

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

Study No. 1
Erosion Study

Seattle City Light

February 2007

TABLE OF CONTENTS

1.0 Introduction.....1

2.0 Study Plan Elements.....1

 2.1. Nexus between Project Operations and Effects on Resources..... 1

 2.2. Agency Resource Management Goals 2

 2.3. Study Goals and Objectives 3

 2.4. Need for Study 4

 2.5. Detailed Description of Study..... 8

 2.6. Work Products 12

 2.7. Consistency with Generally Accepted Scientific Practice..... 13

 2.8. Consultation with Agencies, Tribes, and Other Stakeholders 13

 2.9. Schedule..... 13

 2.10. Progress Reports, Information Sharing, and Technical Review 14

 2.11. Anticipated Level of Effort and Cost..... 14

3.0 Literature Cited15

List of Tables

Table 2.4-1. Summary of Slope Stability along the Boundary Reservoir. (Source: SCL 2006a) 7

Table 2.9-1. Schedule for the Erosion Study..... 14

List of Figures

Figure 2.4-1. Slope and erosion characteristics, Boundary Reservoir..... 5

[This page intentionally left blank.]

Study No. 1 – Erosion Study

1.0 INTRODUCTION

The Boundary Project (Project) is located within the Okanogan Highlands physiographic province, which has a unique geology attributable to volcanism, intrusion of granitic rock, deformation and metamorphism of marine sediment accretionary terrains (Williams et al. 1995, Alt and Hyndman 1984). Continental glaciation approximately 20,000 to 10,000 years ago (Stoffel and others 1991) deeply eroded the bedrock and left areas of thick glacial and post-glacial related sediments. The Project is located in an area where the Pend Oreille River bisects the Selkirk Mountains and cuts through Metaline Limestone and Ledbetter Slate. These two formations are the predominant geologic features along Boundary Reservoir downstream of Metaline Falls. In addition, pockets of glacial related sediments are present between bedrock outcrops along the shoreline of the reservoir. The upstream portion of the reservoir, above Metaline Falls, is characterized by predominantly unconsolidated glacial sediments and side stream and mainstem river alluvial deposits with a few areas of bedrock consisting of Ledbetter Slate.

A reconnaissance-level survey conducted by Seattle City Light (SCL) in 2005 identified erosion at numerous sites along the Boundary Reservoir shoreline and at a few locations along Project-related roads (SCL 2006a). However, this survey did not assess erosion processes and causes, and there is insufficient information to determine the relative contribution to shoreline erosion from wave action, and/or water level fluctuations, or the impacts of these factors on resources. The Erosion Study described in this study plan is intended to address information needs related to Boundary Reservoir shoreline erosion and slope stability, as well as erosion and slope stability associated with Project-related roads. Specifically, the purpose of this study is to gather further information to determine the causes and potential impacts of erosion. The potential causes of shoreline erosion and erosion along Project-related roads include both Project-related factors and non-Project-related factors, and the study will provide information on the relative contribution of these factors. Results of this study will also be used to identify potential impacts of Project-induced erosion to other resources, including aquatic and riparian habitats, water quality, botanical, wildlife, cultural, and visual resources, land uses, and recreation uses. At sites where identified resource sites may be impacted by Project-related erosion, a general feasibility assessment of potential erosion control measures will also be conducted.

2.0 STUDY PLAN ELEMENTS

2.1. Nexus between Project Operations and Effects on Resources

Reconnaissance-level information collected by SCL for preparation of the Boundary Project Pre-Application Document (PAD) indicates that erosion is occurring at a number of locations around the shoreline of Boundary Reservoir (see PAD section 4.3; SCL 2006a). In addition, erosion processes from Project operations specific to the SCL-owned Boundary Wildlife Preserve (BWP) were identified by Enserch Environmental (1994). The Enserch report also provided a general evaluation of Project-related erosion processes at other sites along the reservoir. Erosion and slope stability associated with Project-related roads were described in 1984 (Hart Crowser

1984). Except for the BWP, processes controlling erosion at specific sites along the reservoir shoreline and rates of erosion at these locations are not known. Factors potentially contributing to shoreline slope instability include erosion from Project operations and activities, as well as non-Project sources, including natural processes. Manifestations of shoreline erosion from reservoir operations and roads may include rills and gullies, seepage and frost wedging, frost heave, soil creep, ravelling, undercut slopes, topples, landslides, and sheet erosion. Many of these same manifestations can also result from non-Project-related activities, such as timber management, mining, road construction and maintenance, and natural slope processes. The Erosion Study will provide information needed to understand the relative contributions of several potential factors that may be affecting shoreline and road erosion and associated slope stability. It will also provide information to assess the impacts of erosion on other resources.

2.2. Agency Resource Management Goals

In addition to providing information needed to characterize Project effects, the Erosion Study will provide information to help agencies with jurisdiction over geology and soil resources in the Project area to identify appropriate conditions for the new Project license pursuant to their respective mandates. The study should also help agencies with jurisdictional oversight by providing information to assess the relationship between erosion and land use, recreation, fish and wildlife habitat, botanical resources, and cultural resources. Agency management goals and policies associated with soils and erosion are summarized below.

U.S. Forest Service (USFS)

The National Forest Management Act of 1974 (16 U.S.C. §§ 1600-1614, as amended), Executive Orders, and USFS regulations direct the agency to “manage forest and rangelands in a manner that will improve soil productivity” (Forest Service Manual [FSM] 2550.3). Further, FSM 2554.04 states the USFS is to “monitor the soil resource to detect significant changes in soil properties resulting from the implementation of management plans” and to “use the results of monitoring to evaluate resource management actions and recommend adjustments to practices or mitigation to prevent significant impairment of long-term soil productivity” (FSH 2509.18, 2.03). The overall program focuses on soil productivity, sustainability, and inventories.

The Land and Resource Management Plan for the Colville National Forest (CNF) also includes a number of forest-wide standards and guidelines related to soils and erosion (USFS 1988). Those applicable to the Project include the following:

- National Forest system lands will be managed under the principle of multiple use and sustained yield without permanent impairment of land productivity.
- Identify areas of high soil erosion or mass failure potential and evaluate probable impacts of resource development.
- Comply with State requirements in accordance with the Clean Water Act through the selection and implementation of Best Management Practices. These Best Management Practices include practices to prevent or minimize erosion and runoff from roads, protection of riparian areas, and prompt revegetation of disturbed areas (USDA Forest Service, 1988).

- Revegetate cut and fill slopes and other large areas of disturbed soil, as quickly as possible with vegetation suitable for the management goals of the area.
- Management activity caused suspended and bedload sediment and/or changes in bank stability will be considered ‘excessive’ and mitigation will be implemented.
- Emphasize the protection and improvement of soil, water, vegetation, fish and wildlife resources while managing riparian areas.
- Emphasis will be given to control and reduction of noxious weed infestations.
- Protect eligible cultural resources from human depredation and natural destruction.

U.S. Bureau of Land Management (BLM)

The National Forest Management Act also applies to the BLM. The BLM is required to address the health and productivity of soils and evaluate the potential impacts of projects to soils when preparing resource management plans and subsequent environmental impact statements and environmental assessments.

Washington Department of Ecology (Ecology)

Ecology is responsible for administering the Shoreline Management Act (SMA) and for protecting and restoring waters of the state. The SMA is intended to protect shoreline natural resources, including “...the land and its vegetation and wildlife, and the waters of the state and their aquatic life...” against adverse effects. All allowed uses are required to mitigate adverse environmental impacts to the maximum extent feasible and to preserve the natural character and aesthetics of the shoreline. One of the purposes of Ecology’s Water Quality Program is to prevent point-source pollution or reduce nonpoint-source pollution, or a combination of both. Sediment recruitment can be a point source of pollution but is commonly considered a type of nonpoint-source pollution.

Pend Oreille County

Pend Oreille County has a Shoreline Master Program with the overall goal of developing county shorelines in a way that protects against adverse effects to public health, land, vegetation, wildlife, waters, and aquatic life, and recognizes and protects private property and navigational rights (Pend Oreille County 1974). The plan includes policies to reduce erosion from agricultural and forest practices, mining, and utilities.

2.3. Study Goals and Objectives

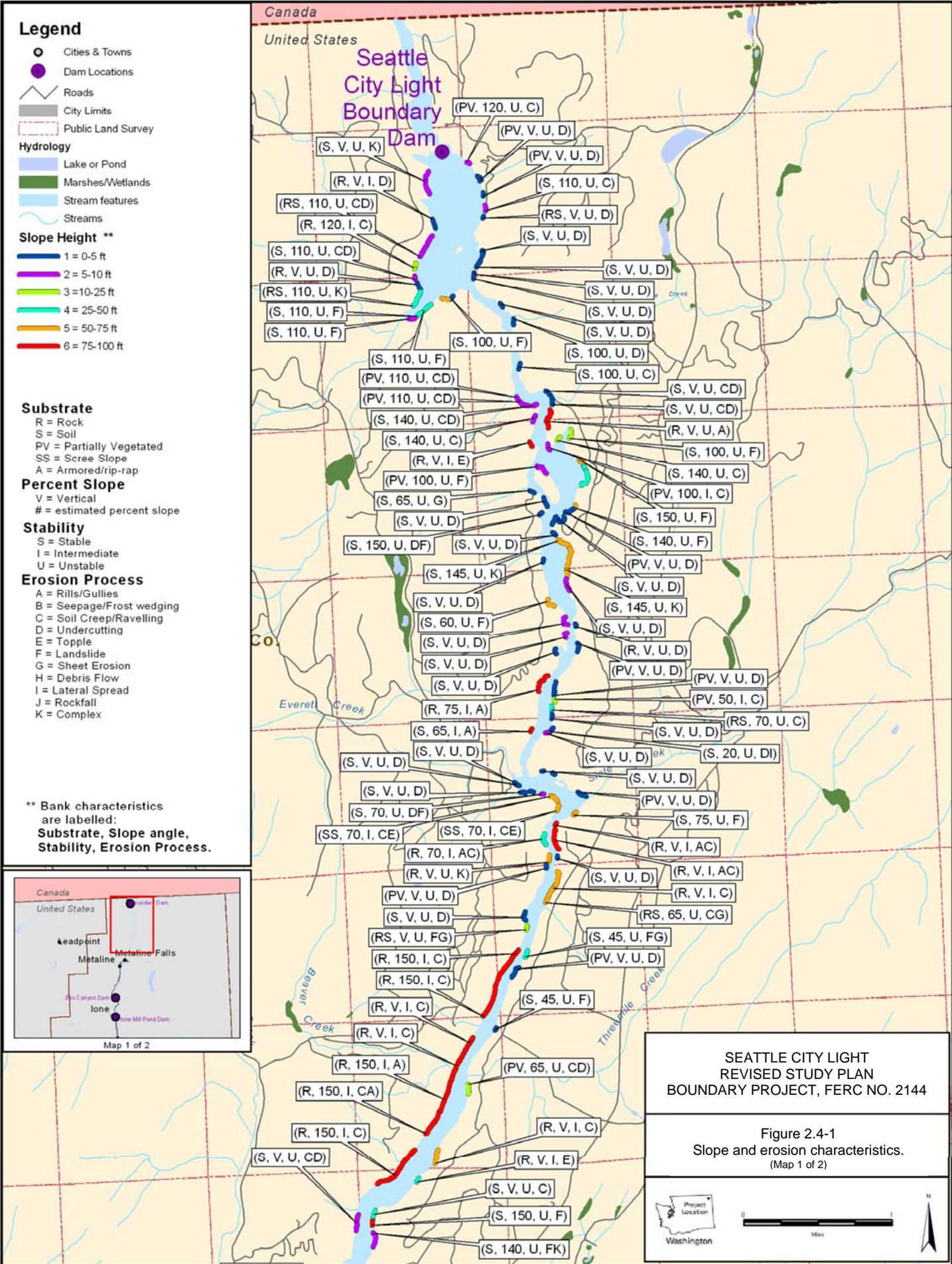
The primary goal of the Erosion Study is to provide the information needed to understand the relationship among several factors that may be contributing to erosion in the Project area and to identify effects of erosion on water quality, aquatic habitat, cultural resources, recreation, wildlife habitat, sensitive plants, noxious weed establishment and spread and scenic resources. Another goal is to provide information on sediment-related processes needed for fish and aquatic studies. The Erosion Study will address the following objectives:

- Identify erosion and slope failure locations along the reservoir shoreline, along Project-related roads or near Project facilities and determine the primary processes causing erosion and slope failures at these locations, including the potential contributions of Project operations (e.g., water levels and water level fluctuations), Project-related recreation (e.g., wave action from boating and dispersed shoreline camping), non-Project sources (e.g., mining, timber management and harvest, and non-Project roads and railroads), and natural processes.
- Provide an estimate of erosion rates, area and volume of land that could be lost to erosion and slope failures at each of the identified sites over the term of the new Project license, and the sediment size fractions contributed at each identified erosion and slope failure site.
- Identify land ownership of areas affected by Project-related erosion and slope failures.
- Identify resource sites that may be impacted by Project-related erosion and slope failures and determine the feasibility of reducing erosion and slope failures at those sites.

2.4. Need for Study

Summary of Existing Information

A number of documents, as well as field observations, have identified shoreline erosion at numerous sites along Boundary Reservoir. The PAD provides a review of existing information and presents the findings of reconnaissance-level surveys and mapping conducted by SCL in 2005 (SCL 2006a). These surveys mapped the entire shoreline, identified stable and unstable sections, and collected data on the slope, height, vegetative cover, and erosion processes for each shoreline section with evidence of erosion (see PAD section 4.3). Results of these surveys indicate that approximately 11.3 percent of the reservoir shoreline has intermediate stability and approximately 15.7 percent is unstable (Figure 2.4-1; Table 2.4-1). Enserch Environmental (1994) estimated that approximately 6 percent of the shoreline is experiencing significant erosion. Slope stability and erosion associated with roads and two landslides within the Project area were evaluated by Hart Crowser in 1984. Hart Crowser (1984) also provided a number of recommendations to reduce erosion and increase stability along portions of Project-related roads.



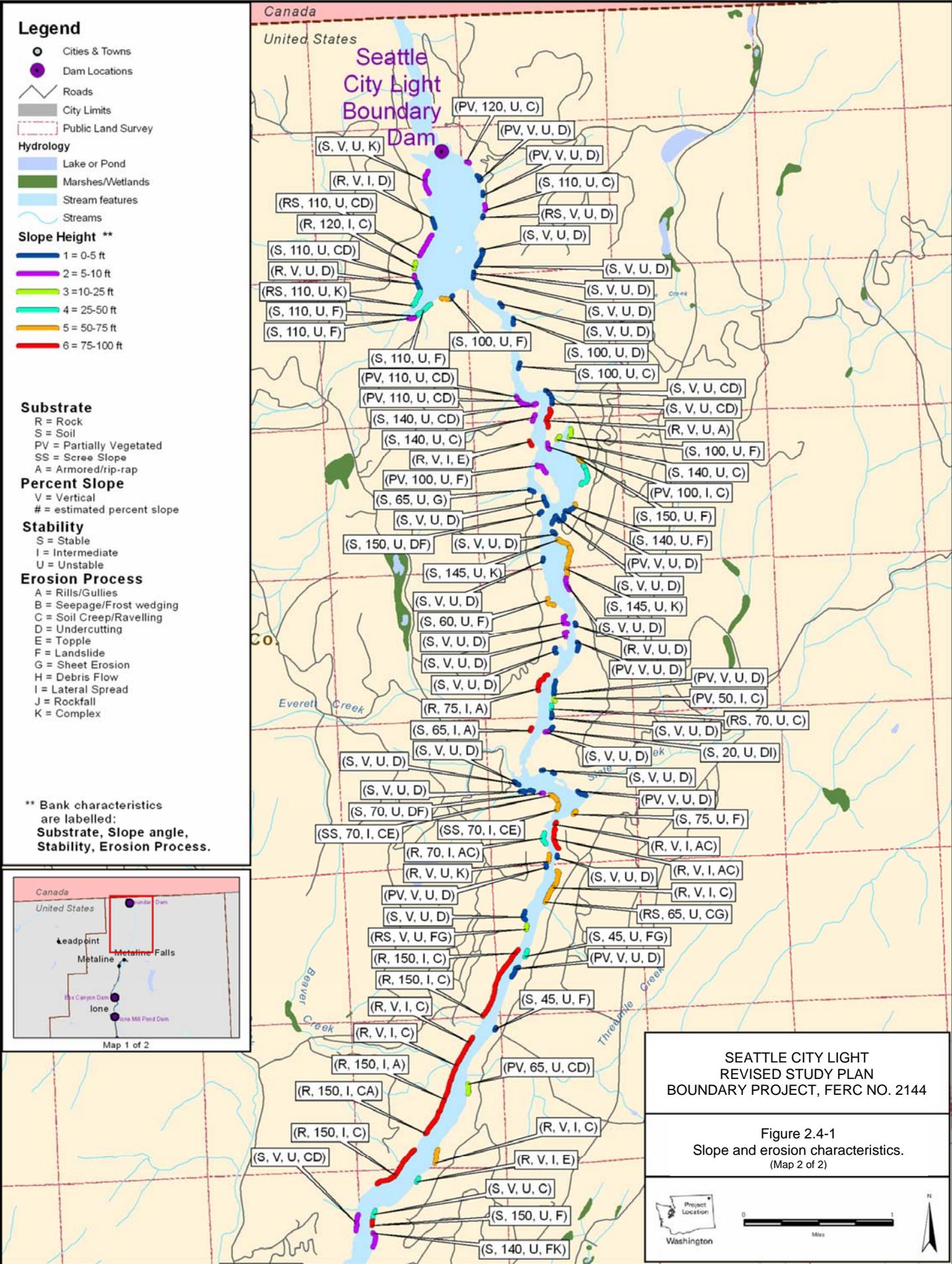


Table 2.4-1. Summary of Slope Stability along the Boundary Reservoir. (Source: SCL 2006a)

Slope Height (ft)	Intermediate Stable Slopes Length (ft)	Percent of Total Shoreline	Unstable Slopes Length (ft)	Percent of Total Shoreline
0–5	5,435.20	2.2	17,688.55	7.3
5–10	3,638.39	1.5	8,366.80	3.5
10–25	1,539.32	0.6	1,697.24	0.7
25–50	1,938.31	0.8	3,116.88	1.3
50–75	3,714.40	1.5	3,936.74	1.6
75–100	11,097.59	4.6	3,284.49	1.4
TOTAL	27,363.22	11.3	38,090.70	15.7

The Boundary reservoir shoreline can be roughly divided into two main categories: (1) shorelines dominated by rock outcrops and cliffs and (2) shorelines dominated by deep fine-textured materials (silt, sand, gravel). The shoreline north of Metaline is generally steeper and more predominantly bedrock. Bedrock cliffs and areas of thin rock soil are common. The shoreline south of Metaline is generally less steep with significant areas underlain by glacial and alluvial related sediments. However, some alluvial and glacial sediments are present along the shoreline north of Metaline and bedrock areas are present along the shoreline south of Metaline.

Erosion is evident along a number of reservoir shoreline sections and beach development is evident. Many areas where beach development has occurred are armored with coarse-grained lag deposits that limit further erosion. In general, areas with silt and fine sands are more susceptible to erosion from water level changes in the reservoir due to the lack of coarse material and in some cases piping of water from water level fluctuations. Some steep slopes with thin soils over bedrock or compact soils may no longer be actively eroding; however, because the steep slope has been undercut, shallow slope failures may occur in the future. Slope failures that have impacted the reservoir from non-Project related processes are also present within the Project area. Two of these slope failures were identified by Hart Crowser (1984). Reconnaissance investigations of the Project vicinity in 2005 and 2006 indicate erosion associated with drainage along the railroad tracks south of Metaline Falls and two large slides related to non-Project road-cut failures.

Need for Additional Information

The existing information identifies the number and location of erosion sites along the Boundary Reservoir shoreline and provides some information characterizing each site. However, information is lacking on the contribution of Project operations to shoreline erosion and slope failures, the processes involved, and the associated effects on water quality, aquatic habitat, cultural resources, land use, recreation, and terrestrial habitats. In addition, the location, extent, causes, and impacts of erosion and slope failures associated with Project-related roads and facilities have not been thoroughly documented. The status of the implementation and the effectiveness of the recommendations made by Hart Crowser (1984) have not been evaluated.

2.5. Detailed Description of Study

Study Area

The study area for the Erosion Study will extend approximately 18 miles along the Pend Oreille River from the Box Canyon Dam tailrace downstream to the U.S.-Canada border and will encompass the following:

- Downstream of Metaline Falls — The reservoir fluctuation zone (elevation 1,970–1,990 feet NGVD 29 [1,994 feet NAVD 88]), and the land within the FERC Project boundary (Project area), which includes most Project facilities, the area 200 horizontal feet (i.e., along the ground surface, perpendicular to the shoreline) beyond the high water level along both shorelines, and the transmission line right-of-way (ROW) from the powerhouse to the Bonneville Power Administration (BPA) interconnection.
- Upstream of Metaline Falls — The reservoir fluctuation zone (elevation ≈1,985–2,015 feet NGVD 29 [2,019–1,989 feet NAVD 88]), as measured at the USGS gage below Box Canyon Dam, and the land within 200 horizontal feet beyond the high water level (approximately 2,015 feet NGVD 29 [2,019 feet NAVD 88]) along both shorelines, extending south to the FERC project boundary for the Box Canyon Project.^{1 2}
- The BWP (155 acres) and adjoining SCL-owned property (85 acres).
- 100 feet around any Project works areas that extend outside the Project boundary.
- 100 horizontal feet along both sides of the river from Boundary Dam to the U.S.-Canada border (approximately 0.9 mile).
- All slopes potentially impacted by Project-related roads, which include the road between the Boundary Dam and the Vista House, the road to the dam off County Road 2975, the County road from SR 31 to the Vista House, and other roads as identified as necessary for Project purposes.
- At locations where slopes potentially impacted by erosion and slope failures associated with the shoreline extend beyond the above described boundaries, the slope will be evaluated to the extent necessary to understand the relationship to the Project.

The ability to conduct surveys on private lands within the study area outside the FERC Project boundary (mainly upstream of Metaline Falls) may be limited due to access constraints in these areas.

¹ The estimated fluctuation range of approximately 1,985–2,015 feet upstream of Metaline Falls is based on the review of existing hydrology, as described in section 1.3.5 of the PSP (see Table 1.3-1, SCL 2006b). Following completion of the Hydrology Dataset and Statistics in March 2007 (see Attachment 1, section 3.1 of this RSP), SCL will review and refine, as necessary, this elevation range.

² As indicated in this and other study plans in the RSP, SCL agrees it is appropriate to study the existing fluctuation range of the reservoir; however, for development of the Preliminary Licensing Proposal (PLP) and License Application, SCL will base its assessment of potential protection, mitigation, and enhancement measures on that portion of the fluctuation zone that is determined to be under the influence of Boundary Project operations, versus the effects of inflows and Metaline Falls that are beyond the control of the Project.

Proposed Methodology

The Erosion Study will consist of seven tasks, each of which is described below. Implementation of this Erosion Study will be coordinated with fish and aquatic habitat and water quality studies, in particular the Sediment Transport and Boundary Reservoir Tributary Delta Habitats Study (see Attachment 2, Study No. 8 of this RSP) and the Toxics Assessment: Evaluation of Contaminant Pathways and Potential Project Nexus (see Study No. 4). Modifications to Erosion Study methods at some locations may be necessary depending on the needs of these other studies.

Task 1 – Information Review

The existing and available information will be reviewed to gain a better understanding and to describe current and historical conditions related to erosion in the study area. The following information should be included in the review:

- The PAD, especially section 4.3 (SCL 2006a).
- Tabular and mapped data from the 2005 reconnaissance erosion study conducted for the PAD (includes length, height, slope, and vegetative cover for each mapped shoreline section with evidence of erosion).
- Boundary Reservoir, Hydrologic and Erosion Processes Affecting Boundary Wildlife Preserve (Enserch Environmental 1994), which is focused on the BWP.
- Slope Stability/Erosion Assessment, Boundary Project (Hart Crowser 1984), which is focused on six slides along access roads.
- Photographs and maps of the reservoir area downstream of Metaline Falls from 1965 (SCL 1966).
- Any available historic aerial photographs and site photos (potential sources include SCL, USFS 1944 aerial photographs, Washington Department of Natural Resources, Washington State Department of Transportation, Pend Oreille County and local historic societies).
- Current (2005) maps, aerial photographs at a scale of 1 inch = 1,000 feet, and LIDAR (Light Detection And Ranging) imagery of the Project area.
- Reconnaissance notes and photos used in preparation of the study plan.

Information will also be solicited from agency personnel, other relicensing participants, and SCL staff familiar with the Boundary Reservoir shoreline and Project-related roads. This information will be incorporated into the Study Report and will also be used as guidance prior to the field investigation tasks.

Task 2 – Determine Shoreline Erosion and Slope Failure Processes At Identified Sites

The focus of this task will be to determine the erosion and slope failure processes for each shoreline section showing evidence of erosion. Most shoreline erosion and slope failure areas

were identified and mapped during a reconnaissance survey in 2005. This map (see Figure 2.4-1) will be verified and refined as necessary. Each site in the 2005 reconnaissance survey database and any identified new sites will be assigned a unique number and will be field checked to determine the following:

1. The process, or processes, causing the erosion and/or slope failure.
2. The relationship of the erosion and/or slope failure process to Project operations, including the indirect effects of lack of vegetation in the fluctuation zone.
3. An estimate of the erosion rate over the life of the current license, 1967 to 2006 (past erosion rate), and the erosion rate over the next license period (future erosion rate) at the site.
4. Estimates of the area and volume of sediment that entered the reservoir from past erosion and/or slope failures and that are likely to enter the reservoir due to continuing erosion and/or slope failures during the next license term.
5. An estimate of the sediment size fractions potentially entering the reservoir currently and in the future from erosion and/or slope failures.

Erosion processes will be determined by field observations and applying site-appropriate geology, geomorphology, and hydrology principles. For each shoreline erosion site, erosion process elements to identify and record will include but not be limited to: topography, soil type and subsoil characteristics (depth to bedrock, texture, rock content, signs of piping, gleyed colors, densic or other restrictive horizons), reservoir water level(s), ground water seepage, and evidence or observations of wind-driven waves, boat waves, roads, and/or recreational uses. Additional site characteristic elements to identify and record will include but not be limited to: dominant vegetation cover type(s) present, an ocular estimate of total plant cover, and estimate of total cover by life-form (tree, shrub, herbaceous) on adjacent undisturbed shoreline segments. Data from each shoreline erosion site will be recorded on a field form and entered into a database. In addition, a photograph or photographs will be taken of each site. Completion of this evaluation will allow for a determination as to whether the erosion is Project-related, and if so, how Project operations may be impacting the site.

The methods used to estimate past and future erosion rates and slope failures will vary from site to site depending on the type and extent of erosion, slope conditions, and vegetation. Techniques will include, but need not be limited to, the following:

- Projecting the slope aspect of the original topography.
- Estimating age of vegetation on past failed slopes.
- Measuring the root exposure of tree stumps in eroded areas.
- Reviewing available historic aerial or site-specific photographs and comparing them to present conditions. The Enserch Environmental Report (1994), for example, contains a large number of site-specific photographs that can be compared to determine changes at those locations since 1994. Photographs and maps of the reservoir downstream of Metaline Falls from 1965 (SCL 1966) can be used to identify areas of preexisting erosion and new erosion sites since 1965.

Estimated erosion rates over the current license period and the next license period may be different at a given site. Consequently, past and future estimates for each site will be developed and categorized within a range of erosion rates based on volume of sediment removed, shoreline regression, length of shoreline, and area impacted. A relative scale — ranging from no erosion to low to moderate and to severe, with example illustrations and definitions for each scale — will be provided. For example, a low erosion rate for the period of the current FERC license might be less than 3 feet in depth and/or height from the high water mark, a moderate rate might be between 3 and 10 feet, and a high rate might be greater than 10 feet. The scale will be developed in coordination with the other resource workgroups and interested agency representatives.

Another important aspect of this task will involve identifying slopes with a high potential to fail as large slabs or slumps over the next license period as these areas may pose a significant risk to important resources. A relatively small area of toe slope erosion can create a fairly large potential failure on a steep slope.

Task 3 – Assess Erosion and Slope Stability Near Project Facilities

Project-related roads and transmission line routes cross steep slopes at a few locations. Erosion and slope stability will be assessed on steep portions of the transmission corridor within the Project area and on all Project-related roads. This assessment will involve field surveys of the slopes adjacent to Project-related roads and the transmission line. Existing erosion sites and unstable or potentially unstable slopes will be mapped on topographic maps or the current aerial photographs and entered into a Geographic Information System (GIS) database. The causes of erosion associated with roads and Project facilities will also be identified. If sites are identified where Project-related erosion is contributing sediment to wetlands or streams, these sites will be mapped.

Task 4 – Determine Land Ownership of Eroded Sites

Land ownership will be determined at all areas where Project-induced erosion or slope failures are identified. This process will involve using GIS to overlay the erosion maps with the land ownership map developed by SCL. GIS will then be used to calculate the linear feet and percent of erosion occurring in the study area by land ownership category.

Task 5 – Identify Resource Values Impacted by Erosion or Slope Failures

Identifying resource values potentially affected by Project-related erosion or slope failures will involve coordination with other resource workgroups. Resources potentially affected by shoreline or road erosion and slope failures include historic properties, recreational developments, dispersed recreation sites, structures and roads (both Project and non-Project), riparian areas and shoreline wetlands, rare plant populations, water quality, aquatic and terrestrial wildlife habitat, and key observation points. Specific locations of some sites with high resource values are currently known; others may not be identified until 2008–2009. Sites identified by resource workgroups as having important resource values will be assessed to determine if they are being impacted by Project-induced erosion and/or slope failures or may be impacted in the future.

An additional aspect of this task will be to assess whether eroded sites in the study area are providing conditions that favor the establishment and spread of noxious weeds. This assessment

will involve combining information from the noxious weed inventory conducted by SCL in 2005 and 2006 with the map of identified erosion sites to determine if these sites are being colonized by invasive non-native plant species.

Task 6 – Feasibility Assessment for Stabilization of Identified Resource Sites

If important resource values are identified as at risk from Project-related erosion and/or slope failures, the sites will be further evaluated to determine if there are feasible means for reducing or treating the erosion or slope failure. This feasibility analysis will be based on field observations and knowledge of current erosion control and slope failure stabilization methods that may be suitable for the site. The analysis will provide a preliminary list of potential control measures necessary to reduce erosion at these sites. Detailed analyses for final design and construction of erosion control and slope stabilization measures will not be part of the study.

Task 7 – Documentation of Fieldwork and Effects Assessment

All identified erosion sites will be assigned a number and clearly identified on aerial photographs and on appropriate base maps. Data collected in Tasks 2 and 3 will be entered into a database and combined with data from previous surveys, if appropriate. The GIS-generated map of erosion and slope failure site locations from 2005 will be refined, with sites along Project-related roads and transmission lines added. A short narrative of field observations and conclusions about erosion processes, erosion rates, potential direct and indirect impacts from erosion to identified resources, and whether or not each erosion and/or slope failure site appears to be Project related will be provided for each site along with photos of each site.

2.6. Work Products

The results of the Erosion Study will be compiled and presented in a written study report completed in standard scientific format. The report will include the following information:

- A narrative describing the geologic setting relevant to the Project, an overview of Project operations and their relationship to the erosion analysis, a discussion of the methodologies used, and a description of erosion processes observed with selected examples.
- An updated and refined map showing each identified erosion and slope failure site. Aerial photographs may also be used to illustrate erosion processes and slope failures at some sites.
- A summary data table linked to the updated map of the erosion/slope failure sites that lists slope height, length, substrate, percent slope, vegetation cover, and erosion/slope failure process for each mapped and numbered site.
- Conclusions about erosion processes and rates, slope failures, and potential impacts to resources for each erosion and slope failure site.
- Information on any high-value resource sites that may be expected to be impacted by Project-related erosion or slope failures now or in the future and the feasibility of potential erosion control slope stabilization at these sites.

- A discussion of direct and/or indirect Project-related erosion processes in the study area, as determined from the results of this study. The full assessment of potential Project-related impacts, including the effects of the type and timing of Project operations and maintenance and Project-related recreation, will be part of the integrated resource analysis conducted for development of the Preliminary Licensing Proposal (see Attachment 1, section 2.4 of this RSP).
- An appendix with a narrative of field observations along with photos of each erosion site. Where possible, earlier photographs of these sites will be included.

GIS layers and metadata of shoreline erosion and slope failures, and the measurements associated with the study will be made available to the agencies upon request.

2.7. Consistency with Generally Accepted Scientific Practice

The methods described above were prepared by a Washington State Licensed Engineering Geologist. Methods for determining erosion processes and rates in lake settings were derived, in part, by approaches described by Vallejo and Degroot (1988), Reid et al. (1988), Enserch Environmental (1994), and Associated Earth Sciences (2003).

2.8. Consultation with Agencies, Tribes, and Other Stakeholders

This study plan was prepared with input from the USFS, WDFW, and Pend Oreille County Noxious Weed Control Board, which was provided at a meeting of the Terrestrial Resources Workgroup on July 26, 2006. Additional comments were provided by the USFS and WDFW at a Terrestrial Resources Workgroup meeting on August 15, 2006. Comments provided by relicensing participants on the draft study plan are summarized in the Proposed Study Plan (PSP), Attachment 2-1 (SCL 2006b) and can also be found in the workgroup meeting summaries, available on SCL's relicensing website (<http://www.seattle.gov/light/news/issues/bndryRelic/>). The proposed Erosion Study plan addressing these comments 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. In response to comments made during the November 15 study plan meeting and comments filed with FERC by the USFS (2007) and USFWS (2007), SCL has further modified this study plan. (SCL's responses to comments are summarized in Attachment 3 and consultation documentation is included in Attachment 4 of this RSP.) Modifications included adding clarification, additional supporting rationale, and additional detail to address the USFS and USFWS comments. SCL believes that the comments are adequately addressed in this revised study plan.

2.9. Schedule

The Erosion Study will be conducted in 2007. However, as other studies are completed, additional assessment may need to take place to incorporate identified resource values that might be impacted by Project-related erosion. The expected schedule summarized in Table 2.9-1.

Table 2.9-1. Schedule for the Erosion Study.

Activity	Timeframe
Review existing information and develop preliminary list of known and potential habitat sites, aquatic resource sites, cottonwood and cottonwood recruitment sites, cultural sites, and recreational sites to be included in the Erosion Study	February–March 2007
Complete study implementation planning details (for field components)	April 2007
Review existing data, reports and photographs	April–May 2007
Conduct erosion field assessments	May–September 2007
Prepare interim study report (first-year results)	November–December 2007
Distribute interim study report	January 2008
Meet with relicensing participants to review first year efforts and results and discuss plans for any second year efforts	February 2008
Include interim report in Initial Study Report (ISR) filed with FERC	March 2008
Hold ISR meeting and file meeting summary with FERC	March 2008
Conduct 2008 follow-up assessments on any newly identified high-value resource sites (if required) per amended study plan	May–September 2008
Prepare “draft” final study report	October–November 2008
Distribute “draft” final study report for relicensing participant review	December 2008
Meet with relicensing participants to review study efforts and results and “cross-over” study results	January 2009
Include final study report in Updated Study Report (USR) filed with FERC	March 2009
Hold USR meeting and file meeting summary with FERC	March 2009

2.10. Progress Reports, Information Sharing, and Technical Review

In addition to preparing the study reports (as described above), there will be several opportunities for information sharing and technical review with relicensing participants. Other workgroups and the USFS will be contacted to discuss potential resource values and local knowledge of erosion and slope processes and will be asked for input on the scale used to categorize erosion rates (see Task 2). In addition, agencies will be invited to participate in field assessments. Preliminary Erosion Study results will be communicated to other workgroups and relicensing participants in early 2008, as described in Attachment 1, section 2.3 of this RSP.

2.11. Anticipated Level of Effort and Cost

The Erosion Study is expected to involve about 100 hours of field time, coordination with other studies, field documentation, data summary, analysis, and GIS mapping, report writing and preparation. The estimated cost for this study is \$40,000–\$60,000.

3.0 LITERATURE CITED

- Alt, D.D. and D.W. Hyndman. 1984. Roadside Geology of Washington. Mountain Press Publishing Company, Missoula, MT.
- Associated Earth Sciences. 2003, Baker River Hydroelectric Project, Reservoir Shoreline Erosion and Deposition Study A14a, Whatcom and Skagit Counties, Washington
- Hart Crowser and Associates. 1984. Slope Stability/Erosion Assessment, Boundary Project, Seattle City Light.
- Enserch Environmental. 1994, Boundary Reservoir, Hydrologic and Erosion Processes Affecting the Boundary Wildlife Preserve.
- Pend Oreille County. 1974. Shoreline Master Plan. Pend Oreille County, Washington. Prepared for Pend Oreille County and the incorporated areas of Metaline Falls, Metaline, Ione, Cusick, and Newport by the Pend Oreille County Shoreline Advisory Committee and the Pend Oreille County Planning Department.
- Reid, J.R., B.S. Snadberg,, and M.D. Millsop. 1988. Bank Recession Processes, Rates and Prediction, Lake Sakakewea, North Dakota, USA. *Geomorphology* 1:161-189
- SCL (Seattle City Light). 1966. Canyon Geology Project No. 2144 – Article 43. Boundary Project, Pend Oreille River. June 7, 1966.
- SCL. 2006a. Pre-Application Document for the Boundary Hydroelectric Project (FERC No. 2144). Seattle, Washington. May 2006. Available online at http://www.seattle.gov/light/news/issues/bndryRelic/br_document.asp
- SCL. 2006b. Proposed Study Plan for the Boundary Hydroelectric Project (FERC No. 2144). Seattle, Washington. October 2006. Available online at http://www.seattle.gov/light/news/issues/bndryRelic/br_document.asp
- Stoffel, K.L., N.L. Joseph, S.Z. Waggoner, C.W. Gulick, M.A. Korosec, and B.B. Bunning. 1991. Geologic Map of Washington – Northeast Quadrant, Washington Division of Geology and Earth Resources, Geologic Map GM-39.
- USFS (USDA Forest Service). 1988. Land and Resource Management Plan. Colville National Forest. United States Department of Agriculture. Forest Service. Pacific Northwest Region.
- USFS. 2007. Boundary Hydroelectric Project, No. 2144-035, comments to Proposed Study Plan. Colville National Forest. January 9, 2007.
- USFWS (U.S. Fish and Wildlife Service). 2007. Seattle City Light, Boundary Dam Relicensing (FERC No. 2144), Comments on Proposed Study Plan (TAILS #14421-2007-FA-0001, File #503.0006. Letter dated January 12, 2007.

Vallejo, L.E. and Gegroot, R., 1988. Bluff Response to Wave Action. *Engineering Geology*, 26: 1-16.

Williams, C.K., B.F. Kelly, B.G. Smith, and T.R. Lillybridge. 1995. Forested Plant Associations of the Colville National Forest. Gen. Tech. Rep. PNW-GTR-360. Portland, OR: United States Department of Agriculture. Forest Service. Pacific Northwest Research Station. 375 p.