Attachment 1: Introduction to Updated Study Report

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List of Acronyms and Abbreviations

#/L	(number of) organisms per liter
7Q10	7-day, 10-year
ADCP	acoustic Doppler current profile
AFDD	accumulated freezing degree-days
AFDM	ash free dry mass
ALEA	Aquatic Lands Enhancement Account
ANOVA	analysis of variance
APE	area of potential effect
ASCII	American Standard Code for Information Interchange
ASTM	American Society of Testing Materials
ATV	all-terrain vehicle
AVRS	Aesthetic/Visual Resources Study
AVS	acid volatile sulfide
BC Hydro	British Columbia Hydro
BLM	Bureau of Land Management
BMI	benthic macroinvertebrates
BPA	Bonneville Power Administration
BWP	Boundary Wildlife Preserve
°C	degrees Celsius
$CaCO_3$	calcium carbonate
CART	combined acoustic and radio transmitter
CBD	Central Business District
CBE	Columbia Basin Environmental
CCC	Civilian Conservation Corps
CEII	Critical Energy Infrastructure Information
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFD	computational fluid dynamic
cfm	cubic feet per meter
CFR	Code of Federal Regulations
cfs	cubic feet per second
CI	confidence interval
cm	centimeter
CNF	Colville National Forest
CPC	Columbia Power Corporation
CPUE	catch per unit of effort
CRP	Conservation Reserve Program

CRTO	continuous record time out
CRWG	Cultural Resources Workgroup
CSI	Composite Suitability Index
CTED	Community, Trade and Economic Development
D50	median particulate size
dB	decibels
dbh	diameter at breast height
DD	Duration of Dewatering
DGPS	Differential Global Positioning System
DI	Duration of Inundation
DNR	Washington State Department of Natural Resources
DO	dissolved oxygen
DOC	dissolved organic carbon
DOE	Determination of Eligibility
DTM	digital terrain model
Ecology	Washington Department of Ecology
ELJ	engineered log jam
EMAP	Environmental Monitoring and Assessment Program
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESI	effective spawning index
EU	excavation unit
EWM	Eurasian watermilfoil
FCR	fire-cracked rock
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FISS	Fisheries Information Summary System
FMS	fixed monitoring stations
FPA	Federal Power Act
FPC	Federal Power Commission
fps	feet per second
FR	Forest Road; *also,* Federal Register
g	gram
GBT	gas bubble trauma
GIS	Geographic Information System
GLO	General Land Office
GMA	Growth Management Act

GPP	gross primary productivity
GPS	Global Positioning System
GRS	Global Remote Sensing, LLC
h	hour
h/d	hour per day
HDPE	high density polyethylene
HEC	Hydrologic Engineering Center
hp	horsepower
HPI	Historic Property Inventory
HPMP	Historic Properties Management Plan
HQR	habitat quality rating
HRM	Hydraulic Routing Model
HSC	Habitat Suitability Curve
HSI	Habitat Suitability Index
HTI	Hydroacoustic Technology, Inc.
Hz	hertz
I&E	interpretive and educational
IAC	Interagency Committee for Outdoor Recreation
IDFG	Idaho Department of Fish and Game
IDL	Idaho Department of Lands
IDPR	Idaho Department of Parks and Recreation
IDT	Idaho Department of Transportation
ILP	Integrated Licensing Process
INLT	Inland Northwest Land Trust
IPNF	Idaho Panhandle National Forests
IRA	Integrated Resource Analysis
ISR	Initial Study Report
ISSSS	Interagency Special Status Sensitive Species
Kalispel Tribe	Kalispel Tribe of Indians
kHz	kilohertz
km	kilometer
Kootenai Tribe	Kootenai Tribe of Idaho
KOP	key observation point
kW	kilowatt
LA	License Application
LAET	lowest apparent effects threshold
lbf	pounds force
LCS	laboratory control sample

LF	low-frequency; linear feet
LFM	limiting factors matrix
LiDAR	light detection and ranging
LM	linear meters
Loop	International Selkirk Loop
LRNRA	Lake Roosevelt National Recreation Area
LRS	Land and Roads Study
LSL	Ledbetter Slate
LWCF	Land and Water Conservation Fund
LWD	large woody debris
m	meter
m/s	meter per second
mg/L	milligram per liter
MHz	megahertz
MIS	Management Indicator Species
mL	milliliter
ML	Metaline Limestone
µg/L	microgram per liter
µm	micrometer
µmhos	micromhos
µS/cm	microsiemens per centimeter
mm	millimeter
MP	milepost
mph	miles per hour
MRS	mine-related sediment
ms	millisecond
MSTM	Mainstem Sediment Transport Model
mV	millivolt
MW	megawatt
MWh	megawatt hour
n	number of observations
N/A	not applicable
N:P	nitrogen to phosphorus
NAD 27	North American Datum of 1927
NAVD 88	North American Vertical Datum of 1988
NBT	neutrally-buoyant target
NGVD 29	National Geodetic Vertical Datum of 1929
ng/L	nanogram per liter

NHPA	National Historic Preservation Act
NO_3	nitrate
NOAA	National Oceanic and Atmospheric Administration
NPCC	Northwest Power and Conservation Council
NPS	U.S. Department of the Interior, National Park Service
NR	North Reservoir
NRA	National Recreation Area
NRCA	Natural Resource Conservation Area
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NRS	National Recreation Survey
NSRE	National Survey on Recreation and the Environment
NTU	nephelometric turbidity unit
NVUM	National Visitor Use Monitoring
NWI	National Wetland Inventory
NWR	national wildlife refuge
NWS	National Weather Service
OHV	off-highway vehicle
OHWL	Ordinary High Water Line
ORRRC	Outdoor Recreation Resources Review Commission
PAD	Pre-Application Document
PAOT	people at one time
PC	personal computer
PCB	polychlorinated biphenyl
PGS	Pacific Geomatic Services
pH	negative logarithm of the hydrogen ion concentration
PHABSIM	Physical Habitat Simulation
PHI	Physical Habitat Index
PHS	Priority Habitats and Species
PID	Polygon Identification
PIT	passive integrated transponder
PLP	Preliminary Licensing Proposal
PLSS	Public Land Survey System
PME	protection, mitigation, and enhancement
PNT	Pacific Northwest Trail
POC	Pend Oreille County
POMMC	Pend Oreille Mines and Metals Company
POSRT	Pend Oreille Salmonid Recovery Team

pps	ping per second
PRM	Project river mile
Project	Boundary Hydroelectric Project
psi	per square inch
PSI	potential spawning and incubation
PST	Pacific Standard Time
PUD	Public Utility District
PW	pulse width
PWC	personal watercraft
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QHA	Qualitative Habitat Assessment
RAWS	Remove Automatic Weather Stations
RCO	Recreation and Conservation Office
RCW	Revised Code of Washington
RD	roaded dispersed
RHABSIM	River Habitat Simulation Model
RLA	Recreation, Land Use and Aesthetics
RM	river mile
RMP	Resource Management Plan
RMSE	root mean square error
RNA	Recreation Needs Analysis
ROW	right-of-way
RP	relicensing participant
RPD	relative percent difference
RRS	Recreation Resource Study
RS	riparian shrub
RSP	Revised Study Plan
RTE	Rare, Threatened, and Endangered
RTK	real-time kinematic
RV	recreational vehicle
SAP	Sampling and Analysis Plan
SCC	System Control Center
SCL	Seattle City Light
SCORP	Statewide Comprehensive Outdoor Recreation Plan
SCORTP	Statewide Comprehensive Outdoor Recreation and Tourism Plan
SD	standard deviation

SEM	simultaneously extracted metals
SI	stranding index
SMA	Shoreline Management Act
SMS	Scenery Management System
SPSS	Statistical Package for the Social Sciences
SPU	Seattle Public Utilities
SR	State Route
SR	South Reservoir
SRP	soluble reactive phosphorus
SS	shovel scrapes
ST	Scenario Tool
STI	supporting technical information
STP	shovel test probe
TAG	technical advisory group
TBM	Tunnel Boring Machine
TCP	Traditional Cultural Property
TDG	total dissolved gas
TI	trapping index
TIN	triangulated irregular network
TKN	total Kjeldahl nitrogen
TL	total length
TMDL	total maximum daily load
TOC	total organic carbon
TP	total phosphorus
TPI	trophic production index
TRDI	Teledyne RD Instruments
TRPA	Thomas R. Payne and Associates
TS	target strength
TSI	trophic state index
UGA	Urban Growth Area
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geologic Survey
USR	Updated Study Report
UTM	Universal Transverse Mercator

VAF	velocity adjustment factor
VES	visual encounter survey
VM	vertical meter
VQO	Visual Quality Objective
VRAP	Visual Resource Assessment Procedure
VRM	Visual Resource Management
WAC	Washington Administrative Code
WASI	Washington Archaeological Site Inventory
WAU	Watershed Administrative Unit
WCC	Washington Conservation Commission
WDAHP	Washington Department of Archaeology and Historic Preservation
WDFW	Washington State Department of Fish and Wildlife
WMA	Wildlife Management Area
WNHP	Washington State Department of Natural Resources, Natural Heritage Program
WOFM	Washington Office of Financial Management
WRCC	Western Regional Climate Center
WRIA	Watershed Resource Inventory Area
WSDOT	Washington State Department of Transportation
WSE	water surface elevation
WSPRC	Washington State Parks and Recreation Commission
WUA	weighted usable area
WWRP	Washington Wildlife and Recreation Program
ZCTA	ZIP Code Tabulation Area

1 GENERAL

This document presents Seattle City Light's (SCL) Updated Study Report (USR) for the Boundary Hydroelectric Project (Project), Federal Energy Regulatory Commission (FERC) No. 2144. The USR describes SCL's overall progress in implementing its relicensing study plan and schedule and provides a summary of the data collected during 2007 and 2008 and an explanation of variances and modifications from the study plans and schedules outlined in the Revised Study Plan (RSP), which was filed by SCL in February 2007 and approved by FERC in its March 15, 2007 study determination letter (FERC 2007).

This USR includes the results of 23 of the 24 studies identified in the RSP. Results from Study 10 are not included in this USR because it was a one-year study conducted in 2007 and reported on in the Initial Study Report (ISR; SCL 2008).

A list of studies and the resource issues(s) that each study is designed to address is provided in Section 5. The study components are organized by resource area, and indicate where one study intersects with studies from other resource areas. Each study report provides all information specified under FERC's Integrated Licensing Process (ILP) requirements (18 CFR § 5.15) and is organized as follows:

- Introduction
  - Study background
  - Study description
- Study objectives
- Study area
- Methods
  - Subsections unique to studies
- Results
  - Subsections unique to studies
- Conclusions
- Variances from FERC-approved study plan and proposed 2008 methods modifications
- References
- Appendices

The process and schedule for developing and sharing information with relicensing participants are described in Section 2 of this USR. Ultimately, the results of the relicensing studies program will be synthesized in an Integrated Resource Analysis (IRA) designed to characterize Project-related resource impacts and evaluate potential protection, mitigation, and enhancement (PME) measures. IRA engagements with relicensing participants started in early 2009 (see Section 4.1). SCL plans to present its assessment of Project impacts in the Preliminary Licensing Proposal (PLP), which will be filed with FERC no later than April 30, 2009, and will refine its presentation of information on impacts and its licensing proposal, including PMEs, in the License Application, which must be filed no later than September 30, 2009.

2 PROCESS AND SCHEDULE OVERVIEW

2.1. FERC Determination and Study Plan Modification

Consistent with requirements under 18 CFR § 5.15, SCL will, within 15 days following the filing of this USR, hold a meeting with relicensing participants and FERC staff to discuss the 2007 and 2008 study results. Within 15 days following this meeting, SCL will file a meeting summary, which will include any changes or additions agreed upon at the meeting to proposed modifications identified in the individual study reports.

FERC staff or any relicensing participant may file a disagreement concerning SCL's meeting summary within 30 days of its issuance. This filing must set forth the basis of any disagreement with the material content of SCL's meeting summary and propose any desired alternative modifications to ongoing studies or new studies. SCL will then have 30 days to respond to the disagreements and possibly propose revised study modifications or new studies. Within 30 days of SCL's response, any remaining disagreements will be resolved by FERC, and the study plan will be amended as appropriate. If no disagreements concerning SCL's meeting summary and request to amend the approved study plan are filed within 30 days, SCL's proposed study plan amendment will be considered approved.

Any proposal to modify an ongoing study must demonstrate that the approved study was not conducted as described in the approved RSP, that it was conducted under anomalous environmental conditions, or that environmental conditions have changed in a material way since the study plan's approval. The proposal must also explain why the study's objectives cannot be met via the approved study's methods and why the proposal for modification was not made earlier, or that significant new information has become available that affects the study.

Any proposal for new information gathering or studies must explain any material changes in the law or regulations applicable to the information request. The proposal must also explain why the study's objectives cannot be met via the approved study's methods and why the proposal for modification was not made earlier, or that significant new information has become available that affects the study. The proposal must indicate how the new study request satisfies the study criteria set forth under 18 CFR § 5.9(b). Finally, specific to the USR, the request must demonstrate extraordinary circumstances warranting approval.

2.2. Study Reporting Timeline through USR Meeting

Table 2.2-1 presents the timeline associated with the USR.

Table 2.2-1. Study progress reporting and relicensing participant review opportunities associated with the USR.

Report / Information Sharing	Proposed Timeframe	Review Comments Due
Hold meetings on Year 2 study results, Integrated Resource Analysis, and assessment of Project effects	1st Quarter, 2009	
File Updated Study Report (USR) [1]	March 2009 [2]	Approximately 60 days [3]
Hold USR meeting (meeting on study results and any proposals to modify study plan) [3]	Within 15 days of updated study report	Disputes/requests to amend study plan due within 30 days from study report meeting summary

Notes:

1 Required under 18 CFR section 5.15(f).

2 The USR must be filed no later than 2 year after FERC approval of the study plan (18 CFR, section 5.15(f)).

3 Applicant must hold a meeting within 15 days of issuance of the study report (18 CFR section 5.15(c)(2)) and issue a meeting summary within 15 days of the meeting (18 CFR section 5.15(c)(3)). Participants then have 30 days to file any disputes or requests to amend the study plan (18 CFR section 5.15(c)(4)).

3 RELEVANT NON-USR STUDIES AND ANALYSES

SCL conducted some studies and analyses that are relevant to, but were not incorporated into, the study program outlined in the RSP. These efforts, described below, include hydrology analyses, bathymetry and topography data collection, and temperature modeling. SCL initiated these efforts prior to the formal relicensing study program, either because they were determined to be prerequisites to other studies or, in the case of temperature modeling, were required for a parallel regulatory process, i.e., the Interstate Temperature TMDL (Total Maximum Daily Load). Beyond its application in the context of the Temperature TMDL, the temperature model of the Boundary Project area is being used to assess the effects of current Project operations as part of FERC relicensing and the Washington Department of Ecology's (Ecology) 401 certification process.

Although the data collection and analyses described below are not part of the RSP approved by FERC, SCL did carefully consider their design and execution in light of FERC's requirements to ensure that they reflect consistency with FERC study criteria (18 CFR § 5.9(b)), such as addressing a nexus between Project operations and resource effects and using methods that are consistent with generally accepted scientific practice.

3.1. Hydrology Data and Statistics

Analyses of existing hydrology data were undertaken by SCL to produce a reliable, hourly hydrologic record needed to conduct environmental and energy production analyses as part of relicensing. The hydrologic analyses were completed based on data from USGS gages 12396500 (Pend Oreille River below Box Canyon) and 12398600 (Pend Oreille River below Boundary Dam), records of water surface elevations measured in the Boundary Dam forebay by SCL and

in Seven Mile Dam forebay by British Columbia Hydro, hydrographic and topographic surveys, and stage recorders (see Study 7, Mainstem Aquatic Habitat Modeling, for an explanation of the location of stage recorders and application of stage data). The analyses involved a rigorous quality assurance procedure to identify and correct errors before data were used in finalizing study results or are used in subsequent modeling.

The hydrologic record report, compiled by R2 Resource Consultants (R2 2008), describes the hydrologic dataset used to support relicensing studies. The record of hourly flows between 1987 and 2005 was used to describe current operations. The report includes a variety of hydrologic statistics used to describe the 19-year period (Calendar Years 1987 through 2005) of hourly records. In addition, average daily flow records between 1912 and 2004 were reviewed to characterize the hydrologic nature of the 19-year record. The hydrologic database for the period 1987 through 2005, along with a summary report covering the same period, was submitted to relicensing participants in March 2008.

Utilizing long-term flow records available from the USGS for the Pend Oreille River in the vicinity of the Project from Calendar Year 1913 through 2006, a flow duration curve was derived from the 94 years of average annual flow, with the results shown in Figure 3.1-1. Based on this analysis, Calendar Years 1997, 2001, and 2002 were selected as the representative wet, dry, and average years, respectively.

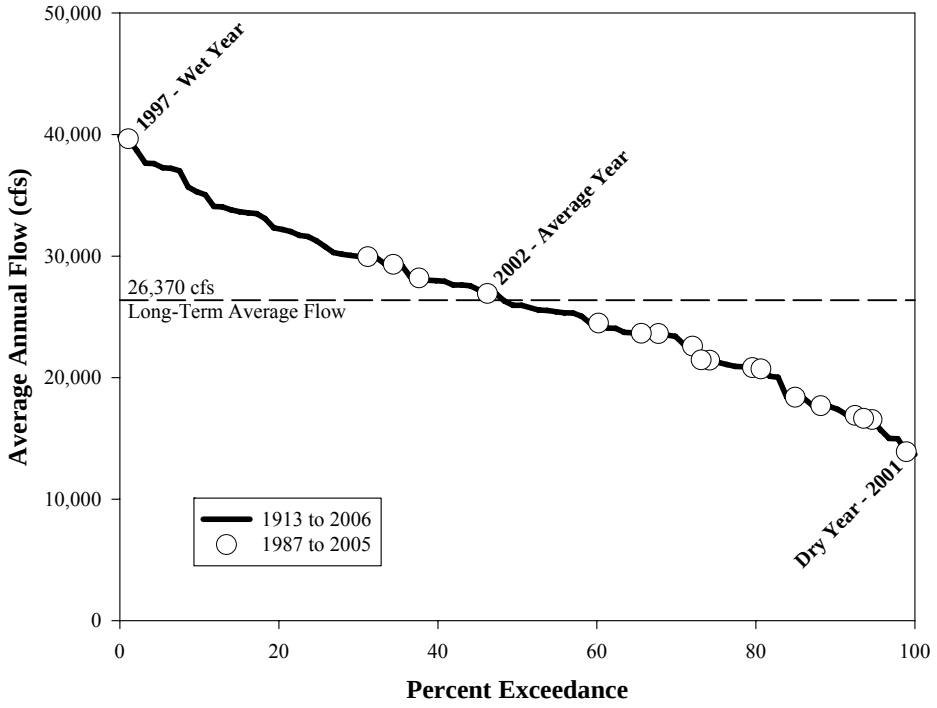

Figure 3.1-1. Flow duration for the Pend Oreille River in the vicinity of Boundary Dam, derived from average annual flows from Calendar Years 1913 through 2006. Percent exceedance of average annual flows from 1987 through 2005 is shown based on ranking these years within the 94-year period, 1913 through 2006.

3.2. Bathymetry and Upland Topography Surveys

Bathymetry and upland topography surveys were performed to chart reservoir bottom and adjacent bare earth surface features and provide detailed topographic data to 1) support biological and other resource studies, 2) support hydrologic modeling, and 3) perform quality control (QC) checks on previous survey work.

The upland topography survey was collected in August 2005 by Terrapoint using an airborne Light Detection and Ranging (LiDAR) sensor. In September through November 2005, these data were supplemented and checked by DeGross Aerial Mapping using aerial photogrammetry. The final upland topography survey covers a longitudinal area from 0.75 miles south of Box Canyon Dam downstream through the Project area and north across the Canada-U.S. border to downstream of the Salmo River confluence. Throughout this area the survey extends approximately 0.75 miles upland of the reservoirs' shorelines.

In 2006, Global Remote Sensing (GRS) conducted the original bathymetry survey. These survey results were supplemented and checked during subsequent bathymetric surveys performed in May through July 2007 by Tetra Tech EC, Inc. (TtEC). TtEC also conducted a bathymetric survey of BC Hydro's Seven Mile Reservoir in August 2007, which was previously unsurveyed, providing full bathymetric coverage from Box Canyon Dam downstream to Boundary Dam, then across the Canada – U.S. border to Seven Mile Dam (approximately 27 miles).

Based on comparisons of the TtEC and GRS bathymetry surveys and a jointly conducted field test, in October 2007 GRS conducted a multibeam bathymetry survey in the lower reservoir, below Metaline Falls. The final dataset, consisting of multibeam bathymetry, scanning laser survey of the shorelines, discrete Global Positioning System (GPS) points, and LiDAR data, was merged by TtEC and R2 Resource Consultants. R2 then published the data in ArcGIS for use in relicensing studies.

3.3. Temperature Modeling

Temperature modeling of the Boundary Project area is needed to satisfy regulatory requirements associated with certification of the Project under Section 401 of the federal Clean Water Act (401 Certification). The temperature model of the Project area was developed in conjunction with models of other segments of the Pend Oreille River to support the Washington-Idaho Interstate Temperature TMDL plan. Although temperature modeling has been conducted outside the FERC-approved relicensing studies program, it addresses a potential nexus between Project operations and resource effects.

Temperature modeling is being conducted for SCL by Battelle, Pacific Northwest National Laboratory (Battelle). Battelle developed a predictive temperature model of the Pend Oreille River from the tailrace of Box Canyon Dam to Boundary Dam. The model, which is based on a state-of-the-art, industry-standard program (CE-QUAL-W2; Cole and Wells 2002), is being used to understand the physical processes controlling water temperature in the Project area, as well as the effects of the Project on existing water temperatures and can also be used to evaluate effects of the Project on temperatures under potential operations scenarios.

The review of available data, model setup for existing conditions, and initial calibration of the model are presented in the final calibration report (Breithaupt and Khangaonkar 2007). Computed error statistics demonstrate that the model is well calibrated, i.e., correspondence between measured data and model predictions is at a level acceptable to Ecology. The calibrated model was used to assess the impact of the Project on temperature under current operations. The results of this assessment are presented in a technical memorandum (Breithaupt, Khangaonkar, and Kim 2008) completed in support of the PLP and the draft Application for 401 Certification. Potential operations scenarios will be evaluated as part of SCL's IRA process (see Section 4.1) and results will be reported in SCL's Application for 401 Certification and License Application.

4 DEVELOPMENT OF PRELIMINARY LICENSING PROPOSAL AND LICENSE APPLICATION

The relicensing studies addressed in the USR will provide much of the information necessary for determining and characterizing Project impacts and identifying appropriate PME measures relevant to those impacts. As noted above, preliminary results of SCL's IRA will initially be presented in the PLP (filed in April 2009) and later refined in the License Application (September 2009).

Table 4.0-1 provides a summary of the opportunities that relicensing participants have to provide input to the USR, IRA, PLP and License Application. Additional details on the planned IRA engagement are provided below.

Table 4.0-1. Steps and schedule for relicensing participant involvement in PLP and License Application development.

Timeframe	SCL Tasks	Interactions with Relicensing Participants
1st Quarter, 2009	Begin developing PLP framework: • Use study results to assess cross-over issues • Identify Project effects (based on information to date)	Hold meetings on Integrated Resource Analysis and assessment of Project effects
March 2009	File Updated Study Report with FERC	Official study report meeting and follow-up (meeting summary, etc.)
March–April 2009	Finish preparation of PLP	
Late April 2009	File PLP with FERC	
April–July 2009		Continue discussions with relicensing participants regarding impact analysis for current operations and for other operations scenarios, along with potential PMEs (to be reflected in License Application)
May–August 2009	Address PLP comments	
August–September 2009	Finish preparation of License Application	
Late September 2009	File License Application with FERC	

4.1. Integrated Resource Analysis (IRA)

The IRA requires assimilation of individual study results, identification and understanding of issues and impacts across resources, and, an integrated analysis of how those impacts might be influenced by elements of other resource areas for the Project as it is currently operated and a variety of operations scenarios. The data collected during the 2007 and 2008 field studies is being utilized to increase the understanding of conditions under existing operating parameters. The IRA includes a predictive exercise that will rely on a variety of analyses and computational models, used for various study evaluations, to predict hydrologic conditions under a variety of operations scenarios to predict their associated habitat effects.

SCL met with relicensing participants on December 3, 2008 to initiate the IRA and discuss a protocol and schedule for the process. The plan and schedule agreed upon by the parties attempts to make the most effective use of the limited time available to interact with relicensing participants prior to issuance of the PLP and between PLP issuance and License Application filing. The complete schedule of planned IRA meetings for 2009 is summarized in Table 4.1-1.

Table 4.1-1. Summary of engagements with relicensing participants on the IRA.

Date	Engagement with relicensing participants [1]
January-March 2009	Meeting(s) to discuss effects of current operations
February-July 2009	Meeting to review SCL's licensing proposal in the PLP and other operations scenarios and PME proposals for the License Application

The purpose of meetings with relicensing participants is to discuss the issue or issues at hand, solicit relicensing participant input, and identify areas of agreement and disagreement on effects analyses and potential PMEs. The outcome of all engagements will be documented in meeting summaries and summarized in the PLP and/or License Application.

Given the complexity of some elements of the overall study program, the fact that some data collection and modeling will continue into early 2009, and because some study areas (such as development of TDG abatement measures) are of a longer-term nature, SCL will identify and explain in the PLP and/or License Application the status of relevant resource analyses, the anticipated schedule for their completion, and when PME proposals are expected to be finalized. SCL will make every effort to complete as much of the analyses and PME identification as possible during the pre-license application period, and for many resource areas, Project effects analysis and PME development are expected to be complete at the time the License Application is filed.

4.2. Proposed Workflow for Study and Modeling Analyses

Computational analysis and modeling of Project operations, hydrology, habitat analyses, and biologic time series are proposed for use in the Project relicensing effort to evaluate a range of potential environmental effects associated with different hydrologic and operations scenarios. This approach is intended to provide relicensing participants and SCL with comparative information on the effects of the existing operations and potential operations scenarios for use in the evaluation of potential PME measures as part of development of the PLP and License Application.

4.3. Models that Support the Integrated Resource Analysis

SCL has developed a suite of models and post-processing analyses needed to support the evaluation of existing Project effects and a range of potential environmental effects associated with different hydrologic and operations scenarios including habitat analyses and biologic time series. These include the scenario tool, hydraulic routing model, mainstem habitat model, trapping and stranding models, mainstem sediment transport model, and tributary delta habitat models. Information that supports the resource models has been developed as part of the relicensing studies and ongoing relevant non-USR studies and analyses (Section 3.0 of this Introduction). The suite of models and supporting post-processing analyses provide tools to be used by SCL and relicensing participants to conduct the IRA for existing Project effects and to support the subsequent comparison of potential environmental effects associated with different hydrologic and operations scenarios.

The following sections provide brief descriptions of the models and post-processing analyses being used during the IRA. More detailed information regarding each model identified below and the applicable resource analyses can be found in the appropriate study report provided in Attachment 2 of this USR.

4.3.1. Scenario Tool and Hydraulic Routing Model

The Scenario Tool and Hydraulic Routing Model (HRM) are software models that will help predict resource impacts and benefits relative to current Project operations and operations scenarios. Using current or future operations and resource criteria, the Scenario Tool produces hourly water surface elevations and flows as input for the HRM. The Scenario Tool is a Microsoft Excel® spreadsheet with an add-in optimization engine (Solver by Frontline Systems, Inc.) that optimizes and simulates Project energy production, Project reservoir and tailwater water surface elevations, and flows.

The Scenario Tool optimizes Project energy production (megawatt hour [MWh]) based on historic hydrologic data and resource criteria input to provide a consistent foundation for the relative comparison of resource impacts or benefits for various operations scenarios in conjunction with study results. Simulation by the Scenario Tool allows the output (elevations, flows, and/or energy production) to be readily used as input data to the HRM. Due to the specific application for resource evaluations, the Scenario Tool results cannot and will not directly translate to future operational changes at the Project.

The HRM has two components: 1) an upstream or reservoir component that addresses the Project area from Box Canyon Dam to Boundary Dam (reservoir HRM); and, 2) a tailwater or downstream component that addresses the area from Boundary Dam to Redbird Creek (a tributary to Seven Mile Reservoir) (downstream HRM), approximately 1 mile north of the Canada-US border.

Using Box Canyon inflows, Project outflows, and the initial Project forebay water surface elevations, the reservoir HRM computes water surface elevations, average velocities at cross section locations, and durations between the Boundary and Box Canyon dams. Similarly, the downstream HRM uses Project hourly outflows and Seven Mile Reservoir water surface elevations (or outflows) to determine water surface elevations, average velocities at various cross sections, and durations downstream of the Project.

4.3.2. Mainstem Habitat Model

The mainstem habitat model uses the 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 are incorporated into the habitat model and compared to Habitat Suitability Indices/Criteria (HSI/HSC) for lifestages and fish species of interest (native salmonids, smallmouth bass, forage species) and other aquatic organisms (benthic macroinvertebrates, periphyton, and macrophytes). The integration of hydraulic, channel morphology and fish response data is 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 Project operation. The mainstem habitat model will also be used to track the effect of fluctuating water surface elevations on potential mountain whitefish and smallmouth bass spawning areas to evaluate which cells of potential spawning habitat remain inundated through the subsequent incubation period (Effective Spawning Index [ESI]). For the IRA, the hourly WUA and ESI data will be summarized by transect and by reach on a monthly, seasonal and annual basis for each operations scenario

4.3.3. Stranding and Trapping Model

Similar to the mainstem habitat model, the stranding and trapping models use the HRM, physical data collected at various locations throughout the Project reservoir (e.g., pool locations), and biological responses (duration of stranding, exposure to water temperatures, cover, etc.) to evaluate the effects of fluctuations in water surface elevations on the risk of stranding and trapping aquatic organisms in mainstem reservoir habitats.

The approach has been formulated to be similar to other analyses involving water surface elevation fluctuations in the varial zone. The stranding model determines the elevation and area of low gradient streambed and areas containing macrophytes and determines the frequency of dewatering from changes in water surface elevation. The stranding model assumes that dewatered areas pose a risk of beaching aquatic organisms on exposed streambed causing immediate injury or mortality. The trapping model calculates the elevation, area and depth of streambed depressions and pools and determines the frequency and duration of isolation from mainstem flow. The trapping model assumes that once a pool becomes disconnected from the mainstem flow, organisms that are trapped are at risk of injury. While the stranding model assumes that injury or mortality occurs within the first hour of dewatering, the trapping model assumes a delayed mortality response depending on the depth of pool and time of year. Fish are assumed to return to potential stranding and trapping areas as soon as the water surface elevation rises and once again inundates the dewatered area. For the IRA, the stranding and trapping indices will use results of the Scenario Tool and HRM to determine the water surface elevations on an hourly basis to evaluate conditions throughout the mainstem habitat modeling study area.

4.3.4. Sediment Transport and Tributary Delta Modeling

The objective of sediment transport and tributary delta modeling is to quantify the effects of Project operations on aquatic habitats in the deltas of the tributary streams. Study efforts involved analyses of tributary delta formation, habitat assessment and sediment transport modeling:

- Tributary delta sediment modeling was conducted to assess whether delta morphologies are sensitive to Project operations and describe if, and how, delta morphologies may change over the term of a new FERC license;
- Aquatic habitat modeling translated fluctuations in Boundary Reservoir water surface elevations into estimates of tributary delta versus reservoir habitat quantity and quality (Habitat Quality Rating) at select tributaries;
- Since cold water plumes at the mouth of tributaries offer potential temperature refugia to native salmonids, water temperatures were modeled to estimate hourly thermal plume areas at four of the tributary deltas during warm summer months;

- Fish access to tributary channels located upstream of depositional deltas was evaluated to identify whether Project operations affect upstream fish movement; and
- Mainstem sediment transport modeling evaluated how erosion and accumulation of mainstem sediments may affect tributary delta habitats.

For the IRA, the tributary delta Habitat Quality Rating, thermal plume area and potential blockages to fish access will be calculated for operations scenarios to assess Project effects. The results of the mainstem sediment transport model will also be used to support other studies such as reservoir shoreline erosion and water quality.

4.3.5. Modeling Limitations

Computational modeling as part of the Boundary Project relicensing analysis will assist in the evaluation of current Project effects and operations scenarios. However, models are inherently limited as representations of actual phenomena, and model input data, as well as modeling objectives and assumptions, involve a degree of uncertainty. Field data from the 2007 and 2008 study program was used to calibrate and validate the models to improve their reliability and predictive nature for the IRA process.

5 SUMMARY LIST OF STUDIES

This USR includes reports for 23 of the 24 relicensing studies.[1] These studies, along with Study 10 (Large Woody Debris Management), are summarized in Table 5.0-1, along with the corresponding resource issue(s) that each study is designed to address. The studies are organized by resource area, and indicate in shaded text where one study will intersect with studies from other resource areas.

All Project elevations included in the USR, unless otherwise noted, are provided relative to both the North American Vertical Datum of 1988 (NAVD 88) and the National Geodetic Vertical Datum of 1929 (NGVD 29). In rare instances when an elevation is provided relative to the NGVD 29 only—e.g., some existing Project drawings—a conversion factor for identifying the NAVD 88 is provided in a heading or legend.

[1] Study 10, Large Woody Debris Management Study, was a 2007 study and was reported on in the Initial Study Report (ISR) in March 2008.

Table 5.0-1. Summary of studies included in this USR.

Identified Resource Issue	Study Title/Description[2]	Study No.
Geology and Soils		
Contribution of the Project to shoreline, hillslope, and Project road related erosion	▪ Erosion Study	1
Water Resources		
Potential Project-related flooding of private property adjacent to upper portion of Boundary Reservoir	▪ Analysis of Peak Flood Flow Conditions Above Metaline Falls	2
	Other relevant study: ▪ Mainstem Aquatic Habitat Modeling Study (hydraulic routing model component)	7
Contribution of the Project to total dissolved gas (TDG) in the Pend Oreille River below the Project	▪ Evaluation of TDG and Potential Abatement Measures	3
	Other relevant studies: ▪ Fish Distribution, Timing, and Abundance Study ▪ Fish Entrainment and Habitat Connectivity Study	9 12
Effect of the Project on toxic compounds in Boundary Reservoir	▪ Toxics Assessment: Evaluation of Contaminant Pathways, Potential Project Nexus	4
	Other relevant studies: ▪ Erosion Study ▪ Mainstem Aquatic Habitat Modeling Study (hydraulic routing model component) ▪ Sediment Transport and Boundary Reservoir Tributary Delta Habitats Study	1 7 8
General water quality in Boundary Reservoir and relation to fish and habitat	▪ Water Quality Constituent and Productivity Monitoring	5
	Other relevant study: ▪ Mainstem Aquatic Habitat Modeling Study (aquatic plant habitat suitability component)	7
pH and dissolved oxygen (DO) in Boundary Reservoir	▪ Evaluation of the Relationship of pH and DO to Macrophytes in Boundary Reservoir	6

[2] Shaded studies are being conducted under another resource area.

Table 5.0-1, continued…

Identified Resource Issue	Study Title/Description[2]	Study No.
Fish and Aquatic Resources		
Effect of load-following operations and pool-level fluctuations on fish and aquatic species and habitats	▪ Mainstem Aquatic Habitat Modeling Study; study includes the following components: ▪ Habitat mapping ▪ Hydraulic routing model ▪ Physical habitat model development ▪ Habitat suitability index (HSI) development, for: - Fish - Macrophytes - Periphyton and benthic macroinvertebrates	7
Sediment transport and effect of reservoir fluctuations on tributary delta habitat	▪ Sediment Transport and Boundary Reservoir Tributary Delta Habitats Study; study includes the following components: ▪ Tributary delta habitat modeling ▪ Evaluation of tributary delta sediment processes ▪ Evaluation of mainstem sediment transport	8
Abundance, distribution, and periodicity of fish in Boundary Reservoir	▪ Fish Distribution, Timing, and Abundance Study; study includes the following components: ▪ Passive and active sampling ▪ Biotelemetry	9
Effect of Project operations on wood recruitment and transport	▪ Large Woody Debris Management Study	10
Aquatic productivity in Boundary Reservoir	▪ Productivity Assessment	11
Fish entrainment and connectivity	▪ Fish Entrainment and Habitat Connectivity Study; study includes the following components: ▪ Evaluation of potential turbine entrainment ▪ Evaluation of potential spillway entrainment	12
Recreational fishery at the Project	▪ Recreational Fishery Study; study includes the following components: ▪ Recreational creel and angler surveys ▪ Triploid trout biotelemetry ▪ Triploid trout management	13
Effect of Project operations on habitat in Boundary Reservoir tributaries	▪ Assessment of Factors Affecting Aquatic Productivity in Tributary Habitats	14

Table 5.0-1, continued…

Identified Resource Issue	Study Title/Description[2]	Study No.
Botanical and Wildlife Resources		
Waterfowl nesting habitat and productivity at Boundary Reservoir	▪ Waterfowl/Waterbird Study	15
	Other relevant study: ▪ Mainstem Aquatic Habitat Modeling Study (hydraulic routing and aquatic plant habitat suitability components)	7
Status of cottonwood and other riparian-dependent plant species adjacent to Boundary Reservoir	▪ Inventory of Riparian Trees and Shrubs	16
	Other relevant studies: ▪ Erosion Study ▪ Mainstem Aquatic Habitat Modeling Study (hydraulic routing model component) ▪ Sediment Transport and Boundary Reservoir Tributary Delta Habitats	 1 7 8
Effect of the Project on rare, threatened, and endangered (RTE) plant species	▪ Rare, Threatened, and Endangered (RTE) Plant Species Inventory	17
Effect of the Project on RTE wildlife species	▪ RTE Wildlife Species Study	18
	Other relevant study: ▪ Big Game Study	 19
Effect of the Project on deer, elk, and other big game species	▪ Big Game Study	19
	Other relevant study: ▪ RTE Wildlife Species Study	 18
Effect of the Project on bats	▪ Bat Surveys and Habitat Inventory	20
Recreation and Land Use		
Recreational use, opportunities and demand in the Project area	▪ Recreation Resource Study; study includes the following components: ▪ Recreation surveys ▪ Regional recreation analysis ▪ Dispersed recreation use, access, and condition analysis ▪ Future recreation use analysis ▪ Recreation carrying capacity analysis	21
	Other relevant studies: ▪ Erosion Study ▪ Recreational Fishery Study	 1 13

Table 5.0-1, continued…

Identified Resource Issue	Study Title/Description[2]	Study No.
Project-related roads system (condition and needs) and public access	▪ Land and Roads Study	22
	Other relevant studies: ▪ Erosion Study ▪ Big Game Study ▪ Recreation Resource Study	 1 19 21
Aesthetic/Visual Resources		
Effect of the Project on visual character and visual quality	▪ Aesthetic/Visual Resource Study	23
	Other relevant studies: ▪ Erosion Study ▪ Recreation Resource Study (recreation surveys component)	 1 21
Cultural Resources		
Effect of the Project on cultural resources	▪ Cultural Resource Study	24
	Other relevant studies: • Erosion Study • Assessment of Factors Affecting Aquatic Productivity in Tributary Habitats • Bat Surveys and Habitat Inventory • Dispersed Recreation Use, Access, and Condition Analysis (a component of the Recreation Resources Study)	 1 14 20 21

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