Susitna-Watana Hydroelectric Project
(FERC No. 14241)

Riparian Vegetation Study Downstream of the Proposed Susitna-Watana Dam
Study Plan Section 11.6

Final Study Plan

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

July 2013

11.6. Riparian Vegetation Study Downstream of the Proposed Susitna-Watana Dam

On December 14, 2012, Alaska Energy Authority (AEA) filed with the Federal Energy Regulatory Commission (FERC or Commission) its Revised Study Plan (RSP), which included 58 individual study plans (AEA 2012). Included within the RSP was the Riparian Vegetation Study Downstream of the Proposed Susitna-Watana Dam, Section 11.6. RSP Section 11.6 focuses on providing an understanding of the local scale riparian ecosystem on the Susitna River downstream of the Project dam site. This baseline information will support the development of a spatially-explicit model to predict potential changes in riparian vegetation due to Project effects.

On February 1, 2013, FERC staff issued its study determination (February 1 SPD) for 44 of the 58 studies, approving 31 studies as filed and 13 with modifications. On April 1, 2013 FERC issued its study determination (April 1 SPD) for the remaining 14 studies; approving 1 study as filed and 13 with modifications. RSP Section 11.6 was one of the 13 approved with modifications. In its April 1 SPD, FERC recommended the following:

Sampling Scheme

> *- We recommend that AEA consult with TWG on the sampling design for vegetation sampling within and outside the focus areas, and file no later than June 30, 2013, the following information:*
>
> > *1) A detailed sampling design, including a schematic of the sampling scheme for each focus area, the stratification factors, and basis for the number of plots within and outside the focus areas.*
> >
> > *2) Documentation of consultation with the TWG, including how its comments were addressed.*

Consultation on the interrelated riparian vegetation, riparian instream flow and riparian groundwater/surface water (GW/SW) study plans was accomplished with TWG representatives in two meetings; held April 23, 2013 and June 6, 2013. Licensing participants were provided the opportunity to address technical details and comments and concerns regarding the study's approaches and methods.

The Riparian Instream Flow, Groundwater, and Riparian Vegetation Studies FERC Determination Response Technical Memorandum (Riparian/GW TM) addresses FERC's April 1 SPD request concerning sampling design for vegetation sampling within and outside the Focus Areas. The Riparian/GW TM was filed with FERC on July 1, 2013. The information regarding RSP Section 11.6 in the Riparian/GW TM has been incorporated into the Final Study Plan, and the documentation of consultation with the TWG regarding that information is presented in the Riparian/GW TM.

11.6.1. General Description of the Proposed Study

The Riparian Vegetation Study Downstream of the Proposed Susitna-Watana Dam includes three primary components. First, AEA will identify, characterize, and map existing riparian (successional) vegetation, wetlands, and wildlife habitat types in riparian areas along the Susitna River downstream from the proposed Project dam site. Existing vegetation mapping will involve both a field effort (to ground-truth the photosignatures on the aerial photography and remote-

sensed imagery to be used in the mapping), and an office-based effort to map riparian vegetation, wetlands, and wildlife habitats digitally in GIS. This component of the study will be coordinated with the Wetland Mapping Study in the Upper and Middle Susitna Basin (Section 11.7) so as to apply the same classification scheme for wetlands mapped in the riparian vegetation study, and allow for cross-referencing with the Cook Inlet basin wetland classification system and Viereck et al. (1992) Level IV vegetation classes, which will be used in the mapping of wetlands in the upper and middle Susitna basin. Note that no functional assessment for wetlands will be prepared for the wetlands mapped in the riparian vegetation study. This is because extensive information on physical processes will be collected in the other riparian-focused Project studies (see below), to enable predictions of how wetlands may change because of the Project's alteration of existing conditions downstream of the proposed dam.

Second, AEA will collect and analyze field data in support of one of the primary shared goals of the five riparian-focused Project studies (see below), which is to characterize landscape development and change on the Susitna River floodplain below the proposed dam. AEA will collect data on sedimentation and erosion, develop vegetation succession models, and describe vegetation-soil-landform relationships. To this end, AEA will resurvey, if possible, sites that were studied for successional vegetation along the Susitna River in the 1980s and 1990s, and collect current information on successional dynamics and sedimentation processes at sites that also will be studied for physical processes (see Section 11.6.4.2 below). Lastly, the riparian vegetation study will be closely coordinated with the Riparian Instream Flow Study (riparian IFS; Section 8.6) and three associated physical processes studies: Groundwater-related Aquatic Habitat Study (Section 7.5), Ice Processes in the Susitna River Study (Section 7.6), and Fluvial Geomorphology Modeling below Watana Dam Study (Section 6.6). The purpose of this close coordination is so that each study can provide necessary and complementary field data, without duplication of efforts. AEA will provide information on sedimentation and erosion, vegetation successional pathways, and mapping in support of the riparian IFS goal of developing a spatially-explicit model to predict potential changes to downstream riparian floodplain vegetation due to Project modifications of natural Susitna River flow, sedimentation, groundwater, and ice processes.

Study Goal and Objectives

The overall goals of the riparian vegetation study are to prepare baseline maps of 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 development of the riparian IFS 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 Section 8.6.3.7). The mapping prepared in this study will be used, in the FERC License Application in 2015 (see Section 11.6.7 below), to assess the impacts to riparian ecotypes, wetlands, and wildlife habitats (see Section 10.19) in areas downstream from the proposed dam, 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:

- Identify, delineate, classify, 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 stratigraphic descriptions, sieve analysis, and several complimentary sediment dating techniques;.
- Quantify and describe Susitna 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);
- Coordinate closely in the implementation of the riparian IFS, groundwater, ice processes, and fluvial geomorphology studies 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 Section 8.6.3.7) to predict potential impacts to downstream riparian floodplain vegetation due to Project alterations of existing conditions downstream of the proposed dam. Because of this close coordination, there will be no duplication of effort among the five studies.

This multi-year study is being initiated in 2012 and will continue in 2013 and 2014. Results from the 2012 work will be used to: (1) delineate the lateral study area boundary for use in 2013 field studies, (2) prepare a preliminary map of riparian ecotypes in a portion of the study area covered by adequate high-resolution aerial imagery, (3) conduct data analysis to support the development of preliminary floristic and ecotype classifications, and (4) support the development of the sampling scheme for the 2013 field season.

11.6.2. Existing Information and Need for Additional Information

Several riparian and vegetation mapping resources for the Project area were identified in the Pre-Application Document (PAD) (AEA 2011). Of primary importance to the riparian vegetation study are the previous vegetation mapping and vegetation successional dynamics studies by McKendrick et al. (1982), UAFAFES (1985), Collins and Helm (1997), and Helm and Collins (1997), which provide information on vegetation successional processes in areas downstream of the two dams proposed in the APA Project in the 1980s. Summary information on riparian processes in those downstream areas, derived from McKendrick et al. (1982) and UAFAFES (1985), is found in APA (1985). These previous studies will serve as a baseline for developing a sampling scheme for the riparian vegetation study proposed here (study plots from the 1980s and 1990s will be resampled if possible; see Section 11.6.4), and will provide a conceptual framework upon which to build a vegetation succession classification and develop predictive models for assessing the downstream effects of the proposed Project on riparian habitats.

Wetlands were mapped for the APA Project in the 1980s through a cooperative agreement between U.S. Fish and Wildlife Service (USFWS) and the APA to produce a preliminary wetlands map for the APA Project area. Those wetlands map data were based on the vegetation mapping completed by McKendrick et al. (1982), with some additional modification using stereoscopic photo-interpretation, and are now a part of the National Wetlands Inventory (NWI; USFWS 1984). The Alaska Vegetation Classification (AVC; Viereck and Dyrness 1980)

vegetation classes that were mapped in the early 1980s were cross-referenced and converted into wetlands classes using the classification scheme of Cowardin et al. (1979). The NWI data from the 1980s cover the current Project area and are expected to be available in digital format sometime in 2012. Those NWI data will help in understanding the types of wetlands that occur in the riparian vegetation study area, but the mapping is coarse-scale (1:63,360 scale) and will not be sufficient for determining effects on wetland resources (e.g., when mapping at the 1:63,360 scale, small drainages and other small wetland habitats are often overlooked). Because those NWI data are nearly 30 years old, and because riparian conditions have almost certainly changed in specific areas over that period, an updated map of riparian wetlands will be needed for the current Project.

Current, high-resolution (≤ 1 m) orthophoto imagery in true color and color infrared (CIR) formats, which will be used for the on-screen mapping work, is available for most of the riparian vegetation study area. Moderate-resolution (4–5 m pixel RapidEye imagery in a false natural color format), which was used to support the allocation of transects and study plots during the 2012 field studies, fills the remaining gaps in the study area. Additional high-resolution aerial imagery, in true color and CIR formats, for the Project area will be needed for the mapping of riparian ecotypes, wetlands, and wildlife habitats, and is expected to be acquired in summer 2013. That additional imagery likely will be available in late 2013 and can be used for mapping at that time (i.e., before the 2014 field season).

11.6.3. Study Area

The riparian vegetation study will be focused on riparian areas along the Susitna River and its tributaries below the proposed dam site. Riparian areas include all vegetation and soils that are directly (via flooding and overland flow) or indirectly (via ground water) influenced by river waters under current climate conditions. As such, these areas are expected to be altered by changes in instream flow, groundwater/surface water interactions, ice processes, and fluvial geomorphic surfaces from construction and operation of the proposed dam.

A preliminary study area for the riparian vegetation study is presented in Figure 11.6-1. The final study area will be defined in consultation with licensing participants in Q1 and Q2 2013 as described below. The study area will include those riparian areas downstream of the proposed 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). The longitudinal extent of the riparian vegetation study area currently extends to river mile (RM) 75 because existing information indicates that the hydraulic effects of the Project below the Three Rivers Confluence at the Sunshine Gage (RM 84) show substantial attenuation, although small hydraulic effects appear to be detectable as far downstream as the Susitna Station Gage (RM 26). The final determination of how far downstream Project operational effects will extend will depend largely on the results of the Open-water Flow Routing Model (see Section 8.5.4.3), which is scheduled to be completed in Q1 2013. Thus, an initial assessment of the downstream extent of Project effects will be developed in Q2 2013 (before the 2013 field season) with review and input from licensing participants during the Technical Workgroup meetings scheduled for 2013 (see Section 11.6.6 below). The assessment of the downstream extent of Project effects will include a review of information developed during the 1980s studies and study efforts initiated in 2012, such as sediment transport (see Section 6.5), habitat mapping (see Sections 6.5 and 9.9),

operations modeling (see Section 8.5.4.2.2), and the Mainstem Open-water Flow Routing Model (see Section 8.5.4.3). The assessment will guide the need to extend studies farther downstream and, if needed, will identify which geomorphic reaches will be subject to detailed investigations in 2013 by the riparian vegetation, riparian IFS, groundwater, and fluvial geomorphology studies. Results of the 2013 riparian IFS studies would then be used to determine the extent to which additional geomorphic reaches should be studied in 2014.

As a starting point for delineating the lateral extent of the riparian vegetation study area, the extent of riverine physiography along the Susitna River has been mapped from the site of the proposed dam to Willow at RM 46. Riverine physiography includes those areas of the valley bottom directly influenced by regular (0–25 year) to irregular (25–100 year) overbank flooding, and includes off-channel water bodies. Riverine physiography was mapped by the riparian vegetation study team by photointerpretation of high-resolution aerial photography and satellite imagery for the Susitna River and currently (late November 2012) is undergoing review by the principal investigators leading the riparian IFS and associated physical processes studies (i.e., groundwater, ice processes, and fluvial geomorphology). Based on these reviews, AEA will prepare a revised riverine physiography map during Q1 2013, which will serve to define the lateral boundaries of the study area for both the riparian vegetation study and riparian IFS in 2013 and 2014. The lateral boundaries of the study area for the riparian vegetation study and riparian IFS will be finalized before the start of the field season in June of 2013.

11.6.4. Study Methods

Integrated Terrain Unit (ITU) mapping is an integrated approach to mapping landscape elements. It is a mulitvariate mapping process in which terrain unit map boundaries are adjusted 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 method of combining various ITUs allows for the preparation of a number of thematic maps that can be customized for specific study needs. An ITU approach to mapping riparian ecotypes, wetlands, and wildlife habitats (see Section 11.6.4.2.3 below) will be used 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 to be used in the riparian vegetation study will involve mapping terrain units such as vegetation type, poplar size class (e.g., pole, timber, large timber), fluvial geomorphology, and surface-form types (macrotopography and microtopography), and then combining them into units with ecological importance (in this case riparian ecotypes, wetlands, and wildlife habitats, see below). Also based on previous ELS studies in Alaska, ELS plots (see Section 11.6.4.2.4 below) will be used in the field to collect detailed data on site characteristics, environmental variables, successional vegetation, and soils.

For the riparian vegetation 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 will be conducted in coordination with the vegetation and wildlife habitat mapping study (see Section 11.5) to derive a seamless map of wildlife habitats that apply Project-wide. Similarly, the mapping of wetlands will be conducted in coordination with the wetland mapping study (see Section 11.7) so that

wetlands in the riparian vegetation study area can be similarly classified and compatible with the wetland types mapped in the Cook Inlet basin wetlands classification system (see Section 11.7); this will result in a single Project-wide wetland map. In the mapping of riparian ecotypes and in the study of riparian vegetation succession, the vegetation succession study plots studied in the 1980s and 1990s by McKendrick et al. (1982), UAFAFES (1985), Collins and Helm (1997), and Helm and Collins (1997) will be relocated where possible and re-sampled. The sampling of previously studied sites will help inform our interpretation of successional dynamics in the Susitna River floodplain.

11.6.4.1. Develop Mapping Materials from Historical and Current Data

Data sources that may be used for the mapping of riparian ecotypes and wildlife habitats include vegetation mapping and vegetation succession studies conducted in the Susitna River drainage by McKendrick et al. (1982), UAFAFES (1985), Collins and Helm (1997), Helm and Collins (1997). For wetlands, NWI data for the Project area, which was developed in the 1980s, should be available sometime in 2012. Additional data include soil surveys, digital elevation data, the National Hydrography Dataset (USGS 1999), and other map products that may have been produced for the area as part of other studies. These data will be compiled and reviewed and, if possible, included as a map layer in ArcGIS to assist the mapping efforts.

The available, high- and moderate-resolution aerial imagery for the project area will be acquired for use in the mapping effort. Additional, fine-scale, recent imagery will be needed to complete the mapping in this multi-year study, and it is expected that imagery will be available in late 2013.

11.6.4.2. Field Surveys

In 2012, the field ground-reference work was completed in two phases. In Phase 1, a helicopter-assisted reconnaissance of the Susitna River from Talkeetna to Willow took place in mid-June. The primary objective of the reconnaissance survey was to determine the feasibility of relocating the vegetation succession study plots originally established by McKendrick et al. (1982) and Collins and Helm (1997) for potential resampling, and to identify potential Focus Areas for the 2013–2014 studies. In previous versions of this study plan, Focus Areas were termed Intensive Stream Reaches; it is in these areas that field plots will be sampled in coordination with researchers from the riparian IFS and at which riparian vegetation field plots will co-located with those used for the groundwater studies.

Phase 2 of the 2012 field sampling occurred in late June–early July and included sampling of preselected study plots in conjunction with the data collection efforts for the Riparian IFS. Riparian habitats were sampled using ITU mapping transects (see below), along which ecosystem characterization and mapping verification data were collected.

In 2013–2014, three sampling methods will be used for the riparian vegetation study, including Focus Area sampling, Non-Focus Area sampling, and ITU mapping transect sampling. Focus Area sampling plots will be defined with stratified random sampling with the stratification unit being riparian ecotype. Ecotypes are local scale ecosystems and are represented in the ITU mapping as multivariate features that combine several vegetation and environmental attributes: vegetation type, geomorphology including flood frequency, poplar successional status (size class), and soils information. Field sampling will be coordinated with the riparian IFS and will

occur from mid-June to late September and will include four components: (1) ELS plots will be sampled along transects within the Focus Areas in coordination with the riparian IFS and groundwater studies, (2) ITU mapping plots will continue to be surveyed along transects in the broader study area (i.e., outside Focus Areas) to rapidly collect field-verification data to further refine the riparian ecotype classes and mapping, (3) ELS plots will be sampled along transects in the broader study area in order to supplement the data from Focus Areas and facilitate the scaling-up of the results from the Focus Areas, and (4) rates of sedimentation across the Susitna River floodplain will be quantified using field stratigraphic descriptions and standard laboratory sediment dating methods. The methods for each of the above components of the riparian vegetation surveys are provided below.

11.6.4.2.1. Sampling Scheme

The preliminary mapping of riparian ecotypes (which was prepared in 2012; see Section 11.6.4.3; along with additional mapping prepared in Q1 and Q2 2013) was used in a stratified random sampling scheme to preselect potential ELS study plots within riparian habitats. The stratified random sample design was developed for each riparian Focus Area using ecotype as the sample strata (see Figure 11.6-2 for an example map of the ELS plots allocated using this stratified random sampling design in Focus Area 104, Whiskers Slough). The ITU mapping of riparian ecotypes completed in 2012 for the middle Susitna River was clipped in GIS using the boundary of each Focus Area. The total area of each Focus Area, the number of ecotypes within each Focus Area, and the total area (acres) of each ecotype within a Focus Area were calculated. The total number of random ELS plots per Focus Area then was determined using the following formula as a guide:

Focus Area plots = 1 plot/ 20 acres + 1.5* the total # of ecotypes in a Focus Area

The above formula accounts for both total area of a Focus Area and the total number of ecotypes such that a smaller Focus Area with a large number of ecotypes would be assigned a larger number of plots than it would if based on area alone. The total area of each ecotype was then divided by the total area of the respective Focus Area to determine the percent area of each ecotype relative to the Focus Area. Ecotypes encompassing $\geq$ 2% of the total area within a Focus Area were assigned a number of random plots using the following formula as a guide:

Random Plots per Ecotype = % total ecotype area*# of Focus Area plots

The GENERATE RANDOM POINTS TOOL from Hawth's Analysis Tools for ArcGIS (http://www.spatialecology.com/htools/rndpnts.php) was used to generate the random plots by ecotype. For the 2013 field studies, stratified random plots will be distributed across three Focus Areas (FA-104, FA-115, FA-128) for a total of 118 plots.

The Non-Focus Area sampling design (satellite areas) will use a targeted/directed sampling scheme to select areas that will document underrepresented vegetation types such as some of the herbaceous communities which are not represented in the existing Focus Areas. Roughly half of the ELS plots will be established in Focus Areas and half in Non-Focus Areas so as to facilitate an even sampling of the existing vegetation types in the study area and ensure that those vegetation types that are underrepresented in Focus Areas are adequately sampled. A total of 94 Non-Focus Area plots will be targeted for sampling in 2013.

ITU transects will be focused in the Lower River study area to collect field data to facilitate the interpretation of aerial imagery signatures and resolve ITU map polygon boundaries. Approximately 60 transects which corresponds to about 300 plots are planned for the Lower River in 2013. More ITU plots can be sampled than ELS plots because the ITU plots involve less intensive sampling. The field sampling plan will be structured so that roughly half the field effort will be spent sampling ELS plots and half sampling ITU plots

In addition to the stratified random sampling described above, ELS plots sampled in Focus Areas will be co-located with ground water installations (see Section 11.6.4.2.4, ELS Plots, below).

Ground-reference plots to be surveyed along ITU and ELS transects sampled in the broader study area (study components 2 and 3, noted above) will be selected to cover the range of riparian habitats identified by photointerpretation of aerial imagery signatures on the high- and moderate-resolution imagery noted above. The objective will be to sample multiple map polygons for each riparian, wetland, and wildlife habitat type, incorporating as much replication as possible. As noted above, the field sampling effort will be structured so that a roughly even sampling of Focus Areas and Non-Focus Areas will be obtained, and a roughly similar effort at sampling ELS plots and ITU plots also will be implemented.

11.6.4.2.2. Surface Elevation

Ground surface elevation will be recorded at all ELS plot centers, including those in Focus Areas and those in the broader study area in coordination with the Flow Routing and Riparian IFS field teams. Riparian vegetation elevation surveying will be conducted in the following manner. Plot centers will be surveyed in by Riparian IFS field teams using a transit (elevation) and GPS unit (latitude/longitude). Transit surveys will be tied into an intermediate benchmark established at each Focus Area and ELS transect (e.g., nail in tree near riverbank). The flow routing field teams will then survey in the intermediate benchmark using an RTK instrument, thus tying the riparian survey plot elevations into project wide elevation datum.

11.6.4.2.3. ITU Mapping Plots

The purpose of the ITU mapping plots is the rapid collection of the basic variables used in the ecotype classification and ITU mapping process. Hence, the methods are designed to allow for efficiency in the field in order to cover a large area in a relatively short amount of time. Transects for the ITU plots will be oriented perpendicular to the Susitna River channel so as to cross various floodplain surfaces and patches of riparian vegetation in different successional stages. Five to ten circular plots of 10-meter (33-foot) radii will be sampled along each transect, each on a distinct floodplain surface and in a distinct vegetation type. The following variables will be recorded at each ITU mapping plot:

- Geo-referenced plot location (< 3-m accuracy);
- Site variables, including physiography, geomorphic unit, surface form, elevation, aspect, and slope.
- Vegetation structure and plant community composition to classify vegetation types to Level IV of the AVC (Viereck et al. 1992).
- Shallow soil pits will be dug to categorize drainage and soil moisture; soil hydrologic variables, including depth of water above or below ground surface, depth to saturated soil, pH, and electrical conductivity (EC); and soil depositional profiles.

- Wildlife sign such as winter or summer browse marks, nests, dens, droppings, singing birds, carcasses, tracks, and burrows.
- Locations of tree ice-scars, ice bull-dozing, or other evidence of disturbance by ice (i.e., ice rafted boulders, etc.) will be recorded at each plot and along each transect for use in the ice processes and riparian IFS.

11.6.4.2.4. ELS Plots

In early 2012, the adequacy of the methods of McKendrick et al. (1982), Collins and Helm (1997), and Helm and Collins (1997) for collecting the data necessary to describe vegetation successional stages were reviewed by the riparian vegetation and riparian IFS leads. In late 2012, in coordination with the riparian IFS, fluvial geomorphology, and groundwater study leads, the field methods for the intensive sampling of riparian vegetation and soils were revised to use modified ELS plots, following the ELS methods of Jorgenson et al. (2009). The ELS plots will be used to collect data on site and environmental variables; vegetation composition (abundance and richness) and structure (size class, density, age); as well as detailed soil characteristics (see Section 11.6.4.2.5, Soil Sampling and Sediment Aging, below). The purpose of the ELS plots is two-fold. First, the ELS plots are designed to facilitate the collection of detailed data on existing conditions (site characteristics, environmental variables, vegetation, and soils) for use in floristic, ecotype, and habitat analyses; sediment stratigraphy, aging, and sieve analyses; and the development of vegetation successional models. Two, the ELS plots and methods are designed to provide baseline data for a possible long-term monitoring study, with emphasis on repeatability of methods and relocation of plots, for use in potential future studies of changes in riparian vegetation because of Project operations.

ELS plots will follow a variable-sized plot design as illustrated in Figure 11.6-3. The plot center (3-m radius) will be reserved as a trample zone in which no vegetation sampling will occur. In addition, at groundwater installations, the plot center will be co-located with the groundwater instrumentation. A 6.5-m radius plot (minus the plot center) will be used to (1) record species and DBH of all trees with a Diameter at Breast Height (DBH, ~1.5 meters) of < 5 cm; and (2) record stem counts of all tall (>1.5 m) shrubs. Protocols will be developed for handling multi-stem clusters from a single individual. Two representative trees of this size class and two representative shrubs within this zone will (1) be aged using increment cores (2 per tree, trees 2-5 cm DBH) or cookies (shrubs and trees < 2 cm DBH) extracted at the root collar; and (2) have approximate heights measured using a laser range finder designed to calculate height automatically. An 11.5-m radius plot (minus the plot center) will be used to record species of all trees with a DBH of ≥ 5 cm. Two trees of this size class within this zone will (1) be aged using increment cores (2 per tree) extracted at the root collar, and (2) have approximate heights measured using a laser range finder as described above. A 16.25-m radius plot (minus plot center) will be used to record DBH and species (if recognizable) of dead standing snags. Height of one representative snag within this area will be measured using a laser range finder.

The 16.25 meter radius plot will be divided into 4 quadrants using 100 meter measuring tapes that will serve as vegetation sampling lines for point-intercept measurements of all herbaceous and shrub species. The orientation of the lines will be determined from a random start bearing to orient the first line. The remaining lines will be oriented at 90 degree intervals to each other. Along each line, point-intercept measurements will be collected every 0.5-m using a laser mounted on a frost probe (Figure 11.6-4) for all herbaceous and shrub species beginning at 3.5

meters (just outside the plot center) and ending at 15.5 meters for a total 25 points per line and a 100 points per plot. All hits of a species by the laser will be tallied by three height classes for shrubs (< 0.20, 0.20–1.5, and 1.5–3 meters) and two height classes for herbaceous species (< 1.5 and 1.5–3.0 meters). For those hits ≥ 1.5 meters the laser will be oriented upwards and binoculars will be used if necessary to detect hits by the laser. Forest canopy cover of trees and tall shrubs > 3-m tall will be measured every 0.5-m using a densiometer. In addition to vascular species, hits of several categories of mosses (feather moss, *Sphagnum* spp., other mosses), lichens (foliose, fruticose, crustose), and bare ground (bare soil, litter, water) will also be recorded.

Once transect sampling is complete a random wander through the plot area will be conducted to record presence of species not previously recorded on the point-intercept transects. The random wander will continue until 10 minutes has passed since a new species has been recorded. Soil pits will be located in one randomly selected quadrant at approximately 9 meters from the plot center point and half way between the two adjacent vegetation sampling lines.

Landscape photographs will be taken from the plot center looking out along each vegetation sampling line, and from the end of each sampling line looking back towards plot center. Ground cover photographs will be taken at meter 13 along each vegetation sampling line.

Additional sampling details include:

- Plot locations (latitude/longitude) will be recorded using Trimble GeoXT GPS units (≤ 1-m accuracy).
- Permanent magnetic survey markers (SurvKap®) will be buried at approximately 20 cm depth at the plot center point to aid in relocating these plots into the future. At sites with ground water installations, magnetic survey marker will not initially be used. Rather the ground water installation will serve as the plot center marker. In the event that ground water installations are removed in the future, a magnetic survey marker will be placed at plot center at that time.
- Site variables, including physiography, geomorphic unit, surface form, elevation, aspect, and slope.
- Vegetation types will be classified in the field to Level IV of the AVC (Viereck et al. 1992).
- Wildlife sign such as winter or summer browse marks, nests, dens, droppings, singing birds, carcasses, tracks, and burrows will be recorded at each plot.
- Locations of tree ice-scars, ice bull-dozing, or other evidence of disturbance by ice (i.e., ice rafted boulders, etc.) will be recorded at each plot and while traversing to the next plot for use in the ice processes and riparian IFS.

The shape of the study plots on both the ITU mapping and ELS plots may vary depending on the shape of the vegetation stand being sampled. However, the same absolute area (tree and shrub plots) and the same total number of points (vegetation sampling lines) will be sampled in all cases. In addition to the shape of the ITU and ELS plots, the locations of the plots will be adjusted slightly in the field, if needed, to minimize sampling within microtopographic transition zones (e.g., plots will be selected so as to avoid sampling across slopes that could have variability in depth to groundwater and surface-water flooding). All field data will be recorded digitally in the field using a standardized data entry form on an Android tablet computer designed to link directly to a relational database (Microsoft Access).

11.6.4.2.5. Soil Sampling and Sediment Aging

- Soil pits will be dug down to basal gravel/cobbles (historic channel bed) or a depth of 2 meters, (whichever is shallower) for soil stratigraphy and sampling. Cut-banks will be used in place of soil pits whenever available and practical.
- The original gravel/cobble surface (historic channel bed) will be identified as a continuous layer of gravelly/cobbly sands (for practical purposes, this layer will be considered continuous when ≥ 40 cm thick).
- For those soils with depth to basal gravels > 2 meters a frost probe (0.25-inch diameter steel rod) will be used to determine the total depth to basal gravels.
- Tarps will be used to place soil materials extracted from the soil pits in order to protect the soil surface and increase efficiency in replacing the fill material when sampling is complete.
- Field stratigraphic descriptions will be prepared and soil samples collected for use in quantifying rates of sedimentation on the Susitna River floodplain. General methods are as follows. Floodplain soil pits will be excavated and soil stratigraphy will be described and measured using standard NRCS field techniques (Schoeneberger et al. 2002). Standard sediment grain-size sieve analysis will be conducted on the entire sediment profile. Depth and thicknesses of buried organic horizons will be recorded.
- Direct dating of fluvial sediments will be conducted using isotopic techniques, including, but not limited to, 137Cs and 210Pb measurements as described in Stokes and Walling (2003).
- Dendrochronologic techniques described above for the ELS plots will be used to age trees and current floodplain surfaces at each soil pit as described by Fritts (1976). The results of the dendrochronology analyses will be used to corroborate the results obtained from sediment aging.
- Soil hydrology indicators will be recorded, including current depth to water table, presence of redoximorphic features (e.g., oxidation/reduction mottles, gley), and presence of hydrogen sulfide (as evidenced by a very pronounced "rotten egg" odor) to be used with the data from the ground water study as complimentary data on sub-surface hydrology.
- Additional soil variables will be collected within the upper 40 cm of the soil profile for use in the ecotype analysis including, drainage class, soil moisture, depth to saturated soil, pH, and electrical conductivity, dominant soil texture, thickness of surface organics, cumulative thickness of organic material, and thaw depth.

11.6.4.3. ITU Mapping of Downstream Riparian Areas

Preliminary mapping of local-scale riparian ecosystems (riparian ecotypes) by photointerpretation of the current aerial imagery available for the study area is currently (as of late November 2012) in progress. Ground-reference data collected in summer 2012 is being used to verify the mapping. For this preliminary mapping effort, the mapping is limited to those areas delineated as riverine physiography (see Study Area, above) and covered by the Matanuska-Susitna Borough (Mat-Su) aerial imagery collected in mid- to late summer 2011, which provides the best color signatures for mapping since the imagery in these areas was collected at full vegetation green-up. Color signatures in areas of the Mat-Su aerial imagery collected in late spring/early summer are not consistent with the mid- to late summer imagery as these areas were

collected prior to full vegetation green-up making consistent and accurate interpretation of photo signatures across the entire study area difficult.

As noted above, riparian ecotypes are proposed to be mapped using an ITU approach. A minimum mapping size of 1 acre for terrestrial polygons and 0.25 acres for water bodies is proposed. ITU map polygons will be attributed with geomorphology (e.g., Braided Active Overbank Deposit); surface form (e.g., Mid-channel Bar); vegetation class (e.g., Open Balsam Poplar Forest), and poplar size class (e.g., pole, timber, large timber). Riparian vegetation in this study will be mapped to the Level IV of the AVC (Viereck, et al. 1992) with adjustments, as needed, for early successional riparian stages following Helm and Collins (1997). Following the mapping, the ITU codes will be aggregated into a set of preliminary riparian ecotypes based on the combination of ITUs that best represents the local-scale riparian habitats in the areas mapped.

Preliminary mapping of local-scale wetland ecosystems (wetland ecotypes) also will be mapped using the ITU approach in late 2012, but wetland ecotypes will be delineated separately, if needed, by photointerpretation so as to fit the wetland classification that will be used for the rest of the Project area (see Section 11.7). In particular, if there are wetlands in the floodplain of the Susitna River downstream of the proposed dam that are not represented in the wetlands mapping conducted in the upper Susitna basin, the existing wetlands mapping for lower elevations in the Matanuska-Susitna Borough (see http://cookinletwetlands.info/) will be consulted so as to map similar wetland types.

The objective of the wetlands mapping in the riparian vegetation study is to prepare a map of wetlands for downstream riparian areas following the same classification system used in the upper Susitna basin, and which can be cross-walked to the existing wetlands mapping for other areas in the Matanuska-Susitna Borough (see Section 11.7 for more information). During consultation with resource management agencies, it was agreed that AEA will map wetlands as part of the riparian vegetation study, but will not conduct formal field wetland determinations in areas downstream of the proposed dam, (see Section 9.6 in AEA 2012). The U.S. Army Corps of Engineers has determined that no wetlands will be filled in the riparian areas downstream of the dam; therefore, wetlands mapping will not be needed for the Clean Water Act Section 404 dredge and fill permit. The wetlands mapping in the riparian vegetation study will be prepared to help in understanding how the downstream effects of alterations in instream flow, groundwater/surface water interactions, ice processes, and fluvial geomorphic features may affect wetlands in the floodplain of the Susitna River.

In December 2012, preliminary wildlife habitat types in downstream riparian areas will be mapped based on the ITU mapping described above, but will be derived using a separate aggregation of ITU parameters that specifically addresses the important elements of wildlife habitat use (see Section 11.5 for more information).

All the mapping of riparian areas will be conducted on-screen in GIS and will make extensive use of the field ground-reference data so that photosignatures are accurately interpreted. This mapping will be an on-going process and is expected to occur in 2012, 2013, and 2014. It is possible that the mapping of the full study area may not be completed until 2014. Once substantial progress has been made on the ITU mapping, however, a preliminary set of riparian ecotypes, wetland ecotypes, and wildlife habitat types will be prepared for review. This review will occur in both 2013 and 2014, and the preliminary set of riparian ecotypes, wetland ecotypes,

wildlife habitat types will be presented in the Initial Study Report and Updated Study Report for review before being finalized.

11.6.4.4. Predicting Changes in Riparian Areas

In the riparian vegetation study, AEA proposes to intensively sample successional vegetation in the same stream reaches (Focus Areas) in which intensive sampling will occur in the riparian IFS and groundwater studies. Additionally, data from the fluvial geomorphology and ice processes studies will be integrated with those from the riparian vegetation, riparian IFS, and groundwater studies to develop comprehensive information on the existing conditions in riparian areas downstream of the proposed dam. This information will be used in the riparian IFS to correlate the range of existing conditions in instream flow, groundwater/surface water interactions, and geomorphic features with existing riparian habitats. These data will provide the baseline from which changes in instream flow, groundwater/surface water interactions, fluvial geomorphic features, and riparian vegetation will be modeled (in the riparian IFS) to predict how riparian habitats will change because of Project development (see the riparian IFS study plan, Section 8.6.3.7). In the modeling of changes in riparian vegetation in the Susitna River floodplain, researchers in the riparian IFS will use the field data noted above plus the results of the vegetation succession model (developed in the riparian vegetation study) in a spatially explicit model in a GIS to map the expected changes in riparian vegetation throughout the floodplain study area (see Section 8.6.3.7).

11.6.4.5. Reporting and Data Deliverables

The reports and data deliverables for this study include:

- **Electronic copies of field data.** A geospatially-referenced relational database of historic data and data collected during the 2012–2014 field seasons, including representative photographs of riparian ecotypes, wetland ecotypes, and wildlife habitat types will be prepared. Naming conventions of files and data fields, spatial resolution, map projections, and metadata descriptions will meet the data standards to be established for the Project.
- **Vegetation and wildlife habitat maps in ArcGIS and PDF formats.** The preliminary and final maps of riparian ecotypes, wetland ecotypes, and wildlife habitat types will be developed and delivered according to the schedule indicated below. Naming conventions of files and data fields, spatial resolution, map projections, and metadata descriptions will meet the data standards to be established for the Project. AEA will use ADNR's webmap application to develop interactive digital maps of riparian vegetation, wetlands, and wildlife habitats from the riparian vegetation study, so that licensing participants can access specific data layers, polygon attributes, and other map features.
- **Initial Study Report and Updated Study Report.** The riparian vegetation study results in the Initial and Updated study reports will be presented according the schedule indicated below. The reports will include descriptions of the riparian ecotypes, wetland ecotypes, and wildlife habitat types identified; a summary table (acreages) of the riparian ecotypes, wetland ecotypes, and wildlife habitat types represented in the mapping effort; and predictions of the expected changes in riparian areas due to Project development. The Initial Study Report will include recommendations for the 2014 field survey effort.

Both reports also will include field plot photos including site, ground, and soil photographs for each plot surveyed.

11.6.5. Consistency with Generally Accepted Scientific Practice

The riparian vegetation study will be conducted using standard methods for the mapping of vegetation, wetlands, and terrain features (onscreen digitizing in GIS over digital aerial imagery). The mapping will be based on intensive ground-reference information, and the field data will be collected using the same methods used in the 1980s and 1990s so that the current data are comparable. These field methods are still appropriate for classifying successional vegetation types. A multivariate, ITU mapping approach (following Jorgenson et al. 2003) will be used for the mapping of wildlife habitats, and the derivation of wildlife habitats will be conducted following methods successfully used for the mapping of wildlife habitats for other recent projects in Alaska (e.g., ABR 2008, Schick and Davis 2008, PLP 2011). The prediction of change in riparian areas will be done in coordination with other studies of physical processes in riverine areas to help determine accurate relationships between physical changes and alterations in riparian habitats.

11.6.6. Schedule

See Table 11.6-1 for schedule information for the riparian vegetation study. In 2014 and 2015, licensing participants will have opportunities to review and comment on the study reports (Initial Study Report in early 2014 and Updated Study Report in early 2015). Updates on the study progress will be provided during Technical Workgroup meetings, which will be held quarterly in 2013 and 2014.

11.6.7. Relationship with Other Studies

The relationships between the riparian vegetation study and other Project studies are illustrated in Figure 11.6-5. The classification and mapping of vegetation, wetlands, and wildlife habitats in this study will be coordinated with the classification and mapping of vegetation, wetlands, and wildlife habitats in areas upstream of the proposed dam—in the vegetation and wildlife habitat mapping study (Section 11.5) and wetland mapping study (Section 11.7). This classification and mapping coordination will be done to yield comprehensive maps of vegetation, wetlands, and wildlife habitats for the Project area, both above and below the proposed dam.

There are four other Project studies related to the riparian vegetation study that are being conducted in riparian areas along the Susitna River downstream of the proposed dam. Data from each of those five riparian-focused studies will be needed to facilitate the predictions of change in riparian vegetation in the Susitna River floodplain (to be conducted in the riparian IFS; Figure 11.6-5). From the riparian IFS (see Section 8.6), information on the range of existing conditions for instream flow and recruitment of poplar (*Populus* spp.), spruce (*Picea glauca*), and willows (*Salix* spp.) will be needed to correlate with data on the existing vegetation in riparian areas. This information, along with the modeling of successional riparian vegetation in the Susitna River floodplain (to be conducted in the riparian vegetation study), will serve as the baseline from which changes in riparian vegetation can be predicted given the predicted changes in instream flow (as one of several factors that can influence plant communities following construction of the proposed dam; see below). In a similar study relationship, data from the groundwater study (see

Section 7.5), which will be used to describe the range of existing conditions for groundwater/surface water interactions, will be needed to correlate with data on existing riparian vegetation. From this baseline, data on the predicted changes in groundwater/surface water interactions as a result of construction of the proposed dam will be needed to help further refine the predictions of changes in riparian vegetation. Two other riparian studies are related to the riparian vegetation study in the same ways. The range of existing conditions for ice effects (from the ice processes study; see Section 7.6) and fluvial geomorphic features (from the fluvial geomorphology study; see Section 6.6) in the Susitna River will be used to determine the baseline conditions that plant communities in riparian areas are responding to now. Then the predictions of changes in ice effects and fluvial geomorphic features as a result of construction of the proposed dam will be used to further refine the predictions of changes in riparian vegetation (to be conducted in the riparian IFS; Figure 11.6-5). As indicated in Figure 11.6-5, data from the riparian vegetation study and each of the other four interdependent, riparian-focused studies will be synthesized in the riparian IFS study to develop a spatially explicit model to predict potential changes in downstream riparian floodplain vegetation due to Project modifications of natural Susitna River flow, sedimentation, groundwater, and ice processes.

Data collected as part of the riparian vegetation study will be used by the other four interdependent, riparian-focused studies. Observations of ice-scars and other evidence of ice disturbance recorded at riparian vegetation plots and transects will be used by researchers conducting the ice processes study to aid in the identification of ice process domains. Soil stratigraphy and sediment aging data will be used by researchers conducting the fluvial geomorphology study, while elevation surveys of the intermediate benchmarks at Focus Areas and ELS transects (conducted by the fluvial geomorphology study team) will tie the vegetation study plots into the study-area-wide elevation datum. The vegetation study plots sampled in the riparian vegetation study will be co-located with groundwater installations and the data from the groundwater study will inform the development of vegetation succession models (to be prepared in the riparian vegetation study). At the same time, the soil hydrology indicators recorded at the vegetation plots sampled in the riparian vegetation study will complement the groundwater data. Riparian ISF field crews will be collecting the dendrology and elevation data at the vegetation study plots in the Focus Areas, and will be performing the seedling recruitment study, all of which will feed into the riparian vegetation study, and specifically into the modeling of riparian vegetation succession. At the same time, the vegetation structure and composition data, and soil stratigraphy and sediment aging data (collected in the riparian vegetation study) will feed into the riparian IFS objectives of describing floodplain vegetation/groundwater/surface water functional groups and developing a predictive model of Project operations changes to erosion and sediment deposition patterns and associated floodplain vegetation. As noted above in Section 11.6.4.4, data from the riparian vegetation study and each of the four interdependent, riparian-focused studies will result in an interdisciplinary dataset for use in predicting potential impacts to downstream riparian floodplain vegetation due to the Project modifications of natural Susitna River flow, sedimentation, groundwater, and ice processes, which is to be conducted in the riparian IFS.

Lastly, the wildlife habitat types mapped in the riparian vegetation study will be used in the Evaluation of Wildlife Habitat Use Study (see Section 10.19) to categorically rank habitat values for each of the mapped riparian wildlife habitats by a selected set of wildlife species of concern. This information will be used in the impact assessments for wildlife habitats and wildlife species (see below) to be conducted for the FERC License Application.

When the predictions of changes in riparian vegetation described above are completed (in the Updated Study Report for the riparian IFS), the mapping of existing riparian vegetation, wetlands, and wildlife habitats prepared in the riparian vegetation study can be used to assess how those features of riparian areas along the Susitna River could be affected by construction of the proposed dam. These impact assessments will be conducted during the preparation of the FERC License Application in 2015.

Using the predictions of changes in riparian vegetation along with predictions of changes in fluvial geomorphic features (as a result of flow alterations and ice processes) and predicted changes in groundwater/surface water interactions (as described above), the predictions of how wildlife habitats could be affected in floodplain areas downstream of the proposed dam will follow relatively easily. This is because wildlife use of riparian areas depends largely on the presence or absence of vegetation, vegetation type, fluvial geomorphic features, and, to a lesser extent, soil properties, and data on the expected changes in all these landscape elements will be available from the five riparian-focused studies described above. With data indicating how wildlife habitats will be affected downstream of the proposed dam, the information from the Evaluation of Wildlife Habitat Use Study (see Section 10.19), will be used to assess what those changes in the availability of habitats important for a selected set of wildlife species of concern are likely to mean for the distribution and abundance of those species in the Susitna River floodplain.

Similarly, for wetlands in the Susitna River floodplain, the same information noted above on the predictions of changes in riparian vegetation, fluvial geomorphic features, and, importantly for wetlands, groundwater/surface water interactions, will be used to predict how riparian wetlands could be affected in areas downstream of the proposed dam.

In addition to the impact assessments for riparian vegetation, wildlife habitats, and wetlands, the development of any PM&E measures needed for those riparian resources will occur during the preparation of the FERC License Application in 2015.

11.6.8. Level of Effort and Cost

The riparian vegetation study is planned as a three-year effort, with field sampling conducted each year by four observers (two crews of two each) during the summers of 2012, 2013, and 2014. Surveys would be conducted for 14 to 18 days in each year, depending on the needs for additional ground-verification data (less extensive field surveys may be needed in 2014 as the mapping of the study area progresses). The riparian vegetation study will involve extensive, office-based activities to delineate the boundaries of various ITUs (e.g., vegetation, geomorphic type, surface form, disturbance type) in a GIS and to prepare study reports.

Total costs in 2013 are estimated to be on the order of $600,000. In 2014, a more limited field survey is expected, to focus on complex areas or areas where the field survey coverage is insufficient. Total costs in 2014 are estimated to be roughly $400,000.

11.6.9. Literature Cited

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11.6.10. Tables

Table 11.6-1. Schedule for implementation of the riparian vegetation study.

Activity	2013				2014				2015
	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q
Develop mapping materials from historical and current data	——								
ITU mapping of riparian, wetland, and wildlife habitat types									
Field plot selection and field surveys		——	——						
ITU map revisions for riparian, wetland, and wildlife habitat types; coordination with other botanical resources mapping study teams			——	——					
Initial Study Report				——	Δ				
Delivery of field data and preliminary riparian, wetland, and widlife habitat maps				——					
ITU mapping of riparian, wetland, and wildlife habitat types					——	——			
Field plot selection (for remaining unmapped areas) and field surveys						——	——		
Final ITU map revisions for riparian, wetland, and wildlife habitat types; coordination with other botanical resources mapping study teams							——	——	
Modeling of riparian vegetation succession in Susitna River floodplain							——	——	
Updated Study Report								——	▲
Delivery of final field data and final riparian/wetland/habitat maps								——	

Legend:

—— Planned Activity
Δ Initial Study Report
▲ Updated Study Report

11.6.11. Figures

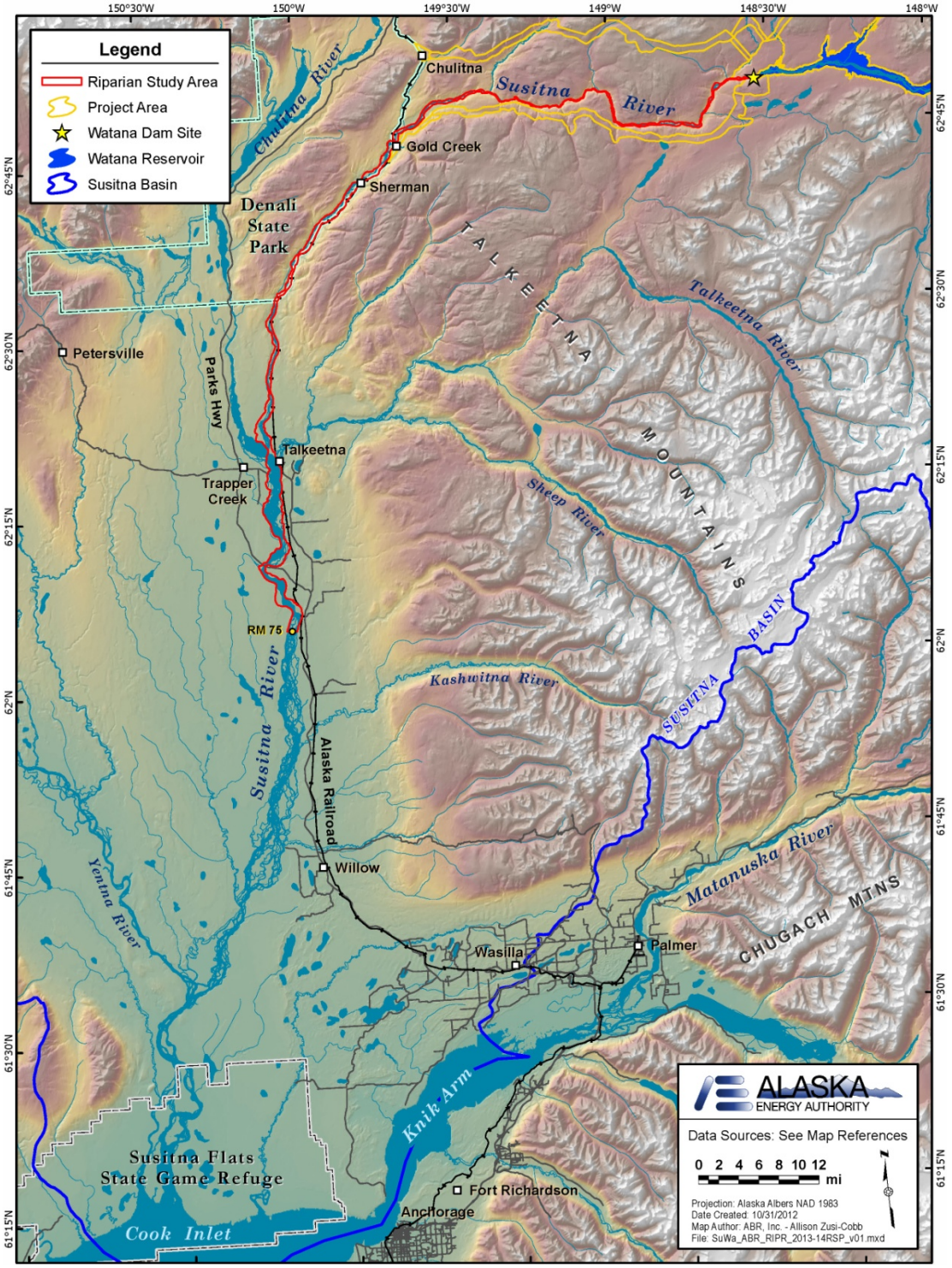

Figure 11.6-1. Preliminary riparian vegetation study area for 2013 and 2014 in the Susitna basin.

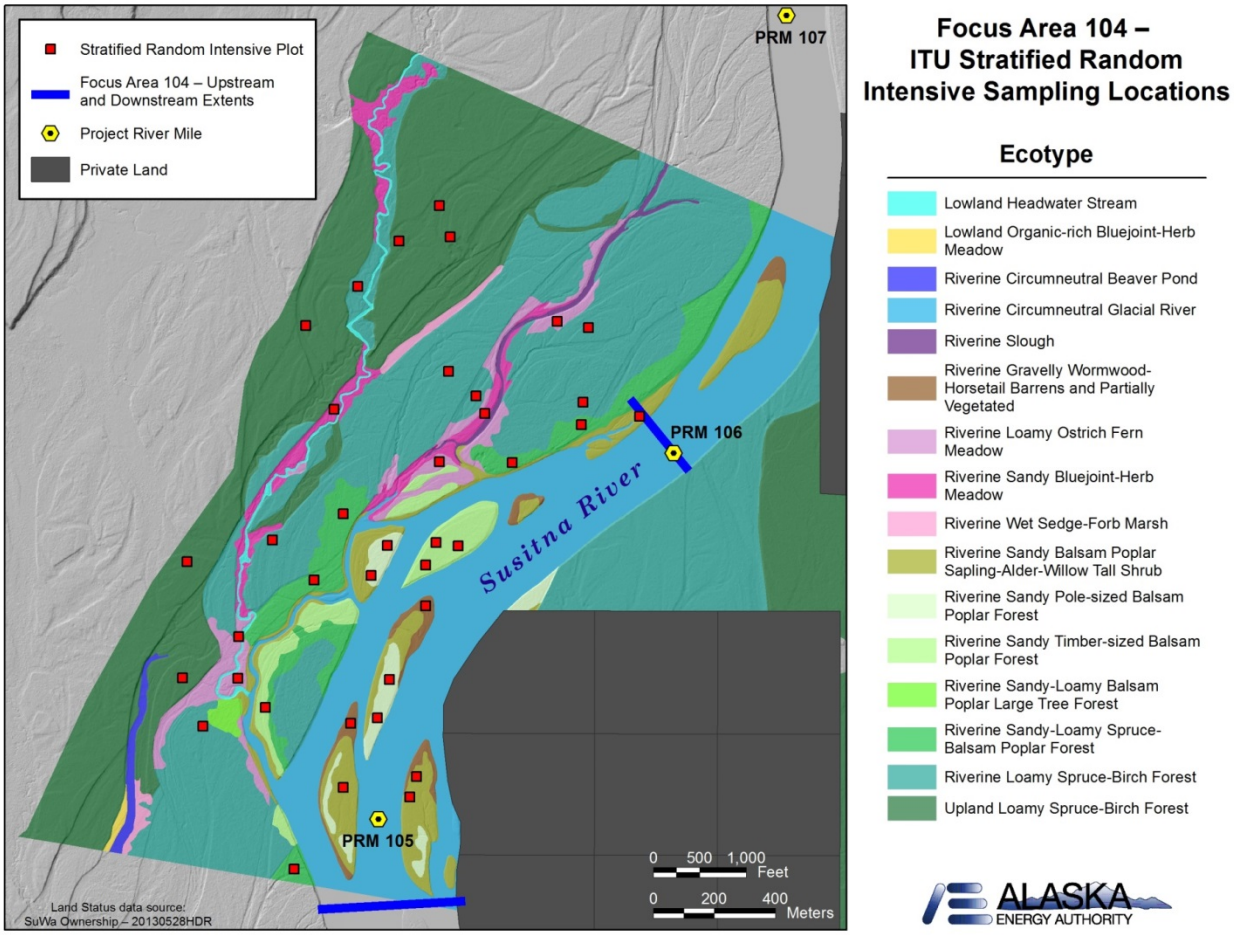

Figure 11.6-2. Map of the stratified random allocation of intensive sampling plots for Focus Area 104 (Wiskers Slough).

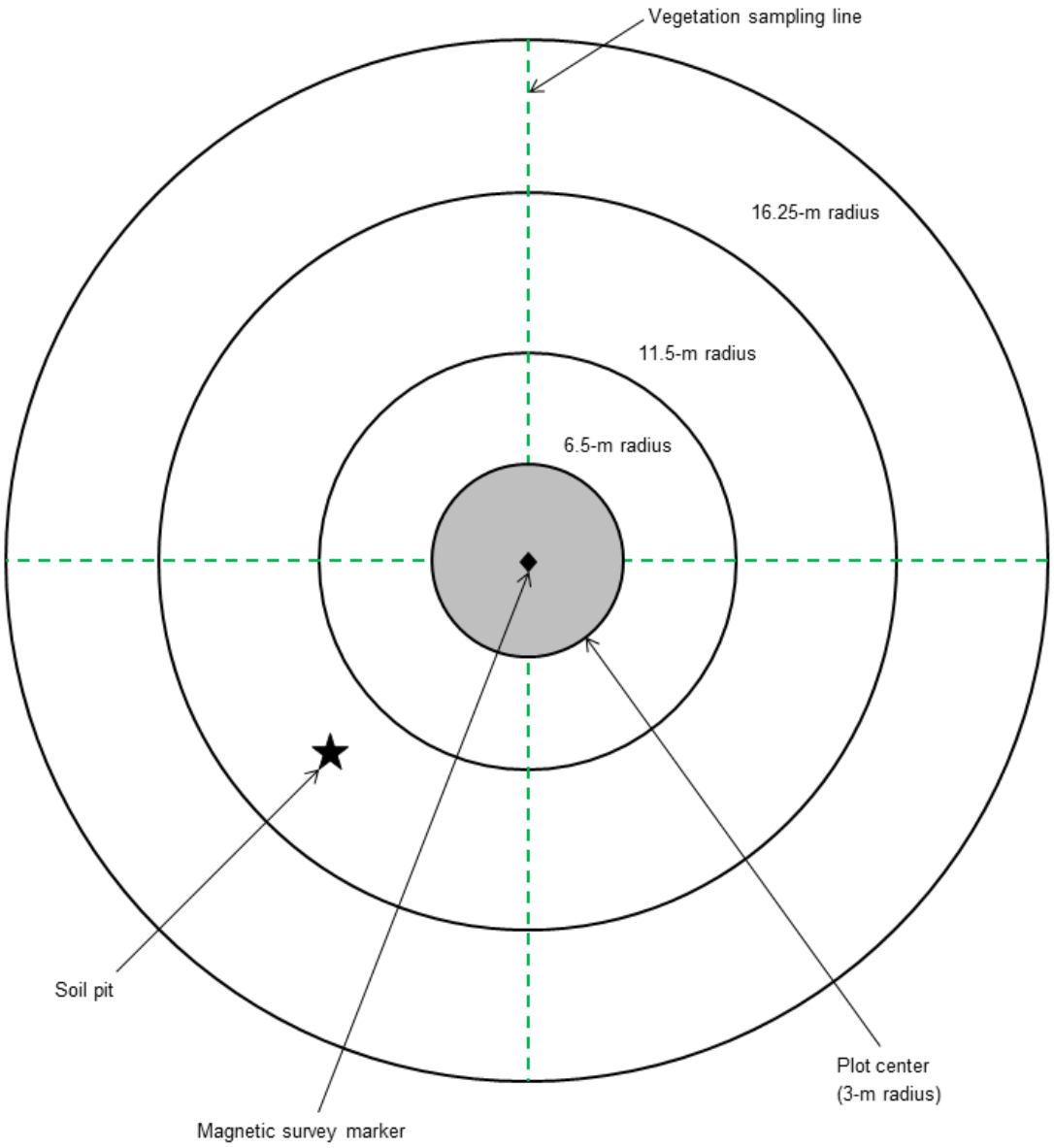

Figure 11.6-3. Diagram of Ecological Land Survey (ELS) plot for use in the riparian vegetation study showing plot center (3-m radius), 6.5-m radius plot (trees < 5 cm DBH and tall shrubs), 11.5 m-radius plot (trees ≥ 5 cm), 16.25-m radius plot (snags), vegetation sampling lines, and soil pit location. Susitna-Watana Hydroelectric Project, Alaska, 2013-2014.

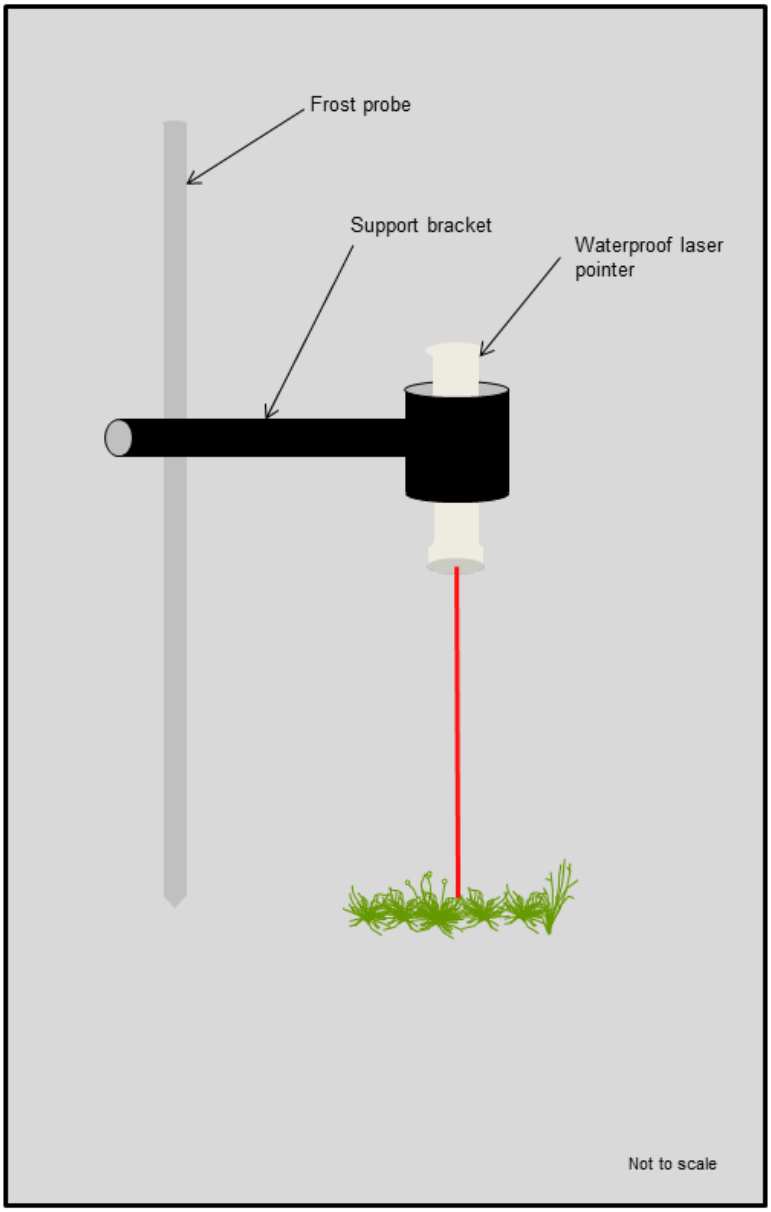

Figure 11.6-4. Diagram of laser point sampler mounted on frost probe for use in the riparian vegetation study, Susitna-Watana Hydroelectric Project, Alaska, 2013-2014.

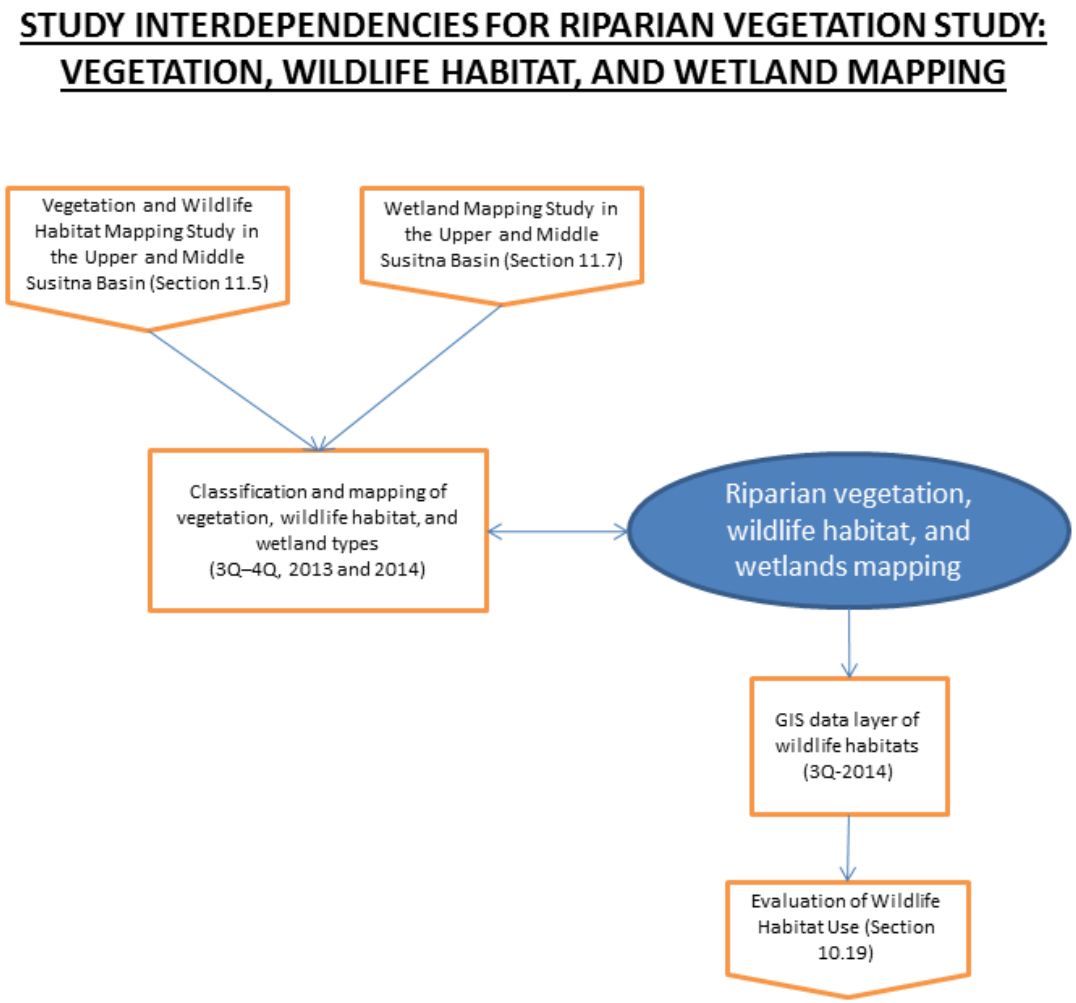

Figure 11.6-5a. Study interdependencies for the riparian vegetation study.

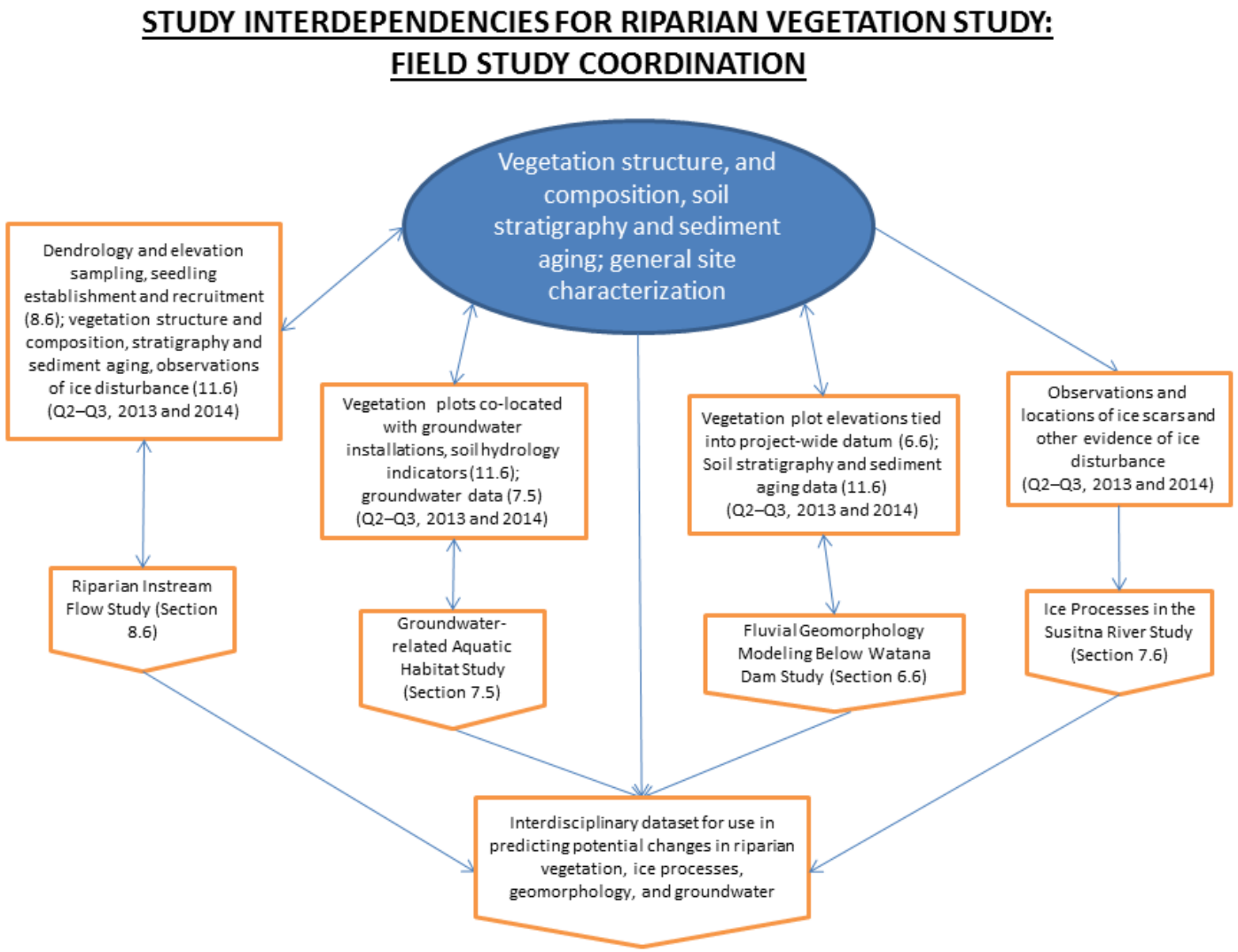

Figure 11.6-5b. Study interdependencies for the riparian vegetation study (continued).

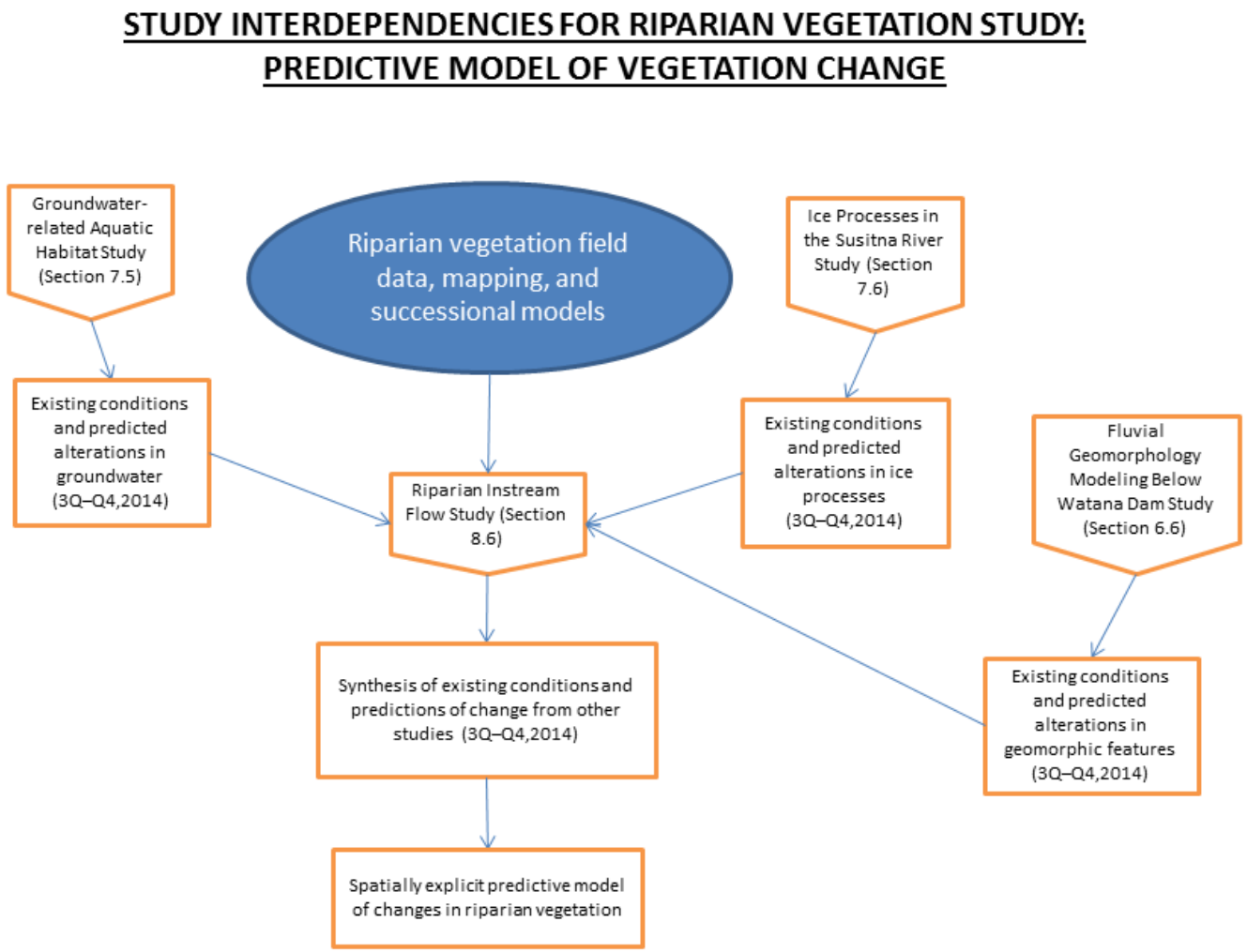

Figure 11.6-5c. Study interdependencies for the riparian vegetation study (continued).