

***Revised Study Plan***  
***Boundary Hydroelectric Project (FERC No. 2144)***

**Study No. 2**  
**Analysis of Peak Flood Flow Conditions above Metaline Falls**

**Seattle City Light**

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# Study No. 2 – Analysis of Peak Flood Flow Conditions above Metaline Falls

## 1.0 INTRODUCTION

During the July 19, 2006, FERC scoping meeting, Mr. Karl McKenzie, owner of Riverview Trailer Court & RV Park in Metaline (Washington), suggested that Boundary Project (Project) operations may exacerbate flood conditions in the Upper Reservoir Reach of the Boundary Reservoir, resulting in the flooding of his and other homes in the town of Metaline. After reviewing the information presented in the Boundary Project Pre-Application Document (PAD; SCL 2006a) and the comments provided during the scoping meeting, FERC identified a gap between existing information and the information needed to evaluate whether Project operations are influencing the duration and level of floods in the area (FERC 2006).

The purpose of this study is to evaluate how Project operations may influence the duration and level of flood conditions in the town of Metaline. If Project operations are influencing the duration and level of flood conditions in the town of Metaline, this study will identify any opportunities and cost of implementing procedures that may attenuate the potential conditions.

The study will use recent topography and bathymetry to perform hydraulic modeling that characterizes the effects of reservoir conditions above Metaline Falls relative to Project operations during periods of high flows in 1972, 1974, and 1997 — the years Mr. Karl McKenzie indicated in the FERC scoping meeting that flooding had occurred.

## 2.0 STUDY PLAN ELEMENTS

### 2.1. Nexus Between Project Operations and Effects on Resources

Project operations affect reservoir levels on a weekly, daily or hourly level. There is some evidence to suggest that Metaline Falls acts as a hydraulic control point, resulting in significant attenuation of water surface elevations in the Upper Reservoir Reach. When the Project is operating at reservoir water surface elevations lower than the hydraulic control at Metaline Falls, fluctuations in water levels observed at the Boundary forebay may not extend upstream of Metaline Falls. The purpose of this study will be to more fully understand the relationship between operational influences of the Project on Boundary Reservoir reaches upstream and downstream of Metaline Falls.

### 2.2. Agency Resource Management Goals

Sections 4(e) and 10(a) of the Federal Power Act require the FERC to give equal consideration to all uses of the waterway on which a project is located. When reviewing a proposed action, FERC must consider the environmental, recreational, fish and wildlife, and other non-developmental values of the project, as well as power and developmental values (including flood control).

Comments provided by Mr. Karl McKenzie during the FERC scoping meeting indicated that there might be some potential for the Project to influence flood levels. However, FERC notes in its study request (FERC 2006) that there is also information in the PAD that suggests that the natural constriction formed by the Canyon Reach and Metaline Falls prevents the Project from significantly affecting flood levels in the Upper Reservoir Reach. Therefore, to fully evaluate the Project's effect on flood conditions and to balance potential enhancement opportunities with their costs, an analysis of flood flows and operations is needed and relevant to FERC's public interest determination.

### **2.3. Study Goals and Objectives**

The goals of the Analysis of Peak Flood Flow Conditions above Metaline Falls Study are to evaluate how Project operations may influence the duration and level of flood conditions in the town of Metaline and to identify any opportunities and cost of implementing procedures that may attenuate those conditions. The objectives of the study are as follows:

1. Select transects (number and location) to measure and model the Upper Reservoir Reach adjacent to and in the vicinity of the town of Metaline.
2. Develop an unsteady-flow, hydraulic model that estimates water surface elevations and storage along modeled transects on an hourly basis under historic 1972, 1974, and 1997 high flow and operational conditions.
3. Document the flow conditions during which flooding of the Metaline area has occurred in 1972, 1974, and 1997; and, the reservoir and surrounding land elevations in the Metaline area during these flood events, if applicable.
4. Determine the operational feasibility, effects on generation, and cost of implementing any procedures that might attenuate flooding conditions attributable to Project operations.

### **2.4. Need for Study**

#### Summary of Existing Information

The Pend Oreille River system is highly regulated, with flows into Boundary Reservoir controlled by several upstream projects including Box Canyon (Pend Oreille County PUD), Albeni Falls (U.S. Army Corps of Engineers), and Hungry Horse (U.S. Bureau of Reclamation). The Boundary Project is operated in a load-following mode to shape available water for energy production during peak-load hours. The normal maximum reservoir water surface elevation is at 1,990 feet NGVD 29 (1,994 feet NAVD 88). Relative to the average daily river flow, the reservoir has relatively little storage capacity (about 43,000 acre-feet) within the authorized maximum drawdown of 40 feet (from elevation 1,990 to elevation 1,950 feet NGVD 29 (1,994–1,954 feet NAVD 88)). From about Memorial Day weekend through Labor Day weekend, Seattle City Light (SCL) voluntarily limits water surface fluctuations to a 10-foot range for reservoir access and recreation (between 1,980 and 1,990 feet NGVD 29 [1,984–1,994 feet NAVD 88]); during the remainder of the year, the water surface may fluctuate between 1,990 and 1,970 feet NGVD 29 (1,994–1,974 feet NAVD 88) in the Forebay and Canyon reaches of the reservoir.

Storage between elevation 1,970 and 1,950 feet (1,974–1,954 feet NAVD 88) is reserved for extreme system load requirements. The Project license has no flood control requirements.

As described in Attachment 1, section 3.1 of this RSP, analyses of existing hydrology data have been undertaken by SCL to produce the reliable hydrologic dataset and statistics (hydrologic record) that is needed to conduct environmental and energy production analyses (as described in Attachment 1, section 3.2) for FERC relicensing of the Boundary Project. This hydrologic record for the Project will be consistently used for evaluations of Project operations, resource effects, and potential alternative operational scenarios. The hydrologic record for the Pend Oreille River system and the Boundary Project will be completed by March 2007 and will be made available in the Information Library on the Boundary Project relicensing website ([www.seattle.gov/light/news/issues/bndryRelic/](http://www.seattle.gov/light/news/issues/bndryRelic/)).

### Need for Additional Information

No formal studies have been done to evaluate the potential relationship of Project operations to flood flows on the McKenzie property in the town of Metaline and any other improved properties within the reservoir floodplain based on readily available, existing information (SCL 2006a).

## 2.5. Detailed Description of Study

### Study Area

The study area for this study includes Boundary Reservoir, from Box Canyon Dam, at river mile (RM) 34.5, to Boundary Dam, at RM 17.0. The study area also encompasses land adjacent to the reservoir sufficient to address the issue of the potential relationship of Project operations to flood conditions on the McKenzie property in the town of Metaline and on any other improved properties within the reservoir floodplain. The portion of the study area that includes the town of Metaline is the Upper Reservoir Reach, from Box Canyon Dam to Metaline Falls to (RM 34.5 to RM 27.8). The two remaining reservoir reaches are downstream of Metaline Falls and include the Canyon Reach (RM 27.8 to RM 19.4) and the Forebay Reach (RM 19.4 to RM 17.0).

### Proposed Methodology

A one-dimensional, unsteady-flow, hydraulic model will be constructed and used to analyze the Project operations relationships to the Upper Reservoir Reach relative to the Metaline area for 1972, 1974, and 1997 flows. The hydraulic model will be developed using hydrologic and hydraulic models by U.S. Army Corps of Engineers (USACE) including HEC-RAS and HEC-FDA (USACE 1998, 2000, 2002a, 2002b, 2002c, 2005). The results of the hydraulic model will be used to understand the relationship between operational influences above and below Metaline Falls relative to flood conditions to determine the Project's ability to attenuate flooding on the McKenzie property in the town of Metaline and any other improved properties within the reservoir floodplain.

The U.S. Geological Survey (USGS 2006) and SCL currently collect hourly hydrologic data in the Pend Oreille River. It is assumed that these data will continue to be collected in 2007 and 2008, and will be available for use in the hydraulic model. These data consist of the following:

- Hourly flow data from the U.S. Geological Survey (USGS) for the Pend Oreille River below Box Canyon Dam (Gage No. 12396500; located upstream of Metaline, Washington). The maximum recorded daily mean flow of 136,000 cfs occurred June 13–14, 1972, which corresponded to a maximum tailwater elevation of 2,014.5 feet (NGVD 29) on June 14, 1972 (Pend Oreille County PUD 2000). This flow and elevation is based on annual flow rate data recorded at this gage from January 1, 1953 to September 30, 1993, by the USGS (Pend Oreille County PUD 2000).
- Hourly flow data from Seattle City Light for total flow release from Boundary Reservoir (energy generation plus spill). Four turbines were operating in 1972 and 1974, and all six turbines were operating in 1997.<sup>1</sup>
- Hourly flow data from the USGS for the Pend Oreille River below Boundary Dam (Gage No. 12398600) near the U.S.-Canada border.

Additional information is needed to develop and calibrate the hydraulic model, and to provide a consistent input database to allow for comparison of Project operations for 1972, 1974, and 1997. The additional data required consist of the following:

- Bathymetry survey maps of Boundary Reservoir will be completed in early 2007 and will provide vertical resolution of 2-foot contours for wetted areas down to a depth of approximately 40 feet from the full pool water surface and 5-foot contours below a depth of 40 feet from the full pool water surface for the reach of the Pend Oreille River between Box Canyon Dam and the U.S.-Canada border. The bathymetry survey will be merged with the LIDAR (Light Detection And Ranging) survey to produce a current 3-D basemap.
- Water surface elevation data (15-minute readings) covering a continuous period encompassing at least one spring and summer will be needed from stage recorders deployed in the Pend Oreille River at the following locations:
  - Just downstream of Box Canyon Dam, in the Upper Reservoir Reach.
  - Just upstream from Metaline Falls, in the Upper Reservoir Reach.
  - Just downstream from Metaline Falls, in the Canyon Reach.
  - At the downstream end of the Canyon Reach.
  - In the Boundary Project forebay, in the Forebay Reach.
- Water surface elevation data will be needed from the stage recorders deployed at these five selected sites during 2007 to develop and calibrate the hydraulic model. Additional water surface elevation data from the stage recorders may be needed in 2008 depending on the flow conditions in 2007.

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<sup>1</sup> The Project began commercial operation in 1967, with turbine-generator units Unit 51 through 54. In accordance with a 1982 license amendment approving expansion of the Project, Units 55 and 56 were constructed in two previously excavated bays in the machine hall and came on line in 1986.

- The conversion between vertical elevation references (NGVD29 and NAVD88) will be needed to convert all elevation data to a common datum.
- A time series of hourly flow releases for 1972, 1974, and 1997 from Box Canyon Dam to the Pend Oreille River will be needed for use as input to the hydraulic model.
- The potential effects of 1972, 1974, and 1997 historic operations on the hourly water surface elevations in the Upper Reservoir Reach of Boundary Reservoir will be assessed relative to the town of Metaline elevations based on the selected transects.

The specific tasks involved in this study are described below.

#### *Task 1) Hydraulic Model Construction*

A one-dimensional, unsteady-flow, hydraulic model will be constructed to estimate flow and water surface elevations in the Upper Reservoir Reach of Boundary Reservoir using additional transects and consistent boundary conditions from the Mainstem Aquatic Habitat Modeling Study (Attachment 2, Study No. 7 of this RSP). The hydraulic model will be developed using cross-sectional profile data derived from bathymetric and LIDAR surveys.

#### *Task 2) Model Calibration*

The hydraulic model will be calibrated to match observed hourly stages obtained from stage recorders. The resulting model will translate Boundary forebay water surface elevations, as a result of 1972, 1974, and 1997 historic operations, to upstream locations on the McKenzie property in the town of Metaline and any other improved properties within the reservoir floodplain.

#### *Task 3) Model Documentation and Executable Model*

An executable model and supporting documentation will be prepared that can be used in the development of GIS maps that illustrate the 1972, 1974, and 1997 land and reservoir elevations on the McKenzie property in the town of Metaline and any other improved properties within the reservoir floodplain.

#### *Task 4) Flood Analysis Documentation*

If flooding conditions occurred due to Project operations in 1972, 1974, and 1997, determine the operational feasibility, effects on energy generation, and cost of implementing procedures that may attenuate any future Project-related flooding conditions on the McKenzie property in the town of Metaline and any other improved properties within the reservoir floodplain.

As described in Attachment 1, section 2.2 of this RSP, SCL has selected and retained the Technical Consultant that will implement the relicensing study program. Prior to actual initiation of the studies, the Technical Consultant will participate, with SCL and relicensing participants, in developing and refining any remaining details related to implementation of the studies.

**2.6. Work Products**

Work products will consist of a calibrated executable model and an interim study report describing the methods used to develop the hydraulic model including channel cross-section profiles (transects) and details of model calibration. The final study report of the Analysis of Peak Flood Flow Conditions Above Metaline Falls will include the final summary of the Hydraulic Routing study component from the Mainstem Aquatic Habitat Modeling Study (Study No. 7).

**2.7. Schedule**

The schedule for completing this study is provided in Table 2.7-1.

**Table 2.7-1.** Schedule for the Analysis of Peak Flood Flow Conditions Above Metaline Falls.

Activity	2007				2008				2009
	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q
Technical Consultant study refinement	-----								
Construct cross-sections for hydraulic model		-----	-----						
Obtain and analyze hourly stage and flow data	-----								
Develop and calibrate hydraulic model		-----	-----						
Prepare interim study report (first-year results)				•					
Distribute interim study report					•				
Meet with relicensing participants to review first year efforts and results and discuss plans for second year efforts					•				
Include interim report in Initial Study Report (ISR) filed with FERC					•				
Hold ISR meeting and file meeting summary with FERC					•				
Continue to collect water surface elevation data at selected sites to help calibrate the model transects					-----	-----			
Prepare “draft” final study report								•	
Distribute “draft” final study report for relicensing participant review									•
Meet with relicensing participants to review study efforts and results and “cross-over” study results									•
Include final study report in Updated Study Report (USR) filed with FERC									•
Hold USR meeting and file meeting summary with FERC									•

## **2.8. Consistency with Generally Accepted Scientific Practice**

One-dimensional unsteady flow hydraulic models are commonly used to evaluate flow and stage fluctuations through rivers and reservoirs. The HEC-RAS model has proven to be very robust under mixed flow conditions (subcritical and supercritical), as will be expected in the vicinity of Metaline Falls of the Pend Oreille River. The HEC-RAS model also has the capability of automatically varying Manning's "n" with stage through the use of the equivalent roughness option. The robust performance and flexibility of HEC-RAS make this model the appropriate choice for determining the relationship between Project operations, flood flows, and corresponding changes in reservoir water surface elevations from the forebay of Boundary Dam to Box Canyon Dam.

## **2.9. Consultation with Agencies, Tribes, and Other Stakeholders**

This study plan was developed in response to FERC's official request (dated August 31, 2006) that SCL conduct a study to assess peak flood flow conditions above Metaline Falls (FERC 2006). A proposed study plan was included in the PSP that was filed with FERC on October 16, 2006.

Since filing the PSP, SCL has continued to work with relicensing participants on its proposed study plans. Relicensing participants provided no comments on the Analysis of Peak Flood Flow Conditions Above Metaline Falls plan at the November 15 study plan meeting, and comments filed with FERC by the USFS (2007) stated that "the Forest Service agrees with SCL's proposed study of Analysis of Flow Conditions. The agency [USFS] appreciates SCL's collaborative effort to provide a consensus based study proposal." No other PSP comments were filed with FERC regarding this study. (Comments are summarized in Attachment 3 and consultation documentation included in Attachment 4 of this RSP). As a result, SCL has made only minor modifications to this plan to add clarification and detail.

## **2.10. Progress Reports, Information Sharing, and Technical Review**

Relicensing participants will have opportunities for study coordination through regularly scheduled meetings, reports and as needed, technical subcommittee meetings. Reports are planned for distribution in early 2008 and 2009. Relicensing participants will have the opportunity to review and comment on these reports. Prior to release of the Initial and Updated Study Reports (which will include the results of this study), SCL will meet with relicensing participants to discuss the study results, as described in Attachment 1, section 2.3 of this RSP. Relicensing participants will also have the option to participate in site visits during transect selection. Relicensing participant workgroup meetings are planned to occur on a quarterly basis, and workgroup subcommittees will meet or have teleconferences as needed.

## **2.11. Anticipated Level of Effort and Cost**

The estimated effort and cost for preparing the study plan, conducting the study, and preparing the report for the Boundary Project ranges from \$30,000 to \$60,000, subject to review and revision as additional details are developed.

### 3.0 LITERATURE CITED

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