

**Susitna-Watana Hydroelectric Project
(FERC No. 14241)**

**Geomorphology Study
Study Plan Section 6.5**

**Part D: Supplemental Information to
June 2014 Initial Study Report**

Prepared for

Alaska Energy Authority



SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

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1. INTRODUCTION

Section 1 (Part A) of the June 2014 ISR for this Geomorphology Study (Study Plan 6.5) details the development of this study from the Revised Study Plan (RSP) in 2012, through the end of the 2013 study season. Section 7 of the ISR (Part C), filed in June 2014, set forth AEA's plan and schedule, at that time, for completing this study and meeting the objectives of the RSP.

As detailed in Section 2.2 of the ISR Part D Overview, various circumstances have required AEA to extend the original timeframe for completing the Commission-approved Study Plan. However, AEA has made meaningful progress with Study 6.5 since the filing of the ISR in June 2014. As detailed below, AEA's recent activities for Study 6.5 have consisted of the following:

- Characterization of the geomorphology of the Upper River Segment and on upstream to the Denali Highway Bridge (RSP Section 6.5.4.1.2.3 and ISR Section 7.2.1.1.3) based on the Upper River Reconnaissance.
- Collection of 2014 bed and suspended-load sediment transport data by the USGS (RSP Section 6.5.4.2 and ISR Section 7.2.1.2).
- Update of the sediment balance in the Middle and Lower Susitna River segments (RSP Section 6.5.4.3.2.1 and ISR Section 7.2.1.3).
- Completed mapping of geomorphic features from 1950s aerials and completed turnover analysis from the 1950s to the 1980s to present (RSP Sections 6.5.4.4.2.1 and 6.5.4.4.2.2, and ISR Section 7.2.1.4).
- Completed mapping the aquatic macrohabitat types in the Middle River from 1980s and current aerial photography (RSP Section 6.5.4.5.2.2 and ISR Section 7.2.1.5).
- Refinement of sediment transport assessment for the pre-Project scenario and completion of literature review on downstream effects of dams (RSP Section 6.5.4.6.2.2 and ISR Section 7.2.1.6).
- Aerial reconnaissance of the reservoir area tributaries (RSP Section 6.5.4.8.2.2 and ISR Section 7.2.1.8).
- Completion of large woody debris (LWD) sampling in the Middle and Lower Susitna River segments (RSP Section 6.5.4.9 and ISR Section 7.2.1.9).
- Review of initial pre- and post-Project 1-D bed evolution model results in the Middle and Lower Susitna River segments (RSP Section 6.5.4.11.2 and ISR Section 7.2.1.11).
- AEA held the first ISR meeting for Studies 6.5 and 6.6 in October 15-17, 21-23, 2014 in Anchorage.
- AEA has completed and filed seven technical memorandums (TMs) documenting results of work performed in 2014 and 2015 (See Section 3 for the list of TMs).
 - Susitna River Historical Cross Section Comparison

- Update of Sediment Transport Relationships and a Revised Sediment Balance for the Middle and Lower Susitna River Segments
 - Mapping of Geomorphic Features and Turnover within the Middle and Lower Susitna River Segments from 1950s, 1980s, and Current Aerials
 - Updated Mapping of Aquatic Macrohabitat Types in the Middle Susitna River Segment from 1980s and Current Aerials
 - Assessment of the Potential for Changes in Sediment Delivery to Watana Reservoir Due to Glacial Surges
 - Dam Effects on Downstream Channel and Floodplain Geomorphology and Riparian Plant Communities and Ecosystems – A Critical Literature Review (Collaborative effort between Study 8.6 and 6.5)
 - Geomorphic Reach Delineation and Characterization, Upper, Middle and Lower Susitna River Segments – 2015 Update. (AEA notes that the geomorphic reach delineation technical memorandum was updated in 2015 to reflect the more detailed information gathered during the August 2014 field reconnaissance of the Upper River Segment and bed material samples collected in the 2014 winter and summer field seasons. The updated version of this technical memorandum is Attachment 1 to this report.)
- Prepared the “2014 – 2015 Study Implementation Report for Geomorphology Study (6.5)” presenting methods, variances, and data collected for study components that have been completed since filing the June 2014 ISR, and filed in November 2015.
 - The “Study Implementation Report” also includes Attachment 1, a technical memorandum “Geomorphic Reach Delineation and Characterization, Upper, Middle and Lower Susitna River Segments – 2015 Update.”

The primary purpose of this Part D Supplemental Information to the ISR is to report on the implementation of the Study Plan from the filing of the ISR in June 2014, through the filing of this ISR Part D. In light of this additional implementation, this Part D also identifies AEA’s plans for completing Study 6.5 in a manner that meets the objectives of the Commission-approved Study Plan.

2. BACKGROUND

2.1. Purpose of Study

The goal of the Geomorphology Study (6.5) is to characterize the geomorphology of the Susitna River, and to evaluate the effects of the Project on the geomorphology and dynamics of the river by predicting the trend and magnitude of geomorphic response. This will inform the analysis of potential Project-induced impacts to aquatic and riparian habitats. The results of this study, along with results of the Fluvial Geomorphology Modeling below Watana Dam Study (Study 6.6), will be used in combination with geomorphic principles and criteria/thresholds defining

probable channel forms to predict the potential for alteration of channel morphology from Project operation. This information will be used to assist in determining whether protection, mitigation, or enhancement measures (PMEs) may be needed, and if so, what those measures may be.

More specific goals of the Geomorphology Study are as follows:

- Determine how the river system functions under existing conditions.
- Determine how the current system forms and maintains a range of aquatic and channel margin habitats.
- Identify the magnitudes of changes in the controlling variables and how these will affect existing channel morphology in the identified reaches downstream of the dam and in the areas upstream of the dam affected by the reservoir.
- In an integrated effort with the Fluvial Geomorphology Modeling Study (RSP Section 6.6), determine the likely changes to existing habitats through time and space.

The study objectives are established in RSP Section 6.5.1:

- Geomorphically characterize the Project-affected river channels and floodplain including:
 - Delineate the Susitna River into geomorphically similar reaches.
 - Characterize and map relic geomorphic forms from past glaciation and debris flow events.
 - Characterize and map the geology of the Susitna River, identifying controlling features of channel and floodplain geomorphology.
 - Identify and describe the primary geomorphic processes that create, influence, and maintain mapped geomorphic features.
- Collect sediment transport data to supplement historical data to support the characterization of Susitna River sediment supply and transport.
- Determine sediment supply and transport in Middle and Lower Susitna River Segments.
- Assess geomorphic stability/change in the Middle and Lower Susitna River Segments.
- Characterize the surface area versus flow relationships for riverine macrohabitat types (1980s main channel, side channel, side sloughs, upland sloughs, tributaries and tributary mouths) over a range of flows in the Middle Susitna River Segment.
- Conduct a reconnaissance-level geomorphic assessment of potential Project effects on the Lower and Middle Susitna River Segments considering Project-related changes to stream flow and sediment supply and a conceptual framework for geomorphic reach response.
- Conduct a phased characterization of the surface area versus flow relationships for riverine macrohabitat types in the Lower Susitna River Segment including:

- Delineation of aquatic macrohabitat per 1980s definitions for selected sites.
 - Comparison of 1980s versus existing macrohabitat areas at selected sites.
 - Estimate potential change in macrohabitat areas based on initial estimates of change in stage from Project operations.
 - Optional – If Focus Areas are extended into the Lower Susitna River Segment, perform analysis of macrohabitat wetted area versus flow relationships for additional sites and flows.
- Characterize the proposed Watana Reservoir geomorphology and changes resulting from conversion of the channel/valley to a reservoir.
 - Assess large woody debris transport and recruitment, their influence on geomorphic forms and, in conjunction with the Fluvial Geomorphology Modeling below Watana Dam Study, effects related to the Project.
 - Characterize geomorphic conditions at stream crossings along access road/transmission line alignments.
 - Integration with the Fluvial Geomorphology Modeling below Watana Dam Study to develop estimates of Project effects on the creation and maintenance of the geomorphic features that comprise important aquatic and riparian macrohabitats and other key habitat indicators, with particular focus on side channels, side sloughs, and upland sloughs.

2.2. Study Components

The study consists of the following components:

- Delineate Geomorphically Similar (Homogeneous) Reaches and Characterize the Geomorphology of the Susitna River
- Bed Load and Suspended-load Data Collection at Tsusena Creek, Gold Creek, and Sunshine Gage Stations on the Susitna River, Chulitna River near Talkeetna and the Talkeetna River near Talkeetna
- Sediment Supply and Transport Middle and Lower Susitna River Segments
- Assess Geomorphic Change Middle and Lower Susitna River Segments
- Riverine Habitat versus Flow Relationship Middle Susitna River Segment
- Reconnaissance-Level Assessment of Project Effects on Lower and Middle Susitna River segments
- Riverine Habitat Area versus Flow Lower Susitna River Segment
- Reservoir Geomorphology
- Large Woody Debris

- Geomorphology of Stream Crossings along Transmission Lines and Access Alignments
- Integration of Fluvial Geomorphology Modeling below Watana Dam Study with the Geomorphology Study

3. STATUS, HIGHLIGHTED RESULTS, AND ACHIEVEMENTS

The following tasks were completed in 2013 and reported in Part A of the ISR for Study 6.5:

- Aerial photography along the entire river corridor from PRM 262 to PRM 3.3 (both 2012 and 2013)
- Data collected on sediment transport by the USGS
- Geomorphic mapping and assessments in the Focus Areas
- Large woody debris mapping and assessment.
- Analysis of historical and current aerial photography
- Mapping of aquatic macrohabitat types and geomorphic features from aerial photographs
- Analysis of sediment transport data and analysis of hydrologic information resulted in the filing of 7 Technical Memorandums.
- One study component, Riverine Habitat versus Flow Lower Susitna River Segment (RSP Section 6.5.4.7, was completed in 2013.

The study has completed the following activities for Study 6.5 since the June 2014 filing of the ISR:

- In the Delineate Geomorphically Similar (Homogeneous) Reaches and Characterize the Geomorphology of the Susitna River study component, several tasks were completed in 2014.
 - Characterization of the geomorphology of the Upper River Segment and on upstream to the Denali Highway Bridge (RSP Section 6.5.4.1.2.3 and ISR Section 7.2.1.1.3) based on the Upper River Reconnaissance.
 - Investigation of the inundation characteristics of the geomorphic surfaces mapped in the 7 focus areas in which field mapping had been performed in 2013.
 - Geomorphic surface mapping was performed for the remaining 3 focus areas in the Middle Susitna River segment (Areas FA-151 Portage Creek, FA-173 Stephan Lake Complex, and FA-184 Watana Dam).
 - Terrace surfaces were evaluated for main channel erosion using the turnover analysis results (Study 6.5 ISR Section 5.4)

- The Bed Load and Suspended-load Data Collection at Tsusena Creek, Gold Creek, and Sunshine Gage Stations on the Susitna River, Chulitna River near Talkeetna and the Talkeetna River near Talkeetna study component was completed in 2014. This involved collection of 2014 bed and suspended-load sediment transport data by the USGS (RSP Section 6.5.4.2 and ISR Section 7.2.1.2). Final data for all three years of data collection; 2012, 2013, and 2014; are presented in Study 6.5 ISR Section 5.2.
- An updated sediment balance in the Middle and Lower Susitna River segments (RSP Section 6.5.4.3.2.1 and ISR Section 7.2.1.3) was developed in the Sediment Supply and Transport Middle and Lower Susitna River Segments study component. The results are presented in the technical memorandum *Update of Sediment-Transport Relationships and a Revised Sediment Balance for the Middle and Lower Susitna River Segments*.
- The Assess Geomorphic Change Middle and Lower Susitna River Segments was completed and the results documented in the technical memorandum *Mapping of Geomorphic Features and Turnover within the Middle and Lower Susitna River Segments from 1950s, 1980s, and Current Aerials*. Task conducted to complete the study component included present (RSP Sections 6.5.4.4.2.1 and 6.5.4.4.2.2, and ISR Section 7.2.1.4):
 - Mapped geomorphic features in the Middle and Lower Susitna River using 1950s aerial photography (geomorphic features had previously been mapped from 1980s and present aerial photography).
 - Performed a turnover analysis from the 1950s, 1980s and present aerials photography to determine the rates at which land is converted to river channel and river channel is converted to floodplain.
- The study component Riverine Habitat versus Flow Relationship Middle Susitna River Segment ((RSP Section 6.5.4.5 and ISR Study 6.5 Section 7.2.1.4) was completed. This involved mapping aquatic macrohabitat types for the remaining 50 percent of the Middle River below Devils canyon in the Middle Susitna River segment from 1980s and current aerial photography (RSP Section 6.5.4.5.2.2 and ISR Section 7.2.1.5). The results are reported in the technical memorandum *Updated Mapping of Aquatic Macrohabitat Types in the Middle Susitna River Segment from 1980s and Current Aerials*.
- Three tasks were performed under the Reconnaissance-Level Assessment of Project Effects on Lower and Middle Susitna River Segments study component (RSP Section 6.5.4.2.6 and ISR Section 7.2.1.6).
 - Refinement of sediment transport assessment for the pre-Project scenario and completion of literature review on downstream effects of dams (RSP Section 6.5.4.6.2.2 and ISR Section 7.2.1.6).
 - Completing the literature review on downstream effects of dams and the resulting technical memorandum “in *Dam Effects on Downstream Channel and Floodplain Geomorphology and Riparian Plant Communities and Ecosystems – A Critical Literature Review* (RSP Section 6.5.4.6.2.4 and ISR Section 7.2.1.6).

- In support of the decision as to whether to continue the 1-D bed evolution model downstream of PRM 29.9, Project related changes in the magnitude of peak flows at Sunshine and Susitna station and changes in flow duration at Susitna Station were determined based on comparison of pre-Project and Max LF OS-1b flows. This effort was a continuation of the streamflow assessment identified in Study 6.5 ISR Section 4.6.2.1.
- Significant tasks performed under the Reservoir Geomorphology study component (RSP Section 6.5.4.2.8) including:
 - Analysis of the potential changes to sediment delivery from the upper Susitna watershed into the reservoir from glacial surges was performed (RSP Section 6.5.4.8.2.1). The results of this effort are documented in the technical memorandum *Assessment of the Potential for Changes in Sediment Delivery to Watana Reservoir Due to Glacial Surges*. As a result of the analysis, it was decided that including a sediment loading scenario in the reservoir sediment trap efficiency task was not warranted.
 - Aerial reconnaissance of the reservoir area tributaries (RSP Section 6.5.4.8.2.2 and ISR Section 7.2.1.8) to support field studies
- Completion of several task in the Large Woody Debris study component (RSP Section 6.5.4.9 and ISR Section 7.2.1.9) including:
 - Completion of the digitization of LWD from 1980s and current aerial photography (Study 6.5 SIR Section 5.9.1)
 - Completion of large woody debris (LWD) sampling in the Middle and Lower Susitna River segments (Study 6.5 SIR Section 5.9.2)
- Conducted aerial reconnaissance of the recently identified Denali East access corridor and portions of the Denali West corridor to identify the general geomorphic condition of streams that the corridor crosses and help with logistical planning of future field work at each crossing (ISR Section 7.2.1.10).
- Review of initial pre- and post-Project 1-D bed evolution model results in the Middle and Lower Susitna River segments (RSP Section 6.5.4.11.2 and ISR Section 7.2.1.11). This included development of an initial framework for integration of the studies based on the First- and Second-order impacts components of the four-order hierarchical evaluation of dam-related impacts identified in the *Technical Memorandum - Dam Effects on Downstream Channel and Floodplain Geomorphology and Riparian Plant Communities and Ecosystems – A critical Literature Review*.

The majority of the results of these efforts since filing of the ISR were documented in the following 7 technical memorandums filed in 2014:

- Geomorphic Reach Delineation and Characterization, Upper, Middle and Lower Susitna River Segments (May 2014)

- Update of Sediment-Transport Relationships and a Revised Sediment Balance for the Middle and Lower Susitna River Segments (September 17, 2014)
- Susitna River Historical Cross Section Comparison (September 17, 2014)
- Mapping of Geomorphic Features and Turnover within the Middle and Lower Susitna River Segments from 1950s, 1980s, and Current Aerials (September 26, 2014)
- Updated Mapping of Aquatic Macrohabitat Types in the Middle Susitna River Segment from 1980s and Current Aerials (September 17, 2014)
- Assessment of the Potential for Changes in Sediment Delivery to Watana Reservoir Due to Glacial Surges (November 14, 2014)
- Dam Effects on Downstream Channel and Floodplain Geomorphology and Riparian Plant Communities and Ecosystems – A Critical Literature Review. Technical Memorandum. (November 14, 2014) [Jointly prepared by the Riparian Instream Flow Study (8.6) and the Geomorphology Study (6.5)]

The 6.5 SIR includes an additional technical memorandum as Attachment 1:

- Geomorphic Reach Delineation and Characterization, Upper, Middle and Lower Susitna River Segments – 2015 Update. (Attachment 1 of Study 6.5 SIR.)

In addition, the Geomorphology Study collaborated with and provided support to the Fluvial Geomorphology Modeling Study (Study 6.6) in the preparation of 2 additional technical memorandums. This integration with Study 6.6 is part of the effort in the Integration of the Fluvial Geomorphology Modeling below Watana Dam Study with the Geomorphology Study (RSP Section 6.5.4.11):

- Decision Point on Fluvial Geomorphology Modeling of the Susitna River below PRM 29.9 (September 26, 2014)
- 2014 Fluvial Geomorphology Modeling Model Development, Attachment 1 of Study 6.6 SIR

4. SUMMARY OF STUDY 6.5 DOCUMENTS

Since filing of the RSP in 2012, AEA and FERC have prepared several documents pertaining to this study. To aid review by FERC staff and licensing participants, each of these documents is listed below. Each of these documents is accessible on AEA's Project licensing website (<http://www.susitna-watanahydro.org/type/documents/>) by clicking on the entry in the "Link" column in the table. In addition, these documents are available on FERC's eLibrary system (<http://www.ferc.gov/docs-filing/elibrary.asp>), in Docket No. P-14241.

Title	Date	Description	Link
6.5. Geomorphology	12/14/2012	This document presents the plan for this study,	RSP for Study 6.5

Title	Date	Description	Link
Study (Revised Study Plan)		including goals, objectives, the study area, and proposed study methods to, in conjunction with Study 6.6, determine Project effects to the fluvial geomorphology of the Susitna River including its channel and floodplain with particular focus on providing information to assist in predicting Project impacts to aquatic and terrestrial habitat.	
Susitna River Large Woody Debris Reconnaissance Technical Memorandum	2/28/2013	The overall purpose of the work presented in this TM was to summarize a large woody debris reconnaissance performed between June 23, 2012 and July 3, 2012, by the Riparian Vegetation Survey team, in order to support development of the final 2013-2014 Large Woody Debris Study plan included in the Geomorphology Study (6.5).	Feb. 2013 TM for Study 6.5
Development of Sediment Transport Relationships and an Initial Sediment Balance for the Middle and Lower Susitna River Segments	3/1/2013	The purpose of the study effort was to make preliminary estimates of the overall sediment balance in the Middle and Lower River segments under pre-Project conditions and the potential magnitude of the changes that will occur under Maximum Load Following Operating Scenario OS-1 hydrologic conditions. Results of this preliminary sediment balance indicated that the portion of the Susitna River between Sunshine and Susitna Station would remain aggradational but the surplus load would be decreased by about one third under Project conditions.	Mar. 2013 TM for Study 6.5 (File 1) Mar. 2013 TM for Study 6.5 (File 2)
Initial Geomorphic Reach Delineation and Character-ization, Middle and Lower Susitna River Segments	3/1/2013	This effort delineated large-scale geomorphic river reaches with relatively homogeneous characteristics for the purposes of stratifying the river into study segments. The reaches were used by other resource studies to stratify their data collection efforts.	Mar. 2013 TM for Study 6.5
Reconnaissance Level Assessment of Potential Channel Change in the Lower Susitna River Segment	3/1/2013	This effort synthesized results from other technical memoranda within an analytical framework to assess the potential Project-related changes in channel morphology of the Lower River. The overall goal was to determine whether portions of the Fluvial Geomorphology Modeling Study and other studies need to be extended downstream in the Lower River based on the potential for the Project to affect channel morphology. Based on the results of the assessment in this TM, the downstream boundary of the 1-D bed evolution model was extended from PRM 79 to PRM 29.9.	Mar. 2013 TM for Study 6.5
Stream Flow Assessment	3/1/2013	The purpose of this TM was to identify the potential Project related changes in Susitna River flows and stage in the Lower River. The Stream Flow Assessment involved analysis of pre-Project and post-Project flows in the Susitna River below Watana Dam.	Mar. 2013 TM for Study 6.5 (File 1) Mar. 2013 TM for Study 6.5 (File 2)

Title	Date	Description	Link
		The results of this TM showed peak flow reduction could potentially result in a narrowing of the Lower River below Sunshine and above the Yentna River Confluence by on the order of 1220 percent. This was a major factor in the decision to extend the 1-D bed evolution model to PRM 29.9 (Susitna Station).	
Synthesis of 1980s Lower Susitna River Segment Aquatic Habitat Information	3/21/2013	This effort was designed to identify whether potential Project effects on aquatic habitat and tributary access in the Lower River warranted additional study and, if necessary, help in planning those studies. This TM addressed the Lower River and utilized information from the 1980s studies.	Mar. 2013 TM for Study 6.5 (File 1) Mar. 2013 TM for Study 6.5 (File 2)
Mapping of Aquatic Macrohabitat Types at Selected Sites in the Middle and Lower Susitna River Segments from 1980s and 2012 Aerials	3/21/2013	The overall purpose of the work presented in this TM was to quantify aquatic macrohabitat types at selected sites in the Middle and Lower Susitna River Segments, compare the resulting areas, and determine the applicability of the 1980s information to current conditions. As a result of the assessment it was determined that macro-habitat area vs. flow relationships at specific locations changed sufficiently over time that 1980s aerial photographs may not be representative of current conditions at the specific sites	Mar. 2013 TM for Study 6.5 (File 1) Mar. 2013 TM for Study 6.5 (File 2) Mar. 2013 TM for Study 6.5 (File 3)
Mapping of Geomorphic Features and Assessment of Channel Change in the Middle and Lower Susitna River Segments from 1980s and 2012 Aerials	3/22/2013	The overall purpose of the work presented in this TM is to quantify geomorphic features in the Middle and Lower Susitna River Segments, compare the resulting areas, and perform an assessment of channel change between the 1980s to present.	Mar. 2013 TM for Study 6.5 (File 1) Mar. 2013 TM for Study 6.5 (File 2) Mar. 2013 TM for Study 6.5 (File 3) Mar. 2013 TM for Study 6.5 (File 4) Mar. 2013 TM for Study 6.5 (File 5) Mar. 2013 TM for Study 6.5 (File 6) Mar. 2013 TM for Study 6.5 (File 7) Mar. 2013 TM for Study 6.5 (File 8)
FERC's Study Plan Determination	4/1/2013	This document presents FERC approval of Study 6.5, which approved AEA's Revised Study Plan with no recommended changes.	FERC SPD for Study 6.5
Draft Initial Study Report for Study 6.5 and	2/3/2014	This draft of the ISR summarized the study methods and variances during the 2013 study season, and presented preliminary data collected for Study 6.5.	Draft ISR for Study 6.5 (File 1)

Title	Date	Description	Link
Appendices		This draft ISR was later republished as Part A of the final ISR.	Draft ISR for Study 6.5 (File 2) Draft ISR for Study 6.5 (File 3) Draft ISR for Study 6.5 (File 4) Draft ISR for Study 6.5 (File 5) Draft ISR for Study 6.5 (File 6) Draft ISR for Study 6.5 (File 7)
Geomorphic Reach Delineation and Characterization, Upper, Middle and Lower Susitna River Segments	5/25/2014	This updated report adds geomorphic reach delineation and characterization for the Upper Susitna River Segment as well as updated median bed-material sizes collected during the 2013 field season in Middle and Lower Susitna River geomorphic reaches. This TM updated the Initial Geomorphic Reach Delineation TM field February 2013. Primary update was adding the Upper Susitna River Segment.	May 2014 TM for Study 6.5
Initial Study Report for Study 6.5	6/3/2014	This document is the Initial Study Report (Parts A, B and C) for Study 6.5. Part A republishes the Draft ISR. Part B identifies supplemental information and errata in Part A. Part C presents study modifications and plans for completing the study.	ISR Part A for Study 6.5 (File 1) ISR Part A for Study 6.5 (File 2) ISR Part A for Study 6.5 (File 3) ISR Part B for Study 6.5 ISR Part C for Study 6.5
Susitna River Historical Cross Section Comparison	9/17/2014	The TM identified changes within the main and side channels of the Susitna River by comparing historical survey data from the 1980s with survey data from the current project. This information was used in Study 6.6 to help validate the 1-D bed evolution model.	Sept. 2014 TM for Study 6.5
Update of Sediment Transport Relationships and a Revised Sediment Balance for the Middle and Lower Susitna River Segments	9/17/2014	The purpose of the study effort was to update the sediment load rating curves and preliminary estimates of the overall sediment balance in the Middle and Lower River segments under pre- Project conditions that were initially provided in a 2013 TM. Sediment transport relationships developed in this TM supported development of the 1-D sediment transport model in Study 6.6.	Sept. 2014 TM for Study 6.5
Mapping of Geomorphic Features and Turnover within the Middle and	9/26/2014	The purpose of this TM was to update the geomorphic mapping and assessment of channel change that were initially provided in the 2013 TM. This TM added	Sept. 2014 TM for Study 6.5 (File 1)

Title	Date	Description	Link
Lower Susitna River Segments from 1950s, 1980s, and Current Aerials		analysis of 1950s aerials and turnover analysis, which were not included in the 2013 TM.	Sept. 2014 TM for Study 6.5 (File 2) Sept. 2014 TM for Study 6.5 (File 3) Sept. 2014 TM for Study 6.5 (File 4) Sept. 2014 TM for Study 6.5 (File 5) Sept. 2014 TM for Study 6.5 (File 6) Sept. 2014 TM for Study 6.5 (File 7) Sept. 2014 TM for Study 6.5 (File 8) Sept. 2014 TM for Study 6.5 (File 9) Sept. 2014 TM for Study 6.5 (File 10) Sept. 2014 TM for Study 6.5 (File 11) Sept. 2014 TM for Study 6.5 (File 12) Sept. 2014 TM for Study 6.5 (File 13) Sept. 2014 TM for Study 6.5 (File 14) Sept. 2014 TM for Study 6.5 (File 15) Sept. 2014 TM for Study 6.5 (File 16)
Updated Mapping of Aquatic Macrohabitat Types in the Middle Susitna River Segment from 1980s and Current Aerials	9/26/2014	The purpose of this TM was the update of the 2013 TM. The update expanded the aquatic macrohabitat mapping in the Middle River from 50 percent to 100 percent. Current mapping was extended above Devils Canyon. This TM replaces the 2013 TM.	Sept. 2014 TM for Study 6.5 (File 1) Sept. 2014 TM for Study 6.5 (File 2) Sept. 2014 TM for Study 6.5 (File 3) Sept. 2014 TM for Study 6.5 (File 4) Sept. 2014 TM for Study 6.5 (File 5)
Assessment of the Potential for Changes in	11/14/2014	The purpose of this TM was to assess the likelihood of a glacial surge in the Susitna River Basin significantly	Nov. 2014 TM for Study 6.5

Title	Date	Description	Link
Sediment Delivery to Watana Reservoir Due to Glacial Surges		increasing sediment delivery to the proposed Watana Reservoir. As a result of the TM, it was determined that the potential delivery of sediment to the proposed reservoir from a glacial surge did not warrant including an increased sediment loading scenario to account for glacial surge.	
Dam Effects on Downstream Channel and Floodplain Geomorphology and Riparian Plant Communities and Ecosystems – A Critical Literature Review	11/14/2014	This TM synthesized studies of hydro project impacts on downstream floodplain plant communities, studies of un-impacted floodplain plant community successional processes, and historic physical and biologic data for the Susitna River floodplain vegetation, including 1980s studies. This TM was produced collaboratively between the Riparian IFS (Study 8.6) and the Geomorphology Study (6.5).	Nov. 2014 TM for Study 6.5
Initial Study Report Meetings, October 16, 2014 (Parts A and B)	11/15/2014	Transcripts and AEA's agenda and PowerPoint presentations for the ISR meeting concerning the Project Geomorphology Study.	Transcripts from ISR Meeting Materials from ISR Meeting
Geomorphology Study (6.5) – 2014-2015 Study Implementation Report and Attachment	11/4/2015	This report describes data collected in 2014 and summarizes the analyses conducted in 2014 and 2015 that are further described in the 2014 TMs and Attachment 1.	2014-2015 SIR for Study 6.5 (File 1) 2014-2015 SIR for Study 6.5 (File 2) 2014-2015 SIR for Study 6.5 (File 3)

5. NEW STUDY DOCUMENTATION SUPPLEMENTING THE ISR

The following table identifies and describes additional reports and other documents that update, refine, or otherwise supplement certain sections of the ISR pertaining to this Study 6.5, during AEA's continued implementation of the Study Plan since the ISR was filed in June 2014.

ISR Reference	Description
Part A, Section 4	This Section is updated and supplemented by the Study Implementation Report for Study 6.5 (Section 4), which described the study methods and variances in 2014 -2015.
Part A, Section 5	This section is updated and supplemented by the Study Implementation Report for Study 6.5 (Section 5), which described the study results in 2014 -2015.
Part A, Section 6	This section is updated and supplemented by the Study Implementation Report for Study 6.5 (Section 6), which discusses the study results in 2014 -2015.

Part C, Section 7	The decision points and modifications in this section are updated and supplemented by the Study Implementation Report for Study 6.5 (Section 7), which presents the decision points from 2014 and proposed modification after conducting studies in 2014 -2015.
Part C, Section 7	The Steps to Complete the Study in this section are superseded by Section 8 in this document (Part D).

6. VARIANCES

6.1. 2013 Study Season

The following variances are reported in the June 2014 ISR:

- The pebble count bed-material samples identified in the Study Plan (RSP Section 6.5.4.2.2) were not collected by the USGS in 2012. Since numerous bed-material samples are being collected throughout the Middle and Lower Susitna River Segments as part of the Fluvial Geomorphology Modeling below Watana Dam Study (ISR 6.6 Section 4.1.2.9), this will not affect the ability to meet study objectives (ISR 6.5 Section 4.2.3). In addition, the USGS did perform pebble counts in 2013 to characterize bed material at the sediment transport measurement sites.
- Due to logistical and safety issues, the bed load samples at Tsusena Creek identified in the Study Plan (RSP Section 6.5.4.2.2) were terminated after 2012, were not collected in 2013, and will not be collected by the USGS in the future. This will not affect the ability to meet study objectives as alternate means are available to determine the bed load passing the dam site for the without Project condition (ISR 6.5 Section 4.2.3).
- The initial sediment balance task in Study Plan (RSP section 6.5.4.3.2.1) calls for comparison of the total sediment load at the Sunshine and Susitna Station gages for an average, wet, and dry year between pre- and post-Project conditions (RSP Section 6.5.4.3.2). The total sediment load was actually determined for the entire 61 year extended record which provided a more comprehensive assessment of the sediment balance (ISR 6.5 Section 4.3.3).
- The Study Plan identifies the determination of effective discharge of the Susitna River at Gold Creek, Sunshine and Susitna Station (RSP Section 6.5.4.3.2.4). In addition to these locations the effective discharge was also calculated for the Susitna River at Susitna Station, the Chulitna River, the Talkeetna River and the Yentna River providing a more comprehensive analysis than originally planned (ISR 6.5 Section 4.3.3).
- It was the intent of the Study Plan (RSP Section 6.5.4.5.2.1) to obtain three sets of aerial photography in 2012 at the following approximate discharges: 23,000, 12,500, and 5,100 cfs. The decision was made to acquire aerials at a single target flow of approximately 12,500 cfs as AEA concluded that aerial photography collected at specified discharges to develop macrohabitat area versus flow relationships was not necessary for the meeting the objectives of the Study Plan as the combination of the 2-D hydraulic modeling,

bathymetry and topography collected in the Focus Areas can provide direct determination of the area of the various macrohabitat types over the range of flows of interest (ISR 6.5 Section 4.5.3).

- Hydrologic analysis of operation scenarios beyond the initial streamflow assessment is identified in the Study Plan for the Geomorphology Study (RSP Section 6.5.4.6.2.1); however, in 2013 it was decided that the analysis would be performed in the Fish and Aquatics IFS (Study 8.5 Section). The initial streamflow assessment was performed as part of the Geomorphology Study (ISR 6.5 Section 4.6.3).
- The variance in the LWD study component (ISR Study 6.5 Section 4.9.3) is related to the August 2013 high-flow event that provided the opportunity to assess LWD movement at several sample areas; this was an unanticipated event and was not included in the Study Plan (RSP Section 6.5.4.9.2). This event provided additional data on wood movement and helps to meet study objectives.

6.2. 2014 Study Season

As noted in Section 4 of the Study Implementation Report for this study, the following variances occurred when implementing this study in 2014:

- For the Delineate Geomorphically Similar (Homogeneous) Reaches and Characterize the Geomorphology of the Susitna River study component there was one variance in 2014 (Study 6.5 SIR Section 4.1.1) to the Study Plan. This involved the collection of opportunistic water quality samples while performing the Upper River reconnaissance. This variance will enhance AEA's ability to meet objectives of the Water Quality Baseline Study (5.5) and Fish Distribution and Abundance in the Upper Susitna River (9.5) by providing additional water quality data.
- For the Bed Load and Suspended-load Data Collection at Tsusena Creek, Gold Creek, and Sunshine Gage Stations on the Susitna River, Chulitna River near Talkeetna and the Talkeetna River near Talkeetna study component (RSP Section 6.5.4.2) there was one variance as described in ISR Part A Section 4.2.3 and Section 6.1 above. This involved the USGS ceasing bed load data collection for the Susitna River at Tsusena Creek after 2012 due to safety and logistical concerns. This variance was proposed as a modification to the study (ISR Part C Section 7.1.2.2) and was implemented in 2014 as a variance to the Study Plan.
- In the Sediment Supply and Transport Middle and Lower Susitna River Segments study component (RSP Section 6.5.4.3) there were two variances in 2013 that were continued in 2014. These were described as variances in 2013 (Study 6.5 ISR Part A Section 4.3.3) and were proposed as modifications to the Study Plan (see Study 6.5 ISR Part C Section 7.1.2.3). One variance involved the time period for calculating total sediment load and the resulting sediment balance and the other involved a calculation procedure for effective discharge. These variances, as described in ISR Part C Section 7.1.2.3, were implemented in 2014. The entire available flow record (61 years) was used to evaluate sediment loads rather than only representative dry, average and wet years and equal arithmetic bins were used to evaluate effective discharge rather than logarithmic bins.

- A third variance in the Sediment Supply and Transport Middle and Lower Susitna River Segments study component (RSP Section 6.5.4.3) involved collecting videos during reconnaissance trips on the Middle and Lower Susitna River. The variance is described in Study 6.5 SIR Section 4.3.1. These videos help document conditions of tributaries and potential sources of sediment from mass wasting along the mainstem Susitna River. These opportunistically collected videos from aerial reconnaissance enhance AEA's ability to meet the objectives of this study component.
- There is one variance in the Riverine Habitat versus Flow Relationship Middle Susitna River Segment study component (RSP Section 6.5.4.5) in 2014 that is a continuation of a 2013 variance and described in Section 6.1 above. This variance involving the collection of aerial photography and the development of macrohabitat area versus flow relationships was proposed as a modification to the study (ISR Part C Section 7.1.2.5) and was implemented in 2014 as a variance to the Study Plan.
- For the streamflow assessment task in RSP Section 6.5.4.6.2.1 of the Reconnaissance-Level Assessment of Project Effects on Lower and Middle Susitna River Segments study component it was indicated that this work would be performed in the Geomorphology Study 6.5. The initial streamflow assessment was performed as part of the Geomorphology study in 2012 and early 2013. It was later decided that future stream flow assessments would be performed by the Fish and Aquatics IFS (Study 8.5). This was proposed in Study 6.5 ISR Part C Section 7.1.2.6 as a modification. However, in 2014 in support of the decision on whether to extend the 1-D bed evolution model downstream of PRM 29.9, hydrologic analyses of Max LF OS-1b were performed in the Geomorphology Study (6.5). The Geomorphology Study will continue to conduct stream flow assessments using results of the 1-D bed evolution model routed flows in the analysis of operation scenarios.

7. STUDY PLAN MODIFICATIONS

7.1. Modifications Identified in ISR

Section 7 of the ISR (Part C) details modifications for this study following the 2013 study season. These modifications are generally summarized as follows:

- A modification to the Study Component: Bed- and Suspended-load Data Collection at Tsusena Creek, Gold Creek, and Sunshine Gage Stations on the Susitna River, Chulitna River near Talkeetna and the Talkeetna River near Talkeetna study component was proposed in Section 7.1.2.2 of the Study 6.5 ISR (Part C) for the elimination of bed load data collection at the Susitna River near Tsusena Creek site in 2014 field season due to safety and logistical reasons. This is described as a 2014 variance in Section 6.2 above.
- For the Sediment Supply and Transport Middle and Lower Susitna River Segments study component two variances occurred in 2013 that modifications were requested to carry forward in 2014. The first involved the hydrologic period used to calculate average annual loads and the second the methods used for determining effective discharge. These

are described in Section 7.1.2.3 of the Study 6.5 ISR (Part C) and identified as a variance in Section 6.2 above.

- There is one variance identified for Riverine Habitat versus Flow Relationship Middle Susitna River Segment study component from 2013 (ISR Study 6.5 Section 4.5.3) that was proposed as a modification for 2014. This variance involving the collection of aerial photography and the development of macrohabitat area versus flow relationships was proposed as a modification to the study (ISR Part C Section 7.1.2.5) and was implemented in 2014 as a variance to the Study Plan. It is identified in Sections 6.1 and 6.2 above.
- One variance was identified for the Reconnaissance-Level Assessment of Project Effects on Lower and Middle Susitna River Segments study component in 2013 that was proposed as a modification for 2014 (Study 6.5 ISR Part C Section 7.1.2.6). In the streamflow assessment task in RSP Section 6.5.4.6.2.1 and the ISR Study 6.5, Part A, Section 4.6.3 of this study component, it was indicated that hydrologic analysis of operation scenarios beyond the initial streamflow assessment would be performed in the Fish and Aquatics IFS (Study 8.5). A study modification was proposed to address this. However, in 2014 in support of the decision on whether to extend the 1-D bed evolution model downstream of PRM 29.9, hydrologic analyses of Max LF OS-1b were performed in the Geomorphology Study (6.5). Therefore in 2014, there was not a variance related to performance of hydrologic analysis by the Geomorphology Study (6.5). Therefore the earlier request for a modification is not necessary.

7.2. Modifications Identified since the June 2014 ISR

As detailed in the 2014 Implementation Report for Study 6.5, AEA proposes modifications to complete the study in a manner that meets Study Plan objectives. These modifications are generally summarized as follows:

- In Section 7.2.1 of the Study 6.5 SIR it is proposed, due to the supply limited nature of the Middle River, that calculation of the effective discharge associated with any operation scenario analyzed in the future not be performed for the Middle River. It is proposed for the Lower River that the effective discharge still be determined, but instead of using sediment transport rating curves, the 1-D bed evolution model sediment transport results will be used to determine effective discharge. This modification is proposed for the Sediment Supply and Transport Middle and Lower Susitna River Segments study component.
- A modification is proposed in Section 7.2.2 of the Study 6.5 SIR to the Reconnaissance-Level Assessment of Project Effects on Lower and Middle Susitna River Segments study component to replace the Grant et al. (2003) framework for analyzing the downstream impact of the Project with the framework for First- and Second-order analysis of dam effects on river morphology (Study 6.5 SIR Section 5.11) that was developed as part of the Geomorphology Study (6.5) specifically for the conditions on the Susitna River.
- Also proposed in Section 7.2.2 of the Study 6.5 SIR is a modification to not perform the determination of the Modified Braiding Index (MBI). Its use is not applicable to the

Middle River segment because the planform does not consist of dynamic multiple bar-braided channels within a braid plain. It is also proposed that the determination of the index not be performed in the Lower River as it will not produce useful information that would add to the assessment of potential Project impacts beyond what is proposed in this study component with the streamflow assessment, sediment transport assessment and framework for First-order and Second-order analysis of dam effects on river morphology.

- A modification for the Reservoir Geomorphology Study component is proposed in Section 7.2.3 of the Study 6.5 SIR. Based on comments at the Initial Study Report (ISR) Meeting held October 16, 2014 in Anchorage, it was decided to develop a 1-D bed evolution model to determine the depositional characteristics of the sand and larger sediment fraction of the sediment inflow to the reservoir for various operation scenarios in the upper end of the reservoir. The proposed 1-D model will be similar to the 1-D bed evolution model developed for the Middle and Lower Susitna River segments in the Fluvial Geomorphology Modeling Study (6.6). The model will extend from just below the downstream limits of the reservoir fluctuation zone to a distance approximately 5 miles upstream of the Oshetna River confluence.

8. STEPS TO COMPLETE THE STUDY

In light of the variances and modifications described above, the steps necessary for AEA to complete this study are summarized below. As necessary and appropriate, these steps have been updated from those appearing in Section 7 of the ISR (Part C).

8.1. Study Component: Delineate Geomorphically Similar (Homogeneous) Reaches and Characterize the Geomorphology of the Susitna River

Much of the effort associated with this study component has been completed. The work under the three tasks that remains from Study 6.5 ISR Part C Section 7.2.1.1 and 7.2.2.1 are identified below.

Identification and Development of Geomorphic Classification System: This task is complete and no work remains.

Geomorphic Reach Delineation: This task is complete and no work remains.

Geomorphic Characterization of the Susitna River: The following activities from Study 6.5 ISR Part C Section 7.2.1.1.3 will be performed as information becomes available to complete the geomorphic characterization of the Susitna River.

- The bedrock and lateral constraint mapping may be updated based on observations during the 2014 field season within MR-1, MR-2, and MR-3.

- Complete the correlation of geomorphic surfaces with water-surface elevations determined from hydraulics generated by the 1-D and/or 2-D Bed Evolution models (Study 6.6) as the model results become available for each focus area.
- Integration of ice-modeling efforts (ice jam backwater and/or dam break surge) with geomorphic surfaces and system dynamics (Study 7.6).
- Integration of data from riparian investigations (Study 8.6) including vegetation mapping and aging to better define age constraints in FAs.
- Analysis of the spatial distribution of geomorphic surfaces and channel types within different aged components of the FAs.
- Integration of turnover analysis results with FA dynamics.
- Complete the investigation of sources of sand that is the volumetrically significant fraction of the sediment load for construction of geomorphic surfaces in the Middle River as results of the finalized sediment balance from the Middle River become available (Study 6.5 ISR Part C Section 7.2.1.3).

A comprehensive Technical Memorandum will be prepared presenting the results of the geomorphic characterization of the Susitna River. The technical memorandum will integrate the information compiled in this study as well as relevant information from the Fluvial Geomorphology Modeling Study (Study 6.6), Fish and Aquatics IFS (Study 8.5), Riparian IFS (Study 8.6), Ice Processes Study (Study 7.6) and Groundwater Study (Study 7.5) to provide a thorough characterization of the key geomorphic processes that create and maintain the geomorphic features that form the Susitna River. The identified processes are conceptualized in the geomorphic models that describe the current (pre-Project) behavior of the Susitna River.

8.2. Study Component: Bed- and Suspended-load Data Collection at Tsusena Creek, Gold Creek, and Sunshine Gage Stations on the Susitna River, Chulitna River near Talkeetna and the Talkeetna River near Talkeetna

This effort was completed in 2014 and no work remains.

8.3. Study Component: Sediment Supply and Transport Middle and Lower Susitna River Segments

Several tasks that were described in Study 6.5 ISR Part C Sections 7.2.1.3 and 7.2.2.3 remain to be performed to complete this study component. The first is to complete the detailed sediment balance between the proposed Watana Dam site (PRM 187.1) and the Three Rivers Confluence (PRM 102.4) considering finalized tributary sediment loading, suspended load measurements for the Susitna River at Tsusena Creek, and contributions from bank erosion and mass wasting.

The characterization of bed-material mobilization will be updated following the methods presented in ISR Study 6.5 Section 4.3.2.3. This will include expansion of the bed mobilization calculations to each of the Focus Areas and for the average hydraulic conditions and bed-

material characteristics for each of the Middle and Lower Susitna River segment geomorphic reaches (LR 5 and LR 6 are not included). Bed mobilization will be determined and summarized for each operation scenario analyzed. The effective discharge in the Lower River Susitna River segment will be determined for each operation scenario using sediment transport rates from the 1-D bed evolution model. The sediment balance will be summarized for each operation scenario from the 1-D bed evolution results in the Middle and Lower Susitna River segments.

The USGS sediment transport data collected in 2014 will be reviewed and, if warranted, final adjustments to sediment transport rating curves for the Susitna River mainstem sites (at Tsusena Creek, at Gold Creek, at Sunshine and at Susitna Station), the Chulitna River, the Talkeetna River, and the Yentna River will be made.

8.4. Study Component: Assess Geomorphic Change Middle and Lower Susitna River Segments

This study component is complete and no work remains.

8.5. Study Component: Riverine Habitat versus Flow Relationship Middle Susitna River Segment

This study component is complete and no work remains.

8.6. Study Component: Reconnaissance-Level Assessment of Project Effects on Lower and Middle Susitna River Segments

Several tasks listed in Study 6.5 ISR Part C Section 7.2.1.6 and 7.2.2.6 remain to be completed on this study component. The remaining effort as identified in RSP Section 6.5.4.6 involves analysis that helps in evaluating and interpreting modeling results from the Fluvial Geomorphology Modeling Study (Study 6.6). Specific efforts remaining include:

- Finalize the sediment transport assessment in conjunction with the detailed sediment balance for the pre-Project condition identified in Section 8.3 above.
- Use the results for the 1-D bed evolution model to perform the streamflow assessment, sediment transport assessment, and framework for First- and Second-order analysis of dam effects on river morphology (See Study 6.5 SIR Section 5.11) for each operation scenario as identified in ISR Sections 4.6.2.1, 4.6.2.2 and 4.6.2.3.
- Complete the concurrent flow and stage analysis to help determine the potential for Project-induced changes in flows and stage on the Susitna River to alter the erosion patterns in the area of the town of Talkeetna. The analysis will be performed for the pre-Project condition and one with-Project scenario.

8.7. Study Component: Riverine Habitat Area versus Flow Lower Susitna River Segment

This study component is complete and no work remains.

8.8. Study Component: Reservoir Geomorphology

Several tasks listed in Study 6.5 ISR Part C Section 7.2.1.8 and 7.2.2.8 remain to be completed on this study component. This includes work in all 4 tasks associated with this study component (RSP Section 6.5.4.8.2). The final two items under the delta formation task involve a proposed study modification presented in Section 7.2 above.

- Reservoir Trap Efficiency and Sediment Accumulation: The Water Quality Modeling Study (5.6) EFDC model will provide the estimate of sediment trapping in the reservoir along with the resulting sediment outflow at the dam. The sediment outflow from the EFDC model and will be used as the upstream sediment supply to the 1-D bed evolution model. Work in the Geomorphology Study (6.5) remaining on this task includes:
 - Continued coordination with the Water Quality Modeling Study (Study 5.6) will occur on the simulation of trapping of fine sediment being performed using the EFDC model for each alternative operation scenario as they become available. The Study 5.6 results will be checked against the sediment trapping estimates previously developed by the Geomorphology Study.
 - The reviewed results of the Watana Dam sediment outflow from the Water Quality Modeling Study (Study 5.6) will be provided to the Fluvial Geomorphology Modeling Study (Study 6.6) to serve as the upstream sediment supply to the 1-D Bed Evolution Model of post-Project scenarios.
- Delta Formation: To complete the delta formation task of the Reservoir Geomorphology study component the following efforts will be performed:
 - Field data will be collected on the six tributaries selected for evaluation in this task (Oshetna River, Goose Creek, Jay Creek, Kosina Creek, Watana Creek and Deadman Creek).
 - The analysis of the potential formation of tributary deltas will be evaluated per RSP Section 6.5.4.8.2.2 for the six selected tributaries. This will include coordination with the Study of Fish Barriers in the Middle and Upper Susitna River and Susitna Tributaries (Study 9.12)
 - Data will be collected (primarily bed material and cross sections) and a 1-D bed evolution model developed that will extend from approximately 5 miles upstream of the Oshetna confluence downstream to the lower elevation in the reservoir fluctuation zone (1850 feet NAVD88). This is part of the proposed study modification presented in the Study 6.5 SIR Section 7.2.3 and Section 7.2 above.
 - The 1-D bed evolution model identified in the modifications in Section 7.2 above and in Study 6.5 SIR Section 7.2.3 will be run for the pre-Project condition and each operation scenario to determine the distribution of coarse sediment deposits in the reservoir fluctuation zone and the portion of the Susitna River upstream of the reservoir that may be affected by reservoir backwater and mainstem delta formation..

- **Reservoir Erosion:** The following work will be performed to complete the reservoir erosion task of the Reservoir Geomorphology study component (RSP Study 6.5 Section 6.5.4.8.2.3):
 - Coordination with the Geology and Soils Characterization Study (Study 4.5) will continue to share information on slope stability, mass wasting and shoreline erosion. Information developed in that study will be used to perform the initial office analysis of reservoir erosion/mass wasting potential that will help refine the field work.
 - All field work for the reservoir erosion task remains to be performed including collection of soil and geology data.
 - Perform reservoir erosion analysis per RSP Study 6.5 Section 6.5.4.8.2.3.
- **Bank and Boat-wave Erosion Downstream of Watana Dam:** All work on this task remains to be performed. This analysis will be performed per RSP Study 6.5 Section 6.5.4.8.2.4, and will use data collected in the Fluvial Geomorphology Modeling below Watana Dam Study (ISR Study 6.6 Section 4.1.2.9).

8.9. Study Component: Large Woody Debris

To complete this study component the two tasks described in Study 6.5 ISR Part C Sections 7.2.2.9 need to be performed per the Study Plan (RSP Section 6.5.4.9.2). The remaining work involves conducting the field inventory of LWD in the Upper Susitna River segment and performing an evaluation of the interactions of LWD with aquatic habitat, geomorphological processes, ice processes, and riparian resources.

8.10. Study Component: Geomorphology of Stream Crossings along Transmission Lines and Access Alignments

To complete this study component the two tasks described in Study 6.5 ISR Part C Sections 7.2.2.10 need to be performed per the Study Plan (RSP Section 6.5.4.10.2). These efforts include the work along the transmission/access corridors and analysis of results.

8.11. Study Component: Integration of the Fluvial Geomorphology Modeling below Watana Dam Study with the Geomorphology Study

To complete this study component the three tasks described in Study 6.5 ISR Part C Sections 7.2.2.11 need to be performed per the Study Plan (RSP Section 6.5.4.11.2 and Study 6.5 ISR Section 4.11.2):

- Results of the final pre-Project model runs in the Middle River will be reviewed and interpreted in terms of the geomorphic response. This will include any refinement as necessary of the framework for First- and Second-order analysis of dam effects on river morphology (See Section 5.11 of Study 6.5 SIR).

- Results from the 1-D Bed Evolution Model runs of post-Project scenarios, as they become available, will be reviewed and interpreted in terms of the geomorphic response.
- Results from the 2-D Bed Evolution Model runs of post-Project scenarios, as they become available, will be reviewed and interpreted in terms of the geomorphic response.