pend Oreille River. Ecology's proposed analysis would focus on data extracted from the model's top layer (upper 2 m). SCL believes that temperature analysis using flow-weighting of temperatures present throughout the water column, rather than just the highest temperature in the water column, is the more appropriate approach for this river reach that is consistent with the state temperature standards. The flow-weighted maximum temperature is more representative of the temperature conditions and distribution throughout the entire water body of the Reservoir; the highest temperature in the water column is not. Specifically, the flow-weighted daily maximum takes into account the presence of waters at depth, as well as waters at the surface, and therefore is more representative of actual conditions. By taking the entire water column into account, this analysis can provide information on whether a project is actually adding heat to the water body as opposed to just changing the distribution of heat.

The Boundary Reservoir is well mixed and the vertical variation of temperature is relatively small. This is unlike reservoirs formed by high-head dams or lakes with long residence times that can show significant temperature stratification. The observations at Boundary Dam show only a small difference in both modeled and measured temperatures from the surface waters to the bottom waters (Figure 3-1), even during the times of maximum temperature gradient on August 17, 2004 and August 1, 2005. The difference in temperature from top to bottom was about 2°C for both those dates. This shows that Boundary Reservoir does not stratify during the summer periods and that the reservoir is well mixed.

The temperature data were processed to compute flow-weighted temperature values as follows:

$$T_W = \sum_{l=1}^{n} (T_l \times Q_l) / Q_T$$

where l is a layer of the water column (l=1, 2,.., n), T_W is the flow-weighted temperature, T_l is the temperature at the layer, Q_l is the flow rate at the layer, and Q_T is the total flow. This means that the temperature of the whole reservoir at the forebay is not simply an average of the temperatures in each layer of the forebay. Rather it considers the flow in each layer. Because the reservoir is wider at the top than at the bottom, the surface layers have bigger cross-sectional area (and more volume) than the bottom layers. Also, the velocity in the surface layers is greater than in the bottom. Consequently, the flow in the surface layers, the Q_l in the equation, will be larger than in the bottom layers. In the equation, the effect on the flow-weighted temperature (T_w) also accounts for cooler temperatures in the bottom layers. Accordingly, the overall effect is a smaller temperature value than the surface temperature. In the case of the Boundary Reservoir at the forebay, the surface layer is 2-m thick, and its cross-section area is 5.5% of the total cross-sectional area, and the flow of the surface layer contributes 4.5% to the total flow in the water column.

The approach of using flow-weighted temperatures to assess compliance with water quality standards for reservoirs is not new. It has been implemented at various locations in the states of Washington and Oregon. In the Willamette River TMDL (ODEQ September 2006) the temperature analysis was conducted using flow-weighted temperatures over most of the Middle and Lower Willamette River segments including the reservoirs and pools.

In the State of Washington, the same approach of computing flow-weighted temperatures using the CE-QUAL-W2 model has been used to assess water quality compliance as part of the Rocky Reach Hydropower Project's 401 Certification process (Ecology 2006).[9,10]

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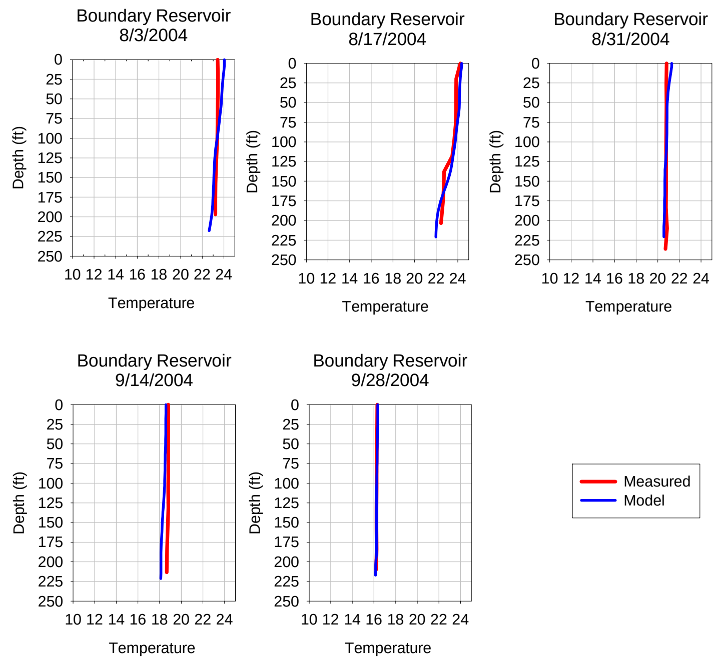
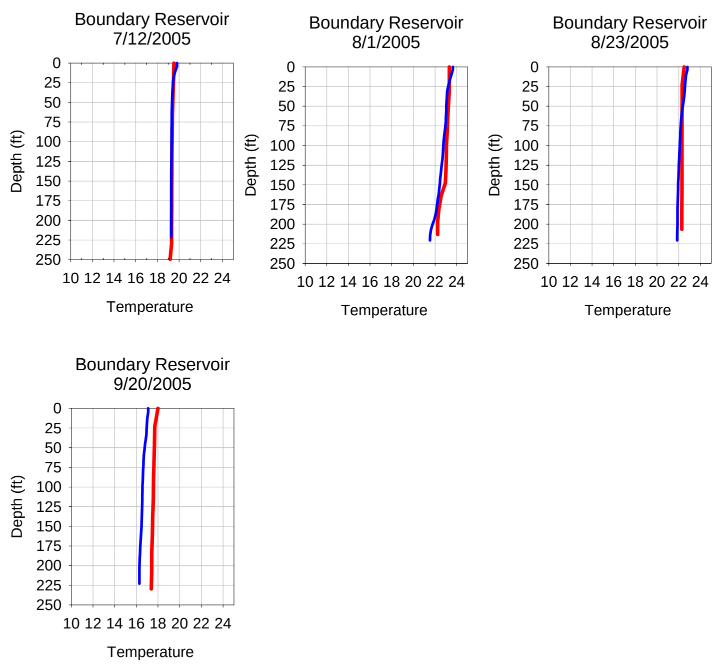
[9] Ecology. March 17, 2006. Rocky Reach Hydroelectric Project (FERC No. 2145). 401 Certification/Order No. 3155.

[10] Rocky Reach Settlement Agreement. March 2006. Chapter 2: Rocky Reach Water Quality Management Plan of the Rocky Reach Comprehensive Plan: Attachment B to the Rocky Reach Settlement Agreement.

2004



2005



Notes:

1. The temperature profiles plots are from Breithaupt and Khangaonkar (2007).
2. The temperature profiles show little variation in temperature over depth.

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Figure 3-1

Temperature Profiles at the Boundary Dam Forebay

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Seattle, WA

4.0 Temperature Assessment: Evaluation of Existing and Natural Conditions

As described in Section 1, summer temperatures in the Pend Oreille River including Boundary Reservoir exceed the 20˚C temperature criterion in the Existing Condition as well as in the Natural Condition. Therefore, the compliance assessment is based on increases in temperature relative to the Natural Condition + 0.3˚C. Hence, the modeling of the Natural Condition is important for compliance assessment and TMDL and load allocation calculations. Ecology conducted model runs in collaboration with SCL and Battelle. The temperature data evaluations conducted for this technical memorandum use the results from the Natural and the Existing Condition models that were set up by Battelle and updated by Ecology.[11] The analyses conducted in Sections 4 and 5 are based on Ecology's model applications conducted for the Pend Oreille River TMDL temperature assessment.

Table 4-1 provides the model configuration for the Existing and Natural Conditions.[12] Under the Natural Condition, all dams were removed (Boundary, Box Canyon, Albeni Falls, and Seven-Mile), no point sources remained, and shade was increased to an estimated potential natural vegetation (PNV) level.

Table 4-1
Existing and Natural Condition Configuration

Case	Pend Oreille River Dams	Point Sources	Shade
Existing	All	All	Existing
Natural	None	None	PNV

The modeling of the Existing Condition is described briefly in Section 4.1. The model setup for the Natural Condition is described in detail in Section 4.2, because it has not yet been documented as has been done for the Existing Condition (Breithaupt and Khangaonkar 2007). Section 4.3 presents the comparison between the Existing and Natural Conditions using flow-weighted temperatures; Section 4.4 does the same using surface temperatures.

4.1 Existing Condition

The Existing Condition represents the model calibration conditions for 2004 and 2005. The model simulation has been presented previously in the calibration report (Breithaupt and Khangaonkar 2007) and is not repeated in this memorandum. However, the setup and application of the model for the Natural Condition (unimpounded condition) has not been documented previously and is described in Section 4.2.

[11] Files for the Existing and Natural Conditions were received via e-mail communication from Mr. Paul Picket of Ecology on 5/4/2007.
[12] Pickett, P. May 10, 2007. Boundary Dam Temperature Modeling. Presentation to the Pend Oreille River TMDL Watershed Advisory Group.

Throughout this memorandum, comparison of temperature conditions are presented at three separate locations in the study domain: the Metaline Pool station (RM 27.1), the Boundary Reservoir forebay station (RM 17.5), and the Boundary Dam tailrace station (RM 16.9). The locations of these stations are shown in Figure 4-1. The Boundary forebay station typically has the highest surface water temperatures within the Boundary Reach.

4.2 Model Setup for the Natural Condition

The model presented in the calibration report (Breithaupt and Khangaonkar 2007) was constructed for the Existing Condition; that is, with the Boundary Reservoir and other upstream and downstream projects in place, assuming normal operating conditions. The Natural Condition corresponds to the Boundary Reach as it existed prior to reservoir construction and without other upstream or downstream projects. Due to the high bed slope in the Boundary Reach, it was necessary to represent the system as a sequence of four river reaches.

The modifications made by Battelle to construct the Natural Condition (unimpounded) inputs were as follows:

- Removed the model input for Boundary Dam.
- Computed the overall bed slope of the river reaches from bathymetry data (Breithaupt and Khangaonkar 2007) and input for each model reach:
  - above Metaline Falls – slope = 0.00038 for RM 33.9 to 27.0
  - below Metaline Falls – slope = 0.00203 for RM 27.0 to 26.0
  - Canyon Reach – slope = 0.00500 for RM 26.0 to 17.0
  - below Boundary Dam – slope = 0.00398 for RM 17.0 to 16.0.
- Included major drops in bed elevation at the Canyon Reach as spillways (or broad-crested weirs):
  - RM 22.0
  - RM 19.5
  - RM 17.2
- Removed the balance flows used in the Existing Condition to match the water surface elevations of Boundary Reservoir.

To represent the removal of Boundary Dam and other upstream and downstream projects for the Natural Condition, three changes were made to the model inputs by Ecology:

1. The shade was changed to that estimated as the potential natural vegetation.
2. The downstream boundary condition for hydrodynamics was changed to a stage-flow relationship to remove the backwater effect due to Seven Mile Dam, downstream of Boundary Dam (this essentially means that Seven Mile Dam was removed).

3. The upstream boundary conditions for flow and temperature were taken from the Natural Condition models for the Box Canyon and Albeni Falls reaches of the Pend Oreille River.[13] (Note that the timing of the unregulated flow in the Natural Condition is significantly different from that of the Existing Condition.)

Figure 4-2 shows the thalweg elevation and the simulated Natural Condition water surface elevation profile for September 11, 2005, when the flow was 4,800 cfs (136.2 m^3/s). As expected, this shows the river characteristics for the Natural Condition in the lower reservoir having much shallower depths than for the Existing Condition. At Metaline Pool and in the tailrace, there is very little change in depth between the Natural and Existing Conditions. The consequences of the shallower depth in the lower reservoir for the Natural Condition are an increase in velocity (for a given flow) and a decrease in residence time. Taken together, both the depth and velocity will influence the water temperature of the Pend Oreille River.

4.3 Comparison between Existing and Natural Conditions - Flow-Weighted Temperatures

Figures 4-3 a, b, and c present continuous time series comparisons of flow-weighted daily maximum temperatures for the Existing and Natural Conditions at Metaline Pool, Boundary forebay, and Boundary tailrace stations, respectively from January 2004 to September 2005. Note that the Natural Condition temperatures climb above the Existing Condition temperatures beginning in July of 2004 and 2005 at all stations, and that they also drop below the Existing Condition temperatures beginning in August of 2004 and 2005 at all stations. This was a result of the temperature lag of Boundary Reservoir discussed in Section 2.

Figures 4-4 a, b, and c present plots of the frequency distribution of the flow-weighted daily maximum temperatures for the Existing and Natural Conditions, as well as the differences between the frequency values. The data are from the summer periods of 2004 and 2005 when the temperatures from the Existing Condition were greater than 20ºC. Existing Condition temperatures were greater than 20ºC approximately from July 9 through September 4, 2004. In 2005, temperatures were greater than 20ºC approximately from July 8 through September 8.

The frequency analysis method predicts maximum temperature differences of 0.50˚C, 0.20˚C, and 0.19˚C between the Existing and Natural Conditions at the Metaline Pool station, Boundary Dam forebay station and, Boundary tailrace station (Table 4-2 a, b, and c), respectively. The difference between Existing and Natural Conditions includes the influence of upstream and downstream projects, the Box Canyon Dam, Albeni Falls, and Seven-Mile Dams, as well as the Boundary Project. Further analysis is required to identify the influence of the Boundary Project alone (described in Section 5).

In the frequency distribution plots (Figure 4-4 a, b, and c), note that the maximum difference does not occur with the maximum temperatures (>23ºC) but with the lower temperatures (≈21ºC) that occur as temperatures begin to decrease in the late summer. During the time of the highest temperatures (early summer), the Natural Condition temperatures are significantly higher than for

[13] Files for the Existing and Natural Conditions were received via e-mail communication from Mr. Paul Picket of Ecology on 5/4/2007.

the Existing Condition. As temperatures begin to fall during the late summer, the Natural Condition with its shorter lag time responds more quickly than the Existing Condition. Consequently, the temperature difference (Existing minus Natural) in this range of temperature is higher, even though no heating has occurred. The differences are attributed to slower cooling in the Existing Condition.

Temperature conditions were evaluated through analysis of the number of days during which maximum temperatures were above 20°C and peak annual temperatures under each condition were analyzed. Figures 4-5 a, b, and c present the number of days in which flow-weighted daily maximum temperatures are above 20°C, as well as peak annual flow-weighted temperatures, for the Existing and Natural Conditions at Metaline Pool, Boundary forebay, and Boundary tailrace stations, respectively. As already mentioned, in the Boundary Reservoir the temperatures are above the 20˚C criterion during July, August, and September in 2004 and 2005. However, as shown in Figures 4-5 a, b, and c, there were actually more days under the Natural Condition with flow-weighted temperatures higher than 20ºC at all stations than under the Existing Condition. For example, in the Boundary forebay station in 2004, 52 days are above 20ºC in the Existing Condition, and in 2005, 54 days are above the criterion. In comparison, the Natural Condition had 63 days in 2004 and 60 days in 2005 that are above 20ºC at the Boundary forebay station. Also, at all stations, the peak annual flow-weighted temperatures in the Natural Condition were higher than those in the Existing Condition (Figure 4-5 a, b, and c).

Table 4-2
Summary of Maximum Flow-Weighted Temperature Differences from Frequency Analysis Comparing Existing Condition with the Natural Condition

a. Metaline Pool

Case	Maximum ΔT relative to the Natural Condition using Flow-Weighted Temperature from Frequency Analysis (Case-Natural)	Maximum ΔT relative to Existing Conditions using Flow-Weighted Temperature from Frequency Analysis (Existing-Case)
Existing	0.50ºC[1]	0.0ºC

b. Boundary Forebay

Case	Maximum ΔT relative to the Natural Condition using Flow-Weighted Temperature from Frequency Analysis (Case-Natural)	Maximum ΔT relative to Existing Conditions using Flow-Weighted Temperature from Frequency Analysis (Existing-Case)
Existing	0.20ºC[1]	0.0ºC

c. Boundary Tailrace

Case	Maximum ΔT relative to the Natural Condition using Flow-Weighted Temperature from Frequency Analysis (Case-Natural)	Maximum ΔT relative to Existing Conditions using Flow-Weighted Temperature from Frequency Analysis (Existing-Case)
Existing	0.19ºC[1]	0.0ºC

Notes:
Period covered by the frequency analysis is July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005 when Existing Condition > 20ºC.
[1] This represents the largest difference between the maximum flow-weighted temperature cumulative frequency distributions for the Existing Condition (with all the dams in place) and Natural Condition.

4.4 Comparison between Existing and Natural Conditions - Surface Temperatures

Figures 4-6 a, b, and c present the instantaneous comparison of surface maximum daily temperatures for the Existing and Natural Conditions at Metaline Pool, Boundary forebay, and Boundary tailrace stations, respectively. As with the flow-weighted temperatures, note that the Natural Condition surface temperatures climb above the Existing Condition temperatures beginning in July of 2004 and 2005 at all stations, and that they also drop below the Existing Condition temperatures beginning in August of 2004 and 2005 at all stations. This was a result of the temperature lag of Boundary Reservoir discussed in Section 2.

Figures 4-7 a, b, and c present plots of the frequency distribution of the daily maximum surface temperatures for the Existing and Natural Conditions and the differences between the frequency values. The data, as in the previous subsection, are from the summer periods of 2004 and 2005 when the temperatures from the Existing Condition were greater than 20ºC. Existing Condition temperatures were greater than 20ºC from July 9 through September 4, 2004. In 2005, temperatures were greater than 20ºC from July 8 through September 8.

The frequency analysis method predicts maximum surface temperature differences of 0.50˚C, 0.76˚C, and 0.19˚C between the Existing and Natural Conditions at the Metaline Pool station, Boundary Dam forebay station and, Boundary tailrace stations respectively (Table 4-3 a, b, and c). The difference between Existing and Natural Conditions includes the influence of upstream and downstream projects, the Box Canyon Dam, Albeni Falls Dam and Seven Mile Dam, as well as the Boundary Project. Further analysis is required to identify the influence of the Boundary Project alone (described in Section 5).

Figures 4-8 a, b, and c present the number of days in which surface daily maximum temperatures are above 20^{o}C, as well as peak annual surface temperatures, for the Existing and Natural Conditions at Metaline Pool, Boundary forebay, and Boundary tailrace stations, respectively. As already mentioned, in the Boundary Reservoir the temperatures are above the 20 ˚C criterion during July, August, and September in 2004 and 2005. However, as shown in Figures 4-8 a, b, and c, at all stations, there were actually the same or more days under the Natural Condition with surface daily maximum temperatures higher than 20ºC. For example, at the forebay station of the Boundary Reservoir, in 2004, 58 days were above 20ºC in the Existing Condition, while in 2005, 60 days were above the criterion. In comparison, the Natural Condition had 63 days in 2004 and 60 days in 2005 that were above 20ºC. Also, at all stations, the highest surface temperatures in the Natural Condition were higher than those in the Existing Condition (Figure 4-8 a, b, and c).

Table 4-3
Summary of Maximum Surface Temperature Differences from Frequency Analysis Comparing Existing Condition with the Natural Condition

a. Metaline Pool

Case	Maximum ΔT relative to the Natural Condition using Surface Temperature from Frequency Analysis (Case-Natural)	Maximum ΔT relative to Existing Conditions using Surface Temperature from Frequency Analysis (Existing-Case)
Existing	0.50ºC[1]	0.0ºC

b. Boundary Forebay

Case	Maximum ΔT relative to the Natural Condition using Surface Temperature from Frequency Analysis (Case-Natural)	Maximum ΔT relative to Existing Conditions using Surface Temperature from Frequency Analysis (Existing-Case)
Existing	0.76ºC[1]	0.0ºC

c. Boundary Tailrace

Case	Maximum ΔT relative to the Natural Condition using Surface Temperature from Frequency Analysis (Case-Natural)	Maximum ΔT relative to Existing Conditions using Surface Temperature from Frequency Analysis (Existing-Case)
Existing	0.19ºC[1]	0.0ºC

Notes:
Period covered by the frequency analysis is July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005 when Existing Condition > 20ºC
[1] This represents the largest difference between the maximum surface temperature cumulative frequency distributions for the Existing Condition (with all the dams in place) and Natural Condition.

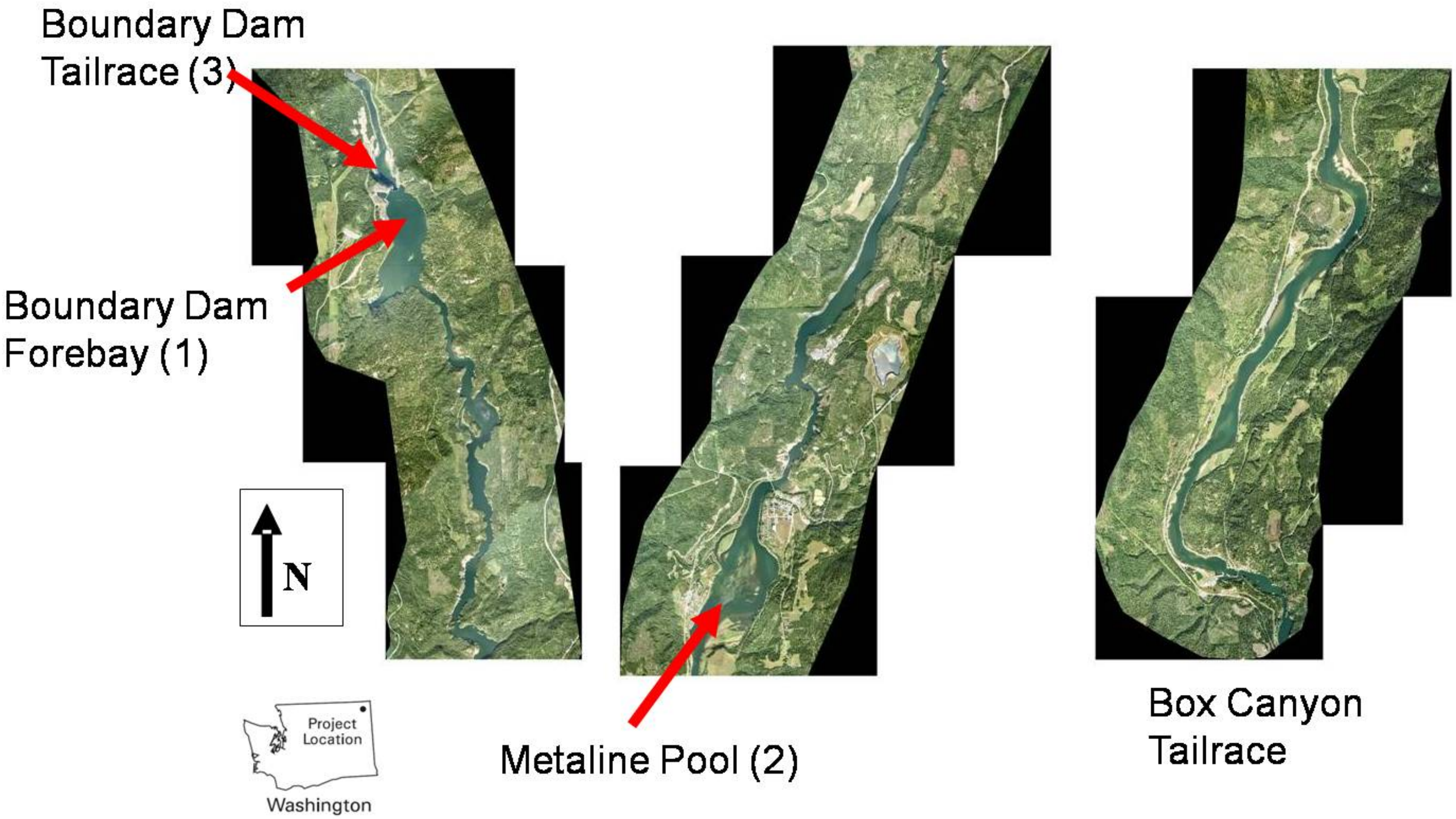

Figure 4-1

Locations of Metaline Pool, Boundary Dam Forebay, and Boundary Dam Tailrace stations

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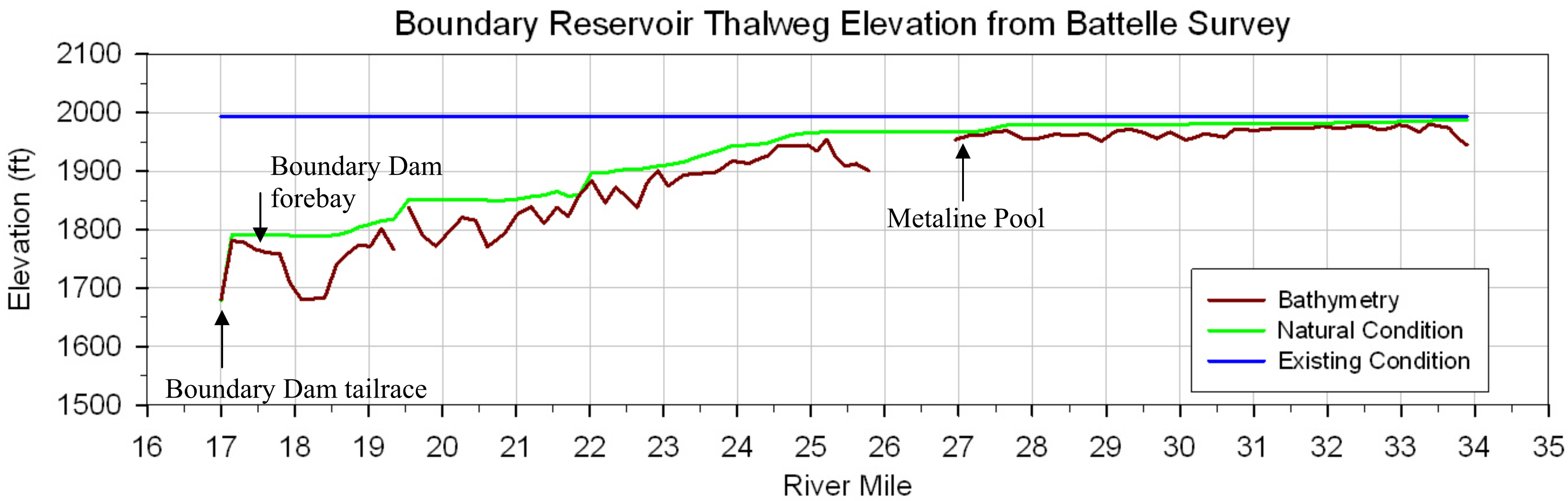


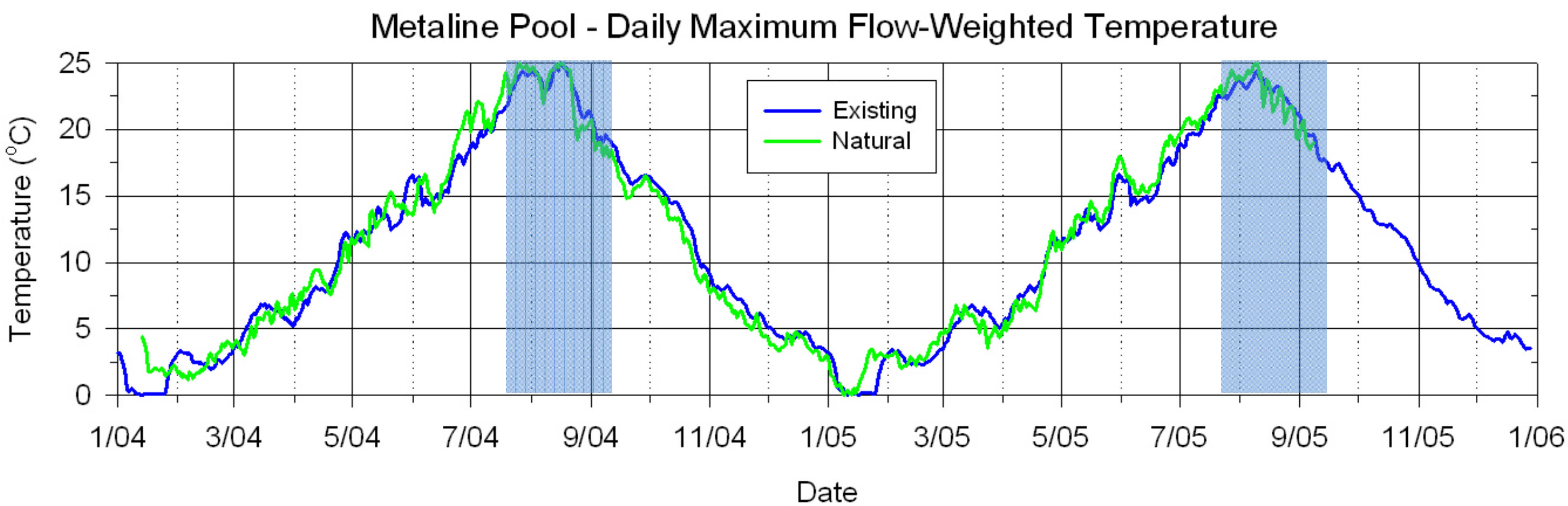
Notes:

1. This plot shows the effect on the water surface elevations from the removal of Boundary Dam in the Boundary Reach of the Pend Oreille River. Water depths are shallower than for the Existing Condition when Boundary Dam is present.
2. The results are for September 11, 2005, when the flow was 4,800 cfs (136.2 m^3/s).
3. Bathymetry data are the thalweg elevations of the channel from Breithaupt and Khangaonkar (2007).
4. Normal operating high pool elevation = 1994 ft (NAVD 88).

Figure 4-2

Water Surface Profile for the Natural Condition

Seattle City Light
Seattle, WA



Notes:

1. Daily maximum flow-weighted temperature is

$$T_W = \sum_{l=1}^{n} (T_l \times Q_l) / Q_T$$

where l is a layer of water column (l=1, 2,.., n), T_W is the flow-weighted temperature, T_l is the temperature at the layer, Q_l is the flow rate at the layer, and Q_T is the total flow.

2. The period when the Existing Condition temperature is over 20ºC is indicated by the shading.

Figure 4-3a

Daily Maximum Flow-Weighted Temperatures for the Existing and Natural Conditions at Metaline Pool

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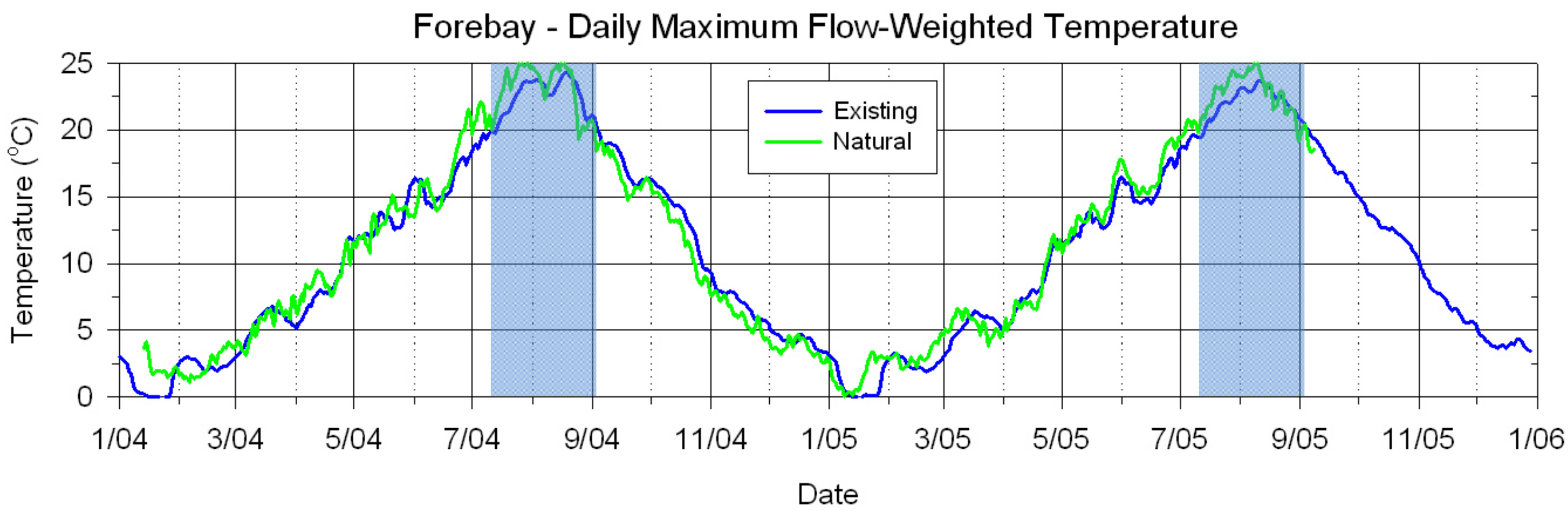
Seattle, WA



Notes:

1. Daily maximum flow-weighted temperature is

$$T_W = \sum_{l=1}^{n} (T_l \times Q_l) / Q_T$$

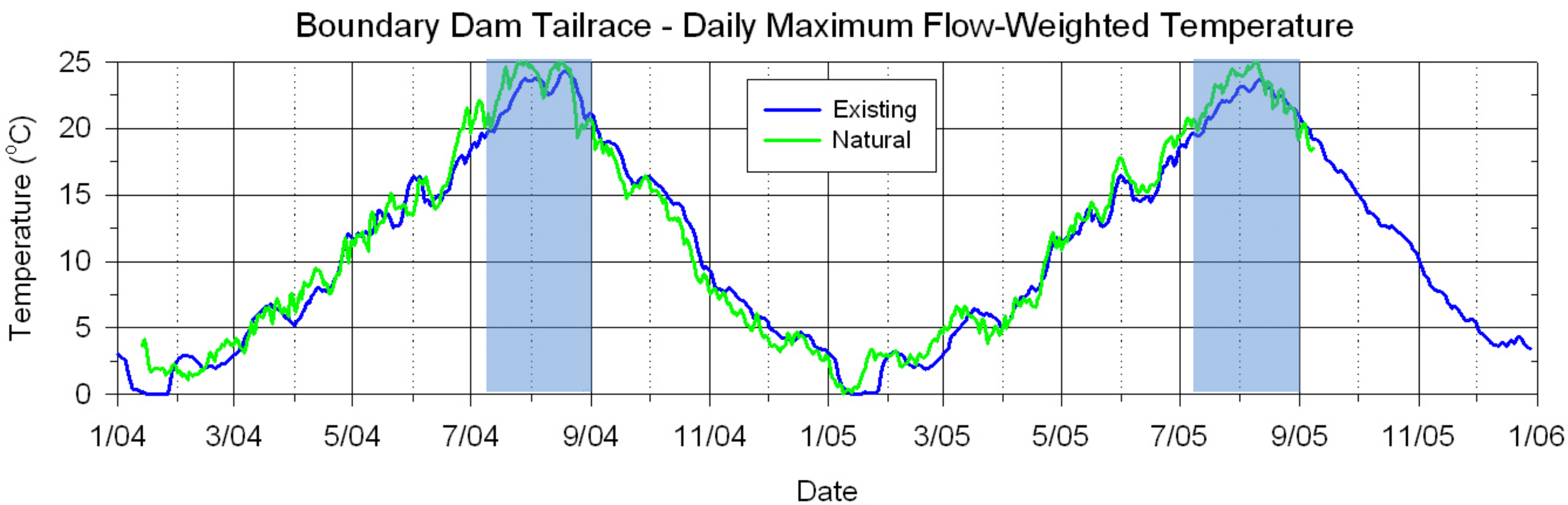
where l is a layer of water column (l=1, 2,.., n), T_W is the flow-weighted temperature, T_l is the temperature at the layer, Q_l is the flow rate at the layer, and Q_T is the total flow.

2. The period when the Existing Condition temperature is over 20ºC is indicated by the shading.

Figure 4-3b

Daily Maximum Flow-Weighted Temperatures for the Existing and Natural Conditions at Boundary Dam Forebay

Seattle City Light
Seattle, WA



Notes:

1. Daily maximum flow-weighted temperature is

$$T_W = \sum_{l=1}^{n} (T_l \times Q_l) / Q_T$$

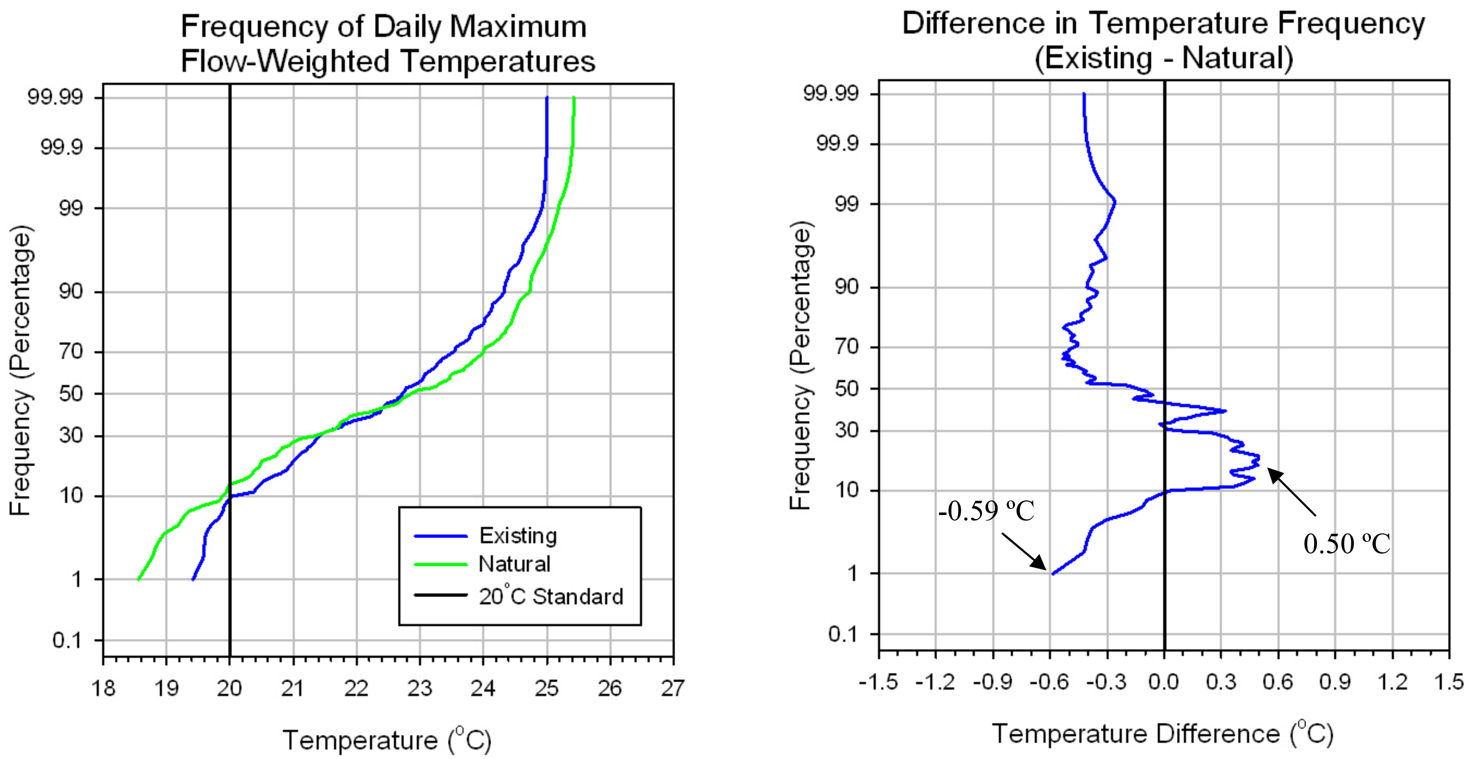
where l is a layer of water column (l=1, 2,.., n), T_W is the flow-weighted temperature, T_l is the temperature at the layer, Q_l is the flow rate at the layer, and Q_T is the total flow.

2. The period when the Existing Condition temperature is over 20ºC is indicated by the shading.

Figure 4-3c

Daily Maximum Flow-Weighted Temperatures for the Existing and Natural Conditions at Boundary Dam Tailrace

Seattle City Light
Seattle, WA



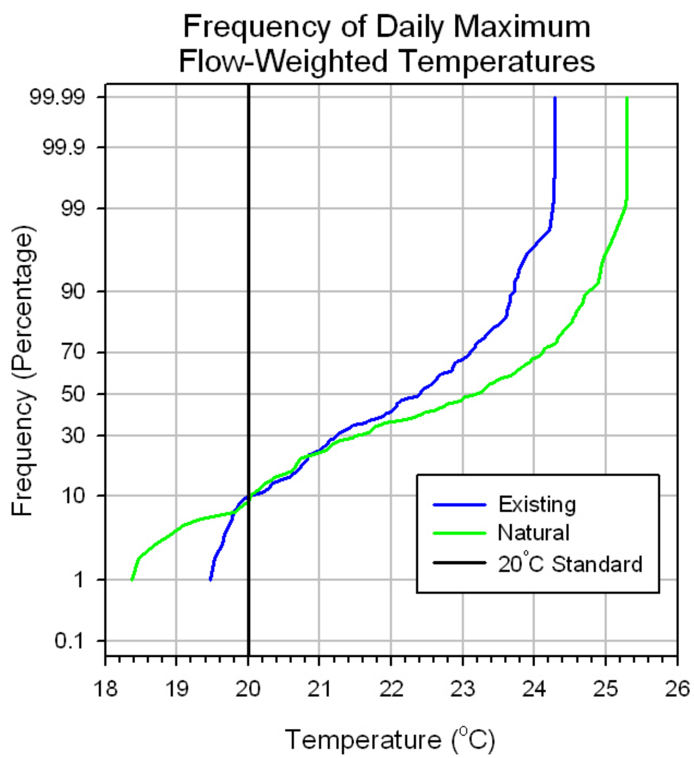
Notes:

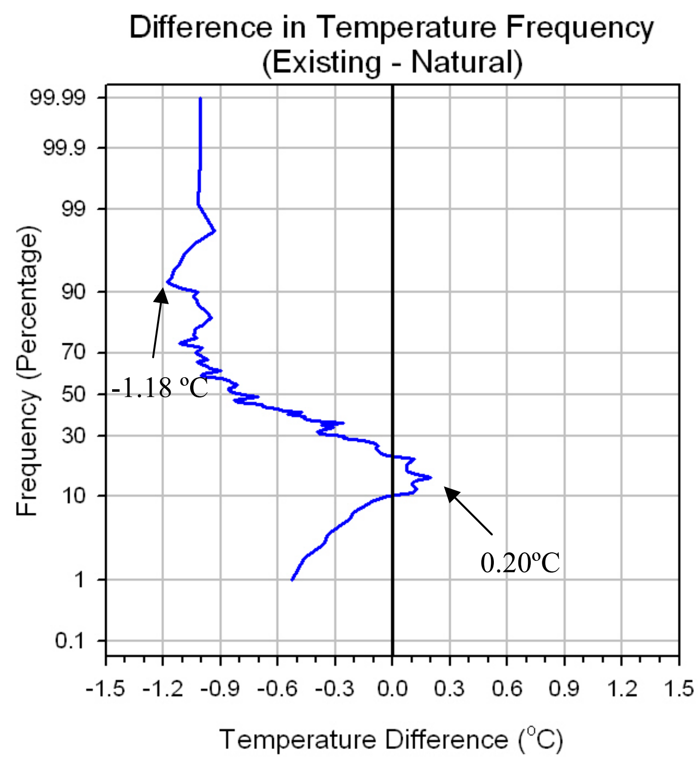
1. Frequency distributions of the maximum flow-weighted temperatures are from model results obtained from Ecology.
2. The difference in temperature at each frequency is obtained by subtracting the Natural Condition values from the Existing Condition values. (When Natural Condition is < 20ºC, the Natural temperature is replaced by the value 20ºC.)
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005.
4. Flow-weighted temperature differences are between -0.59ºC and +0.50ºC due to all the dams on the Pend Oreille River.

Figure 4-4a

Frequency Distributions of the Daily Maximum Flow-Weighted Temperatures for the Existing and Natural Conditions at Metaline Pool

Seattle City Light
Seattle, WA





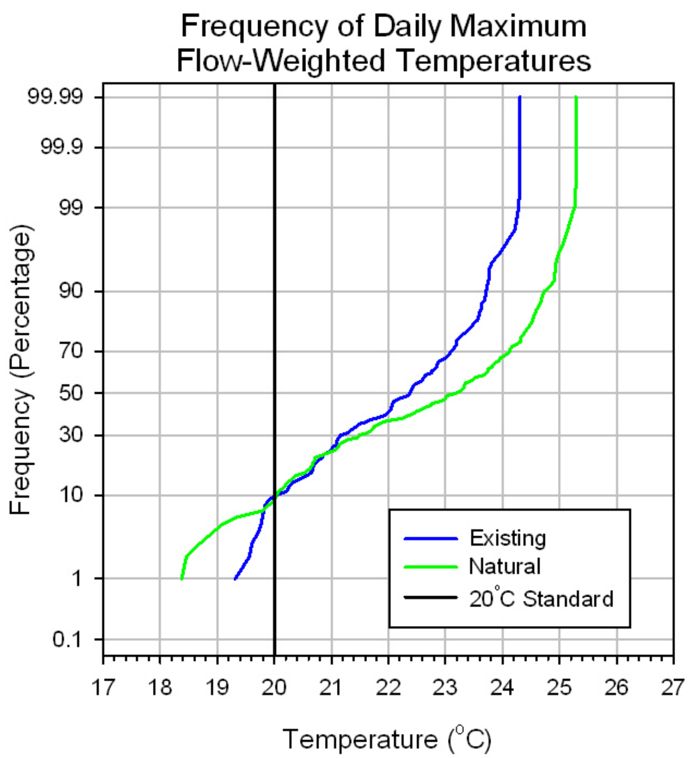
Notes:

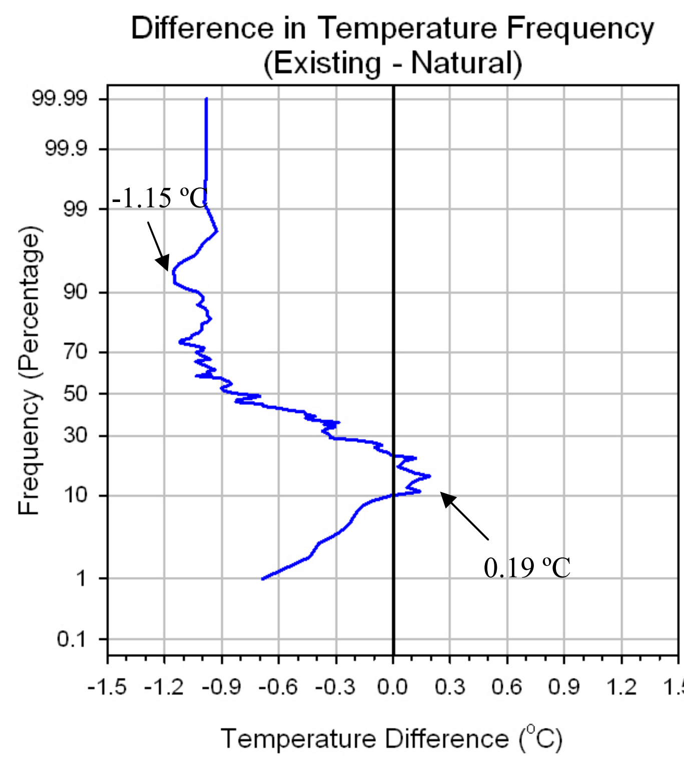
1. Frequency distributions of the maximum flow-weighted temperatures are from model results obtained from Ecology.
2. The difference in temperature at each frequency is obtained by subtracting the Natural Condition values from the Existing Condition values. (When Natural Condition is < 20ºC, the Natural temperature is replaced by the value 20 ºC.)
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005.
4. Flow-weighted temperature differences are between -1.18 ºC and +0.20ºC due to all the dams on the Pend Oreille River.

Figure 4-4b

Frequency Distributions of the Daily Maximum Flow-Weighted Temperatures for the Existing and Natural Conditions at Boundary Dam Forebay

Seattle City Light
Seattle, WA





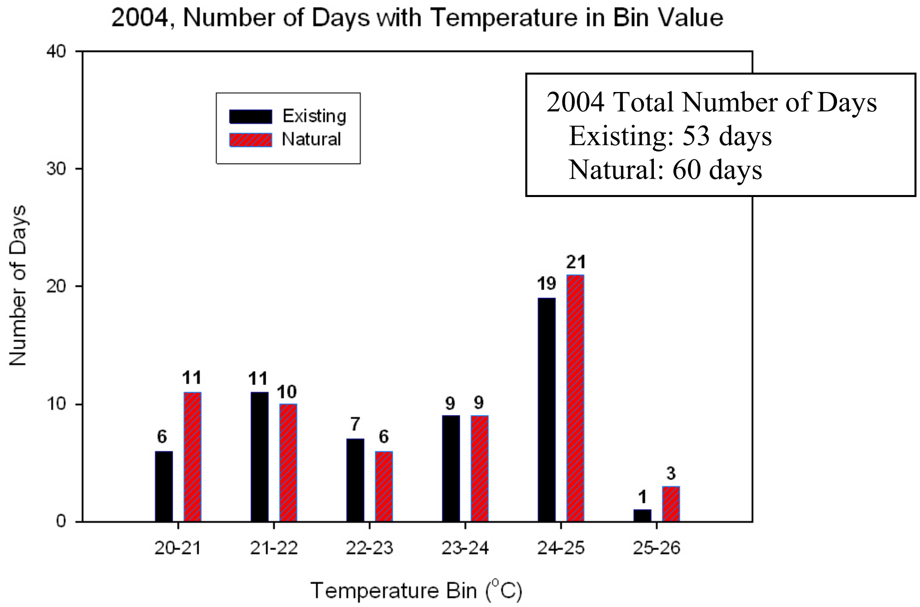
Notes:

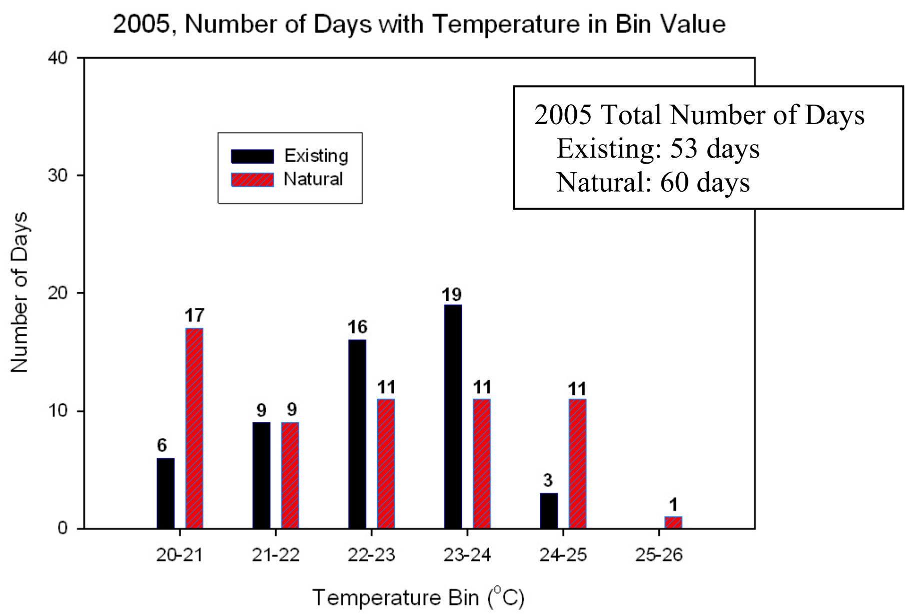
1. Frequency distributions of the maximum flow-weighted temperatures are from model results obtained from Ecology.
2. The difference in temperature at each frequency is obtained by subtracting the Natural Condition values from the Existing Condition values. (When Natural Condition is < 20ºC, the Natural temperature is replaced by the value 20ºC.)
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005.
4. Flow-weighted temperature differences are between -1.15ºC and +0.19ºC due to all the dams on the Pend Oreille River.

Figure 4-4c

Frequency Distributions of the Daily Maximum Flow-Weighted Temperatures for the Existing and Natural Conditions at Boundary Dam Tailrace

Seattle City Light
Seattle, WA





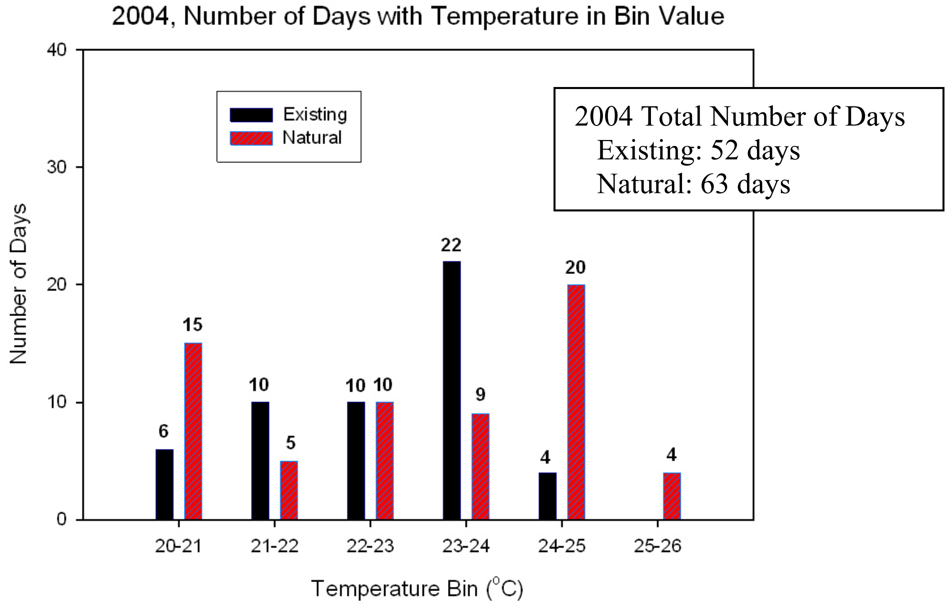
Notes:

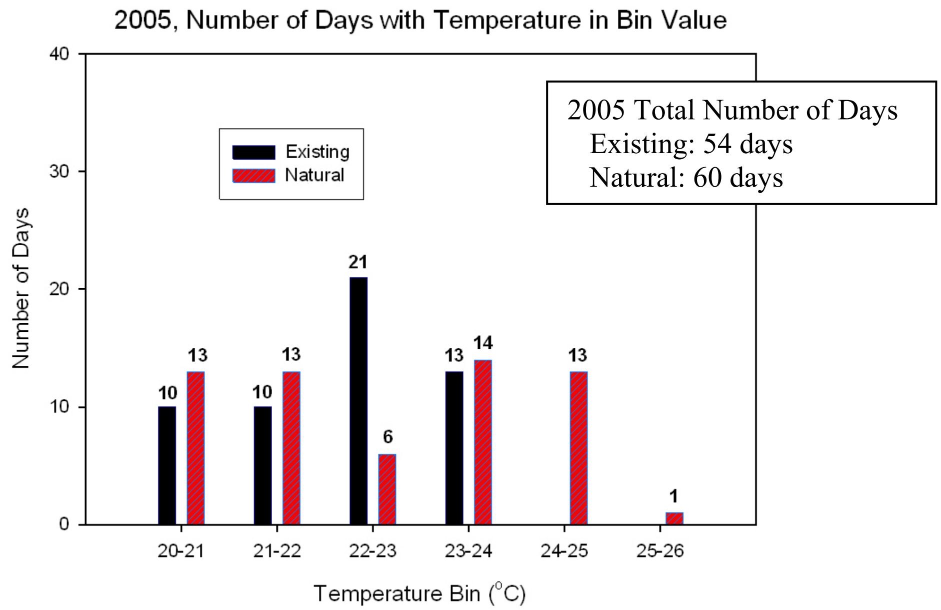
1. The total number of days for 2004 and 2005 was
   Existing – 106 days
   Natural – 120 days
2. Peak annual flow-weighted temperature at the Metaline Pool
   2004 – Existing: 25.01ºC & Natural: 25.43ºC
   2005 – Existing: 24.40ºC & Natural: 25.14ºC

Figure 4-5a

Number of Days the Daily Maximum Flow-Weighted Temperatures Exceeded 20ºC at the Metaline Pool for 2004 and 2005

Seattle City Light
Seattle, WA





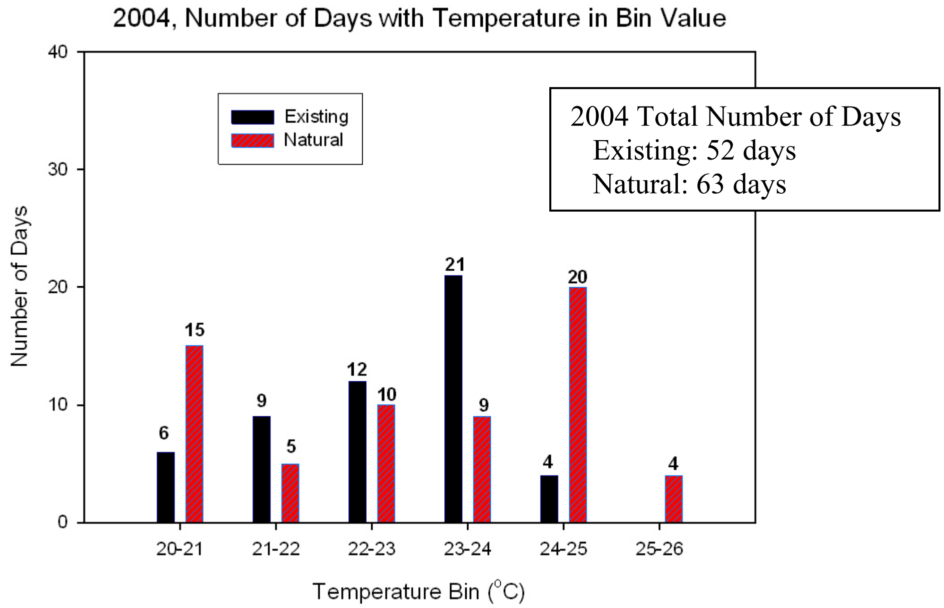
Notes:

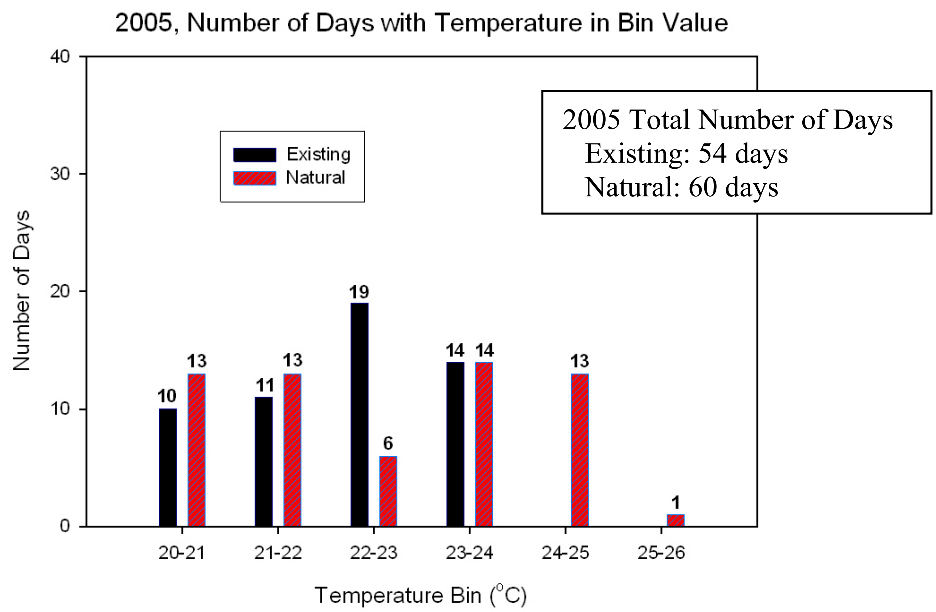
1. The total number of days for 2004 and 2005 was
   Existing – 106 days
   Natural – 123 days
2. Peak annual flow-weighted temperature at the Boundary Dam Forebay
   2004 – Existing: 24.29ºC & Natural: 25.29ºC
   2005 – Existing: 23.72ºC & Natural: 25.15ºC

Figure 4-5b

Number of Days the Daily Maximum Flow-Weighted Temperatures Exceeded 20ºC at the Boundary Dam Forebay for 2004 and 2005

Seattle City Light
Seattle, WA





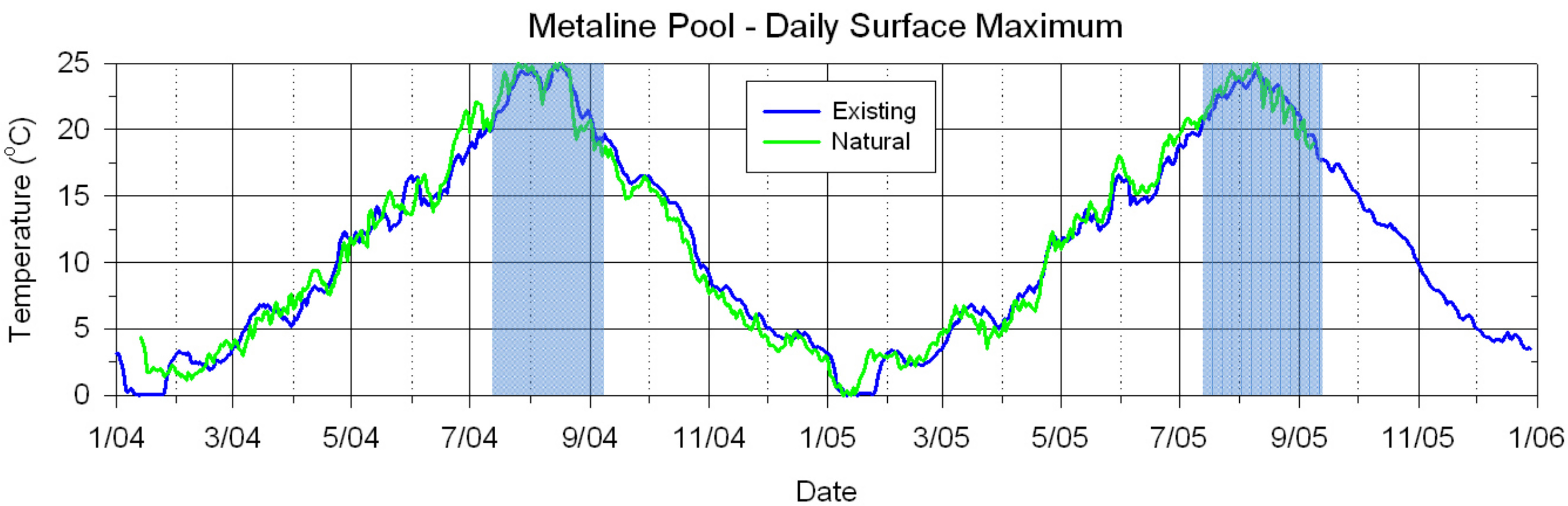
Notes:

1. The total number of days for 2004 and 2005 was
   Existing – 106 days
   Natural – 123 days
2. Peak annual flow-weighted temperature at the Boundary Dam Tailrace
   2004 – Existing: 24.31ºC & Natural: 25.29ºC
   2005 – Existing: 23.71ºC & Natural: 25.15ºC

Figure 4-5c

Number of Days the Daily Maximum Flow-Weighted Temperatures Exceeded 20ºC at the Boundary Dam Tailrace for 2004 and 2005

Seattle City Light
Seattle, WA



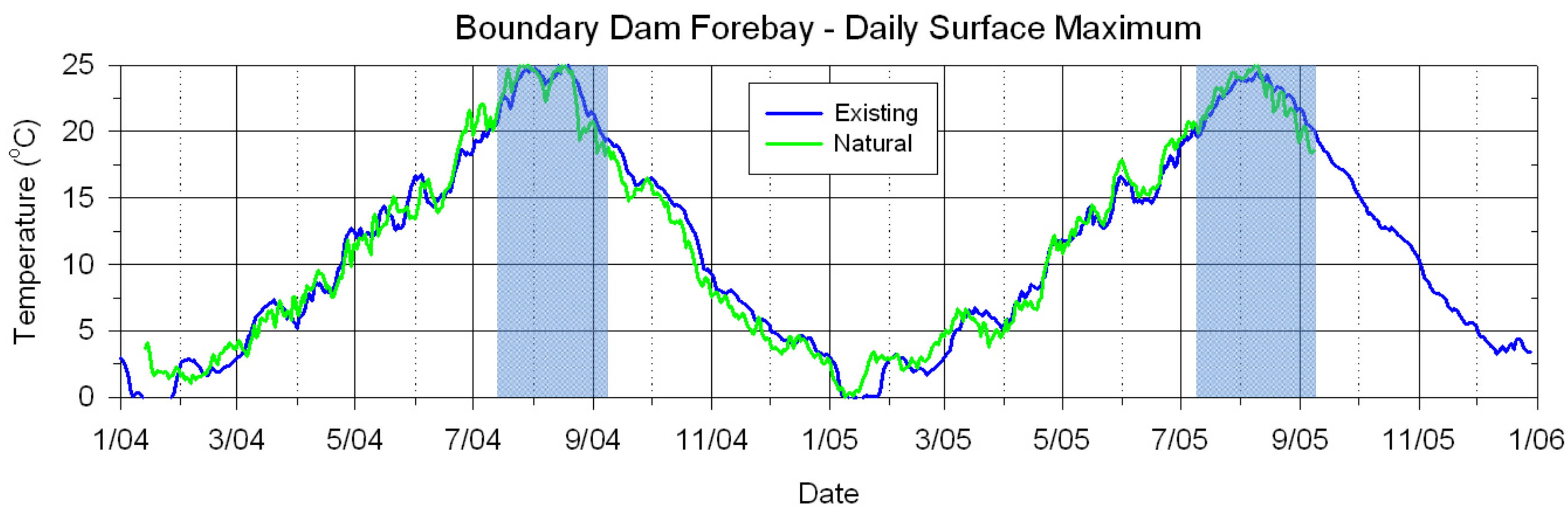
Notes:

1. Daily maximum temperatures are from the surface layer of the models.
2. The period when the Existing Condition temperature is over 20ºC is indicated by the shading.

Figure 4-6a

Daily Maximum Surface Temperatures for the Existing and Natural Conditions at Metaline Pool

Seattle City Light
Seattle, WA

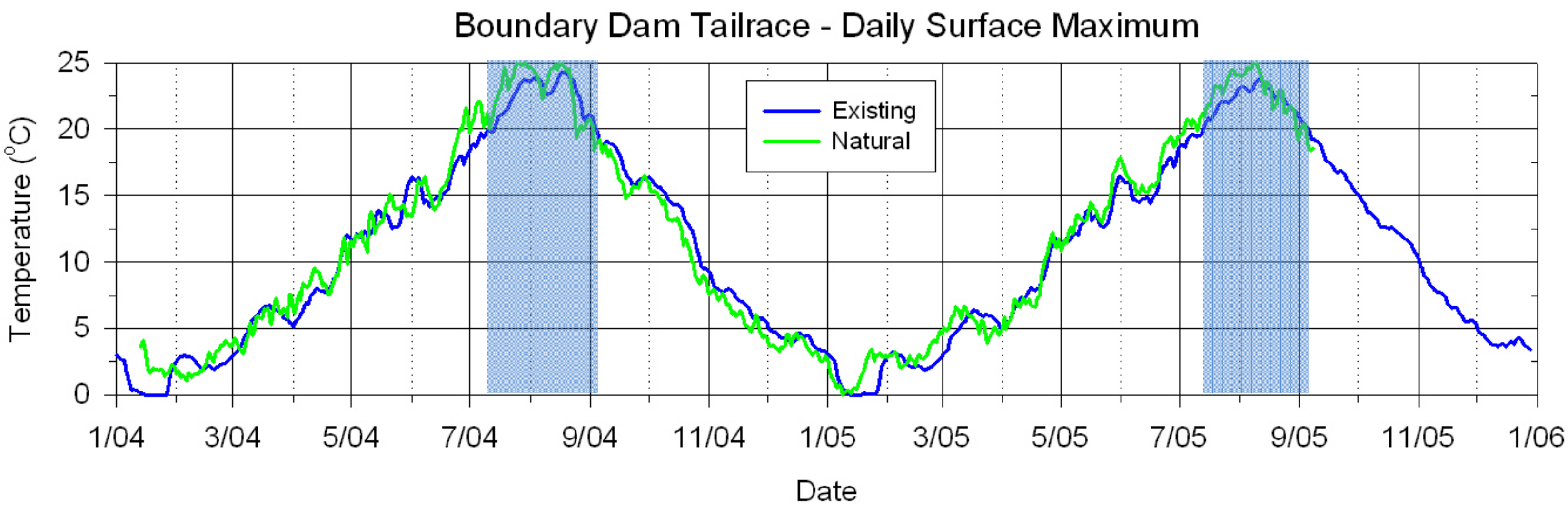


Notes:
1. Daily maximum temperatures are from the surface layer of the models.
2. The period when the Existing Condition temperature is over 20ºC is indicated by the shading.

Figure 4-6b

Daily Maximum Surface Temperatures for the Existing and Natural Conditions at Boundary Dam Forebay

Seattle City Light
Seattle, WA



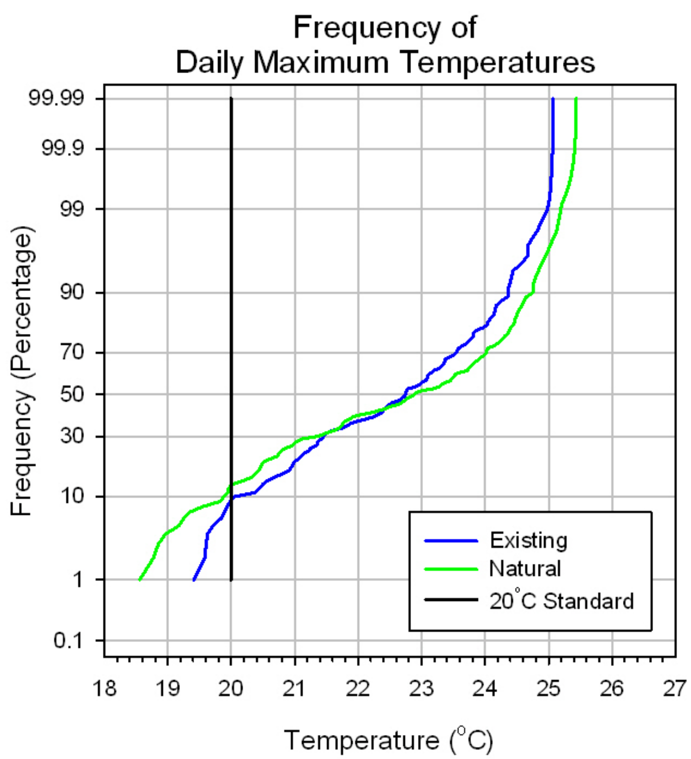
Notes:

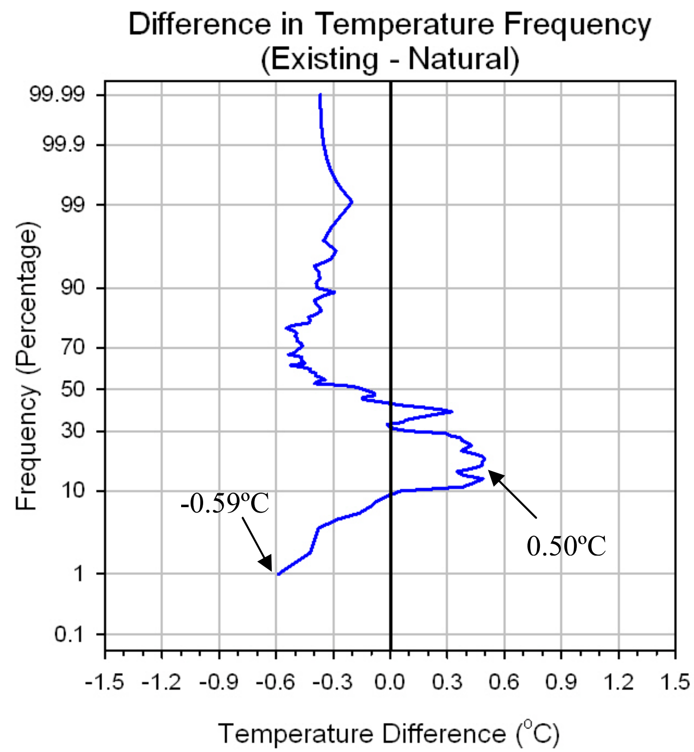
1. Daily maximum temperatures are from the surface layer of the models.
2. The period when the Existing Condition temperature is over 20ºC is indicated by the shading.

Figure 4-6c

Daily Maximum Surface Temperatures for the Existing and Natural Conditions at Boundary Dam Tailrace

Seattle City Light
Seattle, WA





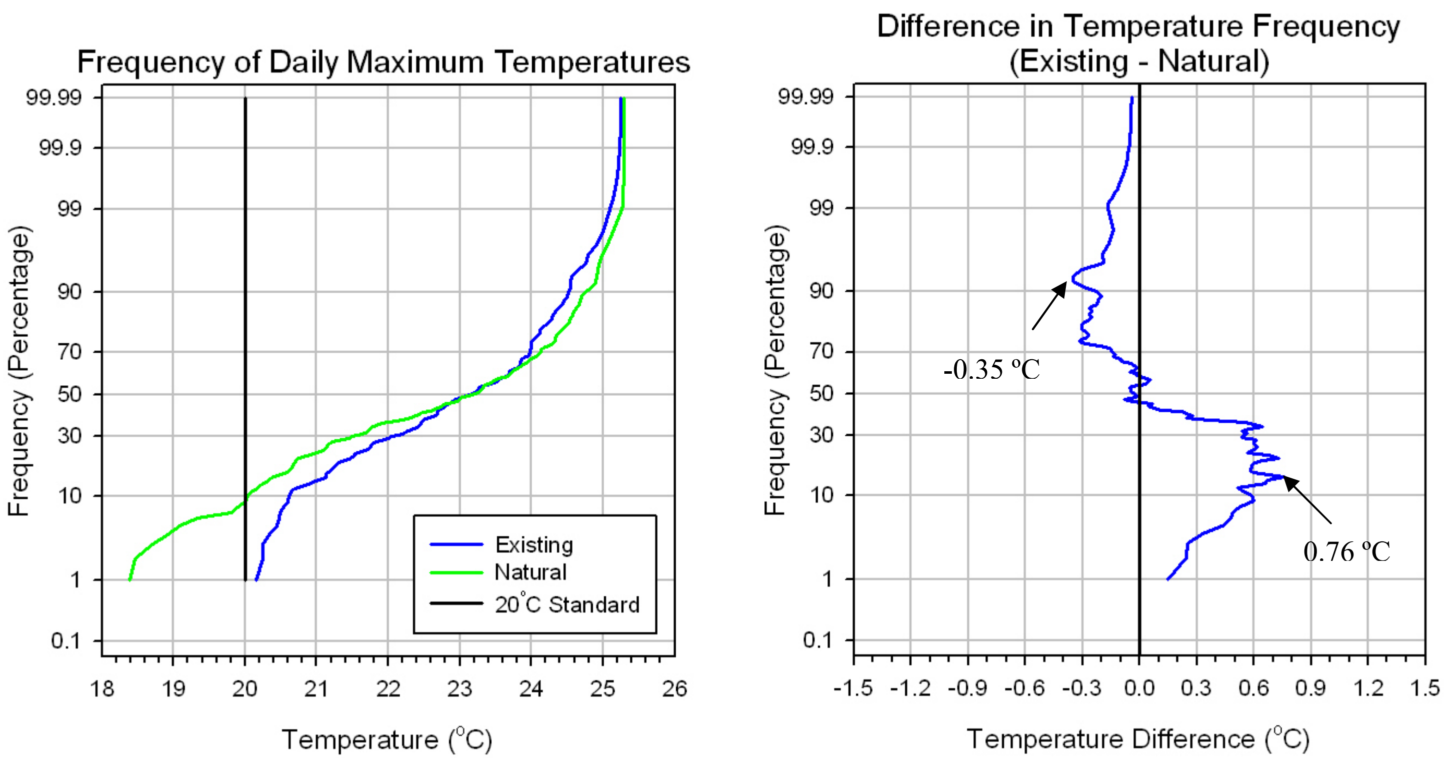
Notes:

1. Frequency distributions of the daily maximum temperatures from the surface layer of the models are from model results obtained from Ecology.
2. The difference in temperature at each frequency is obtained by subtracting the Natural Condition values from the Existing Condition values. (When Natural Condition is < 20ºC, the Natural temperature is replaced by the value 20ºC.)
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005 when Existing Condition > 20ºC.
4. Surface temperature differences are between -0.59 ºC and +0.50ºC due to all the dams on the Pend Oreille River.

Figure 4-7a

Frequency Distributions of the Daily Maximum Surface Temperatures for the Existing and Natural Conditions at Metaline Pool

Seattle City Light
Seattle, WA

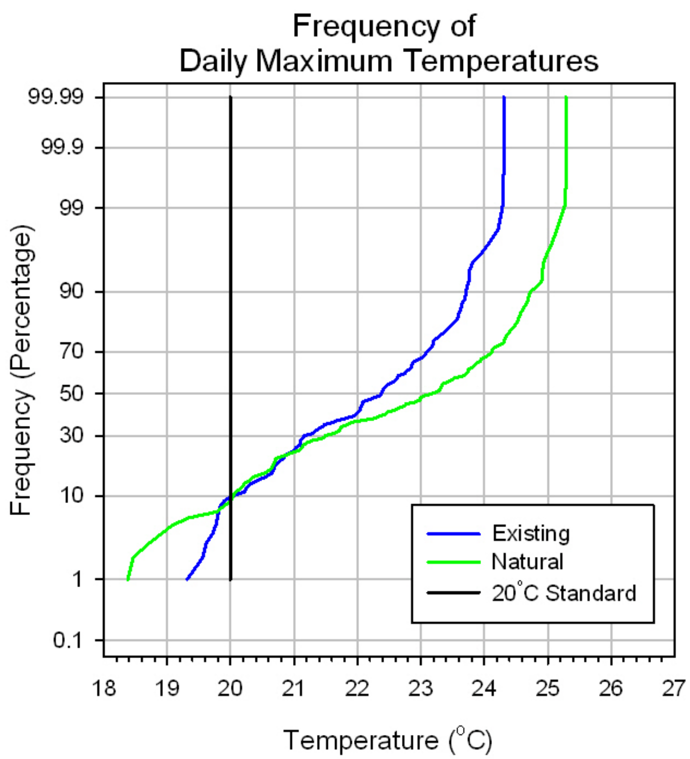


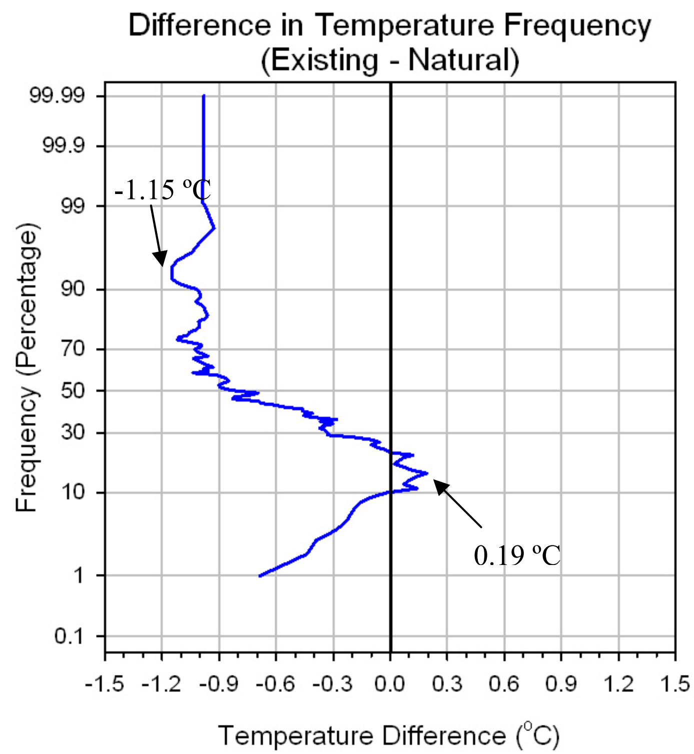
Notes:
1. Frequency distributions of the daily maximum temperatures from the surface layer of the models are from model results obtained from Ecology.
2. The difference in temperature at each frequency is obtained by subtracting the Natural Condition values from the Existing Condition values. (When Natural Condition is < 20ºC, the Natural temperature is replaced by the value 20ºC.)
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005 when Existing Condition > 20ºC.
4. Surface temperature differences are between -0.35ºC and +0.76ºC due to all the dams on the Pend Oreille River.

Figure 4-7b

Frequency Distributions of the Daily Maximum Surface Temperatures for the Existing and Natural Conditions at Boundary Dam Forebay

Seattle City Light
Seattle, WA





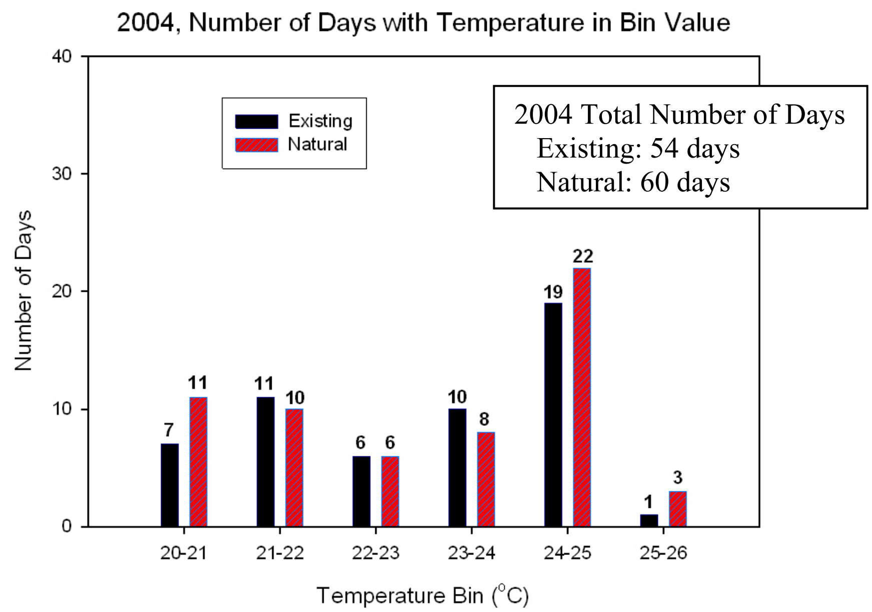
Notes:

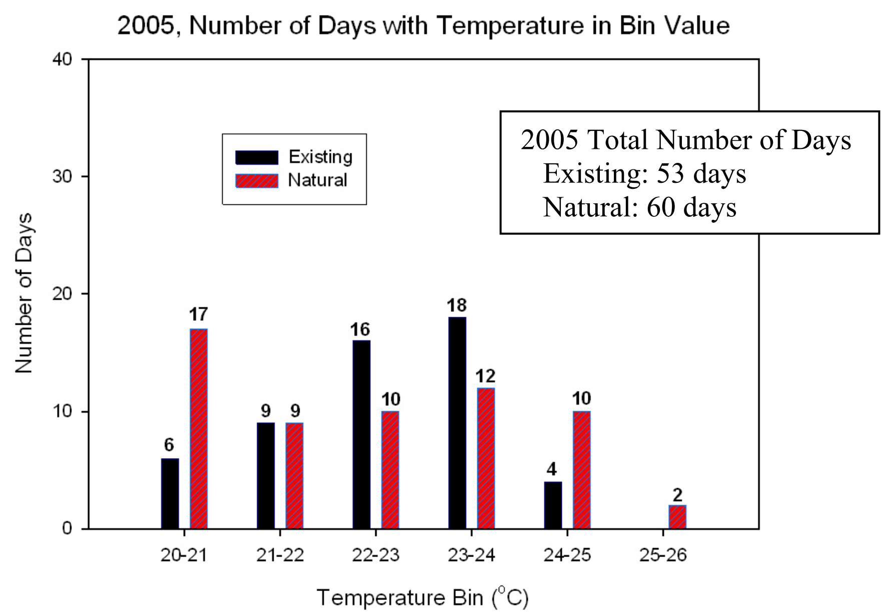
1. Frequency distributions of the daily maximum temperatures from the surface layer of the models are from model results obtained from Ecology.
2. The difference in temperature at each frequency is obtained by subtracting the Natural Condition values from the Existing Condition values. (When Natural Condition is < 20ºC, the Natural temperature is replaced by the value 20ºC.)
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005 when Existing Condition > 20ºC.
4. Surface temperature differences are between -1.15 ºC and +0.19 ºC due to all the dams on the Pend Oreille River.

Figure 4-7c

Frequency Distributions of the Daily Maximum Surface Temperatures for the Existing and Natural Conditions at Boundary Dam Tailrace

Seattle City Light
Seattle, WA





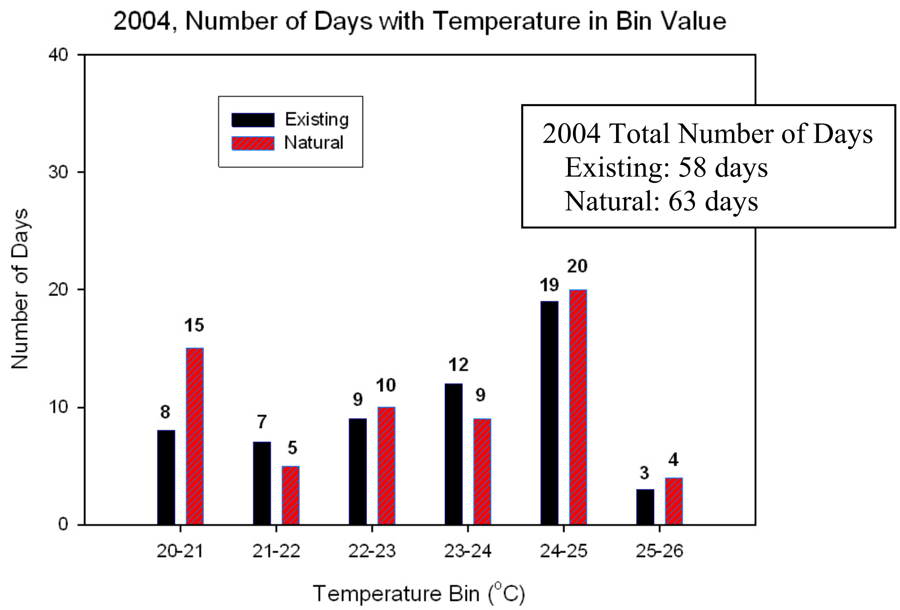
Notes:

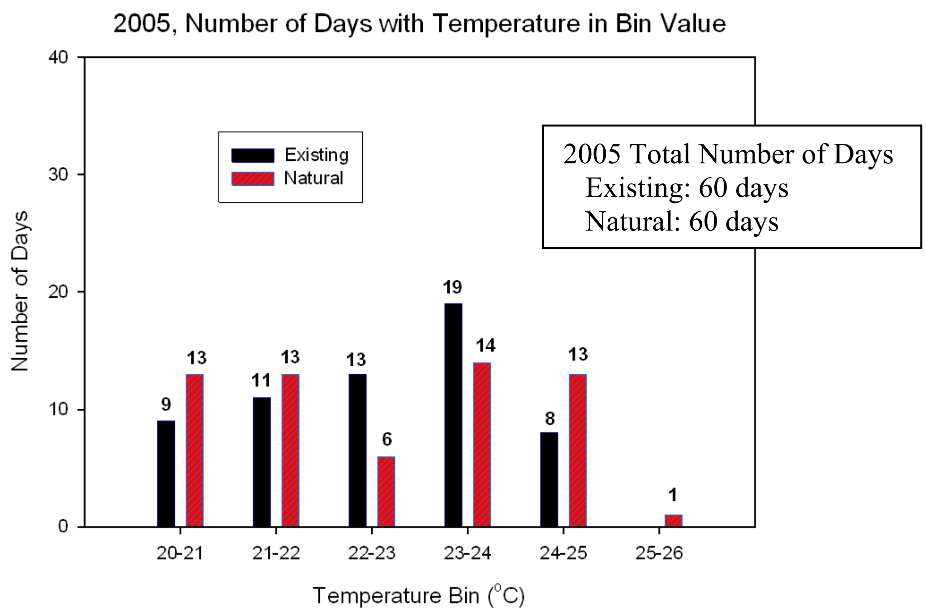
1. The total number of days for 2004 and 2005 was
   Existing – 107 days
   Natural – 120 days
2. Peak annual surface temperature at the Metaline Pool
   2004 – Existing: 25.07ºC & Natural: 25.44ºC
   2005 – Existing: 24.41ºC & Natural: 25.17ºC

Figure 4-8a

Number of Days the Daily Maximum Surface Temperatures Exceeded 20ºC at the Metaline Pool for 2004 and 2005

Seattle City Light
Seattle, WA





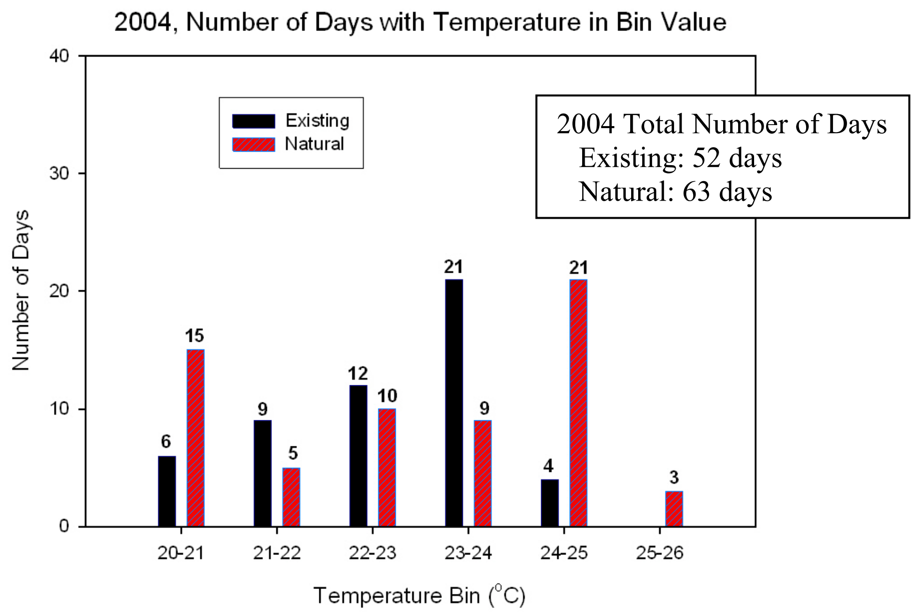
Notes:

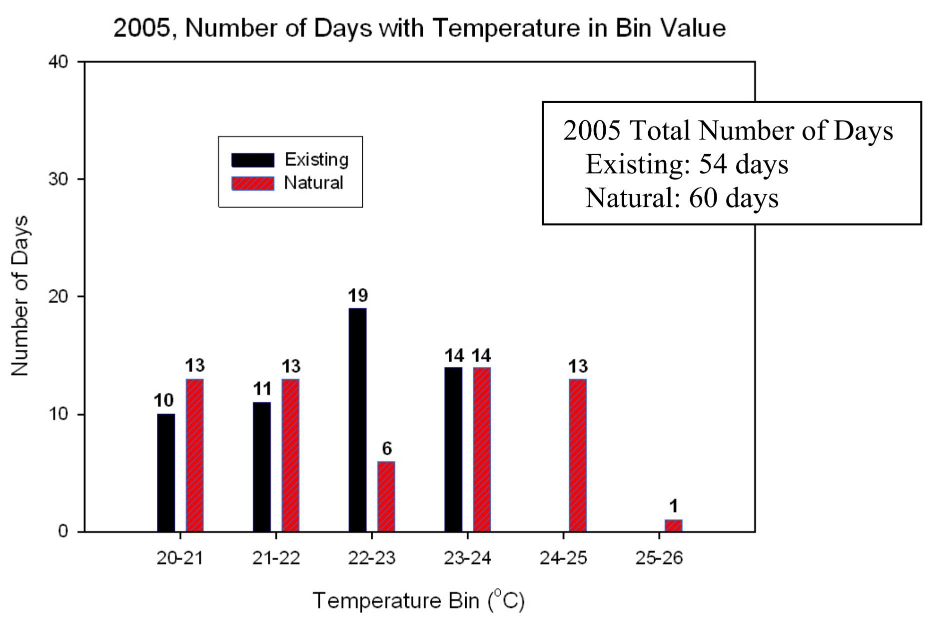
1. The total number of days for 2004 and 2005 was
   Existing – 118 days
   Natural – 123 days
2. Peak annual surface temperature at the Boundary Dam Forebay
   2004 – Existing: 25.25ºC & Natural: 25.29ºC
   2005 – Existing: 24.55ºC & Natural: 25.15ºC

Figure 4-8b

Number of Days the Daily Maximum Surface Temperatures Exceeded 20ºC at the Boundary Dam Forebay for 2004 and 2005

Seattle City Light
Seattle, WA





Notes:

1. The total number of days for 2004 and 2005 was
   Existing – 106 days
   Natural – 123 days
2. Peak annual surface temperature at the Boundary Dam Tailrace
   2004 – Existing: 24.31ºC & Natural: 25.29ºC
   2005 – Existing: 23.71ºC & Natural: 25.15ºC

Figure 4-8c

Number of Days the Daily Maximum Surface Temperatures Exceeded 20ºC at the Boundary Dam Tailrace for 2004 and 2005

Seattle City Light
Seattle, WA

5.0 Evaluation of the Existing Condition without Boundary Project

As described in Section 4, the temperature differences between Existing and Natural Conditions at the Boundary Dam forebay using the frequency analysis approach was 0.20˚C with the flow-weighted temperatures and 0.76˚C for the surface temperatures. However, these differences are not entirely due to Boundary Reservoir as they also include the influence of upstream reservoirs on the river temperatures.

As a result, separating out the Boundary Reservoir contribution requires examination of the *Existing Condition without Boundary Project.*[14] This analysis simulates the changes in temperature response in Boundary Reach without Boundary Dam but with the upstream and downstream dams (Albeni Falls, Box Canyon and Seven-Mile[15]) present; this corresponds to temperature change that would occur if Boundary Dam alone were to be removed. The effects of the upstream and downstream dams can be estimated by comparing model simulations for the Natural Condition to those for the Existing Condition without Boundary Project. Similarly, the effects of the Boundary Project can be estimated by comparing model simulations for the Existing Condition to those for the Existing Condition without Boundary Project.

Table 5-1 provides the model configurations for the Existing Condition, Natural Condition, and Existing Condition without Boundary Project.[16] Under the Existing Condition without Boundary Project, only the Boundary Dam was removed, all the point sources were present, and the shade was the same as for the Existing Condition.

Table 5-1
Model Configurations for Existing Condition, Natural Condition, and Existing without Boundary Project

Case	Pend Oreille River Dams	Point Sources	Shade
Existing	All	All	Existing
Natural	None	None	PNV
Existing without Boundary Project	Albeni Falls, Box Canyon, Seven-Mile	All	Existing

Section 5.1 presents the comparison using flow-weighted temperatures; Section 5.2 does the same using surface temperatures.

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[14] This was referred to as Alternative 4 in the list of proposed alternatives to be examined by Ecology as part of the Pend Oreille TMDL (Pickett 2007).
[15] Seven Mile Dam is not explicitly simulated. However, in the *Existing Condition* and in the *Existing without Boundary Project Condition*, the water surface elevation specified at the downstream boundary at U.S. Canadian border includes the backwater effect of Seven Mile Dam.
[16] Pickett, P. May 10, 2007. Boundary Dam Temperature Modeling. Presentation to the Pend Oreille River TMDL Watershed Advisory Group.

5.1 Flow-Weighted Temperature Evaluation

Figures 5-1 a, b, and c show time series comparisons of the daily maximum flow-weighted temperatures for the Natural Condition and the Existing Condition without Boundary Project at Metaline Pool, Boundary forebay, and Boundary tailrace stations, respectively. The peak temperatures in the Existing Condition without Boundary Project are similar to but slightly lower than the Natural Condition peaks (24-25˚C). Figures 5-2 a, b, and c present plots of the frequency distribution of the daily maximum temperatures for the Existing Condition without Boundary Project and the Natural Condition at Metaline Pool, Boundary forebay, and Boundary tailrace stations, respectively. The maximum differences in temperature at Metaline Pool, Boundary forebay and Boundary tailrace stations were 0.61˚C, 0.40˚C and 0.41˚C, respectively. These differences could be interpreted as the potential effect of upstream and downstream impoundments without the presence of Boundary Reservoir. When compared with the Existing Condition results of 0.50˚C, 0.20˚C and 0.19˚C at the same locations (Table 5-2 a, b, and c) , it can be seen that there was no improvement in the temperature difference with removal of Boundary Dam, but rather, it was actually worse. This occurred because without the Boundary Project the Boundary Reach is an unimpounded river system, with the relatively shallow and well-mixed water column subject to heating. This is in contrast to the Existing Condition in which only the surface layers are subject to summer heating, with the lower depths remaining relatively cool. It is the cooler water in the bulk of the Boundary Reservoir that keeps the flow-weighted temperature low.

The comparisons of the time series of daily maximum flow-weighted temperatures between the Existing Condition without Boundary Project and the Existing Condition are shown in Figures 5-3 a, b, and c. The frequency distributions of the daily maximum flow-weighted temperatures for the Existing Condition without Boundary Project and the Existing Condition at the Metaline Pool, Boundary forebay, and Boundary tailrace stations are shown in Figures 5-4 a, b, and c, respectively. The comparison of these two cases shows any potential change that might occur with the removal of Boundary Dam. These results show that, at all stations, the flow-weighted temperatures for the Existing Condition were the same or lower across the frequency range than for the Existing without Boundary Project. For example, the maximum difference in temperature for the frequency distributions was -0.15˚C at the Boundary forebay station. The negative value for the difference shows that, with the Boundary Dam removed, there would be no improvement in the temperature relative to the Existing Condition, but rather that flow-weighted temperatures would become higher with Boundary dam removed. The results of this comparison (Existing Condition to Existing Condition without Boundary Project) indicate that the Boundary Project is not contributing to the increases in flow-weighted temperatures observed when comparing Existing Conditions to Natural Conditions,

A summary of the maximum temperature differences discussed above for all the cases examined is presented in Table 5-2 a, b, and c corresponding to Metaline Pool, Boundary forebay, and Boundary tailrace stations, respectively. The comparison to the Natural Condition represents the difference relative to the water quality criterion,[17] while the comparison to the Existing Condition represents the change relative to the Existing Condition. For example, the 0.4˚C was

[17] The water quality criterion is the 1-DMax of 20.0°C or the Natural Condition + 0.3°C, whichever is greater. However, differences presented are not adjusted to account for the 0.3°C human use allowance.

the maximum temperature difference for the Existing without Boundary Project above the Natural Condition at the Boundary forebay station, that is, without Boundary Dam but with the upstream dams present. It also included the effect of the Boundary Reach simulated as a river. Similarly, the -0.15˚C temperature difference at Boundary forebay station for the Existing without Boundary Project compared to the Existing Condition shows there would be no improvement from removing the dam. Because these differences were from cumulative frequency distributions, they will not necessarily be additive. Because the distributions were pooled data from the analysis period and were ranked from high to low, there is not necessarily an exact one-to-one correspondence to dates. In Table 5-2 a, b, and c, we have reported the maximum temperature difference without any adjustment or accounting for the 0.3˚C human use allowance.

Figures 5-5 a, b, and c show the number of days that flow-weighted daily maximum temperatures were above 20ºC, and the peak annual flow-weighted temperatures, in Metaline Pool, Boundary forebay, and Boundary tailrace stations, respectively for the Existing Condition, Natural Condition ,and Existing Condition without Boundary Project. At all stations, the number of days with flow-weighted temperatures above 20ºC were the lowest in the Existing Condition, and were higher in both the Existing Condition without Boundary Project and in the Natural Condition. For example, for the Existing Condition without Boundary Project, 57 days were above 20ºC in 2004, and in 2005, 55 days were higher than 20ºC at the Boundary forebay location (Figure 5-5 b). In comparison, in 2004, 52 days were higher than 20ºC in the Existing Condition, while in 2005, 54 days were above 20ºC. The Natural Condition had 63 days in 2004 and 60 days in 2005 that were higher than 20ºC. Also, the peak annual flow-weighted daily maximum temperatures were lower at all stations in the Existing Condition than those in either the Natural Condition or the Existing without Boundary Project.

The data from Figures 5-5 a, b, and c are summarized in Table 5-3 a, b, and c. They indicate that, at all locations, the Existing Condition had fewer days with flow-weighted temperatures above 20ºC, and had lower peak annual flow-weighted temperatures than did the Natural Condition or the Existing Condition without Boundary Project. Accordingly, the Boundary Project does not increase the number of days with flow-weighted temperatures above 20ºC or increase the peak annual flow-weighted daily maximum temperatures.

5.2 Surface Temperature Evaluation

Figures 5-6 a, b, and c show a comparison of the time series of the daily maximum surface temperatures for the Natural Condition and the Existing Condition without Boundary Project at Metaline Pool, Boundary forebay, and Boundary tailrace stations, respectively. The peak temperatures in the Existing Condition without Boundary Project were relatively unchanged from the Natural Condition peaks (≈ 25˚C). Figures 5-7 a, b, and c present plots of the frequency distribution of the daily maximum surface temperatures for Existing Condition without Boundary and the Natural Condition at Metaline Pool, Boundary forebay, and Boundary tailrace stations respectively. For example, the maximum difference in temperature was 0.40˚C at the Boundary forebay station. This difference could be interpreted as the potential effect of upstream impoundments at the Boundary Dam forebay station without the presence of Boundary Reservoir.

The comparison of the time series of the daily maximum surface temperatures between the Existing Condition without Boundary Project and the Existing Condition is shown in Figures 5-8 a, b and c at Metaline Pool, Boundary forebay, and Boundary tailrace stations, respectively. The frequency distributions of the daily maximum surface temperatures for the Existing Condition without Boundary Project and the Existing Condition are shown in Figure 5-9 a, b, and c at Metaline Pool, Boundary forebay, and Boundary tailrace stations, respectively. These results show that the surface temperatures for the Existing Condition and the Existing without the Boundary Project were similar. At the Metaline Pool station, the results are nearly indistinguishable, with a maximum temperature difference of 0.07 ºC. At the Boundary forebay station, the maximum difference in daily maximum surface temperatures from frequency distributions was 0.58˚C. At the Boundary tailrace station, the maximum difference was -0.14 ºC, indicating that daily maximum surface temperatures were lower at all times in the Existing Condition compared to the Existing Condition without Boundary Project.

A summary of the maximum temperature differences for all the cases examined is presented in Table 5-4 a, b, and c. The comparison to the Natural Condition represents the difference relative to the water quality criterion,[18] while the comparison to the Existing Condition represents the potential change relative to the Existing Condition. For example, the 0.40˚C was the maximum temperature difference at Boundary forebay for the Existing without Boundary Project above the Natural Condition, that is, without Boundary Dam but with the upstream dams present. It also included the effect of the Boundary Reach simulated as a river. The 0.58˚C temperature difference at Boundary forebay for the Existing Condition without Boundary Project was the simulated improvement over the Existing Condition due to removing the dam. Because these differences are from cumulative frequency distributions, they will not necessarily be additive. Because the distributions were pooled data from the analysis period and were ranked from high to low, there is not necessarily an exact one-to-one correspondence to dates. In Table 5-4 a, b, and c, we have reported the maximum temperature difference without any adjustment or accounting for the 0.3˚C human use allowance.

Figures 5-10 a, b, and c show number of days surface daily maximum temperatures are above 20ºC, and the peak annual surface temperatures, in Metaline Pool, Boundary forebay, and Boundary tailrace stations, respectively for the Existing Condition, Natural Condition and Existing Condition without Boundary Project. At the Boundary forebay station, in the Existing Condition without Boundary Project, 57 days in 2004, and in 2005, 55 days are above the 20ºC criterion (Figure 5-10 b). In comparison, in 2004, 58 days are above 20ºC in the Existing Condition, while in 2005, 60 days are above 20ºC. The Natural Condition had 63 days in 2004 and 60 days in 2005 that are above 20ºC at the Boundary forebay location. Also, the highest temperatures in the Existing Condition without the Boundary Project at the Boundary forebay station were lower than the Existing Condition in 2004, but higher in 2005. At the Metaline Pool and Boundary tailrace stations, there were the same or less number of days above 20ºC in the Existing Condition as compared to either the Existing Condition without Boundary Project or the Natural Condition. Similarly, peak annual surface temperatures at Metaline Pool and the Boundary tailrace were effectively the same as or lower in the Existing Condition as compared to either the Existing Condition without Boundary Project or Natural Condition.

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[18] The water quality criterion is the 1-DMax of 20.0°C or the Natural Condition + 0.3°C, whichever is greater. However, differences presented are not adjusted to account for the 0.3°C human use allowance.

The data from Figures 5-10 a, b and c are summarized in Table 5-5a, b, and c. They indicate that, at all locations, both the Existing Condition and the Existing Condition without Boundary Project had fewer days with surface temperatures above 20ºC, and had lower peak annual surface temperatures, than did the Natural Condition. Relative to the Existing Condition, it appears that some improvement in the number of days with surface daily maximum temperatures above 20ºC could be achieved at the Boundary forebay station by removing Boundary Dam. However, doing so would not improve surface daily maximum temperatures at the Metaline Pool station, and would actually worsen surface daily maximum temperature conditions at the Boundary tailrace station.

Table 5-2
Summary of Maximum Flow-Weighted Temperature Differences from Frequency Analysis Comparing the Existing Condition, the Natural Condition, and the Existing Condition without Boundary Project

a. Metaline Pool

Case	Maximum ΔT relative to the Natural Condition using Flow-Weighted Temperature from Frequency Analysis (Case-Natural)	Maximum ΔT relative to Existing Conditions using Flow-Weighted Temperature from Frequency Analysis (Existing-Case)
Existing	0.50ºC[1]	0.0ºC
Existing without Boundary Project	0.61ºC[2]	0.01ºC[3]

b. Boundary Forebay

Case	Maximum ΔT relative to the Natural Condition using Flow-Weighted Temperature from Frequency Analysis (Case-Natural)	Maximum ΔT relative to Existing Conditions using Flow-Weighted Temperature from Frequency Analysis (Existing-Case)
Existing	0.20ºC[1]	0.0ºC
Existing without Boundary Project	0.40ºC[2]	-0.15ºC[3]

c. Boundary Tailrace

Case	Maximum ΔT relative to the Natural Condition using Flow-Weighted Temperature from Frequency Analysis (Case-Natural)	Maximum ΔT relative to Existing Conditions using Flow-Weighted Temperature from Frequency Analysis (Existing-Case)
Existing	0.19ºC[1]	0.0ºC
Existing without Boundary Project	0.41ºC[2]	-0.14ºC[3]

Notes:
The period covered by the frequency analyses is July 9, 2004 to September 4, 2004 & July 8, 2005 to September 8, 2005 when Existing Condition > 20ºC, Existing = all dams are present, Natural = no dams are present, Existing without Boundary Project = no Boundary Dam, Box Canyon Dam present, and Albeni Falls Dam present

[1] This represents the largest difference between the maximum flow-weighted temperature cumulative frequency distributions for the Existing Condition (with all dams in place) and Natural Condition.

[2] This represents the largest difference between the maximum flow-weighted temperature cumulative frequency distributions for the Existing without Boundary Project Condition and the Natural Condition. This shows the effect of upstream dams without Boundary Dam present.

[3] This represents the difference between the maximum flow-weighted temperature cumulative frequency distributions for the Existing without Boundary Project Condition and the Existing Condition. This shows the potential temperature difference associated with removal of the Boundary Project compared to Existing Conditions.

Table 5-3
Summary of the Number of Days Flow-Weighted Temperatures above 20°C , and the Peak Annual Flow-Weighted Temperatures, Comparing the Existing Condition, the Natural Condition and the Existing Condition without Boundary Project

a. Metaline Pool

Case	Number of Days Temperature Exceeds 20°C		Peak Annual Temperature (°C)	
	Flow-Weighted Temperature		Flow-Weighted Temperature	
	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

b. Boundary Forebay

Case	Number of Day Temperature Exceeds 20°C		Peak Annual Temperature (°C)	
	Flow-Weighted Temperature		Flow-Weighted Temperature	
	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

c. Boundary Tailrace

Case	Number of Day Temperature Exceeds 20°C		Peak Annual Temperature (°C)	
	Flow-Weighted Temperature		Flow-Weighted Temperature	
	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 5-4
Summary of Maximum Surface Temperature Differences from Frequency Analysis Comparing the Existing Condition, the Natural Condition, and the Existing Condition without Boundary Project

a. Metaline Pool

Case	Maximum ΔT relative to the Natural Condition using Surface Temperature from Frequency Analysis (Case-Natural)	Maximum ΔT relative to Existing Conditions using Surface Temperature from Frequency Analysis (Existing-Case)
Existing	0.50ºC[1]	0.0ºC
Existing without Boundary Project	0.63ºC[2]	0.07ºC[3]

b. Boundary Forebay

Case	Maximum ΔT relative to the Natural Condition using Surface Temperature from Frequency Analysis (Case-Natural)	Maximum ΔT relative to Existing Conditions using Surface Temperature from Frequency Analysis (Existing-Case)
Existing	0.76ºC[1]	0.0ºC
Existing without Boundary Project	0.40ºC[2]	0.58ºC[3]

c. Boundary Tailrace

Case	Maximum ΔT relative to the Natural Condition using Surface Temperature from Frequency Analysis (Case-Natural)	Maximum ΔT relative to Existing Conditions using Surface Temperature from Frequency Analysis (Existing-Case)
Existing	0.19ºC[1]	0.0ºC
Existing without Boundary Project	0.41ºC[2]	-0.14ºC[3]

Notes:
The period covered by the frequency analyses is July 9, 2004 to September 4, 2004 & July 8, 2005 to September 8, 2005 when Existing Condition > 20ºC, Existing = all dams are present, Natural = no dams are present, Existing without Boundary Project = no Boundary Dam, Box Canyon Dam present, and Albeni Falls Dam present
[1] This represents the largest difference between the maximum surface temperature cumulative frequency distributions for the Existing Condition (with all dams in place) and Natural Condition.
[2] This represents the largest difference between the maximum surface temperature cumulative frequency distributions for the Existing Condition without Boundary Project and the Natural Condition. This shows the effect of upstream dams without Boundary Dam present.
[3] This represents the difference between the maximum surface temperature cumulative frequency distributions for the Existing Condition without Boundary Project and the Existing Condition. This shows the potential temperature difference associated with removal of the Boundary Project compared to Existing Conditions.

Table 5-5
Summary of the Number of Days Surface Temperatures are above 20ºC, and the Peak Annual Surface Temperatures, Comparing the Existing Condition, the Natural Condition and the Existing Condition without Boundary Project

a. Metaline Pool

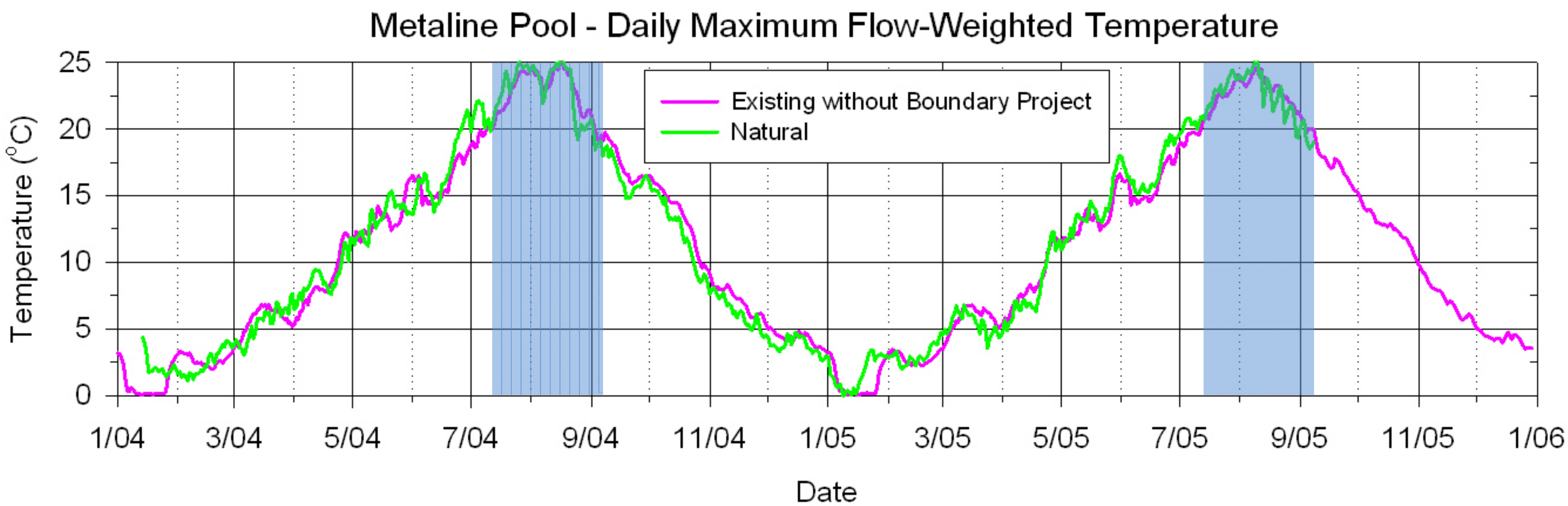
Case	Number of Day Temperature Exceeds 20°C		Peak Annual Temperature (°C)	
	Surface Temperature		Surface Temperature	
	2004	2005	2004	2005
Natural	60	60	25.44	25.17
Existing	54	53	25.07	24.41
Existing without Boundary Project	54	57	25.04	24.62

b. Boundary Forebay

Case	Number of Day Temperature Exceeds 20°C		Peak Annual Temperature (°C)	
	Surface Temperature		Surface Temperature	
	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

c. Boundary Tailrace

Case	Number of Day Temperature Exceeds 20°C		Peak Annual Temperature (°C)	
	Surface Temperature		Surface Temperature	
	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



Notes:

1. Existing without Boundary Project = No Boundary Dam, Box Canyon Dam present, and Albeni Falls Dam present. The designation as Existing without Boundary Project is from Ecology's TMDL analyses.
2. Daily maximum flow-weighted temperature is

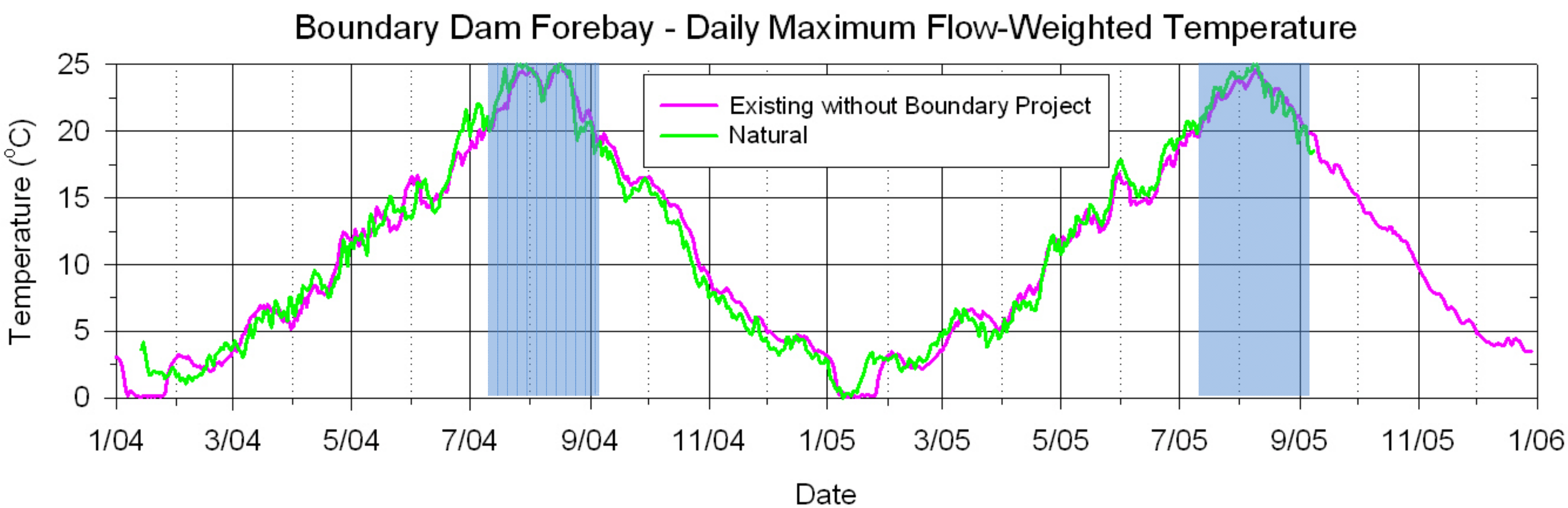
$$T_W = \sum_{l=1}^{n} (T_l \times Q_l) / Q_T$$

where l is a layer of water column (l=1, 2,.., n), T_W is the flow-weighted temperature, T_l is the temperature at the layer, Q_l is the flow rate at the layer, and Q_T is the total flow.
3. The period when the Existing Condition without Boundary Project temperature is over 20ºC is indicated by the shading.

Figure 5-1a

Daily Maximum Flow-Weighted Temperatures for the Existing Condition without Boundary Project and the Natural Condition at Metaline Pool

Seattle City Light
Seattle, WA



Notes:

1. Existing without Boundary Project = No Boundary Dam, Box Canyon Dam present, and Albeni Falls Dam present. The designation as Existing without Boundary Project is from Ecology's TMDL analyses.
2. Daily maximum flow-weighted temperature is

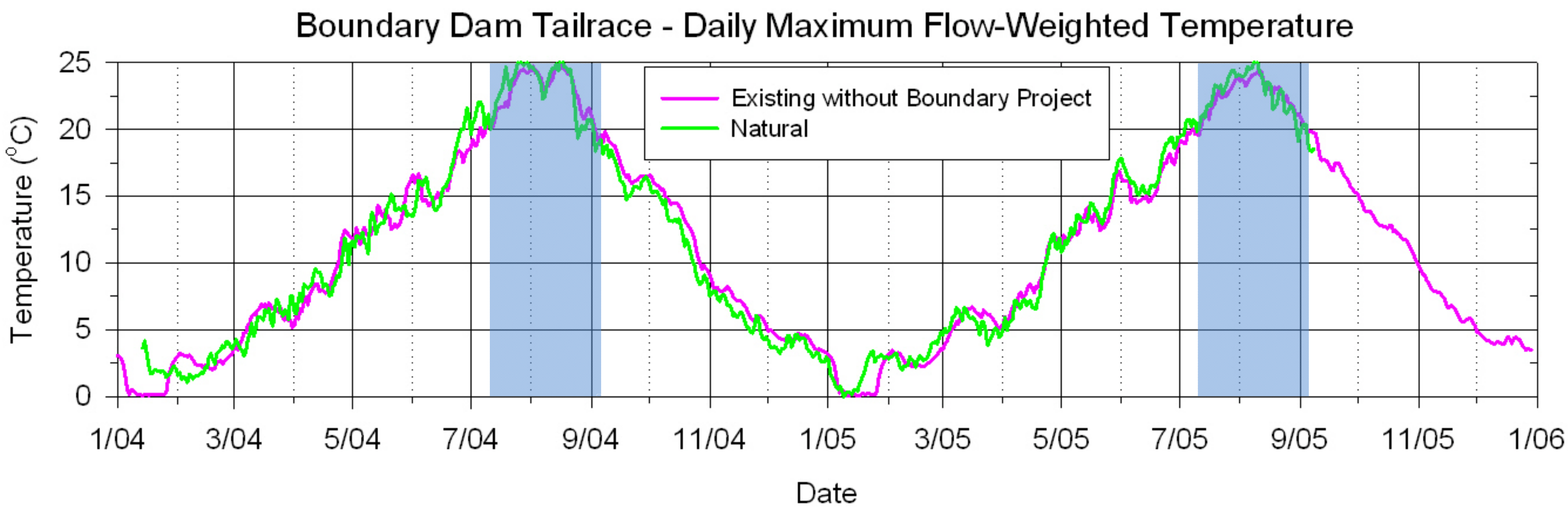
$$T_W = \sum_{l=1}^{n} (T_l \times Q_l) / Q_T$$

where l is a layer of water column (l=1, 2,.., n), T_W is the flow-weighted temperature, T_l is the temperature at the layer, Q_l is the flow rate at the layer, and Q_T is the total flow.
3. The period when the Existing without Boundary Project temperature is over 20ºC is indicated by the shading.

Figure 5-1b

Daily Maximum Flow-Weighted Temperatures for the Existing Condition without Boundary Project and the Natural Condition at Boundary Dam Forebay

Seattle City Light
Seattle, WA



Notes:

1. Existing without Boundary Project = No Boundary Dam, Box Canyon Dam present, and Albeni Falls Dam present. The designation as Existing without Boundary Project is from Ecology's TMDL analyses.
2. Daily maximum flow-weighted temperature is

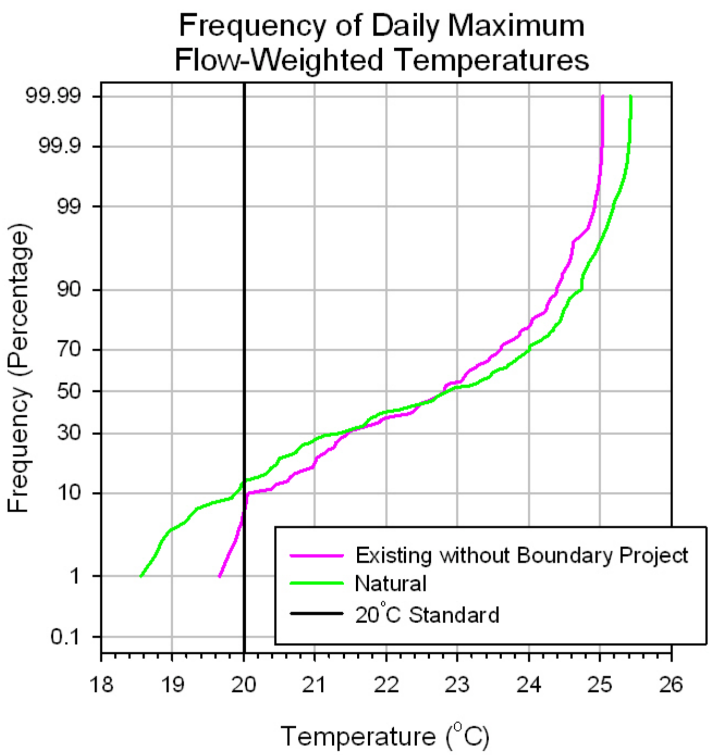
$$T_W = \sum_{l=1}^{n} (T_l \times Q_l) / Q_T$$

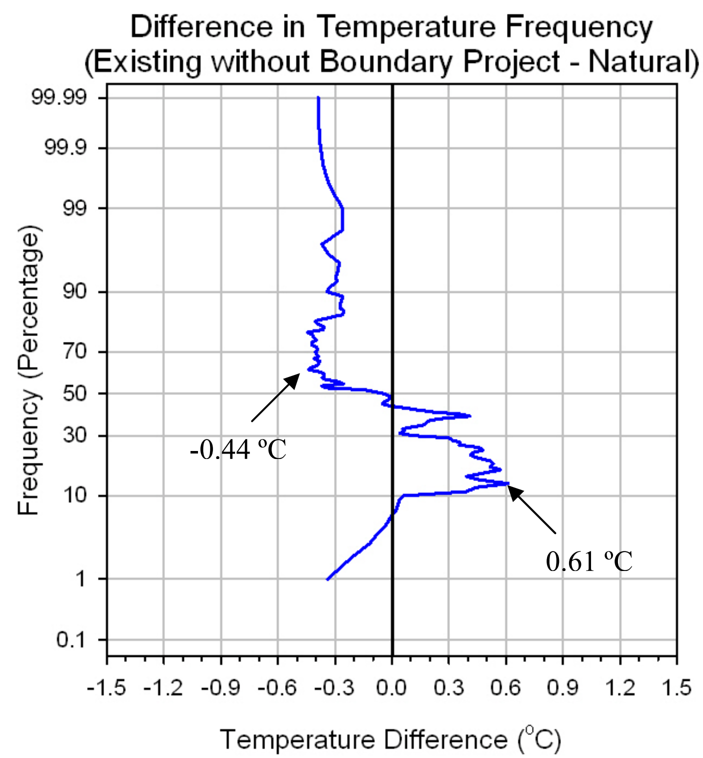
   where l is a layer of water column (l=1, 2,.., n), T_W is the flow-weighted temperature, T_l is the temperature at the layer, Q_l is the flow rate at the layer, and Q_T is the total flow.
3. The period when the Existing without Boundary Project temperature is over 20ºC is indicated by the shading.

Figure 5-1c

Daily Maximum Flow-Weighted Temperatures for the Existing Condition without Boundary Project and the Natural Condition at Boundary Dam Tailrace

Seattle City Light
Seattle, WA





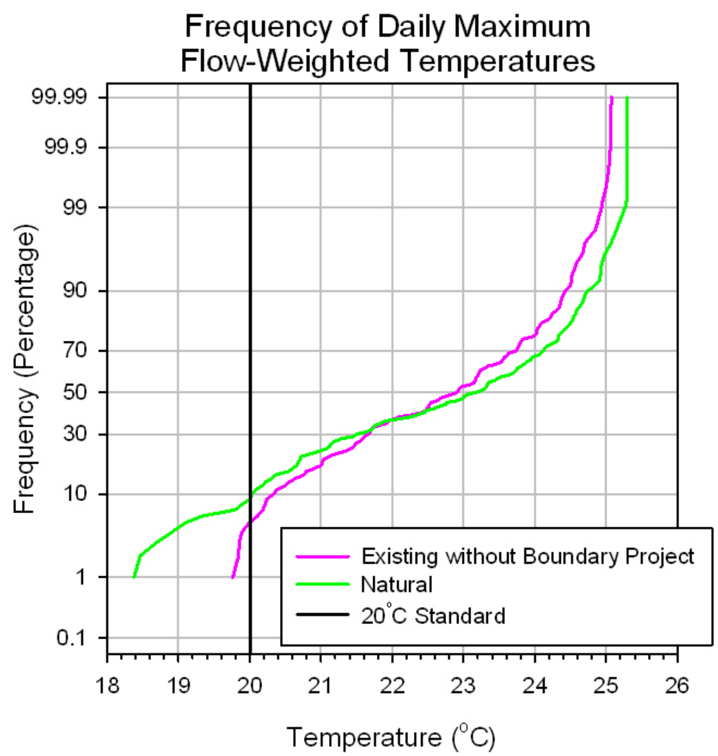
Notes:

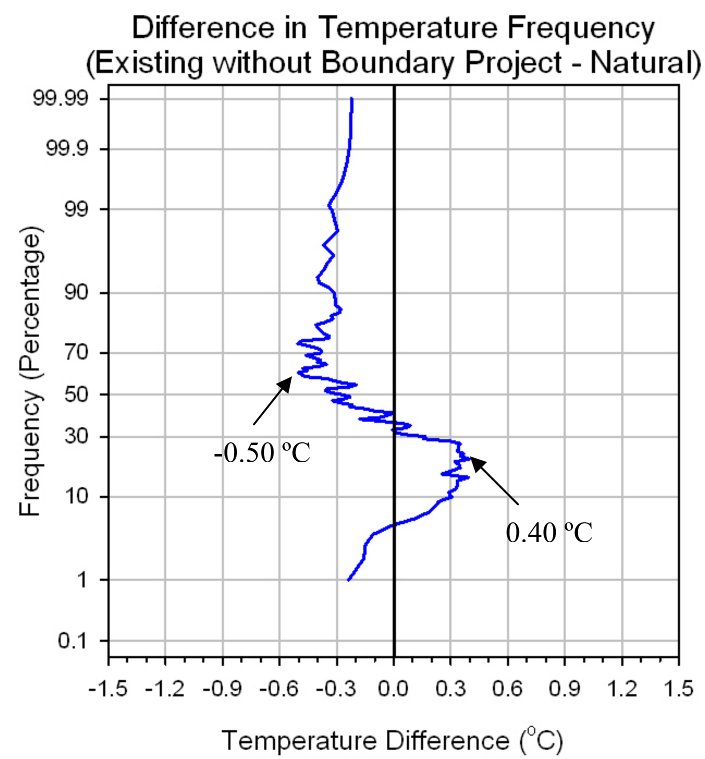
1. Frequency distributions of the maximum flow-weighted temperatures are from model results obtained from Ecology.
2. The difference in temperature at each frequency is obtained by subtracting the Natural Condition values from the Existing without Boundary Project values. (When Natural Condition is < 20ºC, the Natural temperature is replaced by the value 20ºC.)
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005.
4. Flow-weighted temperature differences are between -0.44 ºC and +0.61 ºC due to upstream dams (Box Canyon and Albeni Falls) on the Pend Oreille River.

Figure 5-2a

Frequency Distribution of the Daily Maximum Flow-Weighted Temperatures for the Existing Condition without Boundary Project and the Natural Condition at Metaline Pool

Seattle City Light
Seattle, WA





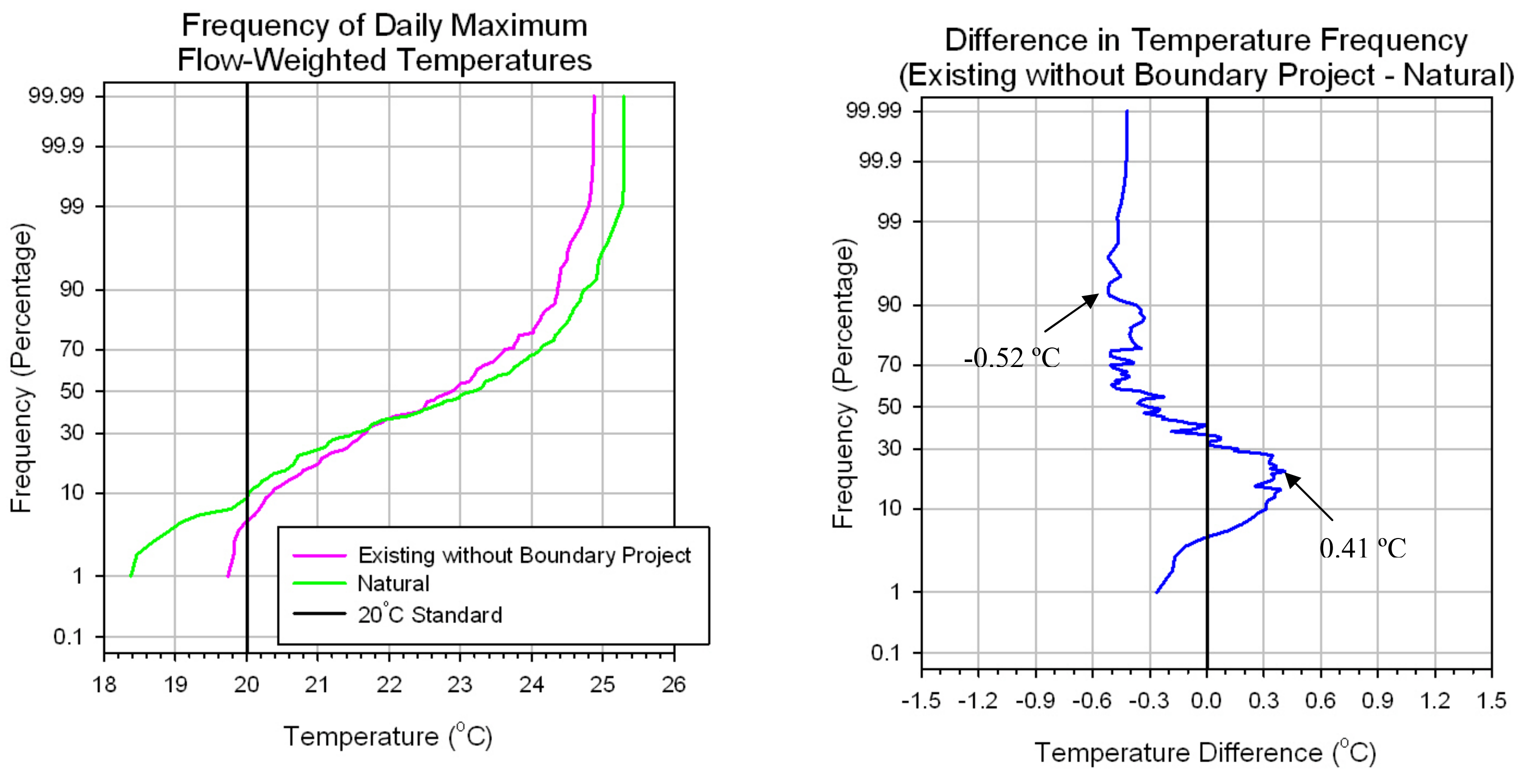
Notes:

1. Frequency distributions of the maximum flow-weighted temperatures are from model results obtained from Ecology.
2. The difference in temperature at each frequency is obtained by subtracting the Natural Condition values from the Existing without Boundary Project values. (When Natural Condition is < 20ºC, the Natural temperature is replaced by the value 20ºC.)
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005.
4. Flow-weighted temperature differences are between -0.50ºC and +0.40ºC due to upstream dams (Box Canyon and Albeni Falls) on the Pend Oreille River.

Figure 5-2b

Frequency Distribution of the Daily Maximum Flow-Weighted Temperatures for the Existing Condition without Boundary Project and the Natural Condition at Boundary Dam Forebay

Seattle City Light
Seattle, WA



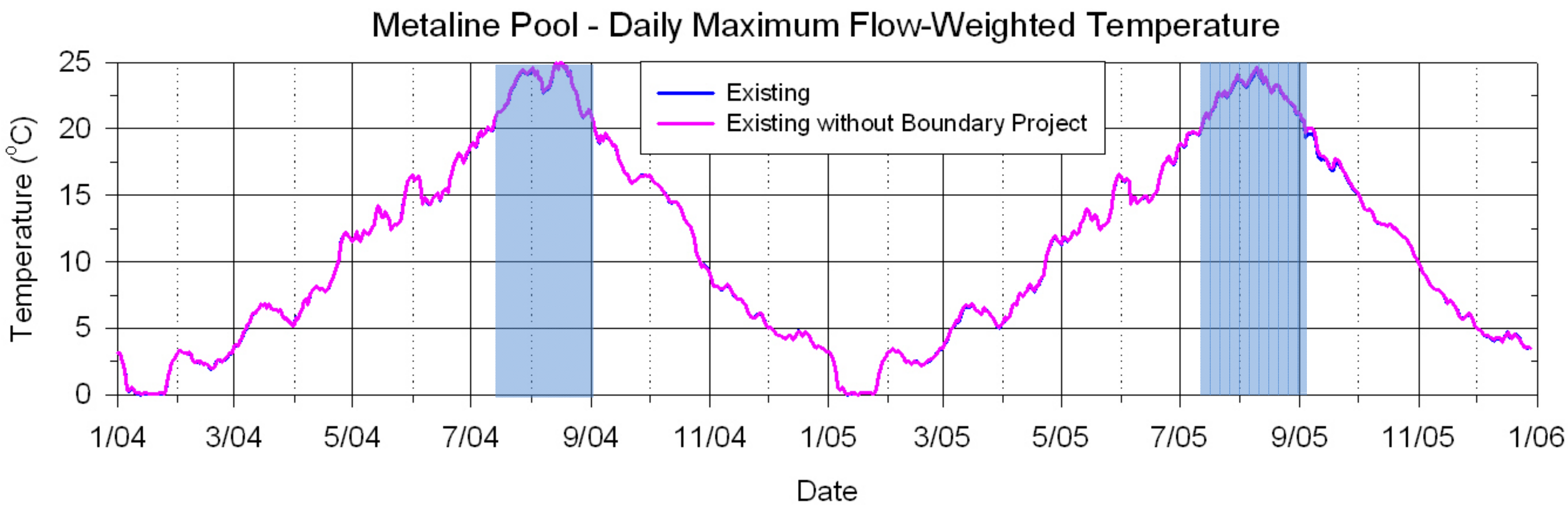
Notes:

1. Frequency distributions of the maximum flow-weighted temperatures are from model results obtained from Ecology.
2. The difference in temperature at each frequency is obtained by subtracting the Natural Condition values from the Existing without Boundary Project values. (When Natural Condition is < 20ºC, the Natural temperature is replaced by the value 20ºC.)
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005.
4. Flow-weighted temperature differences are between -0.52ºC and +0.41ºC due to upstream dams (Box Canyon and Albeni Falls) on the Pend Oreille River.

Figure 5-2c

Frequency Distribution of the Daily Maximum Flow-Weighted Temperatures for the Existing Condition without Boundary Project and the Natural Condition at Boundary Dam Tailrace

Seattle City Light
Seattle, WA



Notes:

1. Existing without Boundary Project = No Boundary Dam, Box Canyon Dam present, and Albeni Falls Dam present.
2. Daily maximum flow-weighted temperature is

$$T_W = \sum_{l=1}^{n} (T_l \times Q_l) / Q_T$$

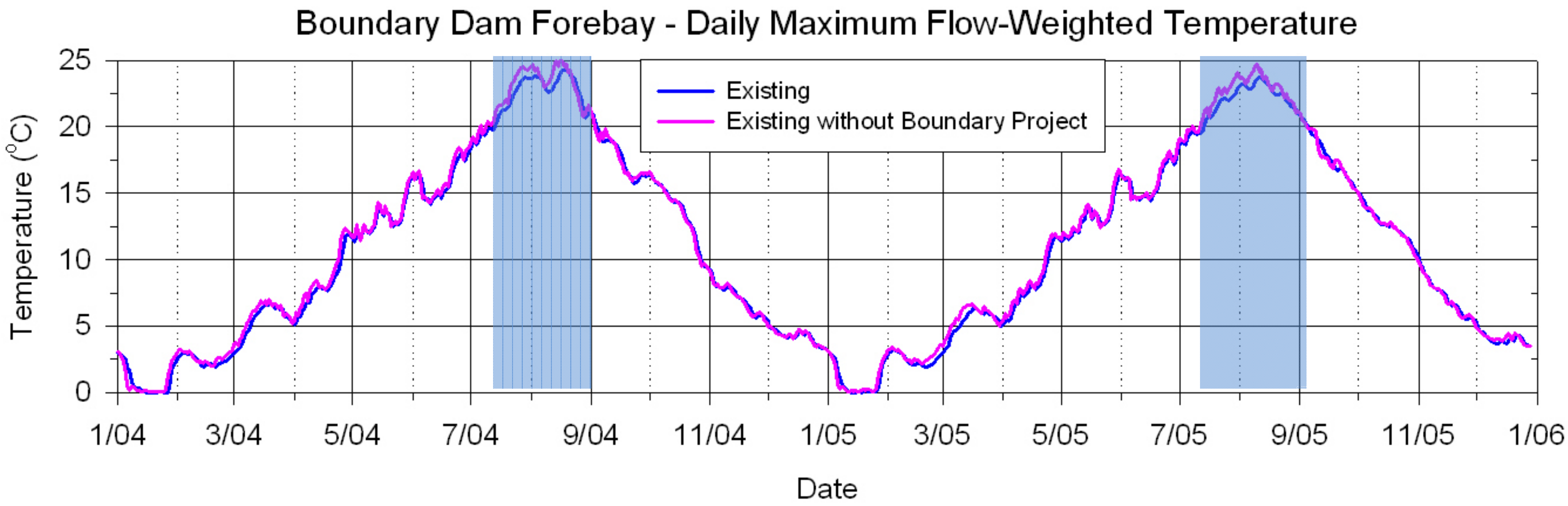
where l is a layer of water column (l=1, 2,.., n), T_W is the flow-weighted temperature, T_l is the temperature at the layer, Q_l is the flow rate at the layer, and Q_T is the total flow.

3. The period when the Existing without Boundary Project temperature is over 20ºC is indicated by the shading.

Figure 5-3a

Daily Maximum Flow-Weighted Temperatures for the Existing Condition and Existing Condition without Boundary Project at Metaline Pool

Seattle City Light
Seattle, WA



Notes:

1. Existing without Boundary Project = No Boundary Dam, Box Canyon Dam present, and Albeni Falls Dam present.
2. Daily maximum flow-weighted temperature is

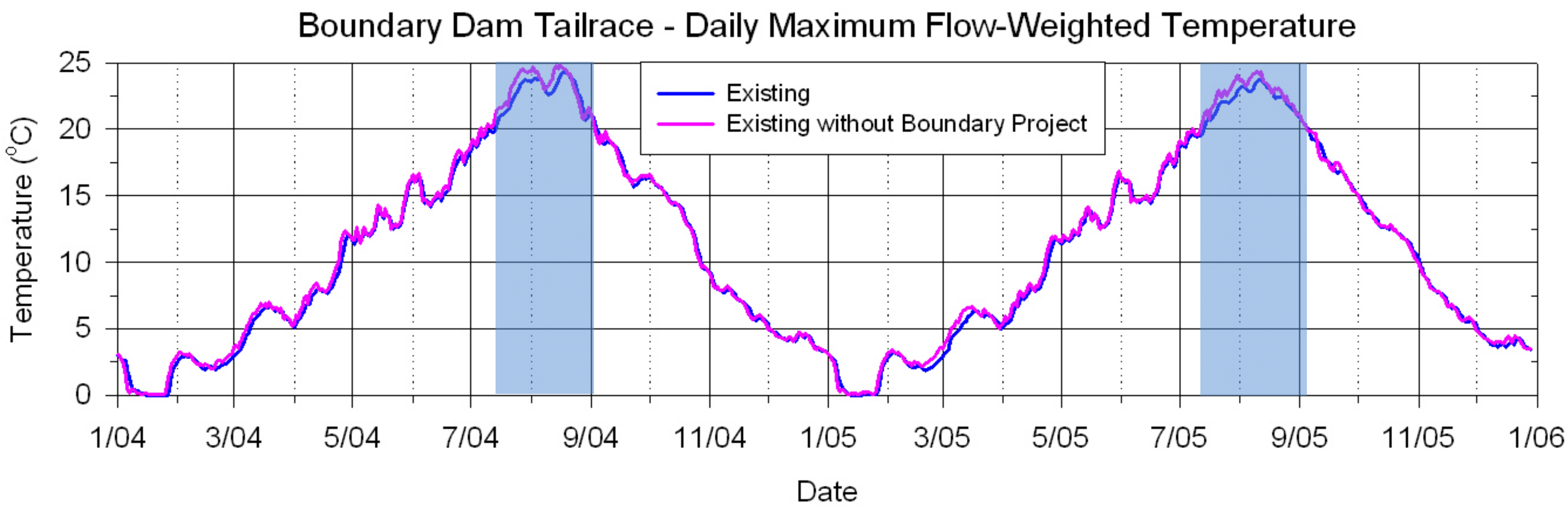
$$T_W = \sum_{l=1}^{n} (T_l \times Q_l) / Q_T$$

   where l is a layer of water column (l=1, 2,.., n), T_W is the flow-weighted temperature, T_l is the temperature at the layer, Q_l is the flow rate at the layer, and Q_T is the total flow.
3. The period when the Existing without Boundary Project temperature is over 20ºC is indicated by the shading.

Figure 5-3b

Daily Maximum Flow-Weighted Temperatures for the Existing Condition and Existing Condition without Boundary Project at Boundary Dam Forebay

Seattle City Light
Seattle, WA



Notes:

1. Existing without Boundary Project = No Boundary Dam, Box Canyon Dam present, and Albeni Falls Dam present.
2. Daily maximum flow-weighted temperature is

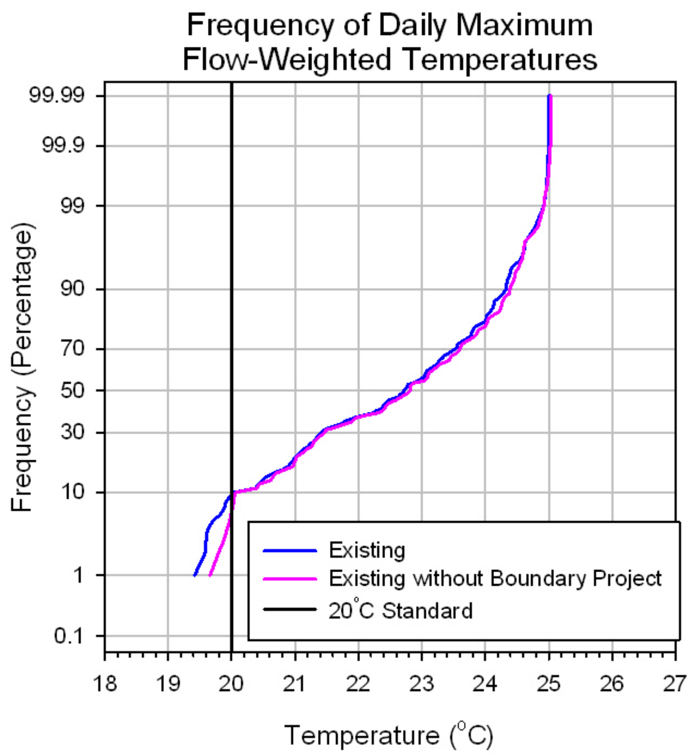
$$T_W = \sum_{l=1}^{n} (T_l \times Q_l) / Q_T$$

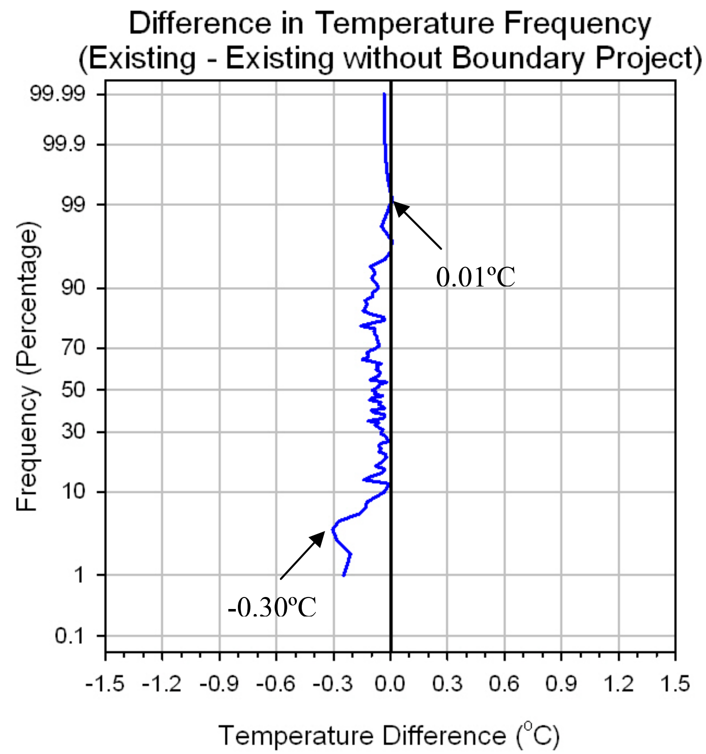
where l is a layer of water column (l=1, 2,.., n), T_W is the flow-weighted temperature, T_l is the temperature at the layer, Q_l is the flow rate at the layer, and Q_T is the total flow.
3. The period when the Existing without Boundary Project temperature is over 20ºC is indicated by the shading.

Figure 5-3c

Daily Maximum Flow-Weighted Temperatures for the Existing Condition and Existing Condition without Boundary Project at Boundary Dam Tailrace

Seattle City Light
Seattle, WA





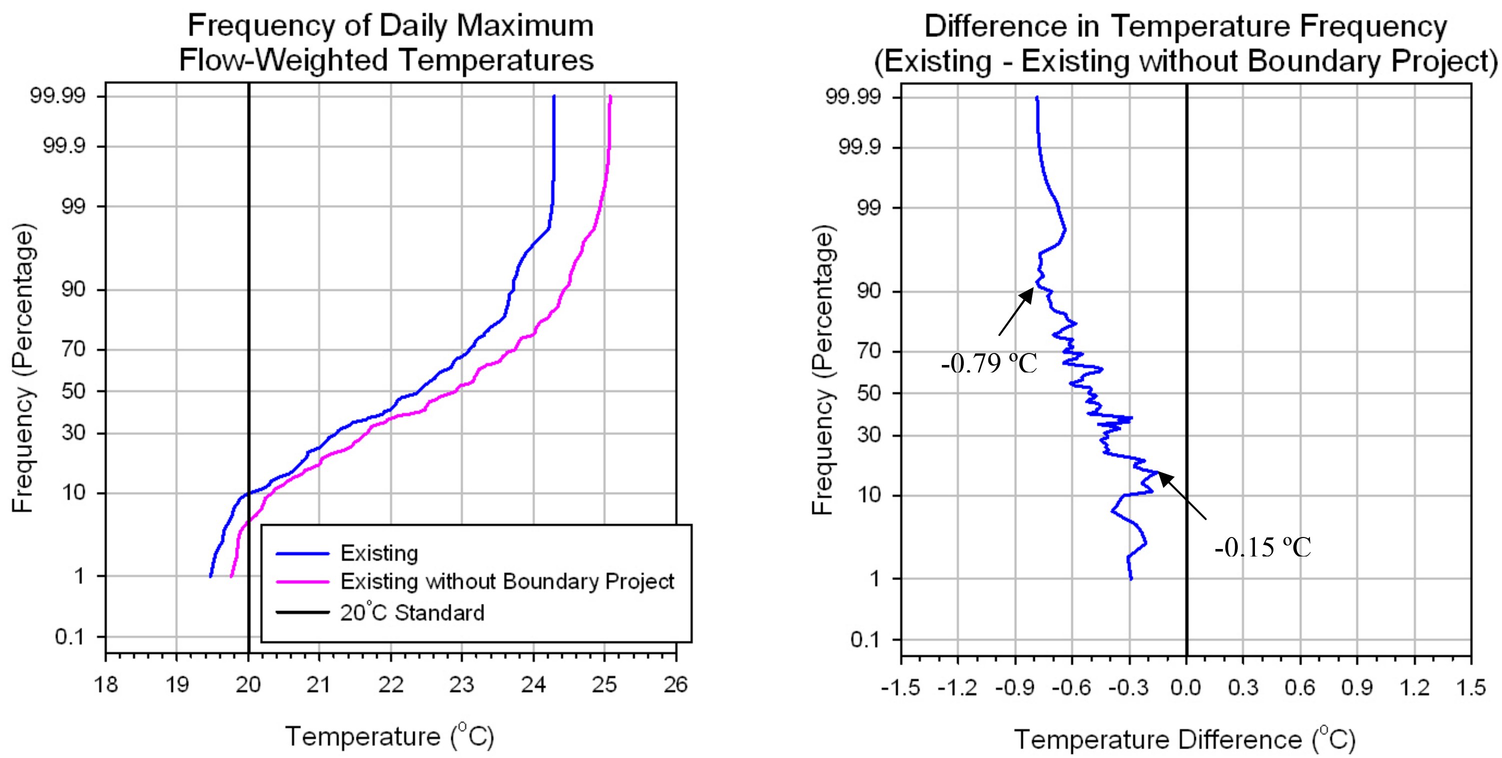
Notes:

1. Frequency distributions of the maximum flow-weighted temperatures are from model results obtained from Ecology.
2. The difference in temperature at each frequency is obtained by subtracting the Existing without Boundary Project values from the Existing Condition values.
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005.
4. Existing Condition flow-weighted temperatures differences are between -0.30ºC and +0.01ºC relative to the Existing Condition without Boundary Project.

Figure 5-4a

Frequency Distribution of the Daily Maximum Flow-Weighted Temperatures for the Existing Condition without Boundary Project and the Existing Condition at Metaline Pool

Seattle City Light
Seattle, WA



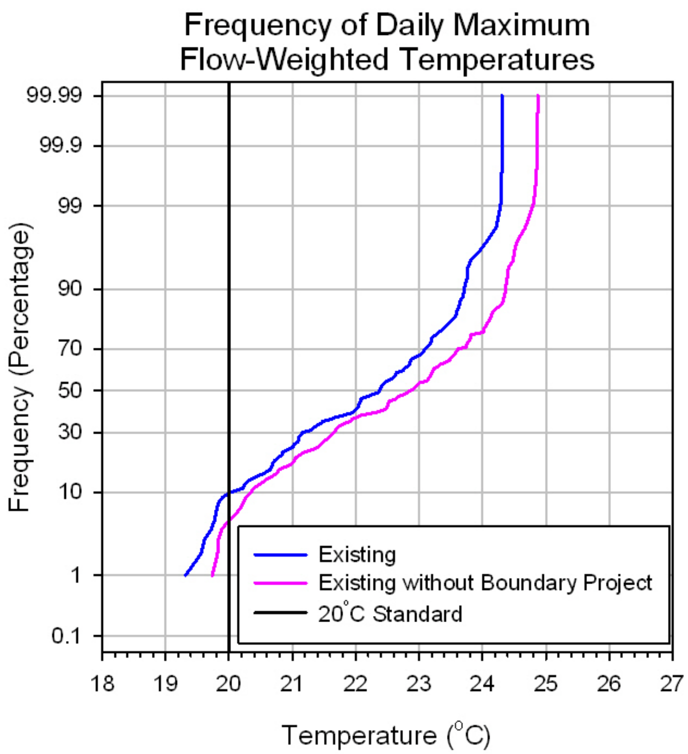
Notes:

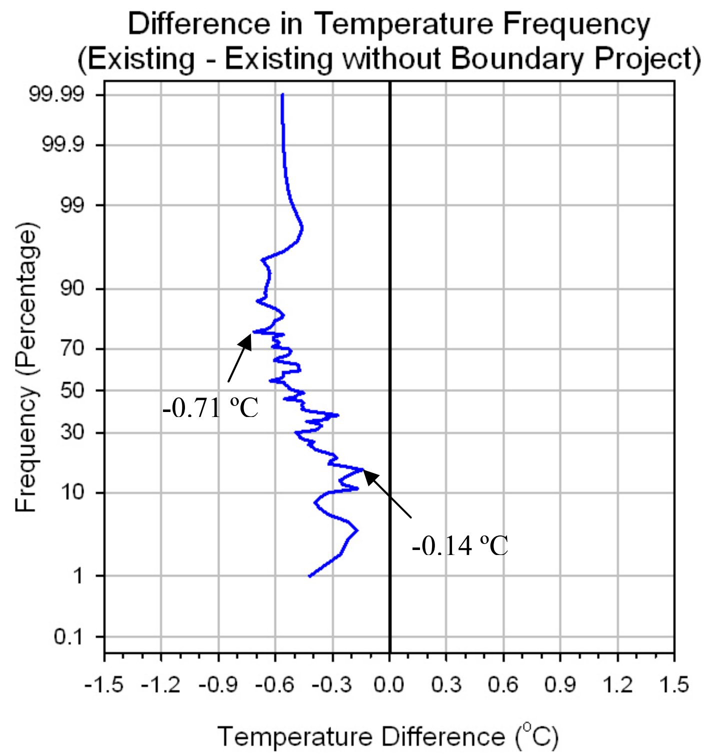
1. Frequency distributions of the maximum flow-weighted temperatures are from model results obtained from Ecology.
2. The difference in temperature at each frequency is obtained by subtracting the Existing without Boundary Project values from the Existing Condition values.
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005.
4. Existing Condition flow-weighted temperatures are between 0.15ºC and 0.79ºC lower than the Existing Condition without Boundary Project.

Figure 5-4b

Frequency Distribution of the Daily Maximum Flow-Weighted Temperatures for the Existing Condition without Boundary Project and the Existing Condition at Boundary Dam Forebay

Seattle City Light
Seattle, WA





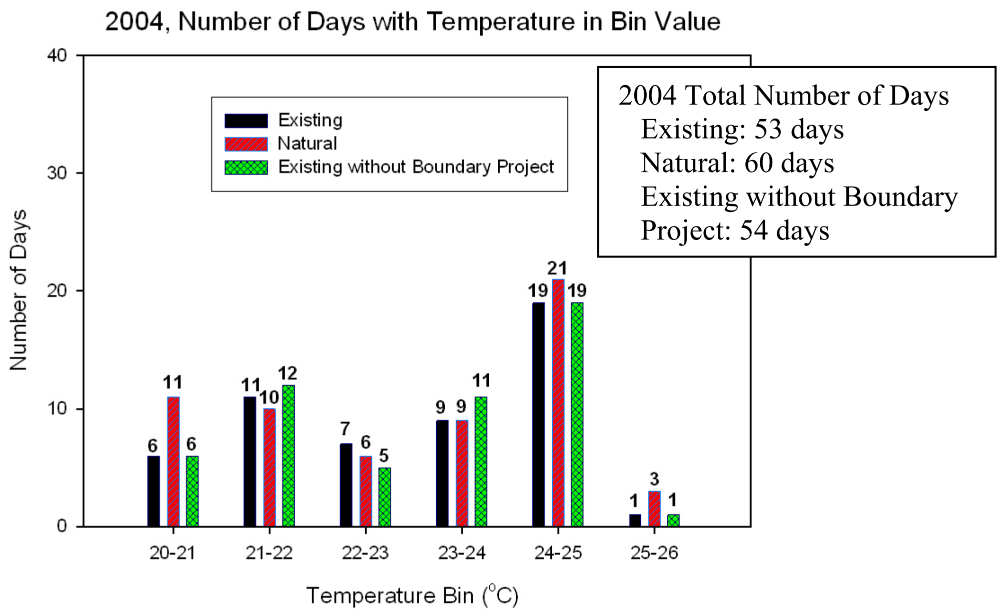
Notes:

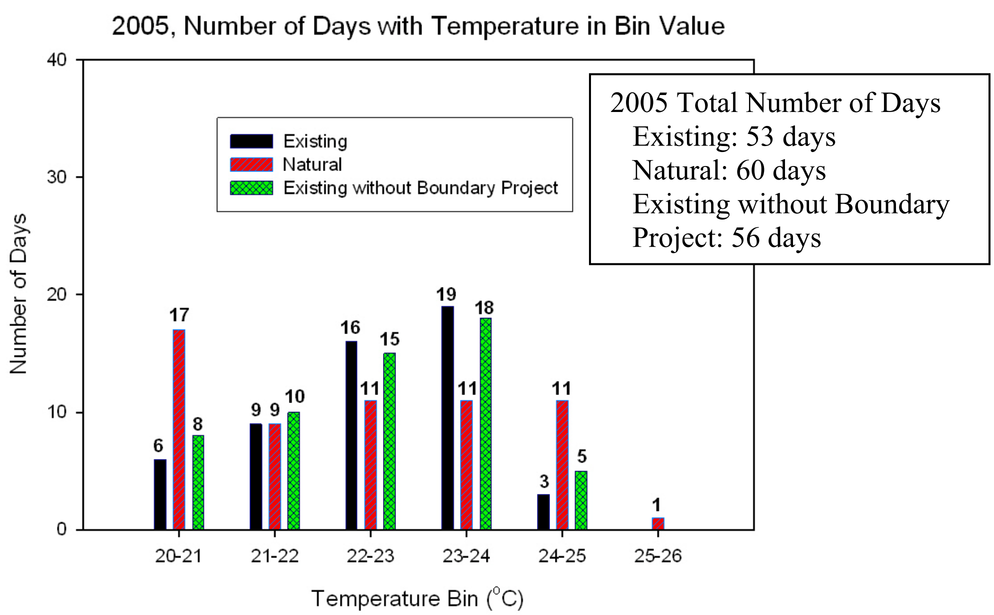
1. Frequency distributions of the maximum flow-weighted temperatures are from model results obtained from Ecology.
2. The difference in temperature at each frequency is obtained by subtracting the Existing without Boundary Project values from the Existing Condition values.
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005.
4. Existing Condition flow-weighted temperatures are between 0.14ºC and 0.71ºC lower than the Existing Condition without Boundary Project.

Figure 5-4c

Frequency Distribution of the Daily Maximum Flow-Weighted Temperatures for the Existing Condition without Boundary Project and the Existing Condition at Boundary Dam Tailrace

Seattle City Light
Seattle, WA





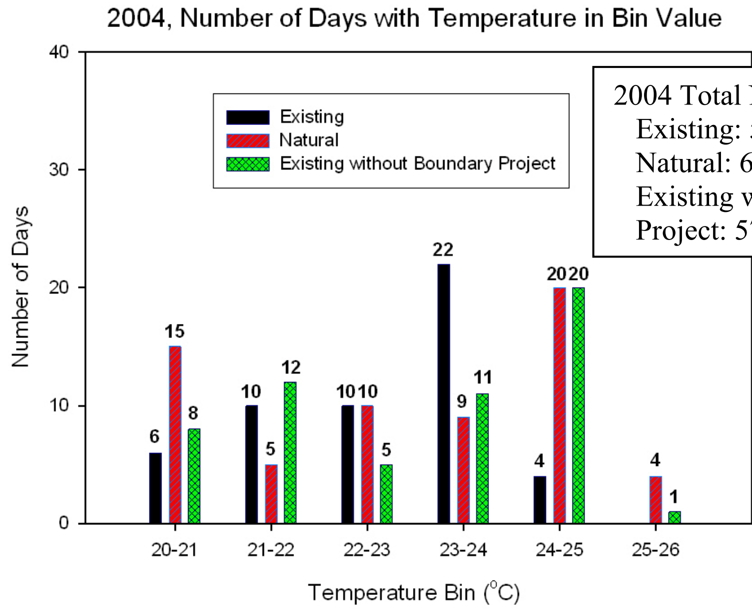
Notes:

1. The total number of days for 2004 and 2005 was
   Existing – 106 days, Natural – 120 days, and
   Existing without Boundary Project – 110 days
2. Peak annual flow-weighted temperatures at the Metaline Pool
   Existing – 2004: 25.01ºC & 2005: 24.40ºC
   Natural – 2004: 25.43ºC & 2005: 25.14ºC
   Existing without Boundary Project
   – 2004: 25.04ºC & 2005: 24.61ºC

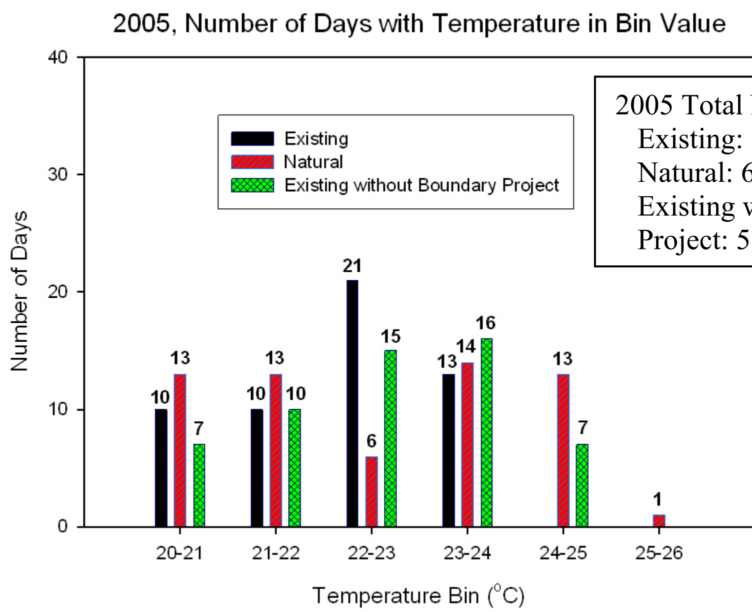
Figure 5-5a

Number of Days the Daily Maximum Flow-Weighted Temperatures Exceeded 20ºC at the Metaline Pool for 2004 and 2005

Seattle City Light
Seattle. WA



2004 Total Number of Days
Existing: 52 days
Natural: 63 days
Existing without Boundary Project: 57 days



2005 Total Number of Days
Existing: 54 days
Natural: 60 days
Existing without Boundary Project: 55 days

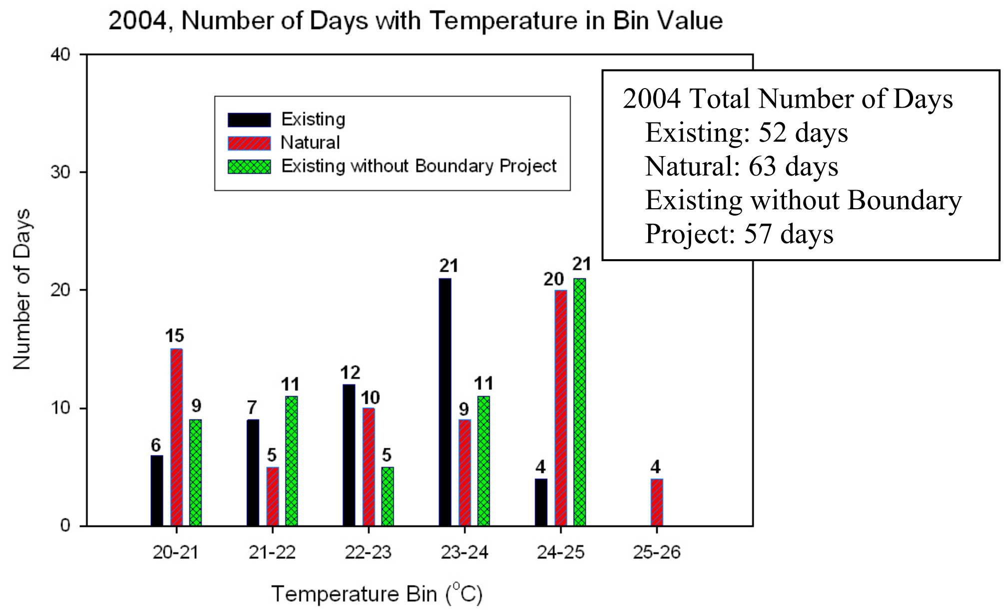
Notes:

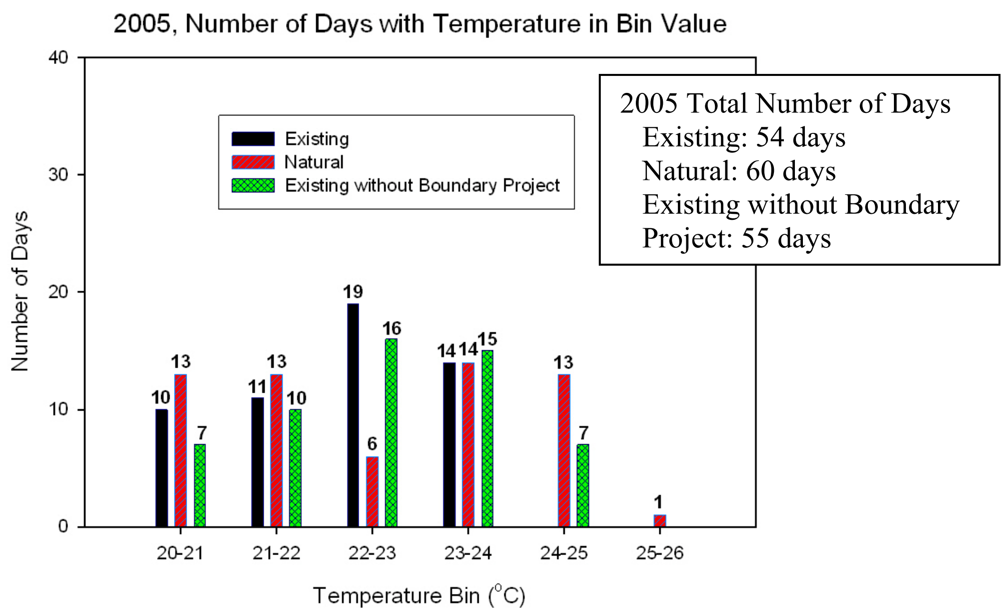
1. The total number of days for 2004 and 2005 was
   Existing – 106 days, Natural – 123 days, and
   Existing without Boundary Project – 112 days
2. Peak annual flow-weighted temperatures at the Boundary Dam Forebay
   Existing – 2004: 24.29ºC & 2005: 23.72ºC
   Natural – 2004: 25.29ºC & 2005: 25.15ºC
   Existing without Boundary Project – 2004: 25.07ºC & 2005: 24.68ºC

Figure 5-5b

Number of Days the Daily Maximum Flow-Weighted Temperatures Exceeded 20ºC at the Boundary Dam Forebay for 2004 and 2005

Seattle City Light
Seattle. WA





Notes:

1. The total number of days for 2004 and 2005 was
   Existing – 106 days, Natural – 123 days, and
   Existing without Boundary Project – 112 days
2. Peak annual flow-weighted temperatures at the Boundary Dam Tailrace
   Existing – 2004: 24.31ºC & 2005: 23.71ºC
   Natural – 2004: 25.29ºC & 2005: 25.15ºC
   Existing without Boundary Project – 2004: 24.87ºC & 2005: 24.34ºC

Figure 5-5c

Number of Days the Daily Maximum Flow-Weighted Temperatures Exceeded 20ºC at the Boundary Dam Tailrace for 2004 and 2005

Seattle City Light
Seattle. WA

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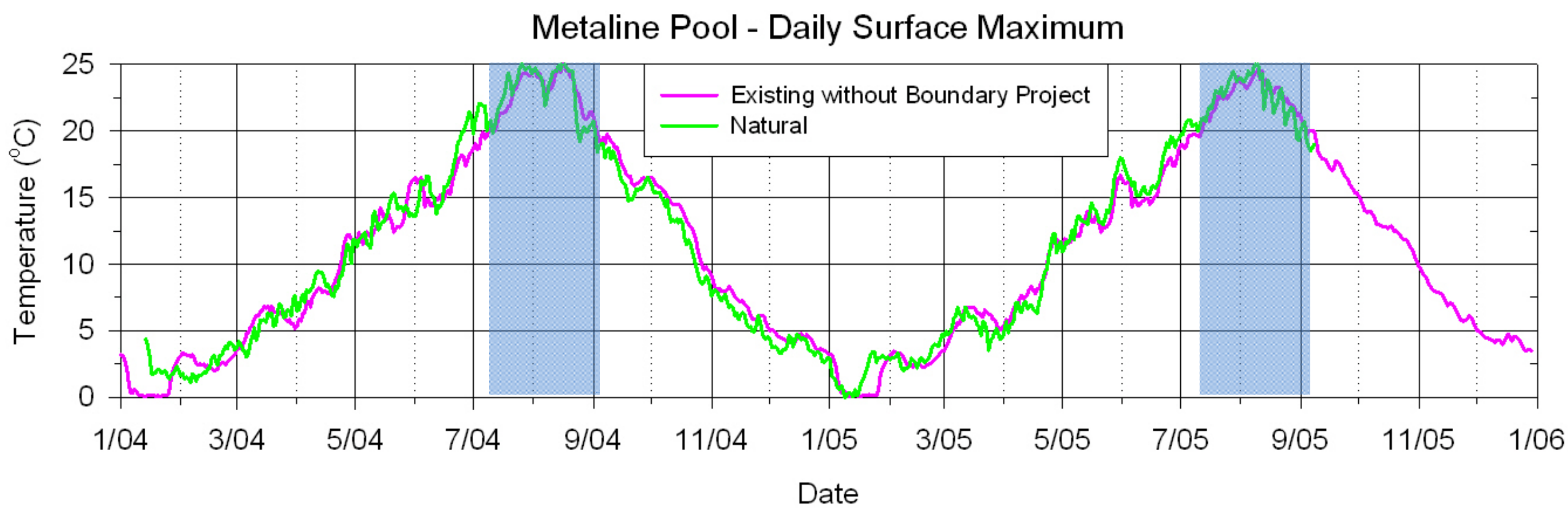


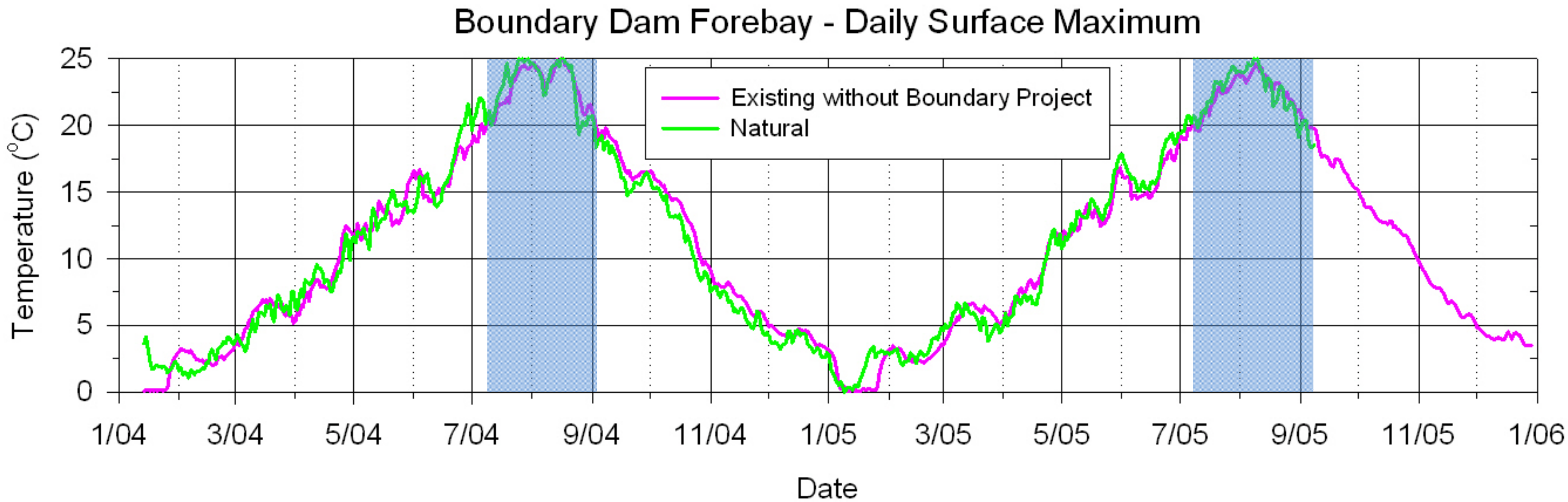
Notes:

1. Existing without Boundary Project = No Boundary Dam, Box Canyon Dam present, and Albeni Falls Dam present. The designation as Existing without Boundary Project is from Ecology's TMDL analyses.
2. Daily maximum temperatures are from the surface layer of the models.
3. The period in which the Existing without Boundary Project temperature is over 20ºC is indicated by the shading.

Figure 5-6a

Daily Maximum Surface Temperatures for the Existing Condition without Boundary Project and the Natural Condition at Metaline Pool

Seattle City Light
Seattle, WA



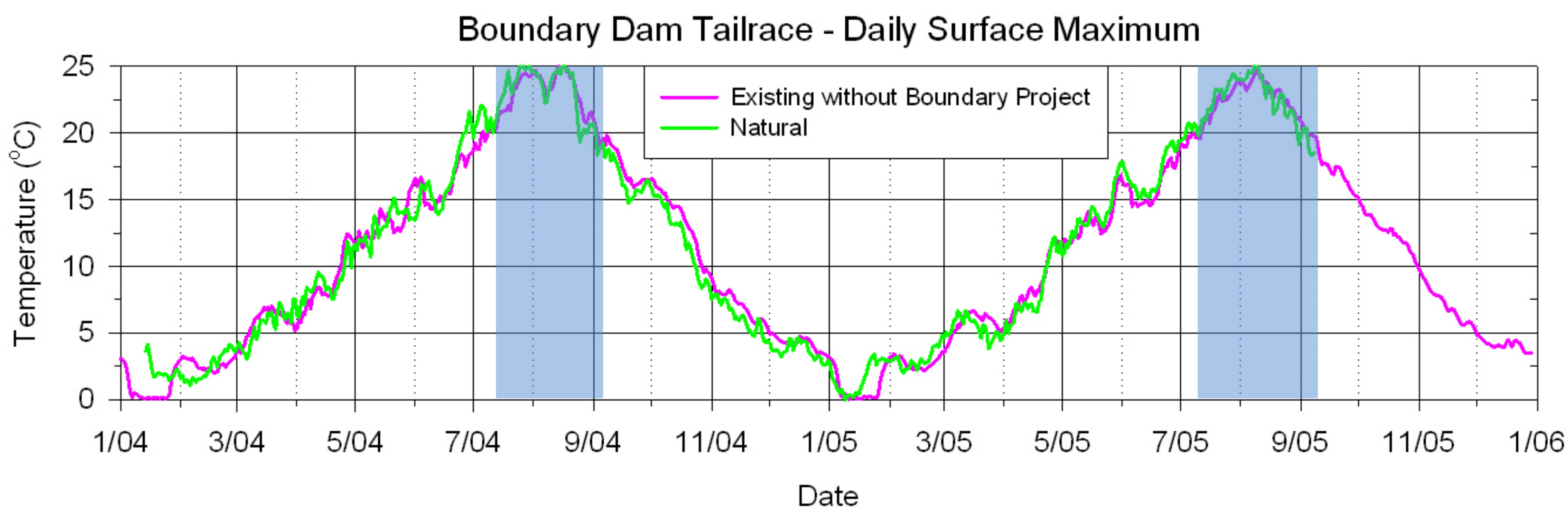
Notes:

1. Existing without Boundary Project = No Boundary Dam, Box Canyon Dam present, and Albeni Falls Dam present. The designation as Existing without Boundary Project is from Ecology's TMDL analyses.
2. Daily maximum temperatures are from the surface layer of the models.
3. The period in which the Existing without Boundary Project temperature is over 20ºC is indicated by the shading.

Figure 5-6b

Daily Maximum Surface Temperatures for
the Existing Condition without Boundary Project and
the Natural Condition at Boundary Dam Forebay

Seattle City Light
Seattle, WA



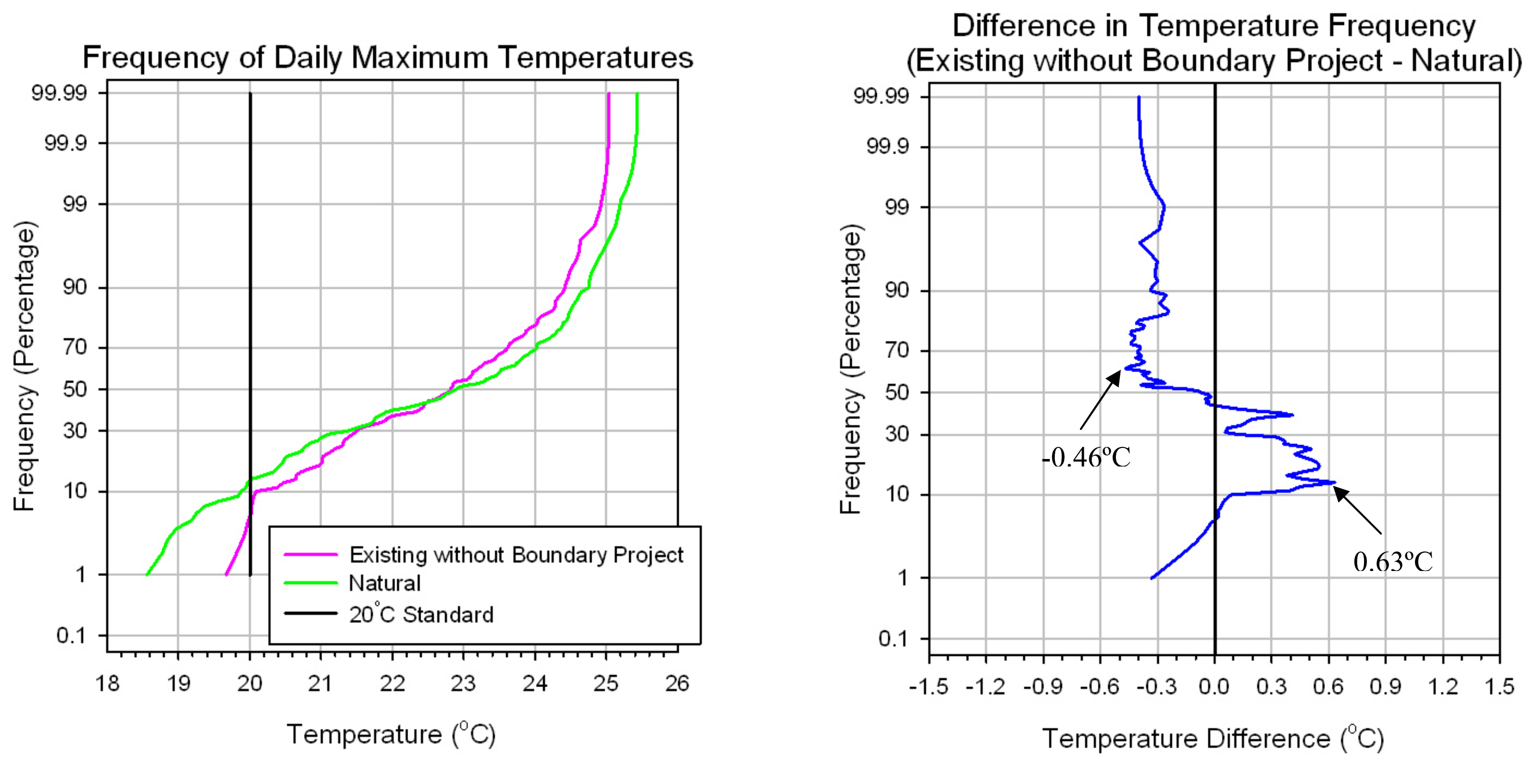
Notes:

1. Existing without Boundary Project = No Boundary Dam, Box Canyon Dam present, and Albeni Falls Dam present. The designation as Existing without Boundary Project is from Ecology's TMDL analyses.
2. Daily maximum temperatures are from the surface layer of the models.
3. The period in which the Existing without Boundary Project temperature is over 20ºC is indicated by the shading.

Figure 5-6c

Daily Maximum Surface Temperatures for the Existing Condition without Boundary Project and the Natural Condition at Boundary Dam Tailrace

Seattle City Light
Seattle, WA



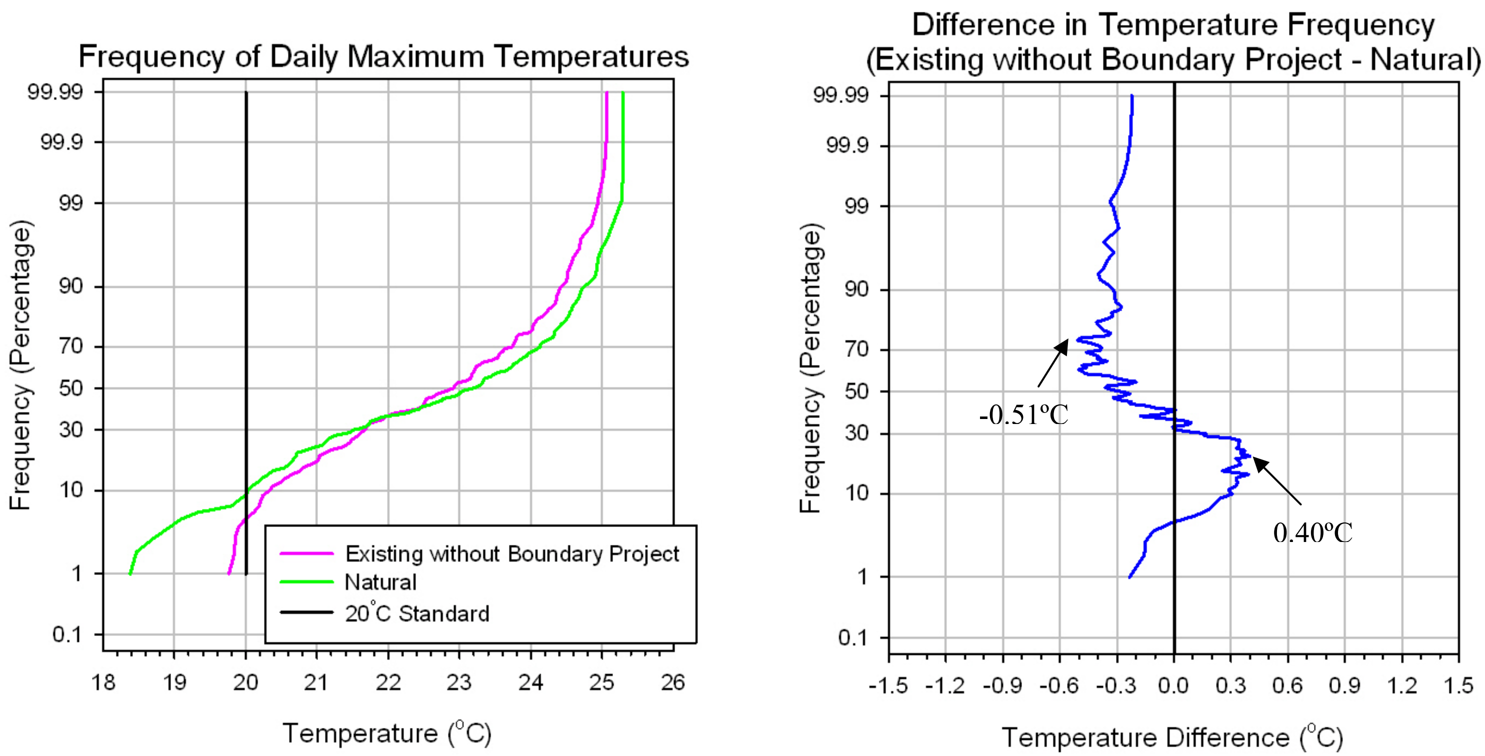
Notes:

1. Existing without Boundary Project = No Boundary Dam, Box Canyon Dam present, and Albeni Falls Dam present.
2. The difference in temperature at each frequency is obtained by subtracting the Natural Condition values from the Existing without Boundary Project values. (When Natural Condition is < 20ºC, the Natural temperature is replaced by the value 20ºC.)
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005.
4. Surface temperature differences are between -0.46ºC and +0.63ºC due to upstream dams (Box Canyon and Albeni Falls) on the Pend Oreille River.

Figure 5-7a

Frequency Distribution of Daily Maximum Surface Temperatures for the Existing Condition without Boundary Project and the Natural Condition at Metaline Pool

Seattle City Light
Seattle, WA



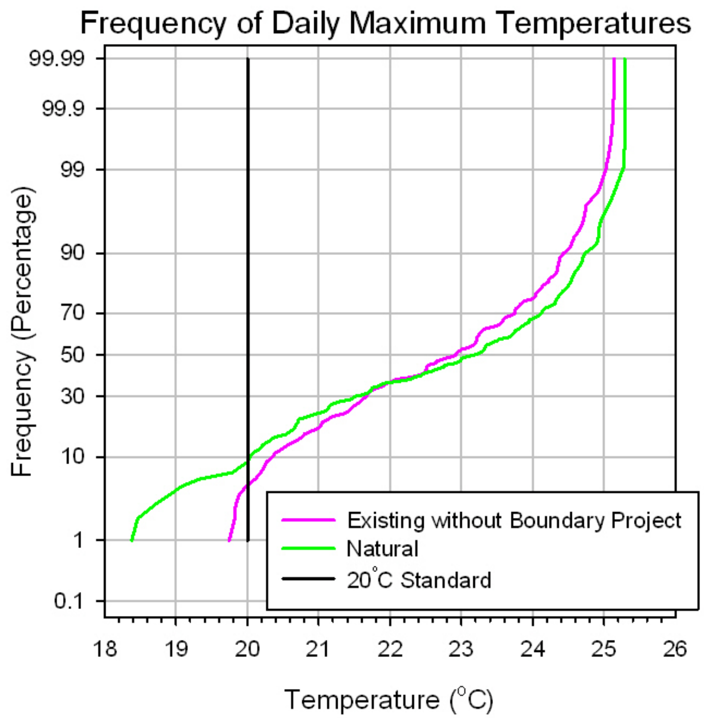
Notes:

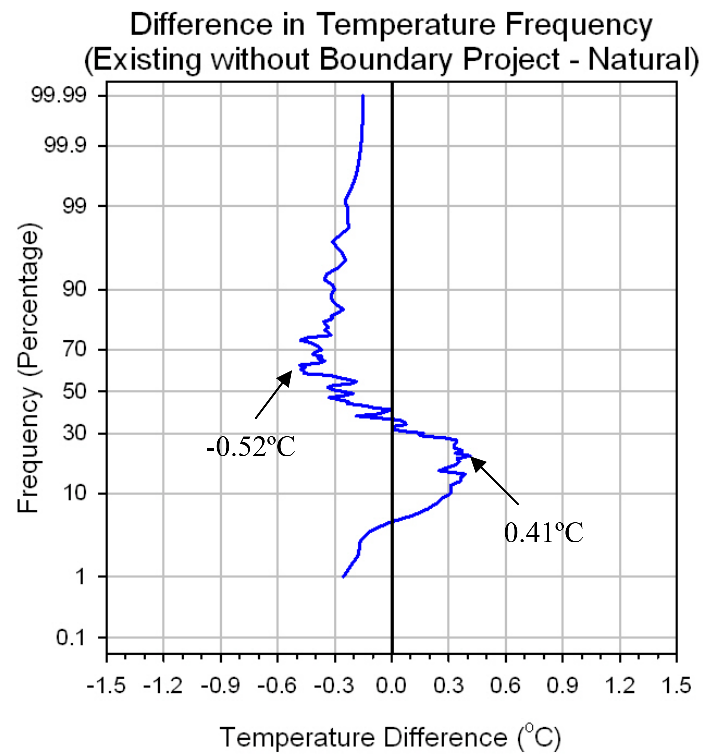
1. Existing without Boundary Project = No Boundary Dam, Box Canyon Dam present, and Albeni Falls Dam present.
2. The difference in temperature at each frequency is obtained by subtracting the Natural Condition values from the Existing without Boundary Project values. (When Natural Condition is < 20ºC, the Natural temperature is replaced by the value 20ºC.)
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005.
4. Surface temperature differences are between -0.51ºC and +0.40ºC due to upstream dams (Box Canyon and Albeni Falls) on the Pend Oreille River.

Figure 5-7b

Frequency Distribution of Daily Maximum Surface Temperatures for the Existing Condition without Boundary Project and the Natural Condition at Boundary Dam Forebay

Seattle City Light
Seattle, WA





Notes:

1. Existing without Boundary Project = No Boundary Dam, Box Canyon Dam present, and Albeni Falls Dam present.
2. The difference in temperature at each frequency is obtained by subtracting the Natural Condition values from the Existing without Boundary Project values. (When Natural Condition is < 20ºC, the Natural temperature is replaced by the value 20ºC.)
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005.
4. Surface temperature differences are between -0.52ºC and +0.41 ºC due to upstream dams (Box Canyon and Albeni Falls) on the Pend Oreille River.

Figure 5-7c

Frequency Distribution of Daily Maximum Surface Temperatures for the Existing Condition without Boundary Project and the Natural Condition at Boundary Dam Tailrace

Seattle City Light
Seattle, WA

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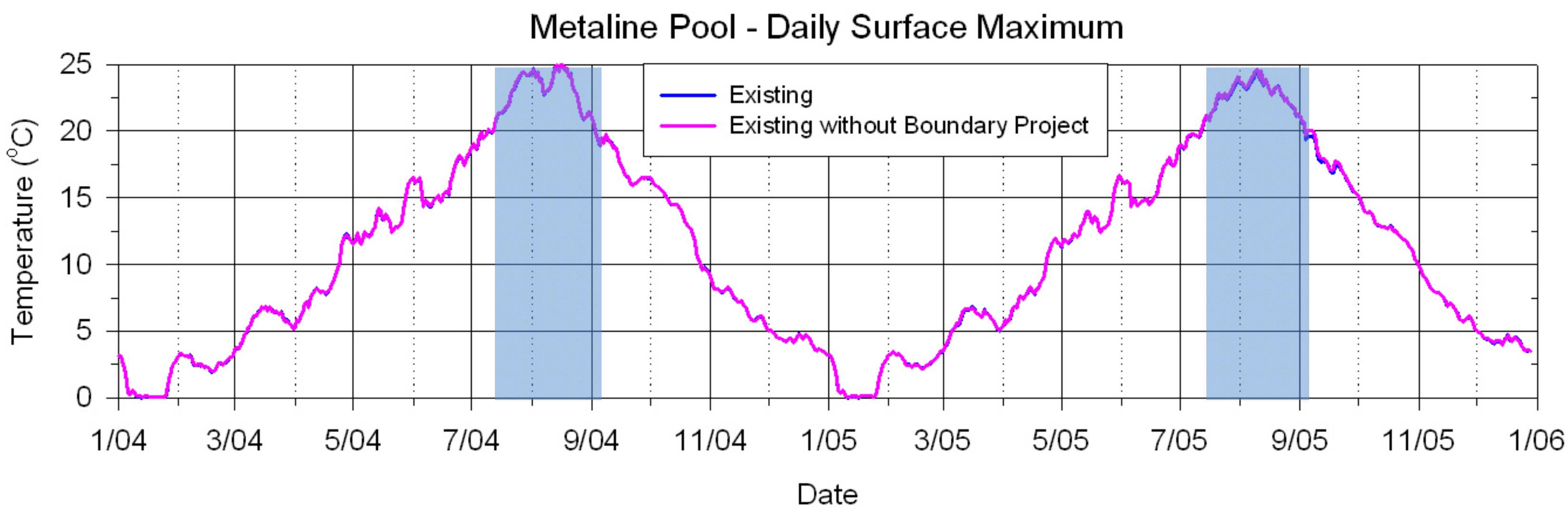


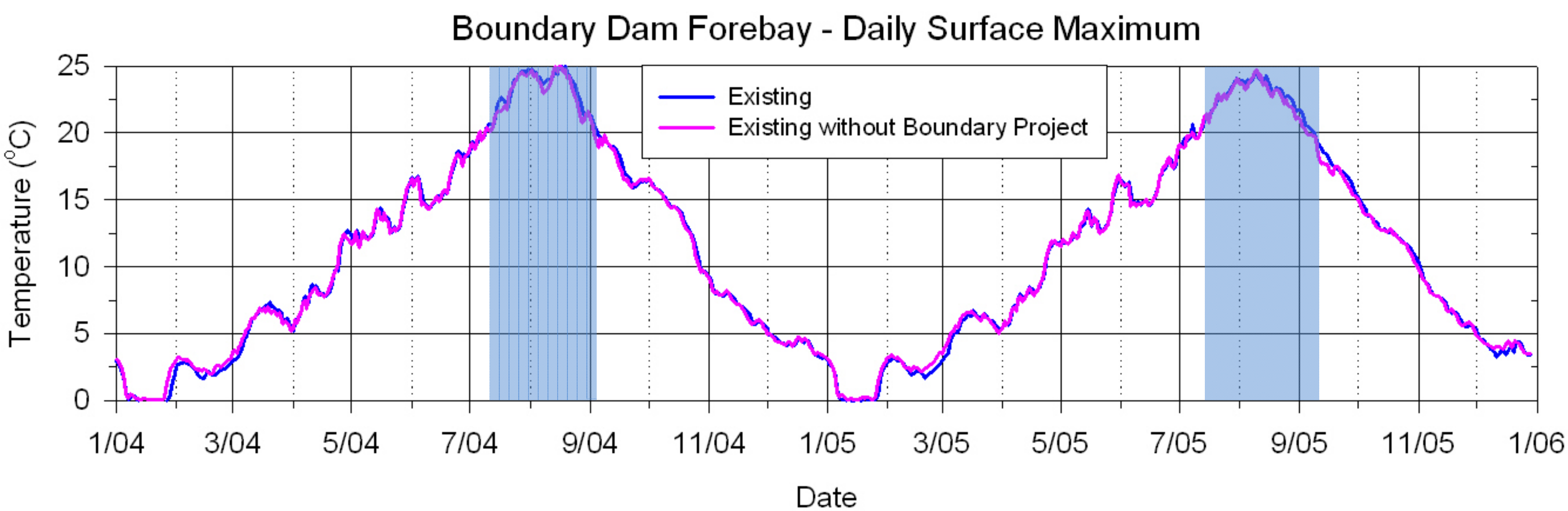
Notes:

1. Existing without Boundary Project = No Boundary Dam, Box Canyon Dam present, and Albeni Falls Dam present.
2. Daily maximum temperatures are from the surface layer of the models.
3. The period when the Existing without Boundary Project temperature is over 20ºC is indicated by the shading.

Figure 5-8a

Daily Maximum Surface Temperatures for the Existing Condition and Existing Condition without Boundary Project at Metaline Pool

Seattle City Light
Seattle, WA



Notes:

1. Existing without Boundary Project = No Boundary Dam, Box Canyon Dam present, and Albeni Falls Dam present.
2. Daily maximum temperatures are from the surface layer of the models.
3. The period when the Existing without Boundary Project temperature is over 20ºC is indicated by the shading.

Figure 5-8b

Daily Maximum Surface Temperatures for the Existing Condition and Existing Condition without Boundary Project at Boundary Dam Forebay

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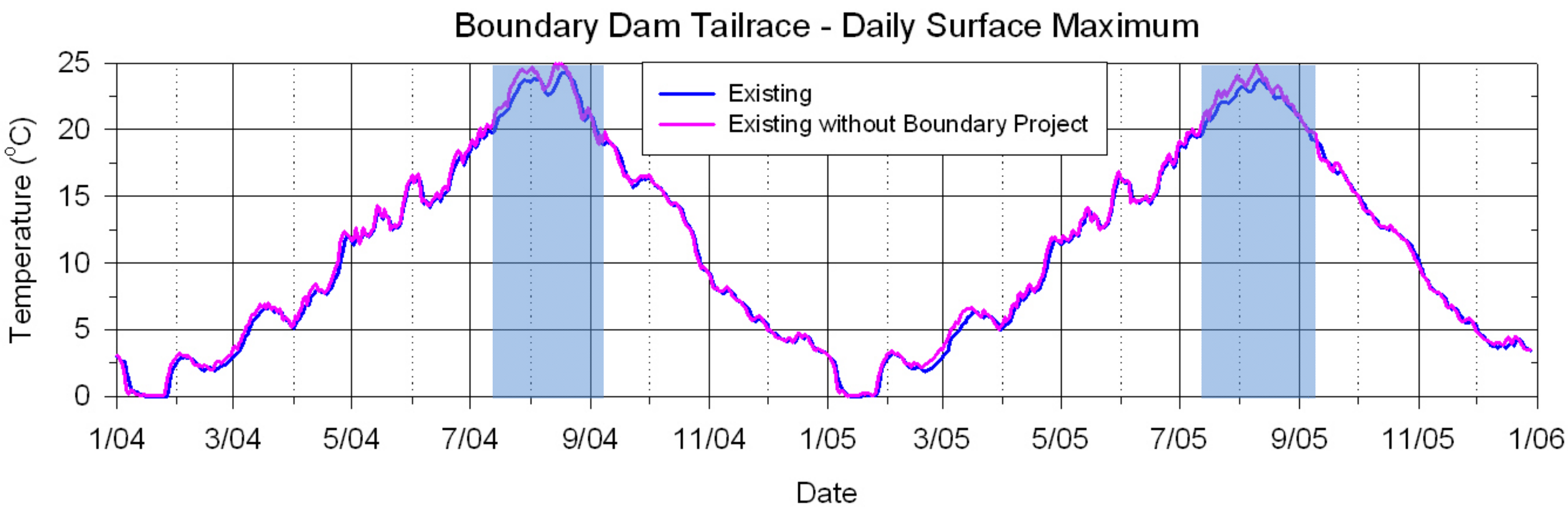

Notes:
1. Existing without Boundary Project = No Boundary Dam, Box Canyon Dam present, and Albeni Falls Dam present.
2. Daily maximum temperatures are from the surface layer of the models.
3. The period when the Existing without Boundary Project temperature is over 20ºC is indicated by the shading.

Figure 5-8c

Daily Maximum Surface Temperatures for the Existing Condition and Existing Condition without Boundary Project at Boundary Dam Tailrace

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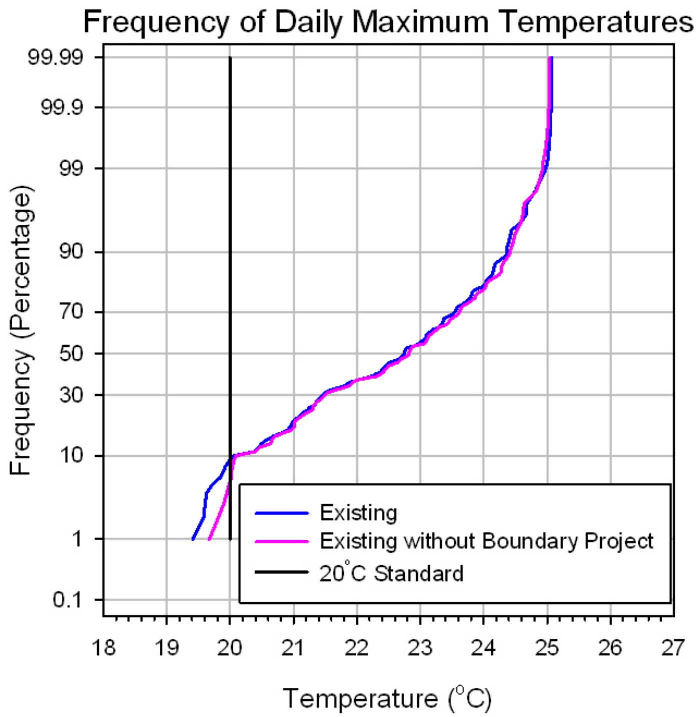

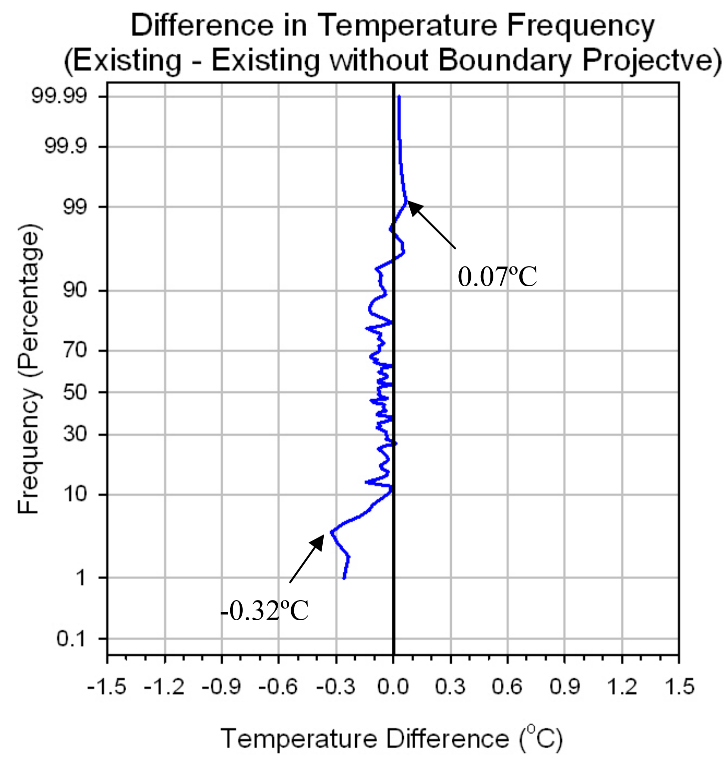

Notes:

1. Existing without Boundary Project = No Boundary Dam, Box Canyon Dam present, and Albeni Falls Dam present.
2. The difference in temperature at each frequency is obtained by subtracting the Existing without Boundary Project values from the Existing Condition values.
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005 when Existing Condition > 20ºC.
4. Existing Condition surface temperature differences are between -0.32ºC and +0.07ºC relative to the Existing Condition without Boundary Project.

Figure 5-9a

Frequency Distributions of the Daily Maximum Surface Temperatures for the Existing Condition and Existing Condition without Boundary Project at Metaline Pool

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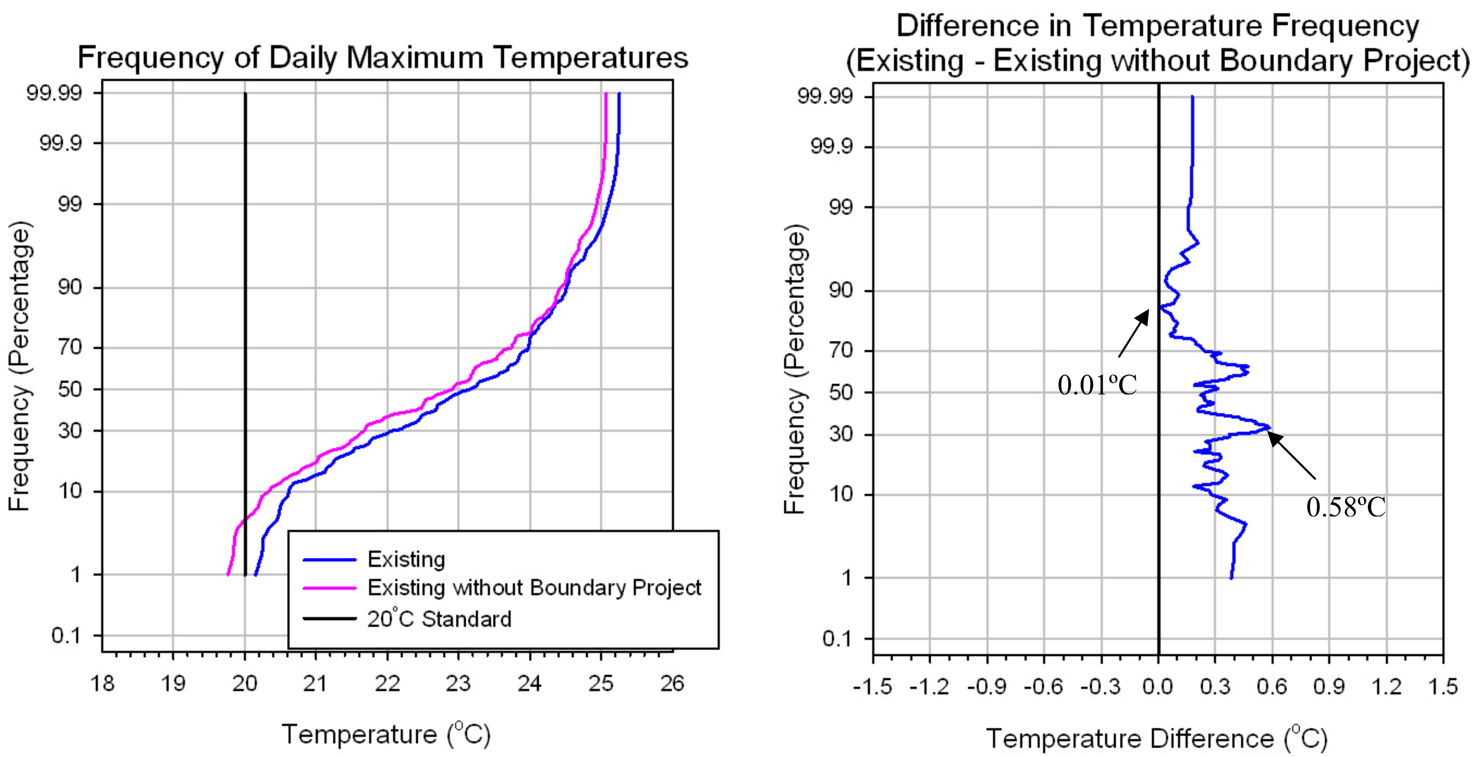

Notes:

1. Existing without Boundary Project = No Boundary Dam, Box Canyon Dam present, and Albeni Falls Dam present.
2. The difference in temperature at each frequency is obtained by subtracting the Existing without Boundary Project values from the Existing Condition values.
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005 when Existing Condition > 20ºC.
4. Existing Condition surface temperatures are between 0.01ºC and 0.58ºC higher than the Existing Condition without Boundary Project.

Figure 5-9b

Frequency Distributions of the Daily Maximum Surface Temperatures for the Existing Condition and Existing Condition without Boundary Project at Boundary Dan Forebay

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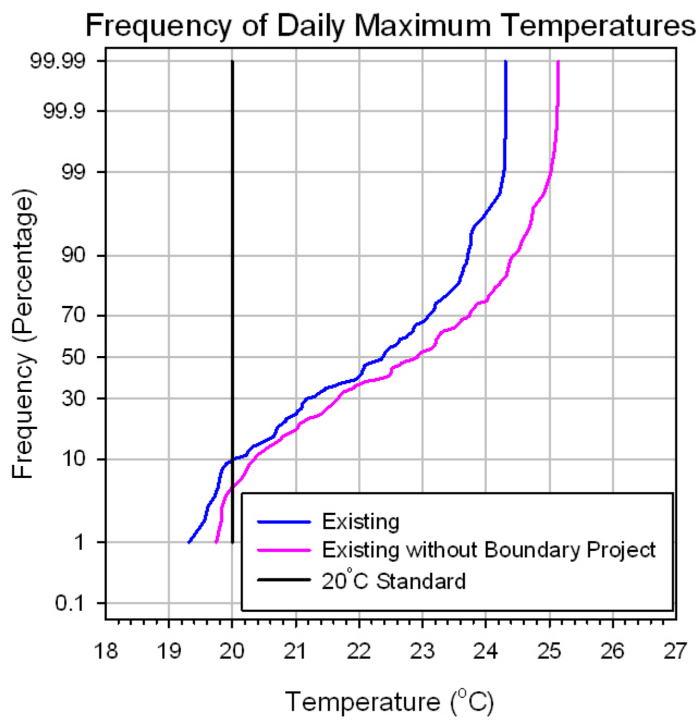

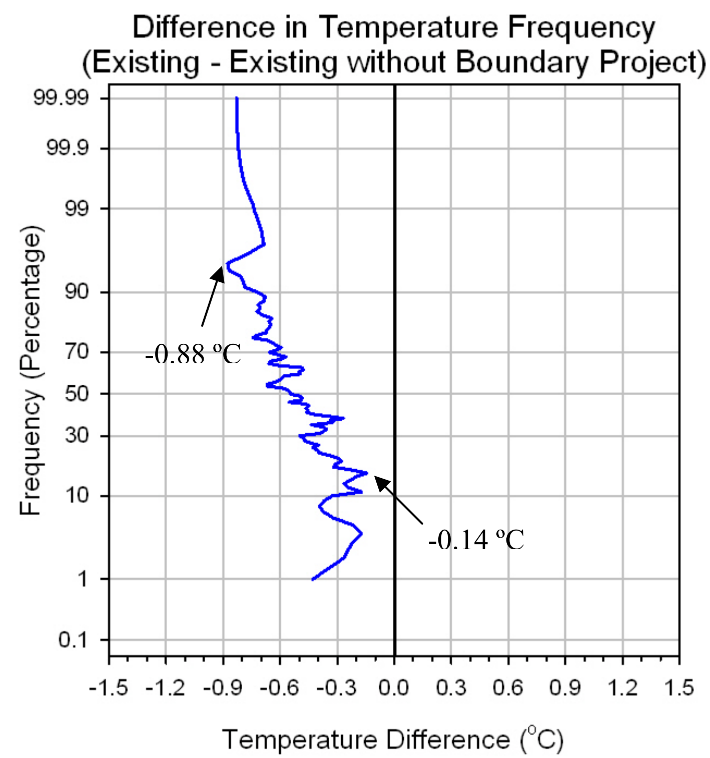

Notes:

1. Existing without Boundary Project = No Boundary Dam, Box Canyon Dam present, and Albeni Falls Dam present.
2. The difference in temperature at each frequency is obtained by subtracting the Existing without Boundary Project values from the Existing Condition values.
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005 when Existing Condition > 20ºC
4. Existing Condition surface temperatures are between 0.14ºC and 0.88ºC lower than the Existing Condition without Boundary Project.

Figure 5-9c

Frequency Distributions of the Daily Maximum Surface Temperatures for the Existing Condition and Existing Condition without Boundary Project at Boundary Dam Tailrace

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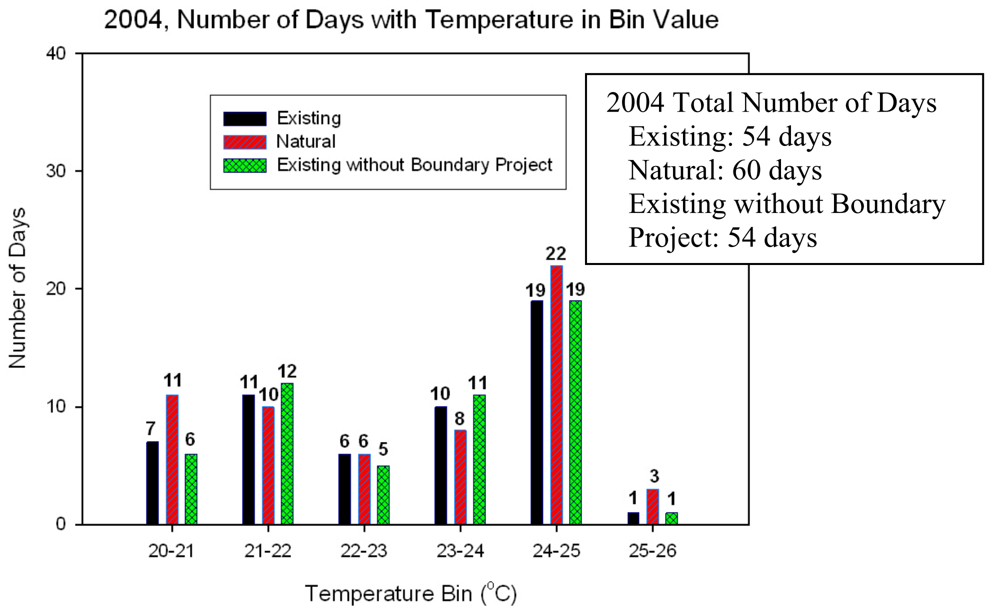

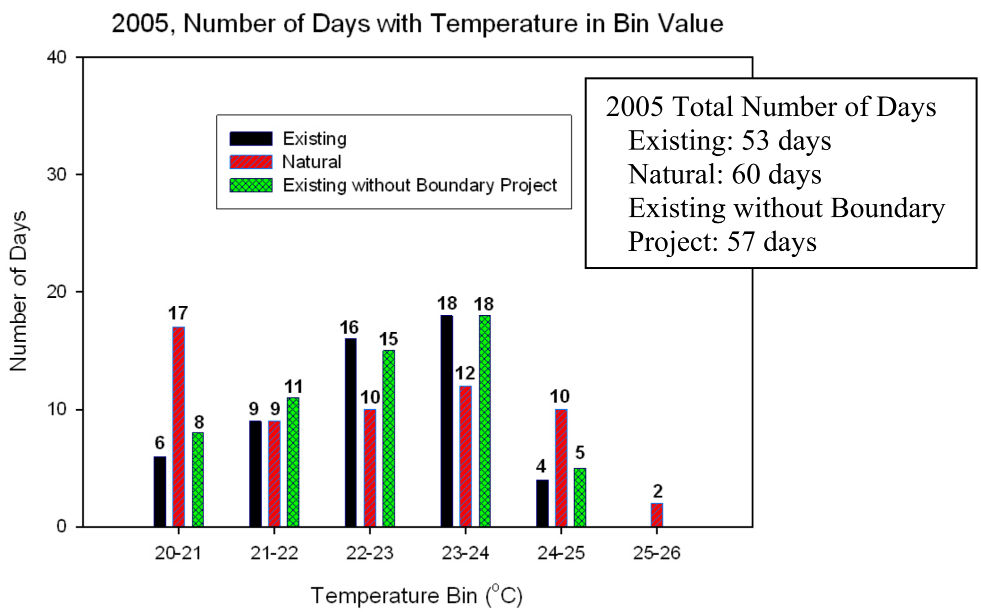

Notes:

1. The total number of days for 2004 and 2005 was
   Existing – 107 days, Natural – 120 days, and
   Existing without Boundary Project – 111 days
2. Peak annual surface temperatures at the Metaline Pool
   Existing – 2004: 25.07ºC & 2005: 24.41ºC
   Natural – 2004: 25.44ºC & 2005: 25.17ºC
   Existing without Boundary Project
   – 2004: 25.04ºC & 2005: 24.62ºC

Figure 5-10a

Number of Days the Daily Maximum Surface Temperatures Exceeded 20ºC at the Metaline Pool for 2004 and 2005

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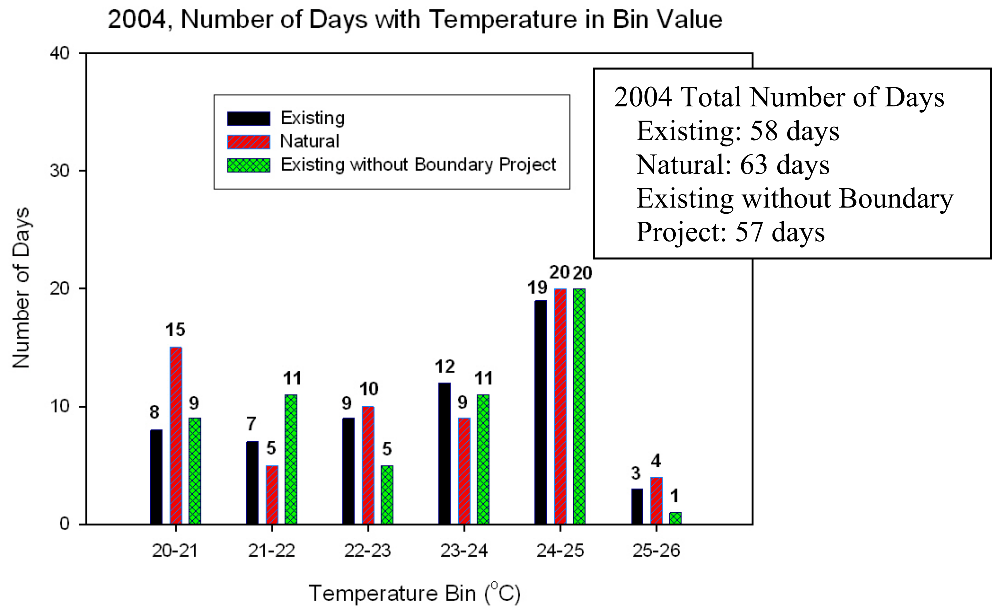

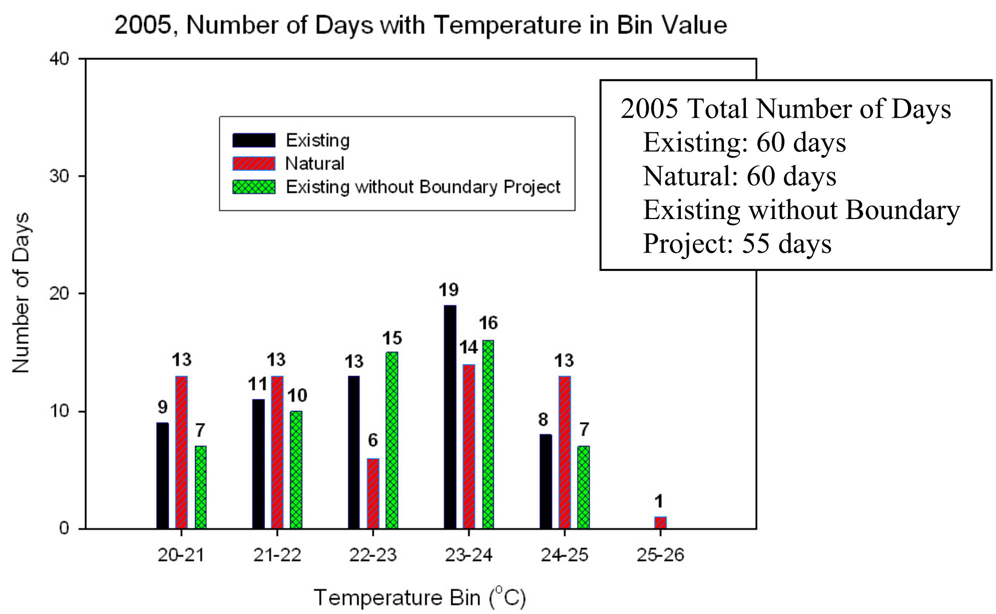

Notes:

1. The total number of days for 2004 and 2005 was
   Existing – 118 days, Natural – 123 days, and
   Existing without Boundary Project – 112 days
2. Peak annual surface temperatures at the Boundary Dam Forebay
   Existing – 2004: 25.25ºC & 2005: 24.55ºC
   Natural – 2004: 25.29ºC & 2005: 25.15ºC
   Existing without Boundary Project
   – 2004: 25.07ºC & 2005: 24.68ºC

Figure 5-10b

Number of Days the Daily Maximum Surface Temperatures Exceeded 20ºC at the Boundary Dam Forebay for 2004 and 2005

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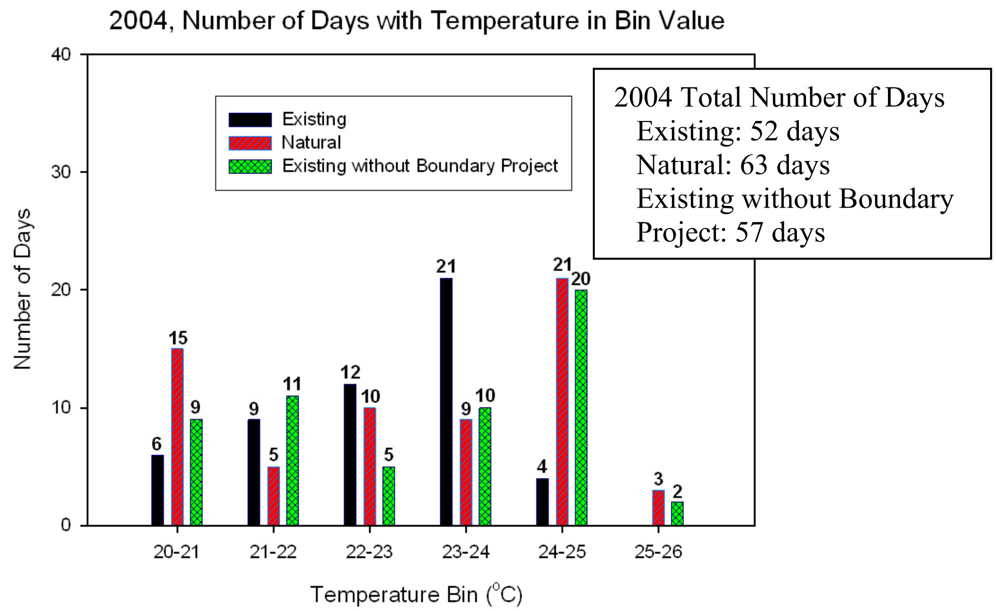

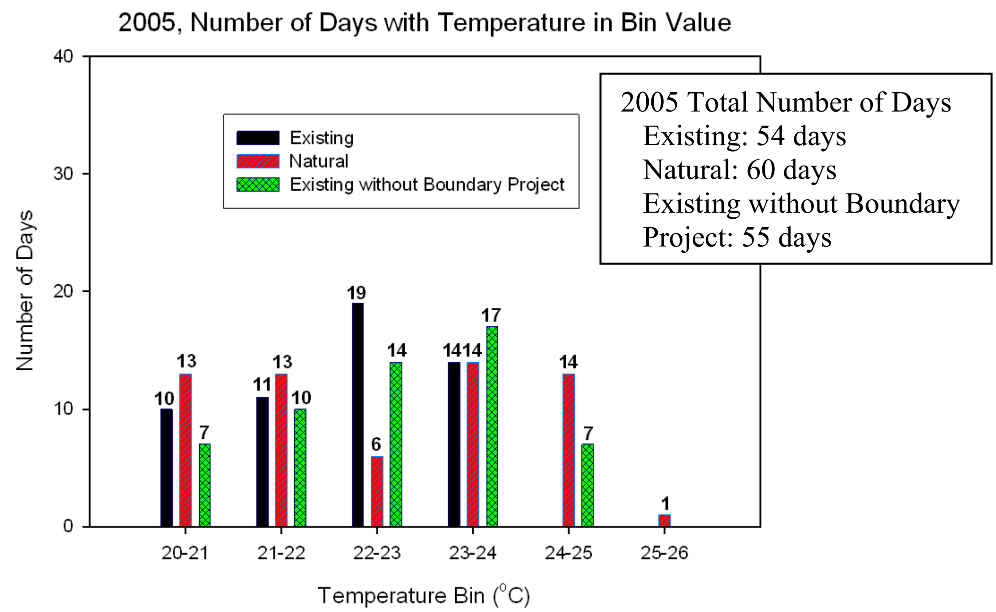

Notes:

1. The total number of days for 2004 and 2005 was
   Existing – 106 days, Natural – 123 days, and
   Existing without Boundary Project – 112 days
2. Peak annual surface temperatures at the Forebay station
   Existing – 2004: 24.31ºC & 2005: 23.71ºC
   Natural – 2004: 25.29ºC & 2005: 25.15ºC
   Existing without Boundary Project – 2004: 25.14ºC & 2005: 24.77ºC

Figure 5-10c

Number of Days the Daily Maximum Surface Temperatures Exceeded 20ºC at the Boundary Dam Tailrace for 2004 and 2005

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6.0 Alternative Operations Analysis: Run-of-river operation with a drawdown to 1974 feet

In this section, at Ecology's request, we present an alternative operations analysis to investigate whether there are any operational changes that could provide significant improvement in surface temperatures in Boundary Reservoir, and particularly at the Boundary forebay station. To do so, SCL evaluated the temperature effects of the most extreme operational modification possible consistent with operational constraints in order to provide an outer bound on possible alternative operational scenarios relative to current operations. The alternative operations scenario that SCL modeled involves run-of-river operation at water surface elevation of 1974 feet NAVD88. It was developed through professional judgment and input from scientists involved in the relicensing of the Boundary Hydroelectric Project on the expectation that it would improve surface water temperature conditions.

In this alternative operations scenario, the forebay of Boundary Dam would be drawn down to an elevation of 1974 NAVD88 during the summer months of July and August. During this period, the dam would be operated in the run-of-river mode where outflow would equal the inflow having accounted for travel time differences. During other months the project would be operated as in the Existing Condition. The elevation of 1974 NAVD88 was selected based on input from SCL engineering staff that this is the lowest drawdown elevation feasible before encountering cavitation constraints that can lead to damage to the Project. The expectation was that lowering the water surface elevation would improve temperature response by (a) reducing travel time, (b) reducing surface area, and (c) reducing warm water accumulations in the forebay.

Table 6-1 provides the model configurations for the Existing Condition, Natural Condition, Existing Condition without Boundary Project, and Run-of-River, 1974 ft Elevation scenario.

Table 6-1
Model Configurations for Existing Condition, Natural Condition, Existing Condition without Boundary Project, and Run-of-River, 1974 ft Elevation scenario

Case	Pend Oreille River Dams	Point Sources	Shade
Existing	All	All	Existing
Natural	None	None	PNV
Existing without Boundary Project	Albeni Falls, Box Canyon and Seven-Mile	All	Existing
Run-of-river, 1974 Elevation	All	All	Existing

Section 6.1 presents the comparison using flow-weighted temperatures; Section 6.2 does the same using surface temperatures.

6.1 Flow-Weighted Temperature Evaluation

Figures 6-1 a, b, and c show time series comparisons of the daily maximum flow-weighted temperatures for the Natural Condition and the Run-of-river, 1974 Elevation operational alternative at Metaline Pool, Boundary forebay, and Boundary tailrace stations, respectively. The peak temperatures in the Run-of-river, 1974 Elevation operation are slightly lower than the Natural Condition peaks (24-25˚C). These results are very similar to the Existing Condition operation. Figures 6-2 a, b, and c present plots of the frequency distribution of the daily maximum flow-weighted temperatures for the Run-of-river, 1974 Elevation operation and the Natural Condition at Metaline Pool, Boundary forebay, and Boundary tailrace stations, respectively. For example, the maximum difference in temperature at Boundary forebay station was 0.15˚C. When compared with the difference between Existing Condition and Natural conditions of 0.20˚C (Table 6-2), it can be seen that there was a minor improvement in the Run-of-river scenario, with the temperature difference of 0.05˚C (0.20˚C - 0.15˚C = 0.05˚C). In contrast, at the Metaline Pool and Boundary tailrace stations, this same comparison indicates that conditions are slightly worse under the Run-of-river scenario than under the Existing Condition, with temperature differences of -0.09˚C (0.50˚C - 0.59˚C) and -0.06˚C (0.10˚C - 0.16˚C) at the Metaline Pool and Boundary tailrace stations, respectively (Table 6-2).

The comparisons of the time series of daily maximum flow-weighted temperatures between the Run-of-river, 1974 Elevation operation and the Existing Condition at the Metaline Pool, Boundary forebay, and Boundary tailrace stations are shown in Figures 6-3 a, b, and c, respectively. The frequency distributions of the daily maximum flow-weighted temperatures for the Run-of-river, 1974 Elevation operation and the Existing Condition at the Metaline Pool, Boundary forebay, and Boundary tailrace stations are shown in Figures 6-4 a, b, and c, respectively. The comparison of these two cases shows potential changes that might occur with the incorporation of the Run-of-river, 1974 Elevation operation compared to current operations. These results show that the flow-weighted temperatures for the Existing Condition were very similar to the temperatures predicted for the Run-of-river, 1974 Elevation operation. The maximum differences in temperature for the frequency distributions were 0.08˚C, 0.16˚C and 0.19˚C at the Metaline Pool, Boundary forebay and Boundary tailrace stations, respectively. However, the differences fluctuated around 0 (see Figures 6-4 a, b and c) indicating that from a practical perspective there was little or no real improvement in conditions.

A summary of the maximum temperature differences for all the cases examined is presented in Table 6-2 a, b, and c corresponding to Metaline Pool, Boundary forebay, and Boundary tailrace stations, respectively. The comparison to the Natural Condition represents the difference relative to the water quality criterion,[19] while the comparison to the Existing Condition represents the change relative to the Existing Condition. In the Tables 6-2 a, b, and c, we have reported the maximum temperature difference without any adjustment or accounting for the 0.3˚C human use allowance.

Figures 6-5 a, b, and c show number of days that daily maximum flow weighted temperatures are above 20ºC and the peak annual flow-weighted temperatures, in Metaline Pool, Boundary

[19] The water quality criterion is the 1-DMax of 20.0°C or the Natural Condition + 0.3°C, whichever is greater. However, differences presented are not adjusted to account for the 0.3°C human use allowance.

forebay, and Boundary tailrace stations, respectively. For example, at the Boundary forebay location, for the Run-of-river, 1974 Elevation operation, 52 days were above 20ºC in 2004, and in 2005, 53 days were above 20ºC (Figure 6-5 b). In comparison, in 2004, 52 days were above 20ºC in the Existing Condition, while in 2005, 54 days were above 20ºC. The Natural Condition had 63 days in 2004 and 60 days in 2005 that were above 20ºC. Therefore, the Run-of-river, 1974 Elevation operation did not result in any significant improvement in the number of days that flow weighted maximum temperatures would be above 20ºC as compared to Existing Condition. Similarly, under the Existing Condition, the peak annual flow-weighted temperatures at all stations were effectively the same or lower than under the Run-of-river scenario or any of the other Conditions.

As shown most clearly in Figures 6-4 a, b, and c, even changing to the extreme alternative operations scenario of Run-of-river, 1974 Elevation does not result in any significant improvement in flow-weighted temperatures at any of the locations in the reservoir.

6.2 Surface Temperature Evaluation

Figures 6-6 a, b, and c show a comparison of the time series of the daily maximum surface temperatures for the Natural Condition and the Run-of-river, 1974 Elevation operation at Metaline Pool, Boundary forebay, and Boundary tailrace stations, respectively. The peak surface temperatures in the forebay are similar ≈25˚C. Relative to Natural Condition, the peak surface temperatures in the tailrace and the Metaline Pool station appear to be a little cooler under the Run-of-river scenario (but similar to Existing Condition). Figures 6-7 a, b, and c present plots of the frequency distribution of the surface daily maximum temperatures for Run-of-river, 1974 Elevation operation and the Natural Condition at Metaline Pool, Boundary forebay, and Boundary tailrace stations, respectively. For example, the maximum difference in temperature was 0.94˚C at Boundary forebay station. It is notable that this difference has increased from the value of 0.76˚C of difference between the Existing and Natural Condition using the frequency analysis method (See section 4.4 and Table 6-3).

The comparison of the time series of the daily maximum surface temperatures between the Run-of-river, 1974 Elevation operation and the Existing Condition is shown in Figures 6-8 a, b, and c at Metaline Pool, Boundary forebay, and Boundary tailrace stations, respectively. The peak temperatures in the Run-of-river, 1974 Elevation operation were relatively unchanged from the Existing Condition peaks (≈ 25˚C), especially at the Metaline Pool and Boundary Tailrace stations but appeared to get slightly warmer in the Boundary Forebay station under the Run-of-river scenario. The frequency distributions of the daily maximum surface temperatures for the Run-of-river, 1974 Elevation operation and the Existing Condition are shown in Figure 6-9 a, b, and c at Metaline Pool, Boundary forebay, and Boundary tailrace stations respectively. These results show that the surface temperatures for the Existing Condition and the Run-of-river, 1974 Elevation operation were very similar in the Metaline Pool and Boundary Tailrace stations, again oscillating around 0 as was the case for flow-weighted temperatures (section 6.1, Figures 6-4 a, b and c). In contrast, at the Boundary forebay station, the surface daily maximum temperatures in the Run-of-river scenario were consistently warmer relative to the Existing Condition (Figure 6-9 b). The difference in surface daily maximum temperature at the Boundary forebay station from frequency distributions ranged from -0.07˚C to -0.55˚C, indicating that the Run-of-river, 1974

Elevation alternative operation scenario would cause maximum surface temperatures to be warmer than they are under the Existing Condition by between 0.07˚C and 0.55˚C throughout the entire critical summer period.

A summary of the surface daily maximum temperature differences for all the cases examined is presented in Table 6-3 a, b, and c. Figures 6-10 a, b, and c show number of days that daily maximum flow weighted temperatures were above the 20ºC, and the peak annual surface water temperatures, in Metaline Pool, Boundary forebay, and Boundary tailrace stations, respectively. For example, at the Boundary forebay station, for the Run-of-river, 1974 Elevation operation, 59 days were above 20ºC in 2004, and in 2005, 60 days were above the 20ºC criterion (Figure 6-10 b). In comparison, in 2004, 58 days were above 20ºC in the Existing Condition, while in 2005, 60 days were above 20ºC. The Natural Condition had 63 days in 2004 and 60 days in 2005 that were above 20ºC. Similarly, peak annual surface temperatures under the Run-of-river alternative operations scenario were effectively the same as or higher than peak annual surface temperatures under the Existing Condition at all stations.

As shown most clearly in Figures 6-9 a, b, and c, even changing to the extreme alternative operations scenario of Run-of-river, 1974 Elevation does not result in any significant improvement in surface temperatures at the Metaline Pool or tailrace locations. At the Boundary forebay location, which was the impetus for the alternative operations analysis, changing to the Run-of-river, 1974 Elevation scenario actually results in an increase in surface daily maximum water temperatures throughout the entire critical summer period. Accordingly, change of Project operations to run-of-the-river does not improve surface temperatures conditions.

Table 6-2
Summary of Maximum Flow-Weighted Temperature Differences from Frequency Analysis Comparing the Existing Condition, the Natural Condition, and the Run-of-river, 1974 Elevation operation

a. Metaline Pool

Case	Maximum ΔT relative to the Natural Condition using Flow-Weighted Temperature from Frequency Analysis (Case-Natural)	Maximum ΔT relative to Existing Conditions using Flow-Weighted Temperature from Frequency Analysis (Existing-Case)
Existing	0.50ºC[1]	0.0ºC
Run-of-river, 1974 Elevation operation	0.59ºC[2]	0.08ºC[3]

b. Boundary Forebay

Case	Maximum ΔT relative to the Natural Condition using Flow-Weighted Temperature from Frequency Analysis (Case-Natural)	Maximum ΔT relative to Existing Conditions using Flow-Weighted Temperature from Frequency Analysis (Existing-Case)
Existing	0.20ºC[1]	0.0ºC
Run-of-river, 1974 Elevation operation	0.15ºC[2]	0.16ºC[3]

c. Boundary Tailrace

Case	Maximum ΔT relative to the Natural Condition using Flow-Weighted Temperature from Frequency Analysis (Case-Natural)	Maximum ΔT relative to Existing Conditions using Flow-Weighted Temperature from Frequency Analysis (Existing-Case)
Existing	0.10ºC[1]	0.0ºC
Run-of-river, 1974 Elevation operation	0.16ºC[2]	0.19ºC[3]

Notes:
The period covered is July 9, 2004 to September 4, 2004 & July 8, 2005 to September 8, 2005. Existing = all dams are present, Natural = no dams are present, Run-of-river, 1974 Elevation operation = as stated with all dams present
[1] This represents the largest difference between the maximum flow-weighted temperature cumulative frequency distributions for the Existing Condition (with all dams in place) and Natural Condition.
[2] This represents the largest difference between the maximum flow-weighted temperature cumulative frequency distributions for the Run-of-river 1974 elevation. and the Natural Condition.
[3] This represents the largest difference between the maximum flow-weighted temperature cumulative frequency distributions for the Run-of-river 1974 elevation and the Existing Condition. This shows the potential temperature difference associated with Run-of-river 1974 elevation alternative operations scenario compared to Existing Conditions.

Table 6-3
Summary of Maximum Surface Temperature Differences from Frequency Analysis comparing the Existing Condition, the Natural Condition, and the Run-of-river, 1974 Elevation operation

a. Metaline Pool

Case	Maximum ΔT relative to the Natural Condition using Surface Temperature from Frequency Analysis (Case-Natural)	Maximum ΔT relative to Existing Conditions using Surface Temperature from Frequency Analysis (Existing-Case)
Existing	0.50ºC[1]	0.0ºC
Run-of-river, 1974 Elevation operation	0.60ºC[2]	0.13ºC[3]

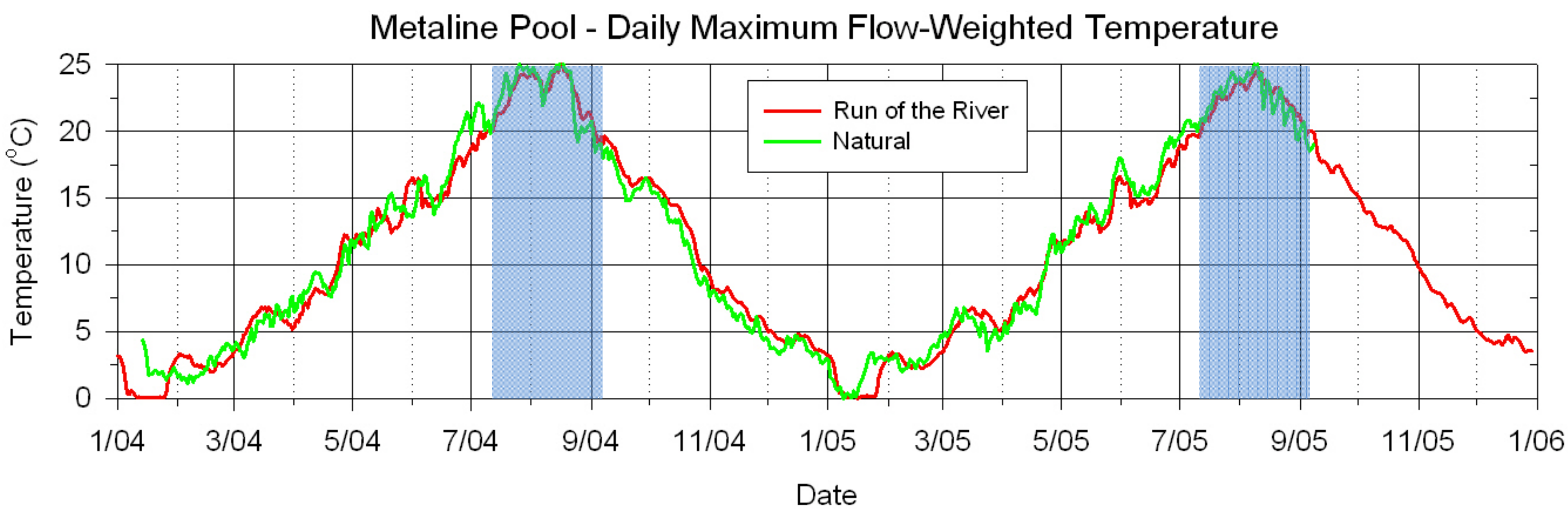
b. Boundary Forebay

Case	Maximum ΔT relative to the Natural Condition using Surface Temperature from Frequency Analysis (Case-Natural)	Maximum ΔT relative to Existing Conditions using Surface Temperature from Frequency Analysis (Existing-Case)
Existing	0.76ºC[1]	0.0ºC
Run-of-river, 1974 Elevation operation	0.94ºC[2]	-0.07ºC[3]

c. Boundary Tailrace

Case	Maximum ΔT relative to the Natural Condition using Surface Temperature from Frequency Analysis (Case-Natural)	Maximum ΔT relative to Existing Conditions using Surface Temperature from Frequency Analysis (Existing-Case)
Existing	0.19ºC[1]	0.0ºC
Run-of-river, 1974 Elevation operation	0.16ºC[2]	0.19ºC[3]

Notes:
The period covered is July 9, 2004 to September 4, 2004 & July 8, 2005 to September 8, 2005. Existing = all dams are present, Natural = no dams are present, Run-of-river, 1974 Elevation operation = as stated with all dams present
[1] This represents the largest difference between the maximum flow-weighted temperature cumulative frequency distributions for the Existing Condition (with all dams in place) and Natural Condition.
[2] This represents the largest difference between the maximum flow-weighted temperature cumulative frequency distributions for the Run-of-river, 1974 elevation. and the Natural Condition.
[3] This represents the largest difference between the maximum flow-weighted temperature cumulative frequency distributions for the Run-of-river, 1974 elevation. and the Existing Condition. This shows the potential temperature difference associated with the Run-of-river, 1974 elevation alternative operations scenario compared to Existing Conditions



Notes:

1. Run of the River = run of river operation during the summer at 1974 ft elevation.
2. Daily maximum flow-weighted temperature is

$$T_W = \sum_{l=1}^{n} (T_l \times Q_l) / Q_T$$

where l is a layer of water column (l=1, 2,.., n), T_W is the flow-weighted temperature, T_l is the temperature at the layer, Q_l is the flow rate at the layer, and Q_T is the total flow.

3. The period when the Run of the River temperature is over 20ºC is indicated by the shading.

Figure 6-1a

Daily Maximum Flow-Weighted Temperatures for the Run of the River and the Natural Condition at Metaline Pool

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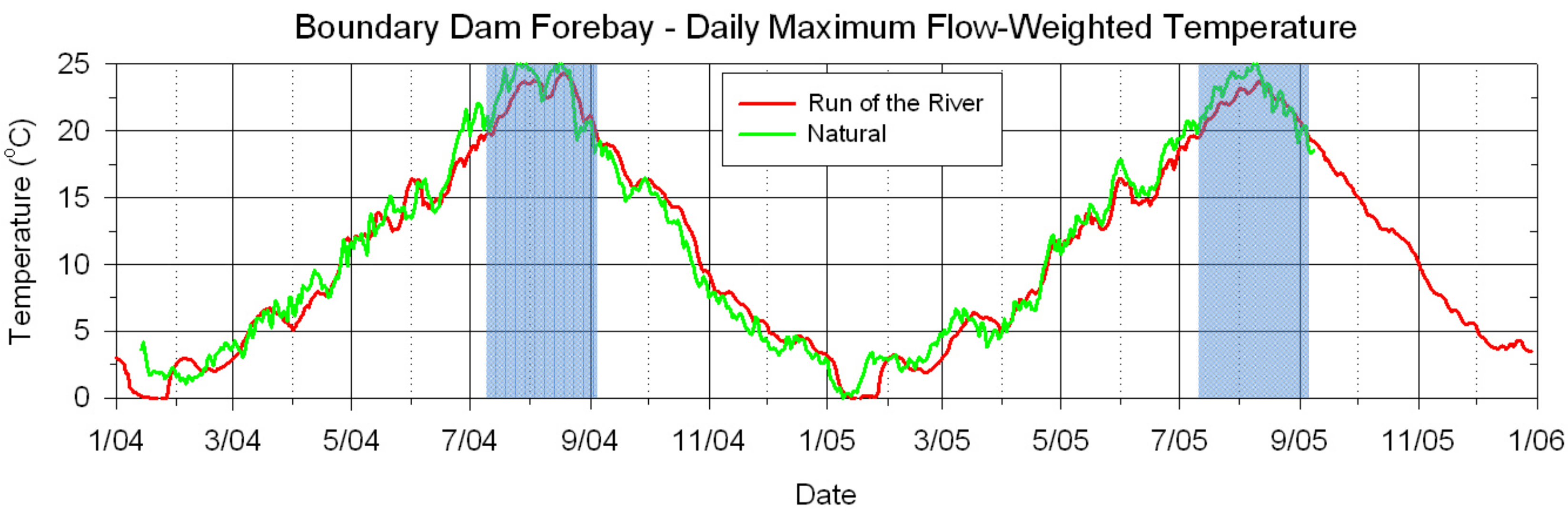

Notes:

1. Run of the River = run of river operation during the summer at 1974 ft elevation
2. Daily maximum flow-weighted temperature is

$$T_W = \sum_{l=1}^{n} (T_l \times Q_l) / Q_T$$

where l is a layer of water column (l=1, 2,.., n), T_W is the flow-weighted temperature, T_l is the temperature at the layer, Q_l is the flow rate at the layer, and Q_T is the total flow.

3. The period when the Run of the River temperature is over 20ºC is indicated by the shading.

Figure 6-1b

Daily Maximum Flow-Weighted Temperatures for the Run of the River and the Natural Condition at Boundary Dam Forebay

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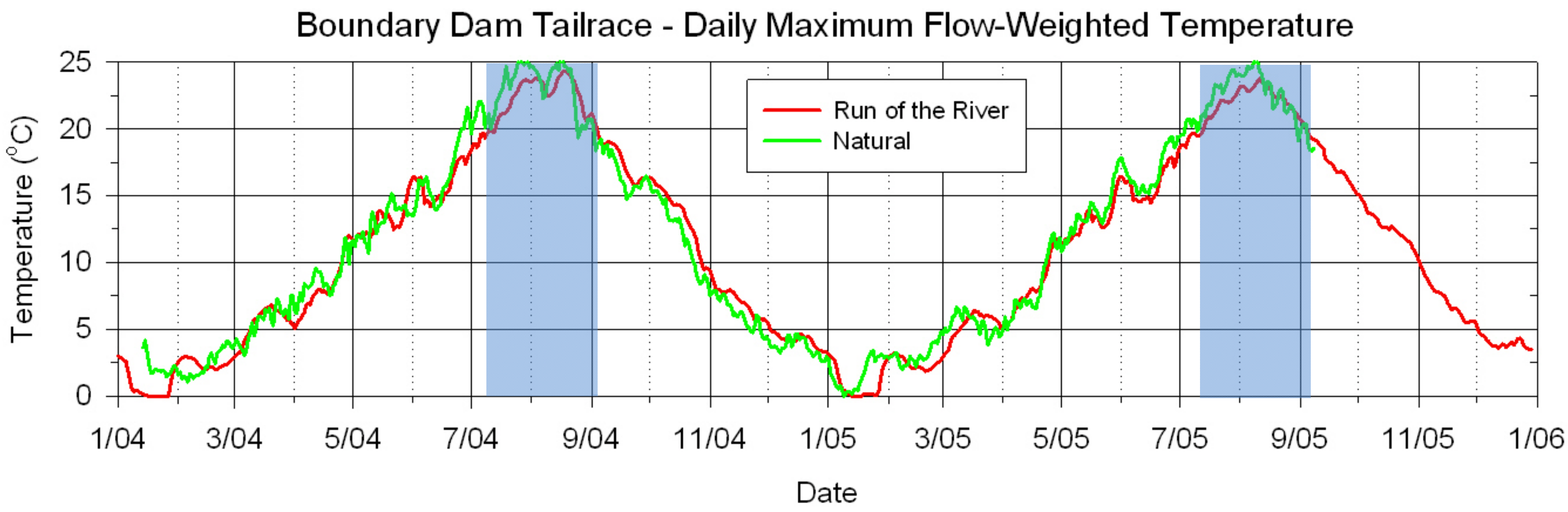

Notes:

1. Run of the River = run of river operation during the summer at 1974 ft elevation
2. Daily maximum flow-weighted temperature is

$$T_W = \sum_{l=1}^{n} (T_l \times Q_l) / Q_T$$

   where l is a layer of water column (l=1, 2,.., n), T_W is the flow-weighted temperature, T_l is the temperature at the layer, Q_l is the flow rate at the layer, and Q_T is the total flow.
3. The period when the Run of the River temperature is over 20ºC is indicated by the shading.

Figure 6-1c

Daily Maximum Flow-Weighted Temperatures for the Run of the River and the Natural Condition at Boundary Dam Tailrace

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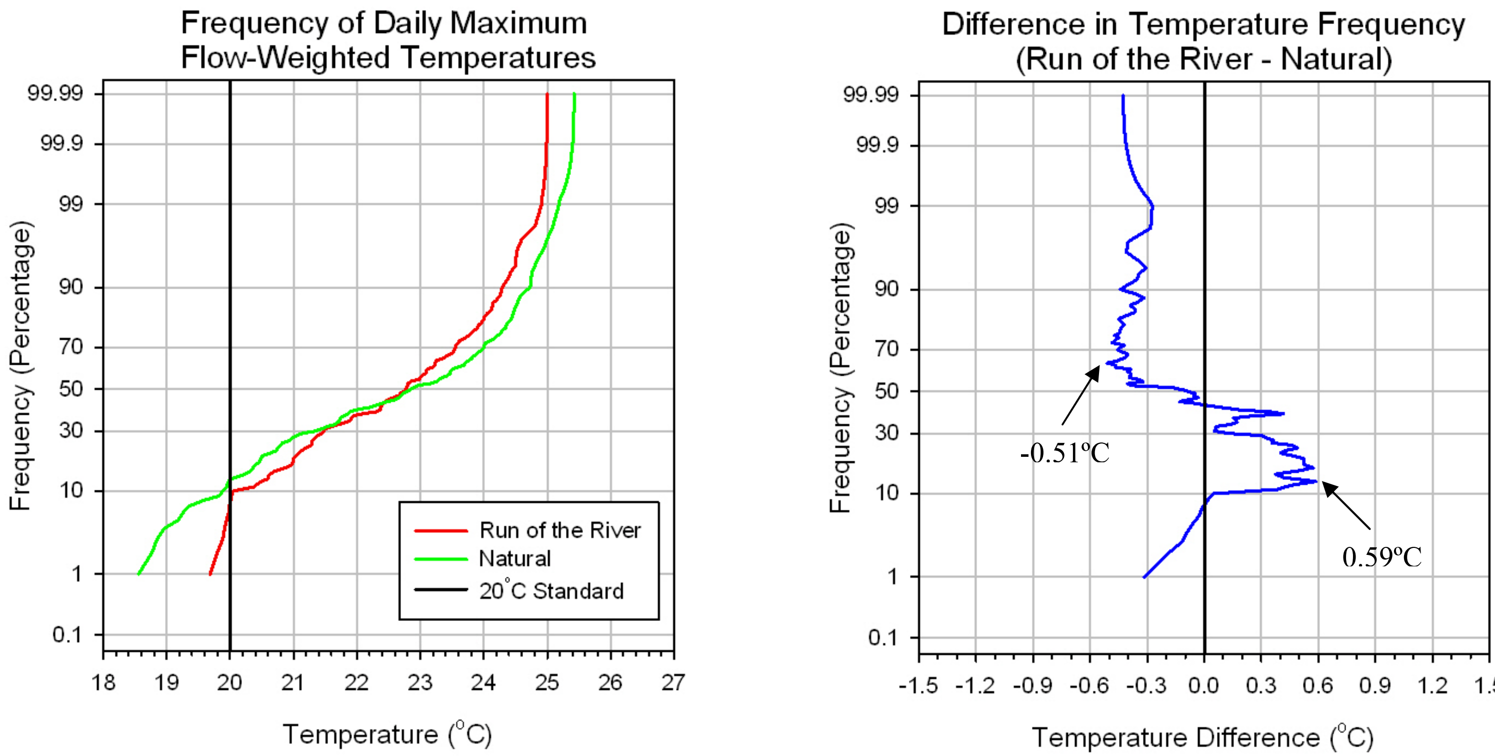

Notes:

1. Run of the River = run of river operation during the summer at 1974 ft elevation.
2. The difference in temperature at each frequency is obtained by subtracting the Natural Condition values from the Run of the River values. (When Natural Condition is < 20ºC, the Natural temperature is replaced by the value 20ºC.)
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005.
4. Flow-weighted temperature differences are between -0.51 ºC and +0.59 ºC due to the Run of the River operational scenario.

Figure 6-2a

Frequency Distribution of the Daily Maximum Flow-Weighted Temperatures for the Run of the River and the Natural Condition at Metaline Pool

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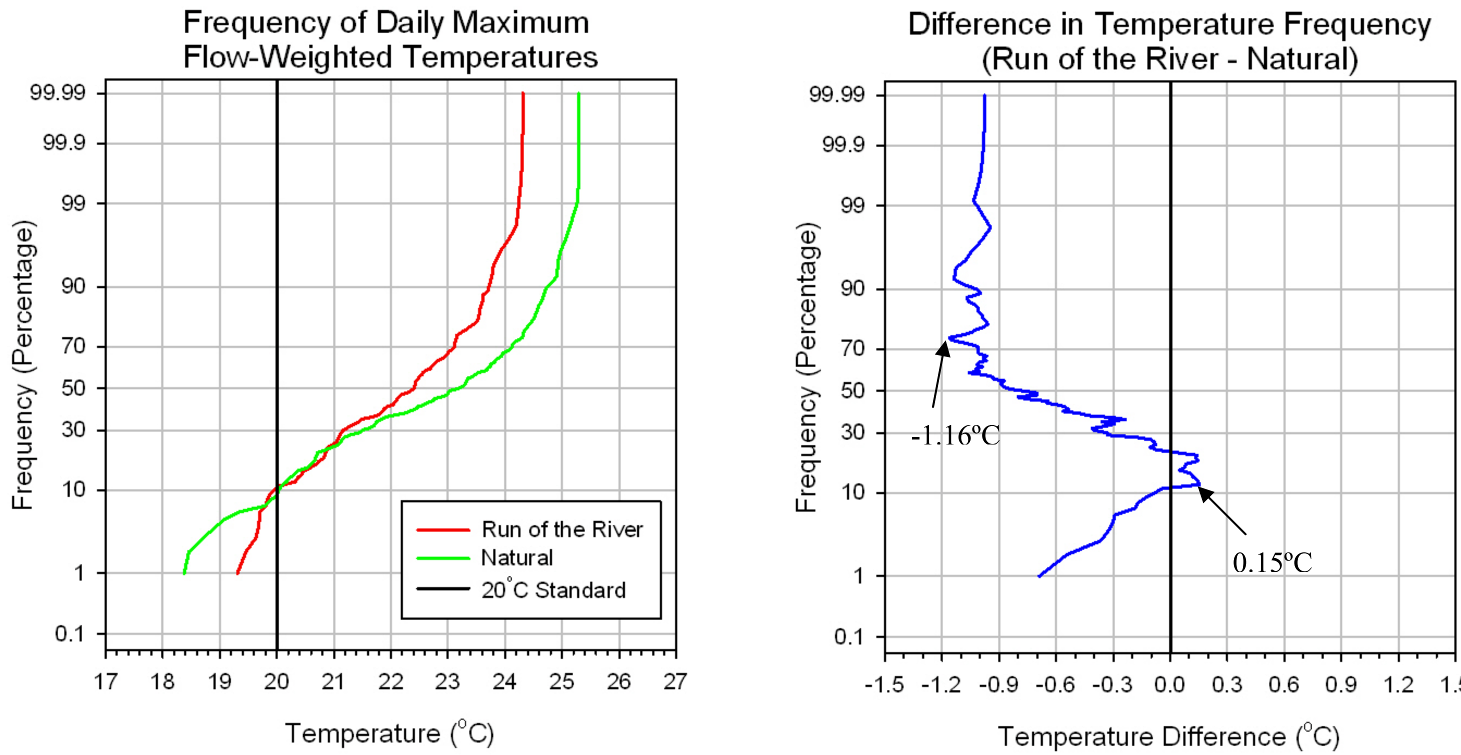

Notes:

1. Run of the River = run of river operation during the summer at 1974 ft elevation.
2. The difference in temperature at each frequency is obtained by subtracting the Natural Condition values from the Run of the River values. (When Natural Condition is < 20ºC, the Natural temperature is replaced by the value 20ºC.)
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005.
4. Flow-weighted temperature differences are between -1.16 ºC and +0.15 ºC due to the Run of the River operational scenario.

Figure 6-2b

Frequency Distribution of the Daily Maximum Flow-Weighted Temperatures for the Run of the River and the Natural Condition at Boundary Dam Forebay

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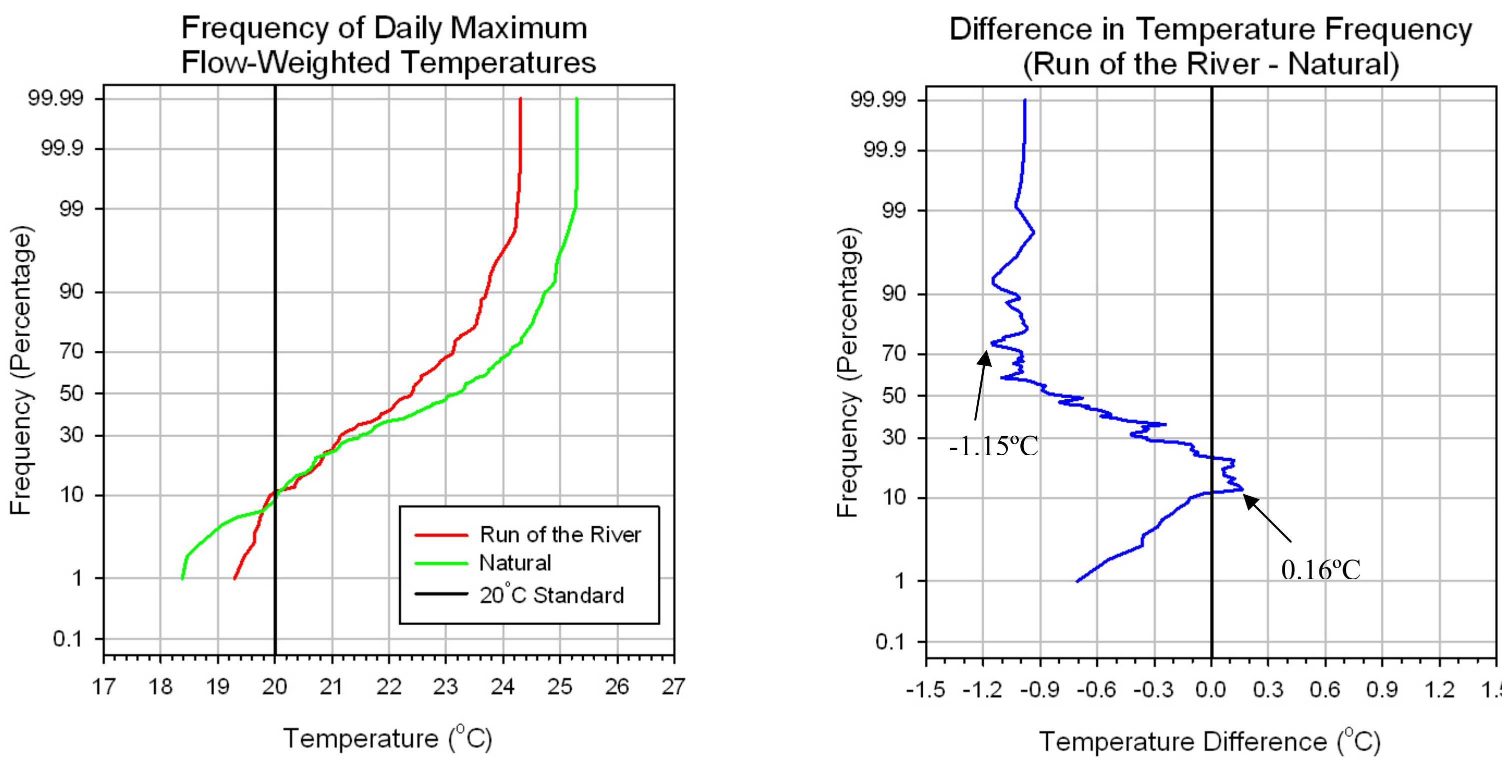


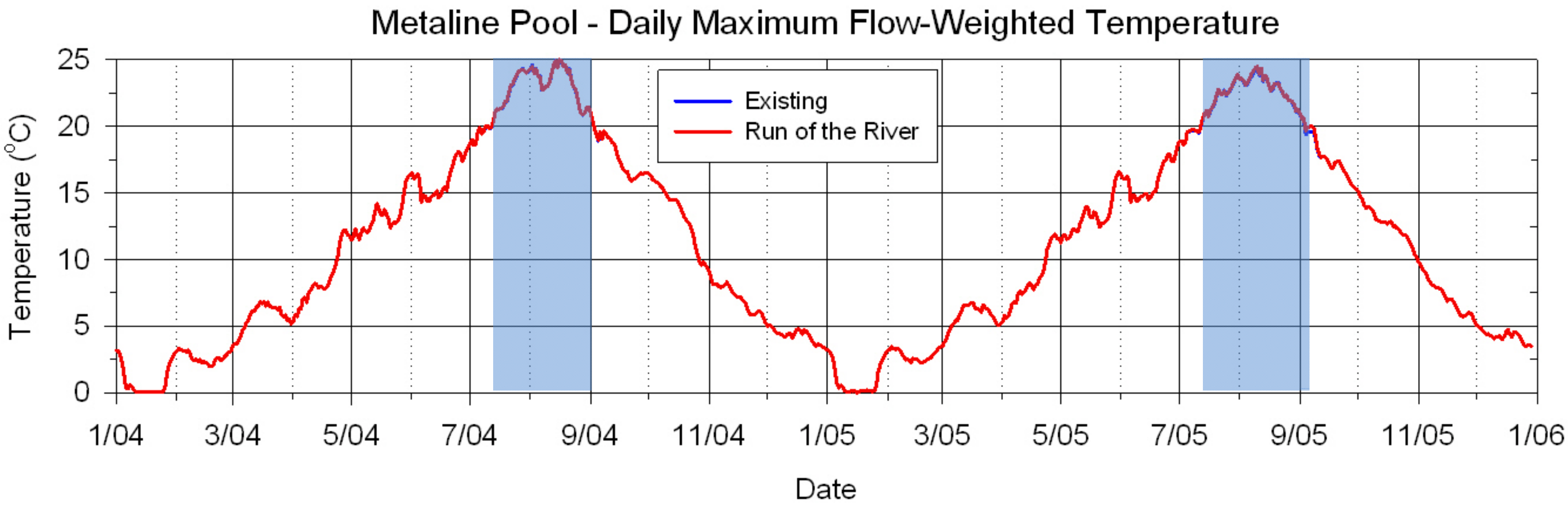
Notes:

1. Run of the River = run of river operation during the summer at 1974 ft elevation.
2. The difference in temperature at each frequency is obtained by subtracting the Natural Condition values from the Run of the River values. (When Natural Condition is < 20ºC, the Natural temperature is replaced by the value 20ºC.)
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005.
4. Flow-weighted temperature differences are between -1.15ºC and +0.16ºC due to the Run of the River operational scenario.

Figure 6-2c

Frequency Distribution of the Daily Maximum Flow-Weighted Temperatures for the Run of the River and the Natural Condition at Boundary Dam Tailrace

Seattle City Light
Seattle, WA



Notes:

1. Run of the River = run of river operation during the summer at 1974 ft elevation
2. Daily maximum flow-weighted temperature is

$$T_W = \sum_{l=1}^{n} (T_l \times Q_l) / Q_T$$

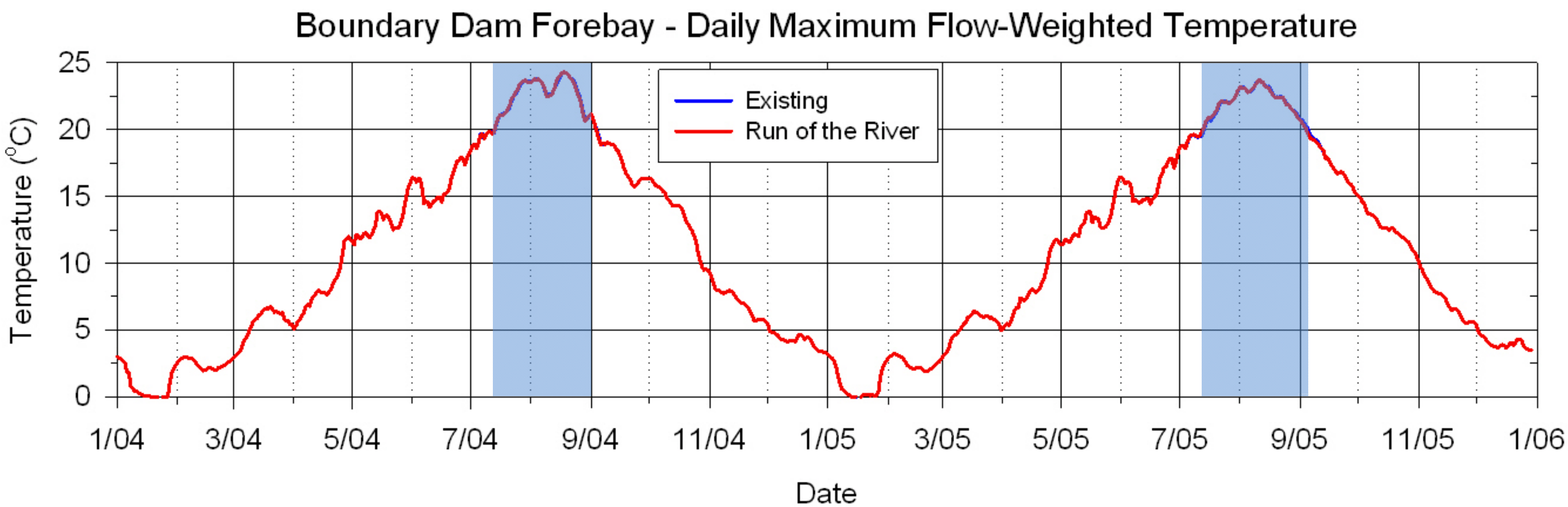
where l is a layer of water column (l=1, 2,.., n), T_W is the flow-weighted temperature, T_l is the temperature at the layer, Q_l is the flow rate at the layer, and Q_T is the total flow.

3. The period when the Run of the River temperature is over 20ºC is indicated by the shading.

Figure 6-3a

Daily Maximum Flow-Weighted Temperatures for the Existing Condition and the Run of the River at Metaline Pool

Seattle City Light
Seattle, WA



Notes:

1. Run of the River = run of river operation during the summer at 1974 ft elevation.
2. Daily maximum flow-weighted temperature is

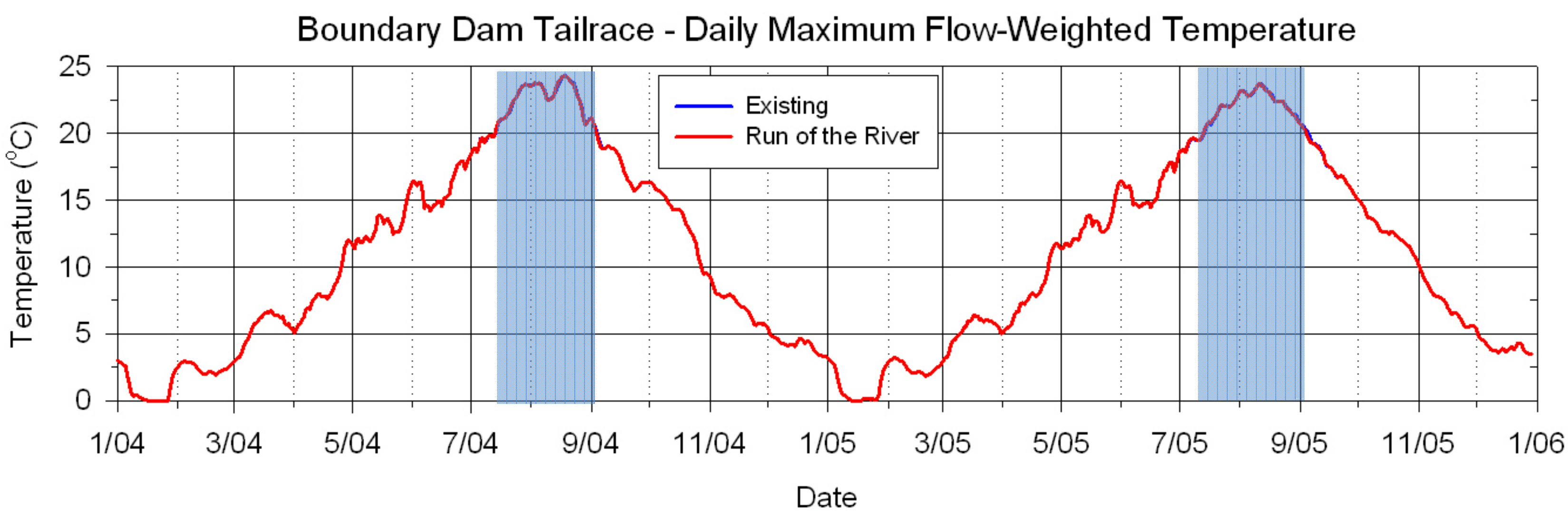
$$T_W = \sum_{l=1}^{n} (T_l \times Q_l) / Q_T$$

where l is a layer of water column (l=1, 2,.., n), T_W is the flow-weighted temperature, T_l is the temperature at the layer, Q_l is the flow rate at the layer, and Q_T is the total flow.
3. The period when the Run of the River temperature is over 20ºC is indicated by the shading.

Figure 6-3b

Daily Maximum Flow-Weighted Temperatures for the Existing Condition and the Run of the River at Boundary Dam Forebay

Seattle City Light
Seattle, WA



Notes:

1. Run of the River = run of river operation during the summer at 1974 ft elevation.
2. Daily maximum flow-weighted temperature is

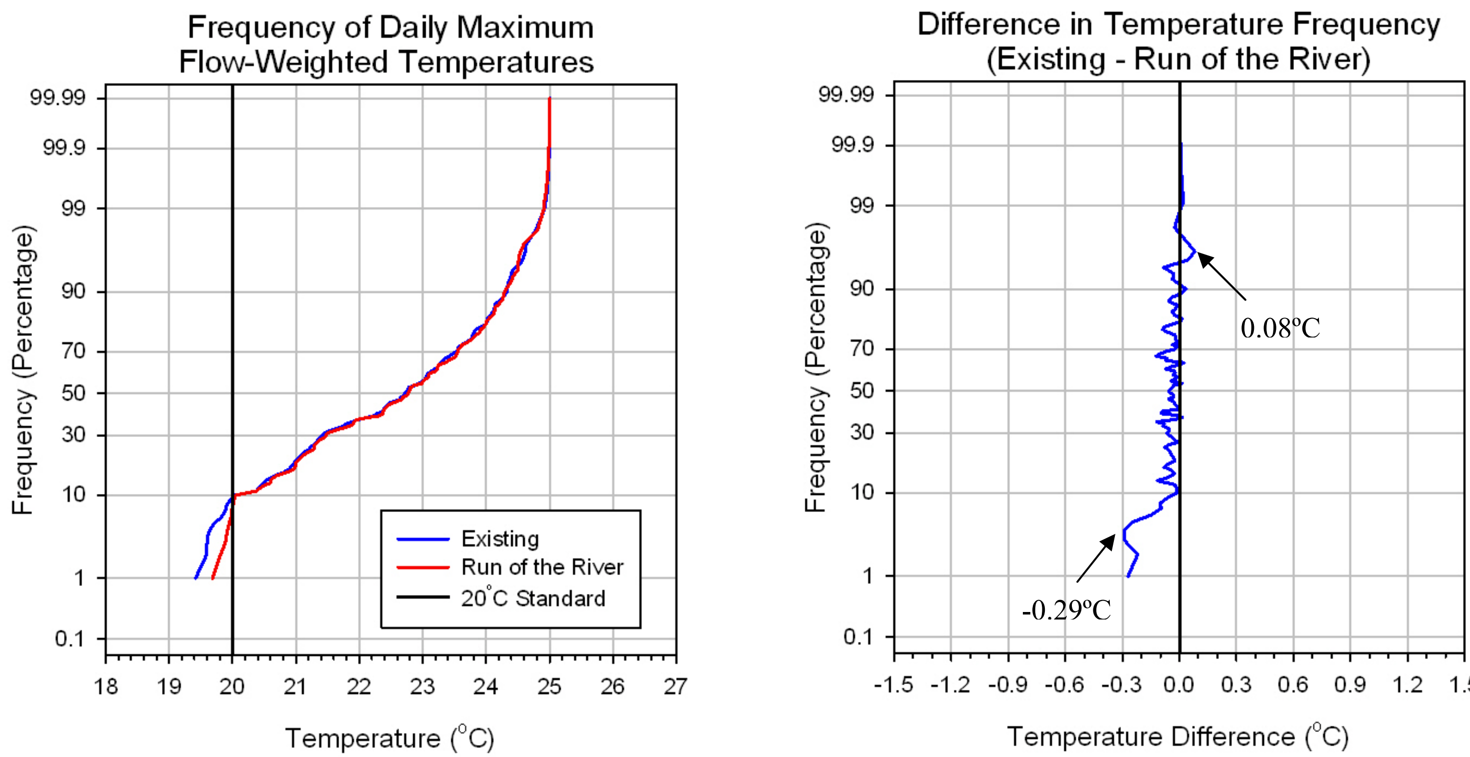
$$T_W = \sum_{l=1}^{n} (T_l \times Q_l) / Q_T$$

where l is a layer of water column (l=1, 2,.., n), T_W is the flow-weighted temperature, T_l is the temperature at the layer, Q_l is the flow rate at the layer, and Q_T is the total flow.
3. The period when the Run of the River temperature is over 20ºC is indicated by the shading.

Figure 6-3c

Daily Maximum Flow-Weighted Temperatures for the Existing Condition and the Run of the River at Boundary Dam Tailrace

Seattle City Light
Seattle, WA

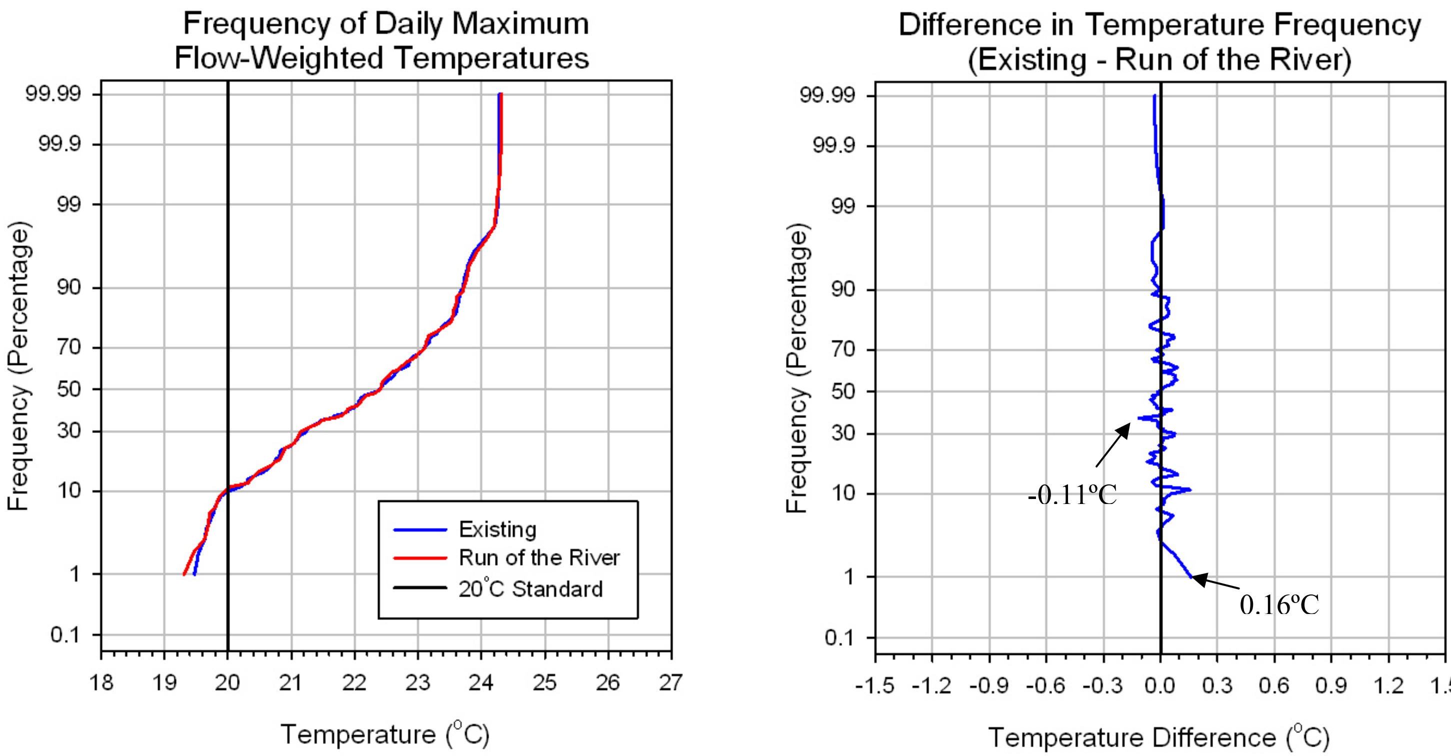


Notes:
1. Run of the River = run of river operation during the summer at 1974 ft elevation.
2. The difference in temperature at each frequency is obtained by subtracting the Run of the River values from the Existing Condition values.
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005.
4. Existing Condition flow-weighted temperature differences are between -0.29ºC and +0.08ºC relative to the Run of the River operational scenario.

Figure 6-4a

Frequency Distribution of the Daily Maximum Flow-Weighted Temperatures for the Run of the River and the Existing Condition at Metaline Pool

Seattle City Light
Seattle, WA



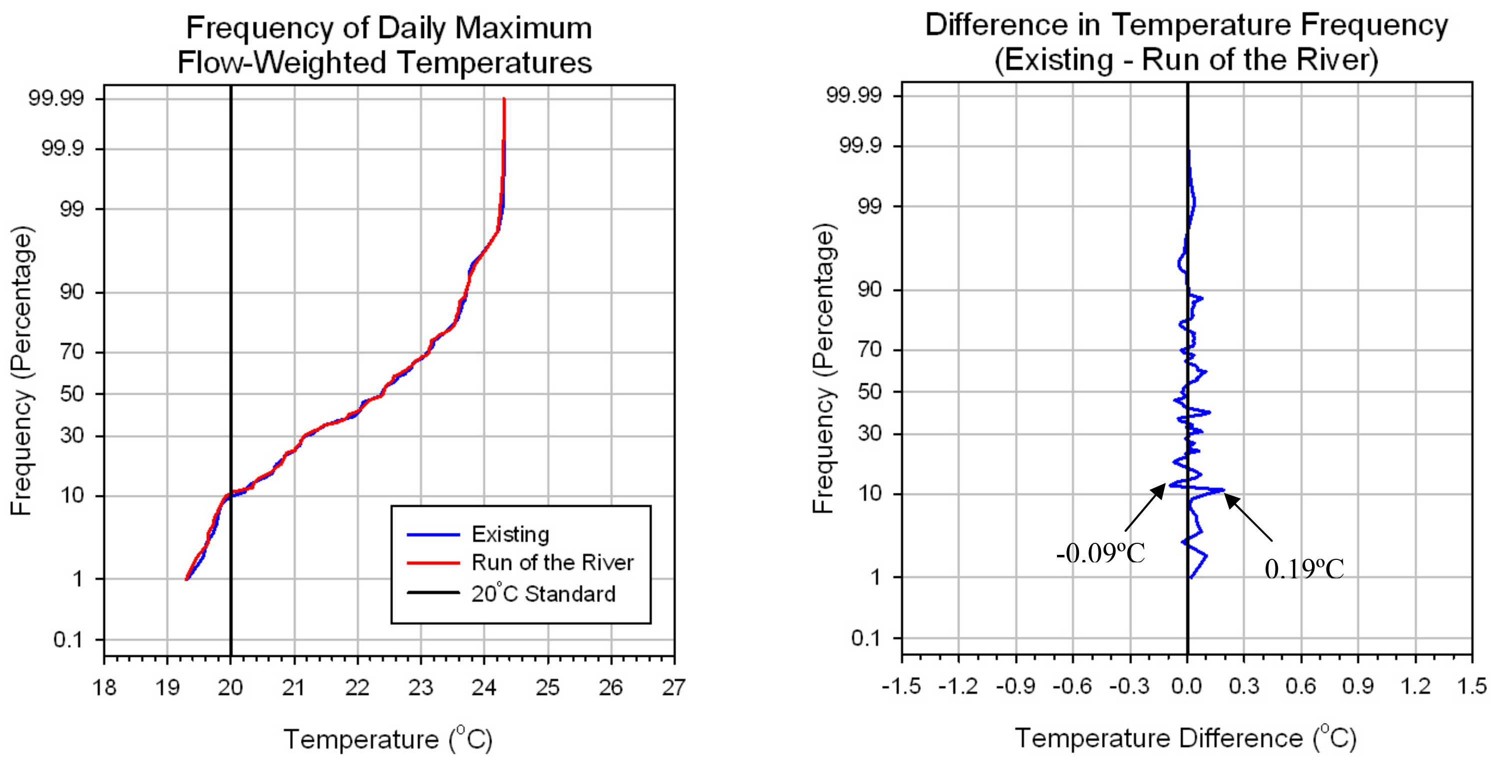
Notes:

1. Run of the River = run of river operation during the summer at 1974 ft elevation.
2. The difference in temperature at each frequency is obtained by subtracting the Run of the River values from the Existing Condition values.
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005.
4. Existing Condition flow-weighted temperature differences are between -0.11ºC and +0.16ºC relative to the Run of the River operational scenario.

Figure 6-4b

Frequency Distribution of the Daily Maximum Flow-Weighted Temperatures for the Run of the River and the Existing Condition at Boundary Dam Forebay

Seattle City Light
Seattle, WA



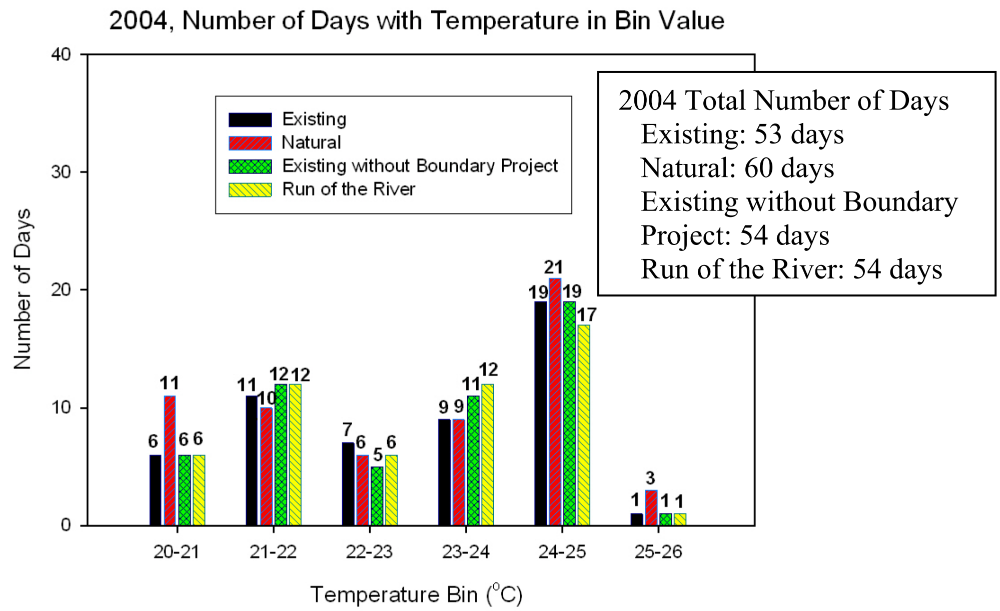
Notes:

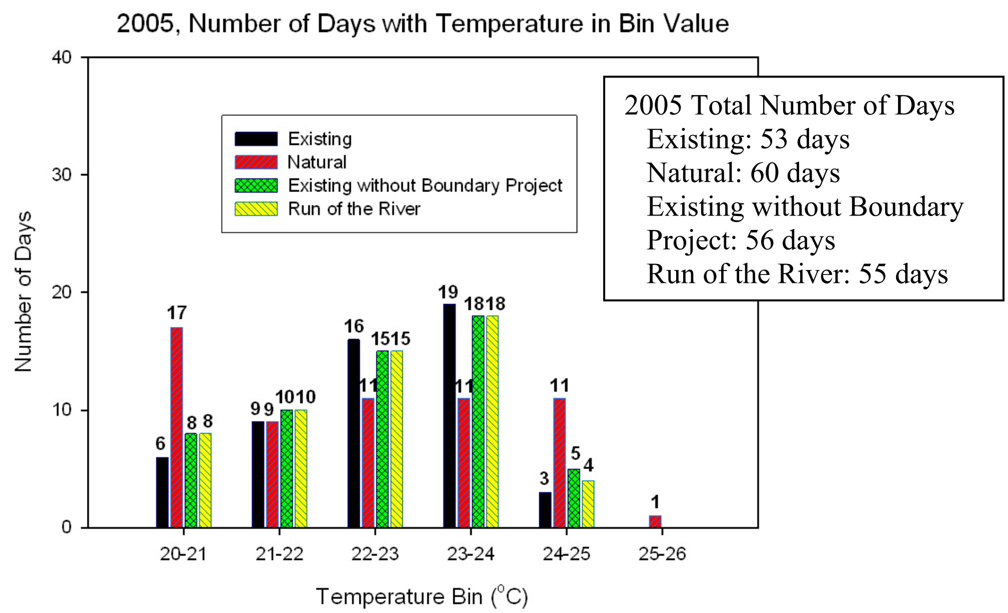
1. Run of the River = run of river operation during the summer at 1974 ft elevation.
2. The difference in temperature at each frequency is obtained by subtracting the Run of the River values from the Existing Condition values.
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005.
4. Existing Condition flow-weighted temperature differences are between -0.09ºC and +0.19ºC relative to the Run of the River operational scenario.

Figure 6-4c

Frequency Distribution of the Daily Maximum Flow-Weighted Temperatures for the Run of the River and the Existing Condition at Boundary Dam Tailrace

Seattle City Light
Seattle, WA





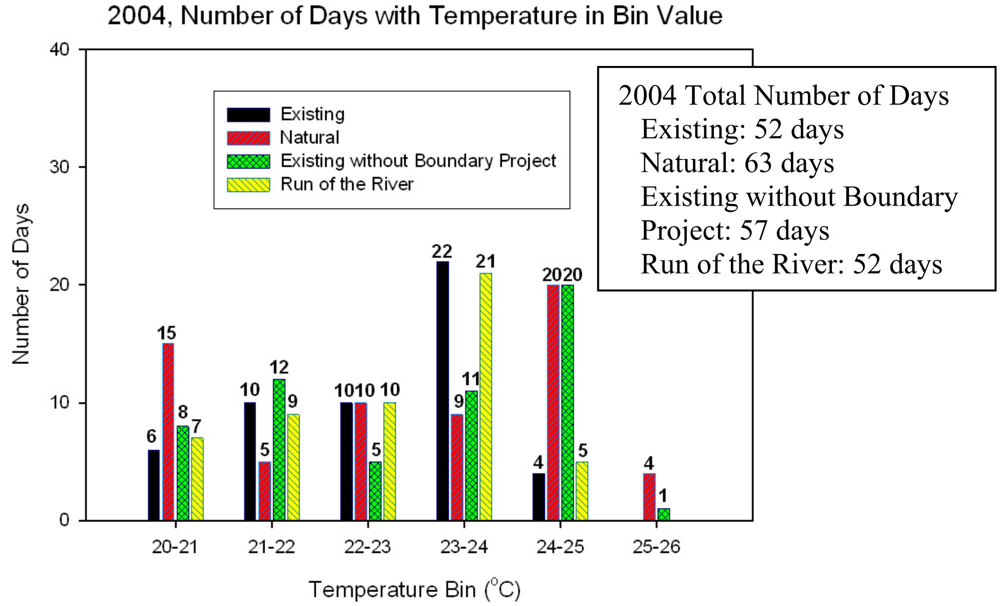
Notes:

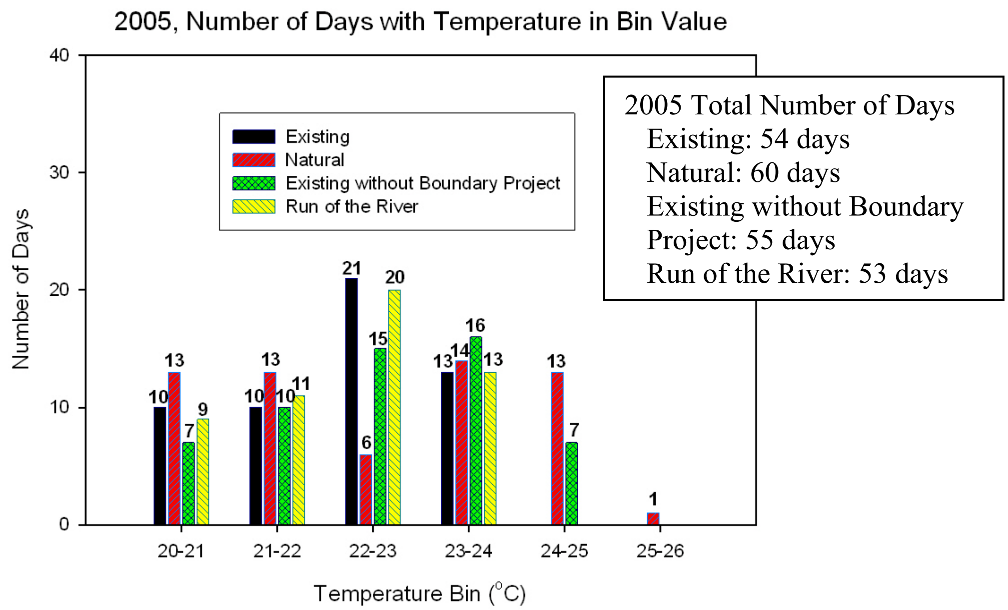
1. The total number of days for 2004 and 2005 was
   Existing – 106 days, Natural – 120 days,
   Existing without Boundary Project – 110 days
   Run of the River – 109 days
2. Peak annual flow-weighted temperatures at the Metaline Pool
   Existing – 2004: 25.01ºC & 2005: 24.40ºC
   Natural – 2004: 25.43ºC & 2005: 25.14ºC
   Existing without Boundary Project
   – 2004: 25.04ºC & 2005: 24.61ºC
   Run of the River
   - 2004: 25.00ºC & 2005: 24.51ºC

Figure 6-5a

Number of Days the Daily Maximum Flow-Weighted Temperatures Exceeded 20ºC at the Metaline Pool for 2004 and 2005

Seattle City Light
Seattle. WA





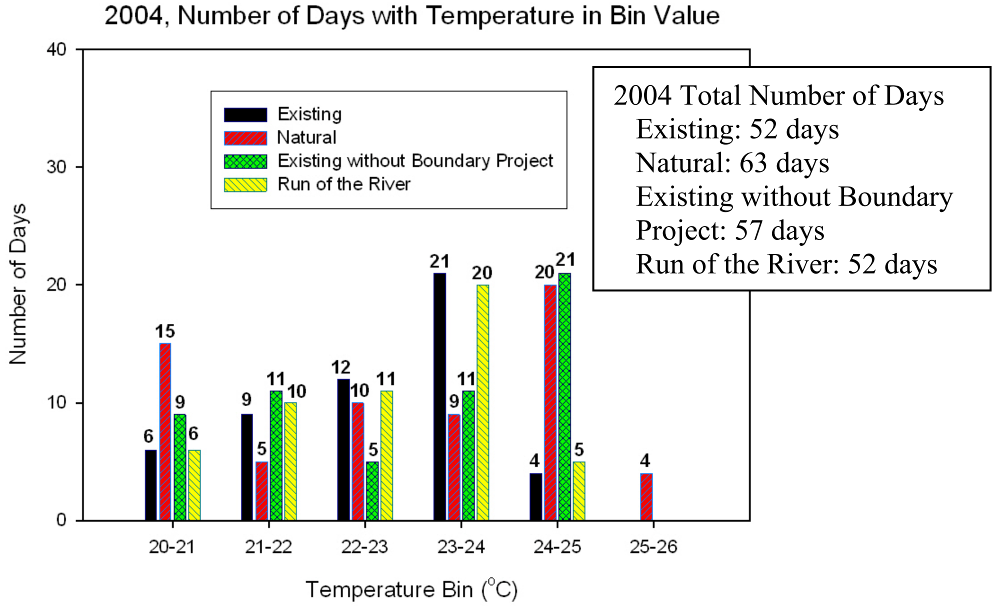
Notes:

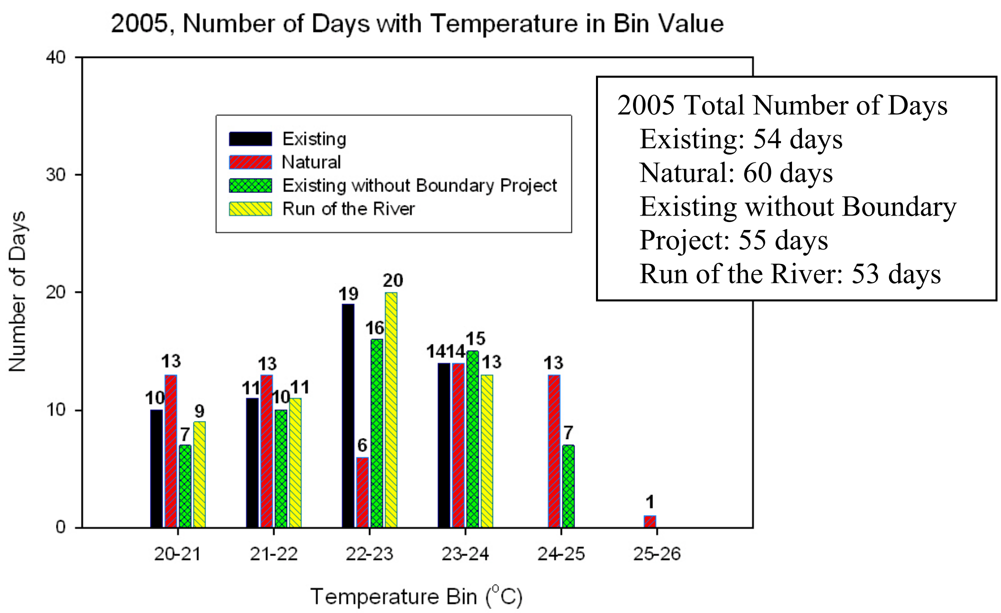
1. The total number of days for 2004 and 2005 was
   Existing – 106 days, Natural – 123 days,
   Existing without Boundary Project – 112 days,
   Run of the River – 105 days
2. Peak annual flow-weighted temperatures at the Boundary Dam Forebay Pool
   Existing – 2004: 24.29ºC & 2005: 23.72ºC
   Natural – 2004: 25.29ºC & 2005: 25.15ºC
   Existing without Boundary Project
   – 2004: 25.07ºC & 2005: 24.68ºC
   Run of the River
   - 2004: 24.32ºC & 2005: 23.76ºC

Figure 6-5b

Number of Days the Daily Maximum Flow-Weighted Temperatures Exceeded 20ºC at the Boundary Dam Forebay for 2004 and 2005

Seattle City Light
Seattle. WA





Notes:

1. The total number of days for 2004 and 2005 was
   Existing – 106 days, Natural – 123 days,
   Existing without Boundary Project – 112 days,
   Run of the River – 105 days
2. Peak annual flow-weighted temperatures at the Boundary Dam Tailrace Pool
   Existing – 2004: 24.31ºC & 2005: 23.71ºC
   Natural – 2004: 25.29ºC & 2005: 25.15ºC
   Existing without Boundary Project – 2004: 24.87ºC & 2005: 24.34ºC
   Run of the River - 2004: 24.31ºC & 2005: 23.75ºC

Figure 6-5c

Number of Days the Daily Maximum Flow-Weighted Temperatures Exceeded 20ºC at the Boundary Dam Tailrace for 2004 and 2005

Seattle City Light
Seattle. WA

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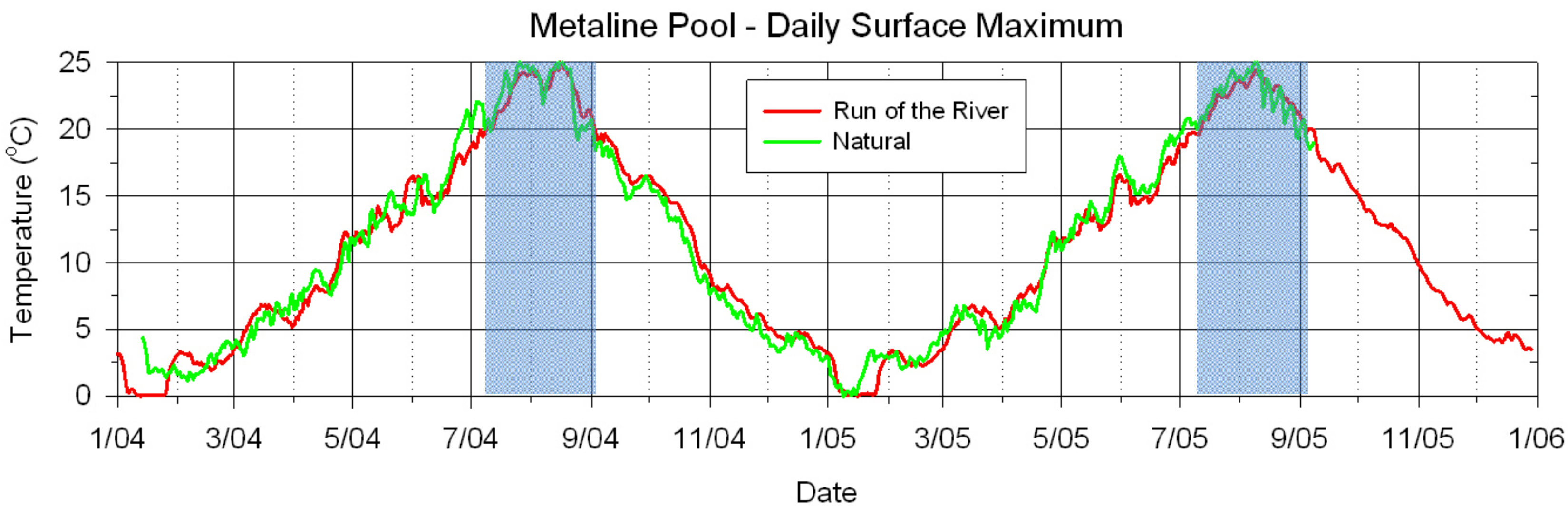
The Business of Innovation



Notes:

1. Run of the River = run of river operation during the summer at 1974 ft elevation
2. Daily maximum temperatures are from the surface layer of the models.
3. The period in which the Run of the River temperature is over 20ºC is indicated by the shading.

Figure 6-6a

Daily Maximum Surface Temperatures for the Run of the River and the Natural Condition at Metaline Pool

Seattle City Light
Seattle, WA

Battelle
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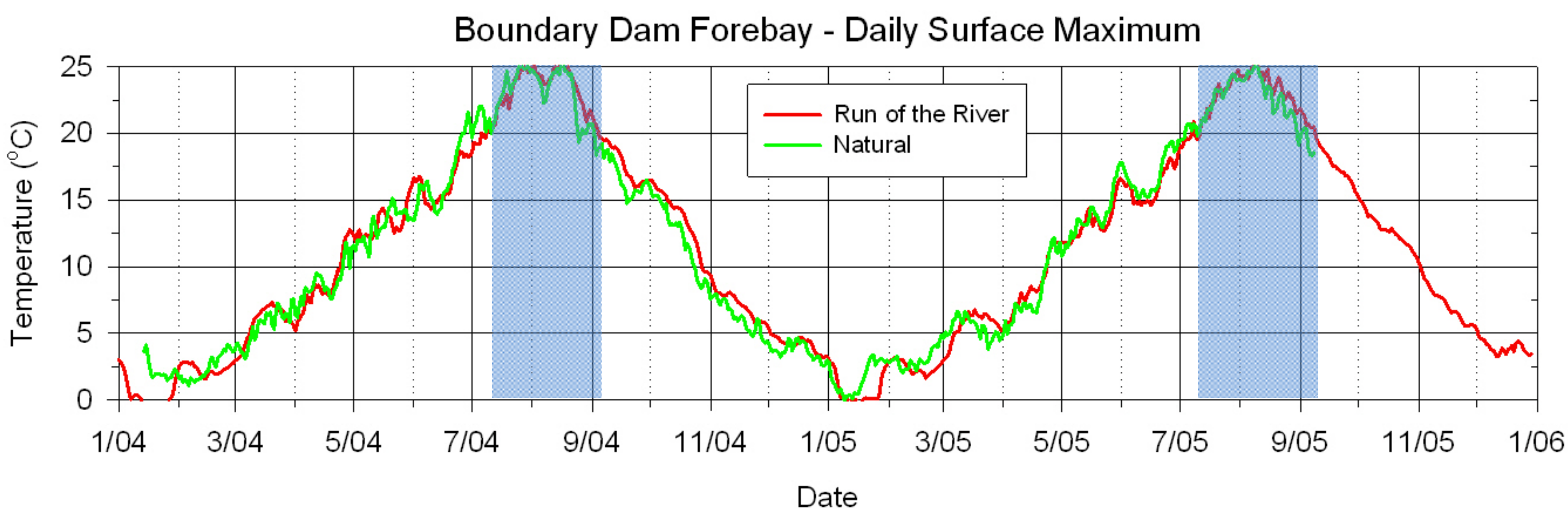

Notes:
1. Run of the River = run of river operation during the summer at 1974 ft elevation.
2. Daily maximum temperatures are from the surface layer of the models.
3. The period in which the Run of the River temperature is over 20ºC is indicated by the shading.

Figure 6-6b

Daily Maximum Surface Temperatures for the Run of the River and the Natural Condition at Boundary Dam Forebay

Seattle City Light
Seattle, WA

Battelle
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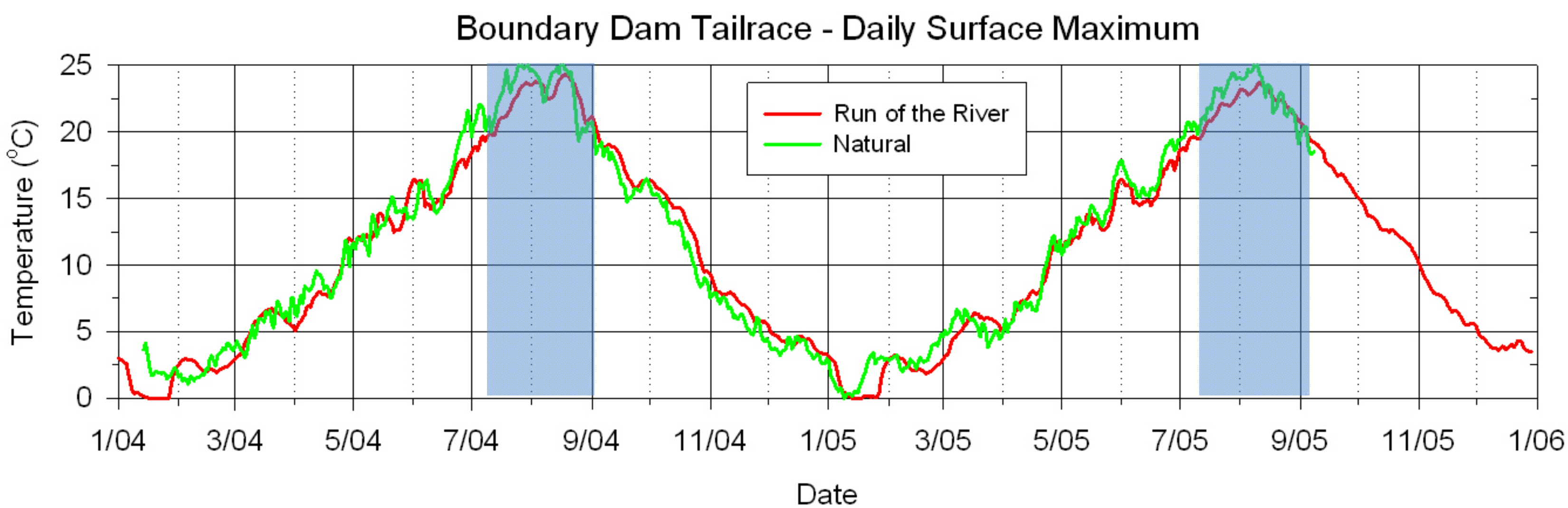


Notes:

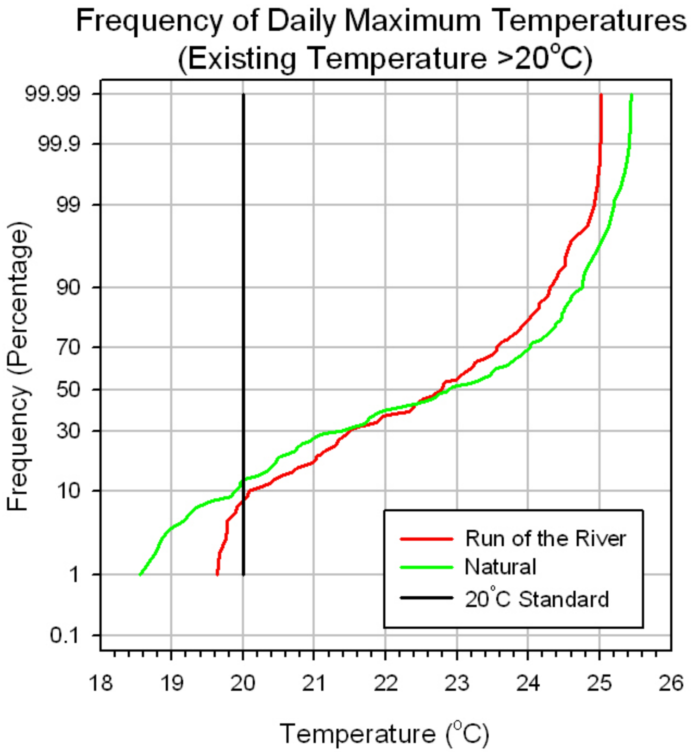
1. Run of the River = run of river operation during the summer at 1974 ft elevation .
2. Daily maximum temperatures are from the surface layer of the models.
3. The period in which the Run of the River temperature is over 20ºC is indicated by the shading.

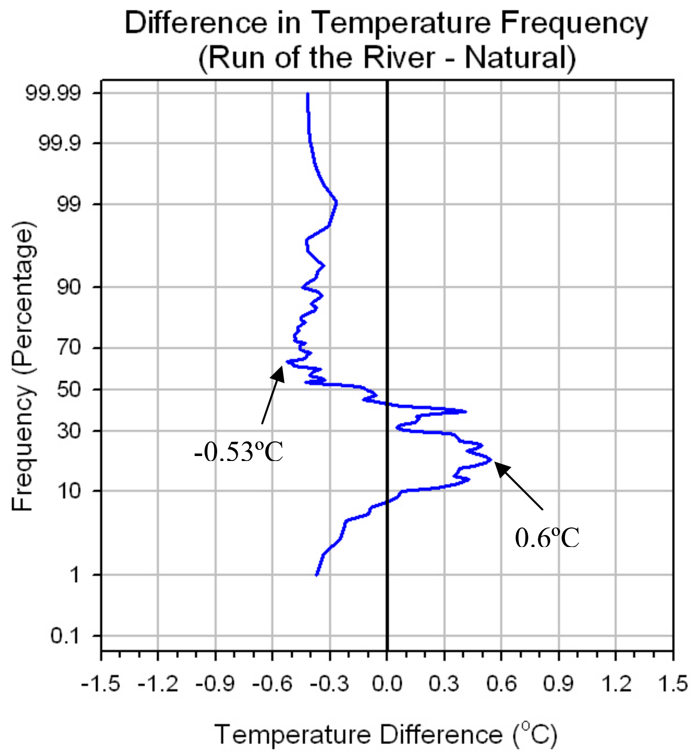
Figure 6-6c

Daily Maximum Surface Temperatures for the Run of the River and the Natural Condition at Boundary Dam Tailrace

Seattle City Light
Seattle, WA

Battelle
The Business of Innovation





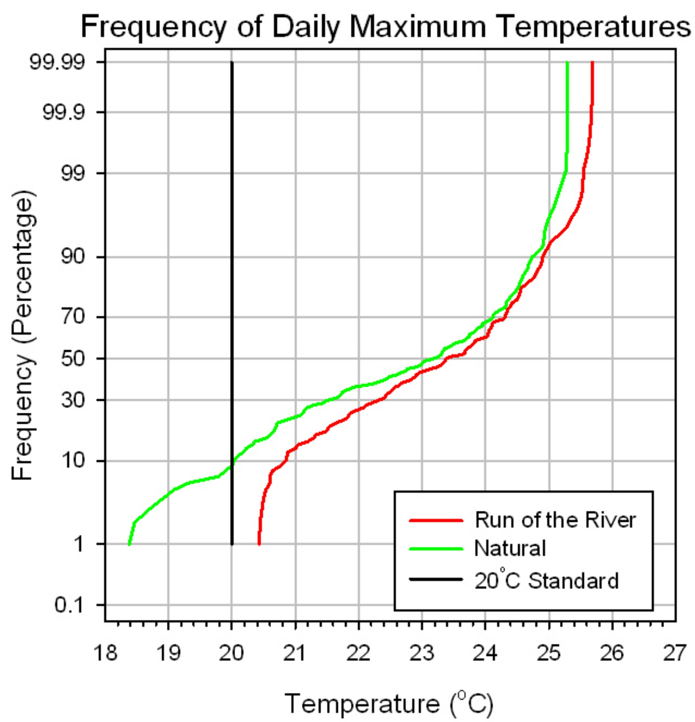
Notes:

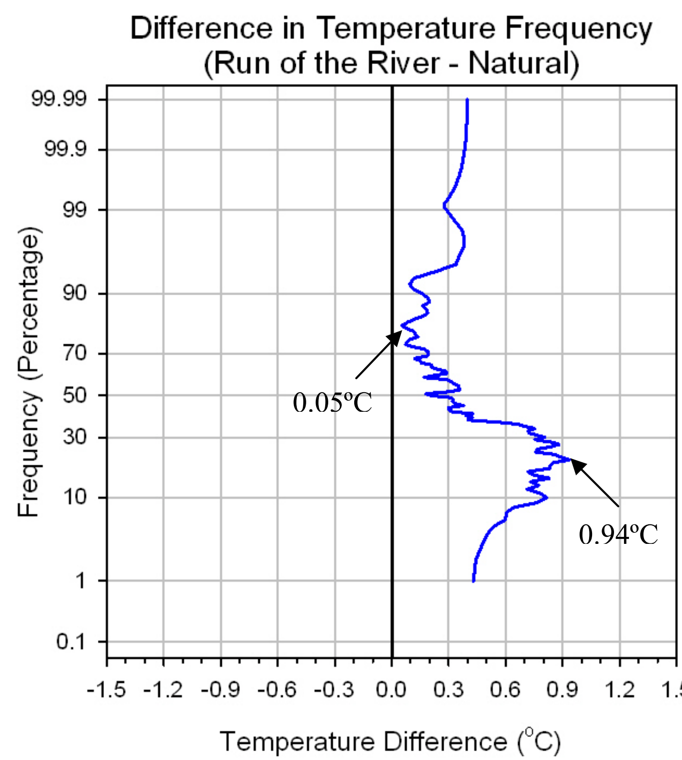
1. Run of the River = run of river operation during the summer at 1974 ft elevation.
2. The difference in temperature at each frequency is obtained by subtracting the Natural Condition values from the Run of the River values. (When Natural Condition is < 20ºC, the Natural temperature is replaced by the value 20ºC.)
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005.
4. Surface temperature differences are between -0.53ºC and +0.60ºC due to the Run of the River operational scenario.

Figure 6-7a

Frequency Distribution of Daily Maximum Surface Temperatures for the Run of the River and the Natural Condition at Metaline Pool

Seattle City Light
Seattle, WA





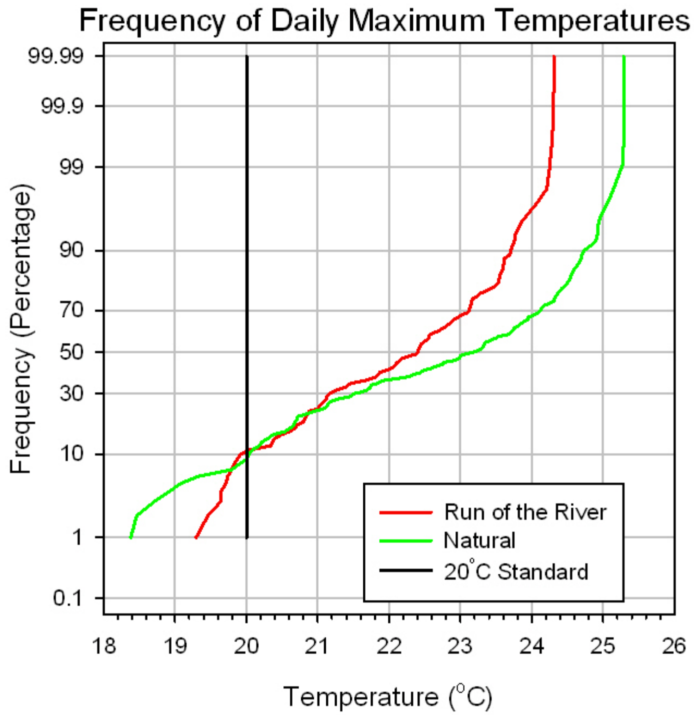
Notes:

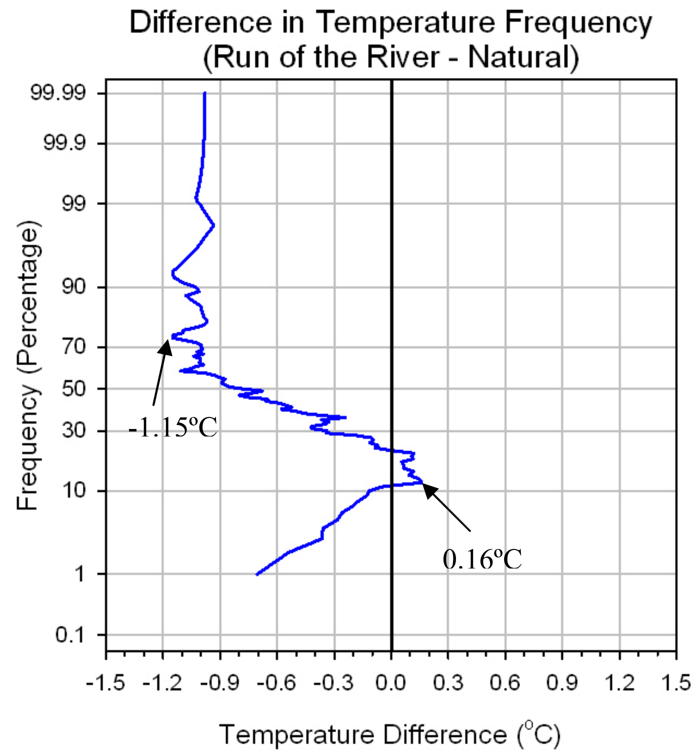
1. Run of the River = run of river operation during the summer at 1974 ft elevation.
2. The difference in temperature at each frequency is obtained by subtracting the Natural Condition values from the Run of the River values. (When Natural Condition is < 20ºC, the Natural temperature is replaced by the value 20ºC.)
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005.
4. Surface temperatures are between 0.05ºC and 0.94ºC higher due to the Run of the River operational scenario.

Figure 6-7b

Frequency Distribution of Daily Maximum Surface Temperatures for the Run of the River and the Natural Condition at Boundary Dam Forebay

Seattle City Light
Seattle, WA





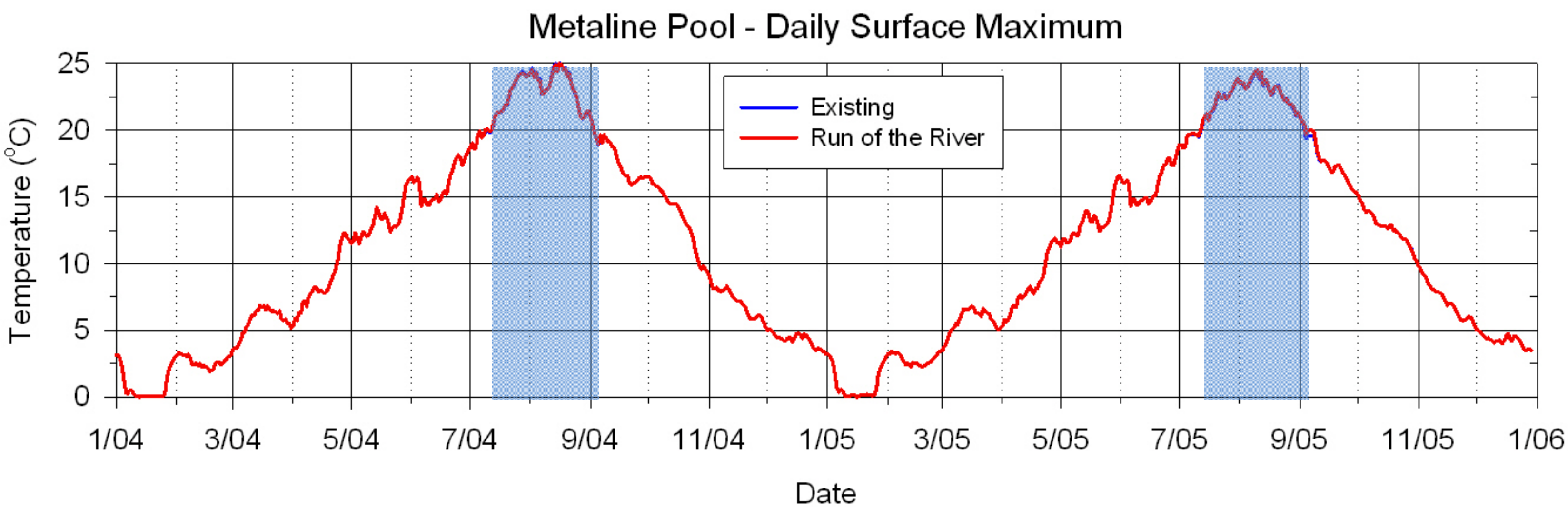
Notes:

1. Run of the River = run of river operation during the summer at 1974 ft elevation.
2. The difference in temperature at each frequency is obtained by subtracting the Natural Condition values from the Run of the River values. (When Natural Condition is < 20ºC, the Natural temperature is replaced by the value 20ºC.)
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005.
4. Surface temperatures are between -1.15ºC and +0.16ºC due to the Run of the River operational scenario.

Figure 6-7c

Frequency Distribution of Daily Maximum Surface Temperatures for the Run of the River and the Natural Condition at Boundary Dam Tailrace

Seattle City Light
Seattle, WA



Notes:
1. Run of the River = run of river operation during the summer at 1974 ft elevation.
2. Daily maximum temperatures are from the surface layer of the models.
3. The period when the Run of the River temperature is over 20ºC is indicated by the shading.

Figure 6-8a

Daily Maximum Surface Temperatures for the Existing Condition and the Run of the River at Metaline Pool

Seattle City Light
Seattle, WA

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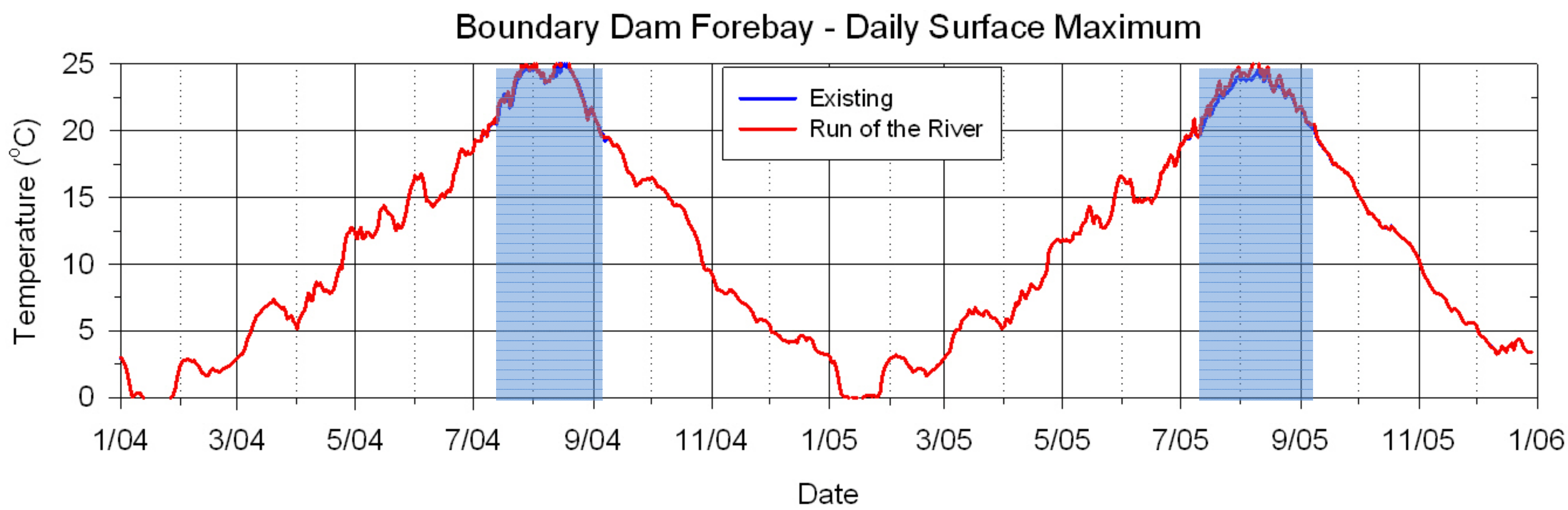
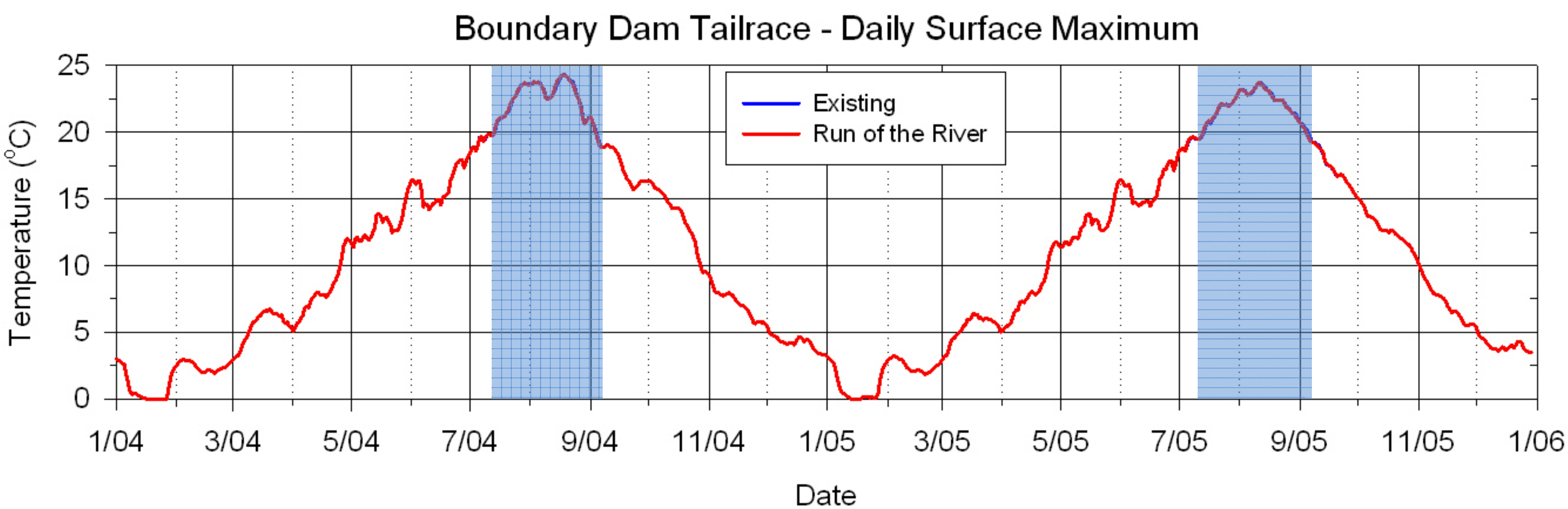


Notes:
1. Run of the River = run of river operation during the summer at 1974 ft elevation
2. Daily maximum temperatures are from the surface layer of the models.
3. The period when the Run of the River temperature is over 20ºC is indicated by the shading.

Figure 6-8b

Daily Maximum Surface Temperatures for the Existing Condition and the Run of the River at Boundary Dam Forebay

Seattle City Light
Seattle, WA



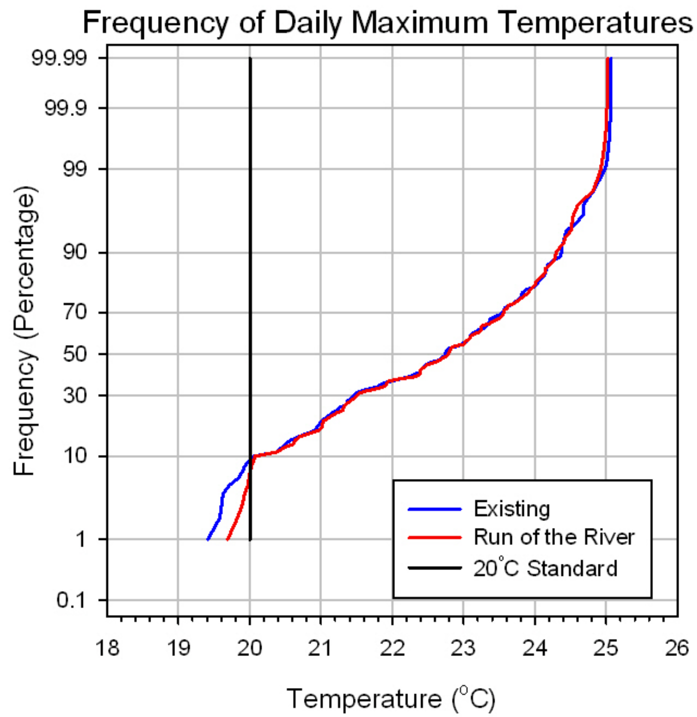
Notes:

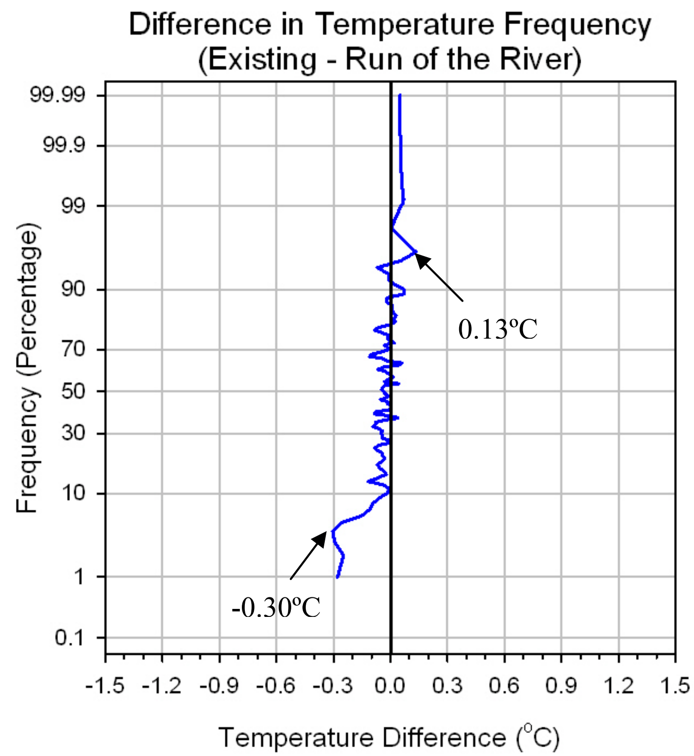
1. Run of the River = run of river operation during the summer at 1974 ft elevation
2. Daily maximum temperatures are from the surface layer of the models.
3. The period when the Run of the River temperature is over 20ºC is indicated by the shading.

Figure 6-8c

Daily Maximum Surface Temperatures for the Existing Condition and the Run of the River at Boundary Dam Tailrace

Seattle City Light
Seattle, WA





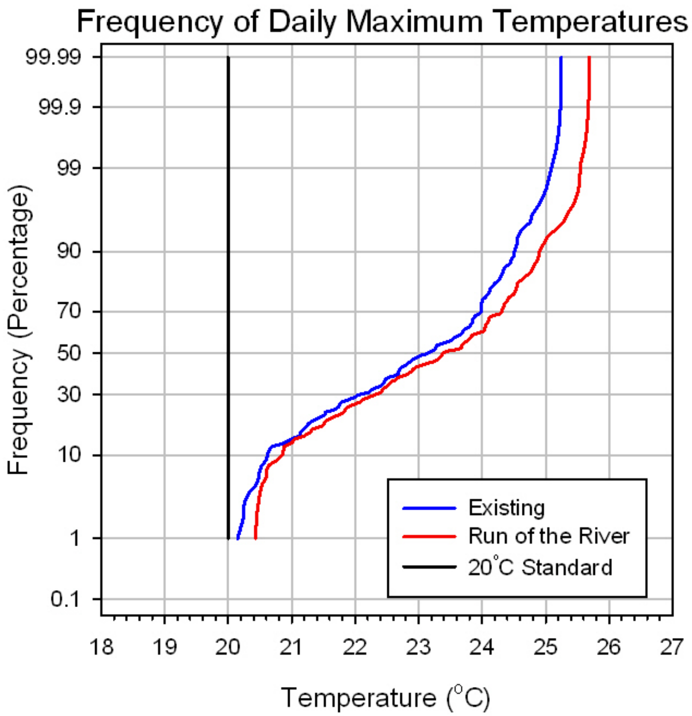
Notes:

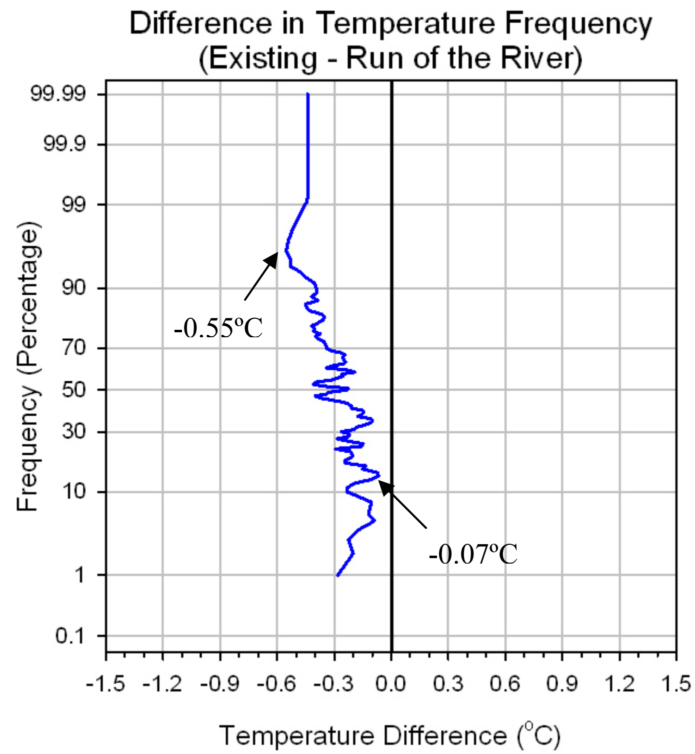
1. Run of the River = run of river operation during the summer at 1974 ft elevation.
2. The difference in temperature at each frequency is obtained by subtracting the Run of the River values from the Existing Condition values.
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005 when Existing Condition > 20ºC
4. Existing Condition surface temperature differences are between -0.30ºC and 0.13ºC relative to the Run of the River operational scenario.

Figure 6-9a

Frequency Distributions of the Daily Maximum Surface Temperatures for the Existing Condition and the Run of the River at Metaline Pool

Seattle City Light
Seattle, WA





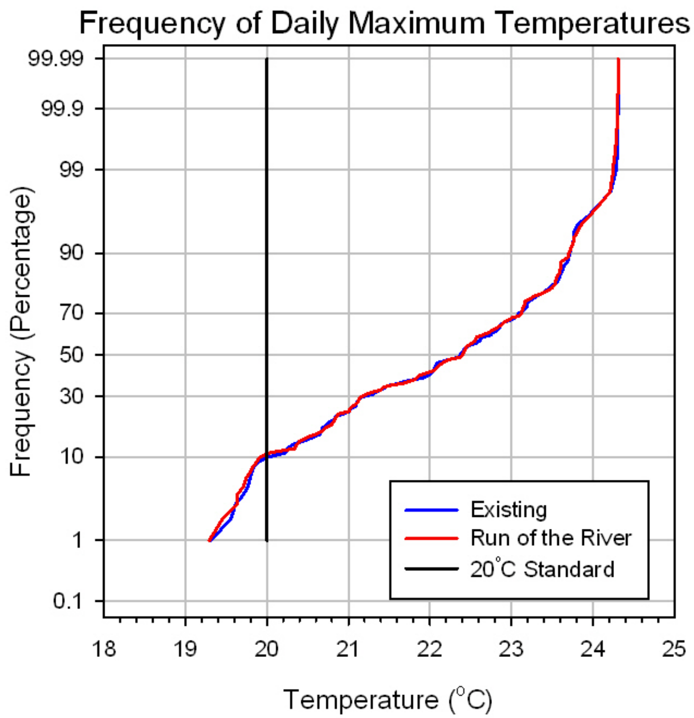
Notes:

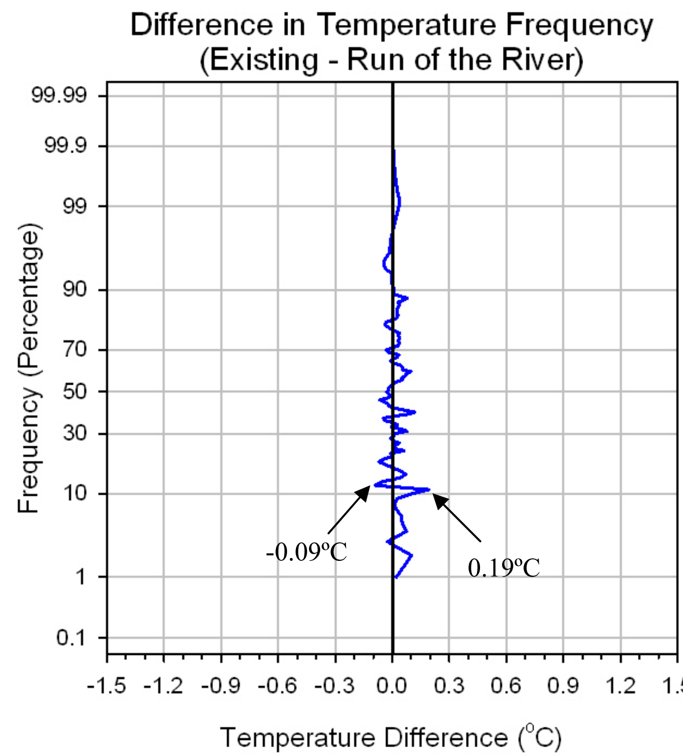
1. Run of the River = run of river operation during the summer at 1974 ft elevation.
2. The difference in temperature at each frequency is obtained by subtracting the Run of the River values from the Existing Condition values.
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005 when Existing Condition > 20ºC.
4. Existing Condition surface temperatures are between 0.07ºC and 0.55ºC lower relative to the Run of the River operational scenario.

Figure 6-9b

Frequency Distributions of the Daily Maximum Surface Temperatures for the Existing Condition and the Run of the River at Boundary Dam Forebay

Seattle City Light
Seattle, WA





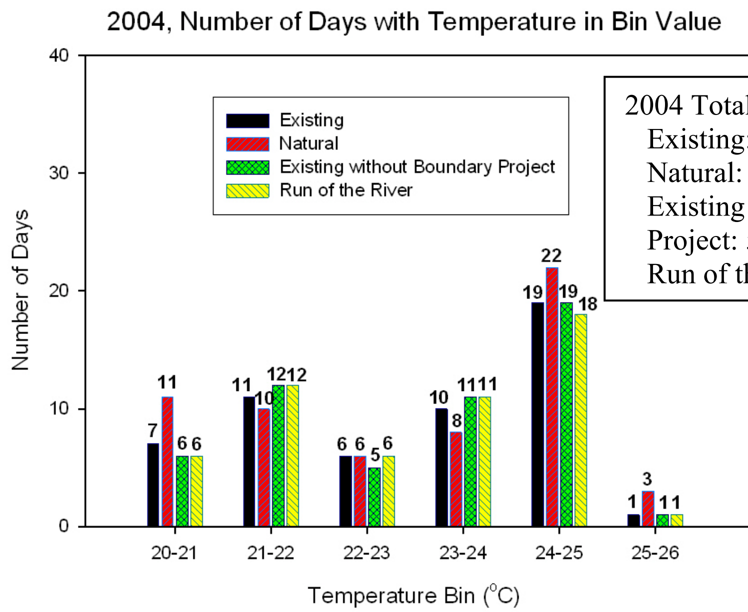
Notes:

1. Run of the River = run of river operation during the summer at 1974 ft elevation.
2. The difference in temperature at each frequency is obtained by subtracting the Run of the River values from the Existing Condition values.
3. The period covered by the frequency analysis was July 9, 2004 to September 4, 2004 and July 8, 2005 to September 8, 2005 when Existing Condition > 20ºC.
4. Existing Condition surface temperature differences are between -0.09ºC and +0.19ºC relative to the Run of the River operational scenario.

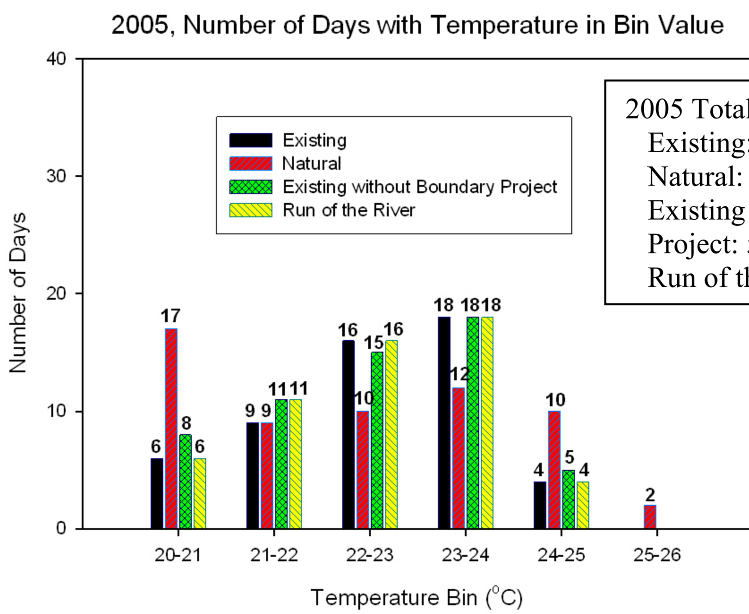
Figure 6-9c

Frequency Distributions of the Daily Maximum Surface Temperatures for the Existing Condition and the Run of the River at Boundary Dam Tailrace

Seattle City Light
Seattle, WA



2004 Total Number of Days
Existing: 54 days
Natural: 60 days
Existing without Boundary Project: 54 days
Run of the River: 54 days



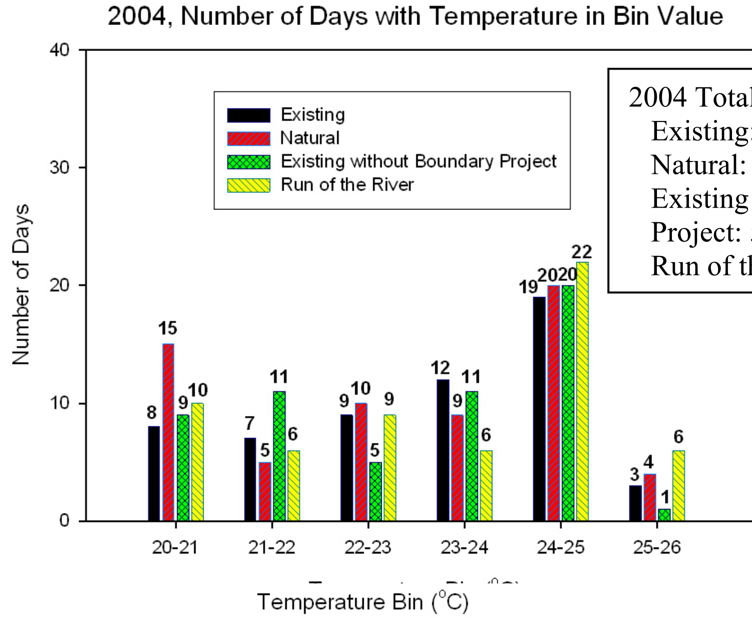
2005 Total Number of Days
Existing: 53 days
Natural: 60 days
Existing without Boundary Project: 57 days
Run of the River: 55 days

Notes:
1. The total number of days for 2004 and 2005 was
   Existing – 107 days, Natural – 120 days,
   Existing without Boundary Project – 111 days
   Run of the River – 109 days
2. Peak annual surface temperatures at the Metaline Pool
   Existing – 2004: 25.07ºC & 2005: 24.41ºC
   Natural – 2004: 25.44ºC & 2005: 25.17ºC
   Existing without Boundary Project – 2004: 25.04ºC & 2005: 24.62ºC
   Run of the River – 2004: 25.02ºC & 2005: 24.52ºC

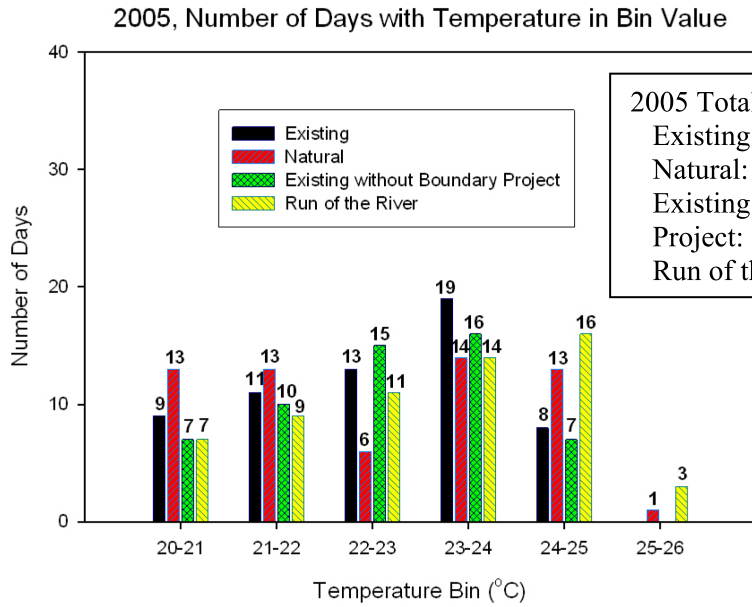
Figure 6-10a

Number of Days the Daily Maximum Surface Temperatures Exceeded 20ºC at the Metaline Pool for 2004 and 2005

Seattle City Light
Seattle, WA



2004 Total Number of Days
Existing: 58 days
Natural: 63 days
Existing without Boundary Project: 57 days
Run of the River: 59 days



2005 Total Number of Days
Existing: 60 days
Natural: 60 days
Existing without Boundary Project: 55 days
Run of the River: 60 days

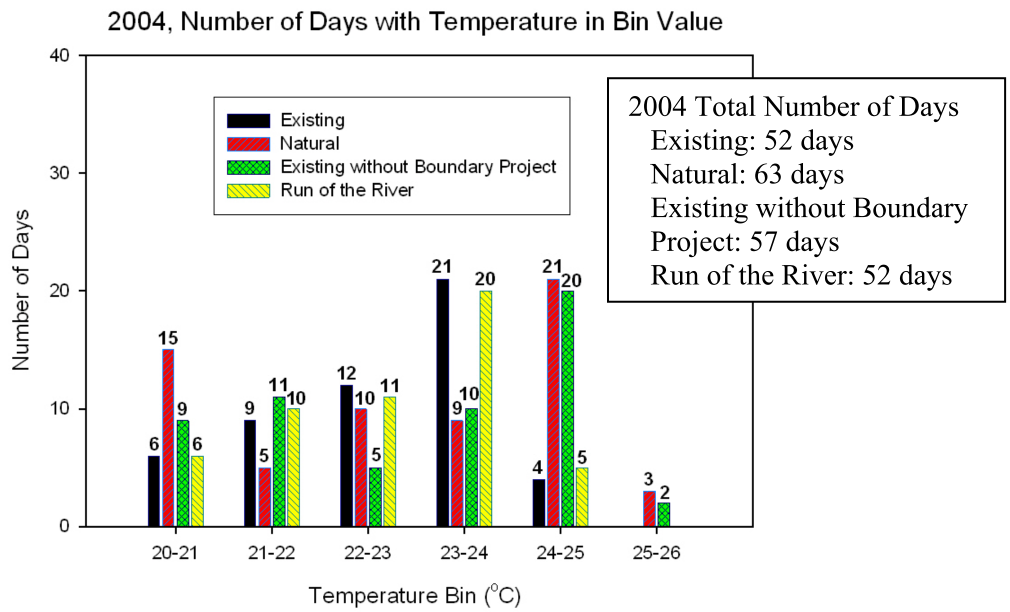
Notes:

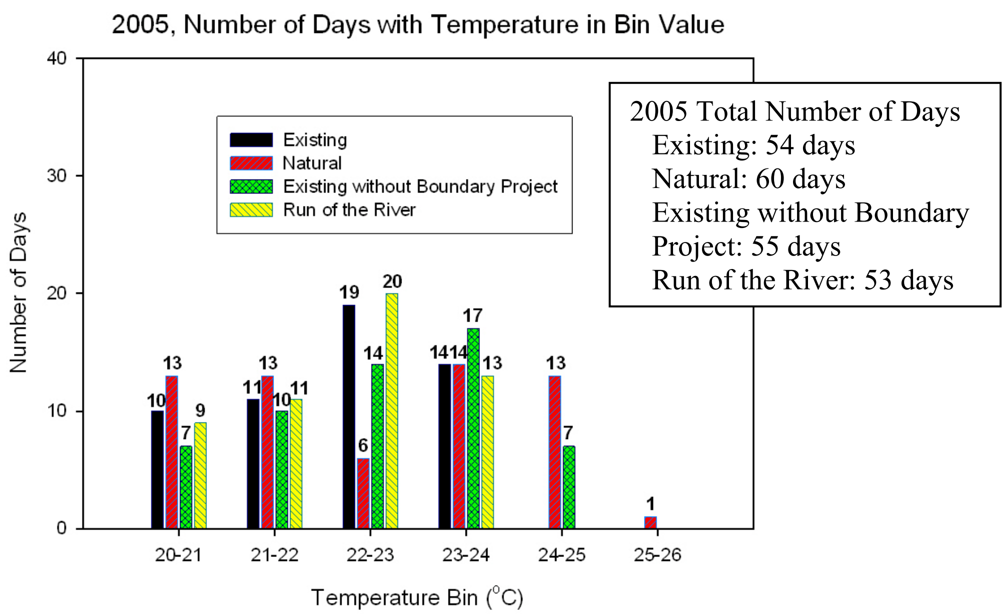
1. The total number of days for 2004 and 2005 was
   Existing – 118 days, Natural – 123 days,
   Existing without Boundary Project – 112 days,
   Run of the River – 119 days
2. Peak annual surface temperatures at the Boundary Dam Forebay
   Existing – 2004: 25.25ºC & 2005: 24.55ºC
   Natural – 2004: 25.29ºC & 2005: 25.15ºC
   Existing without Boundary Project – 2004: 25.07ºC & 2005: 24.68ºC
   Run of the River – 2004: 25.69ºC & 2005: 25.55ºC

Figure 6-10b

Number of Days the Daily Maximum Surface Temperatures Exceeded 20ºC at the Boundary Dam Forebay for 2004 and 2005

Seattle City Light
Seattle, WA





Notes:

1. The total number of days for 2004 and 2005 was
   Existing – 106 days, Natural – 123 days,
   Existing without Boundary Project – 112 days,
   Run of the River – 105 days
2. Peak annual surface temperatures at the Boundary Dam Tailrace
   Existing – 2004: 24.31ºC & 2005: 23.71ºC
   Natural – 2004: 25.29ºC & 2005: 25.15ºC
   Existing without Boundary Project – 2004: 25.14ºC & 2005: 24.77ºC
   Run of the River – 2004: 24.31ºC & 2005: 23.75ºC

Figure 6-10c

Number of Days the Daily Maximum Surface Temperatures Exceeded 20ºC at the Boundary Dam Tailrace for 2004 and 2005

Seattle City Light
Seattle, WA

7.0 Conclusion

Temperatures in the Pend Oreille River are influenced by many environmental factors but are most sensitive to the meteorological conditions and the hydraulic characteristics. Model simulations prepared by Ecology indicate that, in the Boundary Reach, temperatures under Natural Conditions would exceed the numeric state water quality criteria during many days in the summer months. 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 river resulting in modification of the timing and distribution of temperature conditions.

This memorandum presents the results of a modeling-based assessment of the effect of Boundary Reservoir on the temperatures in the Pend Oreille River. As part of this evaluation, several items were examined including: (1) the method for accurately assessing temperature effect where lag time is present (via frequency analysis and flow-weighted temperature), (2) the total temperature difference at the Boundary Project due the presence of all dams on the Pend Oreille River (through comparisons between the Existing and Natural Conditions), (3) the apparent contribution of the Boundary Project to the total temperature difference, and (4) analysis of alternative operations including modeling of an alternative operations scenario consisting of run-of-river operations with a drawdown to 1974 feet NAVD 88 elevation during the summer. The analyses presented include the assessment of the flow-weighted daily maximum temperatures as well as the surface daily maximum temperatures, and provide results at three locations: Metaline Pool, Boundary forebay, and Boundary tailrace.

Cumulative Frequency Analysis and Flow-Weighted Temperatures

The use of cumulative frequency analyses is the appropriate method for assessment of temperature conditions in rivers whose hydrologic and hydraulic characteristics have been modified relative to the natural conditions (Section 2). Our analysis shows that the hydraulic characteristics in reservoirs, affected by the dam operations, induce a lag in the timing of the peak temperatures. This results in the temperatures in the Natural Condition being higher than in the Existing Condition during some periods (early summer) and vice versa in other periods (late summer). Closer examination also shows that maximum temperature differences (described in Sections 4, 5, and 6) occur mostly at the start of the warming period in July, and at the start of the cooling period in late August. At these times of year, the temperatures in the Natural Condition rise and fall more quickly than the temperatures in the Existing Condition. 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. This delayed rise and fall in temperature does not reflect an addition of heat to the system, but rather the slower response time of Boundary Reservoir under Existing Conditions to rapid variation in atmospheric loading. Any comparison on one day therefore, is not an accurate reflection of relative temperature conditions. To make the comparisons in a manner inclusive of all relevant data points, an approach has been used that pools the data for the period during the critical summer months when temperatures exceed the 20˚C criterion. This method, referred to as the Frequency Analysis Approach, uses a cumulative frequency distribution of temperatures for each condition and makes the comparison by identifying the maximum temperature differences between the cumulative frequency curves. This approach eliminates the apparent temperature differences registered due to the effects of the travel time and thermal inertia differences between the Natural and Existing Conditions.

Similarly, analysis of flow-weighted temperatures best reflects temperature conditions in systems like the Boundary Reservoir that are deep but well-mixed, with a small temperature gradient (Section 3). This is especially relevant where examination of the data shows that maximum flow-weighted temperatures are the same or less under the Existing Condition (with Boundary Dam) than for the Existing Condition without Boundary Project (Table 5-2). As shown in Figures 5-5 a, b, and c, peak annual temperatures are similar (≈25˚C) with and without the Boundary Dam, but the presence of the dam results in a slight overall reduction in the peak annual temperature relative to the Existing Condition without Boundary Project. As shown in Figures 5-10 a, b, and c, when focusing exclusively on surface temperatures, the presence of the dam does not appear to cause peak temperatures to be consistently higher than they would be without the dam.

Effect of all Dams on Boundary Project Temperatures

Using the frequency analysis approach, at the Boundary forebay, the largest difference (that is, the increase in temperature above the Natural Condition) under the Existing Condition is 0.20ºC for the flow-weighted temperatures and 0.76ºC for the surface temperatures. These numbers include the effects of all the upstream influences including Box Canyon Dam and Albeni Falls Dam, as well as Boundary Dam. The contribution of dams other than Boundary to the total temperature difference was evaluated by simulating the Existing Condition without Boundary Project, but leaving the upstream dams in place. At the Boundary forebay, the maximum difference relative to the Natural Condition was found to be 0.40ºC for both the flow-weighted and surface temperatures. These temperatures are the same, because in the Existing Condition without Boundary Project, the reach downstream of Box Canyon Dam is an unimpounded river system and is completely mixed.

Effect of Boundary Project Operations on Boundary Project Temperatures

The above flow-weighted results could be interpreted to indicate that the potential effect of the upstream impoundments at the Boundary Dam forebay station is 0.40˚C (Existing Condition without Boundary Project) and -0.20˚C (0.20˚C – 0.40˚C) is attributed to the effect on temperature produced by Boundary Reservoir. Accordingly, the effect of Boundary Reservoir is actually to reduce the flow-weighted temperature at the Boundary forebay. Similar results were obtained at the Metaline Pool and Boundary tailrace stations, indicating that **the Boundary Project does not contribute to increased flow-weighted daily maximum temperatures at any of the locations within the Project area (Section 5.1 and Table 5-2).**

In Section 5.0, a comparison between the Existing Condition and the Existing Condition without Boundary Project was also provided as another means of estimating the relative contribution of Boundary project operations to temperature conditions. The fact that Boundary Reservoir does not contribute to, and may actually reduce flow-weighted temperatures is corroborated in this assessment by showing a decline in maximum flow-weighted temperatures of 0.15˚C at the Boundary forebay due to Boundary Dam (Section 5.1, Table 5-2 and Figure 5-4 b). Similar results were obtained at the Metaline Pool and Boundary tailrace stations, indicating that the Boundary Project does not contribute to increased flow-weighted daily maximum temperatures at any of the locations within the Project area (Section 5.1, Table 5-2 and Figures 5-4 a and c).

The surface temperature results could be interpreted to indicate that the potential effect of the upstream impoundments at the Boundary Dam forebay station is 0.4˚C (Existing Condition without Boundary Project), and 0.36˚C (0.76˚C − 0.40˚C) could then be attributed to the effect on temperature produced by Boundary Reservoir (Table 5-3). However, a comparison between the Existing Condition and the Existing Condition without Boundary Project shows that a maximum surface temperature difference of 0.58˚C may be attributable to Boundary Dam. Similar comparisons at Metaline Pool and Boundary tailrace indicate that, **while the Project may contribute to increased surface daily maximum temperatures at the Boundary forebay, the Boundary Project does not contribute to significant increases in surface daily maximum temperatures at Metaline Pool or Boundary tailrace, and may actually contribute to reductions compared to conditions without the Project (Section 5.2, Table 5-3 and Figures 5-9 a, b, and c).**

Number of Days above 20°C and Peak Annual Temperatures

In addition to the Frequency Analysis Approach, the number of days during which the flow-weighted temperature were above 20°C were determined for each case (Section 5.1, Table 5-3). This analysis demonstrated that, at all locations, the Existing Condition actually resulted in fewer days with flow-weighted temperatures above 20°C than did the Natural Condition and fewer even than the Existing Condition without Boundary Project. Similarly, at all locations, peak annual flow-weighted temperatures in both years were lowest under the Existing Condition and higher in the Existing Condition without Boundary Project and in the Natural Condition. **Accordingly, at all locations, the Boundary Project does not increase the number of days with flow-weighted temperatures above 20°C or increase the peak annual flow-weighted daily maximum temperatures.**

The number of days during which the surface temperatures were above 20°C were also determined for each case (Section 5.2, Table 5-5). They indicate that, at all locations, both the Existing Condition and the Existing Condition without Boundary Project had fewer days with surface temperatures above 20ºC, and had lower peak annual surface temperatures, than did the Natural Condition. Relative to the Existing Condition, it appears that some improvement in the number of days with surface temperatures above 20ºC could be achieved at the Boundary forebay station by removing Boundary Dam. However, doing so would not improve surface temperature conditions at the Metaline Pool station, and would actually worsen surface temperature conditions at the Boundary tailrace station. **Accordingly, while the Boundary Project may increase the number of days with surface temperatures above 20°C at the Boundary forebay, the Boundary Project either has no effect on or actually improves this parameter, as well as peak annual surface temperatures, at the Metaline Pool and Boundary tailrace stations.**

Alternative Operations Analysis - Run-of-river Scenario at 1974 ft

SCL conducted an alternative operations analysis to evaluate whether there were operational changes that could lower surface daily maximum temperatures at the forebay of Boundary Dam (Section 6). To do so, SCL evaluated the temperature effects of the most extreme operational modification possible consistent with operational constraints in order to provide an outer bound on possible alternative operational scenarios relative to current operations. Results presented in Section 6.0 show that the Run-of-river scenario at 1974 ft (NAVD88) during the summer would have insignificant effects on flow-weighted temperatures at all stations (Figures 6-4 a, b and c) and on surface temperatures at the Metaline Pool and Boundary tailrace stations (Figures 6-9 a and c). However, the alternative operations scenario would actually result in an increase in daily maximum surface temperatures at the Boundary forebay station throughout the entire critical summer month time period (Figure 6-9 b).

It is noted that this result is counterintuitive as one would expect the run-of-river at a lower pool elevation operation to improve temperatures by reducing the storage of warm water, reducing depth, and reducing heating due to reduced water surface area. However, a closer examination showed that the area affected by the drawdown is mostly canyon, and accordingly the reduction in surface area with reduced elevation is relatively small. Further, in the current and proposed peaking mode operation, during the night, the flow rate is near zero, whereas during the day flow rate is double the daily average flow rate. In contrast, for the run-of-river operation, because outflow equals inflow, the flow rate during the day is only half of what it is in the Existing Condition which effectively slows down the river speed during the day relative to existing current peaking mode operation, i.e., water velocity during the day in the Existing Condition is nearly twice as high as in the Run-of-river condition. Finally, the reduced water depth in the Run-of-river, Elevation 1974 alternative operations scenario increases temperature amplitude in the Boundary forebay. This, coupled with slower travel time, causes surface temperatures to be warmer than under current operations.

These results of the alternative operations analysis indicate that, rather than reducing or eliminating the surface maximum temperature effect observed at the Boundary forebay, the most extreme change in operations possible consistent with physical Project constraints would instead worsen surface temperature conditions at the forebay. **Accordingly, there do not appear to be operational changes that could lower surface daily maximum temperatures at the forebay of Boundary Dam.**

Exhibit 11

Boundary Hydroelectric Project (FERC No. 2144)

Fish and Aquatics Management Plan

Seattle City Light

March 2010

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List of Acronyms and Abbreviations

DOI	U.S. Department of the Interior
DOT	Washington Department of Transportation
Ecology	Washington Department of Ecology
EPA	U.S. Environmental Protection Agency
FAMP	Fish and Aquatics Management Plan
FAWG	Fish and Aquatics Work Group
fps	Feet Per Second
HPA	Hydraulic Project Approval
I&E	Interpretation and Education
ILP	Integrated Licensing Process
IRA	Integrated Resource Analysis
JARPA	Joint Aquatic Resources Permit Application
LWD	Large Woody Debris
MOU	Memorandum of Understanding
NWRU	Northeast Washington Recovery Unit
PLP	Preliminary Licensing Proposal
PM&E	Protection, Mitigation, and Enhancement
PRM	Project River Mile
PUD	Public Utility District
RRMP	Recreation Resources Management Plan
SEPA	State Environmental Policy Act
USACOE	U.S. Army Corps of Engineers
USFS	USDA Forest Service
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife

Fish and Aquatics Management Plan

Boundary Hydroelectric Project (FERC No. 2144)

INTRODUCTION

This Fish and Aquatics Management Plan (FAMP or plan) has been prepared in support of a new Federal Energy Regulatory Commission License for Seattle City Light's (SCL) Boundary Hydroelectric Project (Project) (FERC No. 2144). The Project is located on the Pend Oreille River in Pend Oreille County, Washington. The Project was constructed in the mid-1960s and operates under a license administered by the Federal Energy Regulatory Commission (FERC). The current license for the Project expires on September 30, 2011, and in accordance with FERC regulations, SCL filed an application for a new license by September 30, 2009. Following submittal of the license application, SCL and Fish and Aquatic Work Group (FAWG) members signed a Boundary Settlement Agreement (Boundary SA) supporting FERC issuance of a new license.

As part of a comprehensive protection, mitigation, and enhancement (PM&E) program, SCL, in consultation with FAWG, has prepared this FAMP to describe the measures that shall be implemented over the Project license period to protect and enhance fish and aquatic resources. With limited exception these measures are non-operational. Under the new FERC license, SCL shall operate the Project as it is currently licensed, but with the formalization of two currently voluntary operational measures: forebay water surface elevation restrictions for summer recreation enhancement and turbine unit sequencing to reduce TDG production during non-spill conditions. Native salmonids in Boundary Reservoir are affected by Boundary Project operations, warm water temperatures during the summer, low primary productivity, and the presence of introduced predatory sportfish. As part of the comprehensive Boundary SA, the settling parties have agreed that PM&E efforts should be primarily directed at Boundary Reservoir tributaries. This maintains the power generation benefits of the Boundary Project while providing the best opportunity for native salmonid protection and recovery.

SCL shall implement the final FAMP in consultation with a FAWG, whose initial members include SCL and representatives from the U.S. Fish and Wildlife Service (USFWS), Bureau of Indian Affairs, Kalispel Tribe of Indians, U.S. Forest Service (USFS), Washington Department of Fish and Wildlife (WDFW), Washington Department of Ecology (Ecology), and the Selkirk Conservation Alliance or the Lands Council as an alternate participant, on behalf of the Hydropower Reform Coalition.

This introductory chapter of the FAMP provides general information on Project facilities and operations, the Project's environmental setting and a brief summary of Project effects (Section 1.1). It also describes the purpose, scope, and organization of the FAMP (Sections 1.2 and 1.3).

1.1. Description of Project Area, Facilities, and Operations

The Project is located in the northeast corner of Washington State, one of eleven hydroelectric and storage projects in the Clark Fork-Pend Oreille River basin. The dam is located approximately one mile south of the U.S.-Canada border and 16 miles west of the Idaho border. The dam is at PRM 17.0 on the Pend Oreille River. The upstream end of Boundary Reservoir extends to Box Canyon Dam at PRM 34.5. Overall, there is relatively little development along the reservoir. Land along the reservoir is owned by SCL, the USFS, U.S. Department of Interior (DOI), U.S. Bureau of Land Management (BLM), Washington State Department of Natural Resources (WDNR), Pend Oreille County, Public Utility District (PUD), the towns of Metaline and Metaline Falls, and private entities. The communities of Metaline Falls and Metaline are located midway along the reservoir, on its east and west sides, respectively. Both sides of the northern portion of the reservoir, from Metaline Falls to Boundary Dam, are relatively inaccessible by road and are bordered mostly by land in federal ownership. Lands along the southern portion of the reservoir are a mixture of private and publicly owned parcels, including SCL's Boundary Wildlife Preserve (BWP). The western side of the reservoir south of Metaline is bordered by U.S. Highway 31.

1.1.1. Project Facilities

Boundary Dam is a 340-foot-high, variable-radius concrete arch dam situated in a narrow canyon. The dam impounds the Pend Oreille River and forms Boundary Reservoir which extends approximately 17.5 miles south from Boundary Dam upstream to the Box Canyon Dam tailrace. The underground power plant was excavated within the massive rock forming the left abutment of the dam. Six turbine-generator units are installed in the underground machine hall and discharge a maximum flow of about 56,000 cfs into the Pend Oreille River. Power from the Project is transmitted to a Bonneville Power Administration (BPA) interconnection via a 0.5-mile-long, 500-kilovolt (kV) transmission line. At its normal maximum water surface elevation, Boundary Reservoir has a surface area of approximately 1,794 acres and a shoreline length of roughly 47 miles. The Boundary Project was built without fish passage facilities. Anadromous fish access to the Upper Columbia River basin, including access to the Pend Oreille River, was blocked in 1942 by construction of Grand Coulee Dam 164 miles downstream.

1.1.2. Project Environmental Setting

The Project is located in the Selkirk Mountains, a western extension of the Rocky Mountains. The topography surrounding the Project is relatively rugged, with nearby mountains rising more than 6,500 feet in elevation and intervening valleys ranging from approximately 2,000 to 2,400 feet. The Pend Oreille River bisects the Selkirk Mountains and cuts through the Metaline Limestone and Ledbetter Slate formations. These two formations predominate along Boundary Reservoir downstream of Metaline Falls and confine the reservoir to a narrow canyon. The adjacent area is characterized by cliffs, rock talus, and steep slopes (SCL 2006). In contrast, the area upstream of Metaline Falls consists predominantly of unconsolidated glacial sediments and river alluvial deposits. The river channel in this area is broader and the surrounding topography more moderate (SCL 2006).

The total average inflow to Boundary Reservoir between 1987 and 2005 was estimated to be 24,100 cfs (SCL 2008a). About 98.1 percent of this volume results from flow releases from Box Canyon Dam. One percent of the inflow comes from Sullivan Creek (the largest tributary to the Pend Oreille River between Box Canyon Dam and Boundary Dam). The remaining twenty-seven tributaries and groundwater together contribute about 0.9 percent of the inflow.

Near the middle of the 17.5 mile Boundary Reservoir, the Pend Oreille River passes through Metaline Falls, a bedrock-controlled, channel constriction (elevation 1,970.6). Water depths in the reach upstream of Metaline Falls typically range from 10 to 25 feet; water depths downstream of Metaline Falls gradually increase, reaching up to 270 feet deep immediately upstream of Boundary Dam.

For pre-licensing study purposes, analyses of the Project area was divided into three reaches above Boundary Dam and a tailrace reach (Figure 1.1-1) (2009a):

Boundary Reservoir (Above Boundary Dam)

- 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 (Below Boundary Dam)

- Tailrace Reach—Boundary Dam downstream to Red Bird Creek confluence with the Pend Oreille River, British Columbia (PRM 17.0–13.9)

The Boundary Reservoir portion of the Pend Oreille River is considered to have good water quality overall; however, Ecology has identified temperature, total dissolved gas, and pH exceedances. During the summer months, mainstem water temperatures often exceed 20°C and can reach 25°C; too warm to provide high quality habitat for native salmonids. Inflow from Sullivan, Slate and several other tributaries provide cold water refugia at tributary confluences with the mainstem reservoir.

1.1.3. Project Fish and Aquatic Resources

Boundary Reservoir and tributaries supports warm, cool and coldwater fish species of native or hatchery origin. No anadromous fish are found in Boundary Reservoir, but some fish may move between reservoir and tributary habitats. The reservoir fish community below Metaline Falls is dominated by largescale suckers, northern pikeminnow, peamouth, yellow perch, and smallmouth bass. Since 2001, hatchery-reared, sterile, rainbow trout were planted in the reservoir as part of a SCL-sponsored recreational fishing program (Solonsky 2009). After 2009, WDFW will not allow triploid trout to be stocked into Boundary Reservoir due to concerns about potential competition with native salmonids, low catch rates, poor trout habitat conditions and low survival and retention in the reservoir. Cutthroat and bull trout are rarely found in mainstem habitats below Metaline Falls, but various species of trout have been captured near the mouths of tributary streams when cool tributary inflow provides refugia from warm summer water temperatures (see Fish Distribution, Timing and Abundance Report, Study No. 9, SCL 2009a).

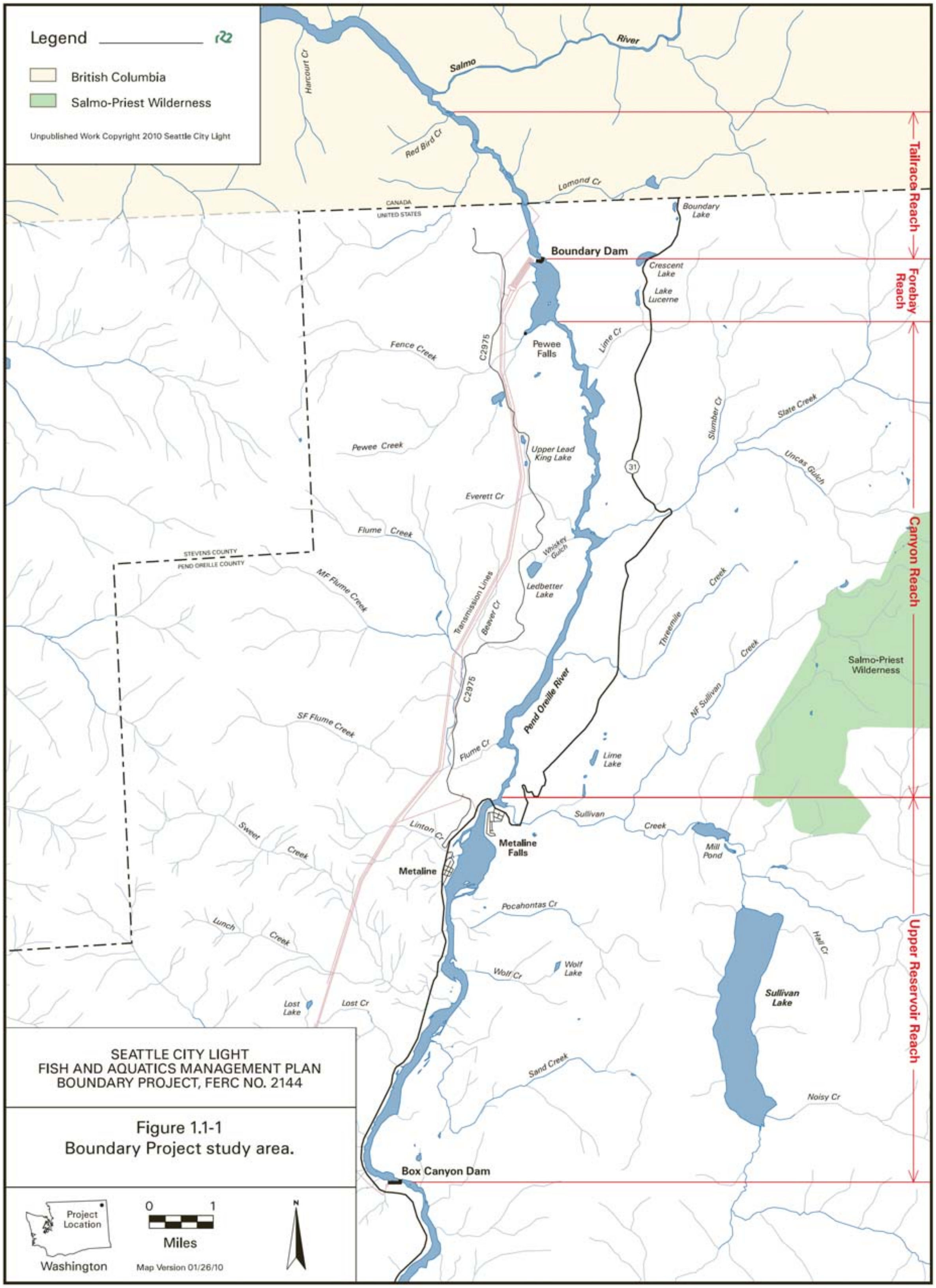


Figure 1.1-1. Boundary Project Study Area.

Fish species diversity is higher in the Upper Reservoir Reach than in deeper reservoir habitats downstream of Metaline Falls. The fish community in the Upper Reservoir Reach is dominated by minnows, suckers, tench, smallmouth bass, pumpkinseed and brown bullhead. Yellow perch and mountain whitefish are found in greater abundance in the Upper Reservoir Reach than below Metaline Falls. Nonnative northern pike and walleye, neither of which had been recorded previously in the Upper Reservoir Reach, were captured in 2007, and are being captured with increasing frequency in the reservoir (see Fish Distribution, Timing and Abundance Report, Study No. 9, SCL 2009a). The varial zone in the Upper Reservoir Reach provides off-channel and slough habitat, often with dense aquatic macrophyte beds in summer. These areas provide spawning and young-of-the-year rearing habitat for a variety of species. Young-of-the-year sunfish, minnows, perch, and suckers are abundant, especially during the summer months.

Cutthroat trout and rainbow trout young-of-the-year were captured exclusively in tributary streams, whereas some mountain whitefish, smallmouth bass, and cyprinid species young-of-the-year were captured in the reservoir (SCL 2009a). Although not abundant, trout 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 2009a). Most salmonids in the vicinity of the Project occur in the tributaries. 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).

The fish community in the Tailrace Reach below Boundary Dam 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 have been observed in the tailrace and three bull trout were captured in the Boundary Dam tailrace during 2007-2008 pre-licensing studies. The results of genetic analyses identified that two of the captured bull trout had originated more than 70 miles upstream in tributaries to Lake Pend Oreille, and one bull trout had originated downstream in the Salmo River. 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. Suckers, smallmouth bass, and triploid rainbow trout accounted for nearly 85 percent of the shallow water catch during 2007 and 2008 sampling in the Tailrace Reach (SCL 2009a). Suckers and hatchery-origin rainbow trout dominated the open water catch. Large northern pikeminnow were also commonly encountered in the deep waters of the spillway pools and afterbay. Aside from suckers and northern pikeminnow, no young-of-the-year fish were captured or observed in the Tailrace Reach.

During initial study plan development, relicensing participants identified bull trout, westslope cutthroat trout, and mountain whitefish as species of interest. Bull trout are listed as a Threatened species under the ESA within the Northeast Washington Unit (NWU). Boundary Reservoir, Sullivan Creek, and portions of Slate and Sweet creeks have been proposed as critical habitat for the recovery of bull trout (Federal Register Vol. 75, No. 9, January 14, 2010). Bull trout have rarely been observed in Boundary Reservoir between the years 1980 to 2008. Over the 29-year period, only 21 bull trout were captured or observed, and all of these were greater than 218 millimeters (8.6 inches) in length. Bull trout recovery goals have been identified for

Sullivan Creek (600 to 850 adult fish) and Slate Creek (25 to 75 adult fish), the largest two tributaries to Boundary Reservoir (USFWS 2002).

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. 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 pure strains of westslope cutthroat trout occur in North Fork Sullivan Creek above the Town of Metaline Falls water supply diversion dam and relatively pure strains occur in Harvey Creek upstream of Sullivan Lake. In comments on SCL's Preliminary Licensing Proposal (PLP), the USFS reported that genetically pure westslope cutthroat trout can also be found in Sweet, Slate and Pewee creeks. 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.

Mountain whitefish spawning and incubation in the Project area occurs from mid-October through mid-January, with peak activity occurring in November and December. 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 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 suggested that most mountain whitefish reside in the Upper Reservoir Reach. Ripe female and milt-flowing male mountain whitefish have been observed in Boundary Reservoir immediately downstream of Box Canyon Dam and whitefish eggs were collected on egg mats in the Box Canyon Dam tailrace during winter 2008/2009 (SCL 2009b). Whitefish eggs were also collected on egg mats at the mouth of Sullivan Creek in winter 2008/2009.

1.1.4. Project Operations and Effects on Aquatic Resources

The Boundary Project is operated in a load-following mode that shapes available water to deliver power during peak-load hours and reduces generation during off-peak hours. Daily water surface elevation fluctuations range from 11.5 feet to 18.02 feet in the forebay, and from 0.42 feet to 4.80 feet in the Box Canyon Dam tailrace. The normal maximum reservoir water surface varies from elevation 1,994 feet at the forebay to 1,999 feet at the Box Canyon tailrace. The reservoir has a small active storage capacity (about 40,843 acre-feet) relative to mean daily flow; retention time of water in Boundary Reservoir averages less than 2 days. The Project is operated within the maximum drawdown of 40 vertical feet of active storage authorized under the license. From Labor Day weekend to Memorial Day weekend, the Project is operated with forebay water surface elevations generally fluctuating within 20 feet of full pool (1,994 feet to 1,974 feet NAVD 88) and only occasionally below 1,974 feet. The magnitude of water surface elevation fluctuations in the Boundary forebay are replicated up through the base of the hydraulic control at Metaline Falls. Metaline Falls attenuates or dampens water surface elevation fluctuations for the upper reservoir area upstream of Metaline Falls.

SCL maintains the summer forebay water surface elevations to facilitate recreational access and use. From Memorial Day weekend through Labor Day weekend, forebay water surface elevations are maintained at or above 1,984 feet NAVD 88 from 6:00 am through 8:00 pm. During nighttime hours, forebay water surface elevations are maintained at or above elevation 1,982 feet NAVD 88.

1.1.4.1. Project Effects on Mainstem Reservoir Habitats

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, Boundary Dam tailrace, and select tributary deltas.

SCL developed a suite of models and analyses to support the evaluation of Existing Conditions and alternative operations. These models and analyses included the Scenario Tool, Hydraulic Routing Model (HRM), mainstem habitat model, trapping and stranding models, mainstem sediment transport model, and tributary delta habitat models (see Mainstem Aquatic Habitat Modeling Report, Study No. 7, SCL 2009a). The Scenario Tool 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. Simulation by the Scenario Tool 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 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.

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 for lifestages and fish species of interest (native salmonids, smallmouth bass, and 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.

Aquatic habitat modeling was supported by field studies of fish, macrophyte, periphyton, and benthic macroinvertebrates. 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. 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 forage fish is fairly low in the Forebay and Canyon Reaches as a result of the scarcity of shallow depths and low water velocities preferred by the smaller fish. 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 tailrace habitat is more affected by fluctuations in water surface elevations as a result of operations at Boundary Dam and BC Hydro's downstream Seven Mile Dam.

The Upper Reservoir Reach has over 86 percent of the shallow water habitat in the 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. 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 bed habitats, often in conjunction with velocities that are more representative of riverine systems supportive of native salmonids. The shallow water zone is quite extensive under most flow conditions.

Due to the presence of low-gradient bars and side channels, Boundary Project operations have the greatest stranding and trapping effect in the Upper Reservoir Reach. The Upper Reservoir Reach also has about 90 percent of the submerged aquatic macrophyte cover, which increases the potential for stranding and trapping of juvenile fish. Trapping indices are substantially higher during dry years when load-following operations increase the frequency and magnitude of pool level fluctuations. 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. Large numbers of minnow fry were observed stranded during major downramping events during the summer. Few fish were observed in areas prone to trapping and stranding during the winter months.

The results of aquatic habitat modeling are best used as a relative index of potentially suitable fish habitat. Abundance of native salmonids and other target species in the Project area are limited by factors other than microhabitat variables (see Exhibit E of the License Application Section 4.5.3.2.1). For example, during an average year there is about 33 percent more WUA for adult cutthroat trout in Boundary Reservoir than WUA for adult smallmouth bass. However, smallmouth bass represented about 10.5 percent of the fish community during surveys conducted in 2007 and 2008 while cutthroat trout represented less than 0.1 percent.

1.1.4.2. Project Effects on Tributary Delta Habitats

Tributary deltas are transition areas between the tributaries and reservoir that provide a variety of ecological functions. Fish may congregate at the tributary confluence to feed on organisms transported in the tributary flow, may use the deltas as temperature refugia, or may stage in delta habitats prior to spawning. Because of the nature of the processes that form the tributary deltas, much of a delta's surface lies within the range of elevations that are subjected to water level fluctuations resulting from Project operations. Analyses of Project effects on tributary delta habitats focused on the distribution and quality of physical habitat conditions (e.g., water depth, cover) and the presence and persistence of thermal plumes at the seven largest tributary deltas (see Sediment Transport and Boundary Reservoir Tributary Delta Habitat Report, Study No. 8, SCL 2009a).

The effect of historic Project operations on tributary delta habitat quality varied in relation to whether the delta was located upstream or downstream of the Metaline Falls hydraulic control. Below Metaline Falls, the Slate and Flume Creek tributary deltas experience the full range of water level fluctuations associated with load-following operations. The five tributary deltas upstream from the Metaline Falls hydraulic control do not experience the full range of water surface elevation fluctuations associated with Project operations. Physical habitat conditions in the inundated portion of the deltas are of low quality; however, salmonids from the reservoir seek out the cold-water inflow from the tributaries.

Thermal plumes at the tributary deltas provide refugia during the summer when mainstem water temperatures rise above the levels suitable for salmonids. Thermographs installed along the thalweg of the stream channels flowing across the seven tributary deltas indicated that thermal plumes persisted throughout the rising and falling of the pool levels. The thermographs at all seven tributary deltas showed a gradient in temperature progressing from the warmer mainstem water to cooler water across the delta to the coldest water in the upstream tributary inflow. Project operations that maintain low reservoir water surface elevations will expose riverine habitat area on the tributary deltas. The quality of this riverine habitat in the delta is lower than riverine habitat in the tributary channels upstream of the deltas. The lower habitat quality of the delta channels is due to the lack of stable bedforms, small substrate particle sizes, sparse cover (e.g., boulders, large woody debris (LWD)), few pools, and shallow channel depths.

1.1.4.3. Project Effects on Fish Entrainment

When inflow to the Project is less than the total powerhouse capacity (approximately 56,000 cfs), the Project is operated as a load-following facility. Because of the large total powerhouse capacity relative to normal flows in the Pend Oreille River, spill generally occurs only during spring runoff. During the period 1987 through 2006, spill conditions averaged 578 hours a year. Infrequent spill conditions results in turbine passage being the primary pathway for fish to move downstream through the Project.

During studies conducted as part of the Integrated Licensing Process (ILP), 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 (see Fish Entrainment and Habitat Connectivity Report, Study No. 12, SCL 2009c). Hydroacoustic target entrainment data were collected and analyzed using split-beam target tracking techniques, and fyke nets were deployed in the Unit 54 draft tube gatewell downstream of the turbine unit. 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. 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. Suckers, pumpkinseed, and yellow perch dominated the fyke net catch in the draft tube of turbine Unit 54.

As part of the comprehensive Boundary SA, estimated mortality rates for fish passing through the turbines and spillways at Boundary Dam were developed. Based on a review of available literature and office-based, turbine survival modeling, fish passage mortality through the existing turbines at Boundary Dam was estimated to vary with the turbine units and fish size. In general, smaller fish were anticipated to have the lowest turbine mortality (5% to 15%), while turbine mortality was expected to increase with fish size (i.e., 23% to 65% for larger fish). After reviewing the results of studies conducted at other dams concerning the effects of shear forces on fish, it was assumed that at low spill flow rates there would be near 100 percent mortality of fish that plunged onto rock instead of falling into the open water of the Boundary tailrace. At spill rates where the flow directly reaches the tailrace pool, the mortality rate will depend on the size of fish and whether the fish remains entrained in the flow jet or freefalls in the air before reaching the tailrace pool (R2 Resource Consultants 2006).

In the comprehensive Boundary SA changes to Boundary Project operations are found to be costly and to provide limited improvement in reservoir habitat conditions. Relicensing participants also acknowledged that, if after non-operational entrainment reduction measures are implemented, Project effects from entrainment are less than the agreed upon targeted juvenile and adult salmonid species survival standard, Project operational changes could be considered. Warm summer water temperatures, low primary productivity, and the presence of non-native predatory sportfish suggest that changes to Project operations would not restore native salmonid populations. As part of the comprehensive Boundary SA some PM&E measures are identified to address dam and reservoir conditions, but the majority of aquatic PM&E measures are focused in the tributaries where opportunities to protect and recover native salmonid populations have the greatest likelihood of success.

2 FAMP PURPOSE AND SCOPE

The FAMP establishes the goals, program objectives, tasks, and schedule for implementing the non-operational aquatic PM&E measures included in the Project license. This FAMP provides information about how SCL shall implement these PM&E measures, conduct monitoring, and report on the progress of their implementation. Information regarding the estimated costs for implementing the measures is provided in Exhibit D of the March 2010 Amended License Application.

The PM&E measures described in this plan are an integrated package of non-operational mainstem and tributary measures designed to benefit native salmonid populations and their habitat. The FAMP is divided into the following elements:

- Mainstem Fish Community and Aquatic Habitat Measures (License Article 9(A))
  - Gravel augmentation below Box Canyon Dam
  - Channel modifications of mainstem trapping pools at Project RM 30.3
  - Mainstem LWD placement at tributary deltas
  - Boundary Reservoir fish community monitoring and evaluation of salmonid predation at select tributary deltas
- Upstream Fish Passage (License Article 9(B))
- Reduction of Project Related Entrainment Mortality (License Article 9(C))
- Tributary Non-native Trout Suppression and Eradication (License Article 9(D))
- Tributary Fish Community and Aquatic Habitat Measures (License Article 9(E))
  - Riparian improvement and stream channel enhancement in Sullivan Creek RM 0.30 to RM 0.54
  - Stream and riparian improvements in Sullivan Creek RM 2.3 to RM 3.0 and NF Sullivan Creek
  - LWD placement and road improvements in Sullivan Creek and selected tributaries upstream of the confluence with Outlet Creek
  - Culvert replacements and LWD placement in tributaries to Boundary Reservoir
  - Riparian planting, culvert replacement and channel reconstruction in Linton Creek RM 0.00 to RM 0.24
  - Riparian and channel improvements in Sweet Creek RM 0.0 to RM 0.6
  - Habitat improvement in Tier-2 tributaries to Boundary Reservoir
  - Closure and restoration of Sullivan Creek dispersed recreation sites
- Mill Pond Dam Site Monitoring and Maintenance (License Article 9(F))
- Native Salmonid Conservation Program (License Article 9(G))
- Recreational Fish Stocking Program (License Article 9(H))

2.1. Mainstem Aquatic Habitat Measures

Relicensing studies indicated that production of native salmonids in Boundary Reservoir is limited by warm water temperatures during the summer, low primary and secondary productivity, and the presence of non-native predatory sportfish species (SCL 2009a). Non-native predators of particular concern include smallmouth and largemouth bass, walleye and a small, but likely expanding population of northern pike. Because of the limitations in Boundary Reservoir and the low likelihood that operational measures could improve these conditions sufficiently to mitigate for the continuing Project effects to aquatic resources, as part of the comprehensive Boundary SA restoration and enhancement measures will primarily be implemented in tributaries to Boundary Reservoir. However, pre-licensing studies did identify several non-operational measures to benefit mainstem habitats.

Mountain whitefish are a native salmonid species thought to spawn in the Boundary Upper Reservoir Reach immediately below Box Canyon Dam. Gravid and milt-flowing mountain whitefish were captured by boat electrofishing during surveys in the Upper Reservoir Reach and egg mats were used to successfully collect several eggs believed to be mountain whitefish. The area immediately below Box Canyon Dam has water depths and velocities appropriate for use by spawning whitefish, but much of the substrate is larger than the gravel size preferred by mountain whitefish. SCL shall place 1,500 yd^3 of gravel among boulder groupings near suspected mountain whitefish spawning areas to increase the amount and quality of potential spawning habitat.

Project operations can cause pool levels to rise and fall on a daily basis, causing fish to become stranded or trapped as pool levels decline. Depressions and pools along the shoreline may become exposed as pool levels drop causing juvenile fish to become trapped and subject to injury and mortality. During the wet, average and dry modeled hydrologic years, 90 percent of exposed trapping area within the Project area occurred in the Upper Reservoir Reach. While nearly all of the trapped fish observed during 2007 and 2008 were 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. An area referred to as the “Cobble Sisters” at PRM 30.3 within the Upper Reservoir Reach was identified as an area with a high occurrence of trapping. The pools and depressions at the site are the result of aggregate mining that occurred prior to completion of the Project and represent about 21 percent of the trapping area within the upper reservoir. The excavated depressions have persisted since construction of the Project, which suggests the area is geomorphically stable. To reduce the incidence of trapping and stranding at the site, SCL shall excavate a channel connecting the pools with the mainstem flow and minimize the risk of fish becoming trapped in isolated pools.

The tributary deltas are important transition zones between mainstem and tributary habitats and coldwater tributary plumes offer thermal refugia to native salmonids during warm summer months. The tributary deltas are characterized as containing poor habitat features due to the lack of stable bedforms, small substrate particle sizes, sparse cover (e.g., boulders, LWD) and few pools. SCL shall enhance tributary delta habitat by providing additional cover for salmonids holding in the coldwater refugia at tributary mouths. LWD jams shall be placed and maintained in the thalweg in the upper delta regions of four tributaries to Boundary Reservoir, including delta regions of Sullivan and Slate creeks which are proposed as critical bull trout habitat.

Both salmonids and predatory sportfish have been observed holding at the confluence of tributaries to Boundary Reservoir and the influence of introduced sportfish predators on salmonid populations is unclear. SCL shall conduct fish community surveys in Boundary Reservoir to monitor changes in salmonid and major predatory sportfish population abundance and size structure. The goal of the mainstem reservoir fish community monitoring is to provide federal, state, and tribal agencies with demographic and population information on fish species inhabiting the Project area to inform future management decisions. SCL shall also conduct a study to evaluate predation on outmigrating native salmonids at select tributary deltas. The objective of the study will be to quantify the proportion of outmigrating native salmonids that are being consumed by predatory fish within selected tributary deltas. Monitoring and evaluation of salmonid and predatory sportfish populations will help guide future native salmonid recovery efforts.

2.2. Upstream Fish Passage

Boundary Dam was built without fish passage facilities because downstream power and water storage projects, such as Grand Coulee and Chief Joseph dams, blocked anadromous fish migrations to the Upper Columbia Basin. Without upstream fish passage facilities, any potential gene flow by native salmonids can only occur in a downstream direction by fish that survive entrainment. However, declines in populations of native salmonids have increased attention on protecting resident fish movements. The USFWS Bull Trout Draft Recovery Plan, for example, currently calls for upstream passage at Albeni Falls (U.S. Army Corps of Engineers (USACOE)), Box Canyon Dam (Pend Oreille PUD (POPUD)) and Boundary Dam (Seattle City Light). POPUD is planning to construct upstream fish passage facilities at Box Canyon Dam targeting upstream passage of bull trout, westslope cutthroat trout, and mountain whitefish.

As part of relicensing activities, SCL and a team of fish passage experts evaluated options for bypassing upstream migrating fish around Boundary Dam (McMillen 2009). As part of the Boundary SA upstream fish passage will be addressed with a traditional trap and haul fishway based on NMFS criteria. A trap and haul facility is appropriate due to comparatively low population sizes of native salmonids and physical site constraints in the tailrace. While agreement has been reached on the preferred alternative, there is uncertainty regarding an appropriate site within the tailrace for the fixed trap-and-haul facility. In addition, because of the low numbers of native salmonids captured or observed in the Boundary Dam tailrace, there is little direct information regarding movement patterns of bull trout, cutthroat trout, or mountain whitefish in the Boundary tailrace.

Consistent with the Boundary SA, the process for developing the trap and haul fishway includes a 2-year study design and planning effort and an 8-year research and development phase to evaluate site specific conditions and biological traits of the target species in the Project area. Details of the research and development phase shall be confirmed after license issuance in consultation with the FAWG, but a conceptual plan was developed that includes multi-year biotelemetry studies and attraction flow tests in multiple tailrace locations (Tables 2.2-1 and 2.2-2).

Since few target fish were captured in the tailrace during pre-licensing studies, fishway attraction effectiveness shall be evaluated using target species from upstream sources or that demonstrate upstream migration behavior. For instance, in consultation with the FAWG and appropriate agencies, SCL may collect bull trout from Lake Pend Oreille, insert radio and/or acoustic tags, release the fish into the Boundary tailrace, and use micro-telemetry studies of those fish to identify an effective fishway entrance location and design.

Table 2.2-1. Initial Conceptual Schedule of Post-licensing Tasks for Upstream Fishway Development.

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Initial study design	X	X													
Stock status and genetic analysis	Conducted as part of the entrainment reduction research and monitoring effort														
Capture, radio-tag and track target species in tailrace				X	X	X	X	X							
Test tailrace attraction by releasing tagged Lake Pend Oreille bull trout in tailrace				X	X	X	X	X							
Tailrace micro biotelemetry			X	X	X	X	X	X							
Design and construction of attraction water at two or three tailrace locations		X	X	X	X	X	X	X							
Construction of fish trap at preferred fish attraction site(s)					X	X	X	X							
Tailrace hydraulic measurements				X					X						
Compile all results – Evaluate alternatives									X						
Tailrace physical model (if needed)				X	X	X	X								
FAWG decision point on fishway location										X					
Conceptual design of upstream fishway										X	X				
FAWG approval of fishway design											X				
Permitting, design and construction of upstream fishway												X	X	X	
Upstream fishway operational															**X**

Table 2.2-2. Conceptual Description of Post-licensing Research, Monitoring and Development Tasks for the Upstream Fishway.

Initial study design	Develop and describe 14-year study program in consultation with and subject to approval of the FAWG. This study program will outline study requirements and objectives, scope the areas of TAC involvement, identify task relationships to other fishway tasks and other PMEs, and describe the detailed scope of work and study plans for year 2-3 studies
Stock status and genetic analysis	Sample and analyze target species in tailrace to identify stock status and genetics.
Capture, radio-tag and track target species in tailrace	Electrofishing and other methods conducted to put radio tags in target fish species in the tailrace
Test tailrace attraction by releasing tagged Lake Pend Oreille bull trout in tailrace	Obtain approvals and transport bull trout to tailrace from Lake Pend Oreille. Implant radio tags in bull trout for analysis of upstream passage behavior
Tailrace micro biotelemetry	Detailed receiver grid in tailrace to assess and evaluate movement and behavior of radio-tagged target species
Design and construction of attraction water at two or three tailrace locations	Release attraction water in the tailrace at two or three locations to evaluate target species response and behavior. This program may include pumping water from the tailrace, gravity flow from the forebay, and potentially evaluating the use of cold water to attract target species.
Construction of fish trap at preferred fish attraction site	Design and construction of fish trap(s) at locations where target species are attracted to attraction water in micro biotelemetry studies.
Tailrace hydraulic measurements	Measurements in the tailrace to support fish passage facility design and potential physical model development.
Tailrace physical model (if needed)	A physical model of the tailrace may be necessary/advantageous to assist in designing and/or understanding target species behavior.
FAWG decision point on fishway location	In year 10, it will be necessary to get FAWG approval of the location and amount of attraction flow to be used for the permanent fish passage facility. It is expected that the TAG will assist with this decision.
Conceptual design of upstream fishway	Efforts to design the permanent facility.
FAWG approval of fishway design	FAWG approval of final designs for permanent upstream fishway.
Permitting, design and construction of upstream fishway	It is assumed that this will consist of some lead time to permit the facility, obtain all necessary approvals and construct the permanent facility. It is expected that the facility will go on-line in year 14 or 15.
Upstream fishway operational	An upstream fishway will be operational by post-licensing year 15. During the interim period, target species captured will be released upstream per handling protocols to be developed in consultation with the FAWG and appropriate agencies.

2.1. Reduction of Project Related Entrainment

Boundary Dam was built without entrainment reduction facilities. As fish pass downstream through Boundary Dam facilities, they are exposed to potential injury and mortality, with the level of mortality depending on the pathway, flow rate, and size of fish. A total of about 55,000 fish was estimated to have been entrained through all Project turbines and spill gates at the Project over a one-year period (SCL 2009a). Suckers, pumpkinseed, and yellow perch dominated the catch in fyke nets installed in the draft tube of turbine Unit 54. Although native salmonids were not captured as part of the turbine Unit 54 fyke net fishing effort, evidence of downstream movement of native salmonids was provided by the capture of two bull trout in the Boundary tailrace identified through genetic analysis as originating upstream in the Lake Pend Oreille basin. Although the number of native salmonids entrained through Boundary Dam may be small, the influence of entrainment on recovery of native salmonid populations is uncertain.

As part of relicensing activities, a team of fish passage experts evaluated alternate entrainment reduction concepts at Boundary Dam including fixed full flow screens, modular inclined screens, and floating or fixed surface collectors (McMillen 2009). The results of the evaluation determined that a floating surface collector concept would provide the most flexibility and potentially the highest incremental increase in fish protection. The estimated incremental increase in survival was 0 to 2 percent for 4-inch fish, -1 to 9 percent for 10-inch fish, and 8 to 21 percent for 24-inch fish. Since little is known about the migration depth of bull trout, westslope cutthroat trout, and mountain whitefish, the efficacy of a floating surface collector concept to reduce entrainment of the target species is uncertain.

Due to uncertainty regarding the effects of entrainment on target fish populations, and uncertainty regarding the efficacy of available entrainment reduction options, SCL shall implement an entrainment reduction program including an evaluation phase to assess the effects of Project entrainment on target species. During Years 1-18, SCL shall develop and implement studies (see Tables 2.2-3 and 2.2-4) sufficient to quantify the effects of entrainment on target species and to determine whether any population of target fish species (i.e., a unique population that constitutes a substantial percentage of fish in the Project area or that has a unique evolutionary niche that requires special protection) or a substantial number of target fish are affected by Project entrainment.

Successful implementation of the Entrainment Reduction Program (ERP) shall mitigate for the effects of entrainment on target species (bull trout, westslope cutthroat trout, and mountain whitefish) by either: (1) preventing entrainment at the Project; (2) reducing entrainment at the Project and mitigating for the remaining effects; or (3) fully mitigating for the effects of entrainment through other measures. The decision as to whether entrainment is best addressed through options 1, 2 or 3 as defined above, shall be made by the FAWG based on site specific information developed under this program. SCL shall work collaboratively with the FAWG in all aspects of this program and all decisions regarding this program made by SCL and the FAWG are subject to the approval of USFS, Ecology, and DOI.

Table 2.2-3. Initial Conceptual Schedule of Entrainment Reduction Tasks (Years 1-18).

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Study design	X	X																
Mainstem/Tributary project survival																X	X	X
Tributary fyke netting				X	X	X	X	X	X	X	X	X	X	X	X	X		
Sullivan screw trap					X	X	X	X	X	X	X	X	X	X	X	X		
Metaline Falls screw trap									X	X	X	X	X	X	X	X		
Tributary stock status/genetics		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Forebay/trashrack screw trap												X	X	X	X	X		
Tailrace screw trap										X	X	X	X					
Reservoir boat electrofishing				X	X	X	X	X	X	X	X	X	X	X	X	X		
Trib delta and mainstem macro biotelemetry											X	X	X	X	X			
Tailrace macro biotelemetry											X	X	X	X	X			
Forebay micro biotelemetry																X	X	X
Forebay hydraulic measurements														X	X			
Forebay CFD modeling															X	X	X	
Downstream conceptual design																X	X	X
Turbine/spillway mortality												X	X	X	X			
Forebay hydroacoustics															X	X	X	X

Table 2.2-4. Description of Initial Conceptual Entrainment Reduction Tasks (Years 1-18).

Study design	Develop 18-year study program in consultation with and subject to approval of the FAWG
Project effects of entrainment	Programmatic review of Project entrainment effects, including life cycle models and other tools to evaluate benefits of entrainment reduction facilities or alternate strategies to improve Project survival
Tributary fyke netting	5 creeks: Sullivan/Slate/Linton/Sand/Sweet, Mar-Nov, configured and deployed to trap upstream and downstream movement of fish> 4 inch, deployed 4 days per week, not manned on 24-hour basis but checked daily or more frequently during expected high debris events, 2 person crew , include trap efficiency tests (upstream and downstream), in addition to species, length, weight, etc, collect tissue samples, insert PIT >4 inch target species
Sullivan screw trap	Small screw trap operated Apr-Jun, Oct-Nov (high flow when delta fyke net less effective), 4 days per week, located in deep turbulent slot in lower reach, include trap efficiency tests (high initial cost of trap purchase but lower operating costs when also deploying fyke nets)
Metaline Falls screw trap	Large screw trap with robust mods, operated Mar-Nov except spill, 4 days per week, pick up PIT tags from trib trapping efforts
Tributary stock status/genetics	Collect and analyze DNA tissue samples of target species from reservoir and tributary reaches
Forebay screw trap	Large screw trap with robust mods, operated downstream of trashrack to evaluate efficacy of potential floating surface collector,
Tailrace screw trap	Large screw trap with robust add-ons, located in turbine outfall turbulence, operated Mar-Nov except during spill
Reservoir fish surveys	Electrofishing /other sampling gear to support Project survival evaluations in addition to Reservoir Fish Community Monitoring
Trib delta and mainstem macro biotelemetry	Fixed receivers established upstream of trib mouths and at mainstem reservoir locations to track seasonal movements, CART tags needed for deepwater areas, include multiple acoustic receivers below Metaline Falls, mouth of Canyon and Forebay
Tailrace macro biotelemetry	Fixed receivers located in tailwater and at US/Canada border to detect downstream movement through area
Forebay micro biotelemetry	Multiple acoustic receiver array in Forebay to track movement of fish during various generation and flow conditions, info used to assess facility design, location and potential efficacy
Forebay hydraulic measurements	Transect measurements in vicinity of trashrack during various generation and flow conditions, multiple tracks using ADCP set at shallow (0-50 ft) and full depth velocity readings
Forebay CFD modeling	Detailed hydraulic modeling to support conceptual design of entrainment reduction facility
Entrainment reduction facility conceptual design	Engineering design to be developed under TAC oversight
Turbine/spillway mortality	Use Hi-Z tags or other methodology to confirm mortality estimates
Forebay hydroacoustics	Deployment may be dependent on technology improvements

2.2. Tributary Aquatic Habitat

Based on the results of extensive modeling, monitoring, and analyses of Project effects, which indicated limited opportunity to recover native salmonid populations through mainstem habitat improvement, many of the Boundary aquatic PM&E efforts focus on implementing measures in Boundary tributaries (SCL 2009a). Most of the tributaries to Boundary Reservoir have been stocked with non-native salmonids such as brook trout, brown trout, and hatchery rainbow trout from out-of-basin stocks. The presence of non-native trout, especially brook trout, is a serious threat to native salmonids as a result of interbreeding (with bull and westslope cutthroat trout) and competition for habitat and food resources. 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. Habitat in the tributary reaches has been degraded by blocking culverts, roads constructed in riparian zones, and past logging practices which reduced LWD recruitment. SCL shall implement biological and habitat treatments in tributaries to Boundary Reservoir to benefit native salmonids, followed by monitoring and adaptive management to increase performance of the measures.

The objective of the tributary aquatic habitat program is to establish self-sustaining, naturally reproducing native stocks of fish and provide access to and improve habitat conditions in tributaries draining to Boundary Reservoir to offset an estimated 304 acres of reservoir habitat affected by the Boundary Project. Fish population and habitat condition goals are needed to guide these restoration efforts. Prior to implementing tributary treatments, a Tributary Management Plan shall be developed that includes a schedule and scope of treatments for each tributary to ensure that treatments are complementary to the population and habitat goals. For instance, removal of culverts that block tributary access might be delayed until after brook trout suppression efforts to reduce the risk of brook trout recolonization. Biological treatments shall include suppression or eradication of non-native fish in tributary reaches and selected lakes draining to Boundary Reservoir. Backpack electrofishing shall be the technique used to capture non-native fish (primarily brook trout) during suppression efforts. Details of the suppression program, including the disposition of captured non-native fish, shall be determined during post-license planning. Eradication of non-native fish shall involve multiple applications of an approved fish toxicant in select water bodies.

Habitat treatments shall consist of a variety of measures designed in response to the site specific conditions. Removal or replacement of blocking culverts will restore access to habitats. Logjams and LWD pieces will be placed to increase channel complexity, retain gravel and support pool formation. Riparian plantings and streamside road improvements will benefit tributary habitat conditions by reducing fine sediment runoff, increase shade and canopy cover to reduce water temperatures, and increase the long-term recruitment of LWD to the streams. Where possible, easements shall be purchased to reduce development and other impacts to the riparian areas and provide long-term protection to native salmonid habitat. Additional details of the location, scope and schedule of biological and habitat treatments are in the main body of the FAMP.

During studies conducted as part of the ILP process, SCL categorized tributaries flowing into Boundary Reservoir according to habitat availability for native salmonids and the potential opportunity to improve conditions through habitat manipulation (see Assessment of Factors Affecting Aquatic Productivity in Tributary Habitats, Study No. 14, SCL 2009a). Twenty-eight tributaries were categorized as primary, secondary, or excluded according to the extent to which habitat improvement action would likely benefit native salmonids. The majority of tributary treatments are directed at primary or secondary reaches (i.e., Tier-1) that provide the greatest potential to influence native fish resources. As part of the comprehensive Boundary SA the settling parties have agreed that, SCL should also implement measures to improve aquatic habitat conditions in low priority tributaries (i.e., Tier-2) that because of their small size and limited adfluvial habitat were previously assumed to have a low potential to benefit native salmonids. The over-riding criterion is that the Tier-2 tributary must have, or potentially have, useable native salmonid habitat that could be effectively improved through habitat improvement or protection.

Suppressing or eradicating non-native fish from tributary reaches and implementing habitat treatments will provide the opportunity for population recovery if there is sufficient recruitment of native salmonids. Currently, no self-reproducing bull trout populations occur in any tributaries to Boundary Reservoir. Outplanting of early lifestage, locally adapted, native salmonids spawned and reared in an appropriate facility may support rapid population response to biological and habitat treatments.

2.3. Mill Pond Restoration, Site Monitoring and Maintenance

Mill Pond, located at RM 3.9 on Sullivan Creek, was created when a log crib dam was constructed in 1909 by the Portland Cement Company. An un-gated concrete dam was built in 1921 just below the log crib dam. The concrete dam is 134 feet long and about 55 feet high and maintains the water surface elevation of Mill Pond at approximately 2,520 feet NAVD 88.

Mill Pond Dam is a complete barrier to the upstream movement of resident fish (SCL 2009). The impoundment has altered natural stream processes in Sullivan Creek by interrupting the downstream transport of all bedload material and some LWD. The dam has created a condition where Sullivan Creek downstream of Mill Pond Dam is sediment depleted (USFS 1996). The sediment transport capacity downstream of the dam exceeds the sediment supply, which has resulted in extensive armoring of the bed surface and a lack of gravels for use by spawning salmonid populations. The Mill Pond impoundment has also slowed water velocities and increased summer water temperatures in lower Sullivan Creek.

POPUD has agreed to remove Mill Pond Dam and restore the site as part of its surrender of the Sullivan Creek Project license. The Mill Pond Decommissioning Plan submitted by POPUD to FERC as part of its surrender application requires removal of both the concrete and log crib dams and artificial foundations to facilitate natural stream functions. Existing sediments that have accumulated behind Mill Pond Dam shall be managed to facilitate dam removal and stream channel restoration. Following dam removal, the Sullivan Creek stream channel, from upstream of Mill Pond Dam site to Outlet Creek shall be restored to a self-functioning system consistent with the Sullivan Creek channel upstream and downstream of Mill Pond. New stream channel banks shall be stabilized with keyed-in logs with root wads and large boulders, and then planted with native herbaceous and woody riparian species.

Benefits of Mill Pond Dam removal and associated site restoration will include elimination of the man-made barrier to upstream fish passage, an increase in the quantity and quality of habitat for native salmonids, restoration of downstream transport of coarse sediment and LWD, and benefits to water quality in the form of reduced summer water temperatures due to reductions in water surface area and increases in water velocity in the area of Mill Pond Reservoir.

Following completion of the restoration effort and after FERC jurisdiction over the site through the Sullivan Creek Project license ends, the New License for Boundary shall require SCL to monitor and maintain the site to ensure that the stream channel and floodplain are functioning in accordance with the design criteria, that riparian and upland vegetation is becoming established and to control non-native plant species.

2.4. Native Salmonid Conservation Program

Outplanting of native salmonids produced from an approved facility can complement brook trout suppression and habitat improvement activities and assist the rapid recruitment and colonization of underutilized tributary habitats. No self-reproducing bull trout populations occur in any tributaries to Boundary Reservoir and artificial propagation of bull trout could be used to seed currently unoccupied habitat (see Assessment of Factors Affecting Aquatic Productivity in Tributary Habitats, Study No. 14, SCL 2009a; USFWS 2002).

SCL shall fund the design, construction, operation and maintenance of a native fish conservation facility for the production of native salmonids to supplement tributaries draining into Boundary Reservoir. The facility shall be designed to produce eyed eggs, fry, and fingerlings and support multiple age class broodstock. The facility shall be designed to simultaneously propagate two species of fish and several life stages including but not limited to westslope cutthroat trout and bull trout. Selection of species, stocks, and lifestages to be produced shall be determined as part of post-license planning in consultation with and subject to approval of the FAWG. Locally adapted, multiple age class broodstock shall be used to maintain long-term fitness traits and the facility shall be operated to minimize genetic divergence from local, naturally spawning stocks. Annual production shall be commensurate with the need to outplant fish in tributaries draining into Boundary Reservoir.

The facility shall be designed to incorporate techniques to increase fish fitness and survival after release. Design considerations for outdoor rearing facilities shall consist of a naturalized, sinuous channel lined with cobble and gravel substrate similar to Boundary drainages, feeding system, natural shading, and instream woody habitat. The primary distribution of fish is assumed to be fingerlings, but may include stream-side incubators or artificial redds to minimize potential domestication.

SCL, in consultation with and subject to approval of the FAWG, USFS, and Ecology, shall establish measurable goals for the Conservation Program by determining appropriate tributary target fish populations and establishing self-sustaining native stocks of fish. Optimal outplanting strategies for achieving desired goals shall be identified by monitoring and evaluating multiple outplanting strategies that consider appropriate fish sizes, outplanting densities, frequency and timing. SCL shall monitor the initial success of outplanted native salmonids and conduct periodic monitoring until population goals are achieved.

2.5. Recreational Fish Stocking Program

Boundary Project operations impact mainstem and tributary delta habitats, and cause loss of fish through entrainment and increased predation on salmonids associated with the reservoir environment (SCL 2009a). Since 2001, SCL has voluntarily stocked sterile rainbow trout in the Boundary Reservoir to increase recreational fish opportunities. As of 2010, SCL will discontinue stocking triploid trout in Boundary Reservoir since WDFW will not permit the activity citing concerns regarding potential competition with native trout and poor trout habitat conditions in the reservoir.

As part of an ongoing WDFW program, fry and fingerling trout are routinely stocked in Washington lakes during the spring and fall where they grow on natural food until the following spring when they are large enough to be harvested. Where fry survival is low, or where there is intense fishing pressure, catchable size trout, 8 inches or larger, are stocked to improve recreational opportunities. In addition to fertile rainbow and cutthroat trout, sterile and hybrid trout are sometimes planted in select lakes. If provided with an abundant food supply, sterile triploid and hybrid trout have the potential to quickly grow to trophy size. Sterile trout are also planted in areas where natural reproduction could adversely affect native species.

To provide recreational fishing opportunities, SCL shall stock trout in 18 lakes within a fifteen-mile area around the Project. Trout species stocked in these lakes may consist of westslope cutthroat, rainbow, rainbow triploid, or tiger trout, and may include fall fry, fingerlings, spring fry and catchable-size fish. These fish shall be annually produced and planted by WDFW; however, fish may be obtained from a commercial production facility if fish are unavailable from WDFW. Approximately 11,678 pounds of fish shall be stocked annually. SCL shall monitor and evaluate lakes receiving the stocked fish. The number, size, and species of fish to be stocked in the selected lakes each year may be modified in response to the information developed through annual monitoring.

2.6. Fund for Habitat Improvements in Tributaries to Sullivan Lake

In addition to the previously described fish and aquatic PM&E measures, SCL shall implement an additional measure governed by License Article 9(I) that is expected to benefit native salmonids in the Project area but that is not addressed in detail by the FAMP.

Sullivan Lake supports a naturally-reproducing, self-sustaining population of kokanee (*Oncorhynchus nerka*) that is a recreational fishery of regional importance (Baldwin and McLellan 2005). Kokanee are a landlocked form of sockeye salmon that rear in Sullivan Lake but spawn in lower Harvey Creek draining to Sullivan Lake. SCL shall help pay for improvements to aquatic habitat conditions in Harvey, Noisy and Jungle creeks that flow into Sullivan Lake through habitat treatments to be implemented under a $2.5 million fund. Improving aquatic habitat conditions in these tributaries will benefit the Sullivan Lake kokanee population and reduce recreational fishing pressure on Boundary tributary streams. In addition, genetic testing of cutthroat trout suggests that relatively pure strains of westslope cutthroat trout occur in Harvey Creek upstream of Sullivan Lake. Improving habitat conditions in Harvey Creek will increase protection to a westslope cutthroat trout population in the Boundary drainage. The Sullivan Lake Upper Tributary Fund is not addressed in the FAMP since SCL's responsibilities are limited to establishing the fund which shall be administered by the FAWG.

2.7. Conclusion

This FAMP shall be the principal guiding document for the planning, implementation, monitoring, adaptation and reporting of PM&E measures for fish and aquatic resources affected by or related to the Project. The FAMP includes specific goals for fish and aquatic resources, as well as clearly defined objectives for achieving the goals.

SCL shall implement the FAMP in consultation with a FAWG. The FAWG shall consist of representatives from SCL and the federal, state, tribal, and local entities having jurisdiction over, or interest in, the implementation of the Project license articles related to fisheries and aquatic resources. At the discretion of the FAWG, technical advisory committees (TACs) shall be created for specific issues, such as upstream passage or hatchery design and operating protocols.

Details regarding consultation, decision making, communications and documentation related to the FAWG are addressed in Section 8 of the Boundary SA and included as Appendix 1 to this FAMP.

In accordance with License Article 9 and the procedures in Appendix 1, SCL shall prepare any proposed amendments to the FAMP in consultation with the FAWG and subject to approval by the United States Forest Service, DOI, and Ecology prior to filing with the Commission.

3 REGULATORY REFERENCE AND DEFINITIONS

Implementation of the FAMP will be conducted following regulatory guidance as identified in various federal, state, and local policy documents and permitting requirements for specific PM&E measures. Depending on the final design of the PM&E measures and implementation methods, it is anticipated that some or all of the permits described in the following sections may be required.

3.1. Federal Authority and Reference

Federal permits and other requirements that may be needed to implement components to the FAMP include:

- USDA Forest Service Special Use Permit.
- USACOE Section 10 and 404 Permits. This permitting is usually considered as part of the Joint Aquatic Resources Permit Application (JARPA). A Section 10 permit is needed for working in, over, or under navigable waters of the United States. A Section 404 permit is needed for dredging or filling in waters of the United States.

- National Historic Preservation Act Review. A review is necessary for any ground-disturbing activity. All cultural resource issues will be addressed by the Cultural Resources Work Group.
- Endangered Species Act Section 7 Review. If specific projects are not covered under the broader Section 7 review conducted as part of Project relicensing, they will need review by the USFWS. This review is generally covered as part of the JARPA process.
- Environmental analysis is necessary for any activity that would be proposed for implementation on federal land ownership. This analysis would need to comply with requirements under the National Environmental Policy Act (NEPA).

A wide variety of documents outline federal policy for the various agencies that could be pertinent to the FAMP. Federal agency staff is responsible for understanding the policies of their respective agencies and alerting the FAWG to policies pertinent to implementing the FAMP.

3.2. Washington State Authority and Reference

State permits that may be needed to implement components of the FAMP include:

- Hydraulic Project Approval (HPA) (WDFW). The HPA permit is needed for any instream activity and is generally included in the JARPA process.
- Aquatic Use Authorization (WDNR). This permit is triggered by use of state owned lands such as shore lands and beds of navigable waters. The Use Permit is generally included in the JARPA process, but may be required if in-water work is required as part of plan development.
- Critical Area Review and State Environmental Policy Act (SEPA). This process is usually considered as part of the JARPA. It is needed when work is considered in or near waterways. There is no required review period; time required for permitting depends on issues identified and the amount and type of additional information that may be required. A SEPA checklist will be required if the JARPA process is not approved or if HPA is not required.
- Shoreline Substantial Development/Conditional Use Permit. The streamlined HPA process generally provides an exemption from the County Conditions Use Permit process.
- Water Quality Certification (Ecology).

Similar to federal regulations, a wide variety of documents outline state policy for the various agencies that will be members of the FAMP. State agency staff is responsible for understanding the policies of their respective agencies and alerting the FAWG to policies pertinent to implementing the FAMP.

3.3. Local Authority and Reference

County or City Regulations will also be followed, and any permits will be obtained for implementing the plan. Examples could be:

- Grading and clearing permits.
- Sensitive Area Ordinance; review occurs as part of the JARPA process.
- Pend Oreille County Shoreline Master Program; review occurs as part of the JARPA process.

3.4. Definitions

To ensure a common understanding of terms used in the FAMP, the following definitions apply:

JARPA: Joint Aquatic Resources Permit Application. This is a combined application for obtaining the following permits:

- Section 404 and Section 10 (USACOE)
- ESA Consultation (USFWS)
- Section 9 Bridge Permit (Coast Guard; not applicable for PM&Es)
- 401 Water Quality Certification (Ecology)
- Hydraulic Project Approval (WDFW)
- Shoreline (Local Government)
- Substantial Development (Local Government)
- Conditional Use (Local Government)
- Permit Variance, Exemption, or Revision (Local Government)
- Floodplain Management (Local Government)
- Critical Areas Ordinance (Local Government)

Engineered logjam: A structure constructed of logs built within the channel or floodplain of a stream and designed according to standard engineering principles (Saldi-Caromile et al. 2004).

Key piece: A piece of LWD that is sufficiently large to be relatively stable. This size is dependent upon stream size and follows classification identified in Fox and Bolton (2007). For streams greater than 98.4 feet in width, a key piece must have an attached rootwad.

LWD: Existing instream woody debris or woody debris that is placed partially or entirely within the ordinary high water mark of the stream. Size is dependent upon stream size and follows classification identified in Fox and Bolton (2007).

Riparian buffer: A buffer on each side of a stream measured from the ordinary high water mark. For the purposes of the FAMP riparian buffers widths are specific to each measure and depend on stream size, geomorphic characteristics, adjacent land ownership, and the presence of roads and other infrastructure.

Riparian plants: Native plants commonly found in riparian zones of the Boundary Project and its tributaries (Table 3-4-1).

Riparian planting density: Planting density for trees and shrubs during restoration of a riparian buffer. Low density is approximately 440 plants per acre (1 plant per 100 square feet spacing). Medium density is approximately 870 plants per acre (1 plant per 50 square feet spacing). High density is approximately 4,360 plants per acre (1 plant per 10 square-feet spacing).

Native salmonids: Bull trout (*Salvelinus confluentus*), westslope cutthroat trout (*Oncorhynchus clarki lewisi*), and mountain whitefish (*Prosopium williamsoni*).

Relicensing participants (RPs): Collectively, the Federal (EPA; through Ecology, USFS, USFWS, Bureau of Indian Affairs, State (WDFW, Ecology), Kalispel Tribe and Selkirk Conservation Alliance (SCA) on behalf of the Hydropower Reform Coalition were active participants in the relicensing process.

Substrate size: Bedload substrate size classifications follow those in WDFW and Ecology (2003).

Compliance monitoring: Monitoring that is conducted to determine if a measure has been implemented according to the planned design.

Effectiveness monitoring: Monitoring that is conducted to determine if a measure is functioning as designed. A measure can be functioning properly and not achieve all biological objectives for the measure. For example, aquatic habitat can be improved, but not used by target species.

Biological monitoring: Monitoring that is conducted to obtain baseline and trend data for organisms. Examples of data include species composition, abundance, and size information collected at one or more locations and time periods.

Research monitoring: Monitoring that is conducted to answer specific scientific questions, such as validating assumptions, reducing uncertainty, or identifying relationships between physical and biological factors. Research monitoring may use the results of biological monitoring for retroactive analysis; however, research monitoring typically identifies specific hypotheses for testing prior to designing a monitoring program and collecting data.

Adaptive management: For the purposes of the FAMP, adaptive management is the periodic adjustment made to the implementation of a PM&E measure over the course of the license based on the results of monitoring or other information. The adaptive management of PM&E measures will occur in collaboration with the FAWG.

Tier 1 Tributaries: All named tributaries draining into Boundary Reservoir categorized as primary (high opportunity for restoration or enhancement of native salmonid habitat) in SCL (2009) plus one tributary categorized as secondary (moderate opportunity for restoration or enhancement). Tier 1 tributaries include Sullivan Creek, Slate Creek, Sweet Creek, Linton

Creek, Sand Creek, Lime Creek, Pewee Creek, Flume Creek, Pocahontas Creek, and their associated drainages.

Tier 2 Tributaries: Tributaries categorized as secondary (from moderate to no opportunity for restoration or enhancement of native salmonid habitat) in SCL (2009). Tier 2 tributaries include Everett Creek, Whiskey Gulch, Beaver Creek, Threemile Creek, Wolf Creek, Lost Creek, and 13 unnamed tributaries.

Culvert Replacements: Culverts replaced on fish-bearing waters designed to meet fish passage criteria in WDFW (2003) design of road culverts for fish passage or current applicable WDFW criteria. Culverts replaced on non-fish-bearing waters will be designed to allow to pass a 100-year flood event.

Table 3.4-1. Common Plants Suitable for Riparian Restoration in the Boundary Project Area and its Tributaries.

Common Name	Scientific Name	Habitat Notes
Mountain alder	*Alnus incana*	high water table, close to streams
red-osier dogwood	*Cornus stolonifera*	wetland and riparian zones, tolerant of fluctuating water table
Douglas spiraea	*Spiraea douglasii*	high water table, close to streams
Sitka alder	*Alnus sinuata*	high water table, close to streams
Native willow species	*Salix* spp.	rivers and streambanks, wetlands; often along backwaters
Black cottonwood	*Populus balsamifera spp. tricocarpa*	fast growing, pioneer species on alluvial soils
Black hawthorn	*Crataegus douglasii*	understory to Populus, moist to mesic sites

3.5. Other Relevant Articles of the License

This will be completed after reviewing final FERC license articles. For example, articles regarding aquatic vegetation management or water quality may be pertinent to the FAMP.

4 PLAN DEVELOPMENT PROCESS

4.1. Federal, State, and Tribal Coordination

The FAMP is the culmination of more than two years of discussion with federal, state, and tribal agencies and implementation of a number of studies conducted by SCL investigating physical and biological processes within the Project area and tributaries to Boundary Reservoir. Following FERC's ILP, SCL developed study plans and reports that were reviewed by relicensing participants. Numerous meetings were held to discuss proposed study plans and the interim and final results of the studies. Following completion of the studies a PLP was drafted by SCL, which included a set of preliminary PM&E measures. Relicensing participants prepared comments on the PLP and included proposed PM&E measures. SCL met with relicensing participants to discuss the effects of the Project as part of an Integrated Resource Analysis (IRA). Throughout the process SCL and relicensing participants have achieved a better understanding of each other's goals and objectives for the management of the Project and the aquatic community in the reservoir and its tributaries (for greater detail regarding RP consultation, see Section 3 of Exhibit E of the License Application).

4.2. Provisions for Further Development and Modification of the FAMP

SCL anticipates that some aspects of the FAMP will require further development and modification. For example, many of the PM&E measures, such as components upstream fish passage, are currently conceptual. To implement specific mitigation or enhancement projects, additional field data and planning will be needed to prepare specific designs. The FAWG will be responsible for providing guidance in the further development and modification of the FAMP and associated fish and aquatics resource PM&E measures.

5 PLAN IMPLEMENTATION

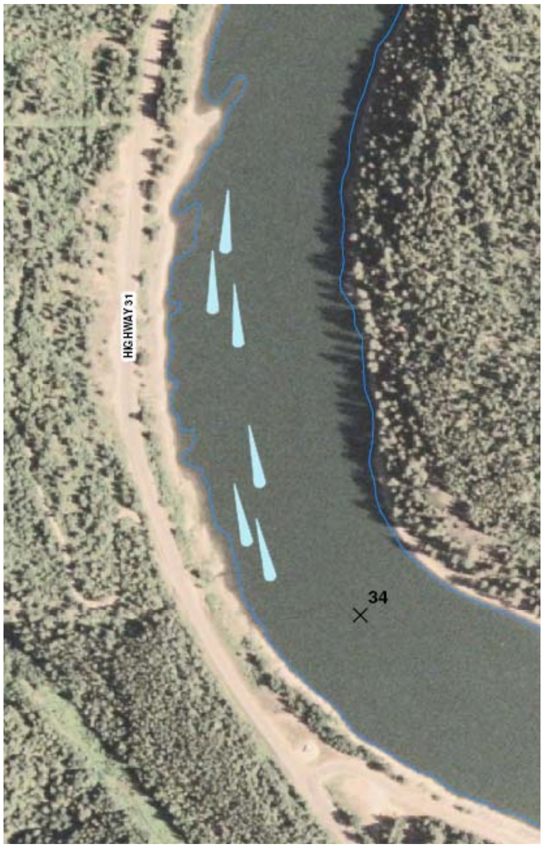
5.1. Mainstem Fish Community and Aquatic Habitat Measures

PM&E measures described in this section of the FAMP shall be governed by License Article 9(A).

5.1.1. Gravel Augmentation below Box Canyon Dam

5.1.1.1. Scope

SCL shall place a total volume of 1,500 cubic yards (yd^3) of screened gravels to increase potential mountain whitefish spawning habitat in the upper reservoir. The gravels will be of a size distribution suitable for use by spawning mountain whitefish and will be placed at up to six sites between PRM 29.1 and Box Canyon Dam. Tentative sites have been identified at PRM 33.7 (0.8 mile below Box Canyon Dam) (Figure 5.1-1), but final site selection will be approved by the FAWG. Up to 25 percent of the gravel/cobble volume (375 yd^3) will be replenished every 5 years. Implementation planning shall be completed within 3 years following license issuance and will be developed in consultation with and approved by the FAWG. Implementation planning will identify depth, velocity, existing substrate, vicinity to existing mountain whitefish spawning areas and other criteria deemed necessary for final site selection. In an effort to increase gravel retention at the placement sites, SCL shall install up to 189 tons of 3-4 ft diameter boulders in weirs or other structural designs. Up to 25 percent of the boulders (about 47 tons) will be replenished every ten years as needed to increase gravel retention. Construction of the boulder weirs and gravel placement will occur in two steps; up to four of the sites will be constructed in Year 4 following license issuance, and the remaining sites will be constructed in Year 10 following license issuance or as otherwise determined by the FAWG. The design and location of the Year 10 gravel augmentation sites will be approved by the FAWG and will consider the effectiveness of sites constructed in Year 4.



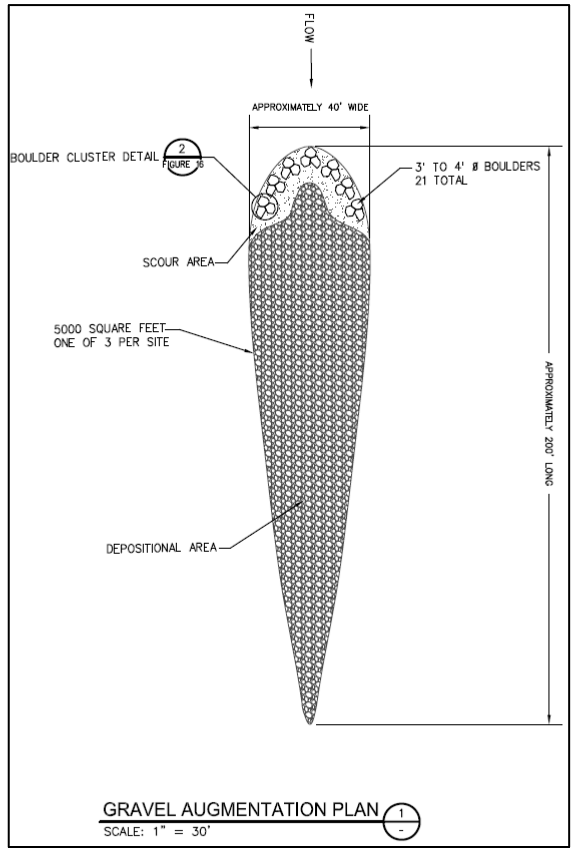


Figure 5.1-1. Tentative location of gravel augmentation sites near PRM 33.7 (left). Conceptual design of boulder cluster and augmented gravel (right) (McMillen 2009).

5.1.1.2. Background Information

Available information from relicensing studies suggests that mountain whitefish spawn in the Box Canyon Dam tailrace area. Standard monthly electrofishing surveys and targeted surveys to locate staging mountain whitefish congregations and individuals ripe for spawning were conducted between February 2007 and December 2008. In addition, egg mats were deployed at a number of locations during November 2008 and January 2009 to better understand the timing of mountain whitefish spawning. The catch of gravid and milt-flowing mountain whitefish by boat electrofishing during these surveys in the Upper Reservoir Reach generally supported the hypothesis that mountain whitefish spawn in the Upper Reservoir Reach during November and December (SCL 2009b). Furthermore, egg mats were used to successfully collect several eggs believed to be mountain whitefish based on egg size, timing, and location and method of egg collection.

A literature review provided information on mountain whitefish spawning habitat suitability criteria (i.e., depth, velocity, and substrate preferences) for use in habitat modeling; these data are pertinent to identifying potential gravel augmentation sites. Mountain whitefish spawning habitat criteria were identified in the Mainstem Aquatic Habitat Modeling Study Final Report

(SCL 2009a). Suitable depths range from 1.5 to 10.0 feet and suitable velocities range from 1.3 to 3.6 feet per second (fps). Substrate types commonly used by spawning mountain whitefish include medium to large gravel and small cobbles.

5.1.1.3. Procedures

SCL shall complete implementation planning within 3 years of license issuance. The specific scope of the planning will be developed in consultation with and approved by the FAWG. The objectives of the implementation planning study are to identify:

- The specific site(s) for gravel augmentation.
- The size and amount of gravel and small cobble to be placed at each site.
- Depth and velocity criteria to support potential mountain whitefish spawning habitat.
- A specific design for boulder placement to increase gravel retention.
- The expected residence time for delivered gravel under a range of flow conditions.
- Specific monitoring protocols.

Potential sites should have depths and velocities within the range of suitable habitat criteria during spawning (November and December) and incubation (through January) periods for mountain whitefish. Preferably, water velocity at the potential site following gravel placement will rarely exceed the critical velocity that results in transport of medium- to large-sized gravel particles. The existing bathymetry and distribution of substrate sizes can affect the transportability of spawning gravels. Large boulders that are currently present, or placed at the site, can help to retain spawning gravels. Potential sites should be dominated by large cobble or larger substrate sizes that can be enhanced by providing substrate within the suitable size range.

Baseline monitoring at the proposed augmentation sites will be conducted to provide information on pre-treatment site conditions. Gravel placement at up to four sites will occur within 4 years of license issuance. Boulders will be used to construct weirs or other structures and placed at sites approved by the FAWG. The method for delivering gravel and boulders to the selected sites and distributing the material within the augmentation area will be determined by SCL, subject to approval of environmental permitting agencies. A compliance report will be prepared following gravel and boulder placement to confirm compliance with design specifications. The remaining gravel placement sites will be constructed in Year 10 for a total of up to six sites for combined Year 4 and Year 10 construction. A compliance report will be conducted following gravel placement (Year 10) and physical and biological monitoring will be conducted to guide future replenishment efforts.

Boulder weirs are expected to increase gravel retention and reduce the frequency of gravel replenishment. However, up to 375 yd^3 of gravels (i.e., 25% of original volume) will be available every 5 years based on the rate of gravel loss observed at the placement sites. If additional boulders are needed to enhance gravel retention at the existing sites, up to 47 tons (i.e., 25% of original volume) will be available for replenishment every 10 years.

5.1.1.4. Compliance, Effectiveness, and Adaptive Management

Prior to the initial gravel and boulder placement effort, physical measurements of the sites will be conducted to identify site conditions to support design specifications and replenishment procedures. The baseline monitoring efforts will include measurements of gravel depth, gravel area, sediment size distribution, number and size of boulders, and water depth and velocity to evaluate whether augmented gravel sites provide potential mountain whitefish spawning habitat. Physical measurements of the Year 4 gravel placement sites will be conducted for three consecutive years (i.e., Years 5, 6, 7) to provide information on the effects of hydrologic conditions on gravel placement sites. In addition, physical measurements of all six sites will be conducted for three consecutive years (i.e., Years 11, 12, 13) to provide information on the relationship between hydrologic conditions and the rate of gravel loss.

Physical effectiveness monitoring will be conducted beginning in Year 9 and every 5 years thereafter to assess the need for gravel and boulder replenishment. Monitoring procedures will be approved by the FAWG, but it is expected that information such as the surface area and depth of gravel, water depths and velocities will be used to evaluate whether the measure is continuing to function as designed.

Biological monitoring will also be conducted for three consecutive years starting in each year of construction and gravel placement at new sites. In addition, biological monitoring will occur at all sites at years 15, 20 and 25. Biological monitoring, using egg mat frames similar to those employed during relicensing studies and a level of effort comparable to the 2008 whitefish egg mat surveys conducted in Box Canyon tailrace, will be conducted following a FAWG approved plan. Information obtained from the physical and biological monitoring will used to guide the design of the Year 10 gravel placement sites and gravel and boulder replenishment. Based upon the physical and biological effectiveness monitoring, the FAWG may determine remediation measures within the specified limits of the gravel augmentation measure.

Compliance monitoring will provide documentation that the gravel and boulder placement and monitoring activities were implemented as specified in the measure. Protocols for demonstrating measure compliance will be identified as part of implementation planning to be approved by the FAWG. At a minimum, compliance monitoring will include documentation collected during implementation, such as survey data, records of purchased materials (gravel, boulders, etc), and photographs of each site before and after augmentation.

5.1.1.5. Reporting and Schedule

The reporting and implementation schedule for mainstem gravel augmentation is summarized in Table 5.1-1.

Table 5.1-1. Reporting and implementation schedule for mainstem gravel augmentation.

PM&E Measure Activity	Schedule
Implementation planning	Within three years of license issuance
Baseline monitoring	Within three years of license issuance
Initial construction of up to four sites	In the fourth year following license issuance
Construction of remaining gravel sites	In the tenth year following license issuance
Gravel/boulder replenishment	In the tenth year following license issuance and every 5 years thereafter, as needed, based on FAWG determination
Compliance reporting	Following gravel placement or replenishment (In the fourth and tenth years following license issuance, and every five years thereafter)
Post-treatment physical monitoring	In the fifth, sixth, seventh, 11th, 12th, and 13th years following license issuance
Pre-replenishment physical monitoring	In the ninth and 14th years following license issuance and every 5 years thereafter
Biological monitoring	In the fourth, fifth, sixth, tenth, 11th, 12th, 15th, 20th and 25th years following license issuance

5.1.1.6. Consistency with Other Plans and PM&E Measures

There are no conflicts between this measure and other resource management plans. Gravel augmentation under this measure could potentially occur near a large cobble bar, locally known as the "Cobble Sisters," near Project river mile 30.3. A channel will be excavated at the Cobble Sisters area to connect mainstem flows to isolated pools to reduce the risk of fish trapping (see PM&E: Channel Modifications of Mainstem Trapping Pools at Project RM 30.3). Implementation planning for these two measures will be coordinated to avoid channel excavations at Cobble Sisters area damaging gravel augmentation sites.

5.1.2. Channel Modifications of Mainstem Trapping Pools at Project RM 30.3

5.1.2.1. Scope

SCL shall excavate a channel to connect mainstem flow to several isolated pools at a large cobble bar near PRM 30.3 to reduce the risk of fish becoming trapped during declining water surface elevations. SCL will excavate a 1,800-foot channel to an elevation below 1,979 feet NAVD 88[1] to connect trapping pools 10-009, 10-013, and 10-016 to mainstem flows. Spoils from excavation will be used to fill Pool 10-016 near the channel margin (Table 5.1-2, Figure 5.1-2). The objective of this measure will be to maintain a wetted connection to mainstem flows in the constructed channel to reduce the risk of fish of being trapped in the pools during periods of declining flow and reservoir water surface elevations.

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

Table 5.1-2. Pools proposed for modification in trapping and stranding Region 10 ("Cobble Sisters").

Pool Number	Current Outlet Elevation	Maximum Depth (ft)	Pool Area (ft^2)
10-008	1989	8.7	48,447
10-009	1990	2.4	9,702
10-013	1991	0.3	1,881
10-016	1992	0.8	7,290
Total			67,320

Figure 5.1-2. Location of trapping pools (left) and conceptual plan (right) for modification at Cobble Sisters.

5.1.2.2. Background Information

Relicensing studies during 2007 and 2008 identified that fry and young-of-year fish become trapped in pools isolated from the mainstem flow 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, Stranding and Trapping Region 10 at PRM 30.3 along the east bank within the Upper Reservoir Reach (commonly referred to as "Cobble Sisters") was identified as an area with a high occurrence of trapping (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 the area is geomorphically stable. SCL is proposing to excavate connecting channels at the Cobble Sisters because these channel features are man-made and stable.

5.1.2.3. Procedures

SCL shall conduct implementation planning, subject to approval of the FAWG, within 3 years following license issuance. Implementation of site modifications will occur within 5 years of license issuance. Implementation planning will provide design specifications for the channel excavation and dispersal of spoils based on field surveys at the Cobble Sisters. The design will include drawings that specify the current and planned topography and shape of the site. The thalweg of the excavated channel will be at an elevation below 1,979 feet NAVD 88 and will result in the excavated channel remaining inundated under all but the most extreme combination of reservoir drawdown and low inflow. Excavation of the channel below elevation 1979 feet will allow fish egress to the mainstem under nearly all flow and operating conditions.

Observations during relicensing studies suggested the risk of stranding was relatively low when shoreline gradients were greater than 4 percent (SCL 2009a). Consequently, channel banks will be graded to a target gradient greater than 4 percent but not so steep as to slough during high flow conditions. Some areas of the channel may not be able to meet the target gradient because of engineering constraints that become apparent during detailed planning and a survey of the site. Excavated substrate used to fill Pool 10-0016 will be contoured to reduce the risk of stranding. The design of the excavated channel will also consider conditions (primarily water velocity) to reduce the likelihood of fine sediment deposition which could contribute to macrophyte growth in the constructed channels. Scalping the tops of islands adjacent to the excavated channel may also be considered for reducing back-eddies and velocity shadows that may contribute to settlement of fine substrate materials and colonization of macrophytes.

5.1.2.4. Compliance, Effectiveness, and Adaptive Management

Compliance monitoring by SCL shall occur within one year following implementation of the measure. Protocols for collecting compliance information will be identified as part of implementation planning to be approved by the FAWG. At a minimum, compliance monitoring will include documentation collected during implementation, such as survey data and photographs of the site before excavation. Measurements of the excavated channel will include the thalweg elevation, thalweg slope, excavated channel width, side slope, channel substrate, and distribution and density of macrophytes. Physical measurements to evaluate whether the site modifications continue to function as designed will be repeated every 10 years following construction and in the event of flows greater than a flood event having a 25-year recurrence interval. During the year following each physical monitoring effort, the FAWG will determine if remediation measures are needed to ensure site modifications continue to satisfy design specifications. SCL shall implement the required measures to satisfy design objectives.

5.1.2.5. Reporting and Schedule

The reporting and implementation schedule for channel excavation at the Cobble Sisters is summarized in Table 5.1-3.

Table 5.1-3. Reporting and implementation schedule for channel excavation at the Cobble Sisters.

PM&E Measure Activity	Schedule
Implementation planning	Within three years of license issuance
Implementation	Within five years of license issuance
Compliance Report	Within six years of license issuance
Physical Monitoring	Every ten years following construction, and following flows exceeding a 25-year recurrence interval
Monitoring Report	Within one year of physical monitoring

5.1.2.6. Consistency with Other Plans

There are no conflicts between this measure and other resource management plans. Gravel augmentation to provide mountain whitefish spawning habitat could potentially occur near the Cobble Sisters area (Section 5.1.1). Implementation planning for this measure and mainstem gravel augmentation will be coordinated to avoid channel excavations at Cobble Sisters area damaging gravel augmentation sites.

5.1.3. Mainstem Large Woody Debris at Tributary Deltas

5.1.3.1. Scope

SCL shall enhance tributary delta habitat by providing additional cover for salmonids holding in the coldwater refugia at tributary mouths. LWD jams will be placed and maintained in the thalweg in the upper delta regions of four tributaries to Boundary Reservoir. Two LWD jams will be placed at the Sullivan Creek delta and one LWD jam will be placed at the deltas of Sweet, Slate, and Linton creeks (total of 5 LWD jams). The Sullivan Creek logjams will have a total volume of not less than 1,700 ft^3, while each logjam in Slate, Sweet and Linton creeks will have a volume of not less than 530 ft^3.

The specific location and design of the LWD jams will be determined during implementation planning by SCL in consultation with and subject to approval of the FAWG. LWD jams will be located in the upper end of tributary deltas to minimize use by non-salmonids. Orientation and construction of each LWD jam will be based on site-specific hydraulic and channel conditions.

Compliance and effectiveness monitoring will be implemented for each LWD jam. SCL shall conduct compliance monitoring and will provide documentation to the FAWG and the FERC that the measure has been implemented as specified. Effectiveness monitoring will evaluate the need for LWD jam repair or replenishment and will involve snorkeling to evaluate use of logjams by salmonids and predatory non-salmonids. The procedures for defining and evaluating effectiveness will be determined during implementation planning and approved by the FAWG. In the event that LWD placement is determined to be ineffective, the FAWG will identify and SCL shall implement alternative measures with a commensurate schedule and level of effort.

5.1.3.2. Background Information

Relicensing studies indicate that native and non-native salmonids use tributary deltas during summer to take advantage of coldwater refugia (SCL 2009b). Deltas also serve as transition areas between the reservoir and tributary and must be used by fish moving between these two habitat types. Habitat studies indicated that there are scarce amounts of LWD (e.g., Figure 5.1-3) or other forms of cover in these tributary delta habitats (SCL 2008).

Figure 5.1-3. Downstream view of Sweet Creek in the upper delta area (left) and looking upstream at Sullivan Creek during early September 2007.

5.1.3.3. Procedures

SCL shall conduct implementation planning with final design specifications to be approved by the FAWG. Implementation planning will identify:

- Specific locations for LWD jams at selected deltas;
- LWD jam design specifications for each location; and
- Specific monitoring protocols.

As part of implementation planning, SCL shall identify LWD jam locations and specifications. General locations of LWD jams are depicted in Figures 5.1-4 and 5.1-5; but final selection of target tributaries and design of LWD placement will be developed during post-licensing implementation planning and approved by the FAWG. Construction of the LWD jams will be completed within 10 years following license issuance. Orientation and construction of the LWD jams will be tailored to each individual site, will be based on the specific hydraulic conditions of each location, and will follow WDFW guidelines (WDFW 2003, Saldi-Caromile et al. 2004). Logjams will be built sufficiently high in the delta to minimize their potential use by non-salmonid predators at typical summer flow levels. Construction access for Sullivan and Linton creeks will be from the shoreline, while access to Sweet and Slate creeks will be from floating barge. The schedule for initial construction of the Sullivan Creek delta logjams may be dependent on upstream Mill Pond Dam removal activities. If permitting, landowner permission, or other issues prevent implementation within 10 years after license issuance, SCL will determine, with approval of the FAWG, alternate locations for installing LWD jams, or will identify and implement alternative measures to provide additional cover in the tributary deltas with a commensurate schedule and level of effort.


Figure 5.1-4. Possible areas for LWD placement in the upper deltas of Sullivan (left) and Linton (right) creeks.


Figure 5.1-5. Possible areas for LWD placement in the upper deltas of Sweet (left) and Slate (right) creeks.

All LWD structures will be appropriately anchored through the use of pilings, boulder ballast, and cabling, or other methods to prevent transport of the large wood. Priority will be given to logs with attached root wads. The LWD structures will be maintained according to design criteria through the term of the license.

5.1.3.4. Compliance, Effectiveness, and Adaptive Management

A compliance report will be prepared within one year following implementation or repair of a LWD structure. Protocols for collecting compliance information will be determined during implementation planning with approval of the FAWG. A compliance report will include documentation collected during construction, repair or replenishment of the LWD jam such as survey data, records of purchased materials (LWD pieces, ballast, etc), and photographs of each site before and after LWD jam placement or repair.

Protocols for collecting effectiveness information will be determined during implementation planning with approval of the FAWG. Physical effectiveness monitoring will occur the ninth year following the construction of a structure and at 10 year intervals thereafter. In addition, physical effectiveness monitoring to determine continued compliance with design specifications will occur following major flood events (i.e., flows greater than a flood event having a 25-year recurrence interval). Physical effectiveness monitoring will evaluate the condition of structures and will include a count of the number, size, and condition of the wood pieces in each jam as well as photos. The main purpose of the physical effectiveness monitoring will be to determine if the structure needs repair or replenishment of the logs in the structure. Repair or replenishment of the LWD jams will occur within one year following physical effectiveness monitoring.

Three consecutive years of biological effectiveness monitoring will occur within the first 10 years following construction. Biological effectiveness monitoring will also be conducted concurrent with physical effectiveness monitoring from License Year 10 through the term of the license. The procedures for defining and evaluating effectiveness will be determined during implementation planning with approval of the FAWG. The results of the effectiveness monitoring will be used to support adaptive management and adjustments to the PM&E measure during repair or log replenishment of a structure. Based upon the physical and biological effectiveness monitoring, the FAWG may devise remediation measures within the specified limits (as described in Section 5.1.2.1 Scope) for the repair and log replenishment of the structures.

5.1.3.5. Reporting and Schedule

The reporting and implementation schedule for mainstem large woody debris at tributary deltas is summarized in Table 5.1-4.

5.1.3.6. Consistency with Other Plans

There are no conflicts between this PM&E measure and other resource management plans. The schedule for initial construction of the Sullivan Creek delta logjams may be dependent on upstream Mill Pond Dam removal activities.

Table 5.1-4. Reporting and implementation schedule for mainstem LWD placement at tributary deltas.

PM&E Measure Activity	Schedule
Implementation	Completed within ten years of license issuance, except Sullivan Creek delta which at the direction of the FAWG may be after the tenth year depending on the influence of Mill Pond Dam removal
Compliance Reporting	Within one year following construction, repair or replenishment of LWD structures
Physical Effectiveness Monitoring	In the ninth year following implementation and every 10th year thereafter; and after flows exceeding a 25-year recurrence interval.
Biological Effectiveness Monitoring	Three consecutive years between initial construction and first scheduled repair/replenishment, and then concurrent with physical effectiveness monitoring
Monitoring Report	Within one year following physical or biological effectiveness monitoring

5.1.4. Boundary Reservoir Fish Community Monitoring and Evaluation of Salmonid Predation at Select Tributary Deltas

5.1.4.1. Scope

5.1.4.1.1. Boundary Reservoir Fish Community Monitoring

SCL shall conduct fish community surveys in Boundary Reservoir beginning in year 5 after license issuance and at five-year intervals thereafter. The objective of the surveys will be to monitor changes in fish population abundance and size structure of focal species over time. Focal species will be westslope cutthroat trout, bull trout, mountain whitefish, smallmouth bass, northern pikeminnow, and northern pike and may include other species as identified by the FAWG. Surveys will be at a level of effort commensurate with the reservoir fish survey portion of the McLellan (2001) study. Study planning shall be completed during the calendar year prior to conducting the field surveys and a summary report will be completed within 1 year of completion of the field surveys. The study design, schedule, implementation, and reporting activities shall be developed in consultation with and subject to approval of the FAWG.

5.1.4.1.2. Evaluation of Salmonid Predation at Select Tributary Deltas

SCL shall conduct a study to evaluate predation on outmigrating native salmonids at select tributary deltas. The objective of the study will be to quantify the proportion (percent by number and biomass) of outmigrating native salmonids from select tributaries that are being consumed by predatory fish within the selected tributary deltas, and determine consumption rates of select predators consistent with the general methods described in Baldwin et al. (2003). The level of effort of the Boundary tributary delta predation study will be commensurate with labor efforts expended by researchers in Baldwin et al. 2003. SCL shall conduct the tributary delta predation study during year 4 and year 15 following license issuance. Study planning will be completed during the calendar year prior to conducting the field surveys and a summary report will be completed within 1 year of completion of the field surveys. The study design and implementation schedule will be subject to approval of the FAWG.

5.1.4.2. Background Information

Trend information on fish communities in the Project area is important for resource management agencies so they can identify any necessary changes in management direction. One example of how trend information could be useful relates to the apparent establishment of a northern pike population in Boundary Reservoir. During 2000, McLellan (2001) observed no northern pike in the reservoir, but during relicensing studies conducted in 2007 and 2008 both adult and juvenile northern pike were observed in areas containing suitable spawning habitat. Although northern pike numbers in Boundary Reservoir are currently low, a self-reproducing population has been established in the Pend Oreille River system, and there is the potential for future population increases. If substantial increases in the abundance of introduced predator fish occur in the Project area, they could become a threat to the already uncommon native salmonids and could affect proposed recovery efforts for these species. Trend information could help management agencies in the development of strategies for the recovery of native salmonids and the setting of priorities and schedules for implementing these strategies. Trend information could also be helpful in the adaptive management of PM&E measures being implemented by SCL as part of the new license.

5.1.4.3. Procedures

5.1.4.3.1. Boundary Reservoir Fish Community Monitoring

In consultation with, and subject to approval of the FAWG, SCL shall complete a fish community monitoring study plan in the calendar year prior to each fish community monitoring field season. The reservoir fish community surveys will follow a consistent format to maintain comparability of results over time, but can be modified at the direction of the FAWG. The survey techniques and periods will be appropriate for the focal species and size, and designed to provide precise metrics (e.g., catch-per-unit-effort) that can be analyzed for spatial and temporal trends. Number, species identification, length and weight information shall be collected for all fish sampled in order to allow assessment of size structure (e.g., Proportional Size Distribution). The level of effort of fish community monitoring will be commensurate with the reservoir fisheries surveys component of McLellan (2001); that is, not including the trophic status, reservoir productivity, and tributary assessment components of the McLellan study. Within a year following completion of the surveys SCL will prepare a survey completion report that summarizes the results of the survey effort and will include a discussion of trends in the focal fish species relative to previous surveys.

5.1.4.3.2. Evaluation of Salmonid Predation at Select Tributary Deltas

In consultation with, and subject to approval of the FAWG, SCL shall complete study planning prior to each field season for the tributary delta predation study. The tributary delta predation study will consist of six components that will be implemented at three selected tributaries. The tributaries to be selected for study, the defined delta region for each tributary, and study methods of the six components will be determined during post-license planning and will be subject to approval of the FAWG. The six components will consist of the following:

a. Quantify the abundance of out-migrating native salmonids from the selected tributaries during peak out-migration timing. For example, if peak westslope cutthroat trout out-migration occurs during the first two weeks of July, then the study period would be defined as, and abundance estimates would be needed for, those two weeks as well as a week or two following in case salmonids are not consumed immediately upon their entrance in to the reservoir, yet they stay within the defined tributary delta region. Abundance estimates for native salmonid outmigrants should be determined by juvenile trapping and established methods to relate trap efficiency with discharge and ultimately lead to an estimate of the total number of salmonids migrating to the reservoir during the study period. Biomass will be calculated by applying mass (grams) data to the abundance values. Outmigration abundance estimates will be developed as part of the Entrainment Reduction Years 1-18 Research and Monitoring Study (Section 5.1.4), and will be used to supply the needed information for this component.

b. Predator abundance within the selected tributary deltas will be estimated using mark-recapture methods. Boat electrofishing and horizontal gill nets will be used to collect predators at the mouth of select tributaries. Predator sampling will be conducted within a level of effort commensurate with Baldwin et al. (2003); that is, effort will not exceed nine 8-hour boat electrofishing efforts and not to exceed 73 gill net sets, each gill net set for approximately 6 hours soak time. Sampling design, schedule, and protocol will be developed in consultation with and subject to approval of the FAWG. The objective of this component is to generate reasonable abundance estimates for selected predator species. By reasonable, it is meant that covariance (ratio of the standard error of the estimate to the estimate [SE/N]) must be lower than 0.50. A covariance between 0.25 and 0.50 is considered adequate for the tributary delta predation study. The abundance estimate must occur during the study period and within the selected tributary deltas. Thus, if the study is conducted during peak out-migration then the predator abundance estimate must be generated concurrently. All predators will be marked during the study; however, it is recognized the numbers of marked and/or recaptured fish may be inadequate to obtain reasonable abundance estimates for some predator species that are not commonly found in tributary deltas. The predator abundance estimate must address and evaluate the assumptions used to ensure unbiased estimates.

c. Predator growth rates will be determined from scale analysis of fish captured as part of the reservoir fish community monitoring.

d. Water temperatures will be monitored over the field sampling period using a temperature recorder placed within each selected tributary delta. If appropriate mainstem Boundary reservoir water temperature data are not available from other sources, a water temperature recorder will be placed immediately upstream of the confluence of one of the selected tributary deltas to record mainstem reservoir water temperature. The location and deployment protocol for monitoring water temperature to be used in the bioenergetics model will be developed in collaboration with and subject to approval of the FAWG.

e. Laboratory diet analysis will be conducted on all predator species with reasonable abundance estimates and an adequate sample size of non-empty stomachs. Minimum sample size and stomach content sampling protocols to obtain reasonable estimates of diet proportions will be determined during planning and subject to approval of the FAWG. Stomach contents of predators collected within the defined delta regions will be analyzed in the laboratory using methods similar to those of Baldwin et al. (2003).

f. If native salmonids are a significant proportion of the diet and adequate predator growth information results from sampling, the "Wisconsin" bioenergetics model (Fish Bioenergetics 3.0; Hanson et al. 1997), in collaboration with the FAWG will be used to estimate consumption rate, number, and biomass of native salmonids consumed by predator species with reasonable population estimates in the selected tributary deltas. The model will use site-specific water temperature history, predator growth information, and diet proportions. Literature values will be used for all species-specific metabolic parameters, predator energy density parameters, and diet energy density parameters.

If the results of the investigation identify that a significant proportion of native salmonids are consumed by predators at tributary deltas, potential non-operational measures including predator control could be implemented under the Entrainment Reduction program (Section 5.1.4) to improve native salmonid survival.

5.1.4.4. Compliance, Effectiveness, and Adaptive Management

Compliance with this PM&E measure will be documented via the Survey Completion Reports. There is no effectiveness monitoring associated with this PM&E. Within the limits of the level of effort outlined above, the FAWG has the discretion to modify the study design to achieve objectives.

5.1.4.5. Reporting and Schedule

5.1.4.5.1. Boundary Reservoir Fish Community Monitoring

Unless otherwise directed by the FAWG, the fish community monitoring study will be conducted in year 5 of the new license and at five-year intervals thereafter. Planning for the fish community monitoring study component shall be completed during the calendar year prior to study implementation, and a summary report of field activities will be completed within 1 year of the field surveys. The reporting and implementation schedule for fish community monitoring is summarized in Table 5.1-5.

Table 5.1-5. Reporting and implementation schedule for Boundary Reservoir fish community monitoring.

PM&E Measure Activity	Schedule
Fish community study plan	Within four years of license issuance and every fifth year thereafter
Conduct fisheries survey	In the fifth year following license issuance and every fifth year thereafter
Survey completion report	In the sixth year following license issuance and every fifth year thereafter

5.1.4.5.2. Evaluation of Salmonid Predation at Select Tributary Deltas

The tributary delta predation study will be conducted in year 4 and 15 of the new license unless otherwise directed by the FAWG. A FAWG-approved study plan will be completed during the calendar year prior to study implementation, and a summary report of field activities will be completed within 1 year of the field surveys. The reporting and implementation schedule for biological monitoring is summarized in Table 5.1-6.

Table 5.1-6. Reporting and implementation schedule for the tributary delta salmonid predation study.

PM&E Measure Activity	Schedule
Tributary delta predation planning	By end of calendar year prior to conducting delta predation study
Conduct tributary delta predation study	In the fourth and 15th years following license issuance
Tributary delta predation study report	Within one year following tributary delta predation field surveys

5.1.4.6. Consistency with Other Plans

There are no conflicts between this PM&E measure and other resource management plans prepared for the Project. Outmigration abundance estimates (see component 1 of the predation study) will be developed as part of the Entrainment Reduction Years 1-18 Research and Monitoring Study (Section 5.3.3).

5.2. Upstream Fish Passage

5.2.1. Scope

This PM&E measure shall be governed by License Article 9(B). SCL shall install, operate, maintain and monitor a single upstream trap-and haul fishway facility (upstream fishway, or fishway) in the Boundary Project tailrace. The purpose of this fishway is to provide safe, timely, and effective passage for bull trout, cutthroat trout, and mountain whitefish (target fish species) in the Project area for the license term and any subsequent annual licenses. The fishway will include a fixed entrance(s) and a release location(s) at least one mile upstream of the Boundary

Dam. The release location(s) shall be determined by the FAWG subject to the approval of the USFS, Ecology, and DOI. Provided the fishway is constructed according to a design that has been approved by the FAWG and by the USFS, Ecology, and DOI and is operated consistent with an approved installation, operation and maintenance plan, and subject only to such minor modifications as are described in Section 5.2.3.4 below, the fishway will satisfy all applicable upstream fish passage requirements.

SCL shall design and construct this upstream fishway using the best available scientific information, including but not limited to the NMFS 2008 Anadromous Salmonid Passage Facility Design Manual (Design Manual), taking into account the site specific conditions at the Project, biological information specific to the target species, and other relevant information. In no case shall attraction flows exceed 1,650 cfs (3% of maximum generation discharge). SCL must demonstrate that any departures from the Design Manual will be effective at achieving the purposes of the facility in providing safe, timely and effective passage for target species. The final design will be subject to the approval of the USFS, Ecology, and DOI.

SCL shall undertake a research and development phase of up to 12 years to evaluate the fishway entrance design, entrance location, and attraction flow volumes that will achieve the purposes of the facility. Within 12 years of license issuance (2 planning years, 8 research years and 2 design years), SCL shall file with FERC for approval, a plan to install, operate and maintain an upstream trap and haul fishway. SCL shall complete construction of the upstream fishway within 2 years of receiving FERC approval and shall monitor fishway operations for the term of the license and any annual licenses issued for the Project.

SCL shall work in consultation with the FAWG in all aspects of the fishway development and implementation processes.

5.2.2. Background Information

Boundary Dam was built without fish passage facilities because downstream power and water storage projects, such as Grand Coulee and Chief Joseph dams, blocked anadromous fish migrations to the Upper Columbia Basin. However, declines in populations of the target fish species have increased focus on migrating resident fish. The USFWS Bull Trout Draft Recovery Plan, for example, currently calls for upstream passage at Albeni Falls (USACOE), Box Canyon Dam (POPUD) and Boundary Dam (Seattle City Light).

As part of relicensing activities, SCL and a team of fish passage experts evaluated myriad options for bypassing upstream migrating fish around Boundary Dam. They developed physical, biological and operational criteria to assist in narrowing potential alternatives, eventually settling on fixed and floating trap and haul facilities, and various manual methods, for bypassing fish around the Project.

During subsequent relicensing negotiations, the Parties agreed to the concept of a more traditional trap and haul fishway based on NMFS criteria. A trap and haul facility was determined appropriate due to comparatively low population sizes of native salmonids and physical site constraints in the tailrace. While agreement was reached on the preferred alternative, there was uncertainty regarding an appropriate site within the tailrace for the fixed trap-and-haul facility. In addition, because of the low numbers of native salmonids captured or observed in the Boundary Dam tailrace, there is little direct information from the Project tailrace regarding seasonal movement patterns of bull trout, cutthroat trout, or mountain whitefish.

Consistent with the Design Manual, the process for developing the trap and haul fishway includes an 8-year research and development phase to evaluate site specific conditions and biological traits of the target species in the Project area. With the support of a TAC, the Parties will collaborate throughout the research and development phase to design appropriate studies, evaluate site specific conditions, and integrate information into a final fishway design.

5.2.3. Procedures

5.2.3.1. Fishway Development Plan

Within 2 years of license issuance, SCL shall file with FERC a Fishway Development Plan (FDP) for collecting site-specific biological and engineering information required to site, design, and install the upstream trap and haul fishway. Implementation of the FDP shall continue for up to 8 years. The FDP shall include methods for identifying, among other things:

a. Site-specific hydraulic conditions in the tailrace of Boundary Dam, under all operating scenarios;

b. Proper location of the upstream fishway and entrance(s) given site specific considerations of the Boundary Dam spillway, sluiceway, powerhouse, and tailrace area;

c. Information on swimming performance, behavior, and migratory pattern of target fish species downstream of the dam sufficient to determine the appropriate location of the fishway entrance(s) under all operating scenarios and related environmental cues, including but not limited to temperature, total dissolved gas, water velocity and lighting; fishway attraction effectiveness shall be evaluated using target species from upstream sources or that demonstrate upstream migration behavior;

d. Structures, devices and measures to allow adjustment of the fishway entrance(s) and auxiliary flow as necessary to effectively attract target fish species into the upstream fishway including the influence of cooler attraction flow water if incorporated into the facility;

e. Structures, devices, and measures to allow adjustment of water flow, water velocity and water surface elevations within the upstream fishway as needed to effectively convey target fish species into the fish trapping device;

f. Provisions for counting and evaluating fish passage through the upstream fishway; and

g. Provisions for transport and release of fish upstream of the dam.

Studies conducted pursuant to the FDP will use the most appropriate technology available, including mark and recapture methods, as determined by the FAWG in consultation with a TAC. The TAC will assist SCL and the FAWG with the design of upstream fish passage studies and analysis of study results. Target fish species being evaluated will represent the size distribution of migrating bull trout, cutthroat trout and mountain whitefish in the Project area.

SCL may evaluate prototype facilities within the 8-year FDP implementation phase.

5.2.3.2. Fishway Design and Construction Plan

Within 12 years of license issuance (2 planning years, 8 research years and 2 design years), SCL shall file with FERC for approval, a Fishway Design and Construction Plan (FDCP) to install, operate and maintain an upstream trap and haul fishway at the Boundary Dam. SCL shall complete construction of the upstream fishway within 2 years of receiving FERC approval on the FDCP.

The FDCP shall integrate the site specific and biological information developed during the FDP implementation phase and shall include, but not be limited to: (1) functional design drawings; (2) quantification of flows needed to operate the fishway; (3) a proposed operations and maintenance plan; and (4) a schedule for installing the facilities.

SCL shall develop the fishway design based upon the best available scientific information, including the Design Manual. Any departures from the Design Manual will be considered by the FAWG based on compelling evidence and in consultation with a TAC (see below). SCL must demonstrate that any departures from the Design Manual will be effective at achieving the purposes of the facility in providing safe, timely and effective passage for target species. The final design will be subject to the approval of the USFS, Ecology, and DOI.

The FDCP shall also include, but not be limited to, the fishway location, operational period, design flow range, trap holding pools, crowder and brail systems; sorting and transport provisions; and sample/anesthetic/recovery tanks. The FDCP will include structures, devices and measures to allow adjustment of auxiliary flow at the fishway entrance(s) as necessary to effectively attract target fish species into the upstream fishway.

Within 12 months of initial fishway operation, SCL shall file with FERC a Hydraulic Evaluation Report documenting compliance with all design specifications.

5.2.3.3. Consultation with FAWG

SCL shall develop all plans and the fishway design, and shall conduct all studies in consultation with the FAWG and subject to approval of the USFS, Ecology, and DOI. As described above, SCL shall convene a technical advisory committee (TAC) consisting of fish passage design experts to assist in developing all plans and designs. SCL will select the fish passage design experts in consultation with and subject to approval of the FAWG. The TAC will provide recommendations to the FAWG pertaining to the site, design and installation of the upstream fishway as well as determine whether development of a computational fluid dynamic or physical scale model of the Boundary Dam and appurtenant facilities are necessary. Decisions regarding fish passage design and evaluation are subject to the dispute resolution provision of the SA.

SCL shall allow a minimum of 30 days for the FAWG to comment and make recommendations before filing any designs and plans with FERC. When filing designs and plans, SCL shall include documentation of consultation; copies of comments and recommendations; and specific descriptions of how comments and recommendations were accommodated by SCL. If SCL does not adopt a recommendation from the FAWG, the filing shall include its reasoning based on Project specific information.

Fishway design drawings (including drawings for any prototype or test facilities to be evaluated) shall be provided to the FAWG for review at the 30 percent (functional design), 50 percent and 90 percent completion stage and SCL shall consult with the FAWG at each stage.

5.2.4. Compliance, Effectiveness, and Adaptive Management

Within 13 years of license issuance, SCL shall file a Post Construction Evaluation Plan (PCEP) with FERC. The PCEP shall include methods for documenting fish passage efficiency, passage time, mortality, injury and fallback rates under a representative range of operating scenarios and environmental conditions. Implementation of the PCEP will begin no later than one year following completion of the Hydraulic Evaluation Report (see Section 5.1.3.3.2) and will continue until safe, timely and effective passage is demonstrated over a range of operating conditions within the first five years of operation. SCL shall modify the fishway based on results of the evaluations and reevaluate fishway effectiveness within this time frame and effort, as determined necessary by the FAWG. PCEP implementation costs including evaluation, planning, and study permitting shall not exceed $1,000,000.

The following limitations shall apply:

a. The need for any modifications shall be determined by the FAWG within 5 years of completing the Hydraulic Evaluation Report and shall be based on information collected from the PCEP.

b. For any fishway constructed pursuant to Design Manual criteria (e.g., a fishway that includes attraction flow of 1,650 cfs) and approved by the FAWG and USFS, Ecology, and DOI, SCL shall make minor modifications including permitting, design, and construction for increasing fishway effectiveness within an amount not to exceed 5 percent of facility construction costs.

c. For any fishway that includes departures from the Design Manual, SCL shall make minor modifications including permitting, design, and construction for increasing fishway effectiveness within an amount not to exceed 10 percent of facility construction costs.

Thirteen years after the PCEP evaluations and any required modifications have been completed, the FAWG shall determine the need and scope for reevaluating fishway performance (including fish passage efficiency, passage time, mortality, injury and fallback rates). The evaluations will be conducted under typical project operations. If fishway performance has decreased when compared to the initial PCEP evaluations, SCL shall implement any corrective measures determined necessary by the FAWG to return performance to its previous level.

In addition, SCL shall implement one year fishway performance evaluation(s) at any time during the license term if substantive changes occur in project operations, structures, or tailwater bathymetry (caused, for example, by severe flow events). If performance has decreased when compared to the original PCEP evaluations, SCL shall implement any corrective measures determined necessary by the FAWG to return performance to its previous level.

5.2.5. Reporting and Schedule

As part of the upstream fish passage program, annual reports will be prepared summarizing information related to monitoring, operations, problems encountered, program status and results of activities during the previous 12 months. Once the fishway has been installed and is operational, annual reports will also quantify the number and condition of target fish species captured and transported, and the location of their release. The reports will also document fishway operations including tailrace water surface elevations, tailrace flow levels, fishway attraction flows, hours of fishway operation, and any maintenance or operational issues identified over the year and repairs implemented to resolve the issues.

SCL will provide the annual reports to the FAWG for a 30 day review. Comments and recommendations by the FAWG will be included in the annual report submitted to the FERC along with specific descriptions of how any comments are accommodated in the report. If recommendations are not adopted, the FERC filing will include SCL's explanations based on Project specific information.

The implementation schedule for the upstream passage program is summarized in Table 5.2-1.

Table 5.2-1. Implementation schedule for the upstream passage program.

PM&E Measure Activity	Schedule
Implementation plan	Within two years of license issuance
Fishway design research	In the third through the tenth years following license issuance
Fishway design	In the tenth through the 12th years following license issuance
Fishway design submittal to FERC	Within 12 years of license issuance
Fishway construction	Within two years of receiving FERC approval of fishway design
Fishway operation	Within two years of receiving FERC approval of fishway design
Status Report	Annually following license issuance

5.2.6. Consistency with Other Plans

There are no conflicts between this PM&E measure and other resource management plans prepared for the Project. Fish collection, transport, and release protocols will be consistent with management objectives developed by the USFS, Ecology, and DOI.

5.3. Reduction of Project Related Entrainment Mortality

5.3.1. Scope

This PM&E measure shall be governed by License Article (9C). To address Project entrainment, the following section describes a program to be implemented by SCL over the license term. Successful implementation of this program shall fully mitigate for the effects of entrainment on target species (bull trout[2], westslope cutthroat trout, and mountain whitefish) by either: (1) preventing entrainment at the Project; (2) reducing entrainment at the Project and mitigating for the remaining effects; or (3) fully mitigating for the effects of entrainment through other measures. The decision as to whether entrainment is best addressed through options 1, 2 or 3 as defined above, will be made by the FAWG based on site specific information developed under this program. SCL shall work collaboratively with the FAWG in all aspects of this program and all decisions made by SCL and the FAWG are subject to the approval of the USFS, Ecology, and DOI.

In Years 1-18, SCL shall develop and implement studies sufficient to quantify the effects of entrainment on target species and to determine whether any population of target fish species (i.e., a unique population that constitutes a substantial percentage of fish in the Project area or that has a unique evolutionary niche that requires special protection) or a substantial number of target fish are affected by Project entrainment. At the conclusion of the evaluation phase, the FAWG will determine whether a population of target species or a substantial number of target fish are affected by Project entrainment. This 18 year evaluation phase shall not exceed $23,000,000 (23 million dollars).

Starting in Year 19, if entrainment reduction measures are determined to be necessary, SCL shall make available up to an additional $47,000,000 (47 million dollars) through year 33 (plus any unexpended funds from the $23,000,000 allocated for studies during the 18 year evaluation phase) to either build facilities at the Project to improve Boundary Dam survival of target species or implement appropriate non-operational measures to improve survival of target species. The decision matrix is more fully defined in the Procedures section of this measure (Section 5.1.4.3). If a population or a substantial number of target species continue to be affected by year 34, SCL shall construct new facilities at the Project, expand existing facilities or implement operational changes to improve survival of target species as more fully explained in Section 5.1.4.3.

[2] Any reasonable and prudent alternatives or measures necessary to minimize the take of bull trout, that may be required by the USFWS pursuant to the Endangered Species Act, will be developed consistent with the Boundary SA to the maximum extent possible.

5.3.2. Background Information

Boundary Dam was built without entrainment reduction facilities. However, declines in native resident salmonid populations have placed increased emphasis on protection of migrating fish. If fish pass downstream through Boundary Dam facilities, they are exposed to potential injury and mortality, with the level of mortality depending on the pathway, flow rate, and size of fish. As part of relicensing activities, estimated ranges of fish mortality for existing entrainment routes at Boundary Dam were developed in collaboration with relicensing participants. Based on a review of available literature and turbine survival modeling (R2 2006), fish passage mortality through the existing turbines at Boundary Dam was estimated to vary with the turbine units and fish size (Table 5.3-1).

Table 5.3-1. Relationship between fish size and estimated turbine mortality at Boundary Dam.

Fish Size (Inch/mm)	Turbine Units 51-54	Turbine Units 55-56
4" (100 mm)	6 to 15%	5 to 12%
10" (250 mm)	13 to 33%	11 to 28%
24" (600 mm)	26 to 65%	23 to 59%

In general, smaller fish are anticipated to have the lowest turbine mortality (5% to 15%), while turbine mortality is expected to increase with fish size (i.e., 23% to 65% for larger fish).

Fish injury and mortality through Boundary Dam also depends on the passage route. Fish primarily pass downstream through the turbines, but may pass downstream through spillways or sluiceways when flow releases exceed turbine capacity (during the period 1987 through 2006, for example, spill occurred an average of 578 hours a year). Fish size, location that they are entrained in the water column, and tailrace conditions will all affect injury and mortality.

As part of relicensing activities, a team of fish passage experts evaluated entrainment reduction concepts at Boundary Dam including:

- Floating Surface Collector;
- Fixed Surface Collector;
- Fixed Full Flow Screen;
- Modular Inclined Screen (MIS);
- Eicher Screen;
- Screw Trap/Inclined Screen at Z Canyon;
- Skimmer Gate modifications; and
- Spillway Gate modifications.

During the initial brainstorming effort, criteria were developed to assist in evaluating entrainment reduction concepts. These criteria were selected to represent the range of physical, biological, and operational variables to be considered in estimating the overall effectiveness of potential entrainment reduction concepts.

The results of the evaluation determined that a floating surface collector concept would provide the most flexibility and potentially the highest incremental increase in fish protection. However, the estimated incremental increase in survival was 0 to 2 percent for 4-inch fish, -1 to 9 percent for 10-inch fish, and 8 to 21 percent for 24-inch fish (McMillen 2009). Since little is known about the migration depth of bull trout, westslope cutthroat trout, and mountain whitefish, the efficacy of a floating surface collector concept to reduce entrainment of the target species is uncertain.

Due to uncertainty regarding the effects of entrainment on target fish populations, and uncertainty regarding the efficacy of available entrainment reduction options, the entrainment reduction program includes an evaluation phase to assess the effects of Project entrainment on target species.

5.3.3. Procedures

All studies shall follow best available science and shall use the most appropriate techniques available at the time of the study. Studies shall be designed to achieve a high level of statistical rigor and precision, in consideration of fish available for study, satisfactory to the FAWG. If requested by the FAWG, SCL shall acquire the assistance of technical experts experienced in salmonid population theory, structure, and dynamics.

Efforts to evaluate and mitigate for Project entrainment will be conducted by SCL pursuant to the following post-licensing schedule:

a. Years 1-2: Peer reviewed development of Fish Behavior and Population Study Plan. Studies shall be developed by SCL, in consultation with the FAWG and subject to the approval of the USFS, Ecology, and DOI, as necessary to determine the swimming performance, behavior, and migratory pattern of target fish species in the Project area. In addition, studies shall be designed to provide sufficient information to determine whether any population of the target species or a substantial number of target fish are affected by Project entrainment and to determine the appropriate location of any entrainment reduction facilities that may be needed in the future. Studies will also quantify the abundance of outmigrating native salmonids from selected Boundary Reservoir tributaries.

b. Years 3-15: SCL shall implement the Fish Behavior and Population Study Plan. SCL in consultation with the FAWG shall review the plan every 3 years and shall make modifications to the study plan as appropriate based on data collection results. SCL shall prepare annual reports in consultation with the FAWG, and shall file final reports with FERC.

   Prior to year 16, SCL shall, in consultation with the FAWG and subject to approval of the USFS, Ecology, and DOI, develop a Dam Passage Survival study plan to be implemented in years 16 – 18 of license issuance. Dam survival shall be calculated as the survival of target species passing through the Boundary powerhouse, sluiceways and spillways. The study plan shall be developed under the guidance of a Technical Advisory Committee (TAC) that includes regional fish passage experts and shall use the most appropriate techniques available at the time of the study. SCL will select the fish passage experts in consultation with and subject to approval of the FAWG. The study plan shall be designed to achieve a high level of statistical rigor and precision, in consideration of fish available for study, satisfactory to the FAWG.

SCL shall also, in consultation with the FAWG and subject to approval of the USFS, Ecology, and DOI; design a study plan to assess hydraulic conditions in the Boundary Dam forebay under all Project operations. The study plan shall include field measurements and may require development of a computational fluid dynamic, or physical scale model of the Boundary Dam and appurtenant facilities and shall be developed under the guidance of the TAC. This study plan will support the development of dam passage survival estimates under a wide range of operating scenarios and environmental conditions, and will assist in the development of entrainment reduction facilities if needed.

c. Years 16-18: SCL shall implement the Dam Passage Survival and Forebay Hydraulic studies.

d. Year 18 Decision Point: The FAWG shall determine, based on information developed during the evaluation phase, whether a population (i.e., a unique population that constitutes a substantial percentage of fish in the Project area or that has a unique evolutionary niche that requires special protection) or a substantial number of target fish, continue to be affected by Project entrainment. A decision on downstream entrainment measures will be made at the conclusion of the evaluation phase by the FAWG in consultation with the TAC and subject to the approval of the appropriate agencies.

e. Years 19-33: Starting in Year 19, if entrainment reduction measures are determined to be necessary at the year 18 decision point based on Project specific information, SCL shall make available up to an additional $47,000,000 (47 million dollars) through year 33 (plus any unexpended funds from the $23,000,000 allocated for the Years 1-18 Fish Behavior and Population Study) to take one of the following actions.

   i. If Boundary Dam survival of target species > 4 inches is less than 60 percent, SCL shall design, build, operate, maintain, monitor, and, as needed, modify facilities to improve Boundary Dam survival of target species. Facilities shall be developed in consultation with the FAWG and the TAC, and shall be subject to approval of the USFS, Ecology, and DOI.

   The licensee shall file a plan for installation, operation, maintenance, and evaluation of the facilities with the Commission for approval within two years of the License Year 18 Decision Point. Facility designs shall include, but are not limited to: (1) functional design drawings of the facilities, (2) a preliminary operations and maintenance plan, (3) a schedule for installing the facilities, (4) a post construction evaluation plan, and (5) provisions for short and long-term monitoring and adaptive management.

   ii. If Boundary Dam survival of target species > 4 inches is greater than 60 percent, SCL shall implement non-operational measures to improve Project survival commensurate with the Project's effects on a target species. Non-operational measures shall be identified, prioritized, implemented and monitored by SCL in consultation with the FAWG and subject to approval of the USFS, Ecology, and DOI. The licensee shall submit a plan and schedule for implementing these measures within one year of the License Year 18 Decision Point.

f. Year 34 Re-evaluation of Project Entrainment Effects: Based upon the monitoring conducted by SCL between years 19-33, the FAWG in consultation with the TAC, shall re-evaluate information regarding Project entrainment effects; that is, the FAWG shall determine whether a population or a substantial number of target fish continue to be affected by Project entrainment. Based upon the results of the re-evaluation, SCL shall take one of the following actions.

   i. If Boundary Dam survival of target species > 4 inches is less than 60 percent, SCL will construct a new facility, expand the existing facility, or make operational changes to improve Boundary Dam survival only if it has been determined by the FAWG, in consultation with the TAC and subject to the approval of the appropriate agencies that (1) a population (i.e., a unique population that constitutes a substantial percentage of fish in the Project area or that has a unique evolutionary niche that requires special protection) or a substantial number of target fish, continue to be affected by Project entrainment; and (2) the proposed facility or operational change has a high likelihood of reducing entrainment effects on a unique population or a substantial number of target fish. Any facility will be developed by SCL in consultation with the FAWG and the TAC and shall be subject to approval of the USFS, Ecology, and DOI. The FAWG may determine that continuing Project effects are better addressed through alternative forms of mitigation that shall be implemented by SCL at a level of effort commensurate with the Project's effects on a target species (i.e., on a unique population or a substantial number of target fish).

   If a new facility or expansion of an existing facility is required, the licensee shall file a plan for the installation, operation, maintenance, and evaluation of the facilities with the Commission for approval within two years of the License Year 34 Decision Point. Facility designs shall include, but are not limited to: (1) functional design drawings of the proposed facilities, (2) a preliminary operations and maintenance plan, (3) a schedule for installing the facilities, (4) a post construction evaluation plan, and (4) provisions for short and long-term monitoring and adaptive management.

   If operational changes are determined appropriate, the licensee in consultation with the FAWG and subject to the approval of DOI, USFS, and Ecology, shall file a plan for timing, frequency, and magnitude of proposed operational changes within two years of the License Year 34 Decision Point. Any operational changes would not be implemented until they received Commission approval.

   ii. If Boundary Dam survival of target species > 4 inches is greater than 60 percent, SCL will implement new or continuing non-operational measures as needed to address Project effects with a level of effort commensurate with the

Project's effects on a unique population or a substantial number of target fish. Such non-operational measures shall be determined in consultation with the FAWG and subject to the approval of the USFS, Ecology, and DOI.

If at any time during this process, SCL is required to develop entrainment reduction facilities, design drawings shall be provided to the FAWG for review at the 30 percent (functional design), 50 percent, and 90 percent completion stage and SCL shall consult with the FAWG at each stage. SCL shall allow a minimum of 30 days for the FAWG to comment and make recommendations before filing any designs and plans with the FERC. When filing designs and plans, SCL shall include documentation of consultation; copies of comments and recommendations; and specific descriptions of how comments and recommendations were accommodated by SCL. If SCL does not adopt a recommendation from the FAWG, the filing shall include its reasoning based on Project specific information.

5.3.4. Compliance, Effectiveness, and Adaptive Management

Compliance with this entrainment reduction program will be documented by SCL in annual reports describing program activities conducted during the previous year. If entrainment reduction facilities are constructed, a hydraulic evaluation report will be completed within 12 months of initial facility operation. The hydraulic evaluation report will be submitted to the FAWG and will identify compliance with design specifications. Provisions for short and long term monitoring, and provisions for modifying the facility as needed to achieve the design parameters will be developed in consultation with the FAWG and subject to approval of the USFS, Ecology, and DOI.

5.3.5. Reporting and Schedule

As part of the entrainment reduction program, annual reports will be prepared summarizing information related to study design, monitoring, operations, problems encountered, program status and results of activities during the previous 12 months. If an entrainment reduction facility is constructed, the annual report will quantify the number and condition of target fish species captured and transported and the location of their release. It will also document operations including forebay flow and water surface elevations, facility flows, hours of facility operation, and any maintenance or operational issues identified over the year and repairs implemented to resolve issues. SCL will provide the annual reports to the FAWG for a 30 day review. Comments and recommendations by the FAWG will be included in the annual reports submitted to the FERC along with specific descriptions of how any comments were accommodated in the report. If recommendations are not adopted, the FERC filing will include SCL's explanations based on Project specific information.

The implementation schedule for the entrainment reduction program is summarized in Table 5.3-2.

Table 5.3-2. Implementation schedule for the entrainment reduction program.

PM&E Measure Activity	Schedule
Research and monitoring study plan and initiation of study components	Within two years of license issuance
Conduct research and monitoring	In the third through 15th years following license issuance
Calculate dam survival	In the 16th through 18th years following license issuance
Hydraulic evaluations and conceptual facility design	In the 16th through 18th years following license issuance
Entrainment reduction measure decision	In the 18th year following license issuance
Implement non-operational measures or Design, build, operate, monitor and modify facilities	In the 19th through 33rd years following license issuance
Re-evaluate project entrainment	In the 34th year following license issuance
Implement non-operational measures or Construct new facility, expand existing facility, or implement operational measures	Beginning in the 34th year following license issuance and thereafter through remaining license term
Status Report	Annually following license issuance

5.3.6. Consistency with Other Plans

There are no conflicts between this PM&E measure and other resource management plans prepared for the Project.

5.4. Tributary Fish Community and Aquatic Habitat Measures

5.4.1. Introduction

The objective of the tributary aquatic habitat program is to establish self-sustaining, naturally reproducing native stocks of fish, provide access to, and improve the habitat condition and function of tributaries draining to Boundary Reservoir to offset an estimated 304 acres of reservoir habitat affected by the Boundary Project. This section describes nine PM&E measures to be implemented as part of this program. Each of the measures is designed to improve aquatic habitat, reduce on-going impacts to aquatic habitat, or improve access to aquatic habitat for native salmonids. Implementation of the measures is spread out over the first 25 years following issuance of a new license with a specific schedule to be determined as part of post-license planning and subject to approval of the FAWG. Within 12 months of license issuance SCL shall submit to the FERC an integrated schedule that has been approved by the FAWG for the completion of the nine tributary aquatic habitat PM&E measures described in this section. The integrated schedule shall prioritize the measures and include milestones for completing the environmental analysis, design, consultation, regulatory review, permitting, and construction for each measure. The integrated schedule will also coordinate with the schedules of other inter-related PM&E measures that could affect their potential effectiveness.

As part of the process for developing an integrated schedule, SCL in consultation with the FAWG shall develop a Tributary Management Plan (TMP) that will include a subsection for each tributary where PM&E measures will be implemented. The TMP is an extension of the FAMP that will provide additional details and a coordinated approach for attaining the over-arching goals, objectives, and direction for treatments to be implemented in tributaries to Boundary Reservoir. The TMP will have a number of objectives:

- Establish an appropriate target fish population size and species for each tributary;
- Establish an appropriate habitat condition objective for each tributary;
- Compile and summarize the available reach-specific tributary habitat and fish community information;
- Coordinate treatments to be implemented in each tributary; and
- Conduct the planning needed for preparation of the integrated schedule.

One objective of the TMP is to ensure that treatments are coordinated, sequenced and complementary to the overall objective for that tributary or other tributaries, and scheduled appropriately. The suite of treatments that could be applied to a tributary will derive from a variety of PM&E measures that may include among other things:

- Non-native trout suppression and eradication;
- Native salmonid outplanting;
- Genetic testing of native salmonids;
- Studies to evaluate the numbers and timing of native salmonid outmigration;
- Studies to evaluate the numbers and biomass of outmigrating native salmonids lost to predation in tributary deltas;
- Channel restoration and stabilization;
- Riparian improvement;
- LWD and LWD jam placement;
- Native salmonid habitat improvement;
- Culvert removal or replacement; and
- Road improvements to reduce sediment delivery to streams.

The appropriate scale (e.g., each length or location) and timing for the implementation of treatments will be described in the TMP for each tributary. For instance, removal of culverts that block tributary access might be scheduled to occur after brook trout suppression efforts in order to reduce the risk of brook trout recolonization. Another example is consideration of the timing for habitat improvements in Sullivan Creek downstream of Mill Pond Dam relative to Mill Pond Dam removal efforts.

The specific treatments to be conducted in tributaries will be determined by, and subject to, the approval of the FAWG and based upon the FAMP, the TMP, and the site-specific plans to be developed for implementing the PM&E measures. One of the major objectives of the TMP is to coordinate these activities with a high level of detail, including site-specific conceptual plans, for activities conducted in Years 1-10 of the license, so there is an efficient use of effort and high likelihood that implemented measures will be successful. Coordination will also occur with any other watershed restoration and management efforts being conducted in the tributaries by federal, state, tribal, local, and non-governmental organizations.

The FAWG will have a minimum of 30 days to review and approve the integrated schedule and TMP prior to submission to the FERC. It is anticipated that the TMP will be periodically updated or appended with new information on tributary habitat and fish community information that becomes available, as determined necessary by the FAWG. A formal update to the TMP will occur at 10 year intervals following license issuance.

Scheduled measures to be implemented will be reviewed annually with the FAWG to allow the opportunity to recommend any desired changes in the upcoming year's efforts, including identifying possible replacement measures. Following FAWG approval of the implementation schedule, SCL shall develop specific plans, permitting, and environmental reviews according to the schedule, including any updated milestones.

The following summarizes the requirements pertaining to all tributary habitat and suppression and eradication PM&Es and follows the general planning process in Figure 5.4-1. Requirements for the decision making process and dispute resolution are provided in the Boundary SA Section 8.2 and Section 9.

SCL shall develop specific plans for each measure pursuant to the integrated schedule described above. Each plan shall include specific goals, objectives, cost estimates, anticipated restoration techniques, maintenance requirements, and monitoring plans and methods. Specific, measureable, success criteria shall also be developed by SCL in consultation and subject to approval by the FAWG and included for each measure in this plan. For each measure that includes a construction component, the plan will include final construction drawings. Where applicable, measures should be addressed on a programmatic basis.

SCL shall develop all site-specific implementation plans in consultation with the FAWG and subject to approval of the USFS, WDFW, and Ecology depending upon specific jurisdiction. Collaboration will also occur with permitting agencies to ensure that required Best Management Practices and other measures, such as timing restrictions, required to obtain permits are incorporated in the plans. For PM&E measures to be implemented on NFS lands, plans will include sufficient information for SCL to conduct any required NEPA analysis on behalf of the USFS. SCL shall allow a minimum of 30 days for the FAWG to comment and make recommendations on the PM&E measure implementation plans.

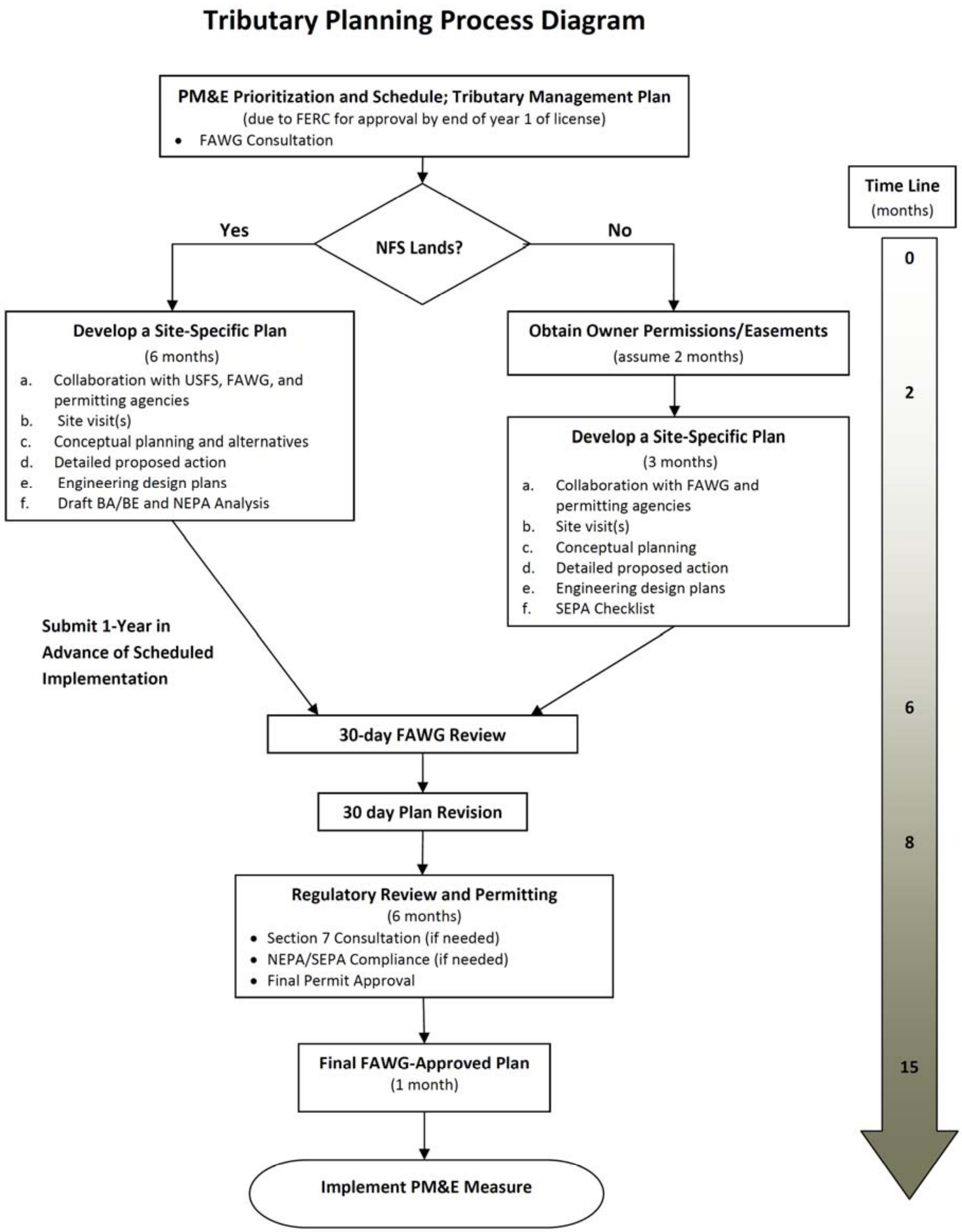


Figure 5.4-1. Tributary Planning Process.

Site specific implementation plans will be attached to the annual reports filed with the FERC. Among other things, annual reports will include a summary of actions implemented during the previous calendar year, a summary of the actions SCL plans to implement for the current calendar year, and a summary of ongoing planning efforts for measures to be implemented in out-years. When submitting an annual report, SCL shall include documentation of consultation; copies of comments and recommendations; and specific descriptions of how comments and recommendations were accommodated by SCL. If SCL does not adopt a recommendation, the annual report shall include their reasoning based on Project specific information. If SCL files a plan without obtaining necessary agency approvals, they shall include specific reasons for doing so.

Most tributary PM&E measures will require landowner permission or one or more permits in addition to FAWG approval to be implemented. Despite SCL's best efforts, a tributary measure or portion of a tributary measure may not be implemented because of the inability to obtain landowner permission or a needed permit, or because initial implementation of a measure suggests the benefits to native salmonids will be less than anticipated. With a few exceptions, which will be described in the specific PM&E measures below, if a tributary PM&E measure, or a portion of a measure cannot be implemented or is determined to be ineffective, any unallocated funds can be redirected to other PM&E measures to be implemented in tributaries to Boundary Reservoir. Reallocation of a PM&E measure's funds will require the approval of the FAWG. The process for reallocating funds will be as follows:

1) The FAWG will determine the amount of funds that would have been spent for the remaining portions of a PM&E measure.

2) SCL shall track the total amount of funds available for reallocation from all unapproved portions of tributary PM&E measures. SCL shall also track the amount of funds spend on alternative PM&E measures. As part of the comprehensive Settlement Agreement an escalation factor will be applied to funds that cannot be immediately reallocated to an alternative measure.

3) Alternative PM&E measures must be implemented in tributaries to Boundary Reservoir.

4) Reallocation of funds will be determined by the FAWG for alternatives analysis, planning, surveys, NEPA/SEPA activity, permitting and design efforts, and for implementing, monitoring, and maintaining alternative PM&E measures.

5) The process for determining the reallocation of funds will be developed by the FAWG and include at a minimum:
    - Identification of resource objectives
    - Evaluation of measures to achieve resource objectives
    - Documentation that the work to be funded is likely to achieve agreed upon resource objectives
    - A schedule for implementation

- Proper documentation in support of any disbursements (including qualifications of proposed recipients and requirements relating to accounting for expenditures).

6) Alternative PM&E measures must be used to protect and/or enhance native fish populations or their habitat. Alternative PM&E measures may expand the level of effort or spatial extents of an existing PM&E measure or may be new PM&E measures that include one or more of the following activities:
   - Riparian planting
   - Streambank stabilization
   - LWD placement
   - Large boulder placement
   - Non-native fish suppression/eradication
   - Conservation easements
   - Culvert replacement
   - Reduction of sediment delivery to a stream (e.g., landslide control or road improvements)

Additional planning details specific to each PM&E measure are provided in their respective subsections below and, with the exception of non-native trout suppression and eradication, shall be governed by License Article 9(E).

5.4.2. Tributary Non-native Trout Suppression and Eradication

5.4.2.1. Scope

This PM&E measure shall be governed by License Article 9(D). SCL shall implement non-native trout suppression or eradication activities in portions of 23 Boundary watershed waterbodies following the schedule identified in Table 5.4-1. Within 12 months of license issuance SCL shall submit to the FERC an integrated schedule that has been approved by the FAWG for the completion of non-native fish suppression and eradication activities that is coordinated with tributary enhancement activities and native trout supplementation activities (Section 5.6). The integrated schedule shall prioritize activities and include milestones for completing the design, consultation, regulatory review, permitting, and implementation. The general schedule identified in Table 5.4-1 will guide the specific integrated schedule to be filed with the FERC.

The type of treatment, number of treatment miles, and treatment schedule in Table 5.4-1 identifies the total treatment effort to be expended during implementation of this PM&E measure. Suppression and eradication treatments include associated permitting and monitoring activities. As part of post-license monitoring and adaptive management, SCL in collaboration with and subject to approval of the FAWG, may reallocate suppression and eradication effort provided the total level of effort is commensurate with activities described in Table 5.4-1. The level of effort for suppression may vary among stream reaches but will be consistent with an average of six electrofishing efforts per reach every 10 years from the start of implementation through the remaining term of the license. Each effort will consist of one to three electrofishing passes to be determined during post-license planning and approved by the FAWG. Eradication of non-native salmonids will be consistent with a level of effort associated with three chemical treatment applications assuming the use of antimycin, rotenone or an equivalent fish toxicant.

Table 5.4-1. Boundary watershed waterbodies identified for suppression or eradication activities.

Waterbody	Schedule (License Year)	Anticipated Action[1]	Treatment Miles[1]	Comment
Sullivan Cr	1-10	Suppression	15.0	All of mainstem
Outlet Cr	1-10	Suppression	0.5	
NF Sullivan Cr	1-10	Suppression	0.3	To NF Sullivan Dam
Pass Cr	1-10	Suppression	0.5	Lowest reach
Rainy Cr	1-10	Suppression	0.1	
Thor Cr	1-10	Eradication	0.2	Mouth to FS Rd 300
Kinyon Cr	1-10	Suppression	0.2	Mouth to Sullivan Cr Rd
Gypsy Cr	1-10	Suppression	0.1	
Copper Cr	1-10	Suppression	0.1	
Deemer Cr	1-10	Suppression	0.5	
Leola Cr	1-10	Suppression	0.1	
Stony Cr	1-10	Suppression	0.5	
Johns Cr	1-10	Suppression	0.3	
Mankato Cr	1-10	Eradication	0.1	
Fireline Cr	1-10	Eradication	0.1	
Sweet Cr	1-20	Eradication	3.0	All of watershed (except Lunch Cr)
Slate Cr	11-15	Suppression	6.5	All of mainstem
Uncas Gulch	11-15	Suppression	2.0	All of tributary
Flume Cr	11-15	Eradication	6.2	All of mainstem
Pewee Cr	16-20	Suppression	1.8	All of watershed
Lime Cr	16-20	Eradication	1.5	All of watershed
Lake Lucerne	16-20	Eradication		
Sand Cr	16-20	Eradication	0.3	Mouth to County Rd 3669
Tier 2 Tribs	20-25	Eradication	See Section 3.4 [2]	

1) At the direction of the FAWG, suppression or eradication treatments may be adjusted as part of post-license monitoring and adaptive management provided the total level of effort is consistent with Table 5.4-1.

2) Tier 2 tributaries are defined as all tributary reaches identified in Relicensing Study 14: Assessment of Factors Affecting Aquatic Productivity in Tributary Habitats (SCL 2004a) that were not categorized as primary restoration opportunities.

5.4.2.2. Background Information

Most of the tributaries to the Pend Oreille River, including Boundary Reservoir, have been stocked with non-native salmonid species such as brook trout, brown trout, and rainbow trout (McLellan 2001). The presence of nonnative trout, especially brook trout, has been identified 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.

Sullivan Creek and Slate Creek have been identified as streams important to the recovery of bull trout in the Northwest Recovery Unit and reduction of non-native fish species as a priority action (POSRT 2005). Surveys by McLellan (2001), R2 Resource Consultants (1998), and the USFS (1998) have documented the presence of 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 sampled 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 trout stocks, but the small sample size and lack of a baseline genetic library from nearby native redband trout populations precluded comparisons and, therefore, unequivocal conclusions (Small and Von Bargen 2009). A variety of non-native species are also present in Sullivan Creek, particularly downstream of Sullivan Lake. In addition to brook trout and rainbow trout, brown trout and kokanee are also present downstream of Sullivan Lake.

5.4.2.3. Procedures

As described in Section 5.4.1, within 12 months of license issuance SCL shall submit to the FERC an integrated schedule that has been approved by the FAWG for the completion of non-native fish suppression and eradication measures described in this section of the FAMP. The integrated schedule shall prioritize the measures and include milestones for completing the design, consultation, regulatory review, permitting, and implementation of suppression and eradication activities. Scheduled activities will be reviewed annually with the FAWG to allow the opportunity to recommend any desired changes in the upcoming year's efforts, including identifying possible replacement suppression and eradication measures. Following FAWG approval of the implementation measures, SCL shall proceed with the development of specific plans, permitting and environmental reviews according to the schedule, including any updated milestones.

Backpack electrofishing will be the technique used to capture non-native salmonids (primarily brook trout) during suppression efforts. All non-native and cutthroat trout, or an appropriate subsample as determined by the FAWG, will be identified, weighed, and measured, and scale samples will be taken from each fish. Any other incidentally captured fish or aquatic organisms will be released unharmed near its capture location. Details of the suppression program, including the disposition of captured non-native trout, will be determined during post-license planning subject to approval of the FAWG. The level of effort for this PM&E measure (up to 3 passes, average of 6 times per 10 years for the miles of stream identified) is based on the recommendations of Peterson et al. (2008) that electrofishing suppression of brook trout involve a cycle of three consecutive years of removal, followed by no more than two years of no suppression to achieve substantial benefits to cutthroat trout. Furthermore, the modeling by Peterson et al. (2008) suggested that a single pass of electrofishing was generally more cost effective than a double pass, unless habitat conditions made efficient electrofishing difficult, or brook trout immigration rates were high. Sheppard and Nelson (2004) recommend conducting at least six removal treatments of two to three passes per treatment within two to three years, targeting mature adults during the first year, trampling nonnative redds, conducting at least one removal during late fall or early winter period, and eradicating adults first, then focusing on the smaller fish (age-0 and age-1). Sheppard and Nelson (2004) also recommended that fish barriers be installed at lower boundaries of treatment areas to prevent re-invasion of nonnative fish. During implementation planning, the FAWG may direct SCL to conduct suppression using a different on/off cycle, vary the number electrofishing passes up to 3 passes, or strategically select the scheduling of subreaches. However, the overall level of effort will not exceed up to 3 passes, an average of 6 times per 10 years for the miles of stream identified.

Eradication efforts will use a chemical toxicant such as antimycin or rotenone. Details of the suppression program, including the specific chemicals to be used, their concentration, and the number of treatment and detoxification stations will be determined during post-license planning subject to approval of the FAWG.

5.4.2.4. Compliance, Effectiveness, and Adaptive Management

Non-native salmonid eradication and suppression will be adaptively managed in consultation with and subject to FAWG approval based on reach-specific conditions and objectives. Compliance will be documented in annual reports. The annual reports will describe the activities relating to non-native salmonid eradication and suppression that were completed during the year and identify any variances from the study plan. Variances will be discussed with the FAWG as well as any needed modifications to the plan for the following year.

Peterson et al. (2008) based their suppression model and management recommendations on demographic parameters (e.g., fecundity, age of maturity, annual survival, immigration etc.) for populations of brook and cutthroat trout they studied in headwater streams of Colorado. Because of the sensitivity of their model to these demographic parameters, they also recommended that monitoring was important for fine-tuning a suppression program. Because the frequency of and scope of electrofishing effort for suppression activities is relatively high in the proposed waterbodies, no additional monitoring effort is proposed. However, as part of post-license planning the FAWG may determine methods for assessing effectiveness from the catch information collected as part of the suppression activities.

For effectiveness monitoring and adaptive management of eradication activities, a 328-foot segment will be delineated per mile of stream treated and designated as a monitoring reach. If less than one mile of stream will be treated, the monitoring segment will be at least 164 feet in length. Each treatment reach will have at least one monitoring reach to be sampled within one year following each treatment. The distribution of the monitoring reaches and specific fish handling protocols will be determined as part of post-license planning and subject to approval of the FAWG. SCL anticipates that blocking nets will be placed above and below each monitoring reach and three complete electrofishing passes will be conducted in the year following treatment to obtain an estimate of non-native trout and cutthroat trout population size (if supplementation occurs) and will allow an evaluation of the effectiveness of the eradication treatment under the prevalent stream conditions. All non-native and cutthroat trout, or an appropriate subsample as determined by the FAWG, will be identified, weighed, and measured, and scale samples will be taken from each fish. Results of the monitoring will be used to revise future eradication efforts.

5.4.2.5. Reporting and Schedule

The reporting and implementation schedule for non-native trout suppression and eradication is summarized in Table 5.4-2.

Table 5.4-2. Reporting and implementation schedule for the non-native trout suppression program.

PM&E Measure Activity	Schedule
Implementation Schedule	Within one year of license issuance
Implementation Planning	One to two years in advance of the scheduled implementation year for each waterbody
Implementation in Sullivan Creek and Tributaries	Begins within one to ten years of license issuance
Implementation in Sweet Creek	Begins within 20 years of license issuance
Implementation in Slate Creek, Uncas Gulch, and Flume Creek	Begins within 11 to 15 years of license issuance
Implementation in Pewee Creek, Lime Creek, Lake Lucerne, and Sand Creek	Begins within 16 to 20 years of license issuance
Annual Reports	Following each year suppression or eradication efforts occur
Eradication effectiveness monitoring and reporting	Within one year following treatment activities

5.4.2.6. Consistency with Other Plans

There are no conflicts between this PM&E measure and other resource management plans prepared for the Project. The schedule for implementing non-native trout suppression and eradication measures will be coordinated with tributary habitat enhancement measures described in the remainder of Section 5.4.

5.4.3. Riparian Improvement and Stream Channel Enhancement in Sullivan Creek RM 0.30 to RM 0.54

5.4.3.1. Scope

This PM&E measure shall be governed by License Article 9(E). This measure has two components to be implemented in Sullivan Creek from RM 0.30 to RM 0.54 (downstream of the Highway 31 Bridge and Sullivan Creek Hydroelectric Project boundary). The riparian improvement and stream channel enhancement to be completed within 10 years after license issuance are described separately. The schedule for implementation of these activities may be dependent on upstream Mill Pond Dam removal activities. If permitting, landowner permission, or other issues prevent implementation of this measure over portions of the reach within 10 years after license issuance, funds equivalent to what would have been expended will be allocated to other tributary PM&E measures as determined in consultation with the FAWG and subject to the approval of the USFS if they occur on NFS lands.

5.4.3.1.1. Riparian Improvement

The objective of this component is to implement riparian improvements along the left bank for up to 1,200 feet of stream to improve riparian functions (shade, potential instream LWD, and erosion control). Activities in some sections of the reach would depend on obtaining easements from non-SCL landowners. Selection of specific plant species and planting locations will be determined as part of post-license planning and design work to be approved by the FAWG 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.

5.4.3.1.2. Stream Channel Enhancement

The objective of this component will be to improve instream spawning and rearing habitat and channel conditions along 1,200 feet of stream by LWD placement (15 to 20 pieces), large boulder placement (5 to 10 boulders), and channel modification. Addition of structural elements will contribute to pool formation, retention of LWD, and retention of coarse sediment suitable for salmonid spawning. Structural elements along the left bank would help stabilize the streambank, protecting downstream property owners and decreasing bank erosion. LWD is wood greater than 4 inches in diameter and 6.6 feet in length. Selection of specific structural elements and their placement will be determined as part of post-licensing implementation planning and subject to approval of the FAWG and generally following WDFW guidelines in Saldi-Caromile et al. (2004).

SCL anticipates that LWD may need replenishment because of loss due to transport or degradation. LWD replenishment will occur on an eight-year basis throughout the term of the license.

5.4.3.2. Background Information

Sullivan Creek is the largest tributary draining into Boundary Reservoir. Biological surveys conducted during relicensing indicated the delta region and lower reaches of Sullivan Creek are used for rearing by cutthroat trout, brown trout, and rainbow trout. It has also been identified as a location of known mountain whitefish spawning. Although few bull trout have been observed in Sullivan Creek, the mainstem of Sullivan Creek is proposed as “critical habitat” by the USFWS.

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 it is likely that any redds are scoured. The bed conditions of the reach have been influenced by suction dredge mining and the Highway 31 Bridge. The dominant habitat types were riffles and rapids. LWD was infrequent throughout the surveyed reach and primarily present above the water surface at the time of the survey, so it is 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 logjams were present during surveys conducted in July 2008. The riparian zone was composed of young (< 40 years old) mixed vegetation. 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). Several riparian sections within this reach are currently not forested, and other sections have patches dominated by low brush and herbaceous vegetation (Figure 5.4-2).

Figure 5.4-2. Sullivan Creek downstream of Highway 31 Bridge.

5.4.3.3. Procedures

Following the schedule filed with FERC described in Section 5.4.1, SCL shall conduct implementation planning subject to consultation and approval of the FAWG for the riparian improvement and stream channel enhancement components of this PM&E measure. At a minimum, the planning will include:

- A description of any field surveys conducted and summary of results.
- A native vegetation list to be used for riparian planting.
- The target size and source(s) for riparian plants.
- Description of planting techniques and density.
- A map or aerial photo with a planting plan.
- Listing of the type, number, and location of instream structures.
- Engineering drawings of any proposed major instream structures (e.g., LWD jams, groins, boulder clusters, etc.).
- Anticipated source(s) of wood and boulders to be used.

SCL shall be responsible for obtaining all applicable permits, environmental reviews (e.g., NEPA), and approvals from Federal and State agencies. Within one year of completing the FAWG approved planning and obtaining any needed permits, SCL shall implement the enhancement activities.

5.4.3.4. Compliance, Effectiveness, and Adaptive Management

SCL shall conduct compliance monitoring within one year following implementation of the PM&E measure. Protocols for collecting compliance information will be developed as part of implementation planning and subject to consultation and approval of the FAWG. At a minimum, compliance monitoring will include documentation collected during implementation of the PM&E measure, such as survey data, records of purchased materials (LWD pieces, ballast, etc), and photographs of each site before and after LWD or boulder placement or plantings.

SCL, in consultation with the FAWG, shall develop effectiveness monitoring protocols. Effectiveness monitoring will be conducted 3 years after planting to determine whether planting success criteria have been achieved. For riparian areas suitable for establishing vegetation, mitigation planting success and any remedial measures shall achieve at least 80 percent survival of trees and shrubs and 50 percent canopy cover of native species at the end of 3 years from the date of planting. Grasses, forbs, shrubs, and trees shall be planted to achieve the desired structure and function for site-specific habitat conditions.

SCL shall conduct additional effectiveness monitoring at eight-year intervals following implementation and will include evaluation of the condition of riparian areas where plantings occurred, LWD and boulder placed in the stream, and any streambank or channel modifications. The main purpose of the effectiveness monitoring will be to assess structure condition to determine if any structure falls below the success levels established during implementation planning and approved by the FAWG and will be used to support adaptive management and adjustments to the PM&E measure at eight year intervals. If a treatment falls below established success levels, SCL shall develop a plan for remediation within 60 days, for approval of the FAWG, to correct the deficiencies. SCL shall begin implementing these remediation measures within 30-days of permit approval or as determined appropriate by the FAWG. Subsequent compliance monitoring will occur as determined by the FAWG.

In addition to the 8 year effectiveness monitoring SCL shall annually, and following major (25-year) flood events, visit measures for routine inspection/maintenance to ensure that no substantive adverse impacts have occurred. No formal reports will be required for these visits although brief written updates shall be provided by SCL upon request by the FAWG.

5.4.3.5. Reporting and Schedule

The reporting and implementation schedule for protection, riparian planting, and stream channel enhancement in Sullivan Creek is summarized in Table 5.4-3.

Table 5.4-3. Reporting and implementation schedule for habitat protection, riparian improvement, and stream channel enhancement in Sullivan Creek RM 0.3 to RM 0.54.

PM&E Measure Activity	Schedule
Planning and Implementation	According to schedule submitted to FERC
Implementation	Within ten years of license issuance
Compliance Monitoring and Reporting	Within one year following implementation
Effectiveness Monitoring	Every eighth year following implementation
Effectiveness Monitoring Report	Within one year following monitoring

5.4.3.6. Consistency with Other Plans

There are no conflicts between this and other resource plans developed by SCL. The schedule for implementation of the activities identified in this PM&E measure may be dependent on upstream Mill Pond Dam removal activities

5.4.4. Stream and Riparian Improvements in Sullivan Creek RM 2.3 to RM 3.0 and NF Sullivan Creek

5.4.4.1. Scope

This PM&E measure shall be governed by License Article 9(E). This PM&E measure affects Sullivan Creek from approximately 265 feet downstream of the confluence of Sullivan Creek and North Fork Sullivan Creek to RM 3.0 and is focused primarily on streambank and channel enhancement, but also includes riparian planting in conjunction with the streambank enhancement. The objective will be to decrease bank erosion on the right bank, provide instream structure to create pools and enhance deposition and retention of spawning gravel, decrease the channel width-to-depth ratio, and promote the riparian buffer along the right bank within 10 years of license issuance. The schedule for implementation of these activities may be dependent on upstream Mill Pond Dam removal activities. If permitting or other issues prevent implementation of this measure over portions of the reach within 10 years after license issuance, funds equivalent to what would have been expended will be allocated to other tributary PM&E measures in tributaries to Boundary Reservoir as determined in consultation with the FAWG and subject to the approval of the USFS for activities that occur on NFS lands.

A brief site visit that included biologists and engineers from the USFS and the SCL relicensing team suggested that conceptually the objectives could be achieved through road relocation/reconstruction or stream channel diversion. Stream channel diversion could be accomplished through the addition of log jam structures, rock barb structures and large woody debris. The log jam and the barbs are anticipated to move the thalweg of Sullivan creek at least 10 feet towards the center of the channel and create at least a 10-feet wide vegetative riparian zone. This action would promote deposition of stream sediment along the existing bank; thus, reducing bank angles and providing a low lying bench appropriate for natural regeneration or riparian planting of willows and other native woody plants. SCL shall undertake additional post-license planning to add substance and detail to the conceptual plan developed in the field and to ensure that modifications do not cause adverse downstream impacts. This plan will be developed in consultation with the FAWG and subject to approval of the USFS. Implementation of this plan will result in completion of the following activities within 10 years after license issuance between RM 2.3 and 3.0:

- Design and construction of seven engineered logjams (1,100 cubic feet volume each)
- Placement of 10 to 20 boulders (average of 3 feet in diameter)
- Channel modifications
- Riparian plantings
- Streambank modifications at two locations (475 feet long and 317 feet long) where Sullivan Lake Road is hydrologically connected to the Creek. Modifications will include decreasing the bank angle through flow redirection, structural, and/or biotechnical techniques
- Either road relocation/reconstruction or stream channel diversion at one site on Sullivan Creek (county rd. 9345 in SCL segment 4; RM 2.5-3.0)

Boulders would primarily be used in boulder clusters, but could also be used to anchor LWD pieces. Selection of specific structural elements and their placement will be determined as part of post-license planning and design work and generally following WDFW guidelines in Saldi-Caromile et al. (2004) and will require approval of the FAWG prior to implementation.

SCL shall also replace the culvert at the Sullivan Lake Road stream crossing of North Fork Sullivan Creek and place LWD in North Fork Sullivan Creek from the mouth to the North Fork Sullivan Creek Dam (RM 0.25) by License Year 15. Instream LWD placement will include 70 pieces of LWD. Of these pieces, at least 6 shall be 12 inches or greater in diameter and a minimum of 35 feet in length. The final number and size of LWD to be placed into North Fork Sullivan Creek will be approved by the FAWG and consider site-specific conditions.

5.4.4.2. Background Information

Two sub-reaches within this PM&E reach, Reach 2 from RM 2.30 to 2.60 and Reach 3 from RM 2.74 to 3.02, underwent channel assessments as part of relicensing studies (Figure 5.4-3) (SCL 2009a). Surveys were also conducted along five segments of Sullivan Lake Road to assess potential effects to Sullivan Creek (Figure 5.4-4). Habitat quality was described as low for salmonid spawning in both survey reaches, moderate for migration and rearing habitat in both survey reaches, low for overwintering habitat in Reach 2, and moderate for overwintering habitat in Reach 3. The reaches were described as being adversely impacted by the presence of Mill Pond Dam, which reduces transport into 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 along Road Segments 3 and 4, limits lateral movement of the channel, and reduces riparian function (Figure 5.4-5). LWD density was 17.7 and 25.0 pieces per 1,000 feet in Reach 2 and Reach 3, respectively. No logjams were observed in Reach 2 and one logjam was observed in Reach 3. Riparian vegetation was described as a mixture of hardwoods and conifers, with the left bank having both young (< 40 years old) and mature trees (40-80 years old), while vegetation on the right bank was primarily young. Channel morphology was described as planebed, with few pools over about half of Reach 2 and throughout Reach 3. McLellan (2001) surveyed the reach from North Fork Sullivan Creek to Mill Pond Dam and observed low numbers of cutthroat trout (less than 1 fish/100 square meters [119.6 square yards]) and rainbow trout (1 fish/100 square meters).

Two fish migration barriers have been identified on North Fork Sullivan Creek. These include the North Fork Sullivan Dam located at RM 0.25 (Andonegui 2003) and the Sullivan Lake Road culvert at the mouth of the stream (USFS (2002) (Figure 5.4-6). Genetic studies of westslope cutthroat trout captured in North Fork Sullivan Creek suggested the population had no introgression from non-native cutthroat trout historically stocked in the region and was substantially divergent from cutthroat collected in Mill Creek and LeClerc Creek (Shaklee et al. 2003). Cool water present within North Fork Sullivan Creek may provide thermal refugia to salmonids during warm summer periods.

5.4.4.3. Procedures

SCL shall conduct planning and design work consistent with the schedule submitted to FERC and subject to approval of the FAWG prior to implementation. At a minimum, the plan will include the following elements:

- The results from any field surveys conducted.
- A list of native plant species to be used for riparian planting.
- The target size and source(s) for riparian plants.
- Planting techniques and density.
- A map or aerial photo with a planting map.
- Listing of the type, number, and location of instream structures.
- Engineering drawings of major instream structures (e.g., LWD jams, groins, boulder clusters, etc.).
- Engineering drawings of the culvert replacement at the mouth of North Fork Sullivan Creek.
- Engineering drawings of road relocation/reconstruction or stream channel diversion along Sullivan Lake Road in Road Segment 4.
- Anticipated source(s) of wood and boulders to be used.

SCL shall be responsible for obtaining all applicable permits, environmental reviews (e.g., NEPA), and approvals from Federal and State agencies. For each LWD and ELJ placement action, the size and number of pieces of LWD will be determined by the FAWG. Site-specific characteristics will need to be considered. The design-life for engineered log structures and wood placed in streams is anticipated to be five to 10 years; consequently, SCL commits to repairs or log replenishment if determined necessary following each eight year monitoring event. If riparian plantings, instream structures, the North Fork Sullivan Creek culvert replacement, or LWD placement cannot be implemented because of permitting or some other issue, equivalent funding would be reallocated to other PM&E measures to be implemented in tributaries to Boundary Reservoir as determine in consultation with the FAWG.

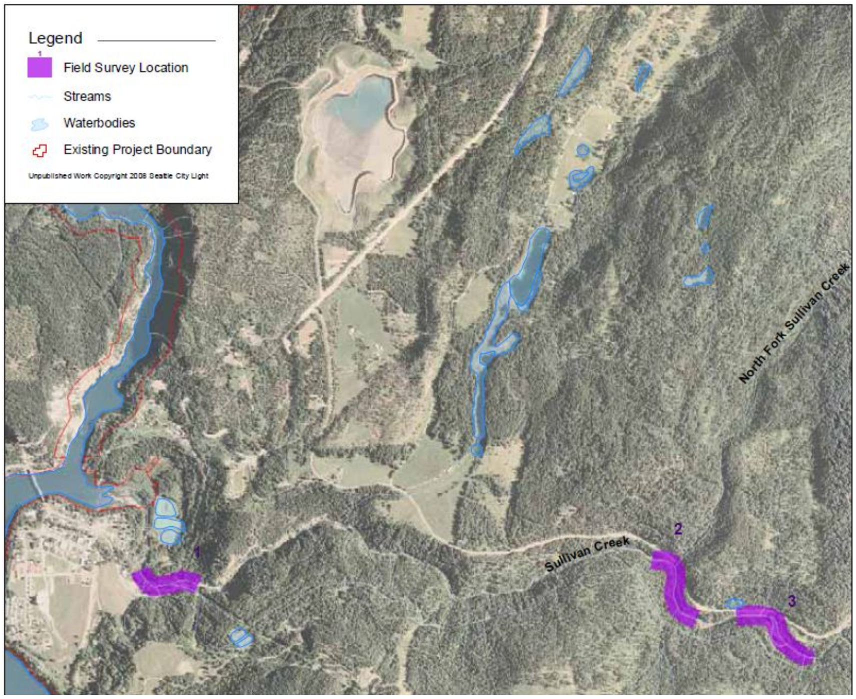


Figure 5.4-3. Reaches of Sullivan Creek surveyed during 2008.

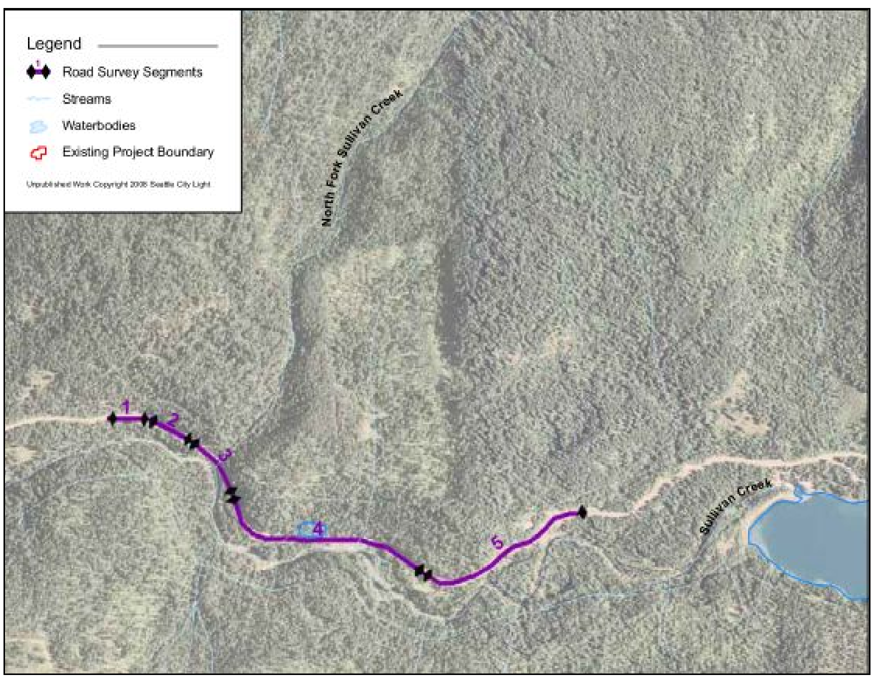


Figure 5.4-4. Sullivan Lake Road Segments surveyed during 2008.

Figure 5.4-5. Section of Sullivan Lake Road hydraulically connected to right bank of Sullivan Creek.

Figure 5.4-6. Outlet of culvert under Sullivan Lake Road draining NF Sullivan Creek.

5.4.4.4. Compliance, Effectiveness, and Adaptive Management

SCL shall conduct compliance monitoring will occur within one year following implementation of the PM&E measure and any repairs that are needed during the term of the license. Protocols for collecting compliance information will be determined during implementation planning and subject to consultation and approval of the FAWG. At a minimum, compliance monitoring will include documentation collected during implementation of the PM&E measure, such as survey data, records of purchased materials (LWD pieces, ballast, etc), and photographs of each site before and after measures or repairs are implemented.

SCL, in consultation with the FAWG, shall develop effectiveness monitoring protocols. Effectiveness monitoring will be conducted 3 years after planting to determine whether planting success criteria have been achieved. For riparian areas suitable for establishing vegetation, mitigation planting success and any remedial measures shall achieve at least 80 percent survival of trees and shrubs and 50 percent canopy cover of native species at the end of 3 years from the date of planting. Grasses, forbs, shrubs, and trees shall be planted to achieve the desired structure and function for site-specific habitat conditions.

SCL shall conduct additional effectiveness monitoring beginning in the eighth year following implementation and every eight years thereafter. The purpose of the effectiveness monitoring will be to assess the PM&E measure's condition to determine if structural repairs, log replenishment, additional plantings, or non-native plant removal is needed to maintain the measure's designed functions. Criteria for determining whether a PM&E measure needs remediation will be determined during post-license planning and is subject to approval of the FAWG. The results of the effectiveness monitoring will be used to support adaptive management and adjustments to the PM&E measure at eight-year intervals. If a treatment falls below established success levels, SCL shall develop a plan for remediation within 60 days, for approval of the FAWG, to correct the deficiencies. SCL shall begin implementing these remediation measures within 30-days of permit approval or as determined appropriate by the FAWG. Subsequent compliance monitoring will occur as determined by the FAWG.

In addition to the 8 year effectiveness monitoring SCL shall annually, and following major (25-year) flood events, visit measures for routine inspection/maintenance to ensure that no substantive adverse impacts have occurred. No formal reports will be required for these visits although brief written updates shall be provided by SCL upon request by the FAWG.

5.4.4.5. Reporting and Schedule

The reporting and implementation schedule for riparian planting and stream channel enhancement in Sullivan Creek from RM 2.3 to RM 3.0 and in NF Sullivan Creek is summarized in Table 5.4-4.

5.4.4.6. Consistency with Other Plans

There are no conflicts between this and other resource plans developed by SCL.

Table 5.4-4. Reporting and implementation schedule for riparian planting and stream channel enhancement in Sullivan Creek RM 2.30 to RM 3.00.

PM&E Measure Activity	Schedule
Implementation Schedule	Within one year of license issuance
Implementation	Within ten years of license issuance
Compliance Monitoring and Report	Within one year of implementation or repairs
Effectiveness Monitoring	Eight years after implementation and every eighth year thereafter
Effectiveness Monitoring Report	Within one year of effectiveness monitoring

5.4.5. Large Woody Debris Placement and Road Improvements in Sullivan Creek and Selected Tributaries Upstream of the Confluence with Outlet Creek

5.4.5.1. Scope

This PM&E measure shall be governed by License Article 9(E). This PM&E measure affects Sullivan Creek and selected tributaries upstream of the confluence with Outlet Creek at RM 5.3. SCL shall place LWD in Sullivan Creek by Year 10 after license issuance in the following amounts:

- Outlet Creek to Rainy Creek – 681 pieces of which 136 are greater or equal to 12 inches in diameter and 35 feet in length.
- Rainy Creek to Gypsy Creek – 330 pieces of which 46 are greater or equal to 12 inches in diameter and 35 feet in length.
- Gypsy Creek to end of fish bearing waters – 728 pieces of which 76 are greater or equal to 12 inches in diameter and 35 feet in length.

Engineered logjams will account for a portion of LWD placement. The number of logjams will be determined as part of post-license planning and subject to approval of the FAWG.

SCL shall undertake the following road improvements along the 12 miles of Sullivan Creek Road (FS Road 2200) between the mouth of Outlet Creek and Leola Creek:

- Sullivan Creek Road – Approximately 6.5 miles of road (described in Table 5.4-5) shall be reconstructed, including resurfacing with 4 inches of gravel, re-grading to divert storm water to the inside ditch, and the replacing of deficient/adding up to 35 new storm water ditch relief culverts including sediment traps or energy dissipaters as needed to reduce delivery of road-related erosion to streams. Two cutslope slides located approximately 1.5 and 1.7 miles, respectively from the junction with Sullivan Lake Road (MP 12) (described in Table 5.4-5), shall be stabilized by removing slumped material installing drainage, re-vegetating, and installing retaining structures while maintaining road width.

- Kinyon Creek – Replace FS Road 2220 culvert with a fish passable structure.
- Stony Creek – Replace FS Road 2200 culvert with a fish passable structure.
- Unnamed creek downstream of Cascade Creek– Replace culvert with a multi-plate arch structure.

Table 5.4-5 identifies road lengths using GIS. Preliminary estimates identify 34,190 ft be regarded. These estimate will be verified during the planning phase prior to implementation.

Table 5.4-5. Preliminary estimate of Sullivan Creek road segments to be graded and provided with stormwater relief culverts.

Road Segment	Location (Lat., Long., WGS84)		Length (Feet)
	(Start)	(End)	
1	48.838701, -117.265967	48.838421, -117.262782	780
2	48.836344, -117.255665	48.833116, -117.249742	2,005
3	48.833099, -117.244231	48.833400, -117.243151	340
4	48.834759, -117.240511	48.835612, -117.235806	1,240
5	48.835079, -117.232928	48.836011, -117.226659	1,550
6	48.836930, -117.221959	48.837002, -117.218439	860
7	48.837701, -117.213904	48.838381, -117.212464	430
8	48.839229, -117.211475	48.840201, -117.211448	375
9	48.841995, -117.208698	48.842334, -117.207501	300
10	48.842622, -117.206403	48.842971, -117.205463	260
11	48.843382, -117.203629	48.843138, -117.200233	820
12	48.843299, -117.196963	48.845333, -117.190788	1,830
13	48.847663, -117.187558	48.848771, -117.185592	650
14	48.849650, -117.180512	48.853351, -117.168071	3,850
15	48.870465, -117.146005	48.871429, -117.145339	400
16	48.871903, -117.142637	48.898605, -117.083586	18,500
Cutslope Slide 1	48.836233, -117.254667		200
Cutslope Slide 2	48.838031, -117.258158		200

SCL shall undertake the following road and habitat improvements in the Sullivan Creek basin upstream of Outlet Creek:

- Johns Creek – Remove the FS Road 2200 505 culvert and implement streambank restoration within the road imprint. Replace FS Road 2200 500 culvert with a fish passable structure.
- Rainy Creek – Remove fish barrier at the mouth of the creek.
- Streambank stabilization near Cascade Creek – Create 3 engineered logjams from LWD currently causing bank instability; supplement with boulders and rock barbs/vanes.
- Channel and weir rehabilitation near mouth of unnamed creek downstream of Cascade Creek – Augment existing log weirs and redirect flows to the thalweg of the channel.

5.4.5.2. Background Information

The Sullivan Creek Watershed Assessment (USFS 1996) identified roads, dispersed recreation, mining, and riparian harvest as anthropomorphic activities contributing to an altered sediment regime, channel straightening, unstable streambanks, and low LWD levels in some areas of Sullivan Creek. The report also suggested that LWD removal from streams may have occurred as part of road building, harvest activities, and to prevent lateral migration of the stream into Sullivan Creek Road. Based upon channel type and current conditions, the USFS described most of the tributaries to Sullivan Creek as being at low risk, in good condition, and providing most of the spawning habitat for the watershed. In contrast, most high risk reaches were located in the mainstem of Sullivan Creek and lack of LWD contributed to low levels of sediment storage, channel instability, and poor spawning habitat conditions. Timber harvest activities that peaked in the mid-1970s in combination with fire suppression have resulted in many overstocked middle structural stage stands. However, changes in forest management practices coupled with natural forest succession are gradually putting stands on a trend towards the historic range of variability.

Fish passage barriers in need of removal or replacement, road repairs, and landslide stabilization projects have been identified by the USFS as part of relicensing discussions.

5.4.5.3. Procedures

SCL will conduct planning and design work consistent with the schedule submitted to FERC and subject to approval of the FAWG prior to implementation. At a minimum, the planning effort will describe:

- The results from any field surveys conducted.
- Listing of the type, number, and location of instream structures.
- Engineering drawings of major instream structures (e.g., LWD jams, groins, etc.).
- Engineering drawings for culvert replacements in Kinyon, Stony, and Johns Creek.
- Engineering drawings of road reconstruction segments.
- Engineering drawings of landslide stabilization.
- Anticipated source(s) of wood and boulders to be used.

For each LWD and ELJ placement action, the size and number of pieces of LWD will be determined by the FAWG. Site-specific characteristics will be considered. SCL shall obtain all applicable permits, environmental reviews (e.g., NEPA), and approvals from Federal and State agencies. The design-life for engineered log structures and wood placed in streams is anticipated to be five to 10 years; consequently, SCL shall repair or replenish logs if determined necessary following each eight year monitoring event. If the activities described in this PM&E measure cannot be implemented because of permitting or some other issue, equivalent funding would be reallocated to other PM&E measures in tributaries to Boundary Reservoir in consultation with the FAWG.

5.4.5.4. Compliance, Effectiveness, and Adaptive Management

SCL shall conduct compliance monitoring within one year following implementation of the PM&E measure and any repairs that are needed during the term of the license. Protocols for collecting compliance information will be determined during implementation planning and subject to approval of the FAWG. At a minimum, compliance monitoring will include documentation collected during implementation of the PM&E measure, such as survey data, records of purchased materials (LWD pieces, ballast, etc), and photographs of each site before and after measures or repairs are implemented.

SCL, in consultation with the FAWG, shall develop effectiveness monitoring protocols. Effectiveness monitoring will occur beginning in the eighth year following implementation and every eight years thereafter. The purpose of the effectiveness monitoring will be to assess the PM&E measure's condition to determine if structural repairs or log replenishment is needed to maintain the measure's designed functions. Criteria for determining whether a PM&E measure needs remediation will be determined during post-license planning and is subject to approval of the FAWG. If a restoration measure falls below success levels as determined through 8-year compliance monitoring, SCL shall develop a plan for remediation within 60 days, for approval of the FAWG, to correct the deficiencies. SCL shall begin implementing these repairs within 30-days of permit approval or as determined appropriate by the FAWG. Subsequent compliance monitoring will occur as determined by the FAWG. The results of the effectiveness monitoring will be used to support adaptive management and adjustments to the PM&E measure at eight-year intervals.

Except for road-related and slide-related work on Sullivan Creek Road, in addition to the 8 year effectiveness monitoring SCL shall annually, and following major (25-year) flood events, visit measures for routine inspection/maintenance to ensure that no substantive adverse impacts have occurred. No formal reports will be required for these visits although brief written updates shall be provided by SCL upon request by the FAWG. SCL shall have no responsibility for 8 year effectiveness or annual monitoring or any maintenance of road-related or slide-related work on Sullivan Creek Road. Annual monitoring and maintenance of measures on Sullivan Creek Road, including slides shall be the responsibility of the Forest Service as part of its regular road maintenance activities. SCL shall be responsible for repairing failures in the work due to improper installation or failure to withstand a 100-year flood (design standard).

5.4.5.5. Reporting and Schedule

The reporting and implementation schedule for LWD placement in Sullivan Creek upstream of the confluence of Outlet Creek and related road improvements is summarized in Table 5.4-6.

5.4.5.6. Consistency with Other Plans

There are no conflicts between this and other resource plans developed by SCL.

Table 5.4-6. Reporting and implementation schedule for LWD placement and road improvements in Sullivan Creek upstream of the confluence with Outlet Creek.

PM&E Measure Activity	Schedule
Implementation Schedule	Within one year of license issuance
Implementation	Within ten years of license issuance
Compliance Monitoring and Reporting	Within 1 year of implementation or repairs
Effectiveness Monitoring	Eight years after implementation and every eighth year thereafter
Effectiveness Monitoring Report	Within 1 year of effectiveness monitoring

5.4.6. Culvert Replacements and LWD Placement in Tributaries to Boundary Reservoir

5.4.6.1. Scope

This PM&E measure shall be governed by License Article 9(E). SCL shall replace the 6 culverts identified in Table 5.4-7 with new stream crossings that meet Washington State and/or USFS criteria as applicable. SCL shall also place LWD (as defined in Section 3.4) in Lime, Flume, and Sand creeks at the levels identified in Table 5.4-8. The objective of this PM&E measure is to improve access to, and/or the habitat quality of, selected tributary reaches used by native salmonids. The culvert replacements will provide passage for juvenile, sub-adult, and adult salmonid lifestages at all design flows and access to suitable habitat located upstream of the culverts. The culvert replacements in Slumber and Styx creeks will also incorporate LWD as needed for bank stabilization and grade control at each site. A secondary objective of the culvert replacements is to improve downstream transport of LWD and reduce the risk of road failure during peak flow events.

Table 5.4-7. Culvert replacements in Slumber, Styx, Flume, and Pocahontas creeks.

Stream	Schedule (license year)	River Mile	Road	Comment
Slumber Creek	11 – 15	0.20	FS Rd 3155	Incorporate LWD placement as with culvert replacement as needed for bank stabilization and grade control
Styx Creek	11 – 15	0.10	FS Rd 3155	Incorporate LWD placement as with culvert replacement as needed for bank stabilization and grade control
Flume Creek	11 – 15	0.82	County Rd 2975	
Flume Creek	11 – 15	4.37	FS Rd 350	
Pocahontas Creek	16 – 20	0.34	Lehigh Hill Rd	Two culverts

Table 5.4-8. LWD placement in Lime, Flume, and Sand creeks**.**

Stream	Schedule (license year)	Miles of Stream	Number of Pieces	Comment
Lime Creek	11 – 15	1.3	284	No logjams needed
Flume Creek	11 – 15	1.0	140	Mouth to SF Flume Cr; at least 20 pieces >=12 inches in diameter and >=35 ft long; no logjams needed
Sand Creek	11 – 15	2.7	*	Use LWD to create 10 pools RM 4.1 to 6.8; no logjams needed
* To be determined by the FAWG				

5.4.6.2. Background Information

Slumber Creek and Styx Creek are tributaries to Slate Creek, with their confluences at RM 2.0 and 4.9, respectively. USFS Road 3155 crosses these tributaries near their mouths (RM 0.20 and 0.10, respectively). During 2008, habitat surveys were conducted upstream and downstream of these culverts for 492 feet in conjunction with evaluation of the culverts (SCL 2009a). Neither of the culverts was found to meet Washington State criteria for fish passage. The habitat survey results for Slumber Creek demonstrated that the habitat upstream of the culvert is slightly more suitable than that found downstream because the mean residual pool depth, mean thalweg depth, and volume of LWD were all greater upstream than downstream. Most notably, the volume of LWD downstream of the culvert in Slumber Creek was lower than the quantity upstream. The data from the habitat survey for Styx Creek suggested that channel complexity and water depth downstream of the culvert were greater than in the upstream section. Most of the habitat downstream and upstream of the culvert consisted of riffles. However, mean residual pool depth, mean thalweg depth, volume of LWD, and riparian structure and cover were all greater downstream of the culvert than upstream. LWD density in Styx Creek was 161 pieces per mile. The USFS reports that westslope cutthroat trout and eastern brook trout are present in both streams (USFS 1998).

McLellan (2001) described two culvert barriers located on Flume Creek. The culvert at County Road 2975 (also known as Boundary Road) was described as perched 8.2 feet above the downstream plunge pool while the culvert at FS Road 350 was described as perched nearly 5 feet with no downstream plunge pool. McLellan (2001) observed only eastern brook trout within Flume Creek, while R2 Resource Consultants, Inc. (1998) also observed a few cutthroat trout. McLellan (2001) did not observe any fish in the reach surveyed upstream from RM 4.14, but did observe brook trout (4 fish per 100 m^2 and 20 fish per 100 m^2) in two reaches between the culvert barriers. According to a habitat survey by McLellan (2001), the culvert at FS Road 350 lies in a high gradient reach (17%) with 595 pieces of LWD per mile, but no pool habitat. In contrast, the two reaches upstream of County Road 2975 surveyed by McLellan (2001) have relatively low gradient (10% and 3%), 611 and 338 pieces of LWD per mile, and more pool habitat (25% and 17% by occurrence). The reach downstream of County Road 2975 is relatively low gradient (3%), had 354 pieces of LWD per mile, but no pool habitat.

The twin culverts at Lehigh Hill Road for crossing Pocahontas Creek were surveyed as part of relicensing study efforts and found to be out of compliance with the Washington State

Administrative Code because water velocity would exceed criteria at the high fish passage design flow (SCL 2009). At the time of the survey, the culverts were also plugged with LWD that would also reduce their fish passage effectiveness. A 5.8 feet high falls and a series of step pools are present below the culverts and a 3.9 feet falls is present upstream of the culverts. These features may serve as partial passage barriers to some fish species and life stages depending upon flow levels (SCL 2009). Between the mouth and approximately RM 0.25 Pocahontas Creek becomes partially or completely dry during summer months when water levels are low. The Pend Oreille Salmonid Recovery Team (2005) indicates that cutthroat trout and rainbow trout are present in Pocahontas Creek.

McLellan (2001) conducted habitat surveys within three reaches on Lime Creek that were downstream of the Highway 31 stream crossing and documented a mean of 435 pieces of LWD per mile, mean gradient ranged from 3 to 10 percent, and pools accounted for between 0 and 25 percent of habitat units in the reaches. During the summer low flow period, Lime Creek flows subsurface for about 328 feet downstream of the Highway 31 stream crossing. Eastern brook trout is the only salmonid known to use the stream.

5.4.6.3. Procedures

Following the schedule filed with FERC described in Section 5.4.1, SCL, in consultation with the FAWG, shall develop a draft and final implementation plan for this PM&E measure consistent with the site specific planning requirements in the USFS Administrative Terms and Conditions. At a minimum, the planning effort will describe:

- A description of any field surveys conducted and summary of results.
- Engineering drawings of the culvert replacements.
- Listing of the type, number, and location of instream structures.
- Anticipated source(s) of wood to be used.

SCL shall be responsible for obtaining all applicable permits, environmental reviews (e.g., NEPA), and approvals from Federal and State agencies. For each LWD placement action, the size and number of pieces of LWD will be determined by the FAWG and based upon the best available science (e.g., Fox and Bolton 2007). Site-specific characteristics will need to be considered. The design-life for log structures and wood placed in streams is anticipated to be five to 10 years; consequently, SCL commits to repairs or log replenishment if determined necessary following each eight year monitoring event. If culvert replacement or LWD placement cannot be implemented because of permitting or some other issue, equivalent funding would be reallocated to other tributary PM&E measures in consultation with the FAWG following the process described in Section 5.4.1.

Routine maintenance of any culverts on NFS lands will be the responsibility of the USFS while maintenance on County roads will be the responsibility of Pend Oreille County.

5.4.6.4. Compliance, Effectiveness, and Adaptive Management

Compliance monitoring shall occur within one year following implementation of the PM&E measure and any repairs that are needed during the term of the license. Protocols for collecting compliance information will be determined during implementation planning and subject to approval of the FAWG. At a minimum, compliance monitoring will include documentation collected during implementation of the PM&E measure, such as survey data, records of purchased materials (LWD pieces, ballast, etc), and photographs of each site before and after measures or repairs are implemented.

Effectiveness monitoring shall occur beginning in the eighth year following implementation and every eight years thereafter. The purpose of the effectiveness monitoring will be to assess the PM&E measure's condition to determine if structural repairs or log replenishment is needed to maintain the measure's designed functions. Criteria for determining whether a PM&E measure needs remediation will be determined during post-license planning and is subject to approval of the FAWG. The results of the effectiveness monitoring will be used to support adaptive management and adjustments to the PM&E measure at eight-year intervals. If a structure falls below established success levels, SCL shall develop a plan for remediation within 60 days, for approval of the FAWG, to correct the deficiencies. SCL shall begin implementing these repairs within 30-days of permit approval or as determined appropriate by the FAWG. Subsequent compliance monitoring will occur as determined by the FAWG.

In addition to the 8 year effectiveness monitoring SCL shall annually, and following major (25-year) flood events, visit measures for routine inspection/maintenance to ensure that no substantive adverse impacts have occurred, with the exception that SCL shall have no responsibility for annual visits to, or providing routine maintenance of, measures (e.g., culvert improvements and road grading) on NFS roads. No formal reports will be required for these visits although brief written updates shall be provided by SCL upon request by the FAWG. It is understood that routine visits to and maintenance of measures on NFS roads (e.g., culverts and road improvements) shall be the responsibility of the Forest Service as part of its regular road monitoring and maintenance activities.

5.4.6.5. Reporting and Schedule

The reporting and implementation schedule for culvert replacements and LWD placement in Lime, Flume, Slumber, Styx, Pocahontas and Sand creeks is summarized in Table 5.4-9.

5.4.6.6. Consistency with Other Plans

There are no conflicts between this PM&E measure and other resource plans developed by SCL. Because instream structures may reduce the effectiveness of non-native trout suppression and eradication efforts, the schedule for these two PM&E measures should be coordinated within affected creeks.

Table 5.4-9. Reporting and implementation schedule for culvert replacements and LWD placement in Lime, Flume, Slumber, Styx, Pocahontas, and Sand creeks.

PM&E Measure Activity	Schedule
Implementation Schedule	Within one year of license issuance
Planning and Implementation	According to schedule submitted to FERC
Implementation for Lime, Slumber, Styx, Flume, and Sand creeks	Between 11to15 years following license issuance
Implementation for Pocahontas Creek	Between 16 to 20 years following license issuance
Compliance Monitoring and Report	Within one year following implementation
Effectiveness Monitoring	Every eighth year following implementation
Monitoring Report	Within one year following monitoring

5.4.7. Riparian Planting, Culvert Replacement and Channel Reconstruction in Linton Creek RM 0.00 to RM 0.24

5.4.7.1. Scope

This PM&E measure shall be governed by License Article 9(E). Linton Creek flows through the town of Metaline and enters the reservoir at Metaline Waterfront Park. This PM&E measure occurs downstream of the Highway 31 stream crossing (between RM 0.0 and 0.24) and replaces up to three culverts, reconstructs the stream channel, places 20 to 25 pieces of LWD, augments gravel substrate in numerous locations, and conducts riparian planting within a distance of up to 50 feet of the stream banks. The objective of this measure is to improve riparian functions, passage conditions at the stream crossings, and spawning and rearing habitat. Implementation of this PM&E measure would occur between Years 16 and 20 following issuance of the new license. Because the Metaline Waterfront Park is a multi-use public recreation area, specific objectives and measurable success criteria for this PM&E will be developed as part of post license planning and design work to be conducted in consultation with the FAWG and the City of Metaline and would need their approval prior to implementation. Restoration work would generally follow WDFW guidelines in Saldi-Caromile et al. (2004). It is anticipated that woody vegetation planting will be high density (approximately 4,360 plants per acre) consisting of regionally appropriate native riparian plant seed mixes and shrubs, as well as native tree saplings (e.g., Table 3.4-1) with the objective of achieving at least 80 percent survival and 50 percent vegetative areal cover of native species after 3 years from the date of planting. Implementation of this PM&E measure depends on permission from the City of Metaline. If permission is not obtained, the funds allocated for any elements of this measure that are not implemented would be allocated to other PM&E measures in tributaries to Boundary Reservoir as determined in consultation with the FAWG and subject to the approval of the USFS if they occur on NFS lands.

5.4.7.2. Background Information

A channel and habitat survey from RM 0.00 to 0.25 (SCL 2009a) indicated that habitat was predominantly low-gradient riffles, with an average channel slope of 2 percent (Figure 5.4-7).

Riparian conditions within the survey reach were found to be poor, stream bank conditions were determined to be fair, and LWD was poor, based on the number of pieces per mile and potential recruitment sources. Pool depth and pool frequency were found to be not properly functioning, but off-channel habitat was classified as fair, due to a wetland connected to Linton Creek upstream of the culvert at RM 0.20. Thirteen culverts are present on Linton Creek, including a major stream crossing at Highway 31 at RM 0.25. Three of the culverts downstream of Highway 31 have been surveyed and two do not meet WDFW passage criteria (SCL 2009a). Results of SCL (2009b) showed that cutthroat trout, rainbow trout, brown trout, brook trout, pumpkinseed, and largescale sucker used the tributary channel from July through September 2008.

Figure 5.4-7. Riparian and channel conditions in lower Linton Creek.

5.4.7.3. Procedures

Following the schedule filed with FERC described in Section 5.4.1, SCL, in consultation with the FAWG and the City of Metaline, shall conduct implementation planning for this PM&E measure. Because one of the three culverts downstream of the Highway 31 stream crossing currently meets WDFW passage criteria, the planning will include a determination of whether replacement of all three culverts, rather than just the two out-of-compliance culverts, is needed to meet the PM&E objectives. At a minimum, the planning effort will describe:

- The results of any field surveys conducted and summary of results.
- A list of native plant species to be used for riparian planting.
- The target size and source(s) for riparian plants.
- A map or aerial photo with a planting map depicting plant types and planting density.
- Listing of the type, number, and location of instream structures.
- Engineering drawings of culvert replacements, major instream structures, or channel reconstruction.

- Anticipated source(s) of wood, boulders, and gravel to be used.

WDFW guidance (Saldi-Caromile et al. 2004) indicates that appropriate planting densities are highly site dependent that requires consideration of the species to be planted, the plant material type (e.g., cuttings, containerized, bare-root, or seed), soil type, hydrologic conditions (e.g., depth to groundwater), and other factors. Although SCL anticipates that high density plantings will be required adjacent to Linton Creek because riparian vegetation currently consists almost entirely of grass and forbs, actual planting densities will be determined as part of implementation planning and subject to approval of the FAWG. Within one year following completion of the planning phase, any regulatory requirements, and acquisition of permits, SCL shall implement the PM&E measure.

5.4.7.4. Compliance, Effectiveness, and Adaptive Management

SCL shall conduct compliance monitoring within one year following implementation of the PM&E measure and any repairs that are needed during the term of the license. Protocols for collecting compliance information will be determined during implementation planning and subject to consultation and approval of the FAWG. At a minimum, compliance monitoring will include documentation collected during implementation of the PM&E measure, such as survey data, records of purchased materials (LWD pieces, boulders, gravel, etc), and photographs of each site before and after measures or repairs are implemented.

SCL, in consultation with the FAWG, shall develop effectiveness monitoring protocols. Effectiveness monitoring will be conducted 3 years after planting to determine whether planting success criteria have been achieved. For riparian areas suitable for establishing vegetation, mitigation planting success and any remedial measures shall achieve at least 80 percent survival of trees and shrubs and 50 percent canopy cover of native species at the end of 3 years from the date of planting. Grasses, forbs, shrubs, and trees shall be planted to achieve the desired structure and function for site-specific habitat conditions.

SCL shall conduct additional effectiveness monitoring beginning in the eighth year following implementation and every eight years thereafter. The purpose of the effectiveness monitoring will be to assess the PM&E measure's condition to determine if structural repairs, log replenishment, additional plantings, or non-native plant removal is needed to maintain the measure's designed functions. Criteria for determining whether a PM&E measure needs remediation will be determined during post-license planning and is subject to approval of the FAWG. The results of the effectiveness monitoring will be used to support adaptive management and adjustments to the PM&E measure at eight-year intervals. If a treatment falls below established success levels, SCL shall develop a plan for remediation within 60 days, for approval of the FAWG, to correct the deficiencies. SCL shall begin implementing the remediation measures within 30 days of permit approval or as determined appropriate by the FAWG. Subsequent monitoring will occur as determined by the FAWG.

In addition to the 8-year monitoring, SCL shall routinely visit restoration sites at least annually, following major flood events (25-year event), or as reasonably required by the FAWG, to ensure that no substantive adverse impacts have occurred at the restoration site. Formal reports will not be required as a result of these routine visits, although brief written updates shall be provided by SCL to the FAWG upon request.

5.4.7.5. Reporting and Schedule

The reporting and implementation schedule for riparian planting along Linton Creek is summarized in Table 5.4-10.

Table 5.4-10. Reporting and implementation schedule for riparian planting, culvert replacement and channel reconstruction along Linton Creek RM 0.00 to RM 0.24.

PM&E Measure Activity	Schedule
Implementation Schedule	Within one year of license issuance
Planning and Implementation	According to schedule submitted to FERC
Implementation	Between 16 to 20 years following license issuance
Compliance Monitoring and Report	Within one year following implementation
Effectiveness Monitoring	Every eighth year following implementation
Monitoring Report	Within one year following monitoring

5.4.7.6. Consistency with Other Plans

There are no conflicts between this and other resource plans developed by SCL. Implementation of this PM&E measure is dependent on the willingness of the City of Metaline to allow SCL to conduct the activity. If the City of Metaline is unwilling to allow the activity or a portion of the activity, then funds allocated for unapproved elements of this PM&E measure would be allocated to other mitigation measures in tributaries to Boundary Reservoir as determined in consultation with the FAWG. Implementation of this PM&E measure should be coordinated with the placement of a LWD jam in the Linton Creek tributary delta (Section 5.1.6) to be implemented by license year 10 and implementation of boat launch and roadway access improvements completed by license year 5 described in the Recreation Resource Management Plan.

5.4.8. Riparian and Channel Improvements in Sweet Creek RM 0.0 to RM 0.6

5.4.8.1. Scope

This PM&E measure shall be governed by License Article 9(E). This PM&E measure has three components including: Riparian buffer protection and plantings, large woody debris placement, and Highway 31 culvert improvements. Each of these components is described below in greater detail.

5.4.8.1.1. Riparian Buffer Protection and Plantings

The objective of this component is to provide long-term protection for the relatively intact riparian zone of Sweet Creek downstream of the Highway 31 culvert. SCL shall pursue the acquisition 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 0.50, which is the location of the Highway 31 culvert (Figure 5.4-8). In addition, SCL proposes to remove non-native vegetation and plant native brush and trees over a 0.3-acre area north of the access road near the high school football field with the objective of improving riparian functions such as shade and LWD and nutrient (i.e., leaf and needle) production. Implementation of the protective portion of this PM&E measure depends on the willingness of current owners (three private owners, the Selkirk School District, WDNR, and DOT) to sell a portion of their land or enter into easement agreements. Similarly, implementing riparian plantings would require permission from the Selkirk School District, even if long-term protection could not be provided. If owners are unwilling to sell or provide easements within the 100-foot buffer, then long-term protection would not be guaranteed. If owners do not grant permission for riparian plantings, then funds equal to the cost of these plantings would be reallocated to other PM&E measures in tributaries to Boundary Reservoir as determined in consultation with the FAWG and following the process described in Section 5.4.1.

5.4.8.1.2. Large Woody Debris Placement

The objective of this PM&E measure will be to increase channel complexity and gravel retention through LWD placement from the mouth of Sweet Creek to RM 0.60. The PM&E measure anticipates the amount of wood to be placed would include 166 pieces of LWD and of these pieces at least 12 shall be 12 inches or greater in diameter and a minimum of 35 feet in length. The bankfull width of Sweet Creek is approximately 33 feet in this reach, making it suitable for placement of channel-spanning LWD. As part of the LWD placement up to 10 channel-spanning structures will be installed over a 558-foot reach downstream of the Highway 31 culvert. Each structure will have one to three LWD pieces, of which at least one will 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 locations and design of the spanning structures and the actual amount, location, and size of the wood to be placed in Sweet Creek is dependent upon site-specific conditions and will be determined as part of post-license planning and design work that will generally follow WDFW guidelines in Saldi-Caromile et al. (2004), and is subject to approval of the FAWG. The presence of eroding stream banks will be considered during this process, and streambank reshaping could be implemented as part of structure placement to reduce erosion.

5.4.8.1.3. Highway 31 Culvert Improvements

The objective of this component is to improve upstream fish passage at the culvert located at RM 0.5 under Highway 31. Improvements may include the addition of baffles, weirs, and/or aprons on the downstream end of the existing culvert. The design of the improvements will occur in collaboration with the Washington Department of Transportation, WDFW, and the FAWG and require their approval.

Figure 5.4-8. Riparian buffer area adjacent to Sweet Creek proposed for protection.

5.4.8.2. Background Information

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 begins at RM 0.60 that is a complete upstream passage barrier to fish. The stream also passes through a large box culvert under Highway 31 at RM 0.50. The culvert does not meet WDFW criteria for fish passage (SCL 2009a), but the presence of a bull trout observed by McLellan (2001) upstream of the culvert indicates that the culvert is passable under some conditions. Cutthroat trout, mountain whitefish, rainbow trout, brown trout, and brook trout were also observed upstream of the culvert; however, only brook trout and cutthroat trout were observed above the series of falls (McLellan 2001). Fish habitat and channel surveys conducted from the mouth to the lowermost falls suggest that 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 culvert appears to block transport of LWD based on the buildup of wood and retention of gravel on the upstream side of the culvert, and streambank erosion is occurring downstream of the culvert (Figure 5.4-9) (SCL 2009a).

The cool water 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 the lower reaches of Sweet Creek (SCL 2009b). While most of the riparian zone of Sweet Creek downstream of Highway 31 is in relatively good condition (SCL 2009a; McLellan 2001), several areas are devoid of riparian trees or brush (i.e., very sparse), have a moderate density of mixed brush, herbaceous plants, and hardwoods with some conifers (moderately sparse), or have a relatively dense hardwood forest cover with some conifers (sparse) that could be improved through riparian planting, which would increase future shade and LWD recruitment potential. Protection of the existing good riparian habitat and improvement of some areas would benefit native salmonids within the stream channel and would help maintain coolwater temperatures in the tributary delta. The reach between Highway 31 and the impassable falls at RM 0.60 is currently used as an improved day use area and rest stop with paved trails.

Figure 5.4-9. Channel conditions downstream of the Highway 31 culvert at Sweet Creek. Note the eroding left bank and lack of instream large woody debris.

5.4.8.3. Procedures

Within one year following license issuance SCL will contact landowners to determine their willingness to sell the portion of their parcels that fall within the buffer, enter into conservation easements, or allow habitat improvement. Any lands that are purchased will be set-aside for protection in perpetuity.

Following the schedule filed with FERC described in Section 5.4-1, SCL, in consultation with the FAWG will conduct implementation planning for this PM&E measure. At a minimum, the planning effort will describe:

- A description of any field surveys conducted and summary of results.
- Listing of the type, number, and location of instream structures.
- Engineering drawings of major instream structures (e.g., drop structures, LWD jams, boulder clusters, etc.).
- Engineering drawings of improvements to the Highway 31 culvert.
- Anticipated source(s) of wood and boulders to be used.

- A list of native plant species to be used for riparian planting.
- The target size and source(s) for riparian plants.
- Description of planting techniques and density.
- A map or aerial photo with a planting plan.

WDFW guidance (Saldi-Caromile et al. 2004) indicates that appropriate planting densities are highly site dependent that requires consideration of the species to be planted, the plant material type (e.g., cuttings, containerized, bare-root, or seed), soil type, hydrologic conditions (e.g., depth to groundwater), and other factors. In areas where the additional vegetation is desirable, SCL anticipates that planting density would vary from low (approximately 440 plants per acre) to high (approximately 4,360 plants per acre) depending upon the location. Actual planting densities will be determined as part of implementation planning and subject to approval of the FAWG. Within one year following approval of the plan by the FAWG, completion of any regulatory requirements, and acquisition of permits, SCL shall implement the activities identified in the PM&E measure. If riparian plantings, instream structures, or culvert improvements cannot be implemented because of permitting, unwillingness of landowners, or some other issue, funds allocated to those elements would allocated to other tributary PM&E measures in consultation with the FAWG following the process described in Section 5.4.1.

5.4.8.4. Compliance, Effectiveness, and Adaptive Management

SCL shall conduct compliance monitoring within one year following implementation of the PM&E measure and any repairs that are needed during the term of the license. Protocols for collecting compliance information will be determined during implementation planning and subject to consultation and approval of the FAWG. At a minimum, compliance monitoring will include documentation collected during implementation of the PM&E measure, such as survey data, records of purchased materials (e.g., plants, LWD pieces, ballast, etc), and photographs of each site before and after measures or repairs are implemented.

SCL, in consultation with the FAWG, shall develop effectiveness monitoring protocols. Effectiveness monitoring will be conducted 3 years after planting to determine whether planting success criteria have been achieved. For riparian areas suitable for establishing vegetation, mitigation planting success and any remedial measures shall achieve at least 80 percent survival of trees and shrubs and 50 percent canopy cover of native species at the end of 3 years from the date of planting. Grasses, forbs, shrubs, and trees shall be planted to achieve the desired structure and function for site-specific habitat conditions.

SCL shall conduct additional effectiveness monitoring beginning in the eighth year following implementation and every eight years thereafter. The purpose of the effectiveness monitoring will be to assess the PM&E measure's condition to determine if structural repairs, log replenishment, additional plantings, or non-native plant removal is needed to maintain the measure's designed functions. Criteria for determining whether a PM&E measure needs remediation will be determined during post-license planning and is subject to approval of the FAWG. The results of the effectiveness monitoring will be used to support adaptive management and adjustments to the PM&E measure at eight-year intervals. If a treatment falls below established success levels, SCL shall develop a plan for remediation within 60 days, for approval of the FAWG, to correct the deficiencies. SCL shall begin implementing these remediation measures within 30 days of permit approval or as determined appropriate by the FAWG. Subsequent compliance monitoring will occur as determined by the FAWG.

In addition to the 8 year effectiveness monitoring SCL shall annually, and following major (25-year) flood events, visit measures for routine inspection/maintenance to ensure that no substantive adverse impacts have occurred. No formal reports will be required for these visits although brief written updates shall be provided by SCL upon request by the FAWG.

5.4.8.5. Reporting and Schedule

The reporting and implementation schedule for channel improvements in Sweet Creek is summarized in Table 5.4-11.

Table 5.4-11. Reporting and implementation schedule for channel improvements in Sweet Creek RM 0.0 to RM 0.6.

PM&E Measure Activity	Schedule
Implementation Schedule	Within one year of license issuance
Planning and Implementation	According to schedule submitted to FERC
Implementation	Between one to 20[1] years following license issuance
Compliance Monitoring and Report	Within one year following implementation
Effectiveness Monitoring	Every eighth year following implementation
Effectiveness Monitoring Report	Within one year following monitoring

[1]. The time period for these activities starts at year 1 to allow SCL to obtain any easements if and when they are available and to potentially reduce the cost of obtaining these at an early date.

5.4.8.6. Consistency with Other Plans

There are no conflicts between this and other resource plans developed by SCL. Implementation of this PM&E measure depends on the willingness of landowners adjacent to the stream. If landowners are unwilling to sell a portion of their lands or enter into conservation easements, then no long-term protection will be guaranteed to this portion of the riparian buffer. Improvements to the Highway 31 culvert will require approval from the Washington Department of Transportation (DOT).

5.4.9. Habitat Improvement in Tier-2 Tributaries to Boundary Reservoir

5.4.9.1. Scope

This PM&E measure shall be governed by License Article 9(E). As part of studies conducted during relicensing of the Boundary Project, SCL categorized tributaries flowing into Boundary Reservoir according to habitat availability for native salmonids and the potential opportunity to improve conditions through habitat manipulation. The results of the analysis were reported in Study 14: Assessment of Factors Affecting Aquatic Productivity in Tributary Habitats (SCL

2009a). Tributaries to Boundary Reservoir were categorized as primary (tributaries with high opportunity), secondary (tributaries with moderate opportunity), or excluded from evaluation (tributaries with little to no opportunity). PM&E measures designed to improve habitat conditions in primary tributaries and one secondary tributary (i.e., Pewee Creek), termed Tier-1 tributaries, are addressed in other Sections (5.4.2. to 5.4.8) of this FAMP. All other secondary and excluded tributaries, hereafter collectively referred to as Tier-2 tributaries, are listed in Table 5.4-12 and addressed in this PM&E measure. Maps showing the location of the Tier-2 tributaries are provided in SCL (2009a, Figures 3.1-1 and 3.4-1).

Under this PM&E measure, SCL, in consultation with the FAWG, shall implement measures to improve aquatic habitat conditions in Tier-2 tributaries commensurate with the resulting benefits to native salmonids. The following sections describe the process for identifying Tier-2 tributaries that provide opportunity for habitat improvement and identifying measures that SCL will implement to benefit native salmonids.

Table 5.4-12. Tier-2 tributaries to Boundary Reservoir.

Stream Name	Confluence with Boundary Reservoir at Project River Mile
Unnamed No. 1	17.2
Unnamed No. 2	17.9
Everett Creek	21.9
Whiskey Gulch	21.9
Beaver Creek	24.3
Threemile Creek	24.3
Unnamed No. 3	25.4
Unnamed No. 4	27.1
Unnamed No. 5	28.9
Unnamed No. 6	29.2
Unnamed No. 7	29.6
Unnamed No. 8	30.1
Wolf Creek	30.3
Unnamed No. 9	31.1
Lost Creek	32.2
Unnamed No. 10	33.5
Unnamed No. 11	33.6
Unnamed No. 12	34.0
Unnamed No. 13	34.3

5.4.9.2. Background Information

As noted above, SCL conducted Study 14: Assessment of Factors Affecting Aquatic Productivity in Tributary Habitats in support of relicensing of the Project (SCL 2009a). The objective of the study was to assess aquatic habitat conditions in tributaries to Boundary Reservoir upstream of their deltas. Twenty-eight tributaries to the reservoir were identified and categorized as primary, secondary, or excluded according to the extent to which habitat improvement action would likely benefit native salmonids (Table 5.4-13).

Habitat improvement measures, such as culvert replacement, non-native fish suppression and eradication, and LWD placement, were developed to address Tier-1 tributaries (see Sections 5.4.2 to 5.4.8). As part of the comprehensive Boundary SA parties will review those tributaries that were deemed low priority in Study 14. It is possible that some secondary or excluded stream reaches that currently appear to offer low potential salmonid habitat due to their short length or small drainage could benefit native salmonids through habitat manipulation or protection.

5.4.9.3. Procedures

5.4.9.3.1. Watershed Assessment

Tier-2 tributaries that are identified for habitat manipulation or improvement under this PM&E must contain potential habitat suitable for native salmonids. SCL shall conduct, in consultation with the FAWG, a watershed assessment to compile and obtain information necessary to determine which Tier-2 tributaries warrant habitat improvement measures. The watershed assessment will be initiated by compiling existing information on the biology and habitat conditions of the Tier-2 tributaries. Little information is currently available for Tier 2 tributaries; however, implementation of the this PM&E measure is scheduled to occur during Years 20-25 following license issuance and additional information may become available through the course of 20 years of post-licensing studies in the Boundary Basin. Information specific to each Tier-2 tributary that will be considered as part of the watershed assessment will include, but not be limited to:

- Watershed area;
- Summer stream water temperature;
- Presence of barriers to upstream fish migration;
- Length of stream accessible to adult adfluvial fish;
- Stream gradient;
- Existing instream and riparian habitat conditions; and
- Any factors potentially limiting salmonid production.

If site-specific data are insufficient SCL, in consultation with the FAWG, shall collect information needed to identify Tier-2 tributary streams that warrant further consideration. SCL shall complete a limiting factors assessment for each of the selected Tier-2 tributaries and identify in consultation with the FAWG the nature and extent of habitat manipulation or protection measures that will benefit native salmonids. The over-riding criterion is that the Tier-2 tributary must have, or potentially have, useable native salmonid habitat that could be effectively improved through habitat improvement or protection.

Table 5.4-13. Stream level of opportunity categorization and criteria (Study 14, SCL 2009a).

Category	Criteria	Reason
Primary (Tier-1)	Adfluvial habitat greater than 250 feet and watershed area is more than 1 square mile.	Streams of this size, at a minimum, have the greatest potential to influence Boundary Reservoir native adfluvial fish resources, and, therefore, if a limiting factor can be improved through human intervention, it may be considered as an opportunity. These streams have both a moderate to large basin to help increase flow and increase overall habitat quality in the reaches accessible to adfluvial fish with the ability to enhance more life stages and sizes of adfluvial species, as well the potential to enhance native fish species.
Secondary (Pewee Cr is Tier-1, all others Tier-2)	Containing either a watershed area greater than 1 square mile or adfluvial habitat length greater than 250 feet. If a tributary meets either of these criteria, and a natural barrier at the mouth is present and native salmonid species are known to occur in the basin, it will be included.	The larger basins, without adfluvial habitat, may be worth evaluating further because there may be potential for watershed improvements that could enhance native salmonid species populations. The smaller basins, with adfluvial habitat length greater than 250 feet, may have some potential for human-aided improvement, possibly improving available habitat for Boundary Reservoir native species. They are not considered prime streams because of the low amount of drainage area limiting overall habitat, and/or limited adfluvial stream length, restricting the potential to benefit adfluvial habitat through human intervention. Tributaries that have natural barriers occurring at the mouth, but have native salmonids known to be present in the basin, are included because these creeks may have opportunities to improve aquatic habitat without the need to supplement existing populations.
Excluded (Tier-2)	Less than 1 square mile and less than 250 feet adfluvial habitat. Has a natural barrier occurring at the mouth of the tributary and no native salmonid populations	These streams, because of their small size and very limited adfluvial habitat, have a low potential to benefit either adfluvial or resident trout under existing conditions, or with any human intervention to current conditions.

5.4.9.3.2. Identify Potential Habitat Improvement Measures

Following the collaborative determination by SCL and the FAWG regarding the type of habitat improvement measure(s) to be applied in each viable Tier-2 tributary, SCL shall prepare a site-specific habitat improvement plan that will be submitted to the FAWG for review and approval. The level of habitat manipulation or protection to be implemented for a selected Tier-2 tributary will be commensurate with potential benefits to native salmonids. During preparation of the habitat improvement plan, SCL, in consultation with the FAWG, shall conduct fieldwork necessary to support the planning effort. The types of measures that could be implemented in Tier-2 tributaries include:

- Riparian planting;
- LWD placement;
- Large boulder placement;

- Non-native fish suppression/eradication;
- Conservation easements; and/or
- Culvert replacement.
- Native Fish Supplementation

The habitat restoration plan will provide a schedule for implementation and describe success criteria for each habitat improvement or protection activity similar to those previously described for Tier-1 (i.e., primary) tributary improvement activities.

5.4.9.3.3. Implement Habitat Improvement Measures

Following FAWG approval of the site-specific habitat improvement plan for each selected Tier-2 tributary, SCL shall implement the measures according to the schedule identified in each plan. Implementation of measures in selected Tier-2 tributaries is scheduled to occur during post-licensing years 20-25. Implementation procedures will be consistent with those described for similar habitat improvement activities previously described for Tier-1 tributaries (see Sections 5.4.2 to 5.4.8), but adjusted for site-specific conditions associated with Tier-2 tributaries.

5.4.9.4. Compliance, Effectiveness, and Adaptive Management

SCL shall conduct compliance monitoring within one year following implementation of a habitat restoration measures in selected Tier-2 tributaries. Protocols for collecting compliance information will be determined during implementation planning and subject to consultation and approval of the FAWG. At a minimum, compliance monitoring will include documentation collected during implementation of the PM&E measure, such as survey data, records of purchased materials (LWD pieces, boulders, etc), and photographs of each site before and after measures or repairs are implemented.

SCL, in consultation with the FAWG, shall develop effectiveness monitoring protocols as part of implementation planning. If riparian planting is implemented on any of the Tier 2 streams, effectiveness monitoring will be conducted 3 years after planting to determine whether planting success criteria have been achieved. For riparian areas suitable for establishing vegetation, mitigation planting success and any remedial measures shall achieve at least 80 percent survival of trees and shrubs and 50 percent canopy cover of native species at the end of 3 years from the date of planting. Grasses, forbs, shrubs, and trees shall be planted to achieve the desired structure and function for site-specific habitat conditions.

SCL shall conduct physical effectiveness monitoring beginning in the eighth year following implementation and every eight years thereafter. The purpose of effectiveness monitoring will be to assess the PM&E measure’s condition to determine if additional treatments are needed to maintain the measure’s designed functions or intended purposes. Criteria for determining whether a PM&E measure needs remediation will be determined during post-license planning and will be subject to approval of the FAWG. The results of the effectiveness monitoring will be used to support adaptive management and adjustments to the PM&E measures at eight-year intervals. If a structure falls below established success levels, SCL shall develop a plan for remediation within 60 days, for approval of the FAWG, to correct the deficiencies. SCL shall begin implementing these remediation measures within 30 days of permit approval or as determined appropriate by the FAWG. Subsequent effectiveness monitoring will occur as determined by the FAWG.

No fish population monitoring will be conducted in Tier-2 tributaries as part of this measure; however, monitoring may occur as appropriate for other PM&E measures.

In addition to the eight-year effectiveness monitoring, SCL shall annually, and following major (25-year) flood events, visit measures for routine inspection/maintenance to ensure that no substantive adverse impacts have occurred, with the exception that SCL shall have no responsibility for annual visits to, or providing routine maintenance of, measures (i.e., culvert improvements) on NFS roads. No formal reports will be required for these visits, although brief written updates shall be provided by SCL upon request by the FAWG. It is understood that routine visits to and maintenance of measures on NFS roads (i.e., culverts) shall be the responsibility of the Forest Service as part of its regular road monitoring and maintenance activities.

5.4.9.5. Reporting and Schedule

The reporting and implementation schedule for habitat restoration measures in Tier-2 tributaries is summarized in Table 5.4-14.

Table 5.4-14. Reporting and implementation schedule for habitat restoration measures in Tier-2 tributaries.

PM&E Measure Activity	Schedule
Watershed Assessment	Within 20 years of license issuance
Site Specific Habitat Improvement Plans	Between 21 to 25 years following license issuance
Implement on-ground Habitat Improvement Activities	Between 21 to 25 years following license issuance
Compliance Monitoring and Report	Within one year following implementation
Effectiveness Monitoring	Every eighth year following implementation
Monitoring Report	Within one year following monitoring

5.4.9.6. Consistency with Other Plans

This PM&E measure complements habitat improvement measures proposed for other tributaries, as described in Sections 5.4.2 to 5.4.8 of this FAMP. There are no conflicts between this PM&E measure and any other resource plans developed by SCL.

5.4.10. Closure and Restoration of Sullivan Creek Dispersed Recreation Sites

5.4.10.1. Scope

This PM&E measure shall be governed by License Article 9(E). The objective of this PM&E measure is to describe the process leading to the closure and restoration by SCL of up to 38 recreation sites located in riparian areas along Sullivan Creek to help restore fish habitat.

5.4.10.2. Background Information

According to the Sullivan Creek Watershed Assessment (USFS 1996), many of the dispersed campsites in the vicinity of Sullivan Creek are located in riparian areas. The dispersed sites receive heaviest use during the summer recreation season (Memorial Day weekend and the period from July 1 to Labor Day weekend), with a second high-use period occurring during the fall hunting season. At the time of the watershed assessment, only five dispersed sites were equipped with sanitary facilities (three sites along Sullivan Creek Road, one at Gypsy Meadows, and one at the Salmo Loop Trailhead).

Many of the dispersed sites received heavy or extreme impact ratings at the time of the watershed assessment (USFS 1996). Dispersed recreation has diminished the supply of LWD and resulted in a lack of shrubs and herbaceous cover in some riparian areas. The effects of dispersed recreation on fisheries were characterized in the watershed assessment as follows:

> Loss of bank vegetation is causing bank instability and sedimentation in localized areas. Loss of riparian vegetation has occurred at dispersed recreation sites with heaviest impacts occurring along portions of the stream between John’s Creek and Cascade Creek.

5.4.10.3. Procedures

5.4.10.3.1. Initial Recreation Site Restoration Plan

SCL shall develop an Initial Recreation Site Restoration Plan (Initial Plan), in consultation with the FAWG and subject to the approval of the USFS. The Initial Plan shall describe, in sufficient detail for NEPA purposes, the recreation sites to be closed and restored and the site-specific measures for each site. The Initial Plan will form the basis for the proposed action under the USFS NEPA process.

The Initial Plan shall be based on a list of up to 38 sites provided by the USFS to SCL that identifies the potential sites to be closed.

The Initial Plan will describe some combination of the following measures to be implemented at each recreation site to be closed:

- Placement of boulders to occupy existing camping and fire ring locations
- Placement of boulders to prevent vehicle access
- Loosening of compacted soils
- Streambank stabilization measures

- Slope grading
- Revegetation with locally derived native trees and shrubs
- One-time suppression of invasive weed species, if feasible[3]
- Removal of fire pits
- Trash removal
- Removing pit toilets
- Public education regarding closure of dispersed sites and locations of new dispersed sites as part of the Multi-Resource Interpretation and Education (I&E) program

The Initial Plan shall also include draft biological evaluations or assessments including survey data as required by regulations applicable to habitat or ground-disturbing activities on NFS lands in existence at the time the Plan is prepared.

Upon completion of the Initial Plan, SCL shall provide it to the USFS for use in the NEPA process.

USFS will develop for use in the NEPA process a comparable level of information on potential replacement recreation opportunities, including but not limited to new sites and facilities to be opened.

5.4.10.3.2. NEPA Process

SCL shall fund the portion of the USFS NEPA process for the proposed action described in the Initial Plan to close and rehabilitate recreation sites. SCL will provide funds to the USFS through a reimbursable collection agreement, consistent with USFS policy and regulations at the time USFS NEPA process is initiated. The NEPA process conducted by the USFS will incorporate all required evaluations and assessments completed by SCL for ground disturbing activities related to closing and rehabilitating recreation sites.

Through the NEPA process, the USFS will also evaluate and identify replacement recreation opportunities, including but not limited to new sites and facilities, to help offset the loss of sites along Sullivan Creek.

5.4.10.3.3. Final Recreation Site Restoration Plan

Following the NEPA decision by the USFS to close and rehabilitate recreation sites and to open replacement recreation opportunities, including but not limited to new sites and facilities within the Sullivan Creek Drainage, SCL shall develop a Final Recreation Site Restoration Plan (Final Plan) in consultation with the FAWG and subject to the approval of the USFS. Based on the NEPA decision on which sites are to be closed SCL shall develop the site specific designs for the closure and restoration of recreation sites. These designs shall detail the exact methods and measures to be employed for site closure, site restoration, streambank stabilization, and all other activities. The Final Plan shall also contain an implementation schedule detailing the

[3] SCL would, if deemed appropriate and following USFS approval, eradicate invasive weeds existing within a given dispersed recreation site as a one-time measure during the restoration of the site.

contemporaneous closing of recreation sites, and opening of replacement recreation opportunities by the USFS.

5.4.10.3.4. Closure and Restoration

Following USFS approval of the Final Plan, SCL shall file the Final Plan with FERC as an amendment to the FAMP. SCL shall implement the Final Plan according to the schedule in the Final Plan, consistent with Section 5.2.7 and Table 5.2-1 below, upon FERC approval of the amendment and in conjunction with the USFS plans for providing replacement recreation sites within the Sullivan Creek Drainage.

SCL's commitment under this measure does not include an obligation to develop replacement recreation sites, or for providing amenities, e.g., sanitation facilities, at any replacement recreation sites. Public education regarding closure of dispersed sites and locations of replacement recreation sites will be provided as part of the Multi-Resource Information & Education program (see Recreation Resource Management Plan).

5.4.10.4. Compliance, Effectiveness, and Adaptive Management

SCL shall be responsible for compliance and effectiveness monitoring and maintenance at the closed and restored sites.

Once a restoration measure has been completed (i.e., the success criteria have been met), SCL shall evaluate the measure every eight years for the term of the license to ensure the measure is meeting the success criteria. If a restoration measure falls below success levels as determined through 8-year compliance monitoring, SCL shall within 60 days, develop a plan for repairs, for approval by the FAWG, to correct the deficiencies. SCL shall begin implementing these repairs within 30 days of permit approval or as determined appropriate by the FAWG. Subsequent monitoring will occur as determined by the FAWG.

SCL shall maintain each restoration measure as required in the plan. SCL shall also routinely visit each restoration site (at least annually, as well as following significant weather events, or as reasonably required by the FAWG) to ensure that no substantive adverse impacts have occurred at the restoration site. Formal reports will not be required as a result of these routine visits, although brief written updates shall be provided by SCL to the FAWG upon request.

5.4.10.5. Implementation Schedule

Closure and restoration of recreation sites along Sullivan Creek shall occur within ten years of license issuance, or as otherwise agreed to with the USFS.

The FAWG shall monitor activities by SCL and the USFS with regard to the closing of existing sites and opening of new recreation opportunities, including but not limited to new sites and facilities, to ensure that the opening of replacement opportunities by the USFS and the closure of existing sites by SCL is occurring on a contemporaneous basis. The implementation schedule will be adjusted by the FAWG, subject to approval by the USFS, as needed to maintain a balance between the closing of sites and opening of new opportunities.

Table 5.4-15. Implementation schedule for closure and restoration of dispersed recreation sites along Sullivan Creek.

PM&E Measure Activity	Schedule
SCL prepares the Initial Recreation Site Restoration Plan, based on a list of sites provided by the USFS, showing the planning level details for the closure and restoration of recreation sites in the Sullivan Creek watershed.	TBD by USFS; but starting no sooner than one year following license issuance
USFS completes NEPA analysis for closure and rehabilitation of existing sites, and opening of replacement opportunities.	TBD by USFS
SCL prepares Final Recreation Site Restoration Plan.	Within six months of USFS NEPA decision.
USFS approves the Final Recreation Site Restoration Plan.	Within 30 days of receiving the Final Recreation Site Restoration Plan.
SCL files Final Recreation Site Restoration Plan with FERC.	Within 30 days of USFS approval.
Implementation of closure and restoration measures	Initiate within one year following FERC approval of the Recreation Site Restoration Plan. Complete based on the approved Plan schedule.

5.4.10.6. Consistency with Other Plans

There are no conflicts between this PM&E measure and other resource plans developed by SCL.

5.5. Mill Pond Dam Site Monitoring and Maintenance

5.5.1. Scope

This PM&E measure shall be governed by License Article 9(F). SCL shall monitor the Mill Pond Dam site and maintain the site to remediation design specifications following completion of dam removal and restoration efforts. SCL shall monitor the Mill Pond Dam site to assess stream channel, floodplain, and upslope conditions to determine if any structures or plantings fall below the success levels established during implementation planning for the decommissioning of Mill Pond Dam. In consultation with the FAWG, SCL shall adaptively manage the site and adjust and implement stream restoration components to maintain remediation benefits.

As part of its surrender application for the Sullivan Creek Project, the POPUD will implement the Mill Pond Decommissioning Plan (Decommissioning Plan) which describes the decommissioning work to be performed at the Mill Pond Dam site. In general, the Mill Pond Decommissioning Plan covers removal and restoration work that will be completed within five years of FERC issuance of a surrender order for the Sullivan Creek Project. Upon FERC's determination that the work required by the Mill Pond Decommissioning Plan has been completed, and FERC's termination of its jurisdiction over the Mill Pond area, SCL shall monitor and maintain the Mill Pond Dam site as described in this measure.

5.5.2. Background Information

Mill Pond, located at RM 3.9 on Sullivan Creek, was created when a log crib dam was constructed in 1909 by the Portland Cement Company. The un-gated concrete dam, built in

1921 just below the log crib dam, is 134 feet long and about 55 feet high and historically maintained the water surface elevation of Mill Pond at approximately 2,520 feet NAVD 88. In 1956, the powerhouse was shut down because of maintenance problems with the wooden flume that conveyed water from Mill Pond to the powerhouse. In 1958, the Federal Power Commission, now FERC, licensed the Project as a non-generating project, with provisions for adding generating capabilities. In 1973, the supporting pillars were removed from the top of the dam creating an open spillway and establishing the current elevation at 2505.7 feet.

Mill Pond Dam has altered the natural sediment transport processes in Sullivan Creek by trapping all bedload material behind the dam (USFS 1996). This has created a condition where Sullivan Creek downstream of Mill Pond Dam is sediment depleted (USFS 1996). Therefore, the sediment transport capacity exceeds the sediment supply in the reach below the dam, which has resulted in a lack of appropriately sized spawning gravel for local trout populations and extensive armoring of the bed surface. Mill Pond Dam has also altered to some extent the downstream transport of LWD (USFS 1996) and is a complete barrier to the upstream movement of resident fish (SCL 2009).

Warm water temperatures, measured at approximately RM 1.7 by R2 Resource Consultants (1998), demonstrated the warming effect of Mill Pond Dam on waters discharged from Sullivan Creek and Sullivan Lake and flowing towards the mouth of Sullivan Creek. During the summer months, water temperatures can exceed 16 ºC, with Mill Pond Dam increasing water temperature by approximately 2.0 to 2.4 ºC (Doug Robison, WDFW, pers. comm. 2009).

Within five years of FERC's issuance of an order authorizing the surrender of the Sullivan Creek License, POPUD will remove Mill Pond Dam, manage sediment, and implement site restoration measures at the Mill Pond site. The POPUD will remove both the concrete and log crib dams and artificial foundations to facilitate natural stream functions in Sullivan Creek. The POPUD will also remedy any barrier to upstream fish passage caused by the construction, operation, or removal of Mill Pond Dam (not including any natural barriers that may be present at the site).

Benefits of Mill Pond Dam removal and associated site restoration will include elimination of the man-made barrier to upstream fish passage, an increase in the quantity and quality of habitat for native salmonids, restoration of downstream transport of coarse sediment and LWD, and benefits to water quality in the form of reduced summer water temperatures due to reductions in water surface area and increases in water velocity in the area of Mill Pond. Under this Mill Pond Dam Site Monitoring and Maintenance Measure, SCL shall monitor and maintain the site to ensure the natural resource benefits associated with the POPUD removing Mill Pond Dam continue through the term of the FERC License for the Boundary Project.

5.5.3. Procedures

Following completion of dam removal and restoration effort required of POPUD and after FERC jurisdiction over the site through the Sullivan Creek Project license ends, the new license for Boundary shall require SCL to monitor and maintain the site to ensure that the stream channel and floodplain continue to function in accordance with the design criteria, that riparian and upland vegetation is becoming established, and to control non-native plant species. SCL shall develop plans and protocols for monitoring and maintenance of the Mill Pond Dam site in consultation with the FAWG and subject to approval by USFS and Ecology.

SCL shall conduct monitoring at the site during Years 2, 4, 6, and 10 following the end of FERC jurisdiction over the site through the Sullivan Creek Project license and then at eight-year intervals for the remainder of the Boundary license term to ensure that the stream channel is functioning in accordance with the design criteria and native vegetation is becoming established. For areas restored according to the Final Decommissioning Plan, SCL shall maintain plantings to achieve the desired structure and function for site-specific habitat conditions. If a treatment falls below success levels established in the Final Decommissioning Plan, within 60 days of monitoring SCL shall develop a plan for remediation, for approval by the FAWG, to correct the deficiencies. SCL shall begin implementing these repairs within 30 days of permit approval or as determined appropriate by the FAWG.

In addition to the eight-year effectiveness monitoring, SCL shall annually, and following major (25-year) flood events, visit the site for routine inspection/maintenance to ensure that no substantive adverse impacts have occurred. No formal reports will be required for these visits although brief written updates shall be provided by SCL upon request by the FAWG. In the event of flows greater than a flood event having a 100-year recurrence interval, SCL will not be responsible for repair of stream restoration measures that may have been damaged from such an event.

5.5.4. Compliance, Effectiveness, and Adaptive Management

SCL, in consultation with and subject to the approval by the FAWG, shall develop protocols for collecting compliance and effectiveness information. SCL shall demonstrate compliance with this measure by providing the results of monitoring and remediation activities. The main purpose of effectiveness monitoring will be to assess stream channel, floodplain, and upslope conditions to determine if any structures or plantings fall below the success levels established during implementation planning conducted by POPUD under the Decommissioning Plan. SCL shall identify in the monitoring plan, developed pursuant to this monitoring and maintenance measure, criteria by which decisions will be made to require the licensee to take corrective action if monitoring shows that any component of the restoration effort has been ineffective. The results of effectiveness monitoring will be used to support adaptive management, in consultation with the FAWG, and adjustments to the stream restoration components of Mill Pond decommissioning at eight year intervals.

5.5.5. Reporting and Schedule

The reporting and implementation schedule for Mill Pond Dam monitoring and maintenance is summarized in Table 5.5-1.

Table 5.5-1. Reporting and implementation schedule for Mill Pond Dam monitoring and maintenance.

PM&E Measure Activity	Schedule
Compliance and Effectiveness Monitoring Protocols	Within one year of FERC determination that POPUD has satisfied surrender conditions
Effectiveness Monitoring of Site Restoration	In the second, fourth, sixth, and tenth years following FERC determination and at 8 year intervals thereafter
Effectiveness Monitoring Report	Within 1 year following completion of effectiveness monitoring

5.5.6. Consistency with Other Plans

There are no conflicts between this PM&E measure and any other resource plans developed by SCL.

5.6. Native Salmonid Conservation Program

5.6.1. Scope

This PM&E measure shall be governed by License Article 9(G). SCL shall fund the design, construction and operation of a fish propagation facility for the production of native salmonids to outplant into tributaries draining into Boundary Reservoir. Implementation planning will be completed within 3 years of license issuance and the facility will be operational within 6 years of license issuance. Facility design and operational protocols are to occur in consultation and subject to approval of the FAWG and the WDFW prior to, and during, implementation. Facility operations will be conducted by qualified staff either contracted or hired by SCL. Staff qualifications will be developed by SCL in consultation with the FAWG. For a state-owned facility, facility design, staff qualifications and operational protocols are subject to completion of an operations agreement between SCL and WDFW. SCL shall outplant propagated native salmonids to supplement existing populations, or to introduce native salmonids into reaches where they are not currently present. Target release sites will include those reaches where non-native trout have been actively suppressed or where underutilized habitat is available in tributaries draining into Boundary Reservoir. Outplanting native salmonids in Boundary tributaries is expected to complement non-native trout suppression and stream habitat improvement activities.

The initial capacity for the facility will be up to 45,000 eyed eggs, fry, or fingerling (3 to 4 inch) fish per year and multiple age class broodstock (capacity of 1,000-2000 pounds). Annual production will be commensurate with the need to outplant fish in areas where non-native suppression/eradication has occurred in tributaries draining into Boundary Reservoir. The frequency of outplanting and number of fish to be planted in each tributary shall be determined based upon the specific population goal developed by the appropriate agencies for that tributary. Any changes to the outplanting schedule will be determined as a result of effectiveness monitoring and adaptive management to be reviewed by the FAWG and subject to approval of the appropriate agencies.

SCL will be open to partnering arrangements at no additional expense to SCL that would allow expansion and/or use of the facility to meet fish propagation needs beyond those of the Project. For any state owned facility, expansion or use of the facility beyond Boundary Project needs will be subject to WDFW approval. Expansion of the facility must not infringe upon the needs of the Project and maximum capacity of an expanded facility will be no more than 20,000 lbs.

The facility will be designed to incorporate techniques to increase fish fitness and survival after release. Design considerations for outdoor rearing facilities will consist of a naturalized, sinuous channel lined with cobble and gravel substrate similar to Boundary drainages, feeding system, natural shading, and instream woody habitat. Other design considerations not limited to outdoor rearing will be evaluated in consultation with the FAWG. Predator exclusion and protection systems will be incorporated into the facility. All water supplies will be alarmed. Broodstock holding and spawning facilities will consist of a naturalized pond designed to allow water drawdown and crowding, fish lift and spawning area. The facility will also include ponds or tanks to hold fish captured during suppression or eradication treatments for re-introduction to target reaches. A propagation building will house administrative offices, incubation room, and early rearing troughs. A pollution abatement facility incorporating Best Management Practices and All Known and Reasonable Technology (AKART) will be constructed on site. The facility will be designed to produce eyed eggs, alevins, fry and fingerling-sized fish. The primary distribution of fish is assumed to be fingerlings, but may include stream-side incubators or artificial redds to minimize potential domestication. Broodstock collection activities, appropriate marking of all outplanted fish for the purpose of identification during effectiveness monitoring, and distribution of eggs, fry and fingerlings shall be funded by SCL.

Westslope cutthroat trout will be the initial target species for propagation, but the facility must be designed to propagate bull trout or other native salmonids. The facility will be designed to simultaneously propagate two species of fish and several year classes (life stages); selection of species, stocks, and lifestages to be produced will be determined as part of post-license planning and subject to approval of the FAWG and WDFW. In addition, the facility will have the capacity to sustain the necessary numbers of broodstock fish to produce this number of eggs, fry, or fingerlings for the purposes of the supplementation program. Locally adapted, multiple age class broodstock will be used to maintain long-term fitness traits and the facility will be operated to minimize genetic divergence from local, naturally spawning stocks.

5.6.2. Background Information

The larger tributaries to Boundary Reservoir contain a variety of fish species, and most salmonid species in the Project vicinity occur in the tributaries (SCL 2006, SCL 2009b). Surveys conducted by the USFS (2005), WDFW (McLellan 2001), and CES (1996) showed that the dominant sport fish 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 observations of bull trout (1 carcass, apparently left by an angler), kokanee, and burbot in Sullivan Creek, and one bull trout 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 self-reproducing bull trout populations occur in any tributaries to Boundary Reservoir. Nevertheless, the Northeast Washington Recovery Unit (NWRU) 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). The NWRU Team also suggested that artificial propagation of bull trout could be needed to seed currently unoccupied habitat, but urged caution and the need to address the threats affecting populations and their habitat before pursuing artificial propagation.

Westslope cutthroat trout are widely distributed in the Project area and tributaries to Boundary Reservoir but threatened by the presence of non-native brook trout. Suppression of brook trout and habitat improvements in tributaries to Boundary Reservoir are proposed as a separate PM&E measure. Peterson et al. (2004) found the survival of age-0 and age-1 cutthroat trout at mid-elevation reaches (approximately 8,200 to 8,858 feet elevation) were 13 times and 2 times higher, respectively, when brook trout abundance was suppressed. Lower elevations similar to the area surrounding the Boundary Project were not sampled. SCL hypothesizes that outplanting of westslope cutthroat trout and habitat improvements in streams can complement brook trout suppression activities and result in higher recruitment to the cutthroat trout population than suppression alone.

5.6.3. Procedures

Preliminary planning suggests that the 40-acre WDFW parcel on Skookum Creek, that formerly included the Usk Hatchery, is a potential location for the propagation facility. In addition to withdrawing water from Skookum Creek, the site has a natural, cold water spring that could be used as a gravity-fed water supply. The water supply could require some passive and/or active heating to increase source water temperature, but the cold water source would be conducive to propagating native salmonids.

A multi-step approach will be used to implement this PM&E measure. Completion of each step will be in consultation with the FAWG and subject to approval of the USFS and Ecology. Prior to construction of the conservation facility, SCL shall prepare annual reports summarizing the activities during the previous year. The first step in the development of the native salmonid conservation facility will be to confirm the feasibility of the site. If the Usk facility proves to be infeasible, SCL will consider alternatives including purchase or funding of an alternate existing facility, or development at a new site with an appropriate source of water.

The second step will be to complete implementation planning that identifies the following:

- Goals and policies of federal and state agencies and the Kalispel Tribe regarding conservation facilities and native trout recovery.
- Risks and benefits of outplanting bull and/or westslope cutthroat trout in the Project area.
- Mitigation measures to be used to reduce risk (e.g., of spreading disease, domestication, etc.).
- A conceptual level description and engineering design for the facility, with specifications.

- Description of any off-site facilities or techniques that could be used as part of release strategies (e.g., acclimation and volitional release ponds, streamside or instream incubation of eyed eggs, etc.).
- Sources and techniques to be used for collecting broodstock.
- Target production levels by life stage.
- A hatchery genetics management plan will be developed.
- A monitoring program to evaluate the success of outplanted native salmonids.

The third step will be preparation of draft and final engineering plans for the facility, completing any required regulatory review (e.g., NEPA compliance) and obtaining any needed permits. Following approval of final design and permitting, SCL shall construct the facility and fund operation and maintenance for the license term.

If a feasible site cannot be identified, SCL shall re-direct mitigation efforts towards the purchase of suitable eggs, fry or fingerlings from another source or toward commensurate PM&E measures as determined in consultation with the FAWG and subject to approval of the USFS and Ecology.

5.6.4. Compliance, Effectiveness, and Adaptive Management

A construction compliance report shall be prepared within one year following construction of the facility that will document any variances from the implementation planning, engineering and construction steps. Prior to the fish conservation facility being operational, the licensee shall annually summarize activities of the previous 12 months. Once the facility is operational, the licensee shall annually summarize the following information: A) numbers, lifestages, size and species of fish produced; B) timing and locations of releases; C) percent survival between life stages; D) results of the effectiveness monitoring; E) substantial disease outbreaks, other problems and remedies that were implemented to reduce the risk of problems reoccurring; and G) effectiveness monitoring. Annual reports are anticipated to be brief and complementary to five-year status reports. Status reports will summarize the annual reports and provide more detailed analysis and assessment of trends in the data. The five-year status reports shall also describe any changes in production or release strategies developed with approval from the FAWG and appropriate agencies and the rationale for implementing the changes.

As part of the tributary management plan, SCL in consultation with and subject to approval of the FAWG will establish population goals for the Conservation Program by determining appropriate tributary target fish populations desirable for the purpose of establishing self-sustaining, native stocks of fish. Optimal outplanting strategies for achieving desired goals will be identified by monitoring and evaluating multiple outplanting strategies that consider appropriate fish sizes, outplanting densities, frequency, and timing. Each outplanting strategy will have independent markers/identifiers for analysis (e.g., otolith marks utilizing calceine, thermal, strontium chloride). SCL shall monitor the initial success of outplanted native salmonids and periodically monitor until population goals are achieved. The reproductive success of outplanted native salmonids will be monitored and evaluated to determine if measurable goals are met. In consultation with the FAWG, information required to evaluate the effectiveness of the Native Salmonid Conservation Program may be obtained from other tributary program PM&E measures (such as suppression and eradication or habitat improvements), and stock status and genetics analyses conducted under the entrainment reduction research and monitoring fund. However, information developed under these PM&E measures may not satisfy all requirements to evaluate the success of the Conservation Program. Under this native salmonid conservation measure, SCL shall fund additional monitoring equivalent to approximately 0.5 FTE on an annual basis including necessary equipment and other associated expenses. The results of effectiveness monitoring will be included in the annual report and summarized in the five-year status reports.

5.6.5. Reporting and Schedule

The reporting and implementation schedule for the native salmonid conservation facility is summarized in Table 5.6-1. If the Usk site proves to be infeasible, and another potential existing facility cannot be identified within three years following license issuance, the FAWG will re-evaluate the compliance schedule for this PM&E.

Table 5.6-1. Reporting and implementation schedule for the native salmonid conservation facility.

PM&E Measure/Activity	Schedule
Complete Implementation Planning	Within three years of license issuance
Facility Draft and Final Engineering Plans	Within four years of license issuance
Facility Construction	Within six years of license issuance
Begin Operations	Within six years of license issuance
Construction Compliance Monitoring Report	Within seven years of license issuance
Annual Reports	Every year
Five-year Status Reports	Every fifth year

5.6.6. Consistency with Other Plans

There are no conflicts between this PM&E measure and other resource management plans prepared for the Project. The effectiveness of the native salmonid conservation program will be evaluated using the results of monitoring conducted under the measure and may be supported by information developed under the tributary improvement program and other fish and aquatic measures.

5.7. Recreational Fish Stocking Program

5.7.1. Scope

This PM&E measure shall be governed by License Article 9(H). SCL shall stock trout in 18 lakes within a fifteen-mile area around the Project (Table 5.7-1). Trout species stocked in these lakes will consist of westslope cutthroat, rainbow, rainbow triploid, or tiger trout, and may include fall fry, fingerlings, spring fry and catchable-size fish. These fish will be annually produced and planted by WDFW under a memorandum of agreement (MOA) to be negotiated with SCL; however, fish may be obtained from a commercial production facility if fish are unavailable from WDFW. Approximately 11,678 pounds of fish will be stocked annually (Table 5.7-2) beginning no later than License Year 2.

The species stocked annually in these lakes can vary and will depend on whether the lake is a closed system or has connection to a tributary. The number, size and species of fish, planting schedule and location may be adjusted in consultation with and approved by WDFW.

SCL shall monitor and evaluate lakes receiving the stocked fish prior to the springtime opening day of trout season. The objective will be to annually conduct biological monitoring on a rotating subset of lakes. Site-specific conditions (i.e., lake ice, weather, and road access) may determine monitoring opportunities. At least six of the lakes receiving stocked fish will be monitored each year. Monitoring activities will consist of yearly fall or pre-Opening Day spring index gillnetting to evaluate recruitment of planted trout fry, trout growth rates, relative trout abundance, and detection of illegally introduced and/or undesirable fish species. Net specifications will be consistent with gill nets employed by WDFW regional biologists for index netting on lowland trout lakes. Nets will be set in each lake during the afternoon and retrieved the following morning allowing net soak times of 12-18 hours. Index net sample sites for each lake sampled will be selected in collaboration with WDFW and the number of sample sites will be dependent on lake surface area (Table 5.7-3).

All fish captured in gill nets will be identified to species and measured for length and weight. Scales will be collected from trout for age determination.

Opening day creel census will be performed on two lakes per year. Lakes to be creel-sampled will be selected each year in collaboration with the WDFW District 1 Fish Biologist. For each lake sampled, standard WDFW creel sampling protocols will be employed, including standardized angler interviews and angler utilization estimates (fishing pressure counts).

Table 5.7-1. Name, county, distance from Boundary Reservoir, and surface area (acres) of lakes to be stocked with salmonids to provide recreational fishing opportunities.

Lake	County	Approximate Distance from Boundary Res. (miles)	Approximate Surface Area (acres) [1]
Big Meadow Lake	Pend Oreille	7.4	4.0
Boundary Lake	Pend Oreille	2.1	10.0
Carls Lake	Pend Oreille	8.3	7.0
Cedar Lake	Stevens	11.4	6.0
Crescent Lake	Pend Oreille	1.2	22.0
South Deception Lake	Pend Oreille	5.0	3.8
Deep Lake	Stevens	9.5	66.0
Frater Lake	Pend Oreille	9.2	11.0
Gillette Lake	Stevens	12.8	47.0
Heritage Lake	Stevens	10.9	71.0
Lead King Lakes[2]	Pend Oreille	0.9	6.6
Leo Lake	Pend Oreille	9.9	39.0
Little Lost Lake	Pend Oreille	1.8	6.0
Nile Lake	Pend Oreille	9.0	23.0
Sherry Lake	Stevens	13.3	26.0
Sullivan Lake	Pend Oreille	3.8	1,291.0
Thomas Lake	Stevens	12.0	163.0
Yocum Lake	Pend Oreille	11.9	42.0

[1] Wolcott (1973); [2]Two neighboring lakes 4.2 and 2.4 acres in size.

Table 5.7-2. Species size, and number (by weight) of fish to be stocked annually under the recreational fish stocking program.

Species	Dominant Size Stocked	Pounds
Cutthroat trout	fall fry	105
	Fingerling	1,744
Rainbow	fall fry	2,660
	Fingerling	625
Rainbow (triploid)	catchable	3,400
	spring fry	317
Tiger trout	Fingerling	2,827
	Total	11,678

Table 5.7-3. Criterion for number of gill nets to deploy for pre-season monitoring of lakes stocked with trout.

Surface Area (acres)	No. of Nets Set
1-24	1
25-149	2
150-349	3
>350	4

An annual report will be prepared identifying the amount, size, species, timing and location of stocking efforts and the results of monitoring and evaluation activities. Any modifications to survey timing, location and protocol, and the location and protocol of Opening Day creel census activities will be developed in consultation with and approved by WDFW.

5.7.2. Background Information

The purpose of this measure is to mitigate for reduced or lost salmonid recreational fishing opportunities in Boundary Reservoir due to Project impacts on aquatic habitat, loss of fish through Project entrainment and predation. Fish stocking in Boundary Reservoir, as a traditional means of mitigating for these impacts, is not supported due to potential competition with native trout and poor trout habitat conditions. Therefore, this off-site mitigation measure was developed as an alternative.

As part of an ongoing WDFW program, fry and fingerling trout are routinely stocked in Washington lakes during the spring and fall where they grow on natural food until the following spring when they are large enough to be harvested (WDFW 2009). The survival rate of fry depends on conditions within the receiving lake. Where fry survival is low, or where there is intense fishing pressure, catchable size trout, 8 inches or larger, are stocked to provide recreational opportunities. In addition to rainbow and cutthroat trout, sterile and hybrid trout are planted in select lakes. Triploid trout are fish that have been sterilized by heat or pressure-treating the eggs after fertilization. Tiger trout are a hybrid cross between a male brown trout and a female brook trout. The tiger trout eggs are sterilized by heat treating the eggs. If provided with an abundant food supply and sufficient residence time, sterile triploid and tiger trout have the potential to grow to trophy size. Sterile trout are also planted in areas where natural reproduction could adversely affect native species.

5.7.3. Procedures

Within one year of license issuance and annually thereafter, SCL shall complete implementation planning to identify:

- Pre-stocking monitoring protocols;
- Source of fish;
- Number, size and species of fish, planting schedule and location; and

- Stocking protocols.

Annual implementation planning, monitoring and evaluation procedures, and stocking and reporting procedures will be developed in consultation with and approved by WDFW within the scope of the measure identified in Section 5.7-1.

5.7.4. Compliance, Effectiveness, and Adaptive Management

A compliance report shall be prepared each license year detailing activities within the previous calendar year. A compliance report will include documentation of the number, size, lifestage and species of fish stocked, fish condition, source of fish and cost of fish. Effectiveness of the fish stocking program will be identified through annual monitoring and evaluation. The number, size, and species of fish to be stocked in the selected lakes each year, under this mitigation program, may be modified, but will not exceed the overall pounds of production as identified in this measure.

5.7.5. Reporting and Schedule

SCL shall prepare annual reports summarizing information related to stocking, monitoring, problems encountered and results of activities during the previous calendar year. Each annual report will also identify activities planned for the upcoming year and highlight any proposed changes from previous protocols. SCL shall provide annual reports to the FAWG, and after a 30-day comment period will revise the annual report, as needed based on comments received, and prepare a final report. Comments and recommendations by the FAWG will be included in annual reports to the FERC with copies provided to the FAWG. The reporting and implementation schedule for the recreational fish stocking program is summarized in Table 5.74.

Table 5.7-4. Reporting and implementation schedule for the recreational fish stocking program.

PM&E Measure Activity	Schedule
Implementation planning	Within one year of license issuance
Fish stocking and monitoring	Annually, beginning no later than the second year following license issuance
Compliance and monitoring report	Annually

5.7.6. Consistency with Other Plans

There are no conflicts between this PM&E measure and other resource management plans. The recreational fish stocking program will be coordinated with the Recreational Resources Work Group.

6 REPORTING, COORDINATION, AND SCHEDULE

6.1. Reporting

Each of the PM&E measures described above has reporting requirements. For the convenience of preparing and reviewing this information, a single annual report shall be prepared by SCL and submitted to the FAWG. The annual report will contain subsections for each PM&E measure, with content dependent on the specific reporting requirement for the PM&E measure and the activities that occurred during the year. For example, during some years the content could include implementation plans while in others it could include the results and analysis of monitoring. The FAWG will have one month to review and provide comments on a draft annual report, and SCL will have one month to address comments and produce a final annual report for submittal to the FAWG and filing with FERC. Under some circumstances a document prepared for a PM&E measure (e.g., an upstream trap and haul facility design study) may require additional review and revision cycles that would take more time than what is available for the annual report, which will necessitate preparation on a schedule different from that of the annual report. Under these circumstances, stand-alone-reports or technical memoranda may be prepared as determined in consultation with the FAWG. A summary shall be provided in the annual report, and the stand-alone report or memorandum will be provided as an appendix.

In addition to plans and reports prepared as part of individual PM&E measures, meeting summaries will be prepared for all FAWG meetings and action items will be identified. SCL shall prepare follow-up memoranda to be circulated among the FAWG within one month following the meeting that identify how action items have been resolved.

6.2. Coordination

Details regarding consultation, decision making, communications and documentation related to the FAWG are addressed in Section 8 of the Boundary SA and included as Appendix 1 to this FAMP. The FAWG will consist of representatives from SCL and the federal, state, tribal, and local entities having jurisdiction over, or interest in, the implementation of fish and aquatics related Project license articles. At the discretion of the FAWG, subcommittees could be created to address specific issues, such as upstream fish passage, that draw on specialized expertise from the agencies represented on the FAWG, or other entities. The FAWG will be responsible for providing technical guidance for all license articles related to fish and aquatics resources, attempting to make recommendations based on reaching consensus in the group. Details regarding consultation, decision making, communications and documentation related to the FAWG are addressed in Section 8 of the Boundary SA and included as Appendix 1 to this FAMP.

In accordance with License Article 9 and the FAWG procedures in Appendix 1, SCL shall prepare any proposed amendments to the FAMP in consultation with the FAWG and subject to approval by the United States Forest Service, DOI, and Ecology prior to filing with the Commission.

6.3. Schedule

During the first 10 years following issuance of a new license it is anticipated that meetings of the FAWG would be relatively frequent because of the large number of PM&E measures to be planned and implemented. SCL anticipates that meetings would occur every other month for the first two years and quarterly for Years 3 through 5 to report on progress made on implementation planning and implementation, and to seek direction from the FAWG. Beginning in Year 6, SCL anticipates a single, one-day annual meeting of the FAWG would be needed to report activities from the previous year and two one-day or two-day meetings every five years to discuss any needed modifications resulting from adaptive management.

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Appendix 1: Boundary Resource Coordinating Committee and Work Groups (Section 8 of the Boundary Hydroelectric Project Relicensing Settlement Agreement)

8. Boundary Resource Coordinating Committee and Work Groups

8.1 Boundary Resource Coordinating Committee

8.1.1 Formation and Purpose

Within 90 days after issuance of the New License, the Licensee shall convene the BRCC to oversee on a broad scale the integrated and efficient implementation of the PM&E measures as specified in the Project Documents. The BRCC will: (1) be comprised of one representative from each signatory party; (2) meet annually to review a rolling three-year work plan that will include the preceding year, the current year, and the upcoming or "Out" year, consisting of a compilation of work plans of the individual Work Groups included in the annual reports (see Section 8.3.3.2); (3) ensure coordination among Work Groups; (4) review annual reports prepared by each Work Group; and (5) address issues affecting overall license implementation.

8.1.2 BRCC Membership

Each Party shall designate a primary representative to the BRCC at the initial meeting, or at any time thereafter with seven days notice. After the initial meeting, designation shall be by Notice to the Parties in accordance with Section 11.11 of the Settlement Agreement. Each member may name alternate representatives. A Party's failure to designate a representative shall not prevent the BRCC from convening or conducting its functions. Members of the BRCC may also serve on the Work Groups established in Section 8.2.1.

8.1.3 BRCC Initial Meeting

At the initial meeting, the BRCC shall establish:

8.1.3.1 Protocols for its annual meetings, including agenda development, timely distribution of materials, and location.

8.1.3.2 Common operating procedures for each Work Group (see Section 8.2), including agenda development (e.g., submission of agenda items), timely distribution of materials, location, and scheduling.

8.1.3.3 Procedures for each Work Group to review and approve the Licensee's implementation schedules that will describe on a month-to-month basis the specific actions that the Licensee plans to implement for the current year and actions planned for the following year (the "Out Year"). The schedule for the current year shall include a description of Project Documents, Work Products, or other materials that will be provided to the Work Groups. "Work Products" include the plans, study designs, reports, and facility designs required by the Project Documents to be filed with the Commission.

8.1.3.4 Protocols for documentation of PM&E measures implemented in the preceding year.

8.1.3.5 Each BRCC member shall also name its Work Group representatives.

8.1.4 BRCC Annual Meetings

BRCC annual meetings shall occur after all Work Group annual meetings and draft final annual reports (including the draft final rolling three-year work plan for that work group) but before the final annual work group reports are due to the Commission.

8.1.5 BRCC Meeting Minutes

The Licensee shall distribute minutes of the annual BRCC meetings, within 30 days of the meeting date, to BRCC members. Any comments, recommendations or questions raised during the annual meetings or in response to the meeting minutes shall be referred by the BRCC to the appropriate Work Group(s) for consideration and response.

8.1.6 BRCC Evaluation of Work Group Processes

The BRCC will evaluate the role, protocols and procedures of the Work Groups five years after issuance of the New License. The BRCC, with input from the Work Groups, will determine if protocols and procedures should remain the same, be modified or discontinued. The BRCC will re-evaluate Work Group roles and procedures periodically thereafter, throughout the term of the New License and any annual licenses.

8.1.7 Federal Advisory Committee Act

BRCC participation by state or federal agencies does not affect their responsibilities and authorities. Issues involving the exercise of agencies' specific authorities can be discussed, but decisions are not delegated to the BRCC. The BRCC does not provide consensus advice to any federal agency (consistent with the Federal Advisory Committee Act).

8.2 Work Groups

8.2.1 Work Group Formation and Purpose

The Licensee shall initially convene the Work Groups not later than 180 days after Commission issuance of the New License. Collaboration among the Parties on the specific requirements of the Project Documents will occur primarily through the Work Groups. At the initial meetings, each Work Group shall review the Project Documents, prioritize actions, and establish a list of tasks to be addressed over the current year and review and propose to the BRCC, as appropriate, revisions to the Work Group procedures established by the BRCC. The following Work Groups are hereby established with the voting members identified below:

8.2.1.1 FAWG Membership

The Licensee, USFWS, BIA, the Tribe, USFS, WDFW, Ecology, and SCA, or The Lands Council as an alternate participant, on behalf of the Hydropower Reform Coalition. The Licensee shall form a TAC when required by the FAMP. TAC members shall be chosen by the Licensee in consultation with and subject to the approval of the FAWG. TACs will be formed as necessary and disbanded upon the completion of their technical advisory assignments from the Licensee and the FAWG.

8.2.1.2 TRWG Membership

The Licensee, USFWS, USFS, WDFW, Ecology, and SCA, or The Lands Council as an alternate participant, on behalf of the Hydropower Reform Coalition.

8.2.1.3 RRWG Membership

The Licensee, USFS and NPS.

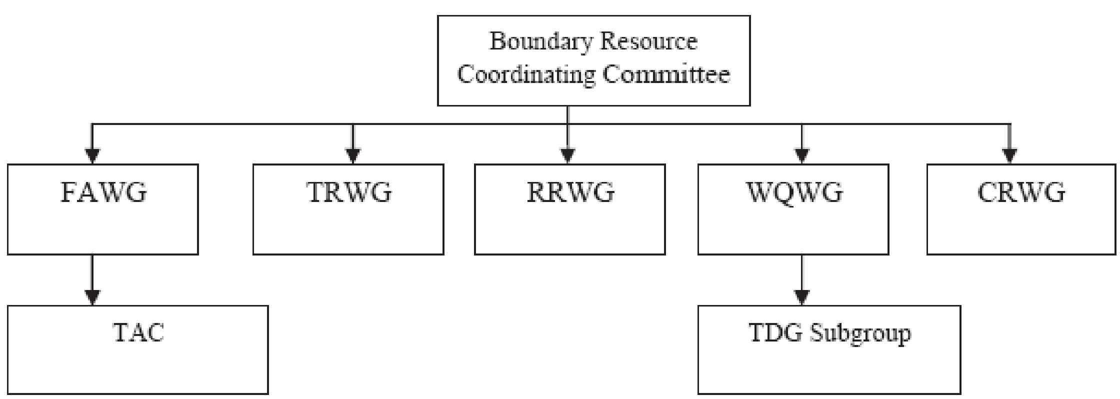
8.2.1.4 WQWG Membership

The Licensee, USFWS, BIA, the Tribe, USFS, WDFW, Ecology, and SCA, or The Lands Council as an alternate participant, on behalf of the Hydropower Reform Coalition. The WQWG will establish a TDG Subgroup, consisting of the Licensee, Ecology, WDFW, USFS and the Tribe to address progress on TDG.

8.2.1.5 CRWG Membership

The Licensee, BIA, the Tribe, and USFS. Washington Department of Archaeology & Historic Preservation and Bureau of Land Management will participate in the CRWG as defined by the Programmatic Agreement (Proposed License Article 7 in Settlement Exhibit 1).

Figure 1: Boundary Resource Coordinating Committee and Work Groups.



8.2.2 New Work Group Voting Members

Any Party may join any Work Group at any time during the term of the New License with 30 days Notice to the current members of the Work Group. Any organization with plan-level authority (as opposed to only permitting authority) over issues addressed by a Work Group that is not a Party to the Settlement Agreement may become a voting member of any Work Group with 30 days' Notice to the Parties if: (1) the organization becomes a signatory of this

Settlement Agreement; and (2) the organization agrees to abide by the protocols governing Work Group operations.

8.2.3 Work Group Non-Voting Members

Any other organization or a member of the public may volunteer to serve as a non-voting participant on a Work Group upon 30 days' Notice to the current members of the Work Group and with the approval of the voting members. To qualify, the organization or member of the public must: (1) identify an interest affected by the decisions of the Work Group; (2) agree to abide by consensus decisions of the voting members; and (3) agree to abide by the protocols governing Work Group operations. A non-voting participant has no decision-making authority within the Work Group (i.e., no voting rights or ability to elevate an issue to dispute resolution). Volunteer participants may be removed from a Work Group by consensus of the voting members with 30 days Notice.

8.2.4 Work Group Voting Member Representatives

Each Party shall designate primary representative(s) to the Work Groups at the initial meeting of the BRCC, or at any time thereafter with seven days notice. After the initial BRCC meeting, designation shall be by Notice to the Parties in accordance with Section 11.11 of the Settlement Agreement. Each member may name alternate representatives to the Work Groups. A Party's failure to designate a representative shall not prevent Work Groups from convening or conducting their functions.

8.2.5 Federal Advisory Committee Act

Work Group participation by state or federal agencies does not affect their statutory responsibilities and authorities. Issues involving the exercise of agencies' specific authorities can be discussed, but decisions are not delegated to the Work Groups. Work Groups do not provide consensus advice to any federal agency (consistent with the Federal Advisory Committee Act).

8.2.6 Work Group Coordination

Any Party may engage on any specific issue within a Work Group on a timely basis, regardless of whether that Party is a current member of the Work Group, and the Licensee shall treat all comments received from a Party under the same provisions that apply to Work Group members. All Work Groups will coordinate among one another if they identify issues through their deliberations that may be of interest to or affect another Work Group or Party.

8.2.7 Work Group Role

The Licensee shall consult with the Work Groups on all aspects of the Work Products. Work Groups will convene as needed to meet the consultation requirements of the Project Documents, but at least annually for the license term and any annual licenses (see Section 8.3.3).

8.2.8 Consensus Defined

Work Groups shall make decisions by consensus. Consensus is achieved when all voting members cast a supportive or neutral vote or have abstained from the decision. When any vote is taken at a meeting on a Work Product, the Licensee shall provide the results to and seek the vote of non-present members within three days. Work Group members not present must inform the Licensee and other Work Group members of their vote on the Work Product within 10 days after the meeting or they shall be deemed to have abstained from the decision.

8.2.9 Work Group Consultation Process

Where the Project Documents require consultation on a Work Product, the Licensee shall strive to, at a minimum, provide Work Group members with a draft Work Product for at least 30 days to review and comment (which the Licensee may reasonably extend upon request of a voting member if needed to facilitate consultation). At the conclusion of this review period, if needed, the Licensee shall convene at least one Work Group meeting to discuss the draft Work Product and attempt to reach consensus with Work Group members. If consensus is achieved, the Licensee shall file with the Commission the Work Product and documentation of all consultations with the Work Group, any concerns and responses thereto, and any other written comments provided to the Licensee. If the final Work Product has been modified in any substantive way by the Licensee in response to comments or otherwise, the Licensee shall provide a new final version to Work Group members 10 days before filing it with the Commission.

8.2.10 Elevation of Work Group Decisions to Dispute Resolution

If consensus is not achieved, any voting member may elevate the issue for dispute resolution as provided in Section 9. The voting member objecting to the Work Product must provide a rationale, supporting documentation, and a proposed resolution of the issue for review. This information shall be provided to the Licensee by the objecting member within 10 days of the Work Group meeting pursuant to the Notice provisions in Section 11.11 of the Settlement Agreement. The Licensee shall provide the information to voting members concurrent with its Notice of Issue Elevation.

8.2.11 Impact of Dispute Resolution and Agency Approval Process on FERC Filing Deadlines

If the dispute is not resolved prior to the date the Licensee is required to make a filing, the Licensee shall make the filing and shall describe to the Commission how the Licensee's filing accommodates any comments and recommendations of the Work Group members. If the Licensee's filing does not adopt a recommendation, the filing will include the Licensee's reasons based on Project-specific information. If any necessary agency approval has not been obtained, the Licensee also shall provide an explanation of why the approval was not obtained. The Licensee shall provide the Commission with a copy of any comments and recommendations provided by Work Group members during consultation. Work Group members may submit their own comments to the Commission.

8.2.12 Agency Approval

Prior to implementing a Work Product, the Licensee shall obtain any necessary Commission approval and any necessary agency approval. Where a Project Document identifies an agency with approval authority, the Licensee shall proceed in a manner consistent with the approval of that agency.

8.2.13 Agency Approval Process

When agency approval is required by the Project Documents, that approval must be provided in writing by the approving agency(s). The approving agency(s) will strive to ensure that written approvals are provided to the Licensee in advance of FERC filing deadlines. To facilitate this process, the Licensee shall provide all final Work Products requiring agency approval to the approving agency at least 30 days prior to the FERC filing deadline or as otherwise noted in the Project Documents, and shall identify whether consensus among Work Group voting members has been achieved. If consensus has not been achieved, the Licensee shall identify efforts taken to resolve the dispute and shall propose a resolution for consideration by the approving agency. Unless an extension would cause the Licensee to miss a FERC filing deadline, the Licensee shall, if requested by an agency with approval authority, grant a 30-day extension for completion of the agency approval process; provided, however, that in the event that granting such an extension delays the Licensee's ability to take action, the schedule for such action will be adjusted.

8.2.14 Agency Involvement in Work Groups

The position of other members does not override an agency's approval, which is an independent authority. The agency with such approval authority will convey its determination to the Licensee, the Work Group, and the Commission. Notwithstanding, agencies do not waive or relinquish in any respect any approval authorities under the Federal Power Act or other applicable law through their participation in the Work Group consensus process and any subsequent dispute resolution process. While the goal of the Work Groups is consensus decision-making where possible, nothing in the Settlement Agreement is intended to transfer legal authority or jurisdiction from any party to any other.

8.2.15 Work Group Member Withdrawal

Any member of any Work Group may withdraw from that Work Group upon Notice to the Licensee. The Licensee shall provide Notice to other Work Group members in the event of a member withdrawal. Any Party that withdraws from this Settlement Agreement shall be deemed to have withdrawn from all Work Groups.

8.3 <u>Meeting Provisions</u>

8.3.1 Work Group Chairs and Facilitators

The Licensee shall arrange, administer, and chair all meetings. Upon request of a majority of voting members in the Work Group(s), the Licensee shall provide a meeting facilitator(s).

Selection of a facilitator(s) will be done in consultation with and for approval by the affected Work Group voting members. The Licensee (either by its own submission or through the facilitator) shall provide no fewer than 10 days prior Notice of any meeting, unless otherwise agreed to by the members of the BRCC or Work Group(s), or required in order to meet a license deadline or an emergency circumstance.

8.3.2 Work Group Meeting Minutes

The Licensee (either by its own submission or through the facilitator) shall provide draft meeting minutes within 10 days after a meeting to members of the Work Group, who shall have 10 days to provide any comments. The Licensee shall distribute final meeting minutes within 30 days of the meeting. Meeting minutes will include Work Group action items, a summary of issues discussed, decisions reached, and member concerns. However, when agency or Work Group approvals of specific actions are required, as identified in the Project Documents, the Licensee shall follow procedures identified in Section 8.2.13. The Licensee shall provide Work Group meeting minutes and products to any Party upon request.

8.3.3 Work Group Annual Meeting

The Licensee shall convene annual Work Group meetings to review the previous year's actions and implementation status and to discuss planned activities for the current calendar year and the Out Year. The Licensee shall provide at least 30 days Notice for the annual meetings. An annual meeting may be cancelled by consensus of Work Group members or by the Licensee if no members of the Work Group respond to the Licensee's annual meeting Notice. However, to ensure continued communication and coordination, no more than two consecutive annual meetings of a Work Group may be cancelled.

8.3.3.1 Work Group Annual Reports

Prior to providing Notice for an annual Work Group meeting, the Licensee shall prepare a draft annual report. The Licensee shall provide the draft annual report to Work Group members no later than the time that it provides the 30-day Notice for the annual meeting. Work Group members shall submit any comments and recommendations on the annual report in writing to the Licensee at or before the annual meeting and may provide verbal comments at the meeting. If the Licensee makes substantive revisions to the annual report after the meeting, the Licensee shall circulate the revised report within 10 days of the meeting, and Work Group members may provide additional comments within 10 days of the Licensee's distribution of the revised report. Receipt of further comments does not trigger further circulation of drafts and solicitation of comments. The Licensee shall file with the Commission a final annual report and response to comments and recommendations on the draft report within 60 days after the annual meeting. A copy of the final report will be provided to the Work Group members.

8.3.3.2 Contents of Work Group Annual Reports

The Licensee shall include, at a minimum, the following information in the annual reports:

(a) A rolling, three-year work plan documenting the implementation of PM&E measures in the preceding year, a month by month description of the specific actions that the Licensee plans to implement for the current year and a summary of actions proposed in the Out Year. Specific elements of this plan include:

(i) A summary of the actions implemented during the previous calendar year; such as field testing and studies, compliance monitoring, design and construction, and other analyses.

(ii) Summaries of results of any monitoring or studies conducted during the previous year, conclusions that the Licensee draws from the results, and any proposed changes to the Project Documents based on the results.

(iii) The implementation schedule for the current year.

(iv) The implementation schedule for the Out Year.

(b) A discussion of any substantial differences between the actions required in the Project Documents and the actions that the Licensee implemented, including consultation comment letters, explanations and any necessary agency or Work Group approvals for any substantial differences.

(c) A discussion of any significant differences between the implementation schedule in the Project Documents and the schedule for the actions the Licensee plans to implement during the year, including an explanation for any significant differences.

(d) Documentation of consultation with the respective Work Groups and any required agency or Work Group approvals in the previous year.

(e) Identification of any issues or Project Document requirements that would benefit from coordination between Work Groups and discussion at the annual BRCC meeting.

8.3.4 Management Plan Review and Amendment

An amendment is any change to the text of a Management Plan. All amendments require FERC approval before they become effective.

8.3.4.1 Scheduled review

The Licensee in consultation with the Work Groups shall review the Management Plans and amend them if needed on the schedule established in each of the plans. The need for amending the Management Plans will be discussed with the Work Group during the annual meeting in the year in which the review is scheduled to occur. If the Work Group determines an amendment to a Management Plan is not needed, this decision will be documented in the Rolling 3-Year Annual Report/Work Plan for the year in which the review is conducted.

The Licensee will compile a running list of potential changes to each management plan suggested by the Work Group. This list will be compiled from sources such as monitoring and be included in the Rolling 3-Year Annual Report/Work Plan for consideration during the next review/amendment cycle.

8.3.4.2 Unscheduled review

Amendments to Management Plans may be proposed based on changes in resource conditions resulting from unforeseen effects, from new or existing Project-related activities, or from natural events in the Project area. Amendments may also be warranted if monitoring or other observations indicate that resource objectives are not being met and/or it is determined that a specific PM&E measure is not providing the intended result. The proposed amended Management Plan will document the rationale for changes and the consultation process with the Work Group.

8.3.4.3 Amendment process

The Licensee will be responsible for preparing the draft and final proposed amended Management Plan, coordinating the review process and schedule with the Work Group, consulting with the Parties as set forth in Section 8.2.9, obtaining all necessary agency approvals as set forth in Section 8.2.13, and submitting the final proposed amended Management Plan to FERC. Failure of the approving agency to respond to a request for approval within 60 days shall be deemed to constitute approval.

8.3.5 Cost of Work Group Meetings

The Licensee shall bear all meeting room rental, materials, and similar costs associated with conducting BRCC and Work Group meetings. Each member or other participant will bear its own cost of attendance, unless otherwise agreed to by the Licensee.

Exhibit 7

Boundary Hydroelectric Project (FERC No. 2144)

Dissolved Oxygen Attainment Plan

Seattle City Light

March 2010

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Dissolved Oxygen Attainment Plan
Boundary Hydroelectric Project (FERC No. 2144)

1 INTRODUCTION

This document describes Seattle City Light's (SCL) proposed Dissolved Oxygen (DO) Attainment Plan for the Boundary Hydroelectric Project (Project), Federal Energy Regulatory Commission (FERC) No. 2144. The following sections include a summary of DO data collected in the Project area during 2007 and 2008 and a description of SCL's proposed approach to post-license DO monitoring. In addition, pH will be measured simulaneously with DO to provide the Washington Department of Ecology (Ecology) with pH trend data for the portion of the Pend Oreille River in the Project area.

1.1. Dissolved Oxygen Standard

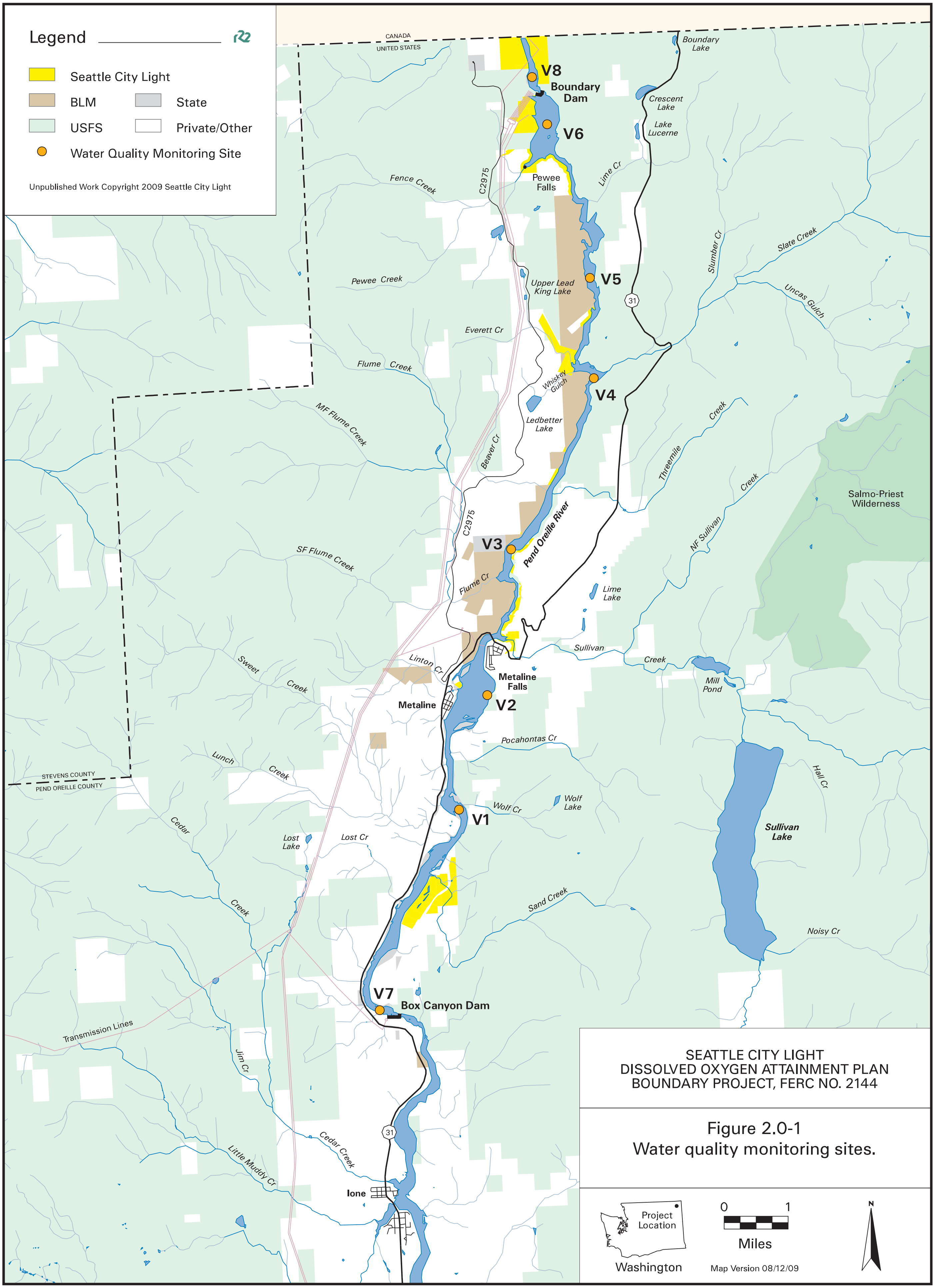
The State of Washington’s water quality criteria for the Pend Oreille River dictate that the lowest one-day minimum concentration of DO shall be 8.0 mg/L (Ecology 2006). This 8.0 mg/L criterion has been established by Ecology to support salmonid spawning, rearing, and migration. The criterion states that DO concentrations are not to fall below 8.0 mg/L at a probability frequency of more than once every ten years on average.

2 DISSOLVED OXYGEN IN THE PROJECT AREA

DO was measured at eight sampling sites in 2007 and 2008 as part of the Project's relicensing studies (Table 2.0-1). Locations of these sampling sites within the Project area are shown in Figure 2.0-1.

Table 2.0-1. Dissolved oxygen sampling sites 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



SEATTLE CITY LIGHT
DISSOLVED OXYGEN ATTAINMENT PLAN
BOUNDARY PROJECT, FERC NO. 2144

Figure 2.0-1
Water quality monitoring sites.

Average, maximum, and minimum DO concentrations measured at all sampling sites during 2007 and 2008 are presented, by sampling month, in Table 2.0-2. 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. All DO concentrations measured in May and June and September through March were greater than 8.0 mg/L, but a few exceedances of the Ecology criterion occurred in July and August (Table 2.0-2). The complete DO dataset is included in Appendix 2 of the Water Quality Constituent and Productivity Monitoring Final Report (SCL 2009) and was provided in Excel® format to Ecology (C. Pratt [SCL] email to M. Mangold [Ecology], February 13, 2009).

In July 2007, DO concentrations were in compliance with the DO criterion 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 (92 feet) (7.0 mg/L minimum) and below 35.0 meters (115 feet) (7.7 mg/L minimum), respectively, fell below 8.0 mg/L. In August 2007, DO concentrations were below 8.0 mg/L 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 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.

DO values recorded show that DO does not vary greatly with depth (Figures 5.1-20 through 5.1-27 in the Water Quality Constituent and Productivity Monitoring Final Report, SCL 2009) or longitudinally (Figures 5.1-28 through 5.1-33 in the 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 in Boundary Reservoir that are related to Project operations. 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.

Table 2.0-2. Dissolved oxygen (mg/L) data summary for water quality monitoring sites in Boundary Reservoir and tailrace (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	<u>**7.9**</u>	8.0	<u>**7.9**</u>	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	<u>**7.7**</u>	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	<u>**7.8**</u>	8.4	<u>**7.0**</u>	8.0	8.4	<u>**7.6**</u>	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	<u>**7.7**</u>	<u>**7.7**</u>	<u>**7.7**</u>	9.7	9.7	9.7	12.0	12.1	12.0	12.6	12.7	12.4

<u>Note:</u>
Bold and underlined text indicates when DO measurements were lower than the one-day minimum numeric criterion of 8.0 mg/L.

3 DISSOLVED OXYGEN ATTAINMENT PLAN

3.1. Dissolved Oxygen Monitoring

Based on the DO data described in Section 2 of this document, SCL proposes a monitoring program to better define the magnitude and spatial and temporal extent of DO concentrations below 8.0 mg/L. Ecology reviewed SCL's Preliminary Licensing Proposal (PLP) and data provided by SCL, and indicated that in its preliminary assessment, DO levels did not appear to be outside of the normal range for this system and that additional monitoring would help to confirm this preliminary assessment (M. Mangold, Ecology, personal communication, June 18, 2009). SCL proposes a five-year DO monitoring plan, including annual reporting and consultation with Ecology, to be implemented following issuance of the new FERC license.

3.2. Monitoring Design

SCL will coordinate with Ecology and the Water Quality Workgroup to finalize the specifics of the monitoring program identified below, including sampling depths, duration of monitoring periods, and measurement equipment to be used. Because DO concentration is dependent on water temperature, temperature will be measured every time DO measurements are made. In addition, Ecology requested that pH data be collected concurrently with DO data collection to provide pH trend information for Ecology's use (M. Mangold, Ecology, personal communication, June 18, 2009).

SCL anticipates that monitoring will be conducted continuously (see Section 3.3 of this plan) at the following sites: Box Canyon Tailrace (V7), Metaline Old (V2), Everett Creek Island (V5), Boundary Forebay (V6), and Boundary Tailrace (V8) stations (Table 2.0-1). Based on the 2007-2008 dataset samples along vertical profiles at these sites will be collected at 10, 30, 45, and 60 meters (33, 98, 148, and 197 feet) to provide DO levels throughout the water column.

Because exceedances were only observed in July and August of 2007, SCL proposes to conduct post-license monitoring during the warmer months of the year, when exceedances are more likely. SCL proposes to "bracket" the period when exceedances occurred and conduct monitoring from June 15 through September 15 during each of the five post-license monitoring years. Monitoring will begin on the falling limb of the hydrograph once it is safe to place equipment (e.g., below approximately 50,000 cfs).

3.3. Monitoring Methods

Continuous DO and pH monitoring will be conducted for the duration of the period described in the preceding section (June 15 - September 15) at each sampling site (V7, V2, V5, V6, and V8). A Hydrolab®, or other comparable measurement device, will be attached to a profile cable at the depth intervals identified above. Calibration and sampling will be performed per manufacturer's specifications and distributor configuration. DO, temperature, and pH will be measured every 15 minutes throughout the data collection period. Data will be downloaded and measurement equipment will be checked for maintenance at a minimum of every 30 days.

A Quality Assurance Project Plan (QAPP) will be prepared to document the quality assurance (QA) and quality control (QC) measures to be observed to ensure that the following objectives are met: data are consistent, correct, and complete, with no errors or omissions; QC sample results have been reviewed and are included; established criteria for QC results are met; measurement quality objectives have been met, or data qualifiers are properly assigned where necessary; and data specified in the sampling process design are obtained. Data collection methods will follow established Ecology and U.S. Environmental Protection Agency (EPA) guidelines. Within six months of license issuance, a QAPP will be filed with Ecology. The QAPP is anticipated to be comparable to that developed and approved by Ecology, for the 2007-2008 water quality sampling (SCL 2009).

3.4. Evaluating Monitoring Results and Potential Secondary Actions

The purpose of the monitoring program is to verify the results of the relicensing study by monitoring more extensively, i.e., continuously, during the summer months when DO levels are more likely to be below 8.0 mg/L. The proposed monitoring program will help to define the magnitude and spatial and temporal extent of DO occurrences below 8.0 mg/L. The monitoring will be used to confirm that DO concentrations in Boundary Reservoir comply with Ecology standards under most conditions, and that DO levels continue to follow expected patterns for the Pend Oreille River system. 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 are needed.

3.5. Compliance Schedule

3.5.1. Reasonable and Feasible Measures

Relicensing study results indicate no correlation between DO levels and water surface elevation fluctuations in Boundary Reservoir related to Project operations. However, water depth and retention time would be less if the reservoir did not exist. At this time, there are no reasonable or feasible measures that have been identified to address DO levels at depth. Installation of an aerator has been used in other waterbodies to increase water movement. The size and volume of water in Boundary reservoir renders an aerator approach infeasible.

3.5.2. Schedule

A QAPP will be filed with Ecology within the six months following license issuance, and the monitoring program will be conducted annually for five years, beginning one-year following issuance of the new Project license. After five years of the monitoring program, SCL will consult with Ecology regarding interpretation of results and potential next steps. SCL will summarize each year's data in a brief technical memorandum, which will be submitted to Ecology in December of each year.

4 REFERENCES

Ecology (Washington Department of Ecology). 2006. Water Quality Standards for Surface Waters of the State of Washington. Chapter 173-201A WAC. Olympia, Washington.

Mangold, M. 2009. Washington Department of Ecology. Personal Communication, June 18, 2009.

SCL. 2009. Updated Study Report. Boundary Hydroelectric Project (FERC No. 2144). Seattle, Washington. Available: http://www.seattle.gov/light/news/issues/bndryRelic/br_document.asp. March 2009.

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Exhibit 8

Boundary Hydroelectric Project (FERC No. 2144)

Fish Tissue Sampling Plan

Seattle City Light

March 2010

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List of Figures

Fish Tissue Sampling Plan
Boundary Hydroelectric Project (FERC No. 2144)

1 INTRODUCTION

This document describes Seattle City Light's (SCL) proposed Fish Tissue Sampling Plan for the Boundary Hydroelectric Project (Project), Federal Energy Regulatory Commission (FERC) No. 2144.

1.1. Purpose

Attachment 1 to the Boundary Project Relicensing Joint Agreement in Principle (AIP), Specific Protection, Mitigation, and Enhancement Provisions, Section (C)(9)(vii), states that SCL shall include the following information in its application to WDOE (Washington Department of Ecology or Ecology) for 401 Water Quality certification:

> A plan for collecting and analyzing tissue samples from sport fish, and sucker (spp.) in Boundary reservoir regarding lead and zinc concentrations. Data will be collected and provided to WDOE and Washington Department of Health (WDOH) to assess human health risks from fish consumption one year after license issuance. If health advisories are warranted, WDOE and WDOH will determine the next steps for tissue sampling or health advisory issuance.

The following sections describe the proposed field methods, laboratory analysis, reporting of results, and implementation schedule associated with the fish tissue sampling effort in Boundary Reservoir.

2 FIELD METHODS

2.1. Sample Site Locations

Sampling will take place in the vicinity of four of the 14 sites sampled for toxics concentrations as part of SCL's Toxics Assessment: Evaluation of Contaminant Pathways (SCL 2009):

- Site 1 - Boundary Dam forebay
- Sites 4 and 5 - Downstream of these sites near Everett Island in the Canyon Reach
- Site 10 - Metaline Falls area
- Site 14 - Downstream of the Box Canyon Dam tailrace

Two of these sites are located to represent the inflow (i.e. Site 14) and outflow (i.e., Site 1) points of the reservoir, and two of the locations were selected to correspond to areas where lead and zinc exceedances were observed as part of the toxics assessment (SCL 2009). Site 10 was selected to obtain fish in the vicinity of sites 10 and 11, where lead levels in some surface water samples exceeded relevant criteria. Site 4 was selected because it is located downstream of sites 5 and 8, where lead and zinc exceedances were measured in sediment and pore water, and because it is an area within the Canyon Reach of the reservoir where target fish species are likely abundant enough to allow field crews to capture sufficient numbers of fish within the desired size ranges. For a summary of toxics exceedances in the Project area, see Table E.4-18 of SCL's Boundary Project License Application. Maps showing the toxics sampling sites can be found on pages 10 through 16 of the Toxics Assessment: Evaluation of Contaminant Pathways (SCL 2009).

2.2. Fish Collection and Processing

Fish will be collected by electrofishing, angling, or fyke netting within the areas shown in Figure 2.2-1. At each site three centrarchids (smallmouth bass [*Micropterus dolomieui*], largemouth bass [*Micropterus salmoides*], black crappie [*Pomoxis nigromaculatus*], or pumpkinseed [*Lepomis gibbossus*]) and three suckers (*Catostomus* spp.) will be collected for tissue analysis. Field crews will attempt to capture centrarchids greater than 7 inches and largescale suckers greater than 8 inches in total length. If sufficient numbers of each species within the target size ranges cannot be captured within these areas, sampling effort will be expanded by field crews until sufficient numbers of fish are captured as close as possible to the locations shown in Figure 2.2-1. If any naturally reproduced salmonids (other than bull trout [*Salvelinus confluentus*]) greater than 7 inches in length are captured while sampling for centrarchids and suckers at the sites identified above, they will be substituted for the centrarchids, for up to a total of three game fish species (i.e., some combination of centrarchids and salmonids) at each of the sites.

Fish will be measured for total length and weight and prepared for transport and delivery according to methods outlined in EPA (2000) and reflecting Ecology's (2005a) efforts completed in Box Canyon and Boundary reservoirs. Sampling and measuring equipment to be used directly in the handling of fish will be cleaned prior to each sampling event. All potential sources of contamination in the field will be identified, and appropriate steps will be taken to minimize or eliminate them. Fish with skin lacerations or fin deterioration will not be used for tissue analysis. Field crews will carefully document all field sample collection and processing activities and identify personnel conducting the sampling. A chain-of-custody label will be completed for each individual fish specimen. Each fish will be individually wrapped in extra heavy duty aluminum foil, placed in a watertight plastic bag, stored on ice, and sent to the laboratory within 48 hours of initial collection.

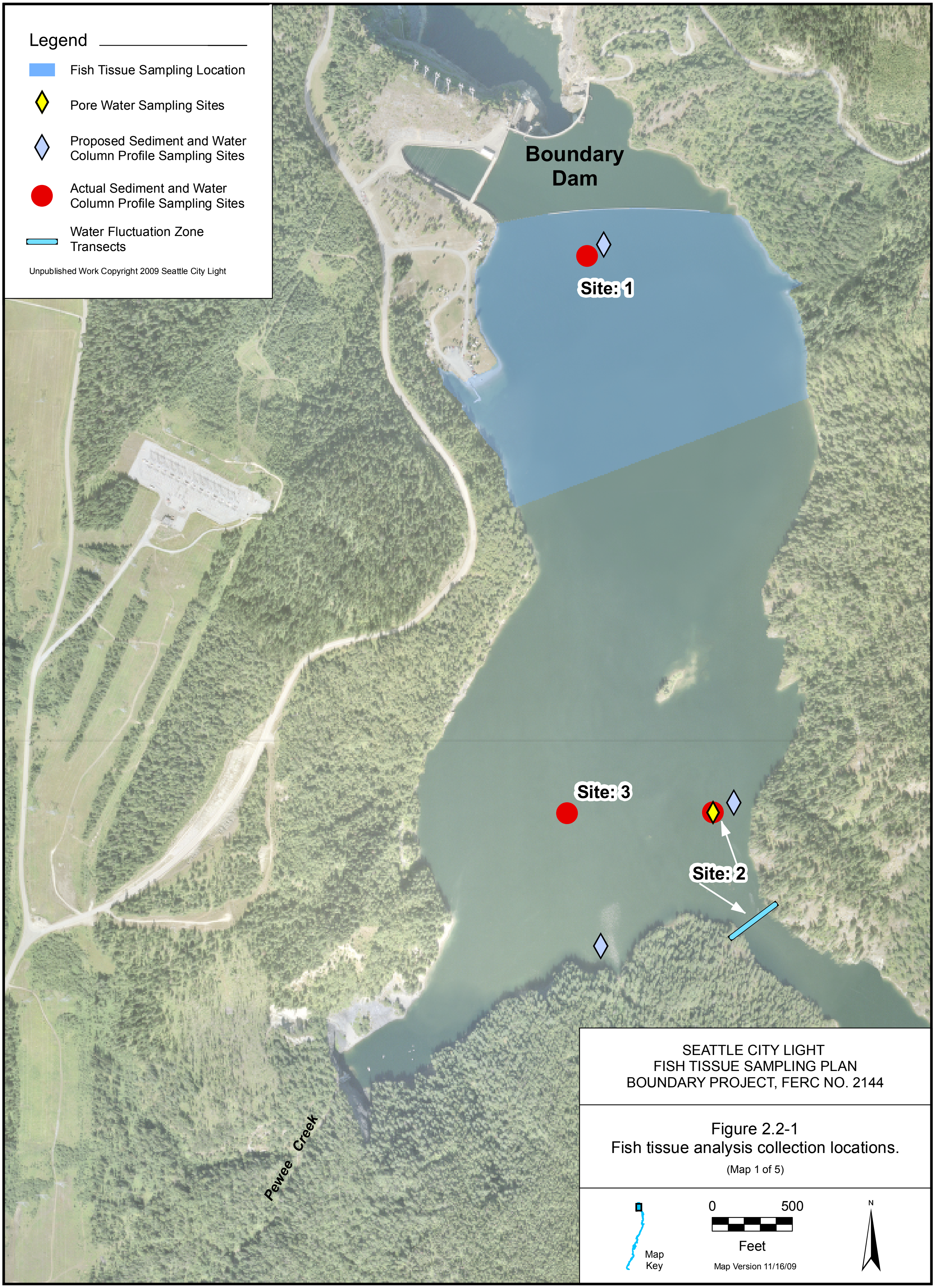
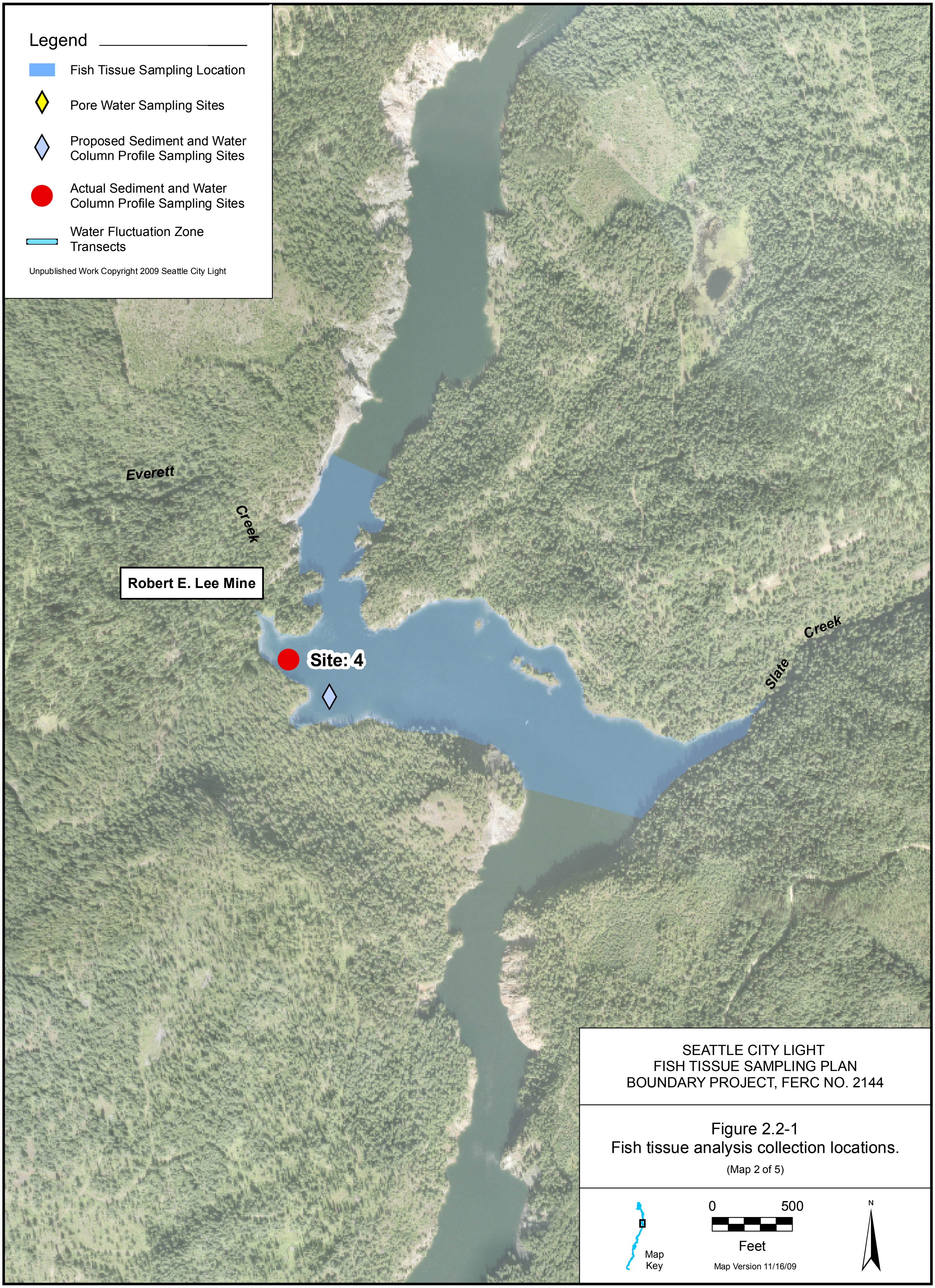


Figure 2.2-1
Fish tissue analysis collection locations.
(Map 1 of 5)



Legend
Fish Tissue Sampling Location
Pore Water Sampling Sites
Proposed Sediment and Water Column Profile Sampling Sites
Actual Sediment and Water Column Profile Sampling Sites
Water Fluctuation Zone Transects
Unpublished Work Copyright 2009 Seattle City Light
Everett
Creek
Robert E. Lee Mine
Site: 4
Slate
Creek
SEATTLE CITY LIGHT
FISH TISSUE SAMPLING PLAN
BOUNDARY PROJECT, FERC NO. 2144
Figure 2.2-1
Fish tissue analysis collection locations.
(Map 2 of 5)
Map Key
0
500
Feet
Map Version 11/16/09
N

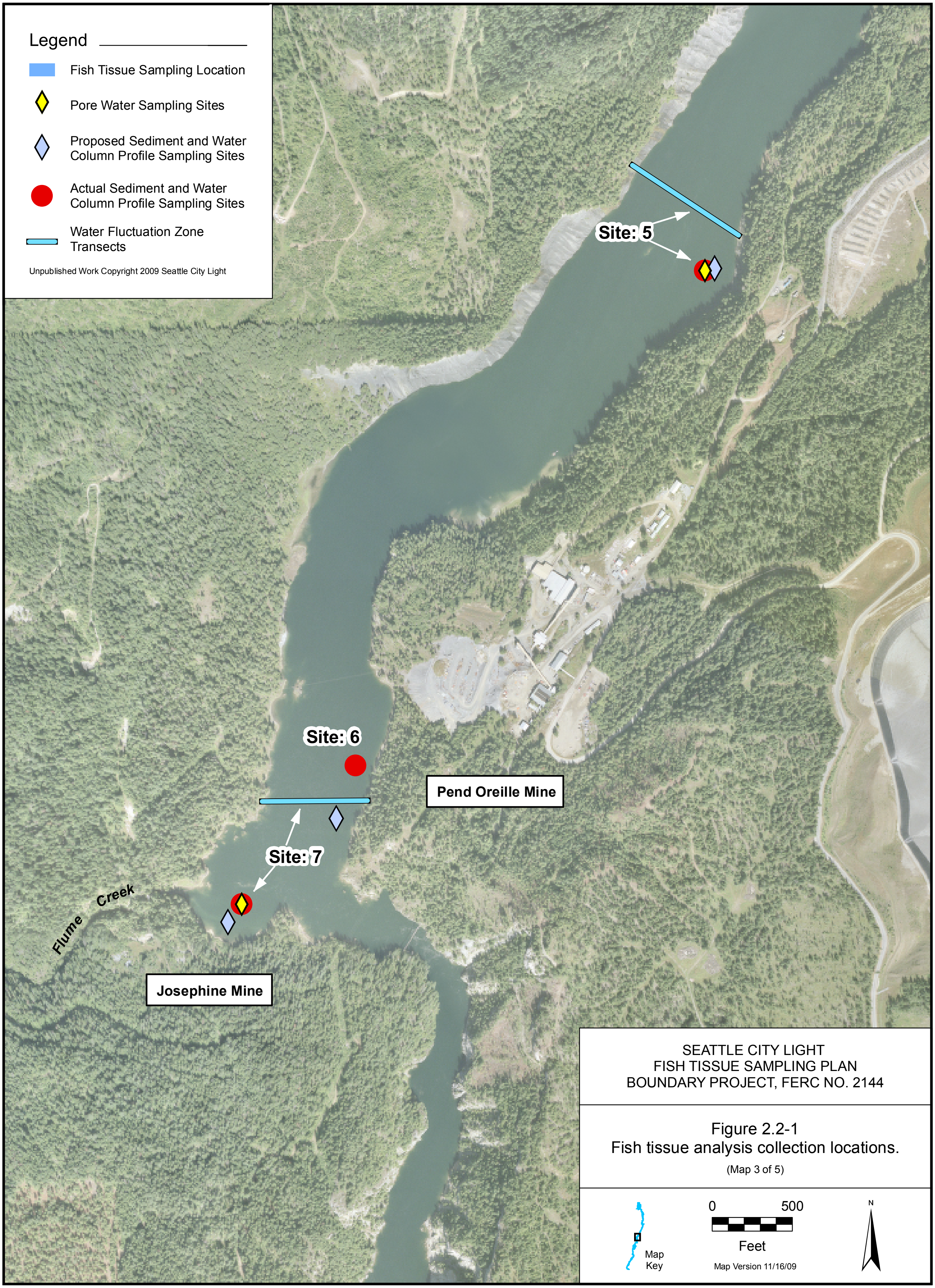


Figure 2.2-1
Fish tissue analysis collection locations.
(Map 3 of 5)

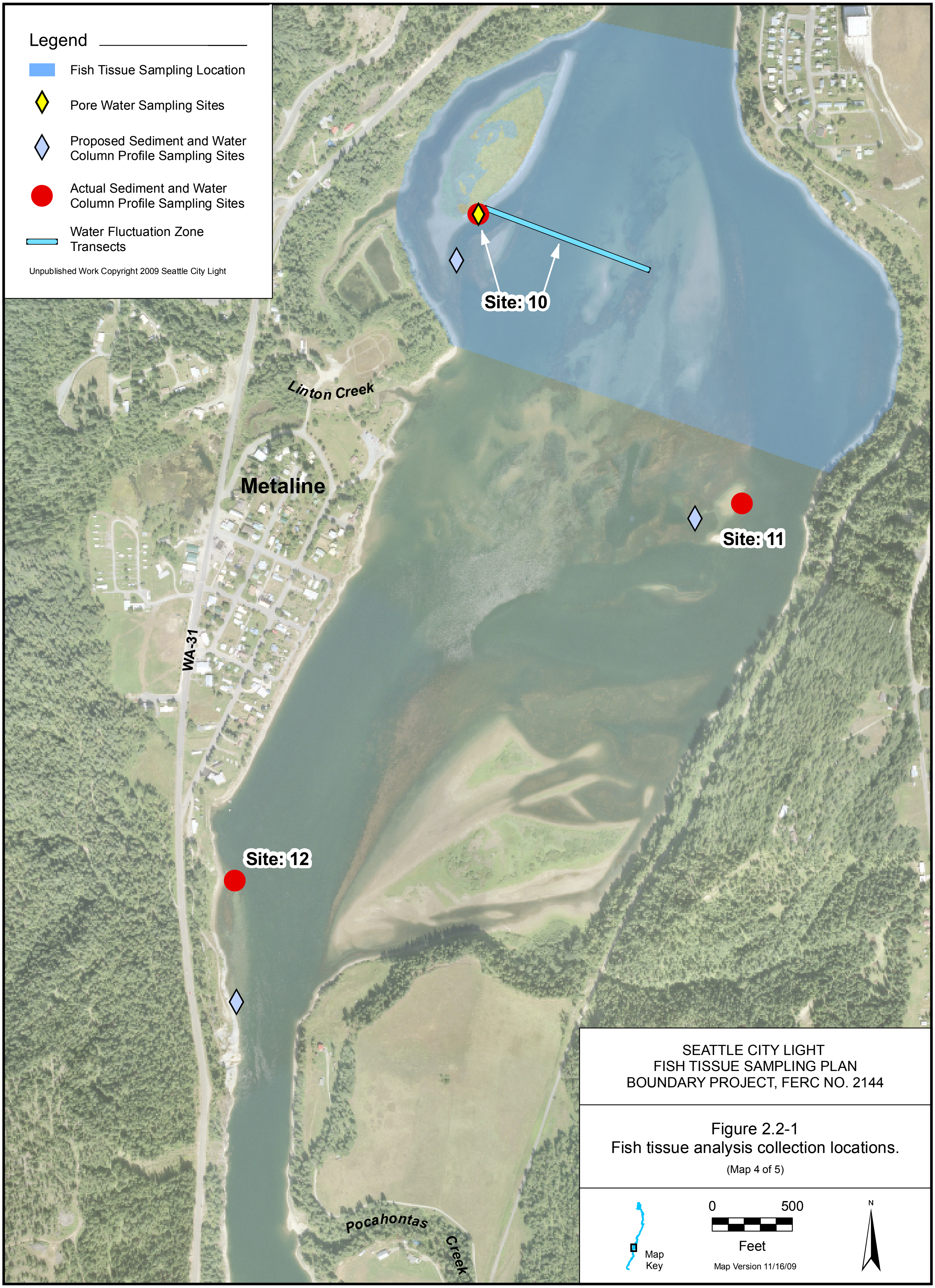


Figure 2.2-1
Fish tissue analysis collection locations.
(Map 4 of 5)

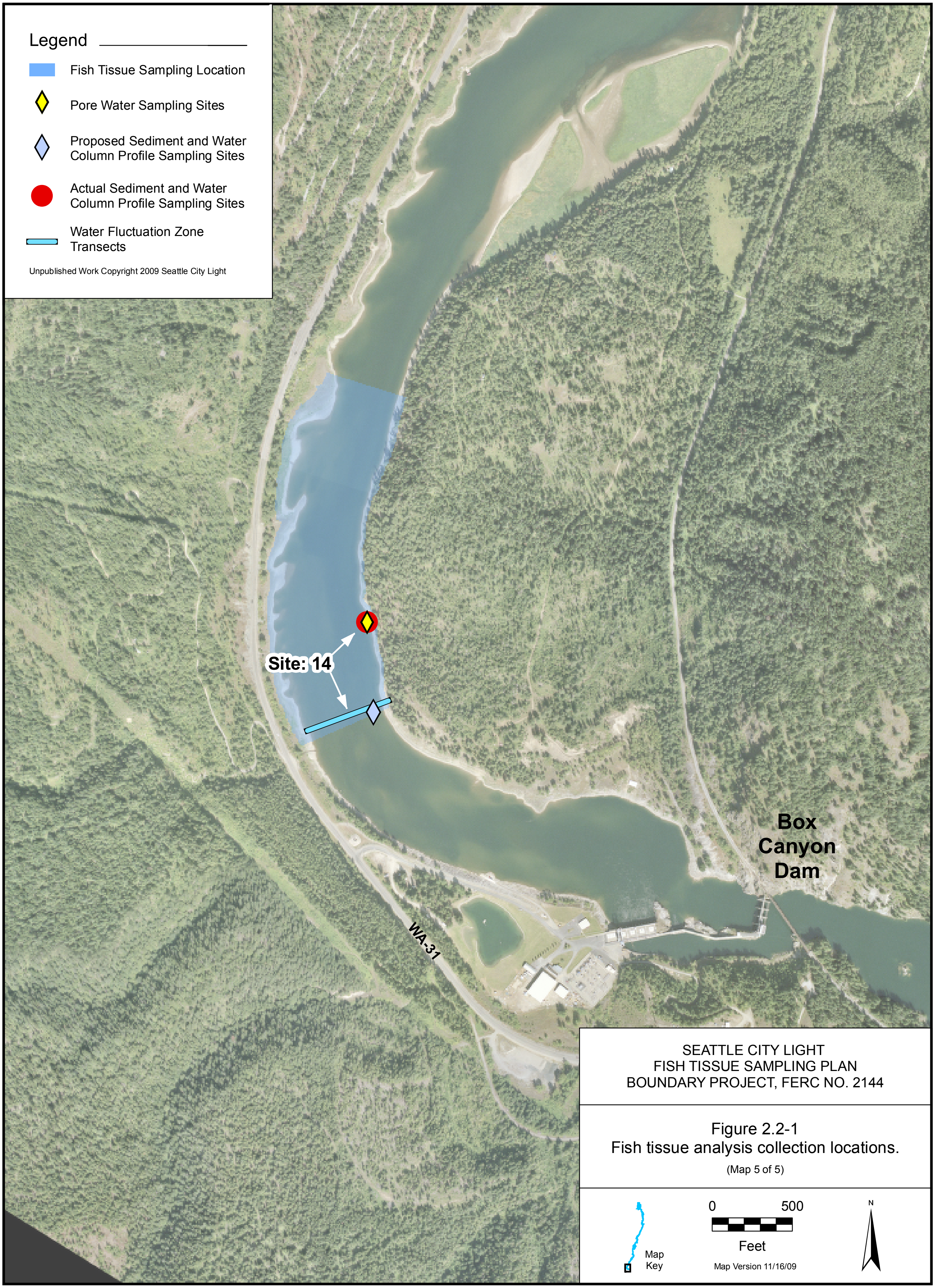


Figure 2.2-1
Fish tissue analysis collection locations.
(Map 5 of 5)

3 LABORATORY ANALYSIS

Tissue samples will be analyzed in a laboratory accredited by Ecology for analysis of samples originating from natural surface waters. Pre-defined Measurement Quality Objectives (MQO's) will be identified in the Quality Assurance Project Plan (QAPP) to determine performance of the laboratory in analyzing tissue samples for lead and zinc. Appropriate detection limits and laboratory performance required for this project will be based on the EPA (2000) as described by Ecology (2005b).

4 REPORTING OF RESULTS

Within 90 days of receiving final results from the laboratory, SCL will provide Ecology and WDOH with a table showing the results of fish tissue analysis for lead and zinc, reported for each fish at each sampling site.

5 IMPLEMENTATION SCHEDULE

Within six months of FERC's issuance of the new Project license, SCL will submit a QAPP for Ecology's approval. Fish tissue collection will occur once during the first summer (July - August) following the approval of the QAPP by Ecology. A table showing the results of tissue sampling for each fish at each sampling site will be provided to Ecology and WDOH within 90 days of receiving final results from the laboratory. If WDOH determines that health advisories are warranted, Ecology and WDOH will identify next steps for tissue sampling or health advisory issuance.

6 REFERENCES

Ecology (Washington Department of Ecology). 2005a. Verification of 303(d) Listings for Fish Tissue in the Skagit and Pend Oreille Rivers. Ecology Publication No. 05-03-017. Washington Department of Ecology, Environmental Assessment Program. Olympia, WA. 27 pages, plus appendices.

Ecology. 2005b. Manchester Environmental Laboratory: Lab User's Manual (Eighth Edition). Washington Department of Ecology, Manchester Environmental Laboratory, Manchester, WA. 186 pages, plus appendices.

Ecology. 2006. Water Quality Standards for Surface Waters of the State of Washington. Chapter 173-201A WAC. Olympia, Washington.

EPA (U.S. Environmental Protection Agency). 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volumes 1 and 2. EPA-823-B-00-007. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

SCL (Seattle City Light). 2009. Study 4 – Toxics Assessment: Evaluation of Contaminant Pathways, Final Report. http://www.seattle.gov/light/news/issues/bndryRelic/br_document.asp. March 2009.

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