Susitna-Watana Hydroelectric Project
(FERC No. 14241)

Riparian Vegetation Study Downstream of the Proposed Susitna-Watana Dam

Study Plan Section 11.6

2014–2015 Study Implementation Report

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

ABR, Inc.—Environmental Research & Services

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LIST OF ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

Abbreviation	Definition
ABR	ABR, Inc.—Environmental Research & Services
AEA	Alaska Energy Authority
ELS	Ecological Land Survey
FA	Focus Area
FERC	Federal Energy Regulatory Commission
IFS	Instream Flow Study
ISR	Initial Study Report
ITU	Integrated Terrain Unit
PM&E	protection, mitigation, and enhancement
PRM	Project River Mile
Project	Susitna-Watana Hydroelectric Project No. 14241
Q1, Q2, Q3, Q4	first quarter, second quarter, third quarter, and fourth quarter of the annual year
R2	R2 Resource Consultants, Inc.
Riparian IFS	Riparian Instream Flow Study
RSP	Revised Study Plan
SIR	Study Implementation Report
SPD	study plan determination
TWG	Technical Workgroup
UK	United Kingdom
USR	Updated Study Report

1. INTRODUCTION

This Riparian Vegetation Study Downstream of the Proposed Susitna-Watana Dam (Riparian Vegetation Study), Section 11.6 of the Revised Study Plan (RSP) approved by the Federal Energy Regulatory Commission (FERC) for the Susitna-Watana Hydroelectric Project, FERC Project No. 14241, focuses on characterizing and mapping local-scale riparian ecosystems on the Susitna River downstream of the Project dam site and developing models to describe the natural successional pathways for riparian vegetation along the Susitna River. This baseline information will be used to support the development of a spatially-explicit model to predict potential changes in riparian vegetation due to Project effects; the model will be developed in the Riparian Instream Flow Study (Riparian IFS) as described in the Study Implementation Report (SIR) for Study 8.6.

A summary of the development of this study, together with the Alaska Energy Authority's (AEA) implementation of it through the 2013 study season, appears in Part A, Section 1 of the Initial Study Report (ISR) filed with FERC in June 2014. As required under FERC's regulations for the Integrated Licensing Process, the ISR describes AEA's "overall progress in implementing the study plan and schedule and the data collected, including an explanation of any variance from the study plan and schedule." (18 CFR 5.15(c)(1)).

Since filing the ISR in June 2014, AEA has continued to implement the FERC-approved plan for the Riparian Vegetation Study. For example:

- From September 23 to September 28, 2014, ABR and R2 conducted field work to collect sediment cores for the floodplain sediment stratigraphy component of the Riparian Vegetation Study.
- On October 17, 2014, AEA held an ISR meeting for the Riparian Vegetation Study.
- On November 14, 2014, R2 and ABR posted the *Riparian Vegetation Groundwater / Surface Water Study Sampling Design Technical Memorandum* (R2 and ABR 2014) to the Project SharePoint site (this document is now Appendix A in the SIR for Study 8.6).
- Integrated Terrain Unit (ITU) mapping of riparian ecosystem components in the study area for the Riparian Vegetation Study was continued in 2014 and 2015.

In furtherance of the next round of ISR meetings and FERC's Study Plan Determination (SPD) expected in 2016, this report describes AEA's overall progress in implementing the Riparian Vegetation Study in 2014 and 2015. Rather than a comprehensive reporting of all field work, data collection, and data analysis since the beginning of AEA's study program, this report is intended to supplement and update the information presented in Part A of the ISR for the Riparian Vegetation Study through June 2015. It describes the methods and results of the 2014 and 2015 efforts, and includes a discussion of the results achieved.

2. STUDY OBJECTIVES

As established in the Study Plan, the overall goals of the Riparian Vegetation Study are to prepare maps of existing, local-scale riparian ecosystems (riparian ecotypes), wetlands, and wildlife habitat types in areas downstream from the proposed Project dam site; characterize sedimentation,

vegetation succession, and vegetation-soil-landscape relationships; and coordinate with the Riparian IFS (Study 8.6) and other closely related studies to provide complimentary data products to support the development of a spatially-explicit model to predict potential changes to downstream riparian floodplain vegetation due to Project modifications of flow, sedimentation, groundwater, and ice processes (to be developed in the Riparian IFS; see Study 8.6). This multi-year study was initiated in 2012. Substantial work on the study occurred in 2013 (see ISR Study 11.6) and 2014 (this report). The mapping prepared in this study will be used in the FERC License Application to assess the impacts to riparian ecotypes, wetlands, and wildlife habitats (see Study 10.19) in areas downstream from the Project dam site, and to develop possible protection, mitigation, and enhancement (PM&E) measures to address any identified effects.

The specific objectives of the Riparian Vegetation Study are to:

- Classify, delineate, and map riparian ecotypes, wetlands, and wildlife habitats downstream from the Watana Dam site;
- Characterize the role of erosion and sediment deposition in the formation of floodplain surfaces, soils, and vegetation using a combination of soil stratigraphic descriptions, sieve analysis, and several complimentary sediment dating techniques;
- Quantify and describe Susitna River riparian vegetation communities using a combination of basic statistical summaries (e.g., basal area, density, stand age) and multivariate statistical techniques (e.g., cluster analysis, ordination, sorted tables), which will be used to develop of a series of conceptual models of floodplain vegetation succession building from those developed by Helm and Collins (1997); and
- Coordinate closely in the implementation of the Riparian IFS (Study 8.6), Groundwater Study (Study 7.5), Ice Processes in the Susitna River Study (Study 7.6), and Fluvial Geomorphology Modeling below Watana Dam Study (Study 6.6) to provide necessary and complimentary data, including vegetation successional models and mapping in support of a spatially-explicit model (to be developed in the Riparian IFS; see Study 8.6) to predict potential impacts to downstream riparian floodplain vegetation due to Project alterations of existing conditions downstream of the Project dam site.

3. STUDY AREA

As established in the Study Plan, the Riparian Vegetation Study is being conducted in riparian areas along the Susitna River below the proposed Project dam site, with the downstream and lateral extents as described below.

The 2013–2014 study area for the Riparian Vegetation Study is illustrated in Figure 3-1; this same study area is being used for the Riparian IFS (Study 8.6), Fluvial Geomorphology Modeling below Watana Dam Study (Study 6.6), and the Groundwater Study (Study 7.5). The study area includes those riparian areas downstream of the Project dam site to a point at which the effects of altered stage and flow effects expected in the Susitna River would not be ecologically significant (i.e., the expected hydraulic alterations would be overridden by the input from other rivers and/or the effects of tidal fluctuations from Cook Inlet). In RSP Section 11.6, the longitudinal extent of the Riparian

Vegetation Study area extended to project river mile (PRM) 75 because existing information at the time the RSP was prepared (2012) indicated that the hydraulic effects of the Project below the Three Rivers Confluence at the Sunshine Gage (PRM 84) showed substantial attenuation, although small hydraulic effects appeared to be detectable as far downstream as the Susitna Station Gage (PRM 26). The final determination of how far downstream Project operational effects would extend was made in Q1 2013 following the completion of the Open-water Flow Routing Model (see ISR Study 8.5). At that time, a Technical Working Group (TWG) meeting was held to discuss the selection of Focus Areas (FAs) and study sites, which included discussion of the downstream extent of the study area for the riparian studies. During the TWG meeting, it was agreed that the downstream extent of the study areas for the riparian studies, including the Riparian Vegetation Study, would extend to Project River Mile (PRM) 29.5, as described in the *Technical Memorandum: Selection of Focus Areas and Study Sites in the Middle and Lower Susitna River for Instream Flow and Joint Research Studies – 2013 and 2014* (March 1, 2013) (R2 2013).

For the 2013 and 2014 work, the lateral extent of the Riparian Vegetation Study area was defined by the extent of the riverine physiographic region generated by the Susitna River. Riverine physiography includes (1) those areas of the valley bottom, including off-channel water bodies, that are directly influenced by regular (0–25 year) to irregular (25–100 year) overbank flooding; and (2) those areas of the valley bottom influenced indirectly by groundwater associated with the Susitna River. In 2012, riverine physiography was mapped by the Riparian Vegetation Study team from the Project dam site to PRM 29.5 (Figure 3-1) by interpretation of image-signatures on high-resolution aerial imagery for the Susitna River. The riverine physiographic map has undergone review and refinement by the principal investigators leading the Riparian Vegetation Study, the Riparian IFS (Study 8.6), and associated physical-processes studies (groundwater [Study 7.5], ice processes [Study 7.6], and fluvial geomorphology [Study 6.6]).

4. METHODS AND VARIANCES IN 2014

This study involves the use of Integrated Terrain Unit (ITU) mapping, which is an integrated approach to mapping landscape elements. ITU mapping is a multivariate mapping process in which terrain unit map boundaries are adjusted by on-screen digitizing over high-resolution aerial photography or satellite imagery so that there is increased coincidence between the boundaries and occurrences of interdependent ITU variables, such as hydrography, geology, physiography, soils, and vegetation units (Jorgenson et al. 2003; 2009). The ITU approach being used to map riparian ecotypes, wetlands, and wildlife habitats is based on methods and concepts developed for Ecological Land Survey (ELS) studies conducted in tundra, boreal forest, and coastal regions in Alaska over the past 15 years (see Jorgenson et al. 2003 for an example study in Southcentral Alaska). The ITU mapping approach for the Riparian Vegetation Study involves mapping terrain units such as vegetation type, balsam poplar size class (e.g., pole, timber, large timber), fluvial geomorphology, and surface-form types. These map data are being combined into units with ecological importance (in this case riparian ecotypes, wetlands, and wildlife habitats). Also based on previous ELS studies in Alaska, a set of field plots are being sampled to collect detailed data on site characteristics, environmental variables, successional vegetation, and soils; a subset of the field plots also are designed for use as permanent, long-term monitoring plots (see ISR Study 11.6, Part A, Section 4.2.5).

For this study, a series of maps will be produced, including maps of the individual terrain units (i.e., geomorphology, surface form, vegetation type, poplar size class), and maps of the aggregated terrain units (i.e., riparian ecotype, wetlands, and wildlife habitat). The mapping of wildlife habitats in the Riparian Vegetation Study is being conducted in coordination with the Vegetation and Wildlife Habitat Mapping Study in the Upper and Middle Susitna Basin (Study 11.5) to derive a seamless map of wildlife habitats that apply Project-wide. Similarly, the mapping of wetlands is being conducted in coordination with the Wetland Mapping Study in the Upper and Middle Susitna Basin (Study 11.7) so that wetlands in the Riparian Vegetation Study area can be similarly classified; this process will result in a single Project-wide wetland map.

4.1. Develop Mapping Materials from Historical and Current Data

The methods for developing mapping materials, as described in the Study Plan, were previously implemented in 2013 with no variances (see ISR Study 11.6, Part A, Section 4.1).

4.1.1. Variances

In 2014, there were no variances from the protocols described in the Study Plan to develop mapping materials from historical and current data.

4.2. Field Surveys

Only limited field surveys for the collection of soil cores for sediment aging analyses were conducted in 2014 (see Sections 4.2.2 and 4.2.4 below). The methods for the field surveys in 2014 were implemented as described in the Study Plan and in more detail in the ISR (Study 11.6, Part A, Sections 4.2.2 and 4.2.4) with no variances.

4.2.1. Plot Allocation Procedures

4.2.1.1. ELS Plots

No ELS plots were sampled in 2014 and therefore no plot allocation procedures were used.

4.2.1.2. ITU Mapping Plots

Vegetation data for 18 new ITU mapping plots were collected in 2014 in association with the soil core collection work (see Section 4.2.4 below).

4.2.1.3. Variances

No variances from the plot-allocation procedures described in the Study Plan and modified in the ISR (Study 11.6, Part A, Section 4.2.1) occurred in 2014.

4.2.2. Floodplain Sediment Stratigraphy Study

In 2014, the field methods for the floodplain sediment stratigraphy study were implemented as described in the Study Plan and in more detail in the ISR (Study 11.6, Part A, Section 4.2.2) with no variances. Field work was conducted from September 23–30 to collect soil cores for sediment

aging and stratigraphic analysis. Twenty-five soil stratigraphy cores were sampled in riparian areas of the Susitna River between PRM 105 and 146 (Figure 4.2-1). Seven of the 25 sediment stratigraphy plots were co-located with previously sampled ELS plots as described in the ISR (Study 11.6, Part A, Section 4.2.1.1). The other 18 sediment stratigraphy plots were sampled in conjunction with ITU mapping plots (see Section 4.2.4 below).

4.2.2.1. Variances

There were no variances from the methods described in the Study Plan and the ISR (Study 11.6, Part A, Section 4.2.2) for the floodplain sediment stratigraphy study.

4.2.3. Surface Elevation

In 2014, no surface elevation data were collected.

4.2.4. Sampling of ITU Mapping Plots

In 2014, 18 new ITU mapping plots were sampled in association with the soil core collection work described above in Section 4.2.2. Because the soil core collection work took place late in the growing season (September), only vegetation structure, plant community composition, and percent cover data for the dominant plant species were recorded at each ITU mapping plot. This does not constitute a variance in the methods for the sampling of ITU mapping plots as described in the Study Plan. Rather, in this case the field team simply acquired additional data on the vegetation present at each soil core collection site.

4.2.4.1. Variances

In 2014, there were no variances from the sampling methods for ITU mapping plots as described in the Study Plan.

4.2.5. Sampling of ELS Plots

No ELS plots were sampled in 2014.

4.3. ITU Classification and Mapping of Downstream Riparian Areas

4.3.1. ITU Classification

In 2014, no additional ITU classification work occurred beyond what was reported in the ISR (Study 11.6, Part A, Section 4.3.1). The final classification of riparian ecotypes, wetlands, and wildlife habitats in riparian areas downstream of the proposed Watana Dam will be conducted after completion and finalization of the ITU mapping.

4.3.2. ITU Mapping

In 2014, the study team continued the ITU mapping work in the study area, and this work has continued in 2015 as well. The methods for ITU mapping in 2014 and 2015 were implemented as

described in the Study Plan with no variances. Current and high-resolution imagery is available to support the ITU mapping work throughout the full study area.

4.3.2.1. Variances

In 2014, there were no variances from the procedures described in the Study Plan for ITU classification and ITU mapping.

5. RESULTS

The cumulative, error-corrected field data collected for this study in 2012, 2013, and 2014 are available at:

http://gis.suhydro.org/SIR/11-Botanical/11.6-Riparian/

See Table 5.1-1 for details.

There were no additional ELS plots sampled in 2014. In September 2014, 18 ITU mapping plots were sampled and 25 sediment cores were collected and described (Figure 4.2-1). The 25 sediment core sampling sites were co-located with 18 ITU mapping and 7 ELS plots. The 7 ELS plots were previously sampled in 2013 for vegetation composition and general soils data (Figure 3-1). The 18 new ITU plots were added in 2014 to provide vegetation data for the 18 additional sites at which sediment cores were sampled.

The 25 sediment cores have been sent to the Department of Geography, University of Exeter, in the UK for ^{210}Pb and ^{137}Cs analyses. Laboratory analyses have not been completed. Sediment isotope laboratory results from the 2014 soil cores will be used to quantify floodplain sediment deposition over the last century.

In 2014 and 2015, substantial progress was made towards completing the ITU mapping for this study. As of June 30, 2015, draft ITU map polygons had been completed for 98 percent of the study area.

6. DISCUSSION

The field data collection efforts and the mapping prepared in 2014 were conducted as planned and described in the Study Plan. Substantial progress has been made in completing the ITU mapping in the Upper, Middle, and Lower River portions of the study area. Additional ITU field data are needed to proof and QC the mapping in the Upper River portion of the study area. The progress of the study to date is sufficient to meet the study objectives with an additional year of field data collection, ITU mapping, and the classification of ecotypes, wetlands, and wildlife habitat types for riparian areas of the Susitna River. When the mapping of riparian ecotypes is complete, the modeling of natural successional pathways for riparian vegetation in the Susitna River floodplain downstream of the proposed Watana Dam, and the collaboration with researchers for the Riparian IFS (Study 8.6) on the modeling of post-development riparian vegetation change, will be conducted.

7. CONCLUSION

In combination, the ITU mapping work and the final field surveys to be completed; the derivation of riparian ecotypes, wildlife habitats, and wetland types; the modeling of natural riparian vegetation successional pathways; and the modeling of riparian change in collaboration with the Riparian IFS (Study 8.6) will be adequate to meet the Study Plan objectives. Substantial progress was made in 2014 and early 2015 in mapping ITU variables (the study area is 98 percent mapped). As described above, once the field work and ITU mapping are completed, the final elements of the study will be performed and reported in the Updated Study Report.

7.1. Decision Points from Study Plan

There were no decision points in the FERC-approved Study Plan to be evaluated for this study following the completion of 2014 work.

7.2. Modifications to the Study Plan

After preparation of the ISR for this study in June 2014, one modification was developed for implementation during completion of this study:

In response to agency comments during the October 17, 2014 ISR meeting concerning the Project riparian studies, the Riparian IFS and Riparian Vegetation Study teams prepared a revised design for the co-located sampling of groundwater/surface water and riparian vegetation (see the *Riparian Vegetation Groundwater / Surface Water Study Sampling Design Technical Memorandum* [R2 and ABR 2014; now Appendix A in the SIR for Study 8.6] for more details). The revised design calls for the additional sampling of rapid vegetation transects (RVTs) to be established in four FAs in the Middle River and along four riparian transects in the Lower River at which there are groundwater/surface water (GW/SW) transects and groundwater wells. In addition to co-located ELS plots and groundwater wells (RSP Section 11.6.4.2.4), to collect vegetation data along the full length of GW/SW transects, a minimum of five RVTs will be sampled in each mapped riparian ecotype along each GW/SW transect. The RVTs will be evenly distributed along elevation gradients within each ecotype, as determined by a digital elevation model derived from Light Detection and Ranging (LiDAR) data for the GW/SW transects. Sampling along RVTs will involve the same point-intercept sampling procedures used on ELS plots (see ISR Study 11.6, Part A, Section 4.2.5) but the RVTs will be smaller in size (25 m [82 ft] in length) and will be oriented perpendicular to each GW/SW transect. The additional data from the RVTs will be combined with those from the ELS plots to model plant frequency response curves along GW/SW gradients as described by Henszey et al. (2004). This modification will assist in achieving the study objectives by increasing the confidence in characterizing the relationship between GW/SW gradients and plant community composition in the study area (to be developed in Study 8.6). The modification also will provide more data for use in modeling the predicted changes in riparian vegetation due to alterations in GW/SW gradients as a result of Project development.

8. LITERATURE CITED

Helm, D. J., and W. B. Collins. 1997. Vegetation succession and disturbance on a boreal forest floodplain, Susitna River, Alaska. *Canadian Field-Naturalist* 111:553–566.

Henszey, R. J., K. Pfeiffer, and J. R. Keough. 2004. Linking surface and ground-water levels to riparian grassland species along the Platte River in Central Nebraska, USA. *Wetlands* 24: 665-687.

Jorgenson, M. T., J. E. Roth, S. F. Schlentner, E. R. Pullman, M. J, Macander, and C. H. Racine. 2003. An ecological land survey for Fort Richardson, Alaska. Technical Report Development Center, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire.100 pp.

Jorgenson, M. J., J. E. Roth, P. F. Miller, M. J. Macander, M. S. Duffy, A. F. Wells, G. V. Frost, and E. R. Pullman. 2009. An ecological land survey and landcover map of the Arctic Network. Natural Resource Report NPS/ARCN/NRTR—2009/270. National Park Service, Fort Collins, Colorado. 307 pp.

R2 (R2 Resource Consultants, Inc.). 2013. Technical Memorandum: Selection of Focus Areas and Study Sites in the Middle and Lower Susitna River for Instream Flow and Joint Research Studies – 2013 and 2014. March 1, 2013. Prepared for the Alaska Energy Authority by R2 Resource Consultants, Inc., Anchorage, Alaska.

R2 and ABR (R2 Resource Consultants, Inc., and ABR, Inc.—Environmental Research & Services). 2014. Riparian Vegetation Groundwater / Surface Water Study Sampling Design Technical Memorandum. November 14, 2014. Prepared for the Alaska Energy Authority by R2 Resource Consultants, Inc., and ABR, Inc.—Environmental Research & Services, Anchorage and Fairbanks, Alaska.

9. TABLES

Table 5.1-1. Server Location and File/Folder Names for the Riverine Vegetation Study Field Data Collected in 2012–2014.

Server Pathway or File/Folder Name	Description
http://gis.suhydro.org/SIR/11-Botanical/11.6-Riparian/	Pathway to data files.
11_6_RIPR_Cumulative_Data_ABR.zip	Zip file containing ELS plot, ITU mapping plot, and soils data in a Microsoft Access database, and a geodatabase of GIS data layers for the Riverine Vegetation Study.
Photos (folder)	Field (JPEG) photos organized in subfolders as follows: ELS and ITU mapping plot photos in 2012 (12-174.3_ELS_plots) and 2013 (13-174.3_ELS_plots), intensive ELS plot photos in 2013 (13-174.3_Intensive_plots), soil profile photos in 2013 (FA104_TR 1_soil_profile and FA104_TR 2_soil_profile), and sediment core sampling photos in 2013 and 2014 (renamed_sediment_core_photos). Each photo is labeled with the sample plot number (see the Access database which links to each photo).

10. FIGURES

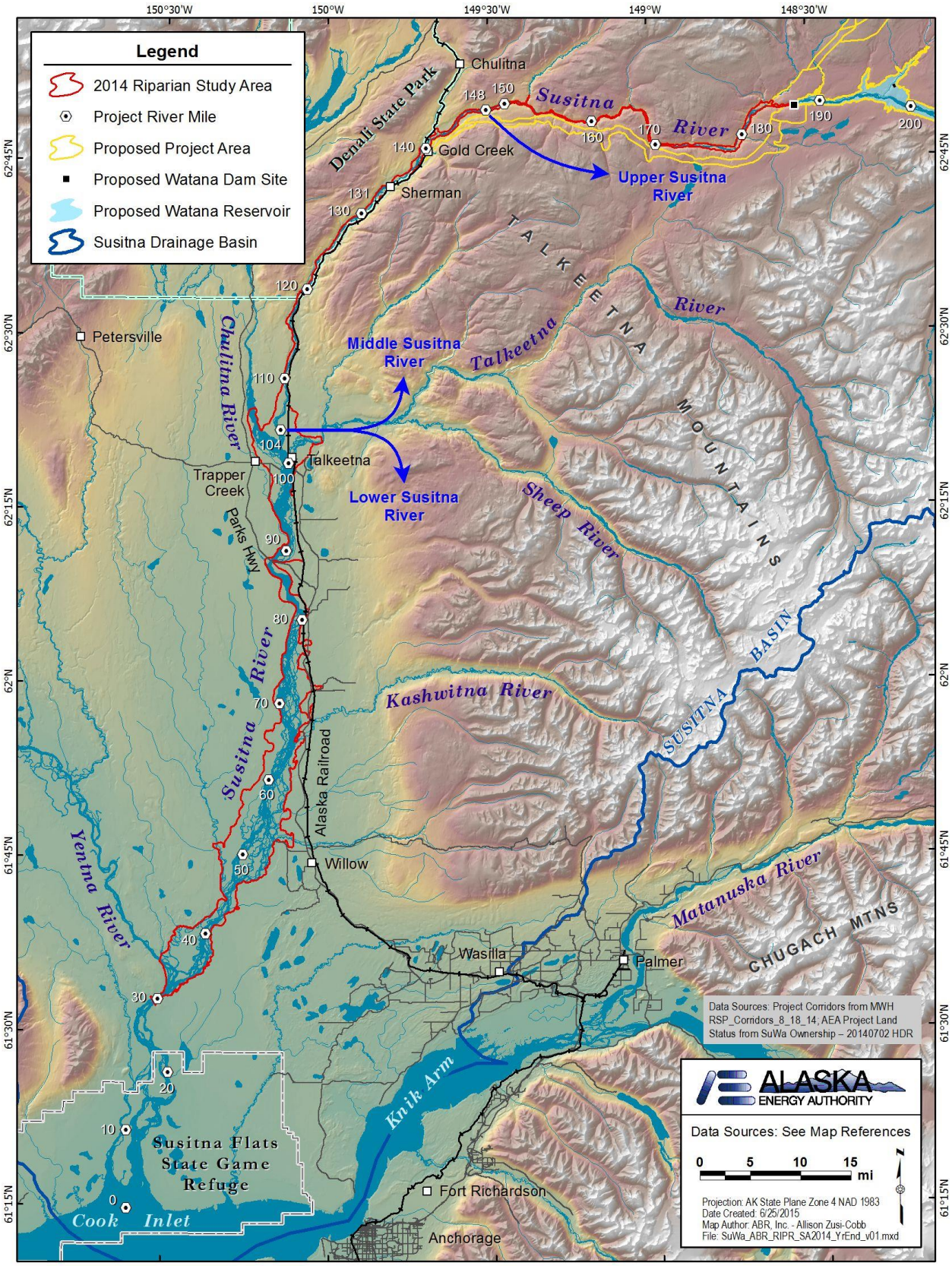

Figure 3-1. Study Area for the Riparian Vegetation Study, Susitna-Watana Hydroelectric Project, 2014.

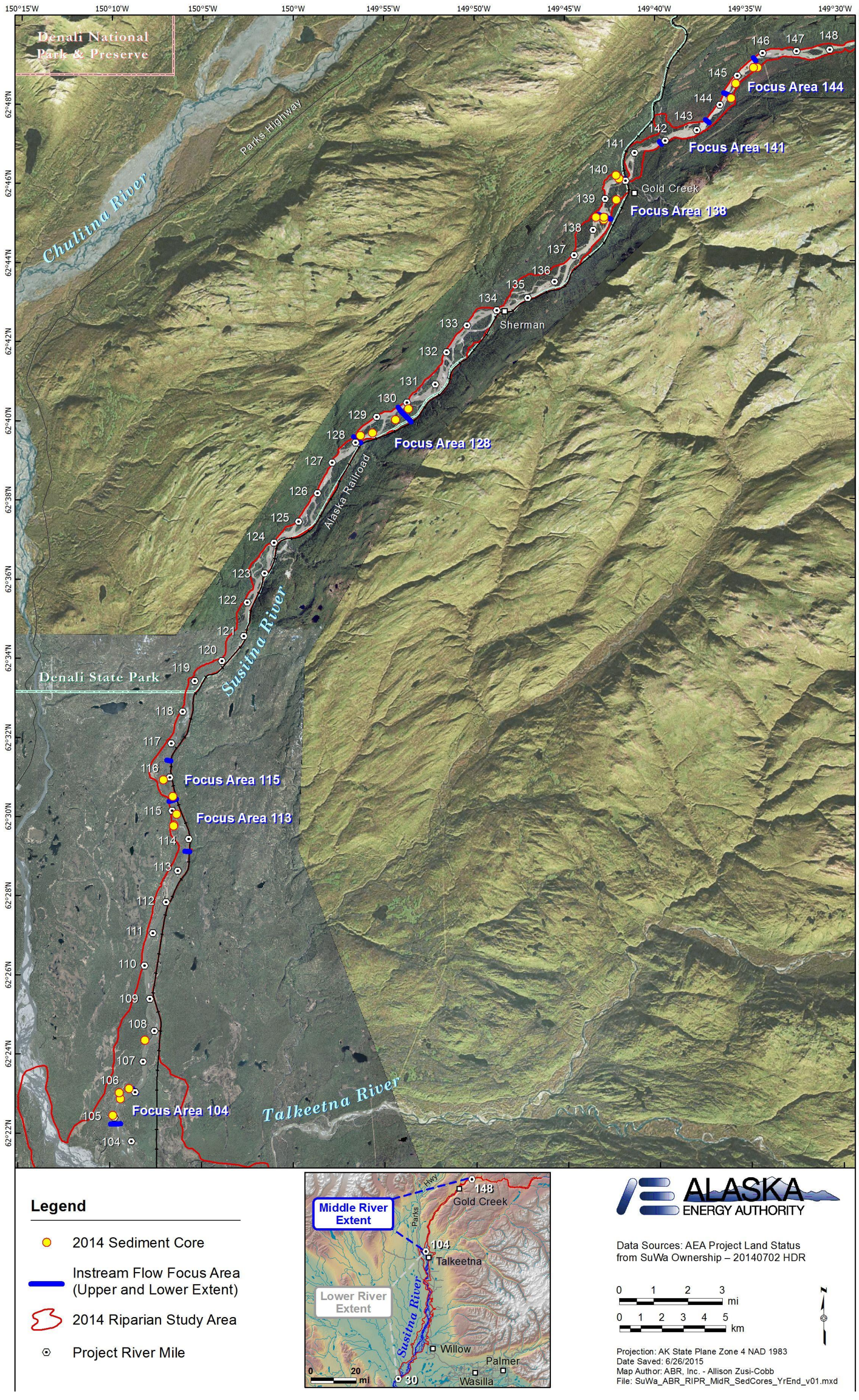

Figure 4.2-1. Sediment Core Sampling Locations, Riparian Vegetation Study, Susitna-Watana Hydroelectric Project, 2014.