Boundary Hydroelectric Project (FERC No. 2144)

Study No. 16

Inventory of Riparian Trees and Shrubs

Interim Report

Prepared for
Seattle City Light

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(Under Contract to Tetra Tech)

March 2008

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Study No. 16: Inventory of Riparian Trees and Shrubs
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Boundary Hydroelectric Project (FERC No. 2144)

1 INTRODUCTION

Study No. 16, the Inventory of Riparian Trees and Shrubs (Riparian Study), is being conducted in support of the relicensing of the Boundary Hydroelectric Project (Project), Federal Energy Regulatory Commission (FERC) No. 2144, as identified in the Revised Study Plan (RSP; SCL 2007) submitted by Seattle City Light (SCL) on February 14, 2007 and approved by the FERC in its Study Plan Determination letter dated March 15, 2007. This interim report describes study efforts conducted through September 2007. No additional field survey work on this study is planned for 2008. However, mapping and analysis of potential riparian tree and shrub habitat in the reservoir fluctuation zone and assessment of Project effects will be completed in 2008 and presented in the Updated Study Report (USR).

2 STUDY OBJECTIVES

The goal of the Riparian Study is to provide information needed to determine the extent, types, and structure of riparian tree and shrub species in the Project vicinity, and to assess Project effects on these species. Specific objectives of this study are as follows:

- Identify the current location, extent, and distribution of riparian tree and shrub species.
- Characterize the species composition and structure of riparian tree and shrub stands.
- Document the age structure of cottonwood stands and the number and age class of snags.
- Estimate the distribution and extent of riparian tree and shrub habitat that could potentially occupy the fluctuation zone.
- Identify potential threats to existing riparian tree and shrub stands (e.g., infestations of exotic species, beaver, erosion, grazing, trampling, and reservoir level fluctuations).

3 STUDY AREA

The study area for the Riparian Study extended approximately 18 miles along the Pend Oreille River from the Box Canyon tailrace downstream to the U.S.-Canada border (Figure 3.0-1) and encompassed the following:

- Downstream of Metaline Falls — The reservoir fluctuation zone under existing Project operations and the land within the FERC Project boundary (Project area). The Project area 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 reservoir shorelines, and the transmission line right-of-way (ROW) from the powerhouse to the BPA interconnection.

- Upstream of Metaline Falls — The reservoir, fluctuation zone (elevation ≈ 1,989–2,109 feet NAVD 88 [1,985–2,015 feet NGVD 29]) [1], as measured at the USGS gage below Box Canyon Dam), and the land within approximately 200 horizontal feet above the high water level (approximately 2,015 feet NGVD 29 [2,019 feet NAVD 88]) along both reservoir shorelines extending to the FERC project boundary for the Box Canyon Project[2,3]
- The Boundary Wildlife Preserve (BWP) (155 acres) and adjoining SCL-owned property (85 acres).
- 100 horizontal feet along both sides of the river from Boundary Dam to the U.S.-Canada border (approximately 0.9 mile).

Concerning the reservoir fluctuation zone, the range of water surface elevations recorded during the survey periods for this study is presented below; these ranges represent typical operating conditions for the period in which data were collected. Existing conditions at the time of surveys were considered adequate to acquire all data required for this study:

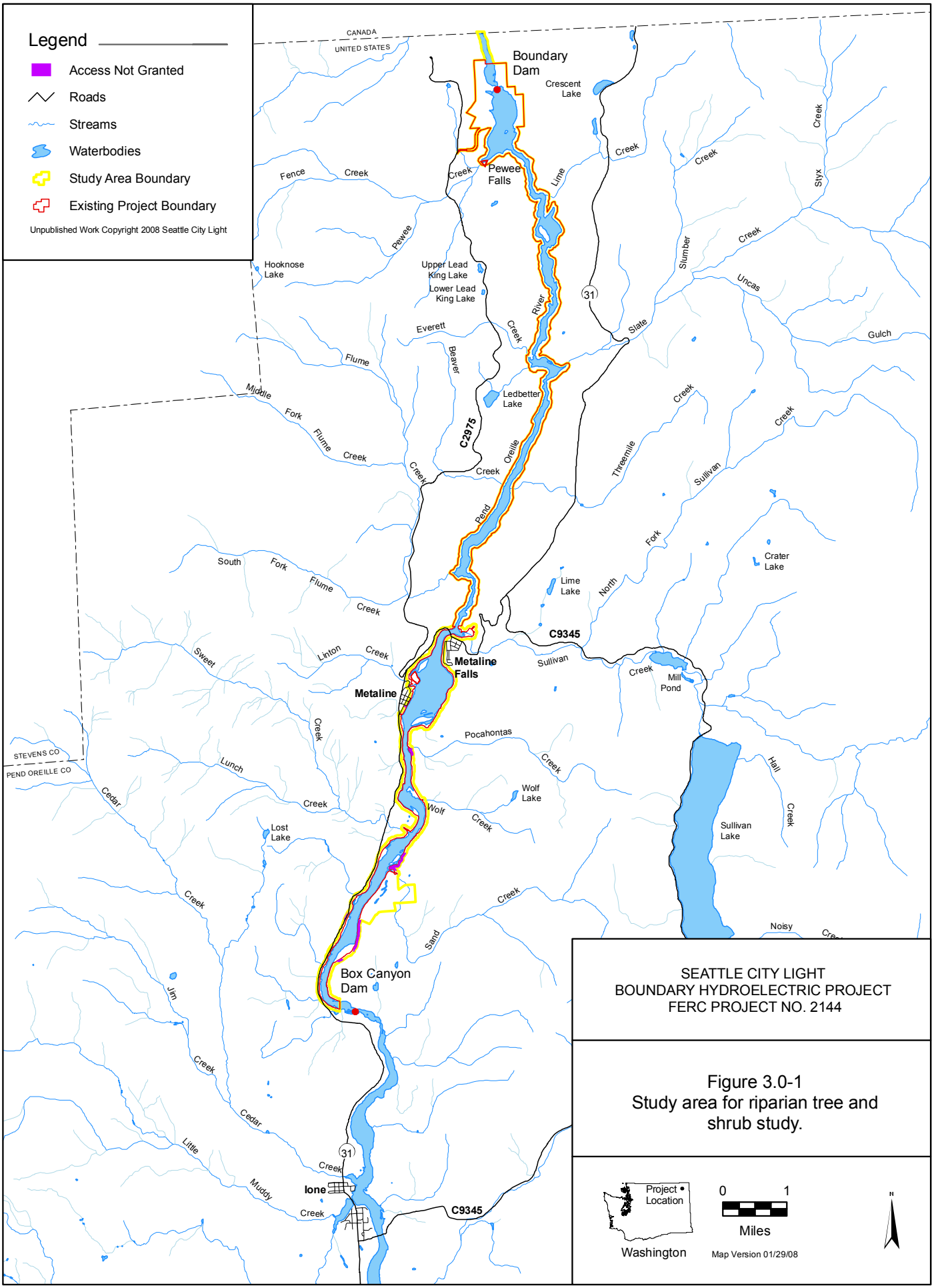
- From Box Canyon Dam to Metaline Falls – Elevation 1,988–1,991 feet NAVD 88 (1,984–1,987 feet NGVD 29), as measured at the USGS gage 12396500
- From Metaline Falls to Boundary Dam – Elevation 1,987–1,991 feet NAVD 88 (1,983–1,987 feet NGVD 29), as measured at the SCL gage located in the Boundary forebay

There were locations in the study area for which access was denied at the time of the survey; these are indicated on Figure 3.0-1.

[1] SCL is in the process of converting all Project information from an older elevation datum (National Geodetic Vertical Datum of 1929 [NGVD 29]) to a more recent elevation datum (North American Vertical Datum of 1988 [NAVD 88]). As such, elevations are provided relative to both data throughout this document. The conversion factor between the old and new data is approximately 4 ft (e.g., the crest of the dam is 2,000 feet NGVD 29 and 2,004 feet NAVD 88).

[2] As indicated in this and other study reports in the Initial Study Report, 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.

[3] Data for the riparian zone downstream of the Box Canyon Dam located within the FERC project boundary for the Box Canyon Project (FERC #2042).are included in this report; however, in the development of the Preliminary Licensing Proposal and License Application, SCL's assessment of potential protection, mitigation, and enhancement efforts will be limited to those effects that are determined to be under the influence of Boundary Project operations.


Legend
Access Not Granted
Roads
Streams
Waterbodies
Study Area Boundary
Existing Project Boundary
Unpublished Work Copyright 2008 Seattle City Light
CANADA
UNITED STATES
Boundary Dam
Crescent Lake
Pewee Falls
Hooknose Lake
Upper Lead King Lake
Lower Lead King Lake
Ledbetter Lake
Lime Lake
Crater Lake
Mill Pond
Wolf Lake
Lost Lake
Sullivan Lake
Metaline
Metaline Falls
Box Canyon Dam
Ione
C2975
C9345
31
STEVENS CO
PEND OREILLE CO
SEATTLE CITY LIGHT
BOUNDARY HYDROELECTRIC PROJECT
FERC PROJECT NO. 2144
Figure 3.0-1
Study area for riparian tree and shrub study.
Project Location
Washington
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Map Version 01/29/08
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4 METHODS

Four tasks were identified for this study:

- Task 1: Map existing riparian tree and shrub stands
- Task 2: Characterize riparian tree and shrub stands
- Task 3: Map potential riparian tree and shrub habitat
- Task 4: Documentation and effects assessment

The methodologies for tasks completed or initiated in 2007 are described in detail below; methods for tasks to be completed in 2008 are described in the RSP.

4.1. Map Existing Riparian Tree and Shrub Stands

The RSP designated the following species as the focus of the study:

- Black cottonwood (*Populus balsamifera* ssp. *trichocarpa*)
- Sitka alder (*Alnus viridis* ssp. *sinuata* [was *A. sinuate*])
- Redosier dogwood (*Cornus sericea*)
- Shining willow (*Salix lucida* ssp. *lasiandra*)
- Coyote willow (*Salix exigua* [including *S. melanopsis*])
- Sitka willow (*Salix sitchensis*)
- Scouler's willow (*Salix scouleriana*)
- Black hawthorn (*Crataegus douglasii*)

Two additional species of willow and an alder species were found in the riparian shrub areas and were added to the focal species list:

- MacKenzie's willow (*Salix prolixa*)
- Bebb's willow (*Salix bebbiana*)
- Grey alder (*Alnus incana*)

The map of tree- and shrub-dominated riparian and wetland habitats in the RSP (Figure 4.4-1 in the RSP [SCL 2007]) served as the starting point for the inventory and mapping of riparian trees and shrubs. The Project's orthophotographs (2005) were also used in the field to develop maps of the distribution of tree- and shrub-dominated riparian and wetland habitats.

All areas previously identified as riparian deciduous tree, riparian shrub, palustrine forested wetland, or palustrine scrub-shrub wetland were surveyed to verify boundaries and categorization. Any errors in the 2005 classification or delineation of existing polygons were noted and corrected. Additional areas that included the focus species were delineated on the field maps or on the aerial photographs. Areas that were difficult to map because of shadows on the aerial photographs or because individual or small patches of riparian species were too small to delineate on a map were recorded using Global Positioning System (GPS) coordinates.

For the purposes of this study, the terms riparian tree/shrub habitat or riparian tree/shrub vegetation are used broadly to include all shrub and forested stands along the reservoir shoreline that are dominated by mesic and hydrophytic deciduous species and includes vegetation that can be classified and mapped as either riparian or palustrine wetland. As defined by the vegetation classification system developed for the Pre-Application Document (SCL 2006) and the RSP (SCL 2007), areas were classified as riparian shrub or riparian deciduous tree if the primary hydrologic influence appeared to be a tributary stream or uphill seep. If the primary hydrologic influence was groundwater or the reservoir, then it was classified as palustrine forested or scrub-shrub wetland.

An area was considered forested if it had at least 30 percent coverage of woody vegetation over 19 feet (6 meters) tall based on the Cowardin et al. (1979) classification system (although two stands of dense cottonwood saplings slightly less than 19 feet tall were also classified as forest). Otherwise, the site was classified as shrub.

The data were digitized using ESRI's Geographical Information Systems (GIS) ArcMap software. The spatial data were used to amend the existing cover-type shape files and to create an accurate and comprehensive map depicting the distribution of riparian trees and shrubs in the study area. The data in the shape file table were updated to reflect the newly calculated acreages of riparian habitats.

4.2. Riparian Tree and Shrub Stand Characterization

Data to characterize stands of riparian tree/ shrub habitat in the study area were collected concurrently with the mapping exercise in Task 1. Stand characterization data were entered onto data sheets during the field survey, which occurred between September 2 and 8, 2007. The sheets were reviewed for missing data and scanned onto the Tetra Tech EC (TtEC) server. The data were later transferred to a Microsoft® Excel spreadsheet and were used to update the GIS shape file. The data are presented in Appendix 1. Data were collected on the following parameters:

- Area (square feet or acres) estimate for each polygon: In general, the vegetation was checked against the existing map or was mapped on paper in the field and the area was calculated later in GIS.
- Species composition: All shrub and tree species, including non-focus species, were recorded for each polygon.
- Canopy cover was visually estimated for all tree and shrub species in each stand. In larger stands, unique homogenous areas were delineated for separate characterization. For example, in the BWP, Sullivan Creek, and the area close to the Metaline sewage ponds, the stands were subdivided into homogenous units for canopy cover estimate. These subdivided areas were treated as separate units in the data analysis. The estimates of canopy cover of each species were made visually after walking through a stand. Cover was recorded for each of the shrub and tree species, including those that were not the focal riparian species.
- Average height(s) was visually estimated for each woody species in the stand.
- Age classes were to be recorded for the willows and other multi-stem focus species using a classification from Crowley et al. (2006) as listed below.

- Seedlings: 1 stem at surface
- Young: 2 to 10 stems at ground surface
- Mature: greater than 10 stems at ground surface and are more than 50 percent living
- Decadent/Dead: greater than 10 stems at ground surface and are less than 50 percent living

This age classification was designed to be used in long-term monitoring in a limited size plot (2-meter by 1-meter plot) along a 100-meter transect. It was noted in Crowley et al. (2006) that using this age-class indicator is not appropriate for rhizomatous species that often develop thickets, such as coyote willow. Many riparian shrub species can reproduce through layering and all of them develop dense thickets. It is just as difficult to estimate the age class of species that form dense thickets as the rhizomatous shrubs referred to by Crowley et al. (2006). For layering and sprouting shrub species, Crowley et al. (2006) suggested measuring percent cover as was done in this study. Although that can be useful as an indicator of reproduction over time, it does not determine age class distribution in a single survey.

The age classification system described above was used at each shrub stand where possible. However, there were some exceptions:

- Most shrub areas were dense thickets and it was very difficult to see well enough to estimate age class distribution. In the denser thickets, shrubs were noted as having shoots or sprouts, indicating that they appear to be successfully reproducing vegetatively.
- It was very difficult to observe seedlings in thickets or areas with other ground cover vegetation. Therefore, there may have been more seedlings than noted.
- In some stands, willow species and Sitka alder took a tree form and had a single trunk, and thereby did not fall within the Crowley et al. (2006) classification. Surveyors used judgment in assessing age class of shrub species regardless of the number of stems.

Where possible, age classes were estimated and it was noted if seedlings were seen. However, this information should be considered more of a recognition that the stands appeared to be regenerating. It was not only difficult to see individuals in the dense vegetation, but it is impossible to know if shrubs that appear to be young are actually young or if they are vegetative extensions of the existing shrubs.

- The age classes used for cottonwoods were as follows:
  - Seedlings: Stem is < 4.5 feet tall or < 1 inch diameter at breast height (dbh).
  - Young: Stem is > or < 4.5 feet and 1 to < 5 inches dbh.
  - Mature: Stem is ≥5 inches dbh.
  - Decedent/Dead: Stem is ≥ 5 inches dbh with < 50 percent live canopy.
  - Snag: Stem is > 5 inches dbh with a completely dead canopy.

In most cottonwood stands, there was a dense shrub understory. Cottonwood seeds sprout in the sun and would be expected at forest edges or in openings. The understory in and adjacent to most stands was dense and, if present, seedlings would be difficult to see.

Deer browse and beaver activity also made it difficult to determine age classes in cottonwood stands in some locations. In many cases, the base of the "shrubbed" cottonwood was thick, suggesting that it could be much older than its height would indicate. Although quite short (less than 2 feet), a browsed, "shrubbed" cottonwood might be a young tree rather than a seedling as classified by height. Professional judgment was used to classify age of these individuals and the effect of browsing was noted on the data sheet. In addition and where possible, the presence of flowers or fruit and growing conditions associated with seedling establishment were noted.

- Approximately 10 to 20 percent of mature trees in each cottonwood stand were to be selected for coring to determine actual age.

  The objective of the tree coring was to document the age structure of cottonwood stands. Because coring can lead to decay and other forms of degradation (Maeglin 1979), and 20 percent is a significant portion of a stand, it was decided (during a September 6, 2007, site visit attended by a number of relicensing participants [RPs], SCL, and the TtEC riparian study team) that the actual number of trees cored would depend on age diversity within a stand. Only a few trees were selected for coring if most of the mature trees in a stand were relatively uniform in size. In stands that were apparently more diverse, mature trees representing a wide range of sizes were selected for coring. This satisfied the coring objective and minimized harm to trees, particularly in large stands such as the BWP. In many cases, much less than 20 percent of the trees were cored, yet the age classification objectives were still met.

  For each tree that was cored, the following data were recorded: dbh, ring count, estimated age (for trees that were hollow and a complete core was not available), estimated height, and whether there was a hollow heart. During coring, many cottonwoods had a strong outflow of a liquid that ranged from fairly clear to red. One of the first cottonwoods to be cored gushed for more than 10 minutes. Due to the potential damage to trees, the surveyors stopped coring when the warning gurgle sound occurred and estimated the age of the tree based on the rings seen on the partial core, the dbh of the tree, and the estimated thickness of the bark.

  Black cottonwood tree rings are recognized as being very difficult to interpret. *Populus* spp. trees generally have rings that are diffuse and porous with nearly uniform vessel size and distribution, resulting in indistinct transitions between rings (Maeglin 1979). Several experienced biologists were contacted and the U.S. Forest Service guide (Maeglin 1979) was consulted for techniques to enhance ring boundaries and improve core readability. Several of the techniques were tried during the survey. Rings were counted in the field immediately after coring, and then placed in a straw and labeled for further processing. Several processing techniques were

tried to improve the distinction between rings, including rewetting with glycerin, applying several different strengths of iodine as a wash, and using a binocular microscope. None of these techniques notably improved the visibility of the rings. The most accurate ring counts, as determined by repetition and agreement by both biologists, involved looking at the wet core immediately after coring, increasing core wetness with saliva, using a hand lens, and backlighting the cores in the sun. Each core was counted several times to confirm the ring count; for particularly troublesome cores, both biologists counted the rings and discussed the outcome.

- Ecotones or transitions to other vegetation layers or habitat types were noted if they were different than shown on the map from the PAD. If needed, changes were noted so the vegetation data layer could be corrected.
- Substrates were categorized as follows. In most areas, more than one type of substrate was observed and all were noted.
    - Stones (> 10 inches [> 250 mm])
    - Cobble (3 to 10 inches [76 to 250 mm]),
    - Gravel (0.08 to 3 inches [2 to 76 mm]), and
    - Fines (includes sand and silt) (< 0.08 inch [< 2 mm])
- Potential direct and/indirect impacts, including Project- and non-Project- related impacts, were recorded. These included the following:
    - Upslope hydrology (flow, flooding, scour);
    - Reservoir water level;
    - Invasive species infestations;
    - Human activities (developed recreation, dispersed recreation, timber harvest, etc.);
    - Damage or trampling from cattle grazing;
    - Damage from beaver, deer, or other wildlife;
    - Erosion;
    - Encroachment of conifers.

There were four areas in the study area for which access was denied at the time of the field surveys; there were riparian tree/shrub stands at 3 of the sites: two palustrine scrub-shrub wetland stands and a palustrine forested wetland. One palustrine scrub-shrub wetland is adjacent to the south end of the BWP (Appendix 1, Figure A.1-2, polygon 55). From the reservoir, the species and cover appeared to be similar to the area at the south end of the BWP. The second site, hosted both a scrub-shrub stand and a forested wetland, located across the reservoir from the BWP (Appendix 1, Figure A.1-2, polygons 52 and 53). Viewed from the reservoir and from the adjacent road, the tree and shrub species and cover appeared to be similar to the tree and shrub polygons to the north of the site (Appendix 1, Figure A.1-2, polygons 51a and 51b). Thus, data from the adjacent polygons were used to classify the inaccessible sites.

For riparian tree/shrub stands that occurred both inside and outside of the study area boundary, only the portions within the study area were analyzed. Examples are Sullivan Creek, the BWP, and the cottonwood forest near Box Canyon Dam.

4.3. Mapping of Potential Riparian Tree and Shrub Habitat

The mapping and analysis of potential riparian tree/shrub habitat in the reservoir fluctuation zone will be conducted in 2008, and the results will be presented in the USR.

4.4. Documentation and Effects Assessment

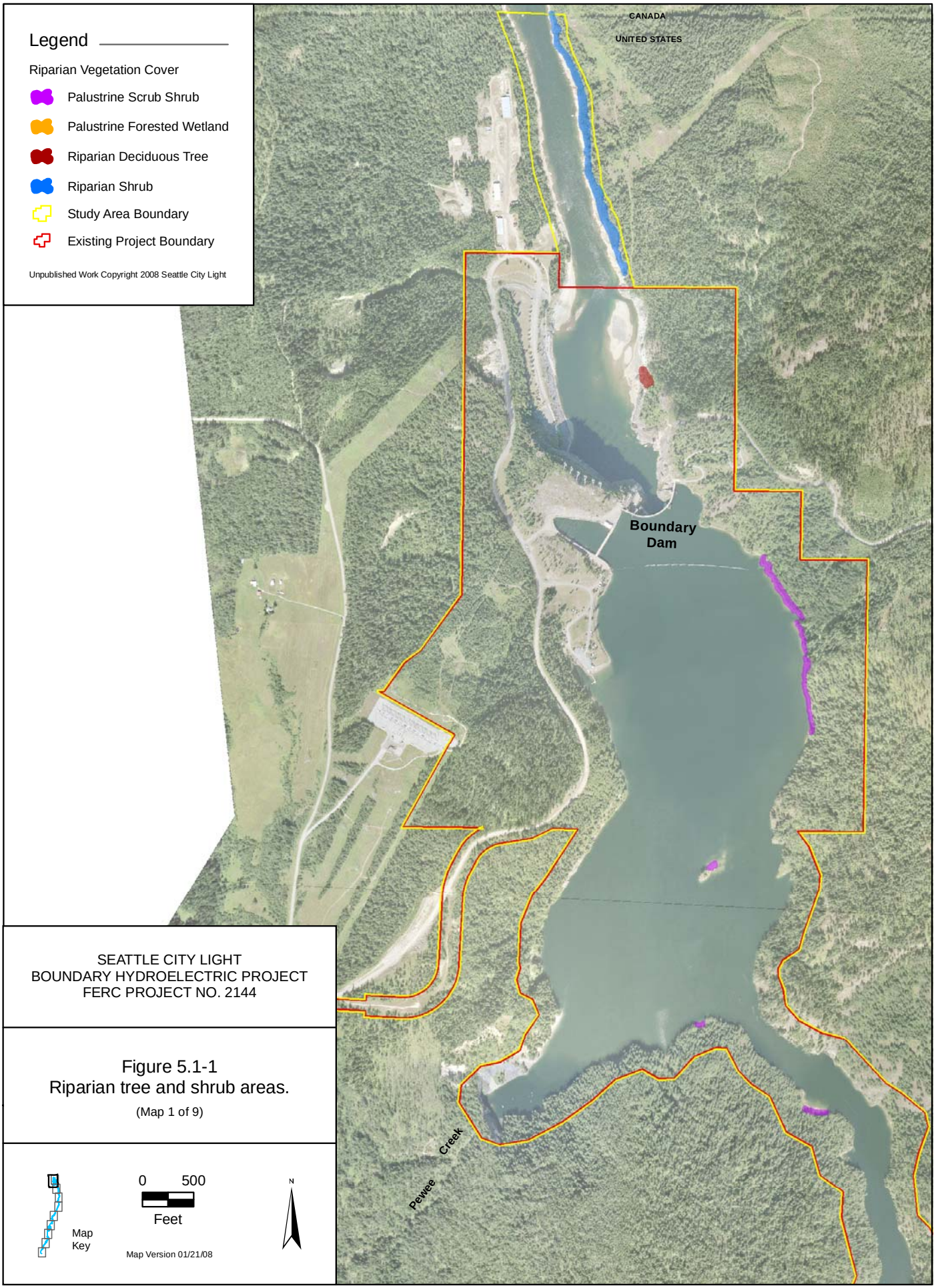
Field data were collected on data sheets during the field survey. The data were later transferred to a Microsoft® Excel spreadsheet that became part of the revised GIS shape file. The data are presented in Appendix 1.

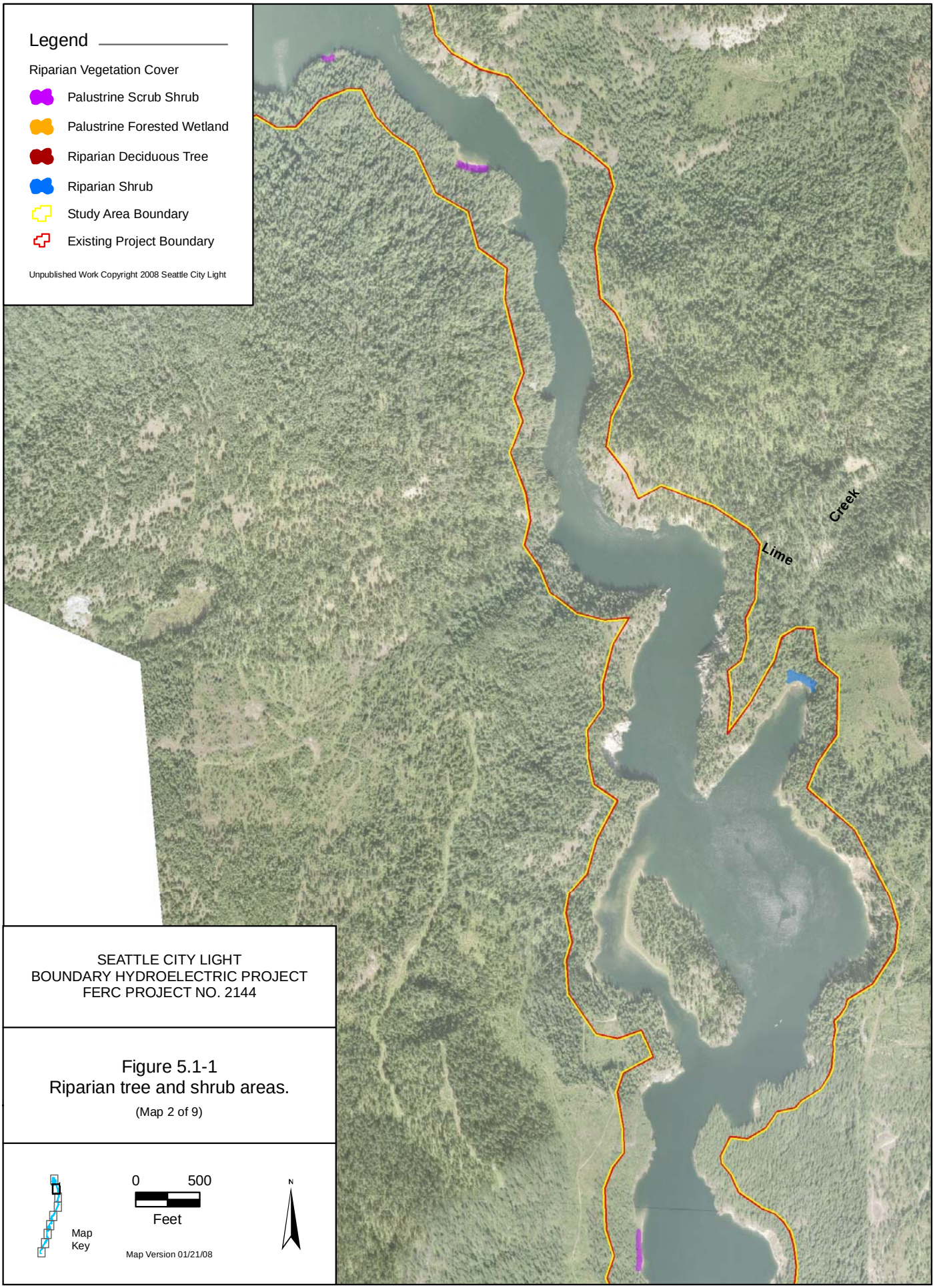
The assessment of Project effects requires data that will be developed with the Hydraulic Routing Model (see Study 7 Interim Report [SCL 2008]) and will be completed in 2008 and addressed in the USR. Current threats to riparian trees and shrub habitats that are not directly related to Project operations are addressed in this report.

5 PRELIMINARY RESULTS

5.1. Map of Existing Riparian Tree and Shrub Stands

Figure 5.1-1 shows the extent and locations of the riparian tree/shrub habitat stands in the study area. Appendix 1 includes a map of all sites surveyed and the detail collected for each polygon. Riparian tree/shrub habitat types occupy 97.7 acres, slightly less than 4 percent of the 2,614-acre study area (Figure 5.1-1). Included are 18.8 acres of riparian shrub, 4.3 acres of riparian deciduous trees, 31.3 acres of palustrine shrub-scrub wetland, and 43.4 acres of palustrine forested wetland. Of the broadly-defined riparian habitat along the reservoir, approximately one-quarter of the acres are classified as riparian types (influenced by seeps or tributary flow) and three-quarters are palustrine wetlands (influenced by the reservoir). The vast majority of the acreage, 96 percent (and virtually all of the forested area), occurs upstream of Metaline Falls, with the remaining split between the lower reservoir reach and the tailrace area (Table 5.1-1).


Legend
Riparian Vegetation Cover
Palustrine Scrub Shrub
Palustrine Forested Wetland
Riparian Deciduous Tree
Riparian Shrub
Study Area Boundary
Existing Project Boundary
Unpublished Work Copyright 2008 Seattle City Light
CANADA
UNITED STATES
Boundary Dam
Pewee Creek
SEATTLE CITY LIGHT
BOUNDARY HYDROELECTRIC PROJECT
FERC PROJECT NO. 2144
Figure 5.1-1
Riparian tree and shrub areas.
(Map 1 of 9)
Map Key
0 500
Feet
N
Map Version 01/21/08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Riparian Vegetation Cover
Palustrine Scrub Shrub
Palustrine Forested Wetland
Riparian Deciduous Tree
Riparian Shrub
Study Area Boundary
Existing Project Boundary
Unpublished Work Copyright 2008 Seattle City Light
Lime
Creek
SEATTLE CITY LIGHT
BOUNDARY HYDROELECTRIC PROJECT
FERC PROJECT NO. 2144
Figure 5.1-1
Riparian tree and shrub areas.
(Map 2 of 9)
Map
Key
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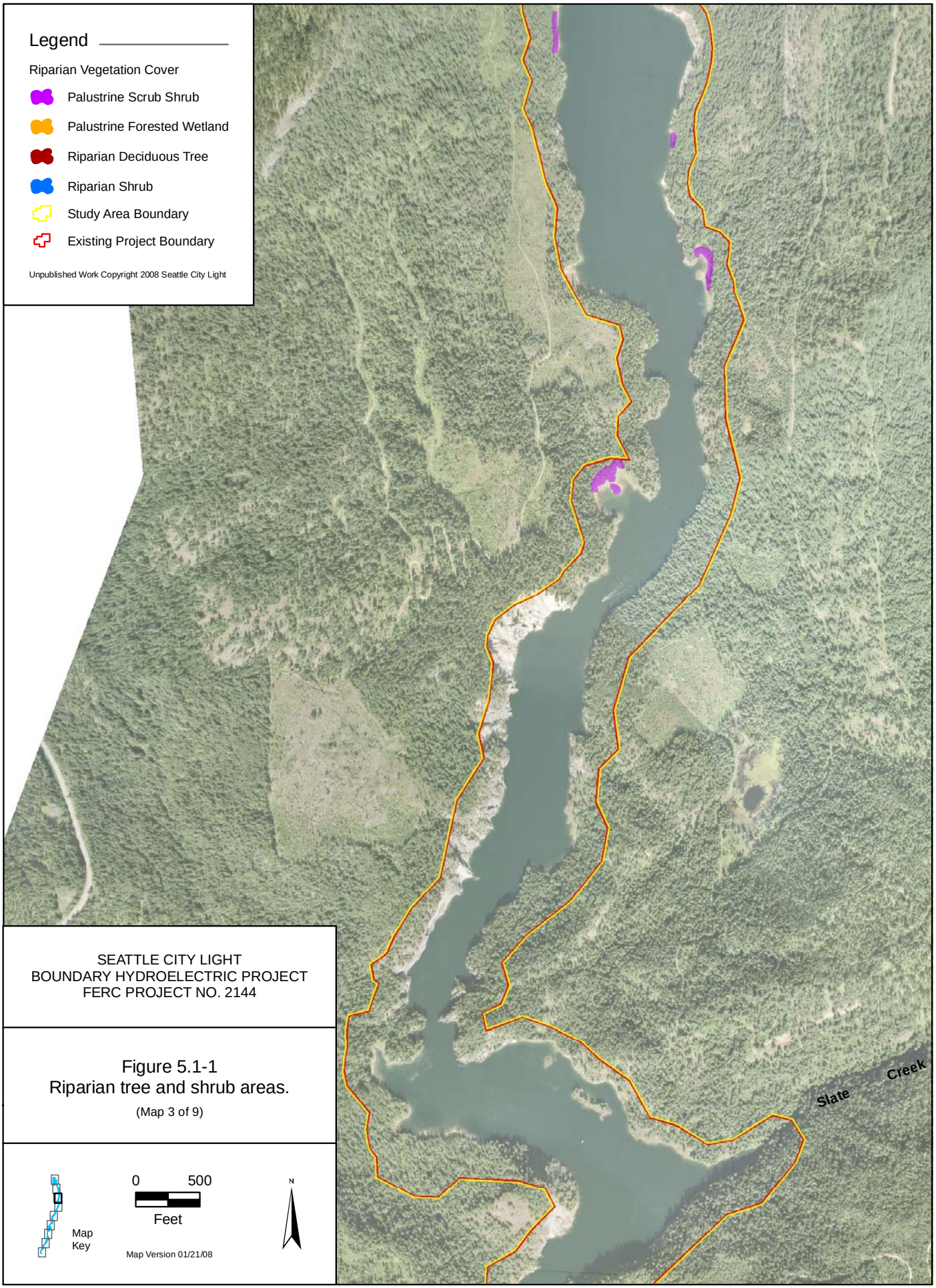
Map Version 01/21/08


Legend
Riparian Vegetation Cover
Palustrine Scrub Shrub
Palustrine Forested Wetland
Riparian Deciduous Tree
Riparian Shrub
Study Area Boundary
Existing Project Boundary
Unpublished Work Copyright 2008 Seattle City Light
Slate
Creek
SEATTLE CITY LIGHT
BOUNDARY HYDROELECTRIC PROJECT
FERC PROJECT NO. 2144
Figure 5.1-1
Riparian tree and shrub areas.
(Map 3 of 9)
Map
Key
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Feet
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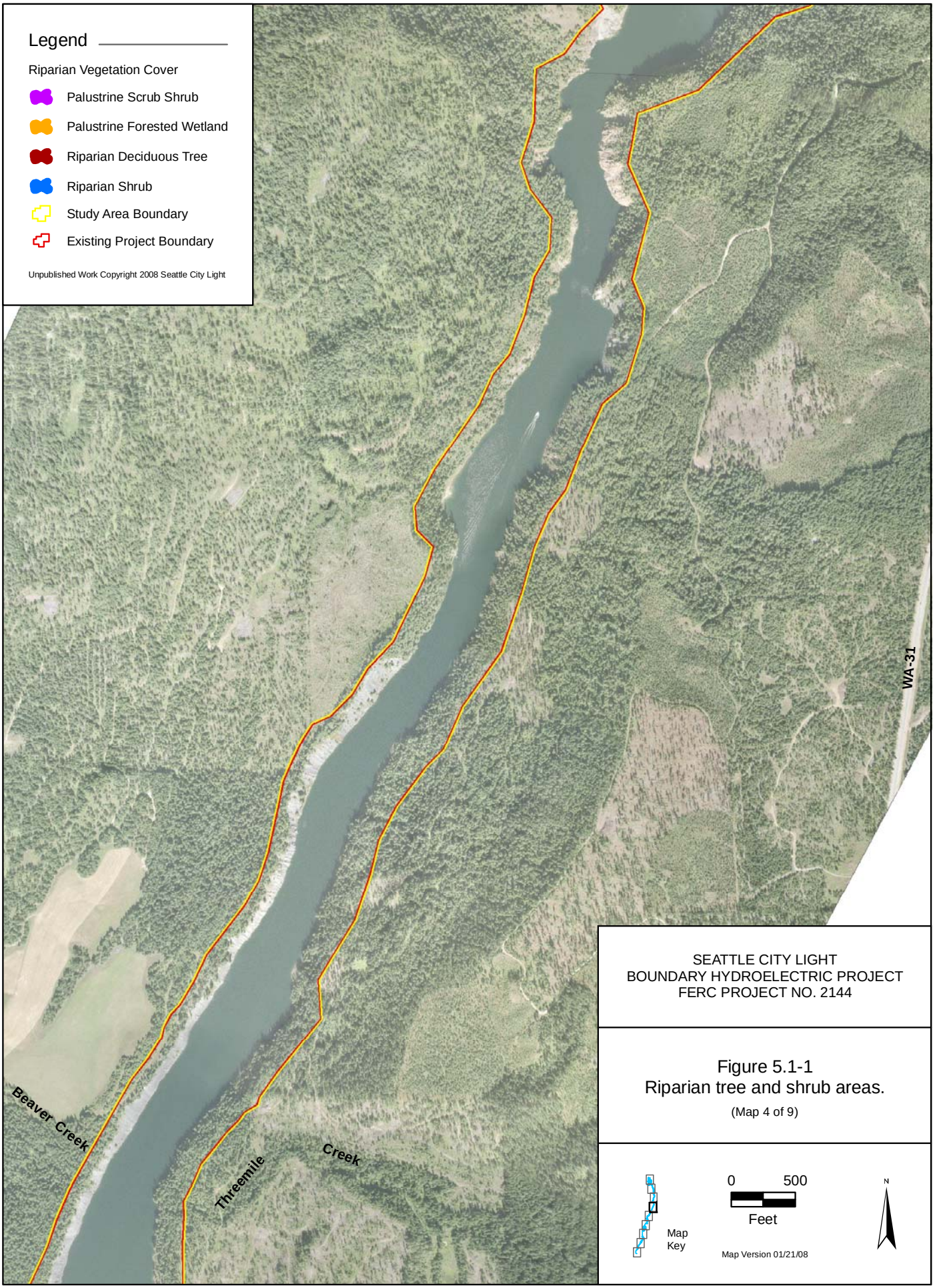
Map Version 01/21/08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Riparian Vegetation Cover
Palustrine Scrub Shrub
Palustrine Forested Wetland
Riparian Deciduous Tree
Riparian Shrub
Study Area Boundary
Existing Project Boundary
Unpublished Work Copyright 2008 Seattle City Light
WA-31
Beaver Creek
Threemile
Creek
SEATTLE CITY LIGHT
BOUNDARY HYDROELECTRIC PROJECT
FERC PROJECT NO. 2144
Figure 5.1-1
Riparian tree and shrub areas.
(Map 4 of 9)
Map
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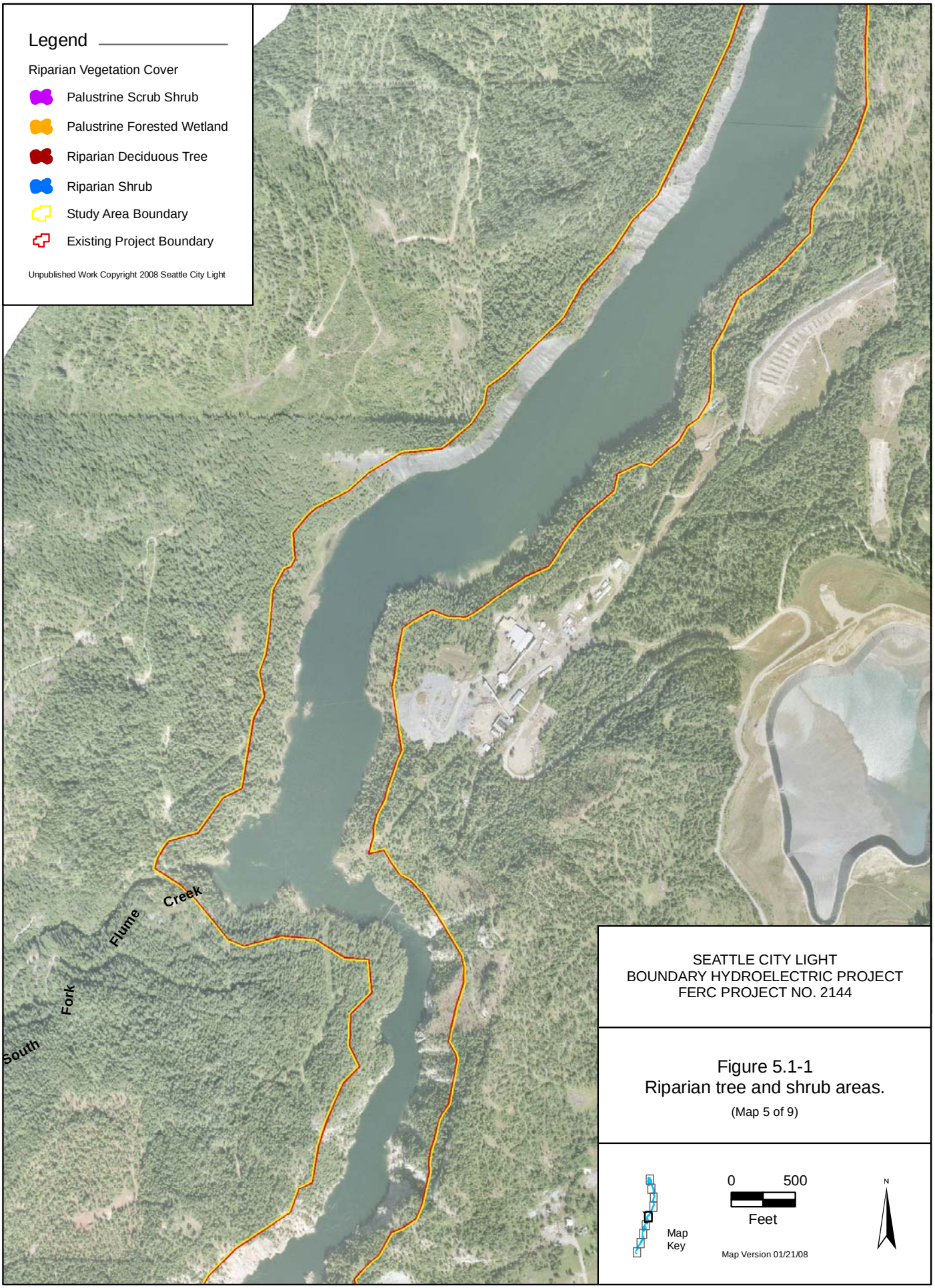
Map Version 01/21/08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Riparian Vegetation Cover
Palustrine Scrub Shrub
Palustrine Forested Wetland
Riparian Deciduous Tree
Riparian Shrub
Study Area Boundary
Existing Project Boundary
Unpublished Work Copyright 2008 Seattle City Light
South
Fork
Flume
Creek
SEATTLE CITY LIGHT
BOUNDARY HYDROELECTRIC PROJECT
FERC PROJECT NO. 2144
Figure 5.1-1
Riparian tree and shrub areas.
(Map 5 of 9)
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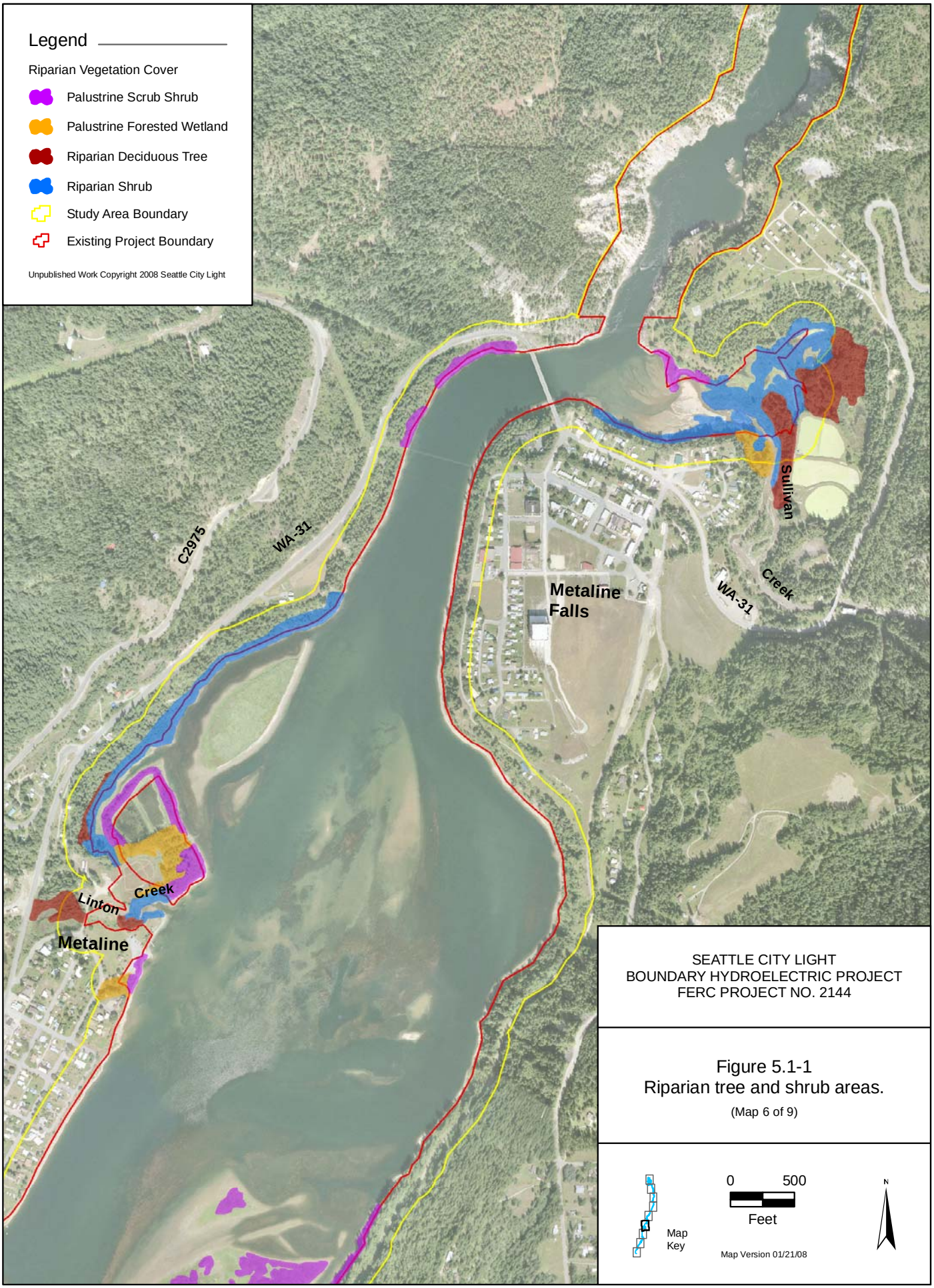
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C2975
WA-31
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Sullivan Creek
Linton Creek
Metaline
SEATTLE CITY LIGHT
BOUNDARY HYDROELECTRIC PROJECT
FERC PROJECT NO. 2144
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Riparian tree and shrub areas.
(Map 6 of 9)
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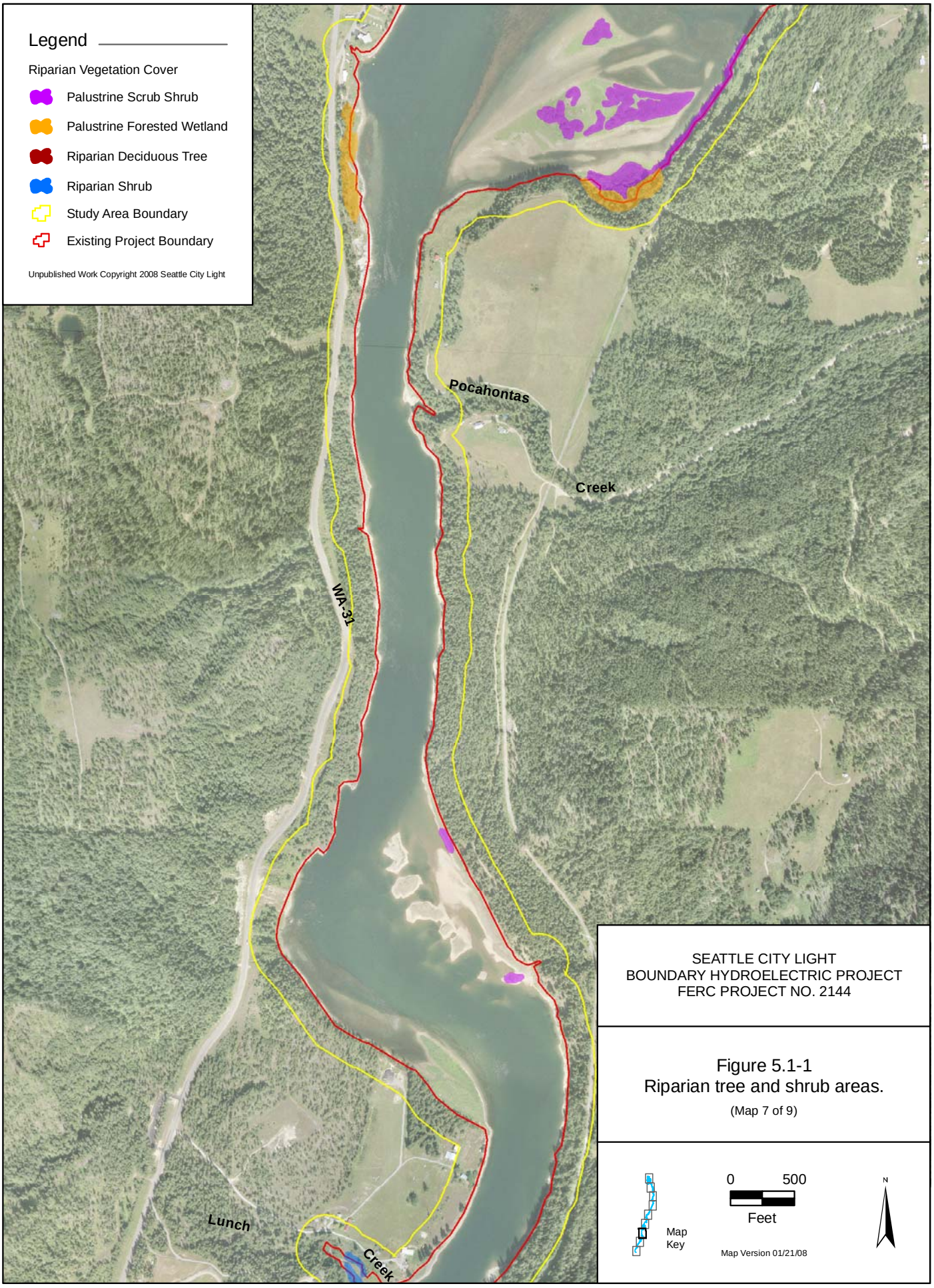
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Pocahontas
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BOUNDARY HYDROELECTRIC PROJECT
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(Map 7 of 9)
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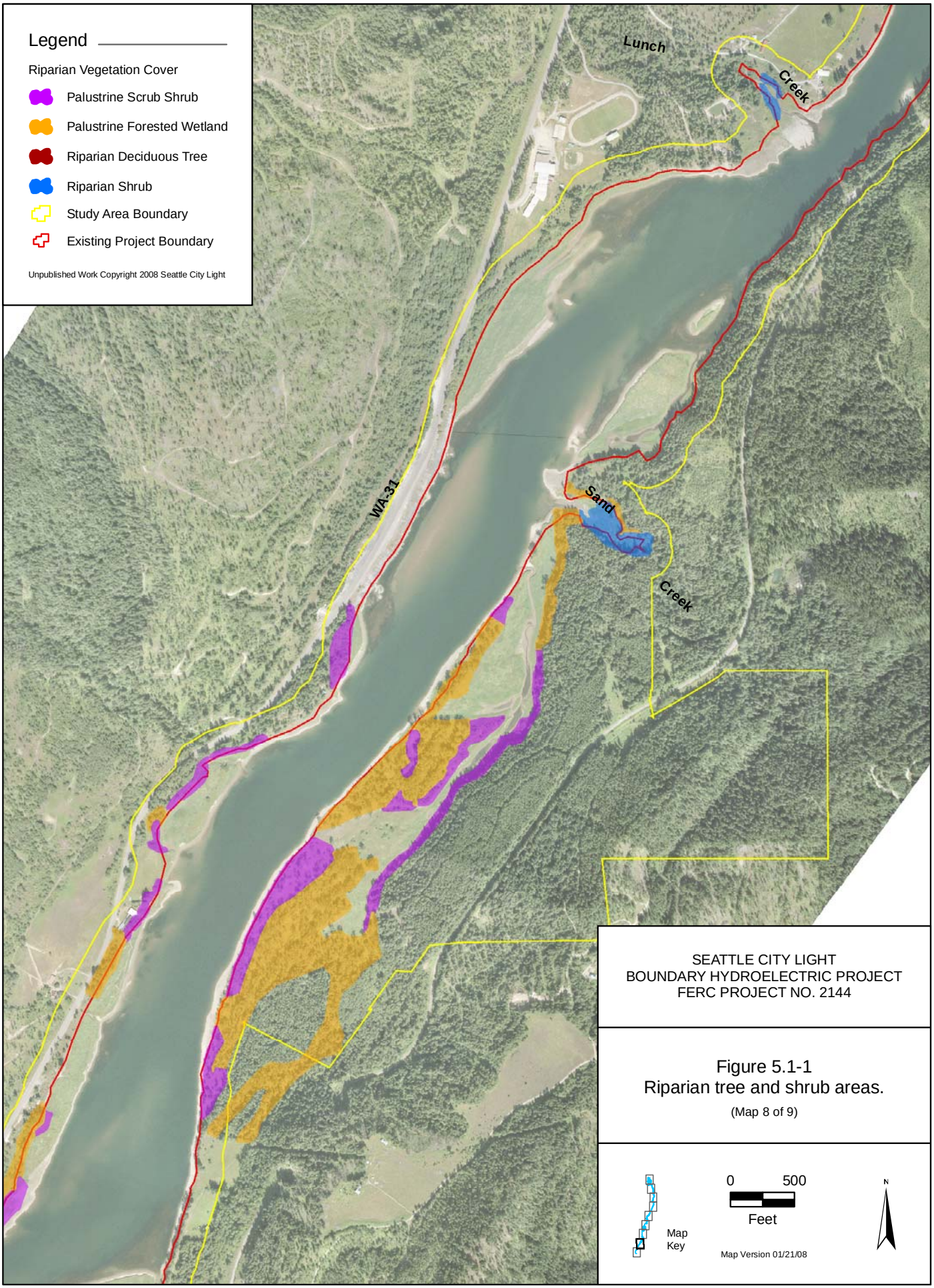
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Creek
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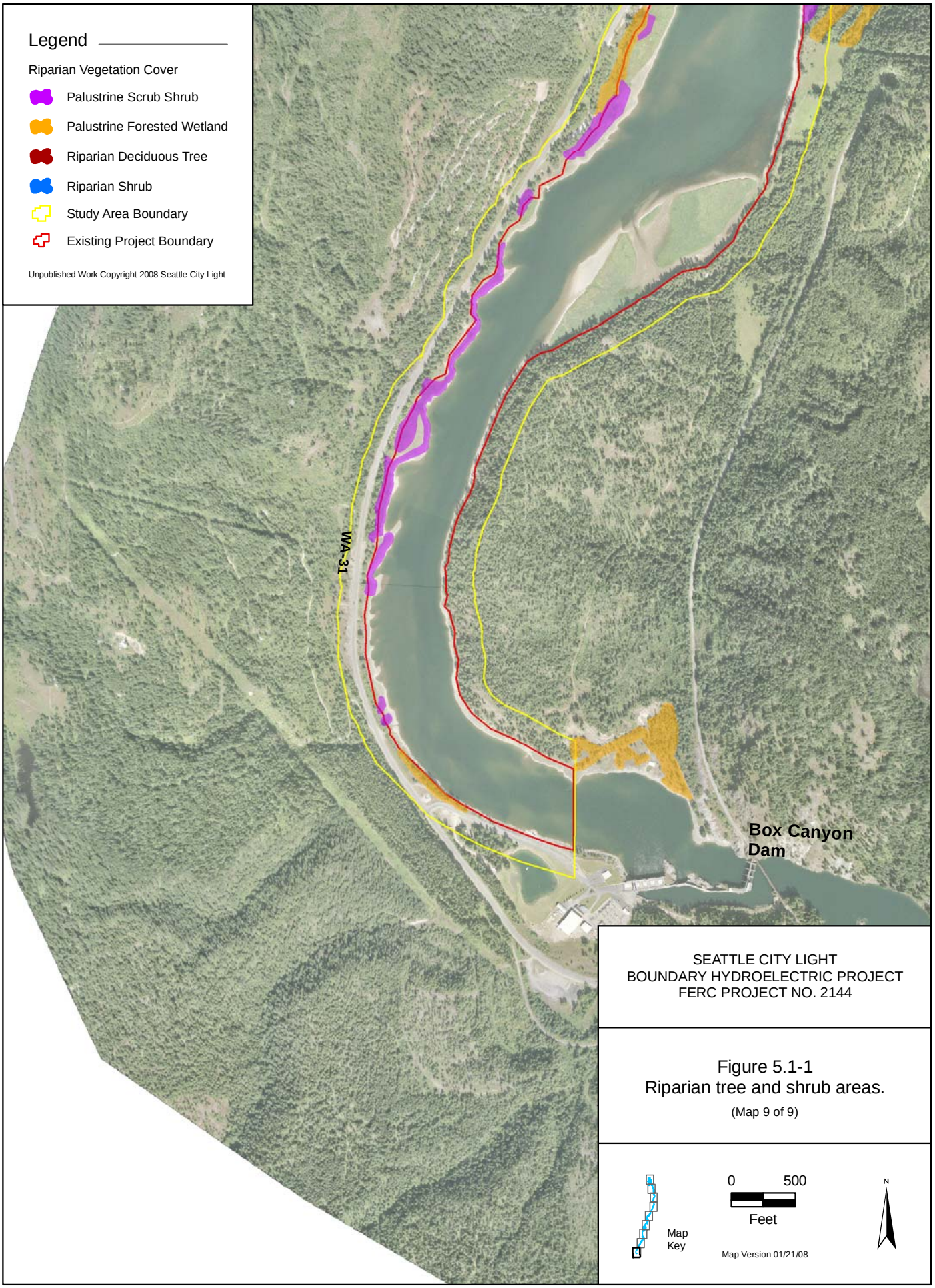
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SEATTLE CITY LIGHT
BOUNDARY HYDROELECTRIC PROJECT
FERC PROJECT NO. 2144
Figure 5.1-1
Riparian tree and shrub areas.
(Map 9 of 9)
Map Key
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Table 5.1-1. Acres of riparian tree/shrub vegetation in the study area.

Survey Area	Vegetation Type Area (ac)				Total Area (ac)
	RDT	RS	PFO	PSS	
Boundary Dam Tailrace	**0.2**	**2.2**	**-**	**-**	**2.5**
Boundary Dam to Metaline Falls	**-**	**0.2**	**-**	**1.5**	**1.7**
Upstream of Metaline Falls					
Sullivan Creek	2.9	8.6	0.6	0.6	12.7
Sand Creek		2.0	0.5	-	2.5
Lunch Creek		0.3	-	-	0.3
NW of Metaline Ponds	0.5	4.8	-	-	5.3
Lynton Creek	0.6	0.6	-	-	1.3
BWP	-	-	29.4	10.5	39.9
Adjacent to BWP (south)	-	-		1.2	1.2
East side Box Canyon Dam	-	-	3.5		3.5
Metaline by Sewage Pond	-	-	2.5	2.6	5.2
PRM 28.9 Islands	-	-		3.3	3.3
East of PRM 28.9 Islands	-	-	1.4	2.3	3.7
West Shore – north of Box Canyon Dam	-	-	3.5	7.7	11.2
Other	-	-	2.0	1.5	3.6
Total Upstream of Metaline Falls	**4.0**	**16.4**	**43.4**	**29.8**	**93.5**
Grand Total	**4.3**	**18.8**	**43.4**	**31.3**	**97.7**

Notes:
Some stands were recorded slightly beyond the study area but the acres are not included in the analysis.
Totals may vary slightly due to rounding
PFO – palustrine forested wetland
PSS – palustrine scrub-shrub wetland
RDT – riparian deciduous trees
RS – riparian shrub

General characterizations of the riparian tree/shrub habitats in the study area are presented below. The areas in the tailrace, downstream of the falls, and upstream of the falls are discussed separately because they are notably different.

5.1.1. Boundary Dam Tailrace

Riparian tree/shrub vegetation on the east shore of the tailrace is unique in the study area; however, it is not unusual vegetation for a free-flowing river in a steep, confined valley bottom. The uphill slopes of the tailrace on the east shore are covered with a steep, mixed conifer forest containing many seeps. At the edge of the forest is a narrow riparian shrub stand that extends north beyond the Canadian border. This stand is dominated by willow, alder, and dogwood and thins toward the emergent wetland vegetation on the cobble shore. Three willow species are present, with coyote willow being dominant. Young coyote willows extend into the emergent vegetation on the cobble shore. High flows and a confined valley bottom likely combine to create scouring conditions that are detrimental to the establishment of any shrub seedlings in the lower elevations at this site. The lower, emergent elevations include only coyote willow seedlings or shoots that may be lost frequently to river scour. Just as the vegetation shows a gradual change from emergent species in the cobble shore to dense shrubs at the forest edge, there is a gradual increase in fines further from the shore. The area is influenced by the

numerous upslope seeps, river flows, degradation/aggradation, and periodic flooding. The riparian shrub area comprises 2.2 acres.

The area close to the dam on the east side does not have upslope seeps and is primarily influenced by the hydrology of the river. In this area, there is one small (0.2 acre) riparian tree (cottonwood) stand located on the cobble/gravel shore. There is a broad size range in cottonwoods in this stand (saplings to 15-inch dbh) and there is very little shrub understory (about 5 percent cover). The trees were not cored because the stand is known to have established since dam construction (based on pre-dam photos) and includes a distribution of sizes. The stand consists of both tall saplings and young trees that were in shrub form due to beaver activity. In this area, scour may also be limiting the extent of the forest and will be further analyzed in the USR.

A few additional cottonwood seedlings occur on the cobble island in the spillway, which is adjacent to and north of the 0.2-acre cottonwood stand. There are no larger trees or shrubs to indicate that a stand could establish, and there was no evidence of browse. The island may be scoured, which would prevent seedling survival.

Downstream of the dam on the west side, there are no upslope seeps and the area is primarily influenced by river hydrology. The west shore does not include deciduous riparian tree/shrub vegetation.

5.1.2. Boundary Dam to Metaline Falls

There are no riparian deciduous tree stands or palustrine forested wetlands along the reservoir between Boundary Dam and Metaline Falls within the study area (there are scattered cottonwood trees just outside the study area on the northwestern edge of the Forebay Recreation Area). Three cottonwood trees, of which two are decadent, were recorded in the riparian shrub stand at the mouth of Lime Creek.

There are seven shrub stands totaling 1.7 acres along the reservoir shoreline downstream of Metaline Falls to Boundary Dam. Alder is the dominant species in each stand, with canopy cover ranging from 15 to 80 percent (average 58 percent). Six of the stands are narrow, palustrine scrub-shrub wetlands, and occur in coves or immediately adjacent to the water's edge. These are in the hydrologic gradient between upland, mixed conifer forest and the reservoir, or between the forest and an herbaceous meadow at the reservoir edge. Although these scrub-shrub wetlands are dominated by alder, dogwood is common. Other shrub species that occur in the shoreline shrub stands north of Metaline Falls are often found in upland habitats but can be found in wetlands (USFWS 1988, 1993). These include snowberry (*Symphoricarpos albus*), hazelnut (*Corylus cornuta*), thimbleberry (*Rubus parviflorus)*, and rose (*Rosa* spp.*)*.

Most of the tributary streams to Boundary Reservoir downstream of Metaline Falls are narrow and shaded by adjacent upland, coniferous forest. These streams support little, if any, riparian tree/shrub vegetation. Only Lime Creek supports a small riparian shrub stand (0.2 acre). It is a mosaic of shrubs (approximately 60 percent canopy cover) and emergent wetland species and because it occurs within the steep, wide Lime Creek outflow, it is classified as riparian. All but

the lowest elevations at this site appear to be more influenced by the stream hydrology than by the reservoir.

5.1.3. Upstream of Metaline Falls

The riparian tree/shrub vegetation along the reservoir shoreline is more complex upstream of Metaline Falls. This area supports over 93.5 acres of riparian tree/shrub habitat. Twenty-five percent of this acreage is classified as riparian because it is influenced by upslope hydrology, tributary streams or seeps. About 43 percent of the area of riparian tree/shrub habitat upstream of Metaline Falls occurs in or adjacent to the BWP. Another 16 percent occurs in and around the town of Metaline, including the park, the islands at Project river mile (PRM) 28.9, and on the east shore by the islands at PRM 28.9. About 15 percent of the acreage borders the west side of the reservoir, within two miles of Box Canyon Dam. Following are descriptions of the larger riparian tree/shrub habitat areas

5.1.3.1. Riparian Deciduous Tree and Shrub Stands

The riparian deciduous tree and shrub stands at tributary stream outlets are primarily under the influence of riverine processes but are also influenced by the reservoir hydrology at the lower elevations. Riparian shrub stands dominated by willow occur at the mouths of Sullivan, Lynton, Sand, and Lunch creeks. There is also a riparian shrub stand north and west of the Metaline sewage pond that is dependent on numerous upslope seeps. This stand is dominated by alder but also has a large component of dogwood and lesser amounts of Douglas spirea (*Spirea douglasii)* and willow. The lowest elevations in all of the riparian shrub stands support willow seedlings where there is cobble substrate. Seedlings also occur in the cobble bars below riparian shrub stands and may reestablish annually, due to flooding and scouring.

The mouths of Sullivan and Lynton Creeks, and the area northwest of the Metaline sewage ponds also support riparian deciduous tree stands dominated by cottonwood. There is also a cottonwood stand at Sand Creek but it is not classified as riparian because it is located on a 10- to 12-foot-high bench and is not directly influenced by the creek.

Detail on the riparian shrub and deciduous tree stands by location is provided below:

- **Sullivan Creek** includes three cottonwood stands, each representing different age distributions. The eastern stand (polygon 19) includes mostly very large cottonwoods (38- to 54-inch dbh), only two tall saplings, and many browsed "shrub" cottonwoods. The two tall saplings were surrounded by dense shrubs, which likely limited access by beaver and deer and associated browsing. Browsing, likely from beaver, appears to be preventing young cottonwoods from growing in this stand. The central cottonwood stand (polygon 18) is on a raised narrow area in the center of a scrub-shrub wetland and includes uniformly-sized trees (9- to 12-inch dbh), 20 to 25 years old, and saplings. The western stand (polygon 17) is on a bench at the south and west sides of the stream and includes a diversity of sizes (12- to 50-inch dbh). The presence of young conifers and the lack of young cottonwoods in this stand may result in succession to a conifer stand over time.

The shrub stands in the Sullivan Creek outlet are dominated by willows (polygons 15a, b, c, and d). The lower elevations, closer to the stream's confluence with the reservoir, are almost exclusively willow, but include cottonwood seedlings at the stand edges as well as a few cottonwood saplings. The cobble bars close to the reservoir include only coyote willow and cottonwood seedlings, showing no evidence of browse, and are likely removed by scour each year.

- **Sand Creek** has a wide outlet bordered by a 10- to 12-foot upland bench. The riparian shrub stand in the outlet is dominated by Sitka willow and dogwood (polygon 40). The upslope edges of the outlet support other shrub species (alder, hawthorn, and snowberry) and cottonwood saplings. The top of the steep, eroded bench above the creek is covered by conifer forest with two narrow stands of mature cottonwood trees at the bench edge (classified as palustrine forested wetland). The cottonwood stands (polygon 41) include several very large cottonwoods and a few snags, but the majority of the trees are a uniform size and approximately 35 years old based on coring. There were conifer saplings in the cottonwood stands, possibly indicating succession of that area to conifer over time. The only young cottonwoods near Sand Creek were growing on the side of the steep bench, close to the shrub stand.

- The outlet of **Lunch Creek** (polygon 38) supports a small riparian shrub stand bordered by an upland bench and cobble at the creek edges. This shrub stand is dominated by Sitka willow at the lower elevations and along the stream edge and by hawthorn growing higher on the bench. Dense stands of reed canarygrass occur higher on the berm and may inhibit seedling establishment.

- The slough to the north and east of the **Metaline** sewage ponds is primarily bordered by riparian shrubs (polygon 22a), although a narrow riparian deciduous tree stand also occurs (polygon 22b). Both of these stands are influenced primarily by the numerous upslope seeps. The narrow strip of riparian deciduous trees, which is dominated by cottonwood and alder, lies between the conifer forest uphill and the riparian shrub stand. Downslope of the shrub stand is emergent wetland vegetation. The cottonwoods represent a wide range of ages (cores estimated between 17 and 60 years). The shrub stand is dominated by alder but includes several willow species. There are many young shrubs and cottonwoods visible in the openings. Only moderate browse was observed on the young shrubs and cottonwoods. The substrate is silt to the slough, not cobble as in most riparian areas, and so there is dense reed canarygrass competing with seedlings.

- The **Lynton Creek** outlet in Metaline Park is bordered by riparian shrubs and a small stand of riparian deciduous trees. The area is dominated by multiple willow species and dogwood, with young shrubs growing on the gradually-sloped bank. Farther from the stream along the reservoir, the shrubs grow on a raised bench and are likely not influenced by Lynton Creek flows. The small riparian tree stand consists of cottonwood of a uniform size (approximately 22 years) and seedlings and saplings at the stand edge. Most of the seedlings are mowed as part of the park maintenance. Farther upstream on Lynton Creek, still in Metaline Park, is a grey alder stand. This

stand was classified as a riparian deciduous forest because it consists of single-stemmed alder, 20 feet tall, with a shrub understory. It also includes a few cottonwoods of a uniform size, which were found to be 24 years old.

5.1.3.2. Palustrine Forested and Scrub-Shrub Wetlands

The deciduous forest and shrub stands that have groundwater or the reservoir as a primary hydrologic influence are classified here as palustrine. In the study area, the stands at higher elevations are generally on silt substrate and are dominated by dogwood and hawthorn and often include species not commonly found in wetlands, such as snowberry. The stands at the lower elevations along the reservoir, on silt or cobble substrates, are dominated by willow and dogwood. Seedlings also occur in the cobble bars below mature shrub stands and may reestablish annually, due to flooding and scouring.

- The **BWP** supports the largest palustrine shrub/forested wetland complex in the study area. Covering 39.9 acres, these stands represent about 40 percent of the combined palustrine shrub/forested stands found in the study area. A large portion of the BWP occurs on what appears to be a relict floodplain or terrace that is no longer influenced by overbank flows. However, there is an old channel that is inundated by backwater during high flows and other low points that could be saturated by groundwater or influenced by the reservoir.

  Palustrine forested wetlands comprise nearly 75 percent of the tree and shrub acreage in the BWP. A wide range of cottonwood sizes (saplings to over 20-inch dbh) occurs, and a few cores confirmed they represent a comparably wide age range (e.g., 35 years for a 10-inch dbh tree and 67 years for an 18-inch dbh tree). The forest understory and the shrub stands are dominated by the same shrub species including dogwood, hawthorn, and snowberry. Two stands included a small amount (less than 5 percent cover) of Bebb's willow and one stand included a few alder. There are cottonwood seedlings and saplings along most of the forest edges and in a few openings. This indicates that sunlight and hydrology are presently appropriate for seedling establishment. Although many of the young cottonwoods have been stunted to shrub size by severe browse, there are a few areas with saplings tall enough to preclude further stunting by browse. The central forested area (polygons 44d and e) supports a few conifers and includes cottonwood saplings in several forest openings. The dense cottonwood forest in the southern portion of the BWP (polygon 47) does not appear to support any cottonwood saplings but does include young conifers, possibly indicating succession to conifer forest over time. There is also an aspen (*Populus tremuloides*) stand (polygon 44a) in the central forested area, and its shoots are competing with the cottonwood saplings. Dense fields of reed canarygrass in the central portion of the BWP include few if any other species and may also be preventing cottonwood seedlings from establishing. Areas dominated by other grass species are typically less dense and numerous cottonwood seedlings have established.

  The cottonwood-dominated palustrine forested wetland on the east shore by **Box Canyon Dam** (polygon 58) is on a flat, dry bench that slopes to the south and east to a depression at the base of a hill. The depression is apparently inundated or saturated

by shallow groundwater, which may be affected by the reservoir elevation. Some of the shoreline has been disturbed, and there is an old road through the stand. The forest is open with only 35 percent cover and no shrub layer. The mature cottonwoods have a wide range of sizes (saplings to 20-inch dbh) and ages (30 to 65 years) and there were several dead and decadent trees. The saplings also have a wide range of sizes from 1- to 5-inch dbh. Seedlings and saplings occur throughout this open stand and site hydrology has apparently supported seedling establishment for many of the last 65 years.

As noted in Section 3, the riparian information collected on the east shore just downstream of the Box Canyon Dam is located within the FERC project boundary for the Box Canyon Project (FERC #2042) but are included in this report.

On the west shore, north of Box Canyon Dam, narrow, palustrine scrub-shrub and forested wetlands extend for about 2 miles between the reservoir and the highway. The area south of Box Canyon Resort supports palustrine scrub-shrub wetlands dominated by willow or dogwood shrubs. The wetlands closer to the highway, some growing at least partially on road fill, consist of dense and mature shrubs. The stand closest to Box Canyon Resort, which is largely on road fill, includes dogwood, hawthorn and snowberry. The palustrine scrub-shrub wetlands at lower elevations along the reservoir are growing mostly in a cobble substrate, are relatively open, and appear to be newly establishing. These lower areas are dominated by willow and dogwood shrubs and are likely frequently inundated and periodically scoured. These stands are also experiencing heavy beaver activity, which is stunting growth.

North of Box Canyon Resort, both palustrine forested (dominated by cottonwood) and scrub-shrub wetlands are sandwiched between the conifer forests bordering the highway and dense reed canarygrass that grows to the reservoir edge. The mature cottonwoods range in age from 20 to 60 years and seedlings grow at the stand edges. A younger cottonwood stand consists of dense trees that are a nearly uniform eight feet tall.

- The **Metaline** sewage ponds are a highly altered habitat including both palustrine scrub-shrub and forested wetlands. The palustrine scrub-shrub wetlands include a line of mature, single-stemmed shining willow along the top of the west berm and a mixture of shrubs, primarily dominated by dogwood, alder, and other willow species, on the sides. There are many young sprouts, primarily willow, on the sides of the berm; however, they are heavily browsed to short shrubs. The palustrine forested wetland on the south side of the sewage ponds is dominated by cottonwoods of a wide range of ages (cores estimated to be 19 to 65 years) with a mixture of shrubs (including snowberry, spiraea, hazelnut, dogwood, and shining willow) in the understory. Cottonwood seedlings and saplings occur along the edge of this forested wetland.

  Palustrine scrub-shrub wetlands characterized by dense, mature thickets of dogwood border the eastern reservoir shoreline below the conifer forest. Similar dogwood

stands occur on the nearby islands. There is also a relatively large cottonwood stand in this area that includes mature trees (core estimates 31 to 62 years) as well as some young trees that were heavily browsed. The browse was heavy enough that many of the seedlings were almost unidentifiable, and no tall saplings were found. Between the cottonwood stand and the reservoir is dense scrub-shrub wetland that is dominated by MacKenzie's willow and alder. The edges of this stand included many willow and alder shoots and sprouts which were also experiencing heavy browse.

5.2. Riparian Tree/Shrub Stand Characterization

It is useful to understand the habitat requirements and regeneration process for the focus species in characterizing the riparian tree/shrub stands. The following narrative provides a summary of these elements for the focus species.

- ***Black cottonwood*** is a pioneer or early seral species and is relatively fast-growing, which gives it an advantage in newly exposed soils. Exposed moist, mineral soil in full sunlight creates favorable habitat for black cottonwood seedlings. Black cottonwood regenerates primarily from seeds, but in existing forests can also regenerate through sprouts, root suckers, or by sprouting from branches fallen in favorable conditions. Copious seeds are produced in the spring when flows are receding and favorable conditions exist along streams. Seeds are viable for a short period (1 to 4 weeks). Full sunlight is needed as the seeds have little endosperm and need to photosynthesize early in establishment. Seedling root growth is relatively fast, up to one-half inch per day, but mortality can be high if the water recedes faster than the roots grow. Rapid root growth and tolerance of inundation and sediment deposition gives black cottonwood a competitive advantage over other alluvial bar species. Because of the need for full sunlight, few seedlings establish in existing cottonwood forests. The specific water and sun requirements often result in the establishment of even-aged stands in years with favorable conditions. Cottonwood establishment by seedling is generally episodic (5 to 10 years), depending on seed viability in the spring and moisture conditions for the first year. In naturally flowing rivers, the cycle of stand development can continue across a valley as a stream meanders (Steinberg 2001, Kovalchik and Clausnitzer 2004).
- ***Sitka alder*** is typically thought of as an early seral shrub in cool, moist uplands where it colonizes open areas. In eastern Washington, it is also found on well-drained riparian sites and wetland margins. Sitka alder is moderately shade tolerant, which allows it to live in forested habitats; however, it does not tolerate dense overstory. Its ability to fix nitrogen allows it to invade recently exposed or sterile mineral soil. Dense stands of Sitka alder can develop, remain stable, and retard the establishment of other species. Sitka alder primarily reproduces from abundant winged, lightweight seeds that can travel long distances, but it can also reproduce vegetatively by re-sprouting from the root crown. Seed dispersal normally occurs in fall and germination occurs the following spring. There are many factors that contribute to low seedling survival rate including summer drought or floods, winter scouring, dense shade, and browse. Seedlings that survive their first year usually develop root systems that remain in contact with a permanent water supply (Uchytil 1989a, Kovalchik and Clausnitzer 2004).

- ***Grey alder*** has habitat requirements and a life history similar to Sitka alder. It can be found in a shrub or tree form and can occur in dense thickets that could be produced through seed or vegetative reproduction. It is generally found in areas with a high water table, often close to streams (Uchytil 1989b).
- ***Redosier dogwood*** is often found in wetlands and riparian zones, but can also be found in the understory of open forests or in forest openings. Redosier dogwood needs moderate to full sun and so would not be expected in closed forests. Redosier dogwood regenerates both from seed and by layering (rooting at branch nodes in contact with moist ground) or by producing new shoots from existing roots. Dense thickets formed through layering are common in eastern Washington. Redosier dogwood seeds are dormant and need cold stratification to germinate, but they may remain viable in a seed bank for many years. The seeds germinate above water level and, after several years of growth, the plants can survive with submerged roots for most of a growing season (Crane 1989, Kovalchik and Clausnitzer 2004).
- ***Willow*** species are found in a wide range of riparian and wetland habitats. There were six species of willow found in the survey area; coyote, Sitka, MacKenzie's, and shining willow were most common, while Bebb's and Scouler's willow were less common and made up a smaller percentage of cover where found. Willow communities tend to be relatively stable once established in wet or moist sites; succession to site conditions more favorable to trees proceeds slowly, if at all. Several willow species can appear either in the shrub or small tree form (Tesky 1992, Anderson 2001, Anderson 2006). Most species found in the study area grow best in full sun; however, Sitka and Scouler's willow can tolerate some shade (Moore 2003, Kovalchik and Clausnitzer 2004, Anderson 2006). All eastern Washington willow species appear to be able to propagate by sprouting/suckering as well as by seed. They root by layering or through the rooting of broken stem and root pieces partially buried by flood deposition or beaver activity (Kovalchik and Clausnitzer 2004). Coyote willow also reproduces by sprouting from underground runners and can create dense, clonal thickets (Anderson 2006). Scouler's willow is not as likely to layer and produces roots only at the cut surface. Willows produce abundant seeds disseminated by wind and water. Seed viability is generally short-lived, and seeds more than a few days old may produce abnormal seedlings. The soil where germination occurs needs to remain moist for the first growing season for the seedling to survive. In the first growing season, seedlings are threatened by summer drought or floods, winter scouring, ice flows, herbaceous competition, shade from other shrubs or trees, and browsing (Kovalchik and Clausnitzer 2004).
- ***Black hawthorn*** typically forms dense thickets in moist areas but can also be found on mesic sites. It is mostly an understory species associated with *Populus* spp. including cottonwood. Black hawthorn reproduces sexually by producing many fertile seeds. It can also regenerate by sprouting and suckering from the root system following the removal of aboveground stems (Habeck 1991).

5.2.1. Riparian Shrub Stand and Palustrine Scrub-Shrub Wetland Characterization

Table 5.2-1 summarizes the dominant species in riparian shrub stands and palustrine scrub-shrub wetlands by study area segment. All species other than willow were found in fruit. Willow species were in fruit in the spring, prior to the survey period. In almost all areas, the alder had deformed cones that included no seeds. North of Boundary Dam, willow species are clearly dominant and provide 60 percent of the shrub cover. Between Boundary Dam and Metaline Falls, Sitka alder is dominant and dogwood is common, but a number of shrub species more typical of uplands also occur in the palustrine scrub-shrub wetlands. Between Metaline Falls and Box Canyon Dam, the vegetation is more complex. There are few, if any, upland shrub species growing in the riparian shrub stands or in the palustrine scrub-shrub wetlands. The only riparian shrub stand where Sitka alder is dominant is north and west of the Metaline sewage ponds, which has a silt substrate and is fed by numerous seeps. In the palustrine scrub-shrub wetlands, willow and dogwood are the dominant species at the lower elevations near the reservoir, where there is generally a cobble component in the substrate. In several of the shrub stands in the BWP and across the reservoir from the BWP, the upland species snowberry is dominant or subdominant. Hawthorn is dominant in two stands at the BWP.

Table 5.2-1. Dominant species in riparian shrub stands and palustrine scrub-shrub wetlands.

Shrub Area Type	Dominant Species	Sub-Dominant Species	Acres
Boundary Dam Tailrace			
Riparian shrub	Coyote willow	Willow, dogwood, Sitka alder	2.2
		Subtotal	*2.2*
Downstream of Metaline Falls			
Riparian shrub	Sitka alder	Dogwood	0.2
Palustrine scrub-shrub wetland	Sitka alder	Dogwood, snowberry, hazelnut	1.5
		Subtotal	*1.7*
Upstream of Metaline Falls to Boundary Dam			
Riparian shrub	Willow species	Willow, dogwood, alder	9.4
	Sitka alder	Dogwood	4.8
	Dogwood	Sitka willow	2.0
	Hawthorn	Sitka willow	0.3
Palustrine scrub-shrub wetland	Snowberry	Hawthorn, Dogwood	12.4
	Dogwood	Alder, willow, Hawthorn	7.2
	Willow species	Dogwood, alder	7.5
	Hawthorn	Dogwood, snowberry	2.6
		Subtotal r	*46.1*
Total Acres Shrub			**50.0**

Shrub stand height and canopy cover varied considerably between and within stands; however, there are a few generalizations that can be made. The canopy cover ranged from dense thickets with 100 percent shrub cover to open stands of less than 20 percent cover. In general, the stands with high canopy cover were mature, appeared to be regenerating vegetatively, had a substrate dominated by fines, and were at the higher elevations. Many of the stands at lower elevations, mostly on gravel and cobble, were more open and included seedlings that may reestablish each

year. Shrub height followed a similar pattern, with the mature, dense stands being taller (8 feet and taller) and the open, young stands being shorter and at lower elevations.

In areas where snowberry was one of the dominant species, such as the BWP, shrub stand height was dependent on the species in the stand. Mature dogwood and hawthorn were over 8 feet tall while the mature snowberry was generally 3 to 4 feet tall. Therefore, the stand height was dependent on the dominant species.

The majority of the riparian shrub stands and palustrine scrub-shrub wetlands were found on fines or gravel with fines (Table 5.2-2). The only species not commonly found on fines is coyote willow, which was most common at the lowest elevations and associated with cobble. Dogwood and MacKenzie's willow were also found on substrates with cobble, though to a lesser extent. The dogwood on cobble substrate was primarily found at the Sand Creek outlet, and the Mackenzie's willow on cobble was largely found in one long narrow strip on the west shore across from the island at PRM 33.1.

Table 5.2-2. Substrate for cottonwood stands and for shrub species, where dominant, in riparian tree/shrub habitats.

Species	Fines or Gravel and Fines		Cobble[1]	
	Acres	Percent	Acres	Percent
Cottonwood	42.2	90	4.7	10
Alder	8.8	99	0.1	1
Dogwood	7.4	68	3.5	32
Hawthorn	2.7	100	-	-
Coyote Willow	.2	-	6.2	100
Shining Willow	2.2	100	-	-
MacKenzie's Willow	1.7	74	0.8	26
Sitka Willow	6.9	84	1.4	16
Snowberry	44.1	100	-	-
All acres[2]	**81.0**	**84**	**17.0**	**16**

Notes:
Totals may vary slightly due to rounding.
1 Substrates with cobble; may also include stone and gravel.
2 Acres by species do not add to all acres because the shrub species acreage includes cottonwood stands where the shrub is dominant.

5.2.2. Cottonwood Stand Characterization

There are 15 riparian deciduous tree and palustrine forested wetlands where black cottonwood is dominant, covering 47.1 acres in the study area. Approximately 90 percent of those were found on fines or gravel and fines (Table 5.2-2). The BWP includes 29.4 acres of cottonwoods in three areas (analyzed as 6 stands), which represents over 60 percent of this forest type (including riparian and palustrine) found in the study area. The next largest single cottonwood areas are at the outlet of Sullivan Creek, with a total of 3.5 acres in three stands and the stand by Box Canyon Dam, also 3.5 acres. Cottonwood forests near Metaline (including across the reservoir)

cover 7.0 acres, but occur as more widely separated stands, which are growing under different environments.

Cottonwood stands in the study area include trees with varying age distributions (see Table 5.2-3). There are even-aged cottonwood stands, which reflect cyclical establishment, and multi-aged stands, which suggest establishment over a number of years. Three even-aged stands appeared to have established about 20 to 25 years ago (center of Sullivan Creek outlet, Lynton Creek outlet in Metaline Park, and south of the Metaline boat dock along the road in the park). The two dense stands of 8-foot cottonwood saplings (one at the south end of Metaline across from the islands at PRM 28.9 and one across from the south end of the BWP) and the stand with many 4-foot saplings across from the south end of the BWP are evident of more recent cyclic establishment. All three of these sapling stands are adjacent to mature stands.

Table 5.2-3. Acres of cottonwood trees in riparian tree/shrub vegetation types by age group.

Vegetation Type	Total Acres	Acres of Mature Trees				Acreage of Stands with Seedlings or Saplings	Decadent Tree Acres	Snag Acres
		Only Pre-Dam Constr. (> 40 years)	Only Post-Dam Constr. (< 40 years)	Acreage with Both Pre- and Post-Dam Constr.	Total Mature Trees			
Tailrace								
Riparian Deciduous Tree	0.2	-	0.2	-	0.2	0.2	-	-
Between Metaline Falls and Box Canyon Dam								
Riparian Deciduous Tree	4.0	1.5	2.0	0.5	4.0	3.1	0.5	4.1
Palustrine Forested Wetland	42.8	19.5	10.3	11.6	41.3	42.8	25.4	26.1
Subtotal Forested Stands[1]	**46.9**	**21.0**	**12.4**	**12.1**	**45.5**	**45.9**	**25.9**	**30.2**
Palustrine Scrub-Shrub Wetland[2]	15.0	6.8	1.1	1.2	9.2	13.3	-	6.3
Riparian Shrub[2]	12.3	-	0.3	-	0.3	12.3	-	-
Grand Total	**74.4**	**27.8**	**14.0**	**13.3**	**54.9**	**71.7**	**25.9**	**36.5**

Notes:
Totals may vary slightly due to rounding
The table does not include 0.6 acres of an aspen dominated RD stand found on the BWP.
1 Vegetation was categorized as forested if the total tree cover was greater than 30 percent (Cowardin et al. 1979).
2 Cottonwoods were present in shrub stands but with less than 15 percent cover.

There is strong evidence that cottonwoods are reproducing and establishing in the study area. There were seedlings or saplings on 79 percent of the acreage with mature trees. Additionally, there were 16.8 acres of forested or shrub stands that included only seedling or sapling cottonwoods but no mature trees. The BWP includes 49 percent (39.0 acres) of the shrub or forested acres with cottonwoods and all of them included some seedlings or saplings.

Of the mature cottonwood acreage in the study area, over three quarters established before Boundary Dam was built. Approximately 30 percent of that acreage also contains trees that were established after the construction of the dam. Almost a quarter of the mature cottonwood acres were fully established after dam construction.

The mature cottonwoods ranged from approximately 30 to 80 feet tall. About 84 percent of the mature trees were 60 feet or taller. The saplings (defined as 1 to 5 in dbh) ranged from about 8 feet to 35 feet tall.

Cottonwood canopy cover in one stand north of Boundary Dam was approximately 30 percent (Table 5.2-4). Between Metaline Falls and Box Canyon Dam, canopy cover ranged from 30 to 75 percent cover in the forested areas. Approximately 80 percent of those forested acres had cottonwood canopy cover between 20 and 45 percent. In the shrub stands that included cottonwood, the cottonwood cover ranged from 1 to 15 percent.

Table 5.2-4. Acres by cottonwood canopy cover in riparian tree/shrub vegetation types.

Vegetation Type	Cottonwood Canopy Cover Ranges (percent)					Total Acres
	1 to 3	5 to 15	20 to 30	35 to 40	50 to 75	
North of Boundary Dam						
Riparian Deciduous Tree	-	-	0.2	-	-	0.2
Between Metaline Falls and Box Canyon Dam						
Riparian Deciduous Tree	-	0.5	-	2.0	1.5	4.0
Palustrine Forested Wetland	-	-	1.4	33.7	7.7	42.8
Subtotal Forested	**-**	**0.5**	**1.6**	**35.7**	**9.3**	**47.1**
Palustrine Scrub-Shrub Wetland[1]	2.9	12.3	-	-	-	15.2
Riparian Shrub[1]	2.7	9.4	-	-	-	12.1
Total Acres	**5.6**	**22.2**	**1.6**	**35.7**	**9.3**	**74.4**

Note:
Totals may vary slightly due to rounding.
1 Vegetation was categorized as forested if the total tree cover was greater than 30 percent (Cowardin et al. 1979).

The four largest cottonwood areas (listed from largest to smallest) occur in the BWP, along the east shore of the Box Canyon Dam tailrace, along the east shore of the reservoir across from Metaline, and adjacent to the Metaline sewage ponds. These stands are also where the largest number of newly establishing cottonwoods can be found, typically growing at the forest edges or in openings. In most areas with saplings, heavy browse appears to be the most immediate threat to survival. In some stands there are virtually no young cottonwoods taller than 2 feet (e.g., Sullivan Creek outlet, the stand east of the islands at PRM 28.9, and some areas in the BWP). In other areas there are tall saplings that are likely beyond further browse risk, such as parts of the BWP and in the vicinity of Box Canyon Dam.

Few cottonwood snags or decadent trees were documented in the study area; these habitat features were noted in only 7 of the 23 cottonwood stands. Most were recorded in the stands

around Metaline, east of the islands at PRM 28.9, at the outlets of Sand and Sullivan Creeks, on the east shore in the Box Canyon Dam tailrace; a very few were noted in the BWP.

In a majority of the cottonwood stands in palustrine forested wetlands, snowberry is the dominant shrub species, and dogwood is common (Table 5.2-5). Snowberry is generally found in upland habitats, so soil moisture conditions must provide a balance between the drier needs of snowberry and the moister needs for cottonwood establishment. In the riparian cottonwood stands, dogwood, alder, and, to a lesser extent, snowberry, were the dominant shrub species.

Table 5.2-5. Acreage of dominant shrub species in palustrine forested wetland and riparian forests

	Tailrace	Upstream of Falls			
Dominant Shrub	**Riparian Deciduous Trees (ac)**	**Palustrine Forested Wetland (ac)**	**Riparian Deciduous Trees (ac)**	**Total (ac)**	**Total (ac)**
Alder	-	1.4	1.0	2.4	2.4
Dogwood	-	5.7	1.5	7.1	7.1
Snowberry	-	32.6	1.4	34.0	34.0
None[1]	0.2	3.7	0.2	3.9	4.1
TOTAL	**0.2**	**43.4**	**4.0**	**47.4**	**47.7**

Notes:
Totals may vary slightly due to rounding.
1 Open forest. No shrub species with cover over 10 percent.

5.3. Potential Riparian Tree and Shrub Habitat in the Fluctuation Zone

This analysis will be completed in 2008 and presented in the USR.

5.4. Documentation and Effects Assessment

The assessment of potential Project and local land use effects will be conducted once all other elements of this study are completed in 2008. However, some general effects were observed and are addressed below by study area section.

Boundary Dam Tailrace: There was evidence of moderate browse by deer and beaver activity that potentially threatens the integrity of riparian shrub and deciduous tree stands. Further, the riparian shrub stands are growing in areas with numerous upslope seeps. Maintenance activities associated with a forest road located upslope of the riparian stand has the potential to change the current hydrology of the seeps.

Boundary Dam to Metaline Falls: Deer browse is evident, although it does not appear to be a severe problem, in several palustrine scrub-shrub wetlands downstream of Metaline Falls.

Upstream of Metaline Falls: At Sullivan Creek, dense stands of reed canarygrass are a potential threat in all of the palustrine scrub-shrub and forested wetlands (except those closest to the reservoir). The densities of the infestations can inhibit reproduction of the willow and cottonwood because they require full sun and open soil.

The riparian tree/shrub stands north and west of the Metaline sewage ponds are growing in areas with numerous upslope seeps; activities associated with management of the area near the sewage ponds have the potential to change the current hydrology of the seeps. Secondly, the reed canarygrass in the slough northeast of the sewage ponds is dense close to the water and poses a potential threat to tree and shrub seedling establishment and the continued integrity of shrub communities close to the water. Thirdly, deer browse and beaver activity are a threat to seedlings, particularly around the sewage ponds. Lastly, there is considerable evidence of human effects in the upland areas adjacent to Metaline Park (mowing of seedlings) and beaver activity along the water's edge.

The dense reed canarygrass on the islands at PRM 28.9 has the potential to limit the dogwood stand expansion. The willow and cottonwood stands across from the islands at PRM 28.9 on the east shore show severe browsing. In the cottonwood forest where the understory was open and seedlings could be seen, every young cottonwood or alder was severely browsed.

At the BWP, the most obvious and immediate threat to seedling survival and the integrity of the palustrine forested wetlands is heavy deer browse that has stunted the majority of cottonwood seedlings. There are a few areas where cottonwood seedlings have grown to sapling size (east of the large stand in the center and on the northern end of the BWP and east of the line of cottonwood along the reservoir). Despite the heavy browsing, the hydrology and light are apparently appropriate because there are cottonwood seedlings establishing and surviving. The other potential threat to the integrity of the forested and scrub-shrub wetlands on the BWP is reed canarygrass. In areas where there is dense reed canarygrass, there are no cottonwood seedlings. In areas dominated by other grass species, which typically grow in stands that are not as dense as reed canarygrass, there are numerous cottonwood seedlings and some saplings.

At the cottonwood stand near Box Canyon Dam, there are many seedlings that survive to sapling height. Therefore, at the current level of browse, the integrity of the cottonwood stand is not threatened. The sun and hydrology are sufficient for seedling establishment and survival.

The shrubs along the west side of the river close to Box Canyon Dam exhibit evidence of beaver activity and deer browse. In some areas it is severe.

6 SUMMARY

Two of the four study tasks for the Riparian Study have been completed. The analysis of potential riparian tree/shrub habitat that could develop in the fluctuation zone will be conducted when the outputs from the Hydraulic Routing Model are available. The results of this analysis and the discussion of Project effects will be presented in the USR.

There are several overall summary statements about existing riparian tree/shrub habitats that can be made at this time:

- The majority of the riparian tree/shrub communities occur south of Metaline Falls.

- Over half of the mature cottonwood trees in the study area established prior to dam construction but there are also stands that include mature trees that have established after dam construction.
- Cottonwoods are reproducing and conditions are favorable for seedling establishment and survival in areas between Metaline Falls and Box Canyon Dam.
- The BWP includes almost 60 percent of the cottonwood stands in the study area.
- Deer browse and beaver activity are noteworthy threats to cottonwood seedlings in most areas south of Metaline Falls. There are several areas where most of the established seedlings were browsed and prevented from growing to tall saplings.
- Reed canarygrass is well established between Metaline Falls and Box Canyon Dam. It grows in dense stands at the edge of shrub and tree stands and may prevent expansion of the stands.

7 VARIANCES FROM FERC-APPROVED STUDY PLAN AND PROPOSED MODIFICATIONS

There was one variance from the FERC-approved study plan.

1. The objective of the tree coring was to document the age structure of cottonwood stands. Because coring can lead to decay and other forms of degradation (Maeglin 1979), it was decided that the actual number of trees to be core sampled would depend on stand diversity (no undue sampling would occur just to meet protocols). During coring, many cottonwoods had a strong outflow of a liquid that ranged from fairly clear to red. Due to the potential damage to trees, the surveyors would listen for a gurgling sound which preceded this outflow, stop coring a tree when this occurred, and estimate the age of the tree based on the rings seen on the partial core, the dbh of the tree, and the estimated thickness of the bark. Further, it was decided during a September 6, 2007, site visit attended by the RPs, SCL, and the TtEC riparian study team, that damage to trees should be minimized and if a site showed a wide distribution of sizes, coring would not be necessary.

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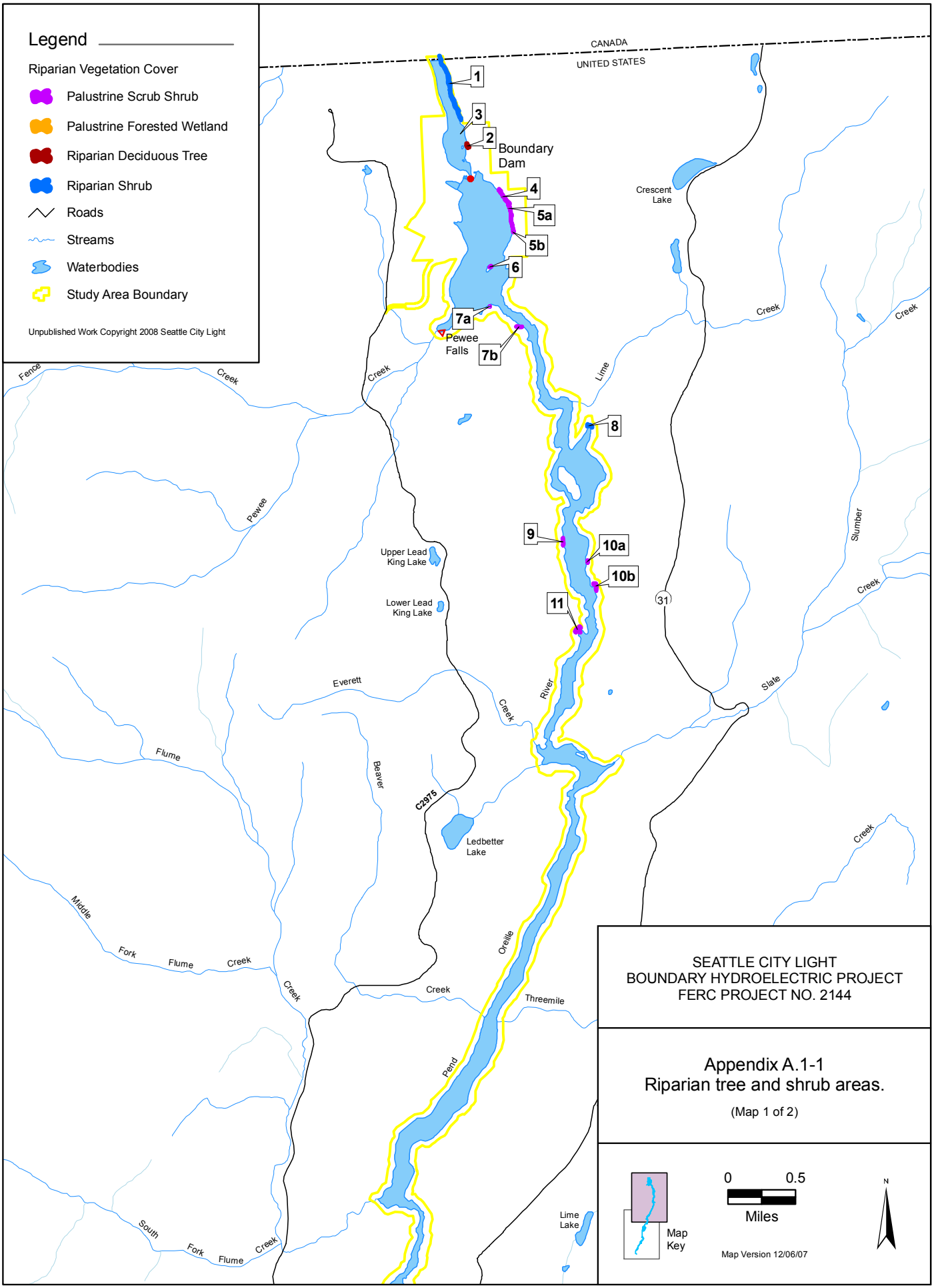
Appendix 1. Locations of Riparian Tree and Shrub Stands Surveyed in the Study Area by Polygon


Legend
Riparian Vegetation Cover
Palustrine Scrub Shrub
Palustrine Forested Wetland
Riparian Deciduous Tree
Riparian Shrub
Roads
Streams
Waterbodies
Study Area Boundary
Unpublished Work Copyright 2008 Seattle City Light
CANADA
UNITED STATES
1
2
3
4
5a
5b
6
7a
7b
8
9
10a
10b
11
Boundary Dam
Pewee Falls
Crescent Lake
Upper Lead King Lake
Lower Lead King Lake
Ledbetter Lake
Lime Lake
Fence Creek
Pewee Creek
Everett Creek
Beaver Creek
Flume Creek
Middle Fork Flume Creek
South Fork Flume Creek
Lime Creek
Slate Creek
Slumber Creek
Threemile Creek
Orville Creek
Pend Oreille River
C-2975
31
SEATTLE CITY LIGHT
BOUNDARY HYDROELECTRIC PROJECT
FERC PROJECT NO. 2144
Appendix A.1-1
Riparian tree and shrub areas.
(Map 1 of 2)
Map Key
0
0.5
Miles
N
Map Version 12/06/07

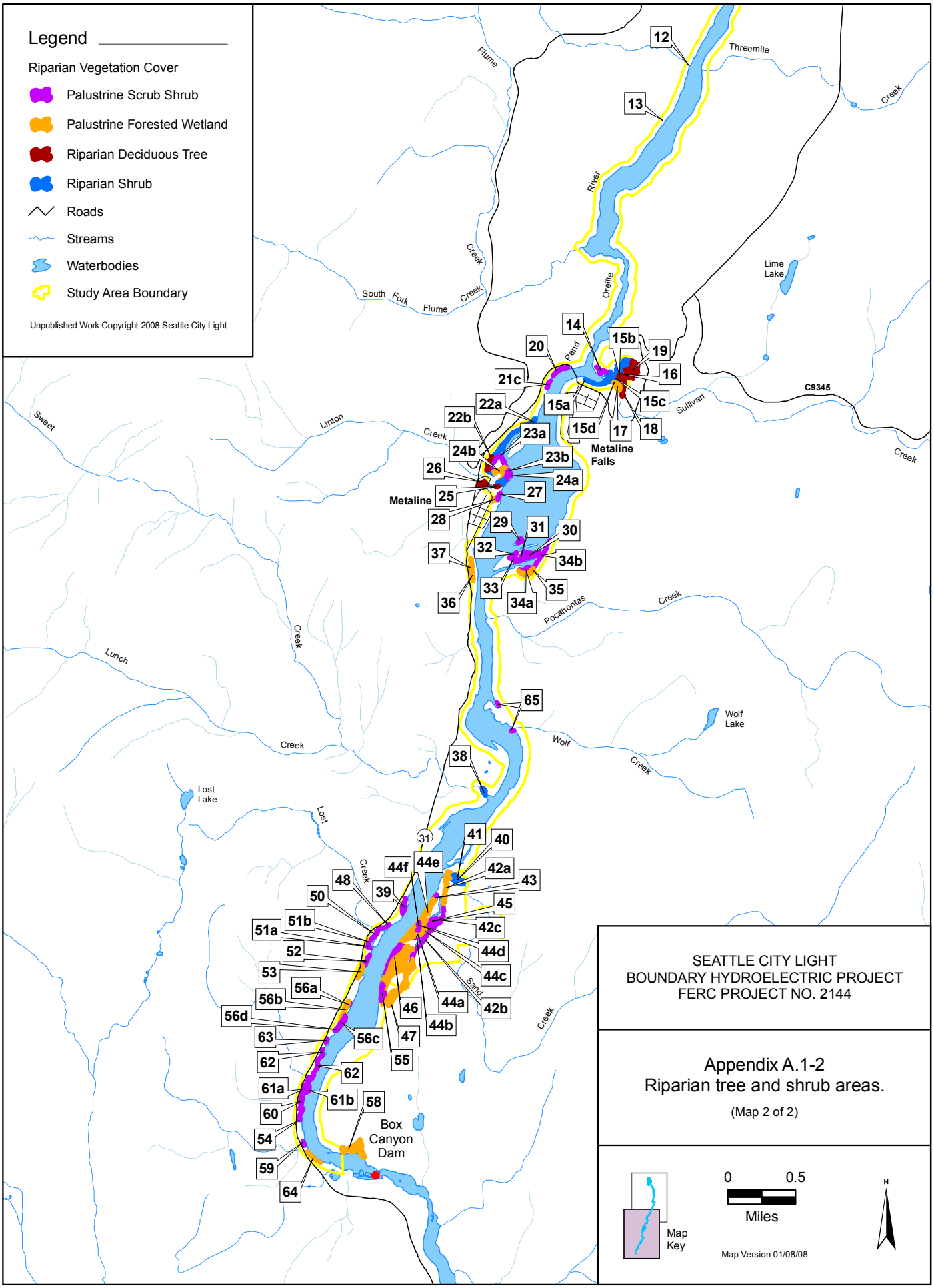

Legend
Riparian Vegetation Cover
Palustrine Scrub Shrub
Palustrine Forested Wetland
Riparian Deciduous Tree
Riparian Shrub
Roads
Streams
Waterbodies
Study Area Boundary
Unpublished Work Copyright 2008 Seattle City Light
Flume
Threemile
Creek
River
Oreille
Pend
Lime
Lake
South Fork Flume Creek
Creek
C9345
Sullivan
Creek
Sweet
Linton
Creek
Metaline
Metaline Falls
Pocahontas
Creek
Lunch
Creek
Creek
Wolf
Lake
Wolf
Creek
Lost
Lake
Lost
Creek
Sand
Creek
Box
Canyon
Dam
SEATTLE CITY LIGHT
BOUNDARY HYDROELECTRIC PROJECT
FERC PROJECT NO. 2144
Appendix A.1-2
Riparian tree and shrub areas.
(Map 2 of 2)
Map
Key
0
0.5
Miles
Map Version 01/08/08
N

Table A.1-1. Data in GIS shape file for each polygon.

Polygon Number	Vegetation Classification [1]	Dominant Species	Dominant Tree No. 1 [2]	Dominant Tree No. 2	Dominant Tree No. 3	Cover Tree No. 1	Cover Tree No. 2	Cover Tree No. 3	Dominant Shrub No. 1 [3]	Dominant Shrub No. 2	Dominant Shrub No. 3	Cover Shrub No. 1	Cover Shrub No. 2	Cover Shrub No. 3	Potential Threats	Comments
Rip_Veg	ABBREV_	Dom_spec	DomTree1	DomTree2	DomTree3	CoverTree1	CoverTree2	CoverTree3	DomShrub1	DomShrub2	DomShrub3	Cover Shrub1	Cover Shrub2	Cover Shrub3	Threats	Comments
1	RS	SALEXI	THUPLI	BETPAP		5	5		SALEXI	ALNVIRS	CORSER	25	20	20	Upslope hydrology changes; Light to moderate deer/beaver	Upslope hydrology appears most influential. Salix exigua seedlings closer to river than most of the larger shrubs; they may reestablish every year.
2	RDT	POPBAL	POPBAL			30			SALPRO	CORSER	RUBPAR	2	1	1	Beaver; scour	
3	REM		POPBAL			2			SALEXI			2			Beaver; scour	PEM; Few willow and cottonwood seedlings; with less browse or scour and appropriate hydrology could grow to shrub or forested.
4	PSS	ALNVIRS	BETPAP			5			ALNVIRS	SYMALB	SHECAN	60	10	10	Browse along shore; reservoir level fluctuations	
5a	PSS	ALNVIRS							ALNVIRS	CORSER	SYMALB	65	25	20	Browse along shore; reservoir level fluctuations	
5b	PSS	ALNVIRS							ALNVIRS	CORSER	SYMALB	75	25	15	Browse along shore; reservoir level fluctuations	
6	PSS	ALNVIRS							ALNVIRS	SYMALB	PHILEW	30	3	1	Reservoir level fluctuations; recreation	
7a	PSS	ALNVIRS							ALNVIRS	CORCOR	RUBPAR	15	10	5	Reservoir level fluctuations; heavy browse	Browse has kept shrubs short
7b	PSS	ALNVIRS	ABIGRA	PINPON		3	3		ALNVIRS	CORCOR	RUBPAR	20	10	5	Tree encroachment, browse, water level fluctuations	
8	RS	ALNVIRS	THUPLI			5			ALNVIRS	CORSER	ACEDOU	25	10	10	Hydrologic changes in Linton Creek	
9	PSS	ALNVIRS							ALNVIRS	RUBPAR	SPIDOU	80	5	5	Reservoir level fluctuations, recreation	
10a	PSS	ALNVIRS							ALNVIRS			70			Reservoir level fluctuations	On a bench above the reservoir.
10b	PSS	ALNVIRS							ALNVIRS			70			Browse, reservoir level fluctuations	
11	PSS	ALNVIRS							ALNVIRS	SYMALB		25	5		Browse, reservoir level fluctuations, invasive plants	
12	US															
13	US															
14	PSS	SYMALB	POPBAL	BETPAP		3	3		SYMALB	CRADOU	CORSER	30	20	20	Invasives	Shrubs on 12 ft. bench; doesn't appear to be affected by Sullivan Creek or reservoir hydrology
15a	RS	SALSIT	POPBAL			5			SALSIT	SALEXI	SALPRO	35	15	5	Flood and scour of Sullivan Creek, western edges: reservoir level	Many seedlings in gravel areas
15b	RS	SALEXI	POPBAL			15			SALEXI	SALSIT	SALPRO	65	20	5	Flood and scour of Sullivan Creek, western edges: reservoir level	Many seedlings in gravel edges, adolescent POPBAL at cliff edges
15c	RS	SALSIT	POPBAL			5			SALSIT	SALEXI	SALLUC	50	30	15	Reedcanary grass, Sullivan Creek hydrology	Flood debris at 4 ft., reed canary grass dense
15d	RS	SALSIT	POPBAL			3	5		SALSIT	ALNVIRS	CORSER	70	20	20	Beaver, Scour at lowest areas	
16	RS	SALSIT							SALSIT	CORSER	ALNVIRS	30	15	15	Changes in hydrology, Reed canary grass	Dense reed canary grass patches in area and adjacent
17	PFO	CORSER	POPBAL	THUPLI		20	10		CORSER	SYMALB	CRADOU	30	20	10	Bench erosion, succession to conifer	On south terrace above Sullivan creek
18	RDT	POPBAL	POPBAL	BETPAP		60	5		SYMALB	CORSER	CORCOR	20	15	5	Wildlife and beaver browse,	
19	RDT	POPBAL	POPBAL			35			CORSER	SYMALB	ALNVIRS	35	35	20	Beaver and wildlife browse severe, changes in hydrology	Large single stem alder stand in the POPBAL forest
20	PSS	CORSER	BETPAP			3			CORSER	ALNVIRS	SYMALB	50	25	20	Upslope hydrology, bench erosion, human activities (road, garbage)	Steep slope on bench above reservoir, upslope seeps, road prism, garbage
21	PSS	CORSER	BETPAP			20			CORSER	ALNVIRS	SYMALB	30	30	30	Upslope hydrology, bench erosion, invasives	Steep slope on bench above reservoir, upslope seeps, road prism, garbage
22a	RS	ALNVIRS	POPBAL			5			ALNVIRS	CORSER	SPIDOU	50	40	15	Upslope hydrology, reservoir fluctuations (on lower elevations), beaver damage moderate,	
22b	RDT	POPBAL	POPBAL			40			ALNVIRS	SPIDOU	CORSER	40	30	15	Upslope hydrology changes	Narrow line of POPBAL between shrubs and conifer forest, many seeps
23a	PSS	SALLUC							SALLUC	CORSER	ALNVIRS	35	15	15	Invasives, Beaver, water fluctuations	Artificial environment: berm around sewage ponds.
23b	PFO	POPBAL	POPBAL			60			SYMALB	SPIDOU	CRADOU	20	15	10	Human activities (eg., mowed POPBAL saplings)	
24a	PSS	CORSER	POPBAL	PINPON		8	5		CORSER	CRADOU	SYMALB	25	25	20	Reservoir water level, invasives (reed canary grass)	

Table A.1-1, continued…

Polygon Number	Vegetation Classification	Dominant Species	Dominant Tree No. 1	Dominant Tree No. 2	Dominant Tree No. 3	Cover Tree No. 1	Cover Tree No. 2	Cover Tree No. 3	Dominant Shrub No. 1	Dominant Shrub No. 2	Dominant Shrub No. 3	Cover Shrub No. 1	Cover Shrub No. 2	Cover Shrub No. 3	Threats	Comments
24b	RS	SALLUC	POPBAL			5			SALLUC	SALPRO	SALEXI	20	20	15	Stream fluctuations, reservoir fluctuations, human activities (in park)	Along Linton Creek outlet.
25	RDT	POPBAL	POPBAL			60			SALEXI	SALPRO		5	5		Mowing, recreation	In park, saplings and seedlings at edges are mowed
26	RDT	ALNINC	POPBAL			5			ALNINC	SYMALB		80	60		Human activities, changes in stream hydrology	
27	PSS	SALEXI	POPBAL			8			SALEXI	CORSER	ROSWOO	20	5	5	Recreation, erosion, reservoir fluctuation, browse	On soil bench above gravel rivers edge. SALEXI at edge of bench with exposed roots due to erosion
28	PFO	CORSER	POPBAL			40			CORSER	ROSWOO		50	20		Human activities	
29	PSS	CORSER							CORSER			80			Invasives	
30	PSS	CORSER							CORSER			75			Invasives, beaver, browse	
31	PSS	CORSER							CORSER			75			Invasives, beaver, browse	
32	PSS	CORSER							CORSER			75			Invasives, beaver, browse	
33	PSS	CORSER							CORSER			75			Invasives, beaver, browse	
34a	PSS	SALPRO							SALPRO	ALNVIRS	CORSER	55	35	25	Browse, especially along edges, beaver	portion is ALNSIN forest (single stem), rest is SALIX thicket
34b	PSS	CORSER							CORSER	ALNVIRS		50	10		Browse, reservoir level	
35	PFO	ALNVIRS	POPBAL			35			ALNVIRS			50			Heavy browse, weeds	
36	PFO	POPBAL	POPBAL			65			CORSER			45			Human activity (road in stand)	
37	PFO	POPBAL	POPBAL			50			CORSER			25			Browse moderate, Human activity (road in stand)	
38	RS	CRADOU	POPBAL			2			CRADOU	SALSIT	CORSER	30	25	10	Invasives, changes in stream hydrology	CRADOU at top of bank only
39	PSS	SYMALB	POPBAL			10			SYMALB	CORSER	CRADOU	30	25	25	Dense invasives (reed canary grass and thistle)	
40	RS	CORSER	POPBAL			3			CORSER	SALSIT	SALPRO	60	50	15	Heavy browse, Change in upslope stream hydrology, Reservoir influence on west end	Area closer to river may be influenced by reservoir
41	PFO	POPBAL	POPBAL			30			CORSER	SYMALB	CRADOU	20	15	10	Young conifers encroaching, erosion of bench	Stand at top of bench, young POPBAL on sides of bench. Stream flood may erode bench; succession from above appears to favor conifers.
42a	PFO	POPBAL	POPBAL	BETPAP		60	5		CORSER	CRADOU	SYMALB	50	35	15	Browse, reed canary grass	
42b	PSS	SYMALB	BETPAP	POPTRE		5	3		SYMALB	CRADOU	CORSER	60	40	25	Browse moderate, reed canary grass	
42c	PSS	SYMALB							SYMALB	CRADOU	CORSER	80	55	30	Browse moderate, reed canary grass	
43	PSS	CORSER							CRADOU	CORSER	SYMALB	35	30	10	Invasives, erosion on shore side	
44a	PFO	SYMALB	POPTRE	POPBAL		60	5		SYMALB	CORSER	BERAQU	70	15	10	POPBAL severely browsed, invasives	
44b	PSS	CRADOU	POPBAL	POPTRE		3	3		CRADOU	SYMALB		15	5		POPBAL severely browsed, POPTRE browsed less than POPBAL; invasives	Succession to POPTRE as browse appears to be more severe on POPBAL.
44c	PSS	CRADOU	POPBAL	POPTRE		5	5		CRADOU	CORSER	SYMALB	40	25	10	Browse, invasives	
44d	PFO	SYMALB	POPBAL	POPTRE		40	5		SYMALB	CRADOU	CORSER	70	15	10	Browse, especially young POPBAL, reed canary grass	
44e	PFO	POPBAL	POPBAL			20									Reed canary grass, browse	POPBAL seedlings and saplings in grass; area without the dense reed canary grass nearby; some heavily browsed, others not
44f	PSS	SYMALB	POPBAL	POPTRE		8	8		SYMALB	CRADOU	CORSER	10	5	5	Heavy browse	Heavy browse
45	PSS	SYMALB	POPBAL			10			SYMALB	CRADOU	CORSER	50	35	10	Heavy browse on POPBAL young and CORSER	
46	PSS	SYMALB	POPBAL	POPTRE		8	2		SYMALB	CRADOU	CORSER	20	15	3	Heavy browse	
47	PFO	SYMALB	POPBAL	POPTRE	PINMON	35	10	5	SYMALB	CORSER	SPIDOU	85	5	5	Browse, succession to conifer	POBA young grazed severely; Few become tall saplings; more young conifer
48	PSS	CRADOU							CRADOU	SYMALB	ALNVIRS	80	75	5	Invasives (reed canary grass and knapweed)	
50	PSS	SYMALB							SYMALB	CRADOU	CORSER	70	60	5	Dense reed canary grass	
51a	PSS	CRADOU							CRADOU	SYMALB	CORSER	50	20	15	Dense reed canary grass	On 5-foot bench above river
51b	PFO	SYMALB	POPBAL			40			SYMALB	CRADOU	SORSER	40	30	20	Dense reed canary grass	
52	PSS	CRADOU							CRADOU	SYMALB	CORSER	50	20	15	No access; from water appears similar to 51a so used that data	

Table A.1-1, continued…

Polygon Number	Vegetation Classification	Dominant Species	Dominant Tree No. 1	Dominant Tree No. 2	Dominant Tree No. 3	Cover Tree No. 1	Cover Tree No. 2	Cover Tree No. 3	Dominant Shrub No. 1	Dominant Shrub No. 2	Dominant Shrub No. 3	Cover Shrub No. 1	Cover Shrub No. 2	Cover Shrub No. 3	Threats	Comments
53	PFO	SYMALB	POPBAL			40			SYMALB	CRADOU	CORSER	40	30	20	No access; from water appears similar to 51b so used that data	
54	PSS	SALEXI	POPBAL			1			SALEXI	CORSER		20	5		Moderate browse, periodic flooding/scouring	
55	PSS	SYMALB	POPBAL	POPTRE		8	2		SYMALB	CRADOU	CORSER	20	15	3		No access: from water appears similar to 46 so that data was used.
56a	PSS	POPBAL	POPBAL			10			CORSER			5				Seedlings and saplings, beginning of new stand in less dense grass area adjacent to mature stand
56b	PFO	POPBAL	POPBAL			60			SYMALB	CRADOU	CORCOR	65	10	10	Human activities (old road bisects stand)	young are along the road and in new stand POPBAL establishing in low area to east - seedlings and saplings'
56c	PSS	SALEXI	POPBAL			5			SALEXI	CORSER	SALLUC	15	10	5	Reservoir water level, flood events, reed canary grass	
56d	PFO	POPBAL	POPBAL			75			CORSER			5			Human activities (south end has dumped cement)	
58	PFO	POPBAL	POPBAL			35									Water level fluctuations, browse, Human activities (road, construction evident)	Wide variety of POPBAL ages
59	PSS	SALEXI							SALEXI	CORSER		50	20		Heavy beaver activity	
60	PSS	CORSER							CORSER	SALPRO		15	10		Flooding, scouring; browse; reed canary grass in areas	
61a	PSS	SALEXI	POPBAL			1			SALEXI	CORSER	SALPRO	25	25	15	Flooding, scouring;	
61b	PSS	SALEXI							SALEXI	CORSER		15	15		Flooding, scouring; beaver	
62	PSS	SALPRO							SALPRO	CORSER	SALEXI	8	5	5	Flooding, scouring; beaver	
63	PSS	CORSER							CORSER	CRADOU	SYMALB	70	25	10	Human activities (on and below highway)	
64	PFO	POPBAL	POPBAL	BETPAP		60	5		CORSER	ALNVIRS	AMAALN	25	5	5	Human activities (on road fill and below), erosion	Very steep area leading up to road to Box Canyon Dam, partially road rip rap
65	PSS	SALEXI	POPBAL			2			SALEXI			5			Flooding, scouring; beaver	Area is cobble beach where Salix and cottonwood established a few plants; beaver activity and hydrology likely prevent further growth and more establishment

Table A.1-1, continued…

Polygon Number	Tree Layer Cover	Tree Layer Height	Shrub Layer No. 1 Cover	Shrub Layer No. 1 Height	Shrub Layer No. 2 Cover	Shrub Layer No. 2 Height	Mature Cottonwood Pre-Dam age	Mature Cottonwood Post-Dam age	Seedlings % of Cotton-wood	Saplings % of Cotton-wood	Mature % of Cotton-wood	Decadent or Dead % of Cotton-wood	Snag % of Cotton-wood	Age (from Tree Cores) or estimated age (years)	Substrate [4]	Acres
Rip_Veg	Tree_lay_cov	Tree_lay_hgt	ShrLay1_Cov	ShrLay1_Hgt	ShrLay2_Cov	ShrLay2_Hgt	MatCOT predm	MatCOTpstdm	COT_seed	COT_sap	COT_mature	COT_decad	COT_sng		Substrate	acres
1	10	50	75	10											CGF	2.3
2	30	50	5	3			N	Y	5	10	85	0	0	Less than 45 years – wide size range	SCG	0.2
3	2	2	2	2											SCG	0.7
4	5	30	60	15	50	6									F	0.4
5a			65	15	50	4									CF	0.1
5b			75	18	50	4									F	0.2
6			30	4											F	0.0
7a	1	2	30	4											F	0.0
7b	6	4	50	4											F	0.1
8	5	30	55	6											F	0.2
9			80	10	10	3									CF	0.1
10a			70	10											F	0.0
10b			70	10	15	3									F	0.2
11	2	5	30	5											GF	0.4
12																0.1
13																0.2
14	5	60	30	10	60	4	Y	N							GF	0.6
15a	5	5	60	5			N	N							CGF	1.4
15b	15	5	90	8			N	N							SCGF	0.3
15c	5	3	80	9			N	N							GF	2.5
15d	8	20	80	20	25	7	N	N							GF	0.3
16			75	10											F	4.6
17	30	80	50	12	20	3	Y	Y	0	10	75	10	5	Mature Trees wide size range: 12 - 50 in DBH	GF	0.9
18	60	60	30	4	15	8	N	Y	0	20	80	0	0	20, 22	F	1.9
19	35	70	60	10	35	3	Y	N	25	5	50	0	10	Trees large: 38 - 54 in DBH - 2 saplings and many shrubbed young	F	4.4
20	3	25	80	13	30	3	N	N							CF	0.8
21	20	30	85	10	30	5									F	0.3
22a	5	5	90	10	5	5	N	N							F	4.8
22b	40	70	40	15	50	5	Y	Y	10	50	25	5	10		F	0.5
23a			35	35	30	12	N	N							F	1.5
23b	65	70	25	15	45	5	Y	Y	5	15	80	0	0	53, 35, 65, 19, 26, 22, 28	F	2.5
24a	10	40	50	10	30	5	N	N	0	0	100	0	0		F	1.1
24b	5	10	30	10	35	5	N	N						60, 53, 17	F	0.6
25	60	45	10	6			N	Y	30	40	30	0	0	22, 23	F	0.2
26	5	30	90	20	65	5	N	Y						24	F	1.0
27	8	5	5	10	35	6	N	N							CGF	0.2
28	40	60	50	10	20	4	N	Y	0	50	45	0	5	20,23	F	0.6
29			80	10											F	0.4
30			75	10											F	2.0
31			75	10											F	0.1
32			75	10											F	0.1
33			75	10											F	0.7
34a			100	12											F	1.7
34b			70	10	7	4	N	N							F	0.6
35	35	70	50	25	10	10	Y	Y	5	0	90	5	0	31, 62, 51	F	1.4

Table A.1-1, continued…

Polygon Number	Tree Layer Cover	Tree Layer Height	Shrub Layer No. 1 Cover	Shrub Layer No. 1 Height	Shrub Layer No. 2 Cover	Shrub Layer No. 2 Height	Mature Cottonwood Pre-Dam age	Mature Cottonwood Post-Dam age	Seedlings % of Cotton-wood	Saplings % of Cotton-wood	Mature % of Cotton-wood	Decadent or Dead % of Cotton-wood	Snag % of Cotton-wood	Age (from Tree Cores) or estimated age (years)	Substrate	Acres
36	65	8	45	10			N	N	0	100	0	0	0	Dense saplings stand; too young to core	CGF	0.6
37	50	50	25	6			Y	Y	5	35	60	0	0	28,96	F	0.7
38			40	10	30	5	N	Y							F	0.3
39	10	60	75	12	30	5	Y	Y							F	1.2
40	3	5	90	10	10	5	N	N							CGF	2.0
41	30	70	35	5	15	10	Y	N	15	20	50	10	5	35 years at 20 in dbh; Wide size range 5” to 40” dbh	F	0.5
42a	60	70	35	15	65	7	Y	Y	50	25	20	0	5		F	1.7
42b	5	40	60	4	65	25									F	2.0
42c			90	5	80	10									F	0.6
43			65	11	10	4									F	0.3
44a	60	75	70	4	15	8	N	N							F	0.6
44b	5	3	15	12	10	4	N	N							F	0.6
44c	10	3	40	12	25	8	N	N							F	0.8
44d	40	70	70	4	20	10	N	Y	0	30	70	0	0		F	9.2
44e	20	4					N	N	10	90	0	0	0		F	0.3
44f	15	4	10	10	10	4	N	Y							F	0.4
45	10	20	60	5	35	12	N	Y							F	0.7
46	10	70	25	4	15	12	Y	N	0	5	65	0	30		F	5.0
47	45	80	85	5	10	7	Y	N	1	10	80	1	10	67, 66	F	20.6
48			80	12	75	5									F	0.3
50			75	5	60	15									F	0.5
51a			65	10	25	4									F	0.2
51b	40	70	50	12	40	5	Y	N	25	25	50	0	0	78	F	0.3
52			65	10	25	4									F	0.5
53	40	70	50	12	40	5	Y	N	25	25	50	0	0	No access	F	1.1
54	1	3	25	4			N	N							SCF	0.4
55	10	70	25	4	15	12	Y	N	0	5	90	0	5		F	1.3
56a	10	5	5	1			N	N							F	0.2
56b	60	60	70	5	20	10	Y	Y	0	10	75	5	10	43, 60, 92	F	1.2
56c	5	4	25	5			N	N							CGF	1.4
56d	75	8	5	5			N	N	20	80	0	0	0	All saplings; too young to core	F	0.4
58	35	35					Y	Y	50	8	40	1	1	54, 46, 46, 35, 30, 54, 37, 40, 20	CGF	3.7
59			70	6											CF	0.1
60			25	7											SCF	0.7
61a			65	6			N	N							SCF	1.1
61b			30	2											CGF	0.3
62			20	5											CGF	0.6
63			95	13	15	4									F	0.2
64	65	50	35	7	10	5	N	Y	15	5	80	0	0	26, 23, 28, 40,	CF	0.4
65	2	1	5	1			N	N							CGF	0.2

Notes:

Field data collected through September 2007 as described in Section 4 of the report. These data are the source of the summary tables in the report.

1 Vegetation classification abbreviations: RS = Riparian shrub, RDT = Riparian deciduous tree, PSS = Palustrine scrub shrub, PFO = Palustrine forest, US = Upland shrub, REM = Riparian emergent.

2 Tree species abbreviations: POPBAL = *Populus balsamifera* ssp. *trichocarpa*, POPTRE = *Populus tremuloides*, BETPAP = *Betula papifera*, PINPON = *Populus ponderosa*, ABIGRA = *Abies grandis*, THUPLI = *Thuja plicata*.

3 Shrub species abbreviations: ACEDOU = *Acer douglasia*, ALNVIRS = *Alnus viridis* ssp. *sinuata* [was *A. sinuate*], ALNINC = *Alnus incana*, *Berberis aquifolium* [syn. *Mahonia aquifolium]*, CRADOU = *Crataegus douglasii*, CORSER = *Cornus sericea, BERAQU*], *PHILEW* = *Philadelphus lewisii*, RUBPAR = *Rubus parviflorus* , SALLUC = *Salix lucida* ssp. *lasiandra*, SALEXI = *Salix exigua* [including *S. melanopsis*], SALSIT = Salix Sitchensis, SALPPRO = *Salix prolixa*, SPIDOU = Spiraea douglasia, SYMALB = *Symphoricarpos albus.*

4 Substrate abbreviations: C = Cobble, G = Gravel, F = Fines, S = Stones.