Susitna-Watana Hydroelectric Project Document
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March 1, 2013

Ms. Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Re: Susitna-Watana Hydroelectric Project, FERC Project No. 14241-000; Submittal of Information Related to Study Plan Determination

Dear Secretary Bose:

By letter dated January 17, 2013, Staff of the Federal Energy Regulatory Commission (Commission) revised the licensing schedule for the Alaska Energy Authority's (AEA) proposed Susitna-Watana Hydroelectric Project, FERC Project No. 14241 (Project).[1] Primarily, Commission Staff's January 17th letter established a process for its April 1, 2013 issuance of the Study Plan Determination (SPD) for 14 of the individual study plans included in AEA's Revised Study Plan (RSP),[2] filed with the Commission on December 14, 2012.[3] Leading up to Staff's April 1 SPD, the January 17th letter required AEA to prepare and file, following consultation with licensing participants, additional information that Commission Staff have deemed necessary for the April 1 SPD. The purpose of this filing is to submit the information required by Staff's January 17th letter, as well as other relevant information in support of these 14 study plans.

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1 Letter from Jeff C. Wright, Federal Energy Regulatory Commission, to Wayne Dyok, Alaska Energy Authority, Project No. 14241-000 (issued Jan. 17, 2013) [hereinafter, "January 17th Letter"].

2 Commission Staff's January 17th letter established April 1 as the SPD date for 13 of the individual studies in the RSP. January 17th Letter, Attachment A. When issuing the SPD for the other individual study plans in the RSP, however, Commission Staff postponed its determination on one additional study until the April 1, 2013 SPD. Letter from Jeff C. Wright, Federal Energy Regulatory Commission, to Wayne Dyok, Alaska Energy Authority, at 3, Project. No. 14241-000 (issued Feb. 1, 2013). In total, the 14 individual studies scheduled for Staff's April 1st SPD consist of the following: (1) Baseline Water Quality (RSP 5.5); (2) Water Quality Modeling Study (RSP 5.6); (3) Mercury Assessment and Potential for Bioaccumulation Study (RSP 5.7); (4) Geomorphology Study (RSP 6.5); (5) Fluvial Geomorphology Modeling Below Watana Dam Study (RSP 6.6); (6) Groundwater Study (RSP 7.5); (7) Ice Processes in the Susitna River Study (RSP 7.6); (8) Fish and Aquatics Instream Flow Study (RSP 8.5); (9) Riparian Instream Flow Study (RSP 8.6); (10) Study of Fish Distribution and Abundance in the Upper Susitna River (RSP 9.5); (11) Study of Fish Distribution and Abundance in the Middle and Lower Susitna River (RSP 9.6); (12) River Productivity Study (RSP 9.8); (13) Characterization and Mapping of Aquatic Habitats (RSP 9.9); and (14) Riparian Vegetation Study Downstream of the Proposed Susitna-Watana Dam (RSP 11.6).

3 Revised Study Plan, Project No. 14241-000 (filed Dec. 14, 2012) [hereinafter, "RSP"].

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As required by Commission Staff's January 17th letter, AEA hereby submits the following documents:

Requested Information[4]	Attachment
Final implementation plan for Study of Fish Distribution and Abundance in the Upper Susitna River (RSP 9.5)	Attachment A, *Final Susitna River Fish Distribution and Abundance Implementation Plan* (March 2013)
Final implementation plan for Study of Fish Distribution and Abundance in the Middle and Lower Susitna River (RSP 9.6)	Attachment A, *Final Susitna River Fish Distribution and Abundance Implementation Plan* (March 2013)
Final implementation plan for River Productivity Study (RSP 9.8)	Attachment B, *Final Susitna River Productivity Study Implementation Plan* (March 2013)
Final focus areas for 2013 middle and lower river studies	Attachment C, *Technical Memorandum, Selection of Focus Areas and Study Sites in the Middle and Lower Susitna River for Instream Flow and Joint Resource Studies – 2013 and 2014* (March 2013)

As directed in Staff's January 17th letter, AEA on January 31, 2013, filed drafts of all these documents with the Commission and distributed them to licensing participants via its licensing website, http://www.susitna-watanahydro.org/meetings/. Also in conformance with Staff's January 17th letter, AEA held technical workgroup (TWG) meetings on February 14th and 15th "to discuss the study results, proposed implementation plans, and selected focus areas in the middle and lower Susitna River."[5] Because Staff of the National Marine Fisheries Service (NMFS) were unavailable to meet on February 14-15 due to a preexisting scheduling conflict, AEA met separately with NMFS on February 7th and 8th to review these materials.

In accordance with Commission Staff's revised licensing schedule, licensing participants may file comments on the attached implementation plans and technical memorandum—as well as the 14 studies subject to Staff's April 1st RSP[6]—by March 18, 2013.[7] Based on the technical information discussed in the February 7-8 and 14-15 meetings, AEA has made changes to the attached implementation plans and technical memo since the drafts of these were filed and distributed on January 31.

AEA also has attached two additional documents related to Commission Staff's April 1st SPD. First, based on RSP comments filed by the Alaska Department of

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4 *See* January 17th Letter, Attachment A, at 5.

5 *Id.*

6 These 14 individual study plans can be found in AEA's RSP, filed with the Commission on December 14, 2012. *See supra* note 2. The RSP can be accessed from the Commission's eLibrary system or AEA's licensing website, http://www.susitna-watanahydro.org/type/documents/.

7 *See* January 17th Letter, Attachment A, at 5.

Environmental Conservation (DCE),[8] AEA has prepared and included as Attachment D an updated Quality Assurance Project Plan (QAPP) for the Baseline Water Quality Study (RSP 5.5).[9] The attached QAPP has been updated to conform with DEC's *Quality Assurance Plan Review Checklist* and *Draft Guidance for a Tier 2 Water Quality Monitoring QAPP*.[10] Second, as discussed in the meetings with NMFS on February 7-8 and the TWG on February 14-15, AEA has prepared and attached as Attachment E a response to interim comments submitted by NMFS and the U.S. Fish and Wildlife Service on Characterization and Mapping of Aquatic Habitat Mapping Revised Study Plan (RSP 9.9), including a comparison table demonstrating that there is no significant difference between AEA's habitat classification system and the classification system promoted by the resource agencies.

As always, AEA appreciates the participation and commitment to this licensing process demonstrated by Commission Staff, federal and state resource agencies, and other licensing participants. Following Commission Staff's April 1st SPD, AEA looks forward to working with licensing participants and Commission Staff in implementing the approved studies, which AEA believes will comprehensively investigate and evaluate the full range of resource issues associated with the proposed Project and support AEA's license application, scheduled to be filed with the Commission in 2015.

If you have questions concerning this submission please contact me at wdyok@aidea.org or (907) 771-3955.

Sincerely,

Wayne Dyok
Project Manager
Alaska Energy Authority

Attachments

cc: Distribution List (w/o Attachments)

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8 State of Alaska Resource Agency RSP Comments, Project No. 14241-000, at 3-6 (filed Jan. 18, 2013) [hereinafter, "DEC RSP Comments"].

9 *See* RSP § 5, Attachment 5-1.

10 DEC RSP Comments, Attachments 1 & 2.

Attachment C

Technical Memorandum, Selection of Focus Areas and Study Sites in the Middle and Lower Susitna River for Instream Flow and Joint Resource Studies – 2013 and 2014 (March 2013)

Susitna-Watana Hydroelectric Project
(FERC No. 14241)

Technical Memorandum
Selection of Focus Areas and Study Sites in the Middle and Lower Susitna River for Instream Flow and Joint Resource Studies – 2013 and 2014

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

R2 Resource Consultants, Inc.

March 1, 2013

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LIST OF ACRONYMS AND SCIENTIFIC LABELS

Abbreviation	Definition
AEA	Alaska Energy Authority
Backwater	Off-channel habitat characterization feature found along channel margins and generally within the influence of the active main channel with no independent source of inflow. Water is not clear.
Baseline	Baseline (or Environmental Baseline): the environmental conditions that are the starting point for analyzing the impacts of a proposed licensing action (such as approval of a license application) and any alternative.
Beaver complex	Off-channel habitat characterization feature consisting of a ponded water body created by beaver dams.
Braided streams	Stream consisting of multiple small, shallow channels that divide and recombine numerous times. Associated with glaciers, the braiding is caused by excess sediment load.
Cascade	The steepest of riffle habitats. Unlike rapids, which have an even gradient, cascades consist of a series of small steps of alternating small waterfalls and shallow pools.
Cfs	cubic feet per second
Channel	A natural or artificial watercourse that continuously or intermittently contains water, with definite bed and banks that confine all but overbank stream flows.
Conductivity	In terms of water conductivity, the ability of water to conduct electricity, normally through the presence of dissolved solids that carry electrical charges.
Confluence	The junction of two or more rivers or streams.
Cross-section	A plane across a river or stream channel perpendicular to the direction of water flow.
Devils Canyon	Located at approximately Susitna River Mile (RM) 150-161, Devils Canyon contains four sets of turbulent rapids rated collectively as Class VI. This feature is a partial fish barrier because of high water velocity.
Distribution (species)	The manner in which a biological taxon is spatially arranged.
Edge habitat	The boundary between natural habitats, in this case between land and a stream. Level five tier of the habitat classification system.
Escapement (spawning)	The number or proportion of fish surviving (escaping from) a given fishery at the end of the fishing season and reaching the spawning grounds.
et al.	"*et alia*"; and the rest
FA	Focus Area
FERC	Federal Energy Regulatory Commission
Floodplain	1. The area along waterways that is subject to periodic inundation by out-of-bank flows. 2. The area adjoining a water body that becomes inundated during periods of over-bank flooding and that is given rigorous legal definition in regulatory programs. 3. Land beyond a stream channel that forms the perimeter for the maximum probability flood. 4. A relatively flat strip of land bordering a stream that is formed by sediment deposition. 5. A deposit of alluvium that covers a valley flat from lateral erosion of meandering streams and rivers.
Floodplain vegetation − groundwater / surface water regime functional groups	Assemblages of plants that have established and developed under similar groundwater and surface water hydrologic regimes.
Fluvial	Of or pertaining to the processes associated with rivers and streams and the deposits and landforms created by them.
Focus Area	Areas selected for intensive investigation by multiple disciplines as part of the AEA study program.
Geomorphic reach	Level two tier of the habitat classification system. Separates major hydraulic

Abbreviation	Definition
	segments into unique reaches based on the channel's geomorphic characteristic.
GIS	Geographic Information System. An integrated collection of computer software and data used to view and manage information about geographic places, analyze spatial relationships, and model spatial processes.
Glide	An area with generally uniform depth and flow with no surface turbulence. Low gradient; 0-1 % slope.
Gradient	The rate of change of any characteristic, expressed per unit of length (see Slope). May also apply to longitudinal succession of biological communities.
Groundwater (GW)	In the broadest sense, all subsurface water; more commonly that part of the subsurface water in the saturated zone.
Habitat	The environment in which the fish live, including everything that surrounds and affects its life, e.g., water quality, bottom, vegetation, associated species (including food supplies). The locality, site and particular type of local environment occupied by an organism.
Instream flow	The rate of flow in a river or stream channel at any time of year.
Juvenile	A young fish or animal that has not reached sexual maturity.
licensing participants; Participants	Agencies, ANCSA corporations, Alaska Native entities and other licensing participants
Life stage	An arbitrary age classification of an organism into categories relate to body morphology and reproductive potential, such as spawning, egg incubation, larva or fry, juvenile, and adult.
Lower segment Susitna	The Susitna River from Cook Inlet (RM 0) to the confluence of the Chulitna River at RM 98.
LR	Lower River Reach
Main channel	For habitat classification system: a single dominant main channel. Also, the primary downstream segment of a river, as contrasted to its tributaries.
Main channel habitat	Level four tier of the habitat classification system. Separates main channel habitat types including: tributary mouth, main channel, split main channel, multiple split main channel and side channel into mesohabitat types. Mesohabitat types include pool, glide, run, riffle, and rapid.
Mainstem	Mainstem refers to the primary river corridor, as contrasted to its tributaries. Mainstem habitats include the main channel, split main channels, side channels, tributary mouths, and off-channel habitats.
Mainstem habitat	Level three tier of the habitat classification systems. Separates mainstem habitat into main channel, off-channel, and tributary habitat types. Main channel habitat types include: tributary mouth, main channel, split main channel, multiple split main channel and side channel. Off-channel habitat types include: side slough, upland slough, backwater, and beaver complex. Tributary habitat is not further categorized.
Mesohabitat	A discrete area of stream exhibiting relatively similar characteristics of depth, velocity, slope, substrate, and cover, and variances thereof (e.g., pools with maximum depth <5 ft, high gradient rimes, side channel backwaters).
Mi	mile(s)
Middle segment Susitna	The Susitna River from the confluence of the Chulitna River at RM 98 to the proposed Watana Dam Site at RM 184.
Migrant (life history type)	Some species exhibit a migratory life history type and undergo a migration to from rivers/lakes/ocean.
Migration	Systematic (as opposed to random) movement of individuals of a stock from one place to another, often related to season.
MR	Middle River Reach

Abbreviation	Definition
Multiple split main channel	Main channel habitat characterization feature where more than three distributed dominant channels are present.
N/A	not applicable *or* not available
Off-channel	Those bodies of water adjacent to the main channel that have surface water connections to the main river at some discharge levels.
Off-channel habitat	Habitat within those bodies of water adjacent to the main channel that have surface water connections to the main river at some discharge levels.
PHABSIM	Physical Habitat Simulation, a specific model designed to calculate an index to the amount of microhabitat available for different life stages at different flow levels. PHABSIM has two major analytical components: stream hydraulics and life stage-specific habitat requirements.
Pool	Slow water habitat with minimal turbulence and deeper due to a strong hydraulic control.
PRM	Project River Mile(s) based on the digitized wetted width centerline of the main channel from 2012 Matanuska-Susitna Borough digital orthophotos. PRM 0.0 is established as mean lower low water of the Susitna River confluence at Cook Inlet.
Project	Susitna-Watana Hydroelectric Project
PSP	Proposed Study Plan
Radiotelemetry	Involves the capture and placement of radio-tags in adult fish that allow for the remote tracking of movements of individual fish.
Rapid	Swift, turbulent flow including small chutes and some hydraulic jumps swirling around boulders. Exposed substrate composed of individual boulders, boulder clusters, and partial bars. Lower gradient and less dense concentration of boulders and white water than Cascade. Moderate gradient; usually 2.0-4.0% slope.
Rearing	Rearing is the term used by fish biologists that considers the period of time in which juvenile fish feed and grow.
Riffle	A fast water habitat with turbulent, shallow flow over submerged or partially submerged gravel and cobble substrates. Generally broad, uniform cross-section. Low gradient; usually 0.5-2.0% slope.
Riparian	Pertaining to anything connected with or adjacent to the bank of a stream or other body of water.
River	A large stream that serves as the natural drainage channel for a relatively large catchment or drainage basin.
River mile	The distance of a point on a river measured in miles from the river's mouth along the low-water channel.
RM	River Mile(s) referencing those of the APA Project.
RSP	Revised Study Plan
Run (habitat)	A habitat area with minimal surface turbulence over or around protruding boulders with generally uniform depth that is generally greater than the maximum substrate size. Velocities are on border of fast and slow water. Gradients are approximately 0.5 % to less than 2%. Generally deeper than riffles with few major flow obstructions and low habitat complexity.
Run (migration)	Seasonal migration undertaken by fish, usually as part of their life history; for example, spawning run of salmon, upstream migration of shad. Fishers may refer to increased catches as a “run” of fish, a usage often independent of their migratory behavior.
Sediment	Solid material, both mineral and organic, that is in suspension in the current or deposited on the streambed.
Sediment transport	The movement of solid particles (sediment), typically due to a combination of the force of gravity acting on the sediment, and/or the movement of the fluid in which the sediment is entrained.

Abbreviation	Definition
Side channel	Lateral channel with an axis of flow roughly parallel to the mainstem, which is fed by water from the mainstem; a braid of a river with flow appreciably lower than the main channel. Side channel habitat may exist either in well-defined secondary (overflow) channels, or in poorly-defined watercourses flowing through partially submerged gravel bars and islands along the margins of the mainstem.
Side slough	Off-channel habitat characterization of an Overflow channel contained in the floodplain, but disconnected from the main channel. Has clear water,
Slough	A widely used term for wetland environment in a channel or series of shallow lakes where water is stagnant or may flow slowly on a seasonal basis. Also known as a stream distributary or anabranch.
Spawning	The depositing and fertilizing of eggs by fish and other aquatic life.
Split main channel	Main channel habitat characterization where three of fewer distributed dominant channels.
Thalweg	A continuous line that defines the deepest channel of a watercourse.
Three Rivers Confluence	The confluence of the Susitna, Chulitna, and Talkeetna rivers at Susitna River Mile (RM) 98.5 represents the downstream end of the Middle River and the upstream end of the Upper River.
TM	Technical Memorandum
Tributary	A stream feeding, joining, or flowing into a larger stream (at any point along its course or into a lake). Synonyms: feeder stream, side stream.
Tributary mouth	Main channel habitat characterization of clear water areas that exist where tributaries flow into Susitna River main channel or side channel habitats.
TWG	Technical Workgroup
U.S., US	United States
Upwelling	The movement of groundwater into rivers, stream, sloughs and other surface water features. This is also called groundwater discharge and may be associated with a gaining reach of a river or stream.

1. INTRODUCTION

Construction and operation of the Susitna-Watana Hydroelectric Project (Project) will affect Susitna River flows downstream of the dam; the degree of these effects will ultimately depend on final Project design and operating characteristics. The Project will be operated in a load-following mode. Project operations will cause seasonal, daily, and hourly changes in Susitna River flows compared to existing conditions. The potential alteration in flows will influence downstream resources/processes, including fish and aquatic biota and their habitats, channel form and function including sediment transport, water quality, groundwater/surface water interactions, ice dynamics, and riparian and wildlife communities (AEA 2011).

The potential operational flow-induced effects of the Project will be evaluated as part of the licensing process and a Revised Study Plan (RSP) has been prepared and submitted to the Federal Energy Regulatory Commission (FERC) that describes the Susitna-Watana Fish and Aquatics Instream Flow Study (FA-IFS) (RSP Section 8.5) and Riparian Instream Flow Study (R-IFS) (RSP Section 8.6) that will be conducted to characterize and evaluate these effects. The plans include statements of objectives, descriptions of the technical framework of the studies, the general methods that will be applied, and the study's nexus to the Project.

Since submittal of the RSP, FERC issued a Revised Study Plan Determination Schedule (January 17, 2013) that specified deliverables of three IFS related analyses; 1) results of the open-water flow routing model (due January 31, 2013), 2) identification of all proposed Focus Areas (FAs) with a description of habitat units within the FAs for all aquatic studies to be implemented in the middle Susitna River (due January 31, 2013), and 3) identification of final focus areas for 2013 middle and lower river studies (due March 1, 2013). Technical Memoranda (TM) pertaining to each of the first two deliverables were prepared and submitted to the FERC on January 31, 2013 (R2 et al. 2013; and R2 2013a) and were subsequently presented and discussed during a Technical Work Group (TWG) meeting on February 14, 2013, that was likewise specified in the January 17, 2013 FERC revised schedule.

This technical memorandum pertains to the third deliverable and contains the final focus areas and study sites for both the middle and lower river segments. The technical memorandum builds upon the content and information presented in the middle river technical memorandum (R2 2013b), with consideration of the comments and suggestions received from the agencies and stakeholders during the February 14, 2013 TWG meeting, to now include study sites that will be sampled in 2013 and 2014 in the Lower River Segment. In addition, the technical memorandum includes a separate discussion of the R-IFS Focus Area (FA) evaluation that was conducted independent of the Fish and Aquatics IFS FA assessment presented in R2 2013b.

1.1. Background

The RSP submitted to the FERC in December 2012 contained 58 study plans that described the objectives, locations and methods to be applied in completing the respective resource specific studies of the Susitna River. While a number of those studies (e.g., Water Quality …, Vegetation…, Wildlife ….) included sampling locations within all three segments of the Susitna

River (Upper, Middle and Lower – see below)[1], the IFS concerned with project operations concentrated primarily in the Middle River Segment and deferred selection of study sites in the Lower River Segment until results of the open water flow routing model had been completed. Substantial information concerning the study site selection process used for the Middle River Segment was presented in the RSP (see Section 8.5.4.2.1.2) in which a total of ten FAs were identified and described. In terms of the FA-IFS, the representativeness of the FAs was subsequently evaluated based on results of the habitat mapping. That analysis was presented in the January 31, 2013 technical memorandum (R2 2013b), discussed during the TWG meeting, and for completeness, provided as well in this technical memorandum. That meeting also advanced the opportunity to describe the analytical framework and statistical methods that were being applied to a separate evaluation of the FAs in terms of their applicability for the R-IFS. That analysis has since been completed and is also summarized in this technical memorandum.

The decision reflected in the RSP to concentrate studies on the Middle River Segment was made because Project operations related to load-following and variable flow regulation were considered to have the greatest potential effects on that section of the river. These effects tend to attenuate in a downstream direction as channel morphologies change, and flows change due to tributary inflow and flow accretion. The diversity of habitat types and the information from previous and current studies that indicate substantial fish use of a number of slough and side channel complexes within this segment, also supported the need to develop a strong understanding of habitat–flow response relationships in this segment.

The Revised Study Plan described the downstream boundary of the Study Area as RM 75 because existing information indicated that the hydraulic effects of the Project below the Three Rivers Confluence are attenuated (See RSP Section 8.5.3). As described in the Revised Study Plan, AEA reevaluated how far downstream Project operational significant effects extend based in part upon the results of the Open-water Flow Routing Model (see RSP Section 8.5.4.3), which was completed in Q1 2013. The results of the Open-water Flow Routing Model are consistent with the information presented in the Pre-Application Document and information presented to Technical Work Groups in October 2012. However, the results suggested that although the effects of flow regulation would continue to attenuate downstream of the Three Rivers Confluence, seasonal changes in river stage would still occur in conjunction with Project operations[2]. In addition, the hydrologic analysis indicated there would be a reduction in the frequency of certain types of flood-flows, which shape channel morphologies, transport sediments, and maintain riparian community structure. As a result, with consideration to the decision criteria noted in the RSP (see page 8-23 of RSP 8.5) AEA has confirmed that studies should be expanded in the Lower River Segment. During the February 14, 2013 TWG meeting, this decision was noted and an initial plan presented for commencing such studies in 2013 and completing the studies in 2014. Thus, in addition to describing FAs and study sites for the Middle River Segment, this technical memorandum presents additional details concerning studies in the Lower River Segment and includes a description and listing of study sites that will

[1] The Upper River Segment represents that portion of the watershed above the Watana Dam site at RM 184, the Middle River Segment extends from RM 184 downstream to the Three Rivers Confluence at RM 98.5, and the Lower River Segment extends from the Three Rivers Confluence to Cook Inlet (RM 0).

[2] Specifically, these seasonal changes in river stage are consistent with the information presented in the Pre-Application Document and information presented to Technical Work Groups in October 2012.

be evaluated in 2013 and 2014. As was noted during the TWG meeting. Information and data collected from sites in 2013 will be reviewed in collaboration with the TWG to determine the extent of studies and sites that warrant sampling in 2014.

1.2. Objectives

The overall objective of this technical memorandum is to describe the rationale and basis for the final selection of the FAs and study sites, and to list those sites, that will serve as locations for conducting detailed IFS related investigations during 2013 and 2014 in both the Middle and Lower River segments of the Susitna River

Specific objectives include:

- Review the general approach to stratification and the study site selection process used in the FA-IFS RSP (see Section 8.5.4.2);
- For the Middle River Segment:
    - Describe and summarize the FA-IFS statistical analysis completed on the habitat mapping results with respect to the ten FAs (and their habitat units)that were initially described in the RSP (Section 8.5.4.2.1.2)
    - Describe and summarize the R-IFS statistical analysis completed on the process domains and vegetation mapping with respect to the ten FAs.
    - List and describe the final FAs and study sites outside of the FAs for all IFS related studies that will be studied in 2013 and 2014.
- For the Lower River Segment:
    - Discuss the rationale and criteria considered for extending the IFS related studies into the Lower River Segment; and
    - List and describe the studies and final study sites that will be evaluated in 2013 and 2014 by resource discipline.

2. REVIEW OF RIVER STRATIFICATION AND STUDY AREA SELECTION PROCESS

The proposed Project will affect flows in mainstem and off-channel habitats in the Susitna River downstream of the dam site at PRM[3] 187.1. In order to characterize the existing and proposed flow regimes and potential Project-induced impacts to riverine habitats and organisms, the Susitna River was stratified into geomorphic reaches based on channel type, gradient, confinement, bed material and tributary confluences. As noted in Section 8.5.4.1.2 of RSP Section 8.5, the selection of study areas or study sites represents an important aspect of all resource related studies inasmuch as the sites or areas studied are those that will ultimately be used for characterizing physical, geomorphological, chemical and biological resources and for evaluating Project effects. It was therefore fundamentally important that the logic and rationale for the selection of such areas be clearly articulated, understood, and agreed to by agencies and licensing participants.

The RSP presented a series of steps that first described the stratification process used for the entire river, and then discussed and evaluated various approaches to study site selection that lead to the identification of specific FAs for intensive study within the Middle River Segment. This process was further described in R2 2013a and discussed during the February 14, 2013 TWG meeting. For completeness, these steps are again presented below to provide context for the segment-specific discussion regarding site selection.

As an initial step in the selection process, the Susitna River was stratified into distinct stratum reflective of certain geomorphic, hydrologic, and physical characteristics shared by each stratum. The number of strata was determined based on the realization that the effects to physical processes and aquatic resources will be resource type-, location-, and habitat-specific. For example, at the site scale level, responses of fish habitat to changes in flow are expected to be different in side sloughs versus mainstem versus side channel versus tributary delta versus riparian habitats. At a broader scale, e.g., segment, it is plausible that effects to the same mainstem habitat types will differ depending on location in the river network. In addition, there will be a cumulative effect running down the length of the Susitna River below the dam. Importantly, different Project operations will affect different habitats and processes differently, both spatially and temporally. The habitat and process models will therefore need to be spatially discrete, at potentially the site/area level, mainstem habitat type level, and segment levels, and

[3] The Project River Mile (PRM) system for the Susitna River was developed to provide a consistent and accurate method of referencing features along the Susitna River. During the 1980s, researchers often referenced features by river mile without identifying the source map or reference system. If a feature is described by river mile (RM) or historic river mile (HRM), then the exact location of that feature has not been verified. The use of PRMs provides a common reference system and ensures that the location of the feature can be verified. The PRM was constructed by digitizing the wetted width centerline of the main channel from 2011 Matanuska-Susitna Borough digital orthophotos. Project River Mile 0.0 was established as mean low water of the Susitna River confluence at Cook Inlet. A centerline corresponding to the channel thalweg was digitized upstream to the river source at Susitna Glacier using data collected as part of the 2012 flow routing transect measurements. The resultant line is an ArcGIS route feature class in which linear referencing tools may be applied. The use of RM or HRM will continue when citing a 1980s study or where the location of the feature has not been verified. Features identified by PRM are associated with an ArcGIS data layer and process, and signifies that the location has been verified and reproduced.

yet able to be integrated to allow for a holistic evaluation of each alternative operational scenario.

As noted in Section 8.5.3 of the RSP, the study area at issue with respect to Project operations and flow regulation effects consists of two segments of the river:

- Middle River Segment – Susitna River from Watana Dam site to confluence of Chulitna and Talkeetna rivers (Three Rivers Confluence) (PRM 187.1 to PRM 102.4)
- Lower River Segment – Susitna River extending below Talkeetna River to mouth (PRM 102.4 to PRM 0)

The Middle River Segment represents the section of river below the Project dam that is projected to experience the greatest effects of flow regulation caused by Project operations. Within this reach, the river flows from Watana Canyon into Devils Canyon, the narrowest and steepest gradient reach on the Susitna River. The Devils Canyon constriction creates extreme hydraulic conditions including deep plunge pools, drops, and high velocities. Downstream of Devils Canyon, the Susitna River widens but remains essentially a single main channel with stable islands, numerous side channels, and sloughs.

The Lower River Segment receives inflow from three other large river systems. An abrupt, large-scale change in channel form occurs where the Chulitna and Talkeetna rivers join the Susitna River near the town of Talkeetna in an area referred to as the Three Rivers Confluence. The annual flow of the Chulitna River is approximately the same as the Susitna River at the confluence, though the Chulitna contributes much more sediment than the Susitna. The Talkeetna River also supplies substantial flow rates and sediment volumes. Farther downriver, the Susitna River becomes notably more braided, characterized by unstable, shifting gravel bars and shallow subchannels. The Yentna River is a large tributary to the Lower Susitna River and supplies about 40 percent of the mean annual flow at the mouth of the Susitna River.

Geomorphic analysis of both the Middle River and Lower River segments confirmed the distinct variations in geomorphic attributes (e.g., channel gradient, confinement, channel planform types, and others) (see RSP Section 6.5) and resulted in the classification of the Middle River Segment into eight geomorphic reaches and the Lower River Segment into six geomorphic reaches (see Figures 8.5-11 and 8.5-12 of RSP Section 8.5, which for convenience have been included as Figures 1 and 2 of this technical memorandum). These reaches were incorporated into a hierarchical stratification system that scales from relatively broad to more narrowly defined categories as follows:

Segment → Geomorphic Reach → Mainstem Habitat Type →

Main Channel Mesohabitat Types → Edge Habitat Types

The highest level category is termed Segment and refers to the Middle River Segment and the Lower River Segment. The Geomorphic Reach level is next and consists of the eight reaches (MR-1 through MR-8) for the Middle River Segment and six reaches (LR-1 through LR-6) for the Lower River Segment (see RSP Section 6.5.4.1.2.2 and RSP Section 8.5 Table 8.5 4). The geomorphic reach breaks were based in part on the following five factors: 1) Planform type (single channel, island/side channel, braided); 2) Confinement (approximate extent of floodplain, off-channel features); 3) Gradient; 4) Bed material / geology; and 5) Major river confluences. This level is followed by Mainstem Habitat Types, which capture the same general categories applied during the 1980s studies but includes additional sub-categories to provide a more refined delineation of habitat features (see RSP Section 8.5 Table 8.5 5). Major categories and sub-categories under this level include: 1) Main Channel Habitats consisting of Main Channel, Split Main Channel, Braided Main Channel, Side Channel; 2) Off-channel Habitats that include Side Slough, Upland Slough, Backwater and Beaver Complexes; and 3) Tributary Habitats that consist of the segment of the tributary influenced by mainstem flow. The next level in the hierarchy is Main Channel and Tributary Mesohabitats, which classifies habitats into categories of Cascades, Riffle, Pool, Run, and Glide. The mesohabitat level of classification is currently limited to the main channel and tributary mouths for which the ability to delineate these features is possible via aerial imagery and videography. Mesohabitat mapping in side channel and slough habitat types will require ground surveys, planned to begin in 2013. The last level in the classification is Edge Habitat and is intended to provide an estimate of the length of shoreline in contact with water within each habitat unit. The amount of edge habitat within a given habitat unit will provide an index of habitat complexity, i.e., more complex areas that consist of islands, side channels, etc. will contain more edge habitat than uniform, single channel areas.

Overall, the goal of the stratification step was to define segments/reaches with effectively similar characteristics where, ideally, repeated replicate sampling would result in parameter estimates with similar statistical distributions. The stratification/classification system described above was designed to provide sufficient partitioning of sources of variation that can be evaluated through focused study efforts that target each of the habitat types, and from which inferences concerning habitat–flow responses in unmeasured sites can ultimately be drawn.

2.1. Selection of Study Areas/Study Sites

In general (as noted by Bovee 1982), there are three characteristic approaches to instream flow studies that pertain to site selection that were considered for application in the Project. These included representative sites/areas, critical sites/areas, and randomly selected sites/areas.

2.1.1. Representative Sites

Representative sites are those where professional judgment or numerically and/or qualitatively derived criteria are relied on to select one or more sites/areas that are considered representative of the stratum or larger river. Representative sites typically contain all habitat types of importance. In general, the representative site approach can be readily applied to simple, single thread channel reaches, where the attributes that are measured are extrapolated linearly based on stream length or area. In this case, the goal of stratification will be to identify river segments that are relatively homogenous in terms of mesohabitat mixes, and the methods used for stratification tend to be classification-based. This approach typically requires completing some form of mapping up front, and using the results to select sites that encompass the range of habitat conditions desired. The results of such habitat mapping were not available during the initial study site/area selection, but since then, the results of the habitat mapping of the Middle River Segment have been completed and analyzed and are reported on in Section 3.1.1.1 of this technical memorandum.

Applicability to the Susitna–Watana Project: Yes – see Section 3 of this technical memorandum.

2.1.2. Critical Sites

Critical sites are those where available knowledge indicates that either (i) a sizable fraction of the target fish population relies on that location, (ii) a particular habitat type(s) is (are) highly important biologically, or (iii) where a particular habitat type is well known to be influenced by flow changes in a characteristic way. For example, in the case of the Susitna River, historical fish studies repeatedly showed the importance of certain side slough, upland slough, and side channel areas for spawning and juvenile rearing. Critical sites or areas are typically selected assuming that potential Project effects to other areas are secondary in terms of implications to fish population structure, health, and size. This assumption can only really be tested if other sites are identified that are similar looking but were not deemed critical, and sampling is performed on those sites as well to confirm the critical nature of the sites that were identified as such.

Applicability to the Susitna–Watana Project: Yes, especially with respect to selection of side channel/side slough/upland slough complexes that have been shown to be influenced by main channel flows and that are biologically important.

2.1.3. Randomly Located Sites

Randomly located sites are those sites, areas, or measurement locations selected randomly from each defined stratum or habitat type, and replicate sites or cross-sections are sampled to estimate variance (e.g., Williams 1996; Payne et al. 2004). Site selection based on random sampling tends to involve statistical multivariate grouping or stratification approaches, such as cluster analysis or ordination techniques. The approach is the least subject to potential for bias, because it relies on distinct rules and algorithms. However, the approach becomes increasingly difficult to apply in site selection when the sites become more complex, such as is the case on the Susitna River. In addition, the number of sites will be contingent on the variability within the universal data set: the greater the number of clusters, the greater the potential number of sites. Strict random sampling is therefore not likely applicable for evaluating off-channel habitats and sloughs where the morphology of multiple channels varies substantially and in complex ways within and across sites.

Applicability to the Susitna–Watana Project: Yes, but more appropriate with respect to main channel mesohabitat sampling (i.e., riffle, run, glide, pool) or selection of mainstem habitat types for Habitat Suitability Criteria (HSC) sampling.

2.1.4. Focus Areas

During the September 11, 2012, Technical Workgroup (TWG) meeting, the concept of “intensive study areas” was introduced and discussed relative to sampling the Middle River Segment. This concept evolved around the realization that a prerequisite to determining the effects of Project development and operations on the Susitna River is the need to first develop an understanding of the basic physical, chemical and ecological processes of the river, their interrelationships, and their relationships with flow. Two general paths of investigation were considered, 1) process and resource specific and 2) process and resource interrelated. Under the first, process and resource specific, studies would focus on determining relationships of flow with specific resource areas (e.g., water quality, habitat, ice, groundwater) and at specific locations of the river without considering interdependencies of other resource areas at different locations. Under the second, process and resource interrelated, studies would be concentrated at specific locations of the river that would be investigated across resource disciplines with the goal of providing an overall understanding of interrelationships of river flow dynamics on the physical, chemical, and biological factors that influence fish habitat.

Because the flow dynamics of the Susitna River are complex, it was reasoned that concentrating study efforts across resource disciplines within specific locations would provide the best opportunity for understanding flow interactions and evaluating potential Project effects and therefore major emphasis was placed on selecting those areas, which were termed Focus Areas (FA). However, it was also reasoned that there will be a need to collect information and data from other locations to meet specific resource objectives. As a result, the study site/area selection process presented in the RSP pertaining to the Middle River Segment represents a combination of both approaches that includes sampling within specified FAs as well as sampling outside of FAs (see Section 3.2 for discussion of sites outside of FAs).

Composition wise, the FAs contain *combinations* of different habitat types and features as characterized according to the hierarchical classification system noted above that may function and respond differently or similarly (compared to other areas) to changes in flow depending on flow timing, magnitude, duration, etc., and their interrelationships with each other and other resource processes. Thus, these areas would be the focus of concentrated studies across disciplines enabling an integrated assessment of resource characteristics and processes and providing a more meaningful understanding of resource interrelationships and how flow regulation would influence these. This approach of concentrating study efforts within selected areas should allow for a more comprehensive evaluation of Project effects on the different resources, than if such features were evaluated solely in isolation resulting in a more fragmented analysis.

As noted in the RSP and in R2 2013, the FA concept represents a combination of all three of the study site selection methods described above, inasmuch as (1) the areas would contain habitat types representative of other areas; (2) the areas would include certain habitat types repeatedly used by fish and therefore can be considered "critical areas," and (3) sampling of certain habitat features or mesohabitat types within the areas would be best approached via random sampling. Since the RSP, results of the habitat mapping of the Middle River Segment have been completed which has allowed for an evaluation of the "representativeness" of the habitat types within the ten FAs described below, compared to areas outside of the FAs. Results of that analysis are presented in Section 3.1.1.3.

3. MIDDLE RIVER SEGMENT STUDY SITE SELECTION

3.1. Focus Areas

The RSP identified and described ten FAs that had been discussed with the TWG and were originally proposed for detailed study within the Middle River Segment. Locations of the FAs are depicted in Figure 1 and their specific characteristics and rationale for selection were described in RSP Section 8.5 Table 8.5.6, which for convenience has been included as Table 1 of this technical memorandum. Schematic photos of each of the areas were likewise depicted in RSP 8.5 as Figures 8.5-13 through Figure 8.5-22 reproduced herein as Figures 3 through 12. The ten FAs were intended to serve as specific geographic areas of the river that will be the subject of intensive investigation by multiple resource disciplines including FA-IFS, R-IFS (see Section 8.6), Groundwater (see Section 7.5), Geomorphology (see Section 6.0), Ice Processes (see Section 7.6), Water Quality (see Section 5.0), and Fish Distribution and Abundance in the Middle/Lower River (see RSP Section 9.6). AEA's inter-disciplinary water resources team developed these FAs using a systematic review of aerial imagery within each of the Geomorphic Reaches (MR-1 through MR-8) for the entire Middle River Segment. Focus Areas were selected within Geomorphic Reach MR-1 (one Focus Area), Geomorphic Reach MR-2 (two Focus Areas), Geomorphic Reach MR-5 (one Focus Area), Geomorphic Reach MR-6 (four Focus Areas), Geomorphic Reach MR-7 (one Focus Area), and Geomorphic Reach MR-8 (one Focus Area). FAs were not selected for Geomorphic Reaches MR-3 or MR-4 due to safety considerations related to Devils Canyon.

The FAs were those deemed representative of the major features within each geomorphic reach and included mainstem habitat types of known biological significance (i.e., where fish have been observed based on previous and/or contemporary studies), as well as some locations (e.g., Slough 17) where previous sampling revealed few/no fish. The FAs were assumed to have included side channels, side sloughs, upland sloughs, and tributary mouths that were representative of these habitat types in other portions of the river. This assumption has now been evaluated based on the results of the habitat mapping. The results of that analysis were presented in R2 (2013b), discussed during the February 14, 2013 TWG meeting and for completeness provided in Section 3.1.1.of this technical memorandum.

Three of the FAs in Geomorphic Reach MR-6 and one in Geomorphic Reach MR-8 contain specific habitat types that were found, during the 1980s studies, to be consistently used by salmon for spawning and/or rearing. These areas included Slough 21, Slough 11, and Skull Creek in Geomorphic Reach MR-6 and Whiskers Slough in Geomorphic Reach MR-8. Overall, 92 percent of the sockeye, 70 percent of the chum, and 44 percent of the slough-spawning pink salmon were found in just these four sloughs. The FA in Geomorphic Reach MR-7 included Slough 6A which, based on the 1980s studies provided primary juvenile rearing habitat; the FA likewise included side channel and upland slough habitats that had been modeled in the earlier studies. By definition, these areas of known fish use represent "critical areas" and were included in the FAs to allow some comparisons with the 1980s data. The upper three FAs (one in Geomorphic Reach MR-1 and two in Geomorphic Reach MR-2) were selected based on their representativeness of the respective geomorphic reaches and the inclusion of a mix of side channel and slough habitat types. However, there is no existing fish information on these areas because they were not sampled in the 1980s. Nominally, the FAs range in length from 0.5 mile to 1.9 miles (Table 1). The rationale used in the selection of each of the FAs is provided in Table 1.

Selection criteria for the FAs considered the following:

- All major habitat types (main channel, side channel, side slough, upland slough, tributary delta) will be sampled within each geomorphic reach.
- At least one (and up to three) FA(s) per geomorphic reach (excepting geomorphic reaches associated with Devils Canyon – MR-3 and MR-4) will be studied that is/are representative of other areas.
- A replicate sampling strategy will be used for measuring habitat types within each FA, which will include a random selection process of mesohabitat types.

- Areas that are known (based on existing and contemporary data) to be biologically important for salmon spawning/rearing in mainstem and lateral habitats will be sampled (i.e., critical areas).
- Some areas for which little or no fish use has been documented or for which information on fish use is lacking will also be sampled.

It is important to note that the FA concept and approach will work for the Middle River Segment since the main channel is relatively confined. However, below the Three Rivers Confluence where the Chulitna and Talkeetna rivers enter, the Susitna River main channel widens and becomes heavily braided and therefore the same FA approach, which includes measurement of the entire main channel, is not applicable in the Lower River Segment. Rather, the selection of study sites/areas there will be more targeted to specific biologically important and representative habitat features, such as tributary mouths, side and upland sloughs, and side channels. More details describing the approach used in selecting study sites in the Lower River Segment are presented in Section 4 of this technical memorandum.

3.1.1. Fish and Aquatics IFS Evaluation of Focus Areas

3.1.1.1. Habitat Mapping Analysis

Habitat mapping of the Middle River Segment of the Susitna River was completed using a combination of geo-rectified aerial imagery (2011 Matsu Ortho Imagery at 1:8000 scale. http://matsu.gina.alaska.edu/wms/imagery) in combination with High Definition aerial videography that was taken of the river in August 2012 (≈ 10,000 cfs) (HDR 2013). The results of the habitat mapping provided a spatial depiction of the distribution of habitat types and features throughout the entire length of the Middle River Segment. Specific habitat types were digitized using ARC GIS and lineal distances computed of each discrete habitat feature. Results of the habitat mapping were used to evaluate the "representativeness" of the Focus Areas with respect to other areas of the river. In this context, representativeness specifically refers to how well habitat units within the FAs represent habitat units outside of these areas within the same geomorphic reach.

There are multiple ways to examine or measure representativeness of the FAs but the most valuable examination will occur after the first year of sampling when more direct information will have been obtained of the existing habitat types from field work. However, at the current planning stage of the study, representativeness was examined by 1) comparing the representation of habitat types within the FAs to the representation of habitat types in the entire geomorphic reach; 2) determining if the habitat types have been proportionately represented (focus vs. non-focus areas); 3) determining if there was a bias in the habitat types that were selected in the FAs; and 4) evaluating whether a random systematic approach in the selection of FAs would yield different results than the selection process and criteria applied to the current FAs.

3.1.1.2. Habitat Data Compilation and Review

The overall objective of Middle River Segment mainstem mapping was to characterize and classify river habitat in the mainstem from the proposed Watana Dam site to the Chulitna River confluence. These data were used to evaluate the selection of FAs for the IFS studies (this technical memorandum) as well as to develop a study site selection approach for the fish distribution and abundance studies (see Fish Distribution and Abundance Implementation Plan for Study 9.6 [R2 2013]). The mapping effort also included tributaries extending 0.5 miles upstream from the confluence with the mainstem. The 0.5 mile extent was used because it was considered a conservative standard that is greater than the expected hydrologic influence of the Project. The actual hydrologic influence is currently not known, at this time.

As a preliminary step in the analysis, the results of the GIS based habitat mapping were presented and discussed during an IFS internal technical review meeting. Habitat mapping generally followed the hierarchical and nested classification system developed specifically for the Susitna River that was described above. Digital mapping results were displayed and reviewed with technical staff who had been in the field and were familiar with channel characteristics. The review process proceeded from the upper to lower geomorphic reaches and resulted in a number of modifications to the habitat types. These modifications were subsequently made and a final draft database of habitat mapping results developed. Overall, the geo-rectified imagery in combination with aerial videography was sufficient to map the Middle River Segment mainstem habitat to the mesohabitat level. However, the imagery was not suitable for mapping off-channel or tributary habitats to this level; mapping of these features will require field surveys, to be initiated in 2013.

Results of the habitat mapping as presented and summarized in HDR (2013) indicated that the main channel habitats within the Middle River Segment of the Susitna River varied by geomorphic reach and generally increased in complexity moving from the upper end of the segment to downstream locations (Table 2). Mesohabitat in the main channel was generally dominated by a mixture of run and glide habitats (Table 3). Glide and run habitats were not distinguished from each other at this level of classification and included smooth-flowing, low turbulence reaches as well as areas with some standing or wind waves and occasional solitary protruding boulders. Run-glide mesohabitat dominated all reaches except MR-4, the reach where Devils Canyon is located. Riffle habitat was most prevalent in MR-4. Riffle habitat was lacking or only found in small amounts in the other Middle River Segment geomorphic reaches.

Side channels were predominantly glide or run, with some riffle areas in the lower reaches (Table 3). Many side channels were not completely inundated with flowing water and so identification of riffle or run habitat was not possible; these were classified as unidentified and were most prevalent in MR-6.

Cascade habitat was not found within any Middle River Segment geomorphic reach. The geomorphic reach through Devils Canyon (MR-4) contained the only rapids in the Middle River Segment, which accounted for 38 percent of the mainstem habitat in that reach. Only 3 pools were found in the Middle River Segment and these were also contained in MR-4 between rapids in Devils Canyon.

Off-channel habitat was assigned to one of three habitat types observed: upland sloughs, side sloughs, and backwaters. Upland and side sloughs were common throughout the Middle River reaches outside of Devils Canyon and downstream of the uppermost reach at MR-1 (Table 4). MR-5 contained some side slough habitat, MR-6 and MR-7 contained abundant side and upland slough habitat, and MR-8 had more prevalent upland sloughs. Beaver complexes always were associated with slough habitats and as such were not categorized as a habitat type but were noted as a characteristic of that slough habitat unit. Beaver dams were more prevalent in upland sloughs than in side sloughs. Beaver dams were only observed in reaches MR-6 and MR-7.

Backwater habitat was relatively rare and found in a few areas in the lower reaches from MR-6 through MR-8. A single backwater was also delineated in both MR-2 and MR-4, but these were very small. The greatest total area of backwater habitat was in MR-6.

The habitat associated with the confluence of tributaries with the main channel river was documented as tributary mouth and clear water plume (Table 5). Not all tributaries that entered the Middle River had tributary mouth habitat. Small tributaries where the vegetation line was close to the mainstem did not fan out and create the areas classified as tributary mouth habitat. In addition, small tributaries or tributaries that flowed into fast moving or turbulent sections of the mainstem did not produce clear water plume habitats. Clear water plume habitats were most prevalent in reaches MR-2 and MR-6. After the results of the habitat mapping were available, the tributaries were further described by the possibility of being fish-bearing (e.g., no barriers) streams. The counts of these by reach are also displayed in Table 5.

3.1.1.3. Evaluation of Representativeness – Representation and Proportionality

The habitat classifications noted above can be summarized by counts or lengths of identified units inside and outside of FAs. However, the length of river that is included in FAs is less than that not included in the FAs, so some scaling of counts and lengths is necessary for proportional comparisons. A suite of scaled metrics were identified and developed that were used in a comparative analysis of the representativeness of habitat types within and outside of FAs. These metrics included the major habitat categories specified in the classification and consisted of percentages or proportions of lineal distances, and densities (length per mile) (Table 6).

Values for these metrics were compared graphically by geomorphic reach. There are two bases for comparison: 1) is each habitat type contained in the geomorphic reach represented in FAs within the reach; and 2) is the representation proportional. The metrics cannot be statistically compared within geomorphic reaches (focus area vs. non-focus area) because they do not represent multiple independent random samples. Thus, there is no estimation of variance available.

The results of this analysis indicated that the FAs have captured the majority of habitat types present in each geomorphic reach. At the end of this technical memorandum, the proportionality metrics are graphically displayed.

Main channel proportionality metrics are displayed graphically in Figure 13. MR-1 is all single main channel. MR-2, MR-5, and MR-6 have a small amount of split main channel, which is not represented within the FA. In MR-7, the split main channel is represented, but at a higher proportion than exists in the full reach. In MR-8, the braided main channel is not represented in the FA, and the split main channel is represented at a lesser proportion in the FA.

Side channels and sloughs proportionality metrics are displayed graphically in Figure 14. MR-1 side channels are represented. MR-2 FAs contain all habitats, with a higher portion of side slough than the full reach. The small amounts of side slough habitat in MR-5 and MR-7are not represented in FAs. MR-6 is well represented by FAs. MR-7 side channels and upland sloughs are represented in FAs. In MR-8, all habitats are represented in the FAs, but there is proportionately more side channel and side slough habitat than in the reach at large.

Beaver complex proportionality is displayed in Figure 15. Beaver habitat is represented in MR-6 and MR-7 at a higher proportionality in FAs than in the total reach.

Backwater and tributary-related habitat proportionality is displayed in Figure 16. MR-1 does not contain these habitat types. In MR-2, identified plumes and backwaters are not represented in FAs. In MR-5, there is only one tributary with a mouth and plume, and it is contained in the FA. In MR-6, all habitats are well represented. In MR-7, the single identified tributary mouth and plume present in the reach is not represented. In MR-8, the single backwater is not in the FA, but the tributary is in the FA.

The main channel mesohabitat comparison is shown in Figure 17. MR-1 and MR-5 are all glide/run habitat. MR-2 has a small amount of identified riffle that is not represented in the FAs. The other reaches are generally well represented.

3.1.1.4. Evaluation of Representativeness – Bias

Statisticians define the representativeness of samples based on the absence of bias. Statistical bias is a consistent under- or over- estimation of a known population parameter. In this application, bias could exist if the FAs are consistently over sampling braided main channels, for example. For model inferences specific to habitat units, bias in proportional sampling is not a large issue. However, if selected samples for any particular part of the program not related to the instream flow-habitat models are used to make inference to entire geomorphic reaches, this selection bias could result in estimation bias.

In this analysis, bias in the selection method was examined by considering the geomorphic reaches as independent replicates of potential bias, and testing if the average bias is different from zero using a t-test or a non-parametric equivalent. For example, if the FAs selection has consistently under-represented upland sloughs, this analysis would highlight that result.

Results of the bias estimates are displayed in Table 7. A negative number in this table indicates that a habitat was over-represented in the Focus Areas, and a positive number indicates that a habitat was under-represented. There is a fairly even distribution of cases where habitat was under-represented and over-represented across reaches. Thus, there is no strong evidence (i.e., no statistically significant results at an alpha level of 0.10) of bias in the habitat types that were selected within the FAs.

3.1.1.5. Evaluation of Representativeness – Random/Systematic Approach

As a fourth comparison, a set of simulated random focus areas were selected based on a random systematic sampling approach. These areas were selected from each geomorphic reach, matching the number and total coverage of focus areas for each geomorphic reach. For example, in MR-2, there are two focus areas with total length equal to 3.2 miles. For simplicity, the simulation selected two equally sized focus areas, also totaling 3.2 miles. The process in MR-2 began with a random start and the formation of eight contiguous 1.6 mile reaches. Then one of the four paired equally spaced reaches ((1,5),(2,6),(3,7),(4,8)) was selected at random. A similar process was applied to the remaining five geomorphic reaches. Both the current focus area location(s) as well as its counter parts that were randomly selected are displayed in Table 8.

The habitat features of this simulated set of focus areas was then evaluated in the same manner as the current focus areas, and comparisons made.

The simulated selection of a set of random systematic focus areas resulted in a different balance of habitat units. Table 9 displays the habitat proportionality metrics for project focus areas, simulated random focus areas, and total geomorphic reach. For some habitat types in some geomorphic reaches, the random focus areas appear to be more representative. For example, the main channel types (main, split, braided) in reach MR-8 are proportionally very similar in the random focus areas and in the reach as a whole. However, in some areas the random focus areas miss the same habitat types, as for off-channel habitats in MR-5. In other areas, the random focus areas are less representative, as in off-channel habitats in MR-8.

Bias estimates for random focus areas are displayed in Table 10. A negative number in this table indicates that a habitat was over-represented in the random focus areas, and a positive number indicates that a habitat was under-represented. These results show that these random focus areas consistently over-represented side channels and consistently under-represented riffles (with alpha = 0.10).

The results provide a yardstick by which the representativeness of study FAs can be measured. Although the study FAs have not perfectly represented every habitat in every geomorphic reach, the results are similar to what would be expected with a random systematic sampling scheme.

3.1.1.6. Selection of Final Focus Areas for FA-IFS

The results of the habitat mapping and statistical analysis indicate that the ten FAs identified in RSP Section 8.5 and presented in R2 (2013b) are generally representative of habitat types found in other portions of the river. As a result, those ten FAs, which are listed in Table 1, should be finalized for study in 2013 in accordance with the respective resource specific RSPs.

3.1.2. Riparian Process Domain Delineation and Evaluation of Focus Areas

The evaluation of FAs for the Middle River Segment for the R-IFS was made based on a stratification of Riparian Process Domains as described in Riparian IFS RSP Section 8.6.3.2. The procedures used for this and the resulting decisions that resulted in the final selection of FAs in the Middle River Segment were made collaboratively between the Riparian Vegetation and R-IFS leads and Dr. Robert Henszey (USFWS), and Dr. Chiska Derr (NMFS) in a riparian work group meeting held February 21, 2013 (see Supplemental Information of U.S. Fish and Wildlife Service/AFWFO/Anchorage filed with FERC under P-14241 [February 26, 2013] (interim comments provided from a consensus meeting with AEA consultants, USFWS, and NMFS regarding Riparian study focus areas). Prior to this meeting, the Riparian vegetation sampling strategy was presented in both the Riparian Vegetation Study RSP Section 11.5, R-IFS RSP Section 8.6 and at TWG meetings held in Anchorage, AK October 24, 2012 and February 14, 2013. This section of the technical memorandum describes the initial evaluation of representativeness of the ten FAs for their applicability to the R-IFS.

For this evaluation, representativeness was examined by 1) comparing the representation of plant community types within the FAs to the representation of plant community types in the entire Riparian Process Domain (Tables 11-13) and 2) determining if the plant community types have been proportionately represented (focus vs. Riparian Process Domain).

3.1.2.1. Initial Selection of Riparian Study Areas

As an initial step in study planning and prior to identification of any FAs, the R-IFS lead examined the entire Middle River Segment from the Watana Dam site to the Three Rivers

Confluence. Eight sections 1-3 miles in length, were identified that captured, upon first examination, the variability in channel confinement (floodplain width) and channel planform type throughout the Middle River Segment. These eight selected sections were ultimately found to correspond to eight of the ten FAs described in the FA-IFS RSP Section 8.5 and in R2 2013a. The two FAs that were not included in the riparian sections were those at Indian River (FA-141) and Portage Creek (FA-151); these sites contained very little floodplain areas.

The question remained however, of whether the eight FAs identified for riparian analysis were representative of vegetation types and abundance within the entire Middle River Segment. As a result, a detailed quantitative analysis was completed that involved the determination of Riparian Process Domains and vegetation typing within the entire Middle River Segment. This analysis allowed for comparisons of vegetation type and abundance between FAs and areas outside of FAs.

3.1.2.2. Determination of Riparian Process Domains

Delineation of Riparian Process Domains was completed using a spatially constrained cluster analysis (Legendre and Legendre 2012) with geologic and geomorphic data gathered in ArcGIS (see Riparian IFS RSP Section 8.6.3.2 for details). Geologic, geomorphic and floodplain vegetation data was collected from geo-rectified aerial imagery and LiDAR digital elevation (2011 Matsu Ortho Imagery at 1:8000 scale, http://matsu.gina.alaska.edu/wms/imagery), and Viereck Level III classification of vegetation typing (ABR unpublished). As stated in the RSP (8.6.3.2), process domains define specific geographic areas in which various geomorphic processes govern habitat attributes and dynamics (Montgomery 1999). Within the mountain river network, temporal and spatial variability of channel, ice, and sediment disturbance processes can be classified and mapped, allowing characterization of specific riparian process domains with similar suites of floodplain disturbance types. The riparian process domain approach is hierarchical in structure allowing for river network stratified sampling to statistically describe elements and processes within each process domain. The cluster delineation resulted in four representative Middle River clusters or Riparian Process Domains (Figure 18).

3.1.2.3. Evaluation of FAs within Riparian Process Domains

Within the four defined Riparian Process Domains, the eight FAs were identified and selected for intensive surveys of physical process, vegetation sampling (see Riparian Botanical Survey RSP Section 11.6 for vegetation statistical sampling protocols) and riparian floodplain interaction modeling. The FAs were those considered most representative of the Riparian Process Domains in terms of vegetation structure and abundance, and channel / floodplain characteristics (channel plan form, channel slope, channel confinement). Process domain variability was assessed in terms of vegetation abundance and structure and within the selected FAs relative to the associated Riparian Process Domain (Tables 11-13). To capture the variability in floodplain vegetation types, and geomorphic terrains within each Riparian Process Domain not found within the Focus Areas, satellite study sites will be surveyed outside Focus Areas using the ITU riparian vegetation sampling protocols detailed in the Riparian Vegetation Study RSP Section 11.6.4.

Vegetation types and geomorphic attributes were then characterized along digitized transects located at ¼ mile intervals from the Watana Dam site (PRM 187.1) to Three Rivers Confluence

(PRM 102.4). In the Middle River study area, a total of 340 transects were placed and aligned perpendicular to the valley bottom axis. Each transect was segmented according to Viereck Level III plant community type and channel type. Lineal distances were computed for each discrete vegetation community or water feature. Segments attributed to active channel types (e.g., Main Channel, Side Channel, Split Main Channel, Braided Main Channel) and segments attributed to each plant community type were summed for each transect. Determinations of active channel vs. off-channel geomorphic features were consistent with definitions provided for Geomorphology Study (HDR 2013). The transect data describes the spatial distribution and abundance of plant communities along the entire length of the Middle River Segment.

Summary tables (Tables 11-13) were subsequently developed of Level III vegetation types, and type abundance for: (1) each of the three riparian process domains (Devils Canyon was excluded leaving three domains); (2) each of the eight FAs; and (3) comparisons between total Riparian Process Domain vegetation type and abundance within the FAs with those found in each domain.

3.1.2.4. Selection of Final Focus Areas for R-IFS

Overall, the analysis demonstrated that the vegetation types and abundance found within the eight FAs provides a good representation of the types and relative abundance of vegetation found within the respective Riparian Process Domains. As a result, these eight FAs were given further consideration by the riparian study team. This team, which included representatives from the USFWS (B. Henzsey) and NMFS (C. Derr), reviewed each of the eight FAs and selected five for detailed study. The three not selected (FA-184, FA-171, and FA-144) were found to be lacking in one or more characteristics including floodplain vegetation, floodplain terrain complexity, or wetland complexity (see Table 14). The final list of FAs that will be sampled for R-IFS investigations is listed in Table 15 and depicted in Figure 18.

3.2. Sites Outside of the Focus Areas

As noted in the RSP Section 8.5 and R2 (2013b), the boundaries of the FAs do not limit the geographic extent of other studies, as many other study sites and areas already have been or will be located as part of resource specific investigations. Indeed, other resource studies have identified study sites outside of FAs as necessary to achieve specific resource study goals and objectives (see Fisheries (RSP Section 9.6, 9.8, and 9.9), Groundwater (RSP Section 7.5), Geomorphology (RSP Section 6.0), Ice Processes (RSP Section 7.6), and Water Quality (RSP Section 5.0). Fisheries studies for example, have and will be conducted in multiple locations both within and outside of FAs as a means to fully characterize fish distributions in the Middle and Lower River segments (see Fish Distribution and Abundance Implementation Plan for Study 9.6 (R2 2013a). In addition, the salmon escapement studies will be monitoring fish movements within a 184-mile section of the river extending from PRM 26 upstream to Kosina Creek at PRM 209.1, and further upstream as necessary. In addition, 17 fixed telemetry stations will be installed within a mixture of tributaries and slough habitats at locations throughout the entire length of the river. Water quality studies will likewise occur at locations within and outside of FAs. A total of 39 water quality monitoring stations have been identified that extend from PRM 20 to PRM 235.1. These sites will be used for collection of baseline water quality data. In addition, water quality sampling will be conducted in selected FAs to provide a more detailed characterization of water quality characteristics in those areas as they relate to fish productivity and main channel flow conditions (see RSP Section 5). Fluvial geomorphology studies involving sediment transport and large woody debris distribution likewise include areas both within and outside of FAs, as do the Ice Processes studies. The Ice Processes studies include time-lapse photography at more than 25 sites in the river extending from PRM 15.1 to PRM 226, as well as winter discharge measurements at selected cross-sections, and winter field studies of FAs as a means to understand how winter conditions affect fish habitats and geomorphology.

In terms of the FA-IFS, there are a total of 80 cross-sectional transects in the Middle River Segment and 8 transects in the Lower River Segment that have been established and flow data collected to support development of the open-water flow routing model (see Open-water Flow Routing Model Results technical memorandum [R2 et al. 2013], and RSP Section 8.5.4.3 and Table 8.5-7 reproduced herein as Table 16). These transects were primarily located across single thread sections of the river; however, some do extend across more complex sections. In most cases, two to three sets of flow measurements have been made at each transect. The resulting data sets can be used, at a minimum, for evaluating velocity-depth distributions across the channel that can be related to biologically relevant criteria associated with various life stage requirements (e.g., spawning, adult holding, juvenile rearing). In many cases (pending review of the cross-sectional data), it should be possible to develop actual habitat-flow relationships following a 1-D PHABSIM type analysis (see RSP Section 8.5.4.6). The cross-sectional transects represent an important dataset that can be used to characterize habitat-flow response characteristics of the main channel of the Susitna River. These types of data were never collected during the 1980s studies and no main channel habitat-flow relationships were developed. Importantly, now that the main channel habitat mapping is completed (see Section 6), the transect locations have been assigned to specific mainstem habitat types (main channel, side channel, split channel, etc.) and main channel mesohabitat types (e.g., riffle, run, glide, pool) and can be randomly selected for analysis. These additional transects may also be useful for extrapolating results/relationships from measured to unmeasured sites (see RSP Section 8.5.4.7).

For the R-IFS, in addition to the five FAs, a quantitative determination will be conducted prior to summer field operations to select additional vegetation sample sites (i.e., satellite sites), throughout each of the three Middle River Process domains representative of herbaceous plant communities. This was specifically requested by Dr. Robert Henszey as noted in the working group meeting summary (see Supplemental Information of U.S. Fish and Wildlife Service/AFWFO/Anchorage filed with FERC under P-14241 [February 26, 2013] (interim comments provided from a consensus meeting with AEA consultants, USFWS, and NMFS regarding Riparian study focus areas).

3.3. Final Listing of Focus Areas and Study Sites for Middle River Segment

The results of the habitat mapping analysis completed for the FA-IFS and the process domain analysis completed for the R-IFS have provided insight into the types and distributions of mainstem habitats and the variability of process domains and vegetative community types within the Middle River Segment of the Susitna River.

With respect to the FA-IFS, the results of the habitat mapping and statistical analysis indicate that the ten FAs identified in RSP Section 8.5 are generally representative of habitat types found in other portions of the river. As a result, those ten FAs, which are listed in Table 1, have been selected for study in 2013 in accordance with the respective resource specific RSPs.

However, according to the existing habitat mapping framework and results, there are some habitat types within individual geomorphic reaches that were not represented in the reach-specific FAs or captured in the existing transects (Table 17). These habitats were reviewed and the following considerations applied in evaluating the need for adding supplemental sites in 2013 to capture those habitats:

- Whether on-the-ground detailed habitat mapping that will occur within FAs in 2013 may identify additional habitat features (e.g., plumes and backwaters) negating the need to add supplemental sites for these currently "missing" habitat types;
- Whether the "missing" habitat types are similar enough to habitat types in FAs within adjacent geomorphic reaches (e.g., split main channel in MR-2 may be similar to split main channel in MR-1) to negate the need for adding supplemental sites, noting that the 2013 studies will help evaluate this; and
- There will be time in 2014 to add supplemental transects to biologically important habitat types that are not found to be represented in the FAs even after the 2013 on-the-ground detailed habitat mapping.

The habitats present within each reach but located outside of FAs were examined and evaluated relative to the above three considerations, as follows:

1. MR-2 Split Main Channel and Backwater

   Figure 19 shows the sole complex with split main channel and the sole backwater identified by habitat mapping in reach MR-2. A supplemental cross-section could be added to this complex. However, both of these features may be represented adequately by similar features in other reaches. Importantly, the only backwater identified by the habitat mapping is very close to a protected raptor nesting area, which is likely to impede additional sampling in that area during some seasons. However, if these habitats are not found to be easily represented by other features, based on detailed habitat studies completed in 2013, then supplemental cross-sections will be added and the backwater habitat sampled in 2014.

2. MR-5 Split Main Channel and Side Slough

   Figure 19 shows the only split main channel and side slough habitat that exists in Geomorphic Reach MR-5, which is downstream of FA-151. However, results of the detailed habitat studies completed in 2013 may reveal that these features are represented by similar features in MR-6. If not, then supplemental cross-sections will be added and the backwater habitat sampled in 2014.

3. MR-7 Tributary Mouth and Plume

   Figure 19 shows the only tributary mouths and plume in MR-7 identified by the habitat mapping. One of the tributaries, Lane Creek, has two associated mouth areas, as it splits into two branches prior to entering the main channel. The plume is associated with Lane Creek. If these features are found to be important habitats that cannot be represented by similar features in other reaches after 2013 detailed habitat studies, then supplemental cross-sections will be added by Lane Creek to capture mouth and plume habitat in 2014.

4. MR-8 Backwater

   Figure 19 depicts one of very few backwater habitats in MR-8. This feature appears to be relatively unique to this area of the river, and therefore supplemental cross-sections will be added in 2013 to capture this backwater habitat.

Results of the R-IFS analysis likewise indicated that the variability of the process domains and vegetative community types are generally captured within the boundaries of the geomorphic reaches and can be sufficiently characterized within a subset of the ten FAs. This subset entails five FAs including the lower four: FA-104, FA-115, FA-128, and FA-138, as well as one FA above Devils Canyon, FA-173. Table 15 depicts the final listing of FAs selected for the R-IFS. The results of the analysis demonstrate that there is sufficient similarity in process domains and vegetation types within the other FAs to one or more of the five FAs that there is no need for specific R-IFS studies in those areas. The results of the R-IFS analysis also did not show the need to add any supplemental sites or FAs in the Middle River Segment.

Overall, the ten FAs, coupled with identified additional sampling sites (i.e., cross-sections) that have been established outside of the FAs, the study sites outside of the FAs that have been identified as part of other resource studies, and supplemental sites as determined will be needed in 2013 (e.g., the one MR-8 Backwater habitat type) and 2014 (based on results of 2013 studies), will collectively provide a comprehensive and spatially expansive array of study areas and sites within the Middle River Segment of the Susitna River.

However, this does not mean that refinements to the list are not possible. As was noted in the RSP, results of the 2013 studies will be reviewed and evaluated, and may result in some refinements to existing study sites/areas and/or establishment of supplemental sites that target specific habitat-flow relationship types. For example, the scaling up/expansion of flow – habitat relationships derived from measured to unmeasured sites or locations within the river may require measurement of certain flow attributes (e.g., determination of the relationships of main channel flow to side channel and side slough breaching flows; defining areas of turbid/non-turbid waters; defining areas of groundwater upwelling) at unmeasured areas. In addition, the results of detailed on-the-ground habitat studies may likewise reveal the need to sample additional habitat types that were not directly captured in the FAs (e.g., habitat types in MR-2, MR-5, and MR-7 noted above). The Final FAs and study sites remain subject to refinement based on results of 2013 investigations and study needs.

Finally, during the February 14 TWG meeting, AEA received feedback regarding potentially moving the location of a MR-2 FA to MR-7. The results of both the FA-IFS and R-IFS FA analysis clearly indicate that the selected areas listed in Tables 1 and 15 are representative of other areas in the Middle River Segment and hence are appropriate and sufficient for detailed study. However, AEA does not oppose making the suggested relocation of a MR-2 FA to MR-7 (or other possible adjustments to existing FA locations) prior to the initiation of the 2013 field studies so long as there is sufficient justification for such relocation and the resulting FA remains representative of other areas in the Middle River Segment.

4. STUDY SITES IDENTIFIED IN THE LOWER RIVER SEGMENT

4.1. Rationale for Lower River Studies

The Revised Study Plan described the downstream boundary of the Study Area as RM 75 because existing information indicated that the hydraulic effects of the Project below the Three Rivers Confluence are attenuated (see RSP Section 8.5.3). As described in the Revised Study Plan, AEA reevaluated how far downstream Project effects extend based in part upon the results of the Open-water Flow Routing Model (see RSP Section 8.5.4.3),which was completed in Q1 2013 (R2 et al. 2013). The results of the Open-water Flow Routing Model are consistent with the information presented in the Pre-Application Document and information presented to Technical Work Groups in October 2012. However, the results suggested that although the effects of flow regulation would continue to attenuate downstream of the Three Rivers Confluence, seasonal changes in river stage would still occur in conjunction with project operations.[1]

As noted in RSP Section 8.5.3, the extent of studies conducted in the Lower River Segment will be based upon consideration of the following six criteria.

- Criteria 1 - *Magnitude of daily stage change due to load-following operations relative to the range of variability for a given location and time under existing conditions (i.e., unregulated flows);*
    - Results of the Open Water Flow routing model were presented in R2 et al. (2013) and discussed during the February 14, 2013 TWG meeting. Results indicated that pre- versus post-Project stage changes varied by location and time and ranged at Gold Creek (Middle River Segment) from an increase in daily average water level of up to 2 to 3 feet in the winter and a reduction of daily average water level of as much as 5 feet in the summer during high natural flow conditions (See Figures 5.4-2 and 5.4-3 of R2 et al. 2013). More typically the change would be about 3 feet in the summer. The predicted change in stage in the upper portion of the Lower River Segment at Sunshine ranged from an increase in daily average water level of up to 1 to 2 feet in the winter and a reduction in water level of as much as 3 feet in the summer during high flow conditions (Figures 5.4-4 and 5.4-5 (R2 et al. 2013). Daily and hourly changes in stage during the summer period at Sunshine were predicted to range from 0.6 to 0.8 feet, but accurate estimates for the winter period are contingent on completion of the winter flow routing model.
- Criteria 2 - *Magnitude of monthly and seasonal stage change under Project operations relative to the range of variability under unregulated flow conditions;*
    - Results of a comparative hydrologic analysis considering existing and with-Project operations was completed by Tetra Tech and presented and discussed during the February 14, 2013 TWG meeting (Tetra Tech 2013). These results were based on a 61 year extended discharge record that had been developed by the USGS. Comparisons were made of monthly flows and annual flows under

[1] Specifically, these seasonal changes in river stage are consistent with the information presented in the Pre-Application Document and information presented to Technical Work Groups in October 2012.

pre-Project and a maximum load following scenario. Results showed substantial changes in seasonal flows during both the summer (Project operational flows were lower) and winter (project operational flow were higher) periods (as had been noted in the Pre-Application Document) with summer changes most pronounced in the upper portions of the river (pre- and post-Project flows at Gold Creek in July: 20,000 cfs versus 6,980 cfs; and at Susitna Station 122,000 cfs versus 108,000 cfs) while winter changes were evident throughout the entire river length (pre-post flows at Gold Creek in January: 1,280 cfs versus 8,840 cfs; and at Susitna Station – 7,910 cfs versus 15,500 cfs). Results of flow duration analysis demonstrated the shifts in flow magnitudes that would occur with Project operations.

    - Flood frequency analysis likewise indicated there would be changes in return periods of specific flood magnitudes. For example at Gold Creek, a two-year flood event (i.e., a flood that occurs on average once every two years) of 43,700 cfs would, under maximum load following operations occur once every 12 years. Likewise, at Susitna Station, a two year flood of 170,300 cfs would occur once in every five years.
    - Further hydrologic analysis will be completed as part of an IHA analysis described in RSP Section 8.5.4.4.1.3.

- Criteria 3 - *Changes in surface area (as estimated from relationships derived from LiDAR and comparative evaluations of habitat unit area depicted in aerial digital imagery under different flow conditions) due to Project operations;*
    - The analysis of LiDAR data (Criteria 3) is still ongoing and results were not available to make quantitative estimates of Project induced areal changes. However, inferences of surface areas can be drawn from the previous work of R&M Consultants and Trihey and Associates (1985). Review of that document and the analysis presented indicates that changes in surface area with flows can be pronounced depending upon the range of flows considered, as well as specific habitat types (e.g., side channel, side sloughs, etc.). As R&M Consultants and Trihey and Associates (1985) noted, surface area responses are a function of streamflow and channel geometry. Examples of flow responses to wetted surface areas for different locations in the Lower River Segment are found in Figures 3-1 through 3-4 of R&M Consultants and Trihey and Associates (1985). Inspection of those relationships indicates that surface areas of certain types of habitats can be quite sensitive to changes in main channel flows. Additional analysis of these data is in progress and will be available in Tetra Tech (2013b).
- Criteria 4 - *Anticipated changes in flow and stage to Lower River off-channel habitats;*
    - The flow and stage changes indicated by the results of the flow routing model and hydrologic analysis cannot be directly related to off-channel habitats since results of the LiDAR analysis has not been completed and detailed bed topography of specific areas has not yet been acquired. However, reasonable inferences can be made based on the timing, magnitude, and duration of flow and stage changes associated with the proposed Project operations on different types of lateral habitats. For example, it is reasonable to assume that some of the lateral habitats

inundated under pre-Project flow conditions could become partially dewatered or disconnected from the main channel under summer time Project operations due to reductions in flow and stage. Conversely under winter time operations, habitats that may normally be disconnected from the main channel and operate as clear water side slough habitats may become connected due to flow increases and breaching at the head end of the channel resulting in turbid water conditions.

- Criteria 5 - *Anticipated Project effects resulting from changes in flow, stage and surface area on habitat use and function, and fish distribution (based on historical and current information concerning fish distribution and use) by geomorphic reaches in the Lower River Segment;*
  - Based on the anticipated changes in stage and flows in the Lower River Segment, it is reasonable to assume there would likely be some effects on fish habitat and fish distribution, resulting from Project operations. However, the magnitude and extent of such effects cannot be defined without further study.
- Criteria 6 - *Initial assessment of potential changes in channel morphology of the Lower River (see Section 6.5.4.6) based on Project-related changes to hydrology and sediment supply in the Lower River.*
  - The initial assessment of potential channel changes was performed and reported in three technical memoranda developed in the 2012 Geomorphology Study: Stream Flow Assessment (Tetra Tech 2013a), Development of Sediment-transport Relationships and an Initial Sediment Balance for the Middle and Lower Susitna River Segments (Tetra Tech 2013b), and Reconnaissance Level Assessment of Potential Channel Change in the Lower Susitna River Segment (Tetra Tech 2013c). The conclusions from each are summarized below.

    Stream Flow Assessment (Tetra Tech 2013a): The primary basis for identifying the need to continue the 1-D bed evolution modeling effort below the initially proposed downstream extent was based on interpretation of the results of the potential changes in hydrology identified in this technical memorandum. A comparison of the annual peak flow frequency results between the existing conditions and the Maximum Load Following Operations Scenario 1 indicates an appreciable reduction in flows in the 1.5- to 5-year range of recurrence intervals in the Lower River. Discharges in the range of the 1.5- to 5-year peaks are often representative of the channel forming or effective discharge to which the bankfull channel capacity adjusts in streams such as the Lower River Segment that have mobile bed material and a substantial sediment supply (Wolman and Miller 1960, Wolman and Gerson 1978, Williams 1978, Andrews 1980). For the 2-year event, the reduction at Sunshine and Susitna Station were estimated at 24 percent and 17 percent, respectively. Numerous researchers have identified hydraulic geometry relationships (i.e., relationships between channel dimensions and discharge) that clearly demonstrate this linkage (Leopold and Maddock 1953, Langbein 1964, Emmett 1972, Parker 1979, Andrews 1984, Hey and Thorne 1986, Julien and Wargadalam 1995). The channel width is typically proportional to about the square-root of the discharge; thus, the indicated reductions in 2-year discharge suggest that the channel could narrow by slightly more than 10 percent in the portion of the Lower River segment below Sunshine, and less than 10 percent downstream from the Yentna River confluence. The narrowing could occur through a combination of vegetation encroachment and sediment deposition along the margins of the channel and by expansion of the mid-channel islands. Since the channel margins, including the side sloughs are key habitat units, changes in these areas could have implications to habitat.

Development of Sediment-Transport Relationships and an Initial Sediment Balance for the Middle and Lower Susitna River Segments (Tetra Tech 2013b): Results from this technical memorandum indicated that the portion of the Lower River Segment below Sunshine is aggradational under pre-Project conditions, and it would likely remain aggradational under Maximum Load Following OS-1 conditions, although the magnitude of the aggradational tendency would be somewhat reduced. The sediment balance results are inconclusive as to whether significant channel change would occur as a result of the Project. More accurate quantification of this change under Project conditions is necessary to provide a basis for understanding the potential implications to the change in sediment balance to both channel form and instream and channel-margin habitat. Extension of the 1-D bed evolution model downstream to Susitna Station will help provide this understanding.

Reconnaissance Level Assessment of Potential Channel Change in the Lower Susitna River Segment (Tetra Tech 2013c): In this technical memorandum, the application of the Grant et al. (2003) conceptual model of channel change suggested that the potential for significant change in the Lower River Segment downstream from Sunshine is indeterminate; thus, it cannot be concluded with certainty that the impacts of the Project would be acceptably small. The results of the model indicated that the portion of the Lower River Segment above Sunshine will continue to be aggradational with respect to the gravel load, but it is likely to see little impact related to sand transport. Although these results are not extreme, the model output suggests that the portion of the Lower River Segment could tend toward degradation and channel narrowing.

As a result, AEA has confirmed that studies should be expanded in the Lower River Segment. During the February 14, 2013 TWG meeting, this decision was noted and an initial plan presented for commencing such studies in 2013 and completing the studies in 2014.

This technical memorandum presents additional details concerning studies in the Lower River Segment and includes a description and listing of study sites that will be evaluated in 2013 and 2014. As was noted during the TWG meeting, the number and locations of sites may ultimately vary depending upon accessibility and safety considerations.

4.2. Resource Specific Studies and Study Sites in Lower River Segment

4.2.1. Fish and Aquatics Instream Flow Study

The Lower River segment consists of approximately 102.4 miles of river between the Three Rivers Confluence and Cook Inlet (Figure 20). For several miles downstream of the Three Rivers Confluence, the Susitna River becomes braided, characterized by unstable, shifting gravel bars and shallow subchannels. For the remainder of its course to Cook Inlet, the Susitna River alternates between single channel, braided, and meandering plan forms with multiple side channels and sloughs. Major tributaries drain the western Talkeetna Mountains (the Talkeetna River, Montana Creek, Willow Creek, and Kashwitna River), the Susitna lowlands (Deshka River), and the Alaska Range (Yentna River). The Yentna River is the largest tributary in the Lower River Segment, supplying about 40 percent of the mean annual flow of the Susitna River at its mouth.

Macrohabitat types in the Lower River Segment include main channel, side channels and sloughs, backwater, and tributary mouths (Tetra Tech 2013a). In comparison to the Middle River, the Lower River channel exhibits much lower gradient with a wider floodplain containing numerous subchannels. Focus Areas were identified in the Middle River to describe existing conditions and the response of habitats to proposed Project releases. Modeling of the Middle River FAs will integrate studies of fisheries, geomorphology, groundwater, riparian, ice processes and water quality. The Middle River FAs range from 0.5 to 1.8 miles in length and data will be collected to develop digital terrain models of each Focus Area. Hydraulic conditions within these FAs will be based on 2-D modeling that will be integrated into PHABSIM-type analyses of potential fish habitat. Due to the size and complexity of the Lower River Segment channel, a similar 2-D modeling of FAs is not feasible.

As described in RSP Section 8.5.4.2.1.2: Selection of Study Areas/Study Sites, instream flow study sites are generally identified following representative, critical, and/or random approaches. Representative or random site selection approaches generally require comprehensive habitat mapping results and selection of critical sites generally requires available knowledge of biologically important habitats. Study areas were tentatively identified by AEA’s inter-disciplinary team including representatives from geomorphology, instream flow-fish, instream flow-riparian, and groundwater. One area was selected in each of the geomorphic reaches LR-1 and LR-2 to describe the mix of thalweg channel, major subchannels, alluvial island complexes, side channels and sloughs observed in aerial photos of the Lower River Segment channel. The area around Trapper Creek near PRM 94.5 was selected as representative of the habitat types in LR-1 (Figure 21), and the area around Caswell Creek near PRM 67 was selected as representative of habitat types in LR-2 (Figure 22).

Fish habitats in the Lower River Segment will be modeled using a 1-D approach involving transects selected to represent major habitat types within each geomorphic reach. Data collection and modeling efforts will be conducted in LR-1 and LR-2 in 2013. Data collection and modeling efforts will be evaluated in Q4 2013 to identify the number, location and type of habitat modeling efforts to be conducted in the Lower River Segment in 2014. The size and complexity of the Lower River Segment channel presents significant challenges to data collection and modeling efforts and the results of the 2013 efforts will guide additional efforts in 2014.

In addition to describing representative habitat types in LR-1 and LR-2, tributary mouths were identified as potential critical sites. During the 1980s, the primary salmon spawning areas within the Lower River Segment appeared to be clearwater tributaries (R&M Consultants, Inc. and Trihey & Associates 1985b); although 1980s sampling limitations may have overlooked some mainstem salmon spawning. Low velocity backwater areas near tributary mouths were used as holding areas by adult salmon during upstream migration into the tributaries, and tributary mouths became a major component of Lower River studies during the 1980s. In addition to evaluating potential effects of Project flow releases on adult salmon holding areas at Lower River Segment tributary mouths, 1980s studies included analyses of salmon access into tributaries and the geomorphic stability of tributary mouths. Thirteen Lower River Segment tributary mouths were selected for study in the 1980s (Table 18) (R&M Consultants, Inc. and Trihey & Associates 1985b).

Recent biological studies appear to support the continued importance of Lower River Segment tributary mouths as salmonid habitat. During 2012, habitats in LR-1 and LR-2 were opportunistically surveyed to collect habitat suitability criteria (HSC). Of the 69 HSC observations of adult, juvenile, and fry life stages, 42 percent were located in tributary mouth macrohabitats.

Of the thirteen tributary mouths studied in the 1980s, five were selected for study during 2013. Trapper Creek and Birch Creek are located in the vicinity of the LR-1 study area, and Sheep Creek and Caswell Creek are located in the vicinity of the LR-2 study area. The Deshka River was identified as an important adult salmon holding area during the February 14, 2013 TWG meeting and the Deshka River mouth was added to the list of 2013 study areas. The mouth of the Kashwitna River is located near the LR-2 study area, but it was not selected for study in 2013 because it does not appear to be heavily influenced by potential Project flow releases (Table 18). In terms of sampling methods, approximately ten transects will be located at each selected tributary mouth extending from the clearwater plume at the tributary confluence upstream into the tributary extending above the extent of backwater influence from the main channel. In addition to evaluating the effects of Project flow releases on salmon habitat, channel and hydraulic data collected at the tributary mouths can be used to evaluate the effects of Project flow releases on boat access into tributaries and use of tributary mouths by recreational anglers. During 2013, the mouths of the tributaries not selected for measurement and modeling will be reconnoitered by representatives of the instream flow–fish, geomorphology and water quality disciplines to evaluate additional modeling efforts in 2014.

Input to the Lower River Segment hydraulic and fish habitat models will include cross-section profiles of each transect measured between high water end points. At least one water surface elevation per transect, and associated channel and mainstem discharge will be needed along with substrate and cover descriptions. The velocity distribution along each study transect will be measured to describe the mean column velocity in each wetted cell in the study transect. Data collection efforts to support the 1-D instream flow fish habitat model will be coordinated with geomorphology and instream flow-riparian study efforts. Those studies will also need data collected along transects and where feasible, instream flow transects will be co-located with geomorphology and instream flow-riparian transects. Data needs for both instream flow fish habitat and geomorphology include:

- Stage recorders installed at key main channel and side channel locations to provide water surface elevations to calibrate the open-water flow routing model and the 1-D PHABSIM models.
- Cross-section profiles at approximately ten transects on the lower portion of each of the five selected tributaries. The number of transects at individual tributaries will depend on channel complexity and the extent of mainstem backwater influence. Where feasible, instream flow fish habitat transects will be co-located with geomorphology and instream flow-riparian transects.
- Thalweg profile for each of the five selected tributaries from the confluence with the main channel or side channel upstream to a location above the backwater influence during high flow conditions.
- Stage recorders will be installed at the lower end of each tributary in the backwater area and on each tributary upstream of the extent of backwater. Stage readings will be recorded at 15-minute intervals during portions of all four seasons for a period sufficient to develop annual hourly inflow records.
- Flow measurements will be collected near the stage recorders upstream of the backwater area to establish rating curves on each of the five tributaries.
- Data collected at tributary mouths will be used to develop a HEC-RAS model to describe the relationship between mainstem flow and tributary water surface elevations.

Water surface elevations will be modeled using a stage:discharge relationship (rating curve) to calculate water surface elevations at each transect. The basic computational procedure will be to perform a log-log regression between observed stage and discharge pairs at each transect. The resulting regression equation will then be used to estimate water surface elevations at all flows of interest. In the stage:discharge relationship and its simulation, each transect is treated as independent. Data input include water surface elevations and three or more associated discharge measurements. If at least three stage:discharge data pairs are not available, water surface elevations will be calculated using Manning's equation.

Velocity distributions within a transect (i.e., the mean column velocity in each wetted cell in a study transect at each simulation discharge) will be simulated over the range of target discharges. Input to the model include at least one set of measured velocities per transect that act as a template to distribute velocities across a channel by solving for the 'n' in Manning's equation. The channel is divided into cells and the velocity calculated for each of these cells. The usual practice is to use one set of velocities as a template for simulating velocities for a particular range of discharges (USGS 2012). When more than one set of velocity measurements is available, a commensurate number of flow ranges can be simulated with different velocity templates. However, accuracy at a measured calibration flow may be affected when trying to achieve a better fit over a full range of calibration flows.

In addition to measurement and modeling of macrohabitat types in Lower River geomorphic reaches LR-1 and LR-2, HSC criteria will be collected from representative habitat types at each of the five tributary mouths. A minimum of three samples will be selected from each of the habitat types within each tributary sampling area. HSC site selection will require the results of habitat mapping of the Lower River Segment. In addition to technical considerations, access and safety will be key non-technical attributes for site selection for all studies conducted in the Lower River Segment.

In support of the evaluation of channel change in the Lower River, geomorphic features in the Lower River were mapped as polygons from the Three Rivers Confluence to Cook Inlet (Tetra Tech 2013b). The results of geomorphic feature mapping provide a spatial depiction of the distribution of channel features throughout the entire length of the Lower River Segment. Results of the geomorphic mapping will be used to evaluate the "representativeness" of the Lower River study areas with respect to other areas of the river. In this context, representativeness specifically refers to how well habitat units within selected study areas represent channel features outside of these areas but within the same geomorphic reach. An evaluation of the representativeness of the Lower River study areas will occur in Q4 2013 after the first year of sampling. By fall 2013, information will be available on the feasibility of measuring and modeling various channel and hydraulic conditions in the Lower River. Information on the distribution of fish among channel features and habitat use will also be used to identify additional data needs to evaluate Project effects on Lower River habitats. The location, number, and type of additional physical and hydraulic data needed to describe Lower River habitats will be confirmed in Q1 2014 prior to the 2014 open-water field data collection period.

4.2.2. Riparian Instream Flow Study

Upon determination that the Lower River Segment would be studied in the 2013 field season, a riparian vegetation sampling approach was developed with R-IFS, Riparian Vegetation Study, Geomorphology Study, and Groundwater Study leads and representatives of USFWS and NMFS. It was agreed that the Lower River Segment sampling approach would include:

1. characterization of both floodplain vegetation type and diversity,
2. broad spatial scope of the Lower River,
3. utilization of Geomorphology Study 1-D sediment transport and flow routing modeling transects, and
4. selective installation of groundwater wells.

It was further agreed that vegetation sampling would be conducted along floodplain wide transects selected to represent Geomorphic Reaches LR-1 to LR-5 extending down river to PRM 29.5 (Figure 20). The utilization of the Geomorphology Study transects will allow for modeling of surface water regime characteristics associated with floodplain vegetation types sampled along each transect. In addition to surface water modeling selective sites, groundwater wells, two per transect, will be installed to characterize groundwater floodplain vegetation type regimes within the Lower River Segment. This riparian sampling approach, capitalizing on the Geomorphology sediment transport and flow routing studies, will provide a broad scale sample of the Lower River Segment floodplain vegetation types, surface water regimes associated with those types and will characterize vegetation type groundwater regimes. These data will be utilized to develop final 2014 riparian vegetation sampling strategy and sampling design.

The riparian sample transect locations in the Lower River Segment are presented and described in Table 19 and depicted in Figure 20.

4.2.3. Groundwater

The Groundwater Study (RSP Section 7.5) has several study objectives involving the Lower River Segment of the Susitna River. Study objectives include data and information synthesis (RSP Section 7.5.4.1.1) which will provide a review of pertinent reports, papers, state and federal database reviews for groundwater wells and springs site information from historical and more recent information. This information will help determine the regional context for geohydrologic units within the larger watershed groundwater flow system. The regional understanding of significant groundwater upwelling areas in the lower reaches will be addressed in study efforts described in RSP Section 7.5.4.3. This study effort will use Ice Processes Study information on open leads during winter conditions (RSP Section 7.6.4.1), existing aerial photography, winter discharge measurements, and other field observations from hydrology programs to characterize the changes in baseflow conditions associated with groundwater upwelling in the portion of the study area above PRM 30.

The Groundwater Study in the Lower River Segment will characterize groundwater conditions associated with five cross-sections that will serve multi-disciplinary purposes, one located in each geomorphologic reach above PRM 30 (Figure 18). These cross-sections will be used across resource disciplines (R-IFS, FA-IFS, and Geomorphology) and will result in the collection of a coordinated set of data that can be used for evaluating Project operational effects, including effects in the winter, on multiple resources. For groundwater studies, two shallow wells will be installed within the floodplain of each cross-section and will be monitored to evaluate groundwater-surface water linkages. This information will be used by the R-IFS to evaluate Project effects on existing riparian communities. These same cross-sections will be used to meet IFS aquatic study objectives for summer and winter flow conditions by characterizing groundwater and surface-water interactions. Groundwater and surface-water levels will be measured at these cross-sections and within associated lateral habitats to understand relationships between groundwater conditions and aquatic surface-water habitats.

Another Groundwater Study activity that was already planned for the Lower River Segment is described in RSP Section 7.5.4.8 – Shallow Groundwater Users. This study objective includes the measurement of private water wells in the overall study area and the adjacent surface water levels on the river to help determine the potential Project effects on shallow well users.

4.2.4. Fisheries

The Fish Distribution and Abundance Study (FDAS) presented in RSP Section 9.6 discussed sampling for relative abundance in the Lower River Segment Geomorphic Reach LR-1. However, results of the recently completed Open Water Flow Modeling and hydrologic and geomorphologic analysis have indicated the need to assess Project effects further downstream within Geomorphic Reaches LR-2 to LR-4. The size of the river, and the density and complexity of channels and channel morphologies in the Lower River Segment create difficult sampling conditions for fish. Because one of the primary goals of the FDAS is to define species presence and relative abundance at different locations in the river, AEA will rely upon a systematic transect approach whereby fish sampling sites will be selected within habitat units encountered along a transect. For this, a total of ten transects will be located within the Lower River Segment extending from PRM 102.4 to 32.3. These transects will be spaced at 7.4-mile intervals and selected with a random start point (Figure 20).

Because of the complex nature of the Lower River Segment, most transects will span multiple habitat types (e.g., main channel, side channel, upland slough, and side slough). Correspondingly, one habitat unit of each type encountered will be selected for sampling along each transect (see Figure 5.4-3 in Susitna River Fish Distribution and Abundance Implementation Plan). Where multiple habitat units of the same type occur, units will be randomized and one selected. Fish distribution and abundance sampling will then be conducted monthly (during open water periods) along a 40-meter length of the unit, starting at the downstream end. If the randomly selected habitat unit is totally inaccessible to field crews, then a second randomly selected habitat unit will be sampled.

The results of the 2013 FDAS, coupled with results of the Salmon Escapement Study (RSP Section 9.7) will provide valuable information concerning the distribution and habitat use by different fish species in the Lower River Segment. The need for additional sampling sites (or modifications in sampling methodologies) in 2014 will include consideration of:

- Extent to which the 2013 sites captured representative habitat types as determined based on results of detailed habitat mapping (to be completed in 2013);
- Extent to which 2013 sites aligned with FA-IFS sites and HSC sampling sites and whether inferences can be drawn relative to fish use of specific habitat types; and
- Capture efficiency of sampling methods (gear types) used in 2013 (i.e., potential need to refine sampling techniques).

4.2.5. Geomorphology

The Geomorphology Study (RSP Section 6.5) contains several efforts that encompass the entire Lower River Segment. These efforts include the delineation and characterization of geomorphic reaches (RSP Section 6.5.4.1), analysis of sediment supply and transport (RSP Section 6.5.4.3), identification of channel change based on historical aerial analysis (RSP 6.5.4.4), reconnaissance level of assessment of potential channel change (RSP Section 6.5.4.6), comparison of 1980s and 2012 riverine macrohabitat versus flow relationships for selected Lower River sites (RSP Section 6.5.4.7) and large woody debris mapping and analysis (RSP Section 6.5.4.9). The Fluvial Geomorphology Modeling Study (RSP Section 6.6) ended the modeling efforts about 8 miles below Sunshine at PRM 79.

Based on the decision to evaluate effects further downstream in the Lower River, additional efforts will be conducted under the Fluvial Geomorphology Modeling Study. Figure 20 identifies the area for extension of the 1-D model. The extension of the Fluvial Geomorphology Modeling Study will have two primary objectives:

- Determine potential Project effects on the geomorphology in the portion of the Lower River Segment from PRM 79 downstream to PRM 29.9 (Susitna Station); and
- Support the evaluation of Project effects by other studies in their resource areas providing channel output data and assessment of potential changes in the geomorphic features that help comprise the aquatic and riparian habitats of the Lower Susitna River Segment from PRM 79 downstream to PRM 29.9 (Susitna Station).

The primary aspect to this effort will be the extension of the 1-D bed evolution model from PRM 79 downstream to PRM 29.9. The extension of the 1-D bed evolution model, along with the open-water flow routing model, will allow a reach level determination of the sediment balance within the Lower River Segment. It will also allow for evaluation of key physical processes such as the extent of inundation, mobilization of bed material on bars and tractive forces associated with the potential scouring of vegetation. The overall development, data collection, calibration and application of the 1-D bed evolution model will be similar to that described in the RSP for the portion of the model from PRM 187.1 (RM 184) to PRM 79 (RM 75). The effort will be performed in conjunction with the R-IFS (RSP Section 8.6) and the Ice Processes Study (RSP Section 7.6) to provide an integrated determination of potential channel change in the Lower River.

Data collection efforts to support the 1-D bed evolution model development and application include:

- Survey approximately 50 cross sections between PRM 79 and PRM 29.9. These would serve both the 1-D bed evolution model and the open-water flow routing model. The cross sections would extend across the main channel and braid plain as well as incorporate significant side channels.
- Collect bed material samples to characterize the bed material at selected model cross sections. Bed material samples would include surface and subsurface and will consist of a combination of pebble counts and bulk samples dependent on the size of the material being sampled. It is anticipated that approximately 200 bed material samples will be collected.
- Level loggers will be installed at key main channel and side channel locations to provide water surface elevations to calibrate the open-water flow routing model and the 1-D bed evolution model. (This effort will be performed as part of the FA-IFS.)
- Expand the USGS sediment transport and discharge measurement program to include the Susitna River at Susitna Station and Yentna River near Susitna Station to support the sediment-transport analysis. This will help refine the sediment transport relationships and provide information to compare current data with the 1980s data.
- Perform a field assessment of the geomorphology of the Lower River Segment downstream to PRM 29.9 while collecting the bed material samples.

The other effort that will be conducted as part of the 2013 extension of the Fluvial Geomorphology Modeling Study into the Lower River Segment will be the analysis of potential Project effects at five selected tributary mouths. The tributary mouths were identified as important habitat with the potential to be affected by the Project in the 1980s study *Assessment of Access by Spawning Salmon into Tributaries of the Lower Susitna River* (Ashton and Trihey 1985). Primary issues are the influence of the Project on fish access to the tributaries and the holding area near the tributary mouths. The potential for changes in sedimentation and hydraulics (area of backwater, depth and velocity) will be investigated at the five selected tributary mouths: Trapper Creek, Birch Creek, Sheep Creek, Caswell Creek and the Deshka River (Figure 20). Sedimentation at the tributary mouths will be determined by a procedure similar to that described in RSP Section 6.6.4.1.2.6. A hydraulic model (HEC-RAS) will be developed for the downstream end of each tributary to support the determination of changes in hydraulic conditions and sediment transport characteristics.

Data collection efforts to support the sediment transport and hydraulic analysis at the selected tributary mouths include:

- Survey of approximately ten cross sections on the lower portion of each of the five selected tributaries. The number of cross sections at individual tributaries will depend on the extent of mainstem backwater influence. Transects from the FA-IFS effort may provide a portion of the cross sections required;
- Survey a thalweg profile for each tributary from the confluence with the mainstem (or the branch of the mainstem) upstream to the location of the upstream most cross section above the backwater influence;
- Collect bed material samples to characterize the bed material in the backwater and confluence area with the main stem and at a location upstream of the backwater effect that can be used to estimate bed load transport. Approximately 10 to 15 bed material samples are will be collected per tributary;
- Level loggers will be installed at the lower end of each tributary in the backwater area and on each tributary upstream of the extent of backwater. Continuous recording of water surface elevations will be performed (As noted above, this effort will be performed as part of the FA-IFS); and
- Flow measurements will be collected near the level loggers upstream of the backwater area to establish rating curves on each tributary for the purpose of developing the flow record for the tributary. (This effort will be performed as part of the FA-IFS.)

Results from the 2013 studies for the Lower Susitna River Segment, modified as described above, will provide a basis for assessing the need to perform further data collection and analysis in 2014.

4.2.6. Ice Processes

The Ice Processes Study includes several components that encompass the entire length of the Lower River Segment (RSP Section 7.6.4.1). Aerial reconnaissance and global positioning system (GPS) mapping of ice features, including ice jams, ice bridges, frazil accumulations, and open leads during the break-up and freeze-up periods will be performed from tidewater to the Oshetna River confluence (from PRM 0 to PRM 235). The data collected include concentrations of frazil ice, locations of ice bridges, ice jams, overflow, and open leads, timing of ice-cover progression, geo-referenced photographs, and videos of ice processes.

Time-lapse cameras will monitor break-up and freeze-up at locations corresponding to flow routing model instrumentation, key ice processes, and fish habitat locations (RSP Section 7.6.4.2). Time-lapse cameras are set to take photos of the main channel or a side channel/slough at one-hour intervals, and the results are compiled into a video. Key information to be derived from time-lapse videos includes the timing of ice cover advance past the camera location, the relative abundance of frazil ice visible in the channel during freeze-up, the growth of border ice during freeze-up from the shore, and the local interaction of ice with the floodplain. During breakup, information derived from the cameras includes documentation of increase of open leads, overflow, ice runs and jams, and local interaction of ice with the floodplain. Immediately post-breakup, crews conduct a foot reconnaissance of each camera location, documenting locations of stranded ice, damaged vegetation, and any erosion or scour attributed to breakup processes.

AEA-operated stream gages coincide with four of these sites. At stream gage locations, air temperature is recorded all winter, and water stage and water temperature are recorded until freeze-up, after which the sensors often are lost or buried. The sites are depicted in Figure 23 and listed below.

- PRM 15.1 – Alexander (camera): Near upper tidal influence and initial bridging location.
- PRM 17.4 – Susitna River near Flathorn Lake (ESS10, camera and gage): Near upper tidal influence.
- PRM 24.7 – Susitna River near Dinglishna Hill (ESS15, camera and gage): Just above upper tidal influence.
- PRM 30 – Susitna River at Susitna Station (ESS20 (two cameras and gage): Confined channel below the Yentna confluence.
- PRM 64.1 – Rustic Wilderness Side Channel (camera): Wide braided section with side channels; fish habitat study site in 1984.
- PRM 91.8 – Main channel and side channel near Birch Creek (camera): Wide, braided section and side channel. Fish habitat study site in 1984.
- PRM 98.4 – Susitna River near Twister Creek (ESS30 camera and gage): Immediately below Three Rivers confluence.

Two reaches have been selected for HEC-RAS modeling of winter flows pre-and post-Project in order to estimate the maximum increase in winter stages. These two locations are downstream of the Sunshine Bridge, between PRM 80 and PRM 85, and downstream of the Yentna confluence, from PRM 28 to PRM 32. These reaches were chosen because they are relatively simple channels compared to much of the Lower River, which makes them suited to HEC-RAS modeling, and because transect data are available. The simple nature of the channels means that Project-induced staging effects will be somewhat amplified, thus the analysis will be conservative. These two reaches also represent the range of flows seen in the Lower River, and thus will reflect the likely range of Project-induced increases in winter stage.

4.2.7. Water Quality

AEA has reviewed the water quality study plans in light of the 2012 study results and has determined that there is no need to modify the water quality sampling effort beyond that described in the RSP Section 5.5 through Section 5.7. The Baseline Water Quality Study and the Water Quality Modeling Study described in RSP Sections 5.5 and 5.6, respectively, are intended to study all three river segments of the Susitna River from the Oshetna River (PRM 235.1) to Alexander Creek (PRM 20); Table 20 and Figure 24 show specific sampling locations by river mile. The primary objective of the water quality studies is to support the overall evaluation of Project effects (construction and operations) on water quality characteristics in the river. This will be accomplished in part through development of a water quality model (RSP Section 5.6) that can be used to predict how Project operations may influence existing water quality conditions.

The work in the Lower River Segment, as described in the RSP, will consist of the following elements:

- Collection of stream temperature and meteorological data.
- Characterization of surface water physical, chemical, and bacterial conditions in the Lower Susitna River.
- Measurement of baseline metals concentrations in sediment and fish tissue.
- Completion of Thermal Infrared (TIR) imaging of the Lower River Segment to identify areas of groundwater inflow and potential thermal refugia.
- Documentation of historical water quality data and combining those data with data generated from the Baseline Water Quality Study. The combined data set will be used in the Water Quality Modeling Study to predict Project impacts under various operations.

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6. TABLES

Table 1. Locations, descriptions and selection rationale of final Focus Areas for detailed study in the Middle River Segment of the Susitna River. Focus Area identification numbers (e.g., Focus Area 184) represent the truncated Project River Mile (PRM) at the downstream end of each Focus Area.

Focus Area ID	Common Name	Description	Geomorphic Reach	Location (PRM)		Area Length (mi)	Habitat Types Present							Fish use in 1980s		Instream Flow Studies in 1980s			Rationale for Selection
				Upstream	Downstream		Main Channel, Single	Main Channel, Split	Side Channel	Tributary Mouth	Side Slough	Upland Slough	Beaver Complex	Spawning	Rearing	IFG	DIHAB	RJHAB	
Focus Area-184	Watana Dam	Area approximately 1.4 miles downstream of dam site	MR-1	185.7	184.7	1.0	X	X	X					*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	Focus Area-184 length comprises 50% of MR-1 reach length (2 miles long) and contains split main channel and side channel habitat present in this reach.
Focus Area-173	Stephan Lake, Complex Channel	Wide channel near Stephan Lake with complex of side channels	MR-2	175.4	173.6	1.8	X		X	X	X			*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	Focus Area-173 contains a complex of main channel and off-channel habitats within wide floodplain. Represents greatest channel complexity within MR-2. Reach MR-2 is 15.5 miles long and channel is generally straight with few side channels and moderate floodplain width (2-3 main channel widths).
Focus Area-171	Stephan Lake, Simple Channel	Area with single side channel and vegetated island near Stephan Lake	MR-2	173.0	171.6	1.4	X		X	X				*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	The single main channel with wide bars, single side channel and moderate floodplain channel width in Focus Area-171 are characteristic of MR-2. Reach MR-2 channel morphology is generally straight with few side channels and moderate floodplain width (2-3 main channel widths).
Focus Area-151	Portage Creek	Single channel area at Portage Creek confluence	MR-5	152.3	151.8	0.5	X			X				X	X				Focus Area-151 is a single main channel and thus representative of the confined Reach MR-5. Portage Creek is a primary tributary of the Middle Segment and the confluence supports high fish use.
Focus Area-144	Side Channel 21	Side channel and side slough complex approximately 2.3 miles upstream Indian River	MR-6	145.7	144.4	1.3	X	X	X	X	X		X	X	X	X			Focus Area-144 contains a wide range of main channel and off-channel habitats, which are common features of Reach MR-6. Side Channel 21 is a primary salmon spawning area. Reach MR-6 is 26 miles long (30% of Middle Segment length) and is characterized by a wide floodplain and complex channel morphology with frequent channel splits and side channels.
Focus Area-141	Indian River	Area covering Indian River and upstream channel complex	MR-6	143.4	141.8	1.6	X	X	X	X		X	X	X	X		X		Focus Area-141 includes the Indian River confluence, which is a primary Middle Susitna River tributary, and a range of main channel and off-channel habitats. Channel and habitat types present in Focus Area-141 are typical of complex Reach MR-6. High fish use of the Indian River mouth has been documented and DIHAB modeling was performed in main channel areas.
Focus Area-138	Gold Creek	Channel complex including Side Channel 11 and Slough 11	MR-6	140.0	138.7	1.3	X	X	X		X	X	X	X	X	X			The Focus Area-138 primary feature is a complex of side channel, side slough and upland slough habitats, each of which support high adult and juvenile fish use. Complex channel structure of Focus Area-138 is characteristic of Reach MR-6. IFG modeling was performed in side channel habitats.
Focus Area-128	Skull Creek Complex	Channel complex including Slough 8A and Skull Creek side channel	MR-6	129.7	128.1	1.6	X	X	X	X	X			X	X	X	X		Focus Area-128 consists of side channel, side slough and tributary confluence habitat features that are characteristic of the braided MR-6 reach. Side channel and side slough habitats support high juvenile and adult fish use and habitat modeling was completed in side channel and side slough habitats.
Focus Area-115	Lane Creek	Area 0.6 miles downstream of Lane Creek, including Upland Slough 6A	MR-7	116.5	115.3	1.2	X	X	X			X	X		X	X		X	Focus Area-115 contains side channel and upland slough habitats that are representative of MR-7. Reach MR-7 is a narrow reach with few braided channel habitats. Upland Slough 6A is a primary habitat for juvenile fish and habitat modeling was done in side channel and upland slough areas.
Focus Area-104	Whiskers Slough	Whiskers Slough Complex	MR-8	106.0	104.8	1.2	X	X	X	X	X	X		X	X	X	X	X	Focus Area-104 contains diverse range of habitat, which is characteristic of the braided, unconfined Reach MR-8. Focus Area-104 habitats support juvenile and adult fish use and a range of habitat modeling methods were used in side channel and side slough areas.

Table 2. Main channel habitat classifications by geomorphic reach in the Middle Susitna River.

Main Channel Type	MR-1		MR-2		MR-3		MR-4		MR-5		MR-6		MR-7		MR-8	
	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)
Main Channel	71%	12,737	74%	74,938	74%	16,470	99%	64,096	85%	26,400	28%	96,199	28%	41,538	24%	18,235
Split Main Channel	0%	-	8%	8,148	16%	3,600	0%	-	15%	4,835	18%	62,885	52%	77,346	6%	4,514
Braided Main Channel	0%	-	0%	-	0%	-	0%	-	0%	-	8%	26,400	0%	-	32%	24,430
Side Channel	29%	5,235	18%	17,646	9%	2,090	1%	699	0%	-	46%	161,115	19%	28,723	38%	28,398
Grand Total	100%	17,972	100%	100,732	100%	22,161	100%	64,794	100%	31,235	100%	346,599	100%	147,607	100%	75,577

Table 3. Main Channel mesohabitat classifications in the Middle Susitna River.

Main Channel Mesohabitat	MR-1		MR-2		MR-3		MR-4		MR-5		MR-6		MR-7		MR-8	
	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)
Main Channel	71%	12,737	74%	74,938	74%	16,470	99%	64,096	85%	26,400	28%	96,199	28%	41,538	24%	18,235
Glide or Run	71%	12,737	71%	71,986	72%	16,030	28%	18,397	85%	26,400	26%	90,714	23%	33,840	24%	18,235
Pool	0%	-	0%	-	0%	-	1%	500	0%	-	0%	-	0%	-	0%	-
Rapid	0%	-	0%	-	0%	-	39%	25,519	0%	-	0%	-	0%	-	0%	-
Riffle	0%	-	3%	2,953	2%	440	30%	19,680	0%	-	2%	5,485	5%	7,698	0%	-
Split Main Channel	0%	-	8%	8,148	16%	3,600	0%	-	15%	4,835	18%	62,885	52%	77,346	6%	4,514
Glide or Run	0%	-	8%	8,148	16%	3,600	0%	-	15%	4,835	18%	61,922	42%	62,562	6%	4,514
Riffle	0%	-	0%	-	0%	-	0%	-	0%	-	0%	963	10%	14,784	0%	-
Braided Main Channel	0%	-	0%	-	0%	-	0%	-	0%	-	8%	26,400	0%	-	32%	24,430
Glide or Run	0%	-	0%	-	0%	-	0%	-	0%	-	7%	24,922	0%	-	32%	24,008
Riffle	0%	-	0%	-	0%	-	0%	-	0%	-	0%	882	0%	-	1%	422
Unidentified	0%	-	0%	-	0%	-	0%	-	0%	-	0%	595	0%	-	0%	-
Side Channel	29%	5,235	18%	17,646	9%	2,090	1%	699	0%	-	46%	161,115	19%	28,723	38%	28,398
Glide or Run	29%	5,235	6%	5,716	8%	1,677	0%	-	0%	-	26%	89,118	13%	19,080	28%	21,528
Pool	0%	-	0%	-	0%	-	1%	342	0%	-	0%	-	0%	-	0%	-
Riffle	0%	-	0%	-	0%	-	1%	357	0%	-	1%	2,522	0%	279	9%	6,870
Unidentified	0%	-	12%	11,930	2%	414	0%	-	0%	-	20%	69,475	6%	9,363	0%	-
Grand Total	100%	17,972	100%	100,732	100%	22,161	100%	64,794	100%	31,235	100%	346,599	100%	147,607	100%	75,577

Table 4. Off channel habitats classified in the Middle Susitna River.

Off-Channel Habitats	MR-1		MR-2		MR-3		MR-4		MR-5		MR-6		MR-7		MR-8	
	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)
Backwater	n/a	-	0.6%	201	0.0%	-	100.0%	91	0.0%	-	1.5%	1,236	2.4%	1,458	2.0%	453
Side Slough	n/a	-	51%	16,130	100%	712	0%	-	100%	4,482	47%	38,898	16%	10,038	27%	6,195
Beaver Complex	n/a	-	0%	-	0%	-	0%	-	0%	-	7%	5,393	4%	2,584	0%	-
Side Slough	n/a	-	51%	16,130	100%	712	0%	-	100%	4,482	41%	33,505	12%	7,454	27%	6,195
Upland Slough	n/a	-	48%	15,261	0%	-	0%	-	0%	-	51%	42,361	81%	50,067	71%	16,190
Beaver Complex	n/a	-	0%	-	0%	-	0%	-	0%	-	15%	12,512	12%	7,171	0%	-
Upland Slough	n/a	-	48%	15,261	0%	-	0%	-	0%	-	36%	29,849	68%	42,027	71%	16,190
Grand Total	n/a	-	100%	31,592	100%	712	100%	91	100%	4,482	100%	82,495	100%	61,563	100%	22,838

Table 5. Tributary features classified in the Middle Susitna River. Potential fish-bearing tributaries were identified as a subset of those classified by the habitat mapping.

Tributary Feature	MR-1	MR-2	MR-3	MR-4	MR-5	MR-6	MR-7	MR-8
Tributary	0	39	6	10	3	63	21	4
Tributary Mouth	0	10	3	8	2	11	3	0
Clear Water Plume	0	5	2	0	1	4	1	0
Potential Fish-bearing Tributaries	0	12	3	5	1	22	13	1

Table 6. Metrics used to compare the representation and proportionality of habitat types between focus areas and non-focus areas within each geomorphic reach.

Level	Habitat Type	Comparison Metric	Numerator	Denominator
Macro-Habitat	Main Channel	Percent of main channel that is single unsplit main channel	Length of main channel habitat (HDR)	Total length of main channel (thalweg, R2)
	Split Main Channel	Percent of main channel that is in split main channel	Length of main channel that is in split main channel (R2 calculated)	Total length of main channel (thalweg, R2)
	Braided Main Channel	Percent of main channel that is in braided main channel	Length of main channel that is in braided main channel (R2 calculated)	Total length of main channel (thalweg, R2)
	Side Channel	Side channel length per river mile	Total length of side channels (HDR)	Total length of main channel (thalweg, R2)
	Upland Slough	Upland slough length per river mile	Total length of upland slough habitat (HDR)	Total length of main channel (thalweg, R2)
	Side Slough	Side slough length per river mile	Total length of side channel habitat (HDR)	Total length of main channel (thalweg, R2)
	Backwater	density of backwaters (#/mile)	# backwaters (HDR)	Total length of main channel (thalweg, R2)
	Tributary	density of tributaries (#/mile)	# tributaries (HDR)	Total length of main channel (thalweg, R2)
	Tributary Mouth	density of tributary mouths (#/mile)	# Tributary Mouths (HDR)	Total length of main channel (thalweg, R2)
	Clear Water Plume	density of plumes (#/mile)	# plumes (HDR)	Total length of main channel (thalweg, R2)
Mesohabitat	Glide or Run	Percent of main/side channel habitat in glide/run	Total length of Glide or Run (HDR)	Total Length of Main + Side Channel Habitat (HDR)
	Riffle	Percent of main/side channel habitat in riffle	Total length of Riffle (HDR)	Total Length of Main + Side Channel Habitat (HDR)
	Beaver Complex	Percent of slough habitat that is beaver complex	Total length of Beaver Complex Habitat (HDR)	Total length of slough habitat (HDR)

Table 7. Estimated bias for each proportionality metric (total for reach – focus area) where estimates could be made. Statistical comparison was made using a t-test or nonparametric alternative when the sample size (number of geomorphic reaches with bias estimate) was greater than three.

	MR-1	MR-2	MR-5	MR-6	MR-7	MR-8	Average Bias	p-value
Main Channel		-5%	-8.7%	-18%	40%	-33%	-5%	0.70
Split Main		5%	8.7%	22.4%	-40%	7%	0.6%	0.63
Braided Main				-4.0%		26%	11%	n/a
Side Channel	-0.33	-0.10		0.021	0.13	-1.02	-0.26	0.28
Side Slough		-0.46	0.155	-0.14	0.13	-0.42	-0.15	0.32
Upland Slough		0.04		-0.02	-0.43	-0.29	-0.1740	0.22
Backwaters		0.07		-0.018	-1.35	0.19	-0.28	1.00
Tributaries		0.18	-1.64	0.337	0.10	-0.66	-0.34	0.41
Tributary Mouth		0.36	-1.46	0.081	0.20		-0.20	0.88
Clear Water Plumes		0.33	-1.64	-0.018	0.07		-0.31	1.00
Beaver Complex				-9.8%	-25%		-18%	n/a
Glides/Runs		-3.3%		4.43%	14.0%	4.0%	4.8%	0.27
Riffles		3.3%		-4.43%	-14.0%	-4.0%	-4.8%	0.27

Table 8. Identification of existing focus area boundaries and counterpart locations of areas selected via a random systematic approach.

Geomorphic Reach	Geomorphic Reach			Current Focus Area			Random Focus Area		
	Start	End	Length	Start	End	Length	Start	End	Length
MR-1	187.1	184.6	2.5	185.7	184.7	1	186.2	185.2	1
MR-2	184.6	169.6	15	175.4	173.6	1.8	181.4	179.8	1.6
				173	171.6	1.4	175.0	173.4	1.6
MR-5	153.9	148.4	5.5	152.3	151.8	0.5	152.8	152.3	0.5
MR-6	148.4	122.7	25.7	145.7	144.4	1.3	146.8	145.3	1.5
				143.4	141.8	1.6	140.8	139.3	1.5
				140	138.7	1.3	134.8	133.3	1.5
				129.7	128.1	1.6	128.8	127.3	1.5
MR-7	122.7	107.8	14.9	116.5	115.3	1.2	117.8	116.6	1.2
MR-8	107.8	102.4	5.4	106	104.8	1.2	104.9	103.7	1.2

Table 9. Comparison of simulated random focus areas to project focus areas by geomorphic reach for main channel habitat (FA=project focus areas; RFA=random systematic focus areas, Total=Total for the geomorphic reach.)

	MR-1			MR-2			MR-5			MR-6			MR-7			MR-8		
	FA	RFA	Total	FA	RFA	Total	FA	RFA	Total	FA	RFA	Total	FA	RFA	Total	FA	RFA	Total
%Main Channel in Single Main Channel	100 %	100 %	100 %	100 %	78%	95%	100 %	100 %	91%	88%	85%	71%	36%	57%	53%	6%	51%	66%
% Main Channel in Split Main Channel	0%	0%	0%	0%	22%	5%	0%	0%	9%	0%	15%	22%	64%	43%	47%	39%	5%	8%
% Main Channel in Braided Main Channel	0%	0%	0%	0%	0%	0%	0%	0%	0%	12%	0%	6%	0%	0%	0%	55%	44%	26%
Side Channel Length/Main Channel Length	0.51	0.80	0.49	0.26	0.43	0.22	0.00	0.00	0.07	1.02	1.17	1.19	0.23	0.52	0.37	1.15	1.42	1.02
Side Slough Length/Main Channel Length	0.00	0.00	0.00	0.54	0.03	0.20	0.00	0.00	0.17	0.36	0.50	0.29	0.00	0.00	0.13	0.36	0.00	0.22
Upland Slough Length/Main Channel Length	0.00	0.00	0.00	0.16	0.37	0.19	0.00	0.00	0.00	0.28	0.15	0.31	1.18	0.51	0.63	0.60	0.00	0.58
Backwaters per River Mile	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.2	0.2	1.5	0.0	0.2	0.0	0.0	0.2
Tributaries per River Mile	0.0	0.0	0.0	0.7	1.3	2.4	0.5	0.0	0.2	0.9	4.2	2.2	0.8	2.6	1.5	1.4	0.0	0.6
Tributary Mouths per River Mile	0.0	0.0	0.0	0.2	0.6	0.7	0.5	0.0	0.2	0.3	0.7	0.4	0.0	1.7	0.3	0.0	0.0	0.0
Clear Water Plumes per River Mile	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.0	0.2	0.1	0.2	0.2	0.0	0.9	0.1	0.0	0.0	0.0
Proportion of Slough Habitat in Beaver Complex	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	32%	14%	22%	0%	81%	13%	n/a	n/a	n/a
Proportion of Main Channel in Glide/Run	100 %	100 %	100 %	100 %	100 %	97%	100 %	100 %	98%	93%	97%	96%	70%	92%	84%	90%	92%	90%
Proportion of Main Channel in Riffle	0%	0%	0%	0%	0%	3%	0%	0%	2%	7%	3%	4%	30%	8%	16%	10%	8%	10%

Table 10. Estimated bias for each proportionality metric (total for reach – focus area) where estimates could be made for random focus areas. Statistical comparison was made using a t-test or nonparametric alternative when the sample size (number of geomorphic reaches with bias estimate) was greater than three.

	MR-1	MR-2	MR-5	MR-6	MR-7	MR-8	Average Bias	p-value
Main Channel		17%	-9.5%	-14%	17%	60%	14%	0.34
Split Main		-17%	9.5%	7.5%	-17%	-31%	-9.6%	0.29
Braided Main				6.3%		-28%	-11%	n/a
Side Channel	-0.31	-0.20	0.073	0.018	-0.15	-0.41	-0.16	0.084
Side Slough		0.17		-0.19	0.63	0.58	0.30	0.22
Upland Slough		-0.17	0.17	0.13	-0.39	0.22	-0.0058	0.96
Backwaters		0.07		-0.011	0.20	0.19	0.11	0.12
Tributaries		1.2	0.20	-2.0	-1.1	0.57	-0.22	0.71
Tributary Mouth		0.045	0.40	-0.28	-1.4		-0.32	0.48
Clear Water Plumes		0.33	0.20	-0.011	-0.78		-0.07	0.81
Beaver Complex				7.9%	-68%		-30%	n/a
Glides/Runs		-3.3%	-2.0%	-0.54%	-8.4%	-1.9%	-3.2%	0.078
Riffles		3.3%	2.0%	0.54%	8.4%	1.9%	3.2%	0.078

Table 11. Riparian process domain #1 (RPD1). Plant communities typed, and measured, along transects using Alaska Vegetation Classification (AVC) Level III (1992) community descriptions. First column describes communities identified along transects in RPD1 and remaining columns describe communities within Focus Areas in the riparian process domain. The sum of lengths (line-intercept sampling method; length in meters) for each cover type are reported in parentheses.

Plant Community	RPD1 (PRM 168.25-187)	FA-184 Watana Dam	FA-173 Stephan Lake Complex	FA-171 Stephan Lake Simple
Closed Conifer Forest	Yes (3625.5)	No	Yes (44.4)	Yes (134)
Open Conifer Forest	Yes (7080.3)	Yes (69.9)	Yes (407.9)	Yes (111)
Conifer Woodland	Yes (849.7)	Yes (105.4)	No	No
Closed Mixed Forest	Yes (2912)	Yes (81.1)	Yes (268.3)	Yes (314.1)
Open Mixed Forest	Yes (5567.7)	Yes (134.7)	Yes (746)	Yes (715.4)
Mixed Woodland	Yes (250.8)	No	Yes (77.7)	Yes (35.9)
Closed Broadleaf Forest	Yes (250.7)	Yes (8.5)	Yes (81.5)	No
Open Broadleaf Forest	Yes (329.4)	No	Yes (156.8)	Yes (13.1)
Broadleaf Woodland	Yes (31.3)	No	No	No
Closed Alder/Willow Shrub	Yes (750.9)	Yes (28.4)	Yes (246.9)	Yes (24.8)
Open Alder/Willow Shrub	Yes (585.6)	Yes (35)	Yes (155.5)	Yes (47)
Herbaceous	Yes (470.8)	No	Yes (47.4)	No
Partially Vegetated	Yes (228.4)	Yes (27.7)	Yes (119.7)	Yes (25.4)
Non-vegetation cover types[1]	Yes (16012.4)	Yes (810.8)	Yes (1857.3)	Yes (1164.2)
Total Transect Length	38945.4	1301.6	4209.4	2585.0
# of Plant Communities	13	8	11	9
% Plant Communities overlap with RPD1	100%	62%	85%	69%

Notes:

1 Includes channel types (main channel, side channel, side slough, upland slough, etc.) as well as roads, and other human disturbances.

Table 12. Riparian process domain #3 (RPD3). Plant communities typed, and measured, along transects using Alaska Vegetation Classification (AVC) Level III (1992) community descriptions. First column describes communities identified along transects in RPD3 and remaining columns describe communities within Focus Areas in the riparian process domain. The sum of lengths (line-intercept sampling method; length in meters) for each cover type are reported in parentheses.

Plant Community	RPD3 (PRM 108-153.5)	FA-151 Portage Creek	FA-144 Side Channel 21	FA-141 Indian River	FA-138 Gold Creek	FA-128 Skull Creek Complex	FA-115 Lane Creek
Closed Conifer Forest	No	No	No	No	No	No	No
Open Conifer Forest	Yes (1243.9)	No	No	No	No	No	No
Conifer Woodland	Yes (307.6)	No	No	No	No	No	No
Closed Mixed Forest	Yes (5325.2)	No	Yes (20.8)	No	No	No	No
Open Mixed Forest	Yes (15444.3)	Yes (40.1)	Yes (30.4)	Yes (490.5)	Yes (257.6)	Yes (7.6)	Yes (322.6)
Mixed Woodland	Yes (6053.8)	No	Yes (125.5)	Yes (215.4)	Yes (73.7)	Yes (816.8)	Yes (233)
Closed Broadleaf Forest	Yes (10657.8)	No	Yes (645.7)	Yes (328)	Yes (1230)	Yes (307.9)	Yes (263)
Open Broadleaf Forest	Yes (17955.5)	Yes (9.5)	Yes (403.1)	Yes (140)	Yes (1271.9)	Yes (2240.5)	Yes (674.6)
Broadleaf Woodland	Yes (3480.4)	Yes (31.2)	No	No	No	Yes (61.9)	Yes (197.1)
Closed Alder/Willow Shrub	Yes (6008.8)	Yes (24)	Yes (232.9)	Yes (34.9)	Yes (439.5)	Yes (268.8)	Yes (21.5)
Open Alder/Willow Shrub	Yes (6188.6)	No	Yes (327.1)	Yes (330.9)	Yes (223.3)	Yes (307.1)	Yes (61.2)
Herbaceous	Yes (4138.2)	No	No	No	Yes (234.9)	Yes (21.3)	Yes (183.5)
Partially Vegetated	Yes (677)	No	Yes (10.6)	Yes (48.9)	Yes (50.9)	No	No
Non-vegetation cover types[1]	Yes (65375.2)	Yes (456)	Yes (2808.3)	Yes (2360.6)	Yes (1944.8)	Yes (3313.2)	Yes (2553.4)
Total Transect Length	142856	561	4604	3949	5727	7345	4510
# of Plant Communities	12	4	9	7	8	8	8
% Plant Communities overlap with RPD3	100%	33%	75%	58%	67%	67%	67%

Notes:

1 Includes channel types (main channel, side channel, side slough, upland slough, etc.) as well as roads, and other human disturbances.

Table 13. Riparian process domain #4 (RPD4). Plant communities typed, and measured, along transects using Alaska Vegetation Classification (AVC) Level III (1992) community descriptions. First column describes communities identified along transects in RPD4 and remaining columns describe communities within Focus Areas in the riparian process domain. The sum of lengths (line-intercept sampling method; length in meters) for each cover type are reported in parentheses.

Plant Community	RPD4 (PRM 104-107.75)	Whiskers Slough
Closed Conifer Forest	No	No
Open Conifer Forest	Yes (557.3)	Yes (71.5)
Conifer Woodland	Yes (87)	No
Closed Mixed Forest	Yes (5285.1)	Yes (109.6)
Open Mixed Forest	Yes (20752.7)	Yes (10185.8)
Mixed Woodland	Yes (2727.7)	Yes (820)
Closed Broadleaf Forest	Yes (2776.5)	Yes (994.1)
Open Broadleaf Forest	Yes (1328.1)	Yes (831.1)
Broadleaf Woodland	Yes (607.7)	Yes (180.5)
Closed Alder/Willow Shrub	Yes (320.5)	Yes (313.6)
Open Alder/Willow Shrub	Yes (508.9)	Yes (185.3)
Herbaceous	Yes (2198.3)	Yes (770.3)
Partially Vegetated	Yes (290.3)	Yes (100)
Non-vegetation cover types[1]	Yes (7020.7)	Yes (2848.1)
Total Transect Length	44461	17410
# of Plant Communities	12	11
% Plant Communities overlap with RPD4	100%	92%

Notes:

1 Includes channel types (main channel, side channel, side slough, upland slough, etc.) as well as roads, and other human disturbances.

Table 14. Rationale for Riparian IFS Focus Area selection

Focus Area ID	Common Name	Riparian IFS	Riparian IFS Selection Rationale
Focus Area-184	Watana Dam		Not-selected. Floodplain vegetation occurs on only a few mid-channel island bars. Non-focus area vegetation sampling will be conducted in these areas.
Focus Area-173	Stephan Lake, Complex Channel	X	Focus Area captures the diversity of floodplain vegetation types in the upper moderately confined riparian process domain from the dam site to Devils Canyon.
Focus Area-171	Stephan Lake, Simple Channel		Not-selected. Approximately 0.5 miles south of FA-173. Similar vegetation types but less floodplain terrain complexity.
Focus Area-151	Portage Creek		Not-selected. Steep valley walls immediately adjacent to channel. Floodplain vegetation is minimal.
Focus Area-144	Side Channel 21		Not-selected. Process domain representative vegetation, however, lacking in off-channel water body and wetland complexity.
Focus Area-141	Indian River		Not selected. Very limited floodplain area.
Focus Area-138	Gold Creek	X	Representative floodplain vegetation types and river right beaver dam wetland complex.
Focus Area-128	Skull Creek Complex	X	Representative floodplain vegetation types and complex off-channel water bodies and associated wetlands.
Focus Area-115	Lane Creek	X	Representative floodplain vegetation types and off-channel water bodies associated with beaver dam wetland complex.
Focus Area-104	Whiskers Slough	X	Transition riparian process domain between, Three Rivers confluence and moderately confined riparian process domain. Representative floodplain vegetation types and off-channel water bodies and associated beaver dam wetland complexes.

Table 15. List of Focus Areas selected for Riparian-IFS studies within each Riparian Process Domain.

Middle River Riparian Process Domain	Location (PRM)		Associated Riparian-IFS Focus Areas			
					Location (PRM)	
	Upstream	Downstream	Focus Area ID	Common Name	Upstream	Downstream
RPD1	187	168.25	Focus Area-173	Stephan Lake, Complex Channel	175.4	173.6
RPD2	168	153.75	None	N/A	N/A	N/A
RPD3	153.5	108	Focus Area-138	Gold Creek	140	138.7
			Focus Area-128	Skull Creek Complex	129.7	128.1
			Focus Area-115	Lane Creek	116.5	115.3
RPD4	107.75	104	Focus Area-104	Whiskers Slough Complex	106	104.8

Table 16. Partial list of river cross-sections, and flow and water surface elevations measured in 2012 on the Susitna River between River Miles 75 and 184. The list does not include additional measurements in late September/October. Those measurements had not been processed at the time this study plan was prepared.

Project River Mile	High Q Trip			Mid Q Trip			Low Q Trip		
	Date	Time	Discharge	Date	Time	Discharge	Date	Time	Discharge
PRM 225.0	6/14/12	17:57	26,932	8/9/12	15:03	11,260	--	--	--
PRM 187.2	6/17/12	16:30	27,698	8/6/12	16:13	14,707	9/15/12	13:17	7,838
PRM 186.2	6/18/12	14:13	24,493	8/6/12	17:05	14,419	9/15/12	14:05	7,630
PRM 185.5	6/18/12	16:10	25,389	--	--	--	--	--	--
PRM 185.2	6/19/12	13:00	26,676	--	--	--	--	--	--
PRM 184.9	6/19/12	15:49	27,619	8/6/12	18:24	14,239	9/15/12	14:57	7,714
PRM 184.4	6/19/12	16:51	27,886	8/7/12	12:38	14,775	9/15/12	15:52	8,353
PRM 183.3	6/20/12	13:19	29,426	8/7/12	13:35	14,183	9/15/12	16:41	8,310
PRM 182.9	6/20/12	16:01	29,218	--	--	--	--	--	--
PRM 181.6	6/20/12	17:56	29,645	8/7/12	14:44	14,705	9/15/12	17:55	8,689
PRM 179.5	6/21/12	12:28	30,866	8/7/12	15:41	14,345	9/14/12	17:05	8,361
PRM 178.5	6/16/12	18:35	29,756	8/7/12	16:37	14,799	9/14/12	17:47	8,738
PRM 176.5	6/21/12	14:40	31,240	8/8/12	12:07	14,559	9/16/12	14:50	10,768
PRM 174.9	6/21/12	16:12	31,163	--	--	--	--	--	--
PRM 173.1	6/21/12	17:39	30,571	--	--	--	9/16/12	16:29	11,082
PRM 170.1	6/22/12	12:56	31,121	8/8/12	15:16	14,568	9/16/12	17:33	11,137
PRM 168.1	6/22/12	14:33	32,265	8/8/12	16:03	14,655	9/17/12	15:19	14,619
PRM 153.7	6/25/12	17:15	32,162	8/10/12	15:03	14,588	--	--	--
PRM 152.9	6/26/12	13:43	30,487	--	--	--	--	--	--
PRM 152.1	6/26/12	15:38	30,036	8/10/12	16:07	15,351	9/29/12	15:20	18,488
PRM 151.1	6/25/12	14:00	33,180	--	--	--	--	--	--
PRM 148.3	6/26/12	18:24	32,114	8/10/12	18:03	14,941	--	--	--
PRM 146.6	6/27/12	12:24	31,030	--	--	--	--	--	--
PRM 145.7	6/27/12	13:51	31,396	8/12/12	13:12	17,354	9/29/12	16:51	18,131
PRM 145.5	6/27/12	14:40	31,868	--	--	--	--	--	--
PRM 144.9	6/27/12	17:01	31,949	--	--	--	--	--	--
PRM 144.3	6/27/12	18:50	31,121	--	--	--	--	--	--
PRM 143.5	6/28/12	12:17	30,330	8/12/12	14:58	17,006	--	--	--
PRM 143.0	6/28/12	13:53	29,492	--	--	--	--	--	--
PRM 142.2	6/28/12	15:15	29,753	8/12/12	16:29	16,798	9/29/12	17:45	18,301
PRM 141.9	6/28/12	16:27	30,583	8/12/12	17:13	16,803	--	--	--
PRM 141.7	6/28/12	17:41	30,555	--	--	--	--	--	--
PRM 140.0	6/29/12	14:48	30,378	8/13/12	12:54	16,350	9/30/12	13:56	17,619
PRM 139.8	6/29/12	16:21	30,378	--	--	--	--	--	--
PRM 139.0	6/30/12	13:56	28,039	8/13/12	13:58	16,449	--	--	--

Project River Mile	High Q Trip			Mid Q Trip			Low Q Trip		
	Date	Time	Discharge	Date	Time	Discharge	Date	Time	Discharge
PRM 138.7	6/30/12	14:51	28,230	8/13/12	14:48	16,344	--	--	--
PRM 138.1	6/30/12	16:33	28,203	--	--	--	--	--	--
PRM 137.6	6/30/12	18:13	27,893	8/13/12	16:14	16,409	9/30/12	15:00	17,382
PRM 136.7	7/1/12	13:35	26,756	--	--	--	--	--	--
PRM 136.2	7/1/12	16:06	26,943	--	--	--	--	--	--
PRM 135.0	7/1/12	18:33	26,526	8/13/12	17:41	15,627	--	--	--
PRM 134.3	7/2/12	12:16	25,463	--	--	--	10/1/12	13:40	15,568
PRM 134.1	7/2/12	13:18	26,166	8/14/12	13:14	16,491	--	--	--
PRM 133.8	7/2/12	14:30	25,715	8/14/12	14:05	16,275	--	--	--
PRM 133.3	7/2/12	16:22	25,678	--	--	--	--	--	--
PRM 132.6	7/2/12	17:57	25,046	8/14/12	15:17	16,039	--	--	--
PRM 131.4	7/3/12	22:08	28,628	--	--	--	--	--	--
PRM 129.7	7/3/12	17:33	28,243	8/14/12	17:00	16,330	10/1/12	16:16	15,731
PRM 128.1	7/4/12	15:40	26,748	8/15/12	12:50	15,926	--	--	--
PRM 126.8	7/4/12	17:22	27,608	8/15/12	13:40	16,078	10/1/12	17:02	15,582
PRM 126.1	7/5/12	14:24	27,248	--	--	--	--	--	--
PRM 125.4	7/5/12	16:38	26,427	--	--	--	--	--	--
PRM 124.1	7/5/12	18:11	26,132	8/15/12	14:27	16,161	10/1/12	17:42	15,582
PRM 123.7	7/6/12	12:18	23,875	--	--	--	--	--	--
PRM 122.7	7/6/12	14:23	23,331	--	--	--	--	--	--
PRM 122.6	7/6/12	15:59	22,890	8/15/12	16:13	16,287	--	--	--
PRM 120.7	7/6/12	17:19	22,687	--	--	--	--	--	--
PRM 119.9	7/7/12	12:19	20,715	8/16/12	12:54	16,005	10/3/12	14:47	13,998
PRM 118.4	7/7/12	14:06	20,656	--	--	--	--	--	--
PRM 117.4	7/7/12	16:15	20,747	--	--	--	--	--	--
PRM 116.6	7/7/12	17:36	20,665	8/16/12	14:15	16,136	10/3/12	15:53	14,323
PRM 116.3	7/8/12	12:42	23,766	--	--	--	--	--	--
PRM 115.7	7/8/12	14:05	25,006	--	--	--	--	--	--
PRM 115.4	7/8/12	16:13	25,958	--	--	--	--	--	--
PRM 114.4	7/8/12	18:29	25,860	--	--	--	--	--	--
PRM 113.6	7/9/12	14:23	28,329	8/16/12	16:38	16,311	10/3/12	16:41	13,476
PRM 111.9	7/9/12	15:23	28,296	--	--	--	--	--	--
PRM 110.5	7/9/12	16:46	28,825	8/17/12	14:57	15,254	10/3/12	17:33	14,172
PRM 108.3	--	--	--	8/17/12	17:55	16,394			
PRM 107.1	7/9/12	18:26	28,409	8/18/12	13:12	15,508	10/4/12	14:10	14,558
PRM 106.1	--	--	--	8/18/12	14:22	15,278	--	--	--
PRM 105.3	--	--	--	8/18/12	15:52	15,362	--	--	--

Project River Mile	High Q Trip			Mid Q Trip			Low Q Trip		
	Date	Time	Discharge	Date	Time	Discharge	Date	Time	Discharge
PRM 104.7	--	--	--	8/18/12	17:48	15,377	--	--	--
PRM 104.1	--	--	--	8/19/12	12:49	15,345	--	--	--
PRM 103.5	--	--	--	--	--	--	10/4/12	16:49	14,575
PRM 102.7	7/10/12	13:53	26,635	--	--	--	--	--	--
PRM 101.4	--	--	--	--	--	--	--	--	--
PRM 98.4	7/11/12	14:09	46,499	8/20/12	14:51	40,623	10/5/12	14:37	39,065
PRM 97.0	7/11/12	18:27	45,118	8/20/12	17:03	40,261	--	--	--
PRM 91.6				8/21/12	14:55	46,330	--	--	--
PRM 91.0	7/12/12	15:39	43,922	8/21/12	16:51	46,197	--	--	--
PRM 88.4	--	--	--	8/22/12	15:01	41,697	--	--	--
PRM 87.1	7/12/12	18:00	42,550	--	--	--	--	--	--
PRM 86.3	7/13/12	13:13	41,895	--	--	--	--	--	--
PRM 85.4	--	--	--	8/22/12	18:01	40,468	--	--	--
PRM 84.4	--	--	--	8/23/12	15:16	36,988	--	--	--
PRM 83.0	7/13/12	16:09	41,975	--	--	--	--	--	--
PRM 82.3	--	--	--	8/23/12	17:52	37,947	--	--	--
PRM 80.0	--	--	--	8/24/12	15:07	36,580	--	--	--

Table 17. Habitat types by geomorphic reach and how representativeness will be achieved. (FA=Focus Area; CS=Cross-section).

	MR-1			MR-2			MR-5			MR-6			MR-7			MR-8		
Habitat	FA	CS	NEED	FA	CS	NEED	FA	CS	NEED	FA	CS	NEED	FA	CS	NEED	FA	CS	NEED
Main Channel	X			X			X			X			X			X		
Split Main Channel	n/a					X			X		X		X			X		
Braided Main Channel	n/a			n/a			n/a			X			n/a				X	
Side Channel	X			X					X	X			X			X		
Side Slough	n/a			X					X	X				X		X		
Upland Slough	n/a			X			n/a			X			X			X		
Beaver Complex	n/a			n/a			n/a			X					X	X		
Backwater	n/a					X	n/a			X			X					X
Tributary	n/a			X			X			X			X			X		
Tributary Mouth	n/a			X			X			X					X	n/a		
Clear Water Plume	n/a				X		X			X					X	n/a		

Table 18. Summary of Potential Effects of With-Project Flows on Tributaries of the Lower Susitna River from 1980s studies, and tributary mouths proposed for modeling in 2013 (indicated by highlighting) (1980s summary adapted from Ashton and Trihey (1985)).

Tributary	Project River Mile (approx.)	Geomorphic Reach	Location of Tributary Mouth in		Effects of With-Project Flows on			
					Fish Access into Tributaries at 21,000 cfs (USGS Sunshine Gage 15292780)		Reduction in Backwater Area during June/July	
			Side Channel	Main Channel	Potential Passage Problem	No Passage Problem	Moderate Change	Slight Change
Trapper Cr.	94.5	LR-1	X		X		X	
Birch Cr.	92.5	LR-1		X		X	X	
Sunshine Cr.	88	LR-1	X			X	X	
Rabideaux Cr.	87	LR-2	---	---		X	X	
Montana Cr.	81	LR-2		X	X			X
Goose Cr.	76.5	LR-2	X		X			X
Sheep Cr.	69.5	LR-2	X			X	X	
Caswell Cr.	67	LR-2	X		X		X	
Kashwitna R.	65	LR-3	X			X		X
Little Willow Cr.	54.5	LR-3	X			X	X	
Willow Cr.	52.5	LR-3	X			X		X
Deshka R.	45	LR-3		X		X	X	
Alexander Cr.	14	LR-6	X			X	X	

Table 19. List of Lower River 2013 Riparian Vegetation Sampling Transects, and Geomorphic Reach Types (Tetra Tech, 2013d).

Lower River Geomorphic Reach	Location (PRM)		Riparian Transect	Riparian Transect Location (PRM)
	Upstream	Downstream		
LR-1	102.4	87.9	RIP LR-1	95.0
LR-2	87.9	65.6	RIP LR-2	69.0
LR-3	65.6	44.6	RIP LR-3	53.5
LR-4	44.6	32.3	RIP LR-4	38.2
LR-5	32.3	23.5	RIP LR-5	30.8
LR-6	23.5	3.3	N/A	N/A

Table 20. Proposed Susitna River Basin Temperature and Water Quality Monitoring Sites.

Susitna River Mile	Description	Latitude (decimal degrees)	Longitude (decimal degrees)
15.1	Susitna above Alexander Creek	61.4014	-150.519
25.8[3]	Susitna Station	61.5454	-150.516
28.0	Yentna River	61.589	-150.468
29.5	Susitna above Yentna	61.5752	-150.248
40.6[3]	Deshka River	61.7098	-150.324
55.0[1]	Susitna	61.8589	-150.18
83.8[3]	Susitna at Parks Highway East	62.175	-150.174
83.9[3]	Susitna at Parks Highway West	62.1765	-150.177
97.0	LRX 1	62.3223	-150.127
97.2	Talkeetna River	62.3418	-150.106
98.5	Chulitna River	62.5574	-150.236
103.0[2,3]	Talkeetna	62.3943	-150.134
113.0[2]	LRX 18	62.5243	-150.112
120.7[2,3]	Curry Fishwheel Camp	62.6178	-150.012
126.0	Slough 8A	62.6707	-149.903
126.1[2]	LRX 29	62.6718	-149.902
129.2[3]	Slough 9	62.7022	-149.843
130.8[2]	LRX 35	62.714	-149.81
135.3	Slough 11	62.7555	-149.7111
136.5	Susitna near Gold Creek	62.7672	-149.694
136.8[3]	Gold Creek	62.7676	-149.691
138.0[1]	Slough 16B	62.7812	-149.674
138.6[3]	Indian River	62.8009	-149.664
138.7[2]	Susitna above Indian River	62.7857	-149.651
140.0	Slough 19	62.7929	-149.615
140.1[2]	LRX 53	62.7948	-149.613
142.0	Slough 21	62.8163	-149.576
148.0	Susitna below Portage Creek	62.8316	-149.406
148.8[2]	Susitna above Portage Creek	62.8286	-149.379
148.8	Portage Creek	62.8317	-149.379
148.8[3]	Susitna above Portage Creek	62.8279	-149.377
165.0[1]	Susitna	62.7899	-148.997
180.3[1]	Susitna below Tsusena Creek	62.8157	-148.652
181.3[3]	Tsusena Creek	62.8224	-148.613
184.5[1]	Susitna at Watana Dam site	62.8226	-148.533
194.1	Watana Creek	62.8296	-148.259
206.8	Kosina Creek	62.7822	-147.94
223.7[3]	Susitna near Cantwell	62.7052	147.538
233.4	Oshetna River	62.6402	-147.383

Notes:

1 Site not sampled for water quality or temperature in the 1980s or location moved slightly from original location.

2 Proposed mainstem Susitna River temperature monitoring sites for purposes of 1980s SNTEMP model evaluation.

7. FIGURES

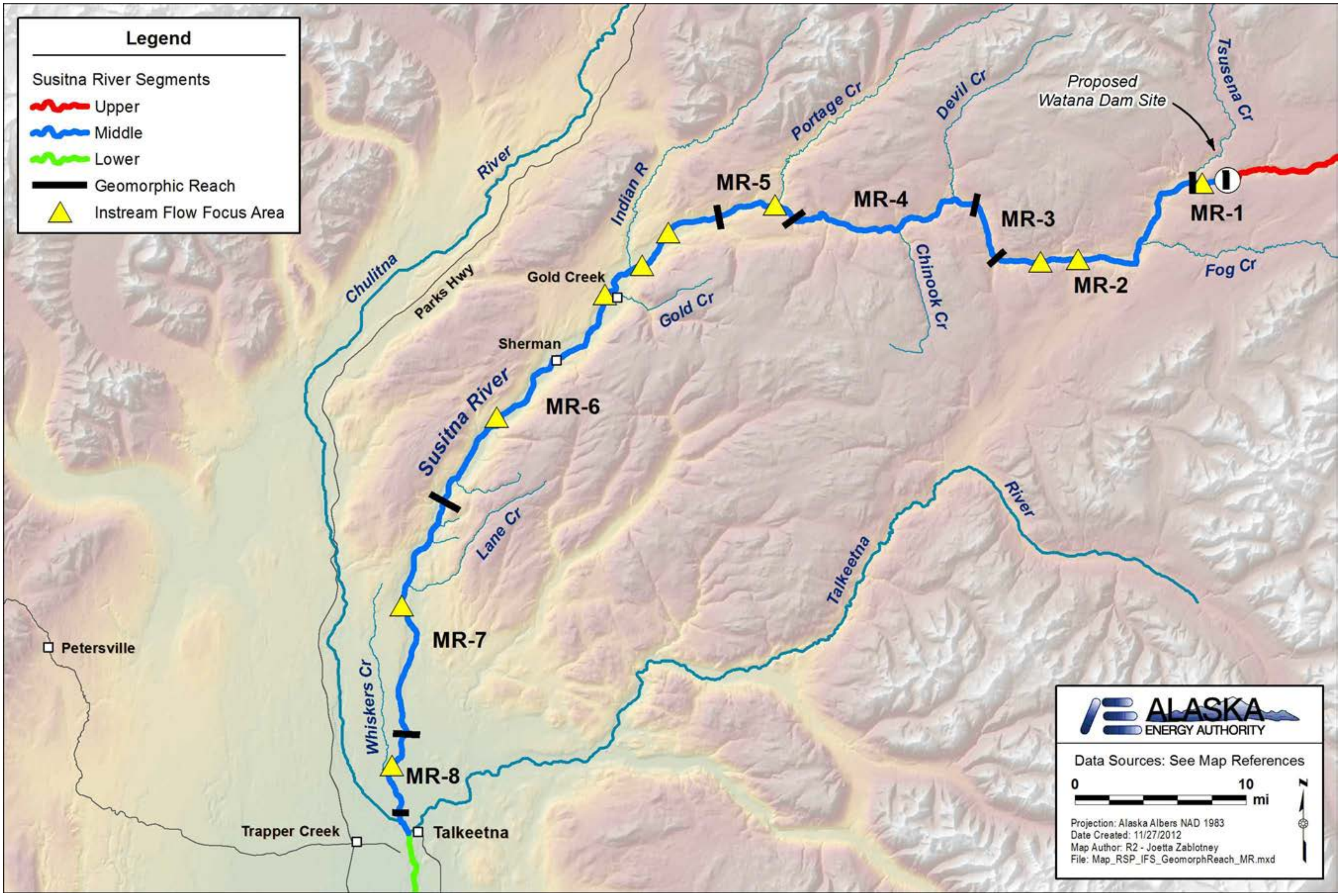

Figure 1. Map of the Middle Segment of the Susitna River depicting the eight Geomorphic Reaches and locations of proposed Focus Areas. No Focus Areas are proposed for in MR-3 and MR-4 due to safety issues related to sampling within or proximal to Devils Canyon.

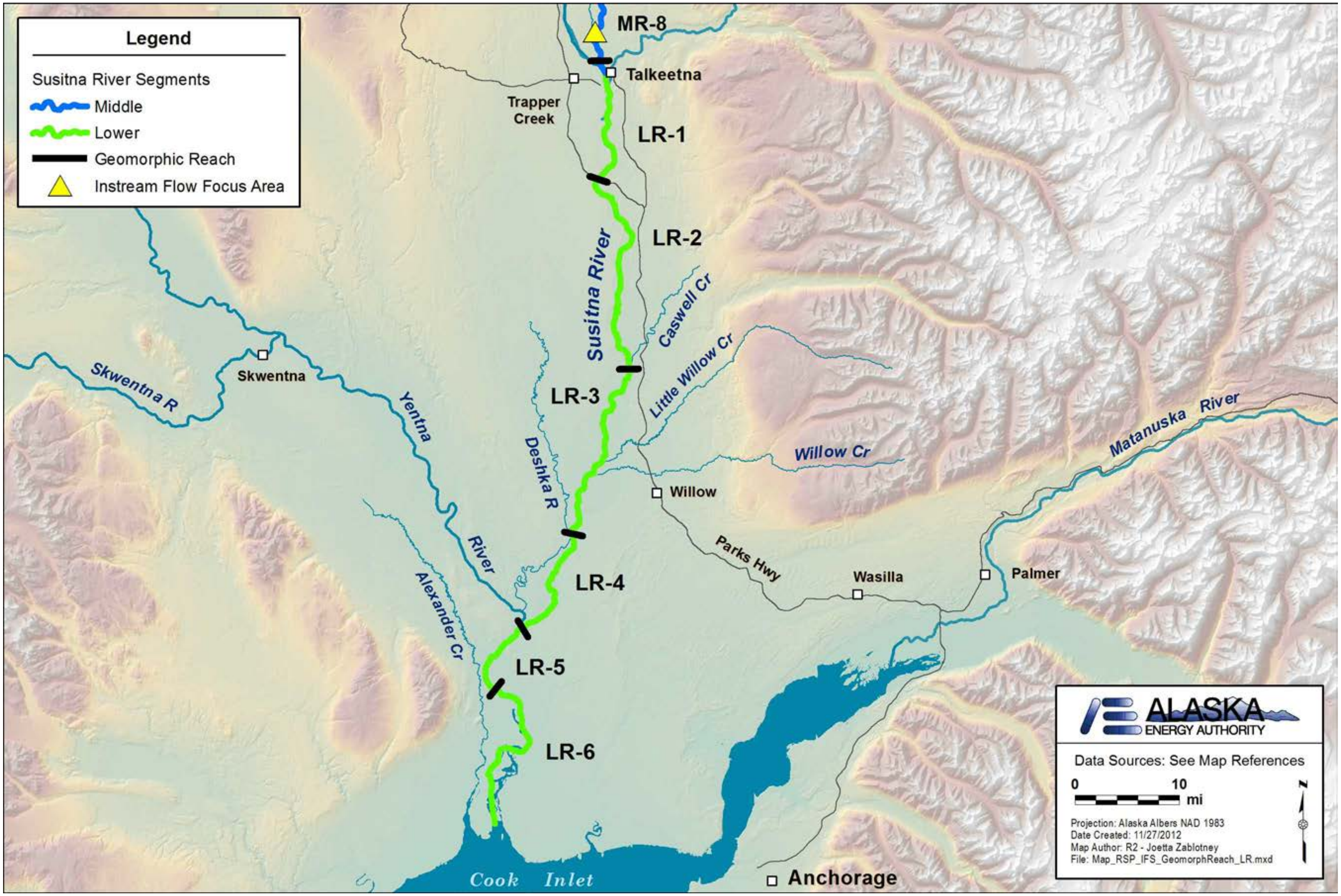

Figure 2. Map of the Lower Segment of the Susitna River depicting the six Geomorphic Reaches. Focus Areas have not been identified in this segment but will be considered pending results of open-water flow routing modeling.

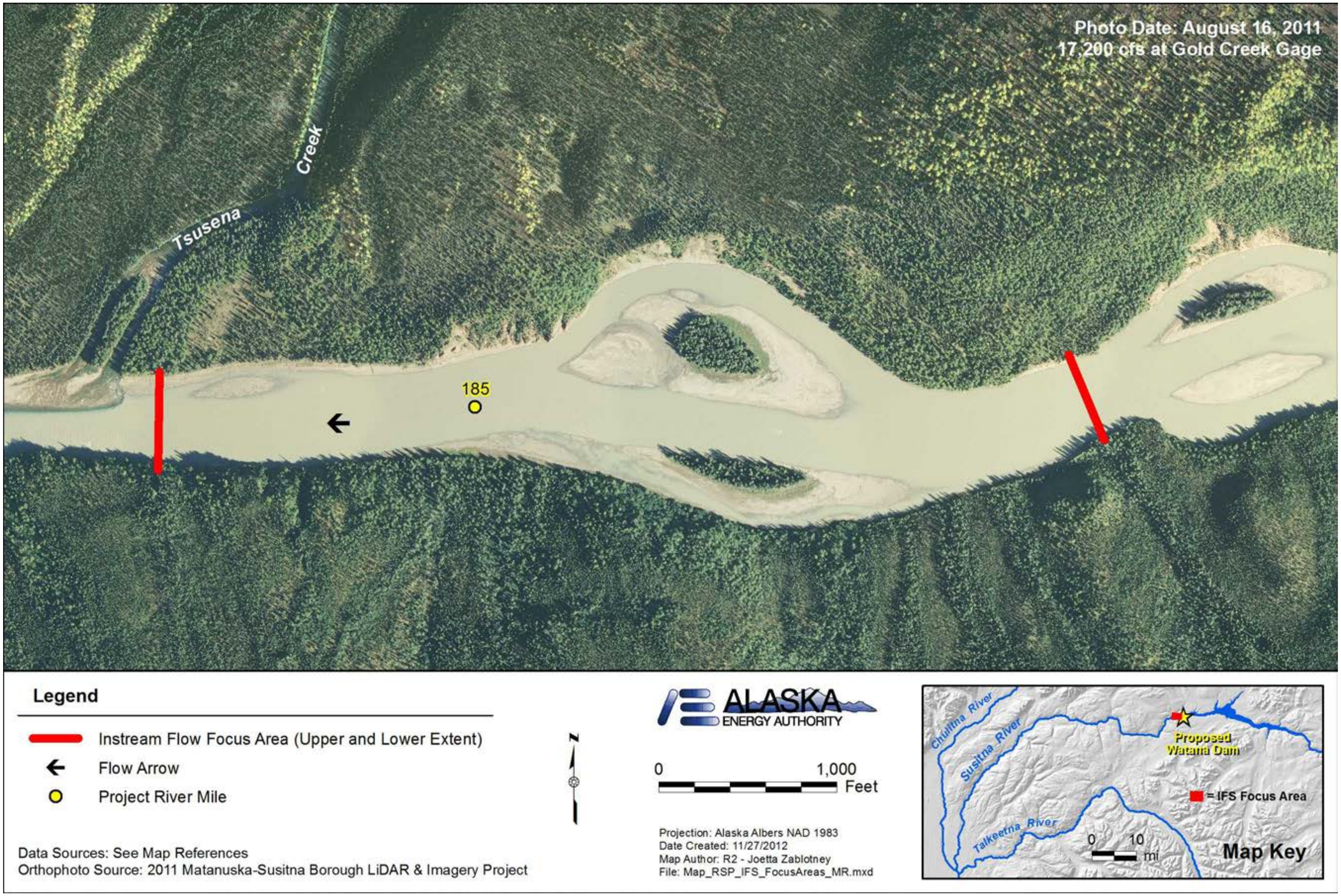

Figure 3. Map showing Focus Area 184 that begins at Project River Mile 184.7 and extends upstream to PRM 185.7. The Focus Area is located about 1.4 miles downstream of the proposed Watana Dam site near Tsusena Creek.

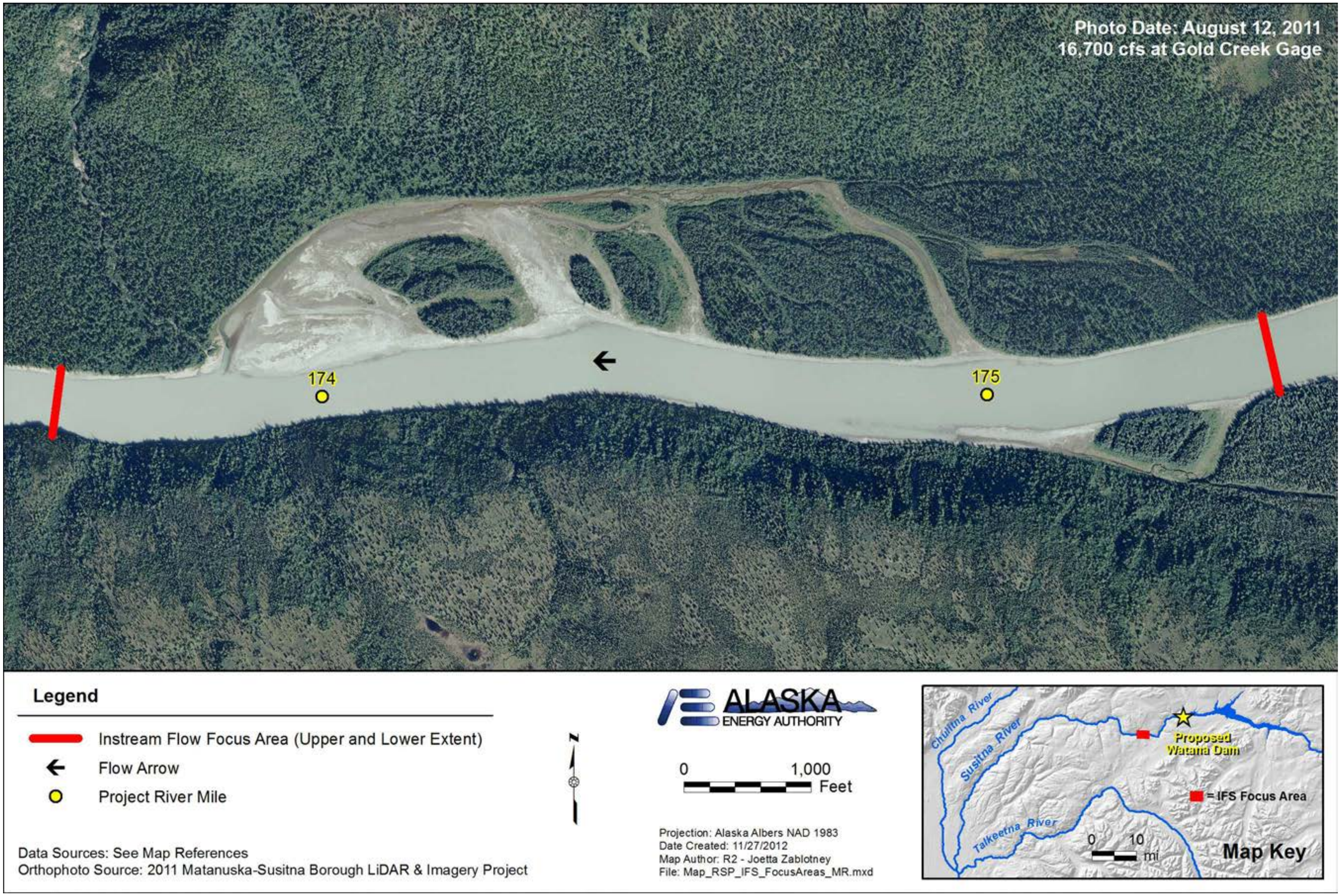

Figure 4. Map showing Focus Area 173 beginning at Project River Mile 173.6 and extends upstream to PRM 175.4. This Focus Area is near Stephan Lake and consists of main channel and a side channel complex.

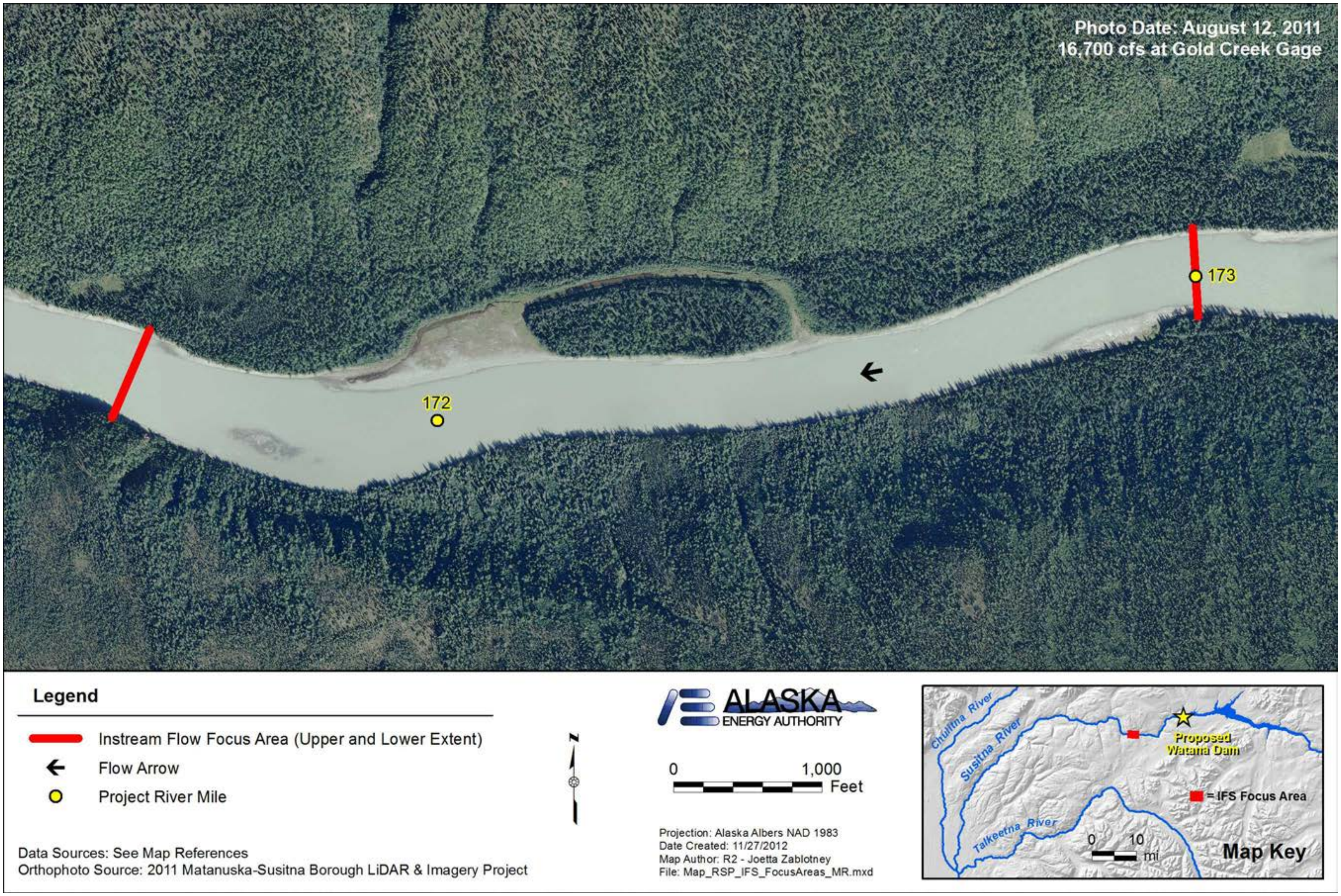

Figure 5. Map showing Focus Area 171 beginning at Project River Mile 171.6 and extends upstream to PRM 173. This Focus Area is near Stephan Lake and consists of main channel and a single side channel with vegetated island.

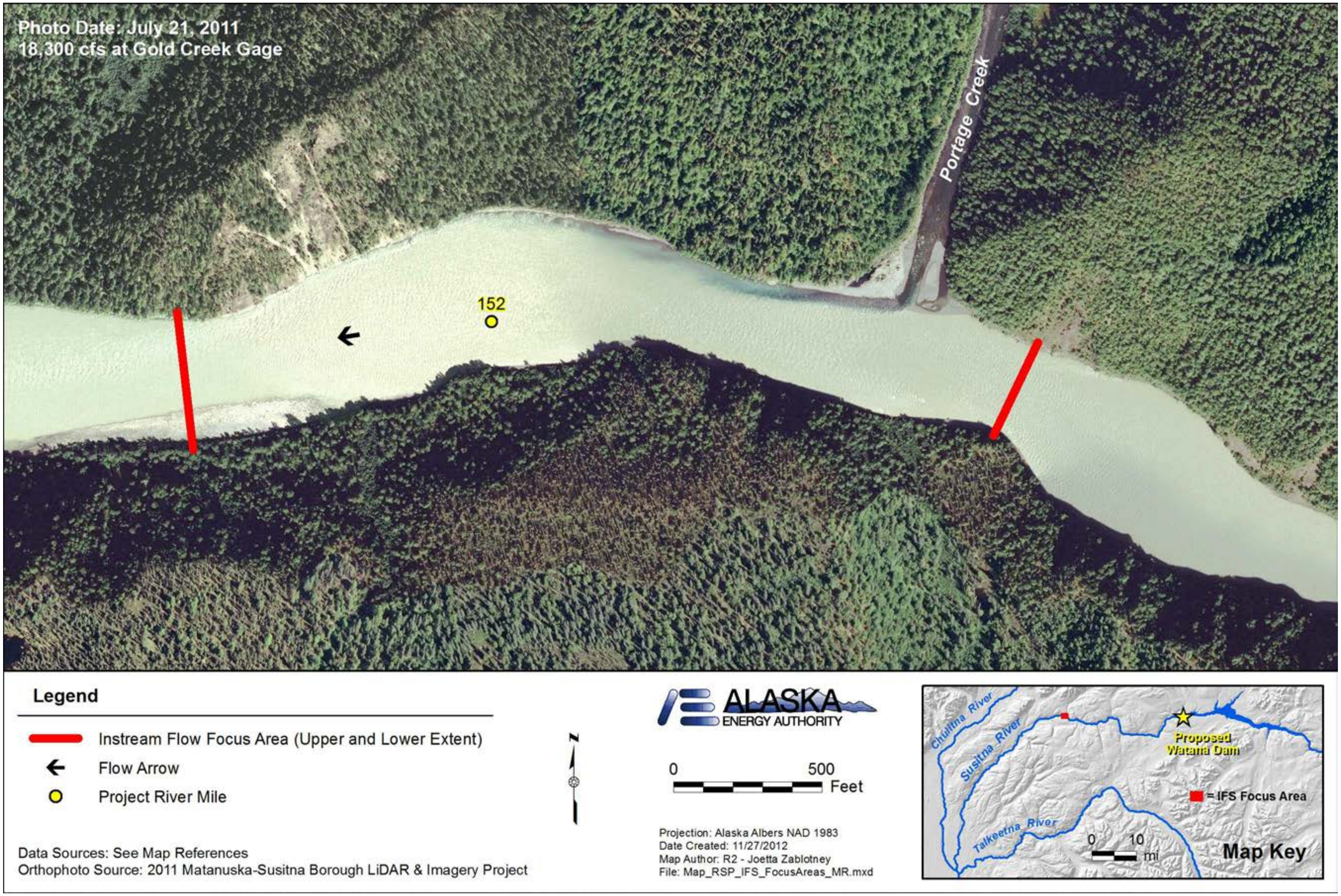

Figure 6. Map showing Focus Area 151 beginning at Project River Mile 151.8 and extends upstream to PRM 152.3. This single main channel Focus Area is at the Portage Creek confluence.

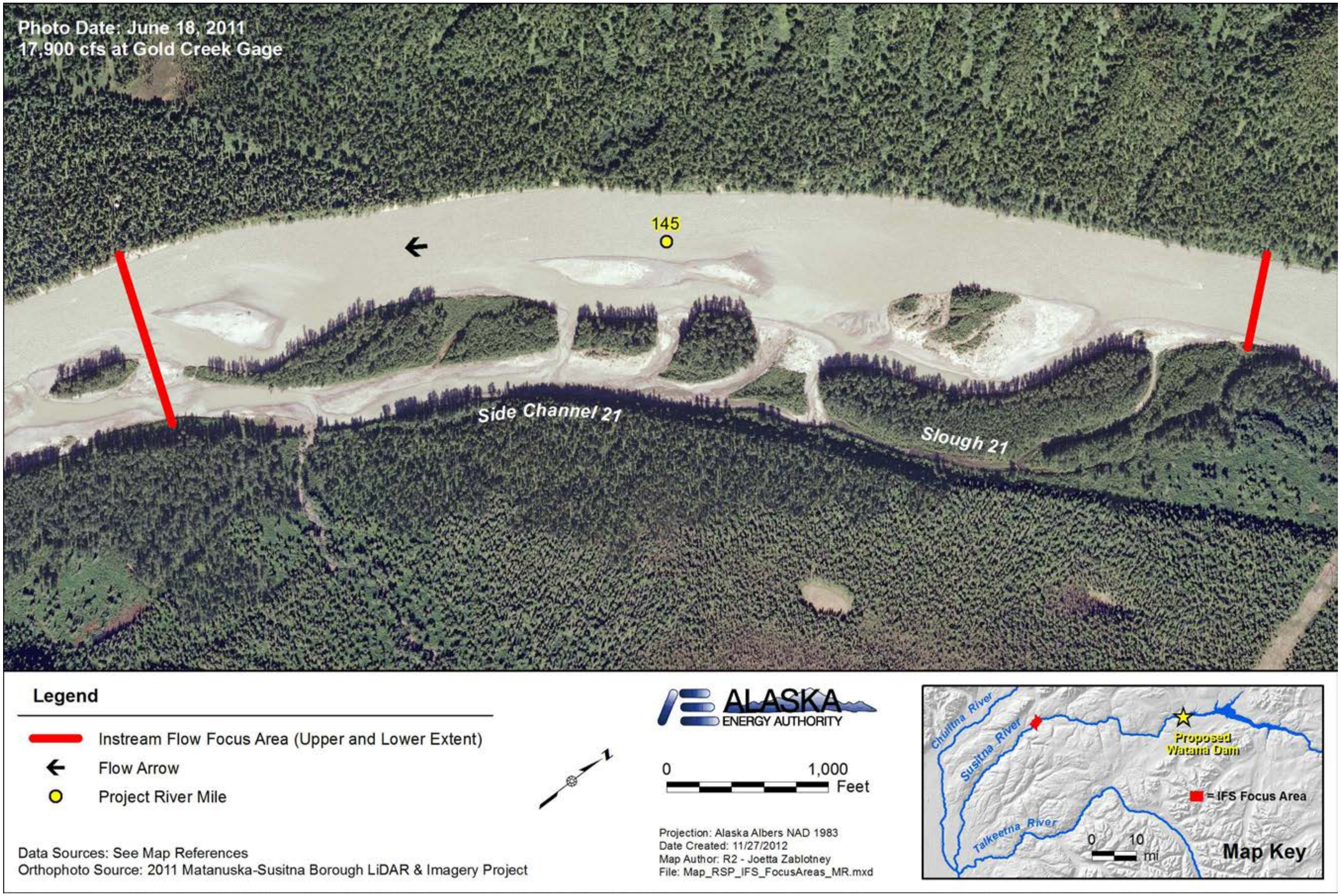

Figure 7. Map showing Focus Area 144 beginning at Project River Mile 144.4 and extends upstream to PRM 145.7. This Focus Area is located about 2.3 miles upstream of Indian River and includes Side Channel 21 and Slough 21.

Figure 8. Map showing Focus Area 141 beginning at Project River Mile 141.8 and extends upstream to PRM 143.4. This Focus Area includes the Indian River confluence and a range of main channel and off-channel habitats.

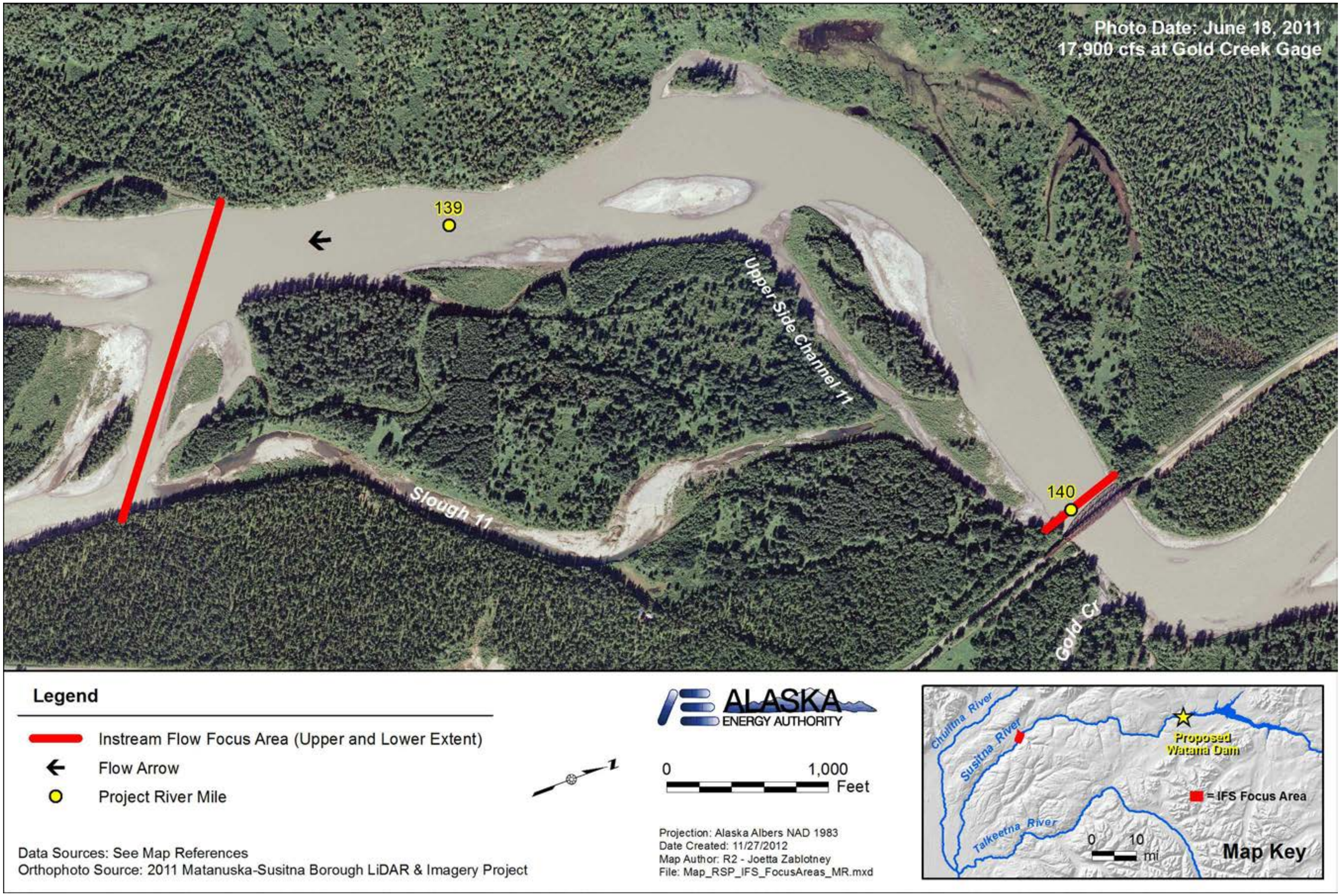

Figure 9. Map showing Focus Area 138 beginning at Project River Mile 138.7 and extends upstream to PRM 140. This Focus Area is near Gold Creek and consists of a complex of side channel, side slough and upland slough habitats including Upper Side Channel 11 and Slough 11.

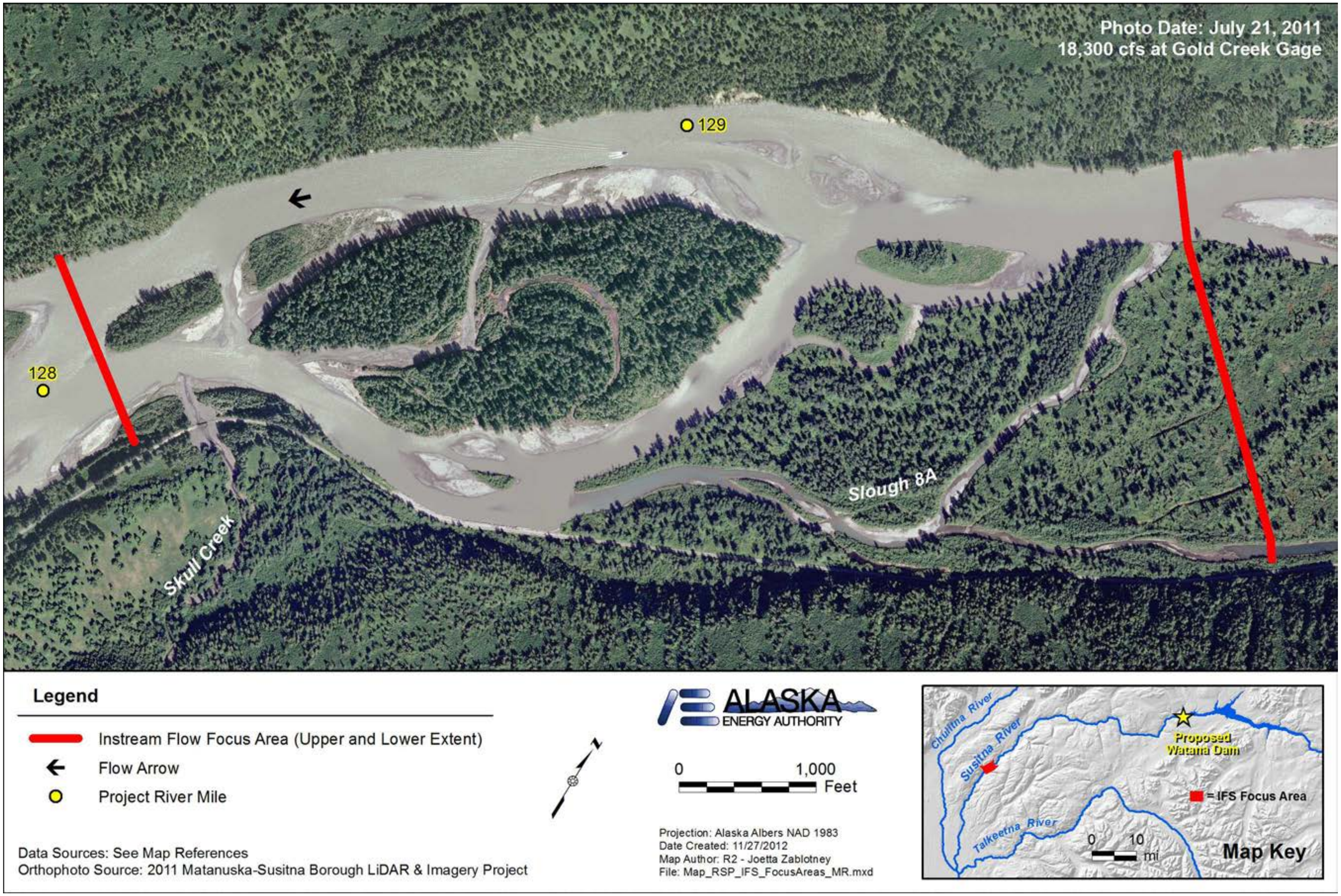

Figure 10. Map showing Focus Area 128 beginning at Project River Mile 128.1 and extends upstream to PRM 129.7. This Focus Area consists of side channel, side slough and tributary confluence habitat features including Skull Creek.

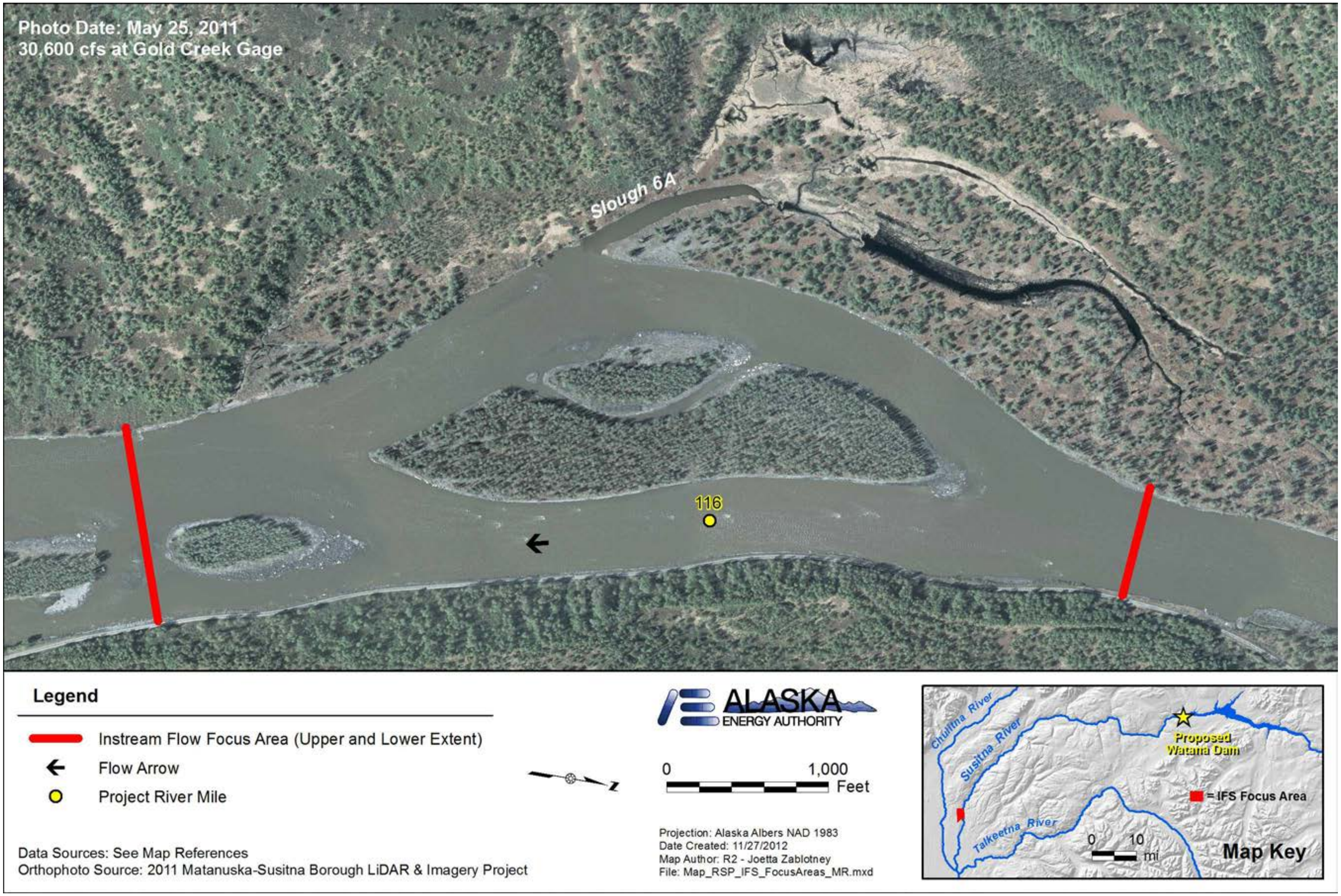

Figure 11. Map showing Focus Area 115 beginning at Project River Mile 115.3 and extends upstream to PRM 116.5. This Focus Area is located about 0.6 miles downstream of Lane Creek and consists of side channel and upland slough habitats including Slough 6A.

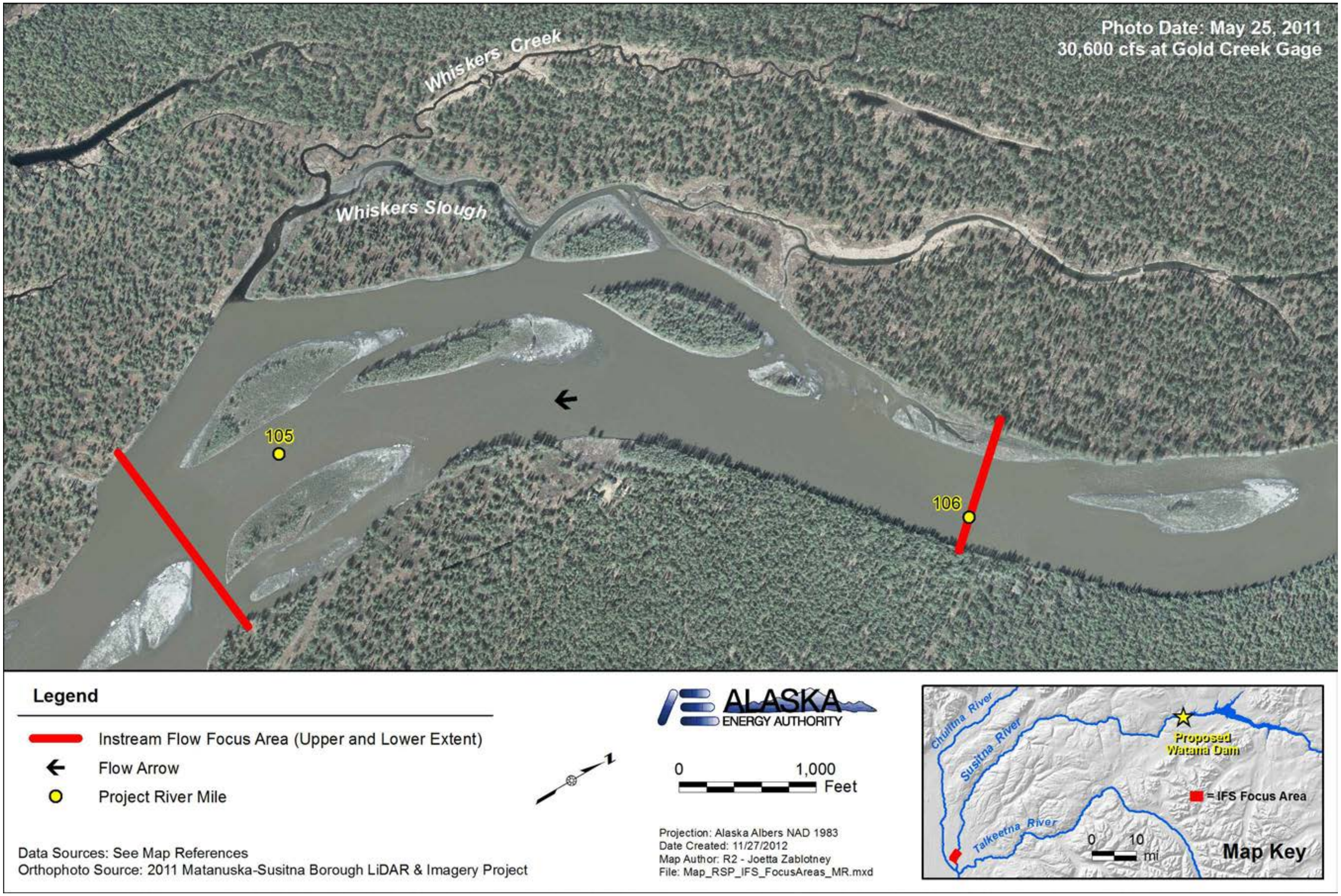

Figure 12. Map showing Focus Area 104 beginning at Project River Mile 104.8 and extends upstream to PRM 106. This Focus Area covers the diverse range of habitats in the Whiskers Slough complex.

Figure 13. Percent of main channel in single main, split main, and braided main channel habitat by geomorphic reach and focus area (F), non-focus area (NF), and total (T).

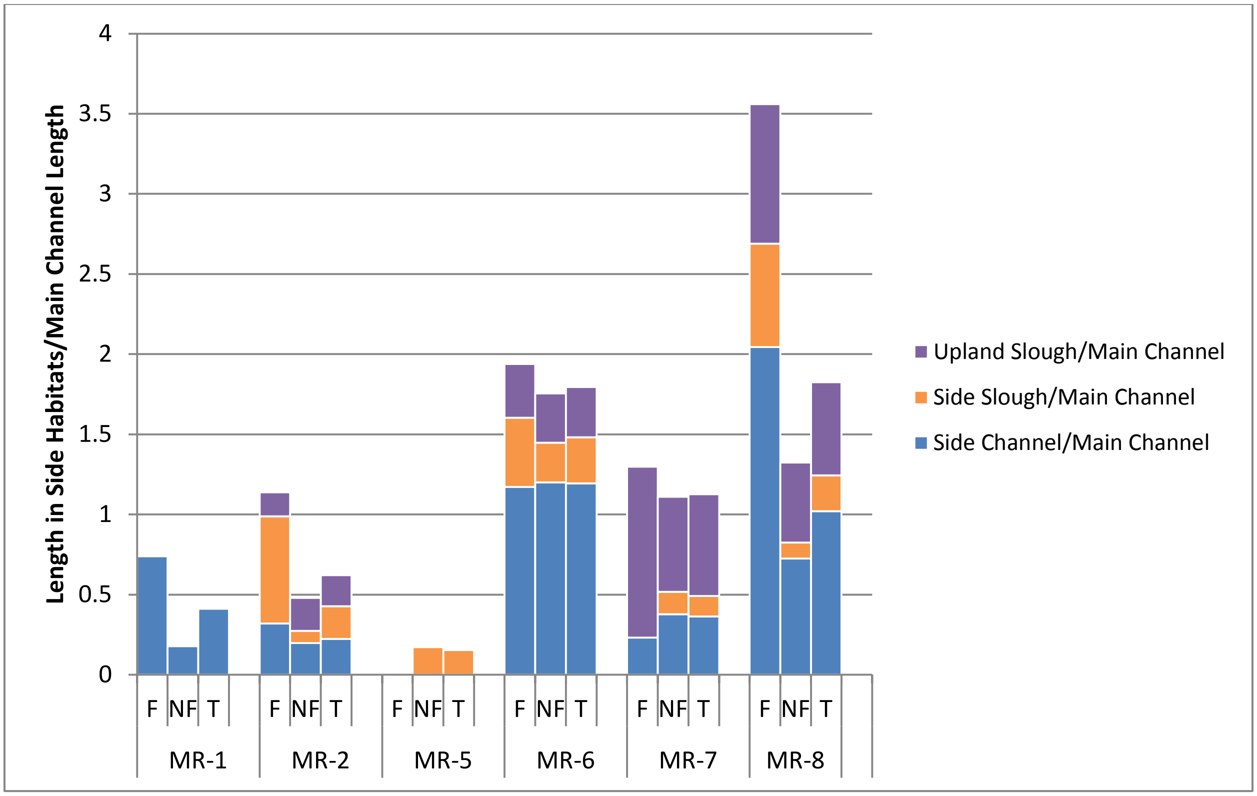

Figure 14. Side channel, side slough, and upland slough lengths per mile of main channel by geomorphic reach and focus area (F), non-focus area (NF), and total (T).

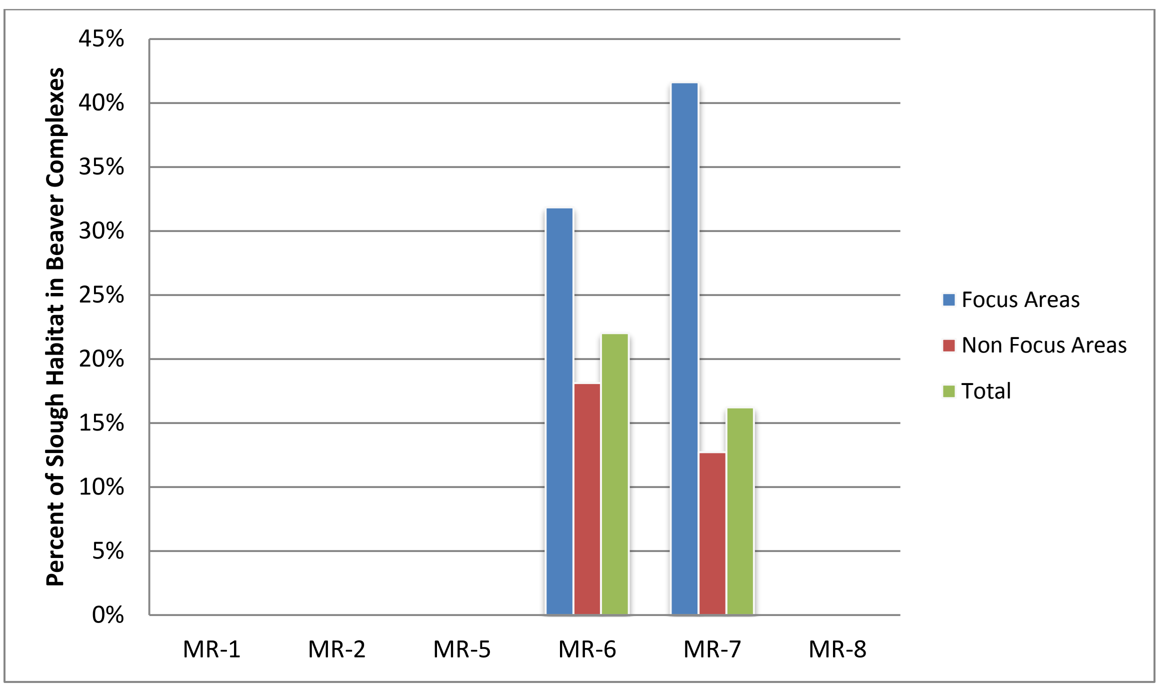

Figure 15. Percent of slough habitat that is in beaver complex by geomorphic reach and focus area (F), non-focus area (NF), and total (T).

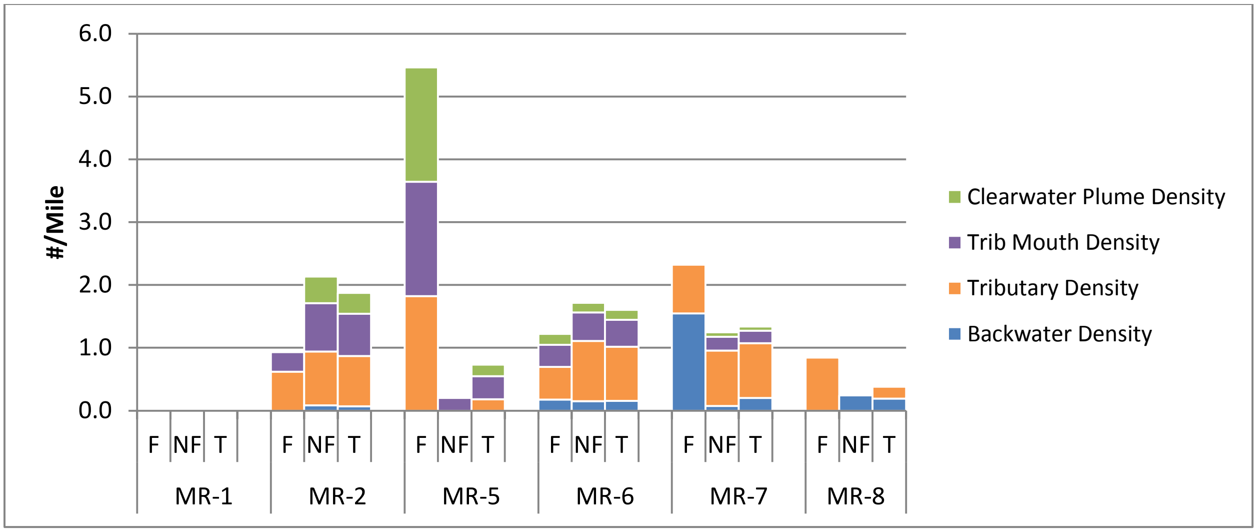

Figure 16. Backwaters, tributaries, tributary mouths, and plumes density (#/mile) by geomorphic reach and focus area (F), non-focus area (NF), and total (T).

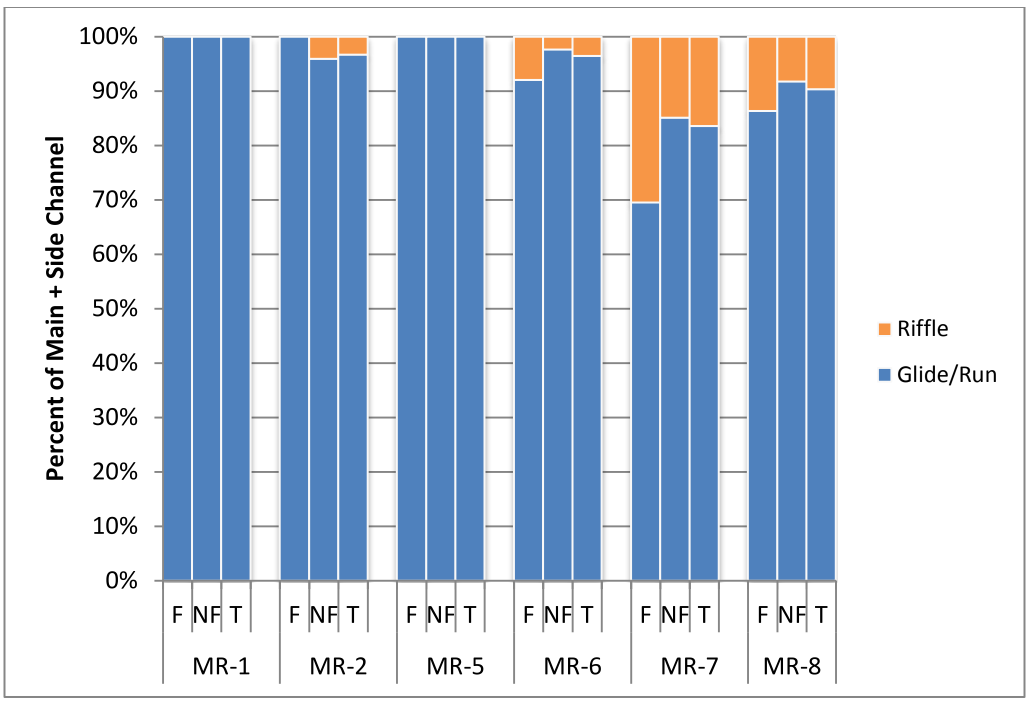

Figure 17. Percent of main and side channel habitat that is in riffle vs. glide/run habitat by geomorphic reach and focus area (F), non-focus area (NF), and total (T).

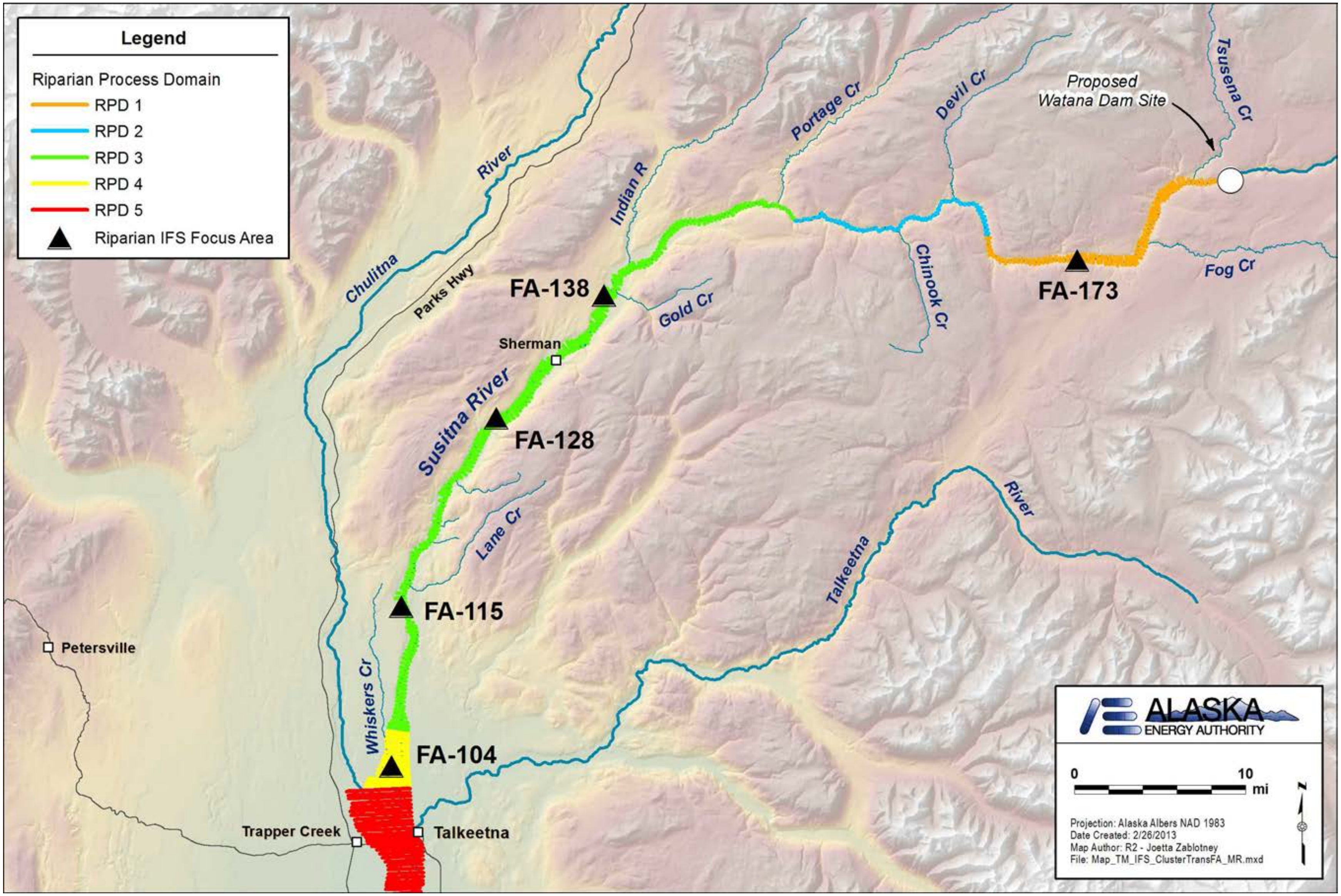

Figure 18. Riparian Process Domains on the Middle River with locations of associated Riparian IFS Focus Areas.

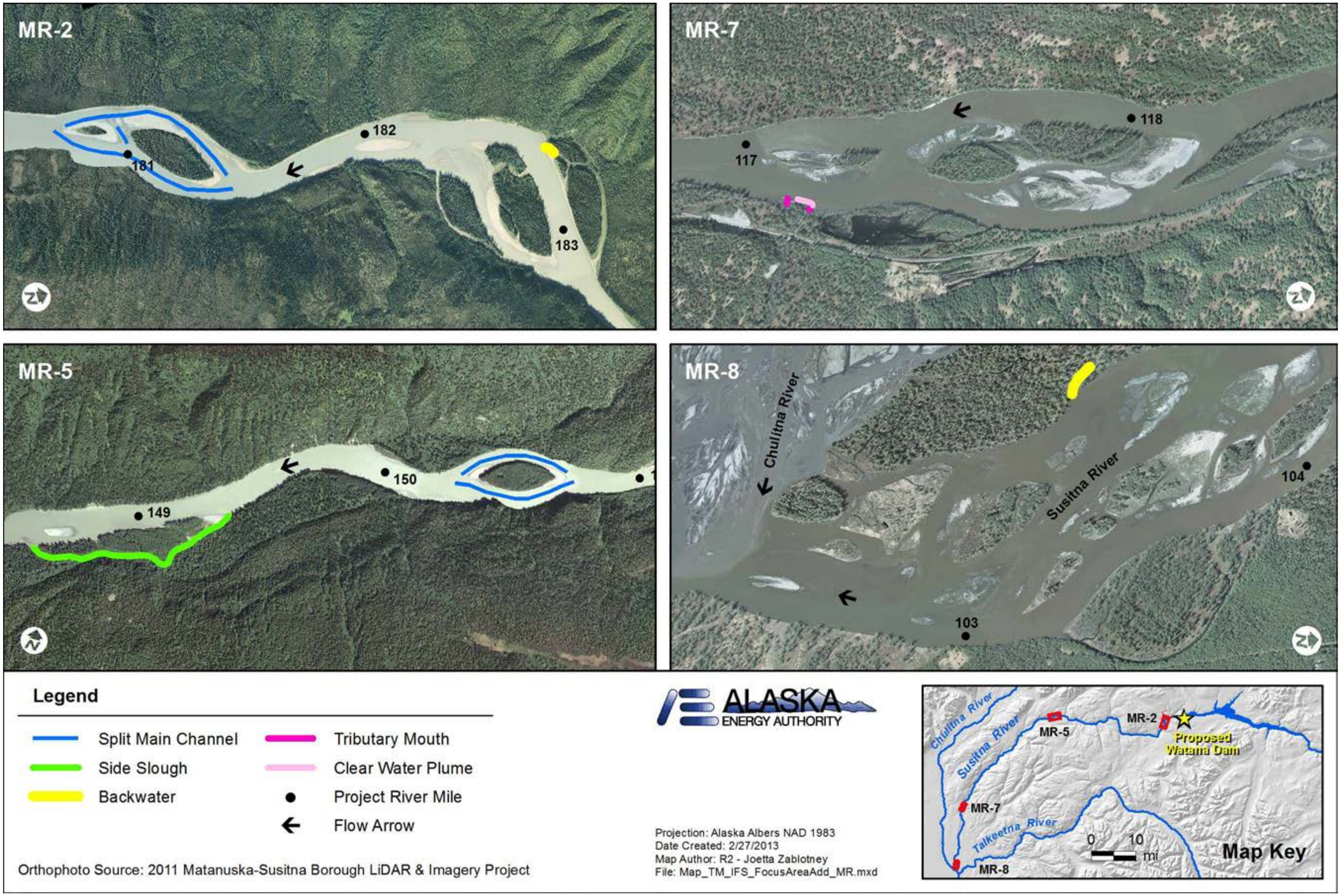

Figure 19. Locations of habitat types missing from the Focus Areas by Geomorphic Reach. Habitat types included split main channel (MR-2, MR-5), side slough (MR-5), Tributary mouth (MR-7) and backwater (MR-2 and MR-8).

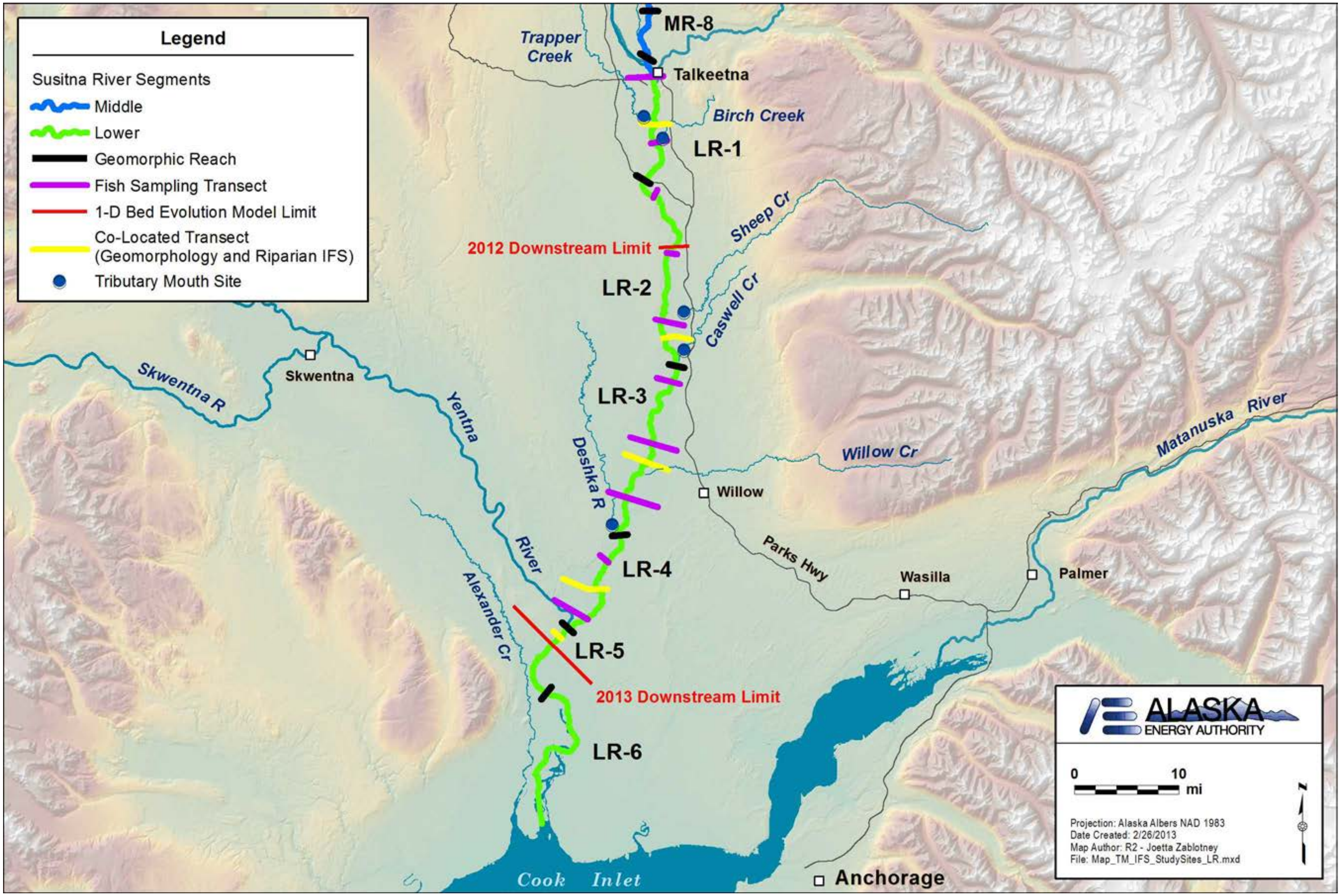

Figure 20. Map of the Lower Segment of the Susitna River depicting the six Geomorphic Reaches and locations of proposed 2013 study areas for geomorphology, instream flow–fish, instream flow-riparian and fish distribution and abundance.

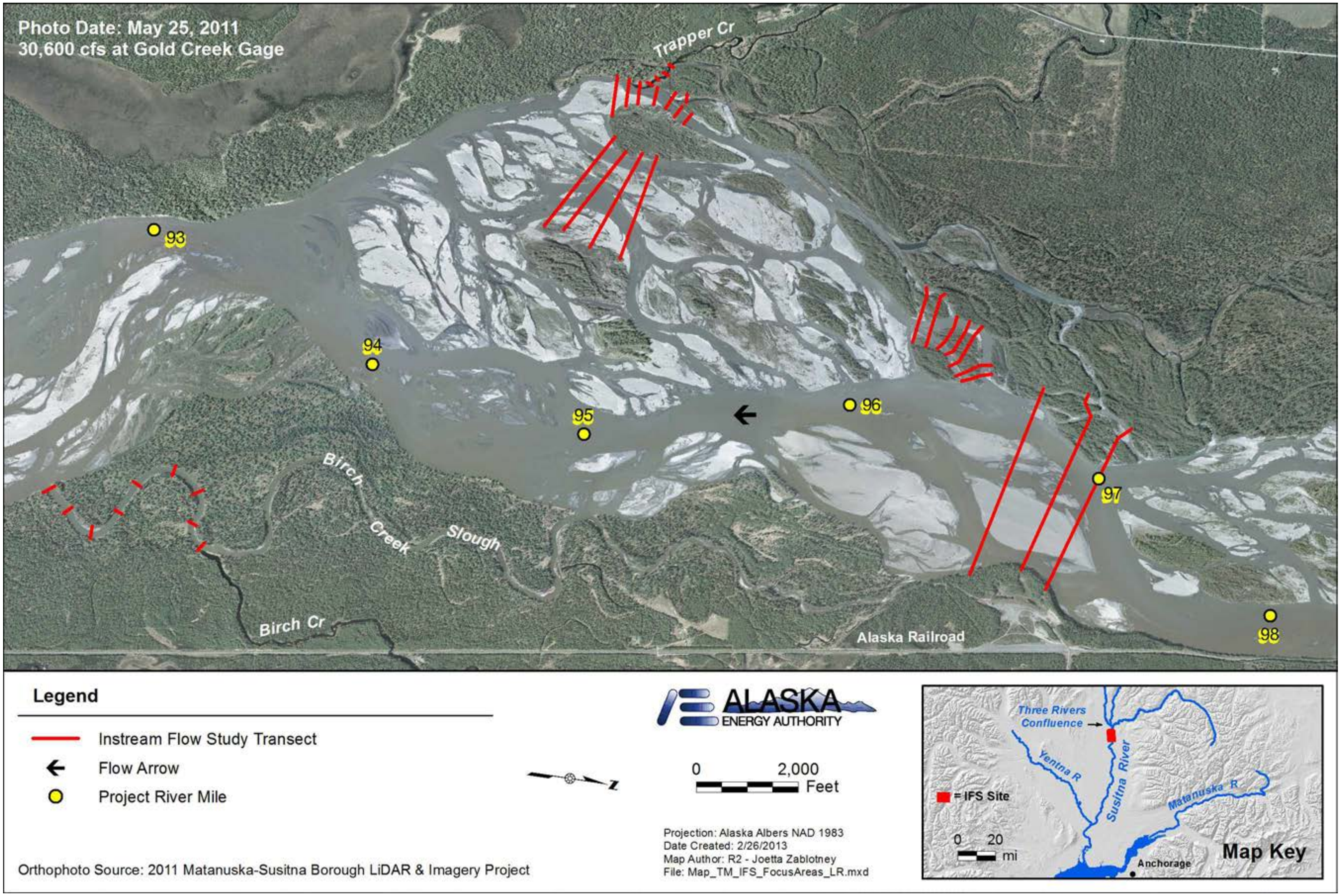

Figure 21. Map showing proposed location of lower Susitna River instream flow-fish habitat transects in Geomorphic Reach LR-1 in the vicinity of Trapper Creek. The proposed location, number, angle, and transect endpoints are tentative pending on-site confirmation during open-water conditions. Where feasible, instream flow fish habitat transects will be co-located with geomorphology, open-water flow routing, and instream flow-riparian transects.

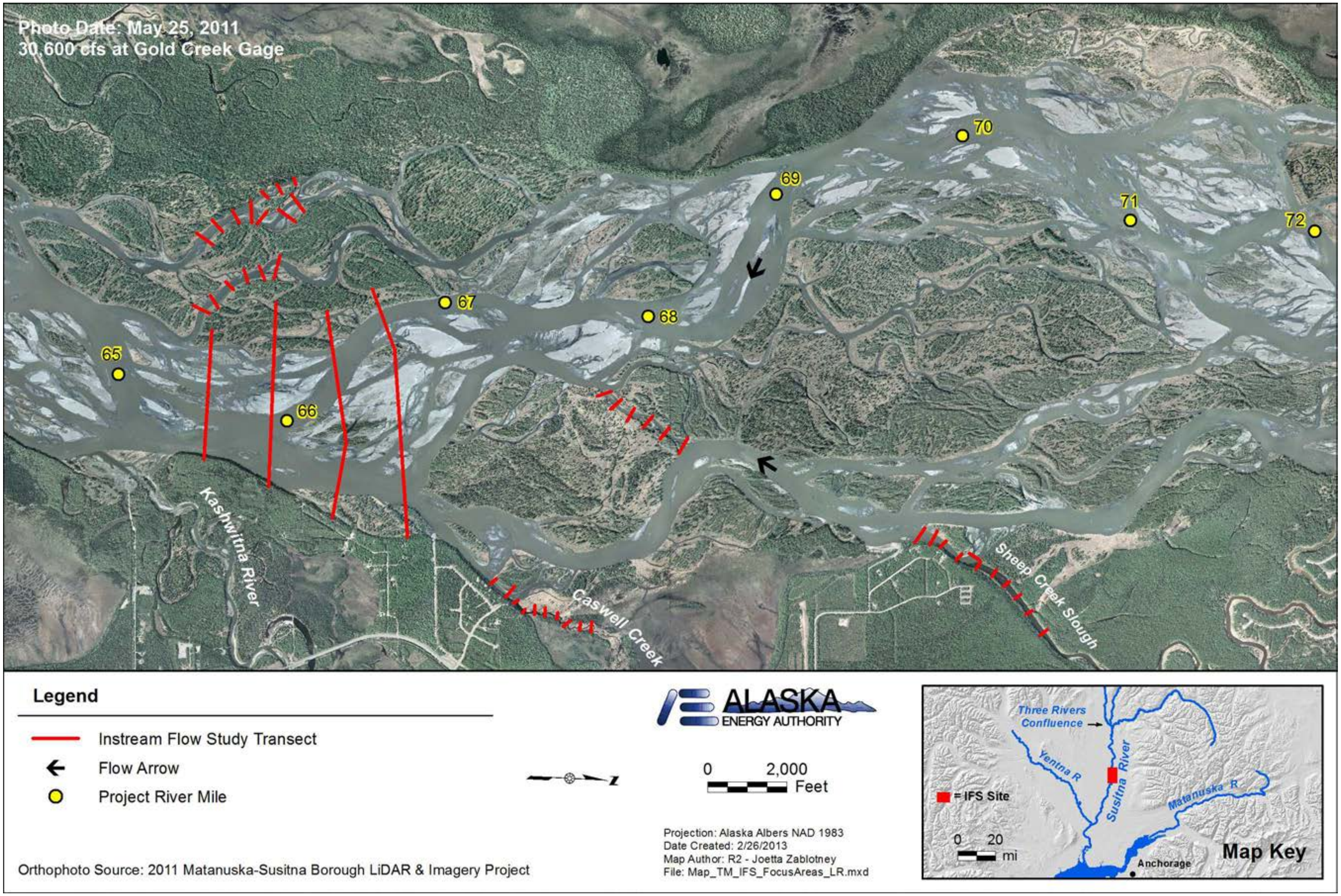

Figure 22. Map showing proposed location of lower Susitna River instream flow-fish habitat transects in Geomorphic Reach LR-2 in the vicinity of Caswell Creek. The proposed location, number, angle, and transect endpoints are tentative pending on-site confirmation during open-water conditions. Where feasible, instream flow fish habitat transects will be co-located with geomorphology, open-water flow routing and instream flow-riparian transects.

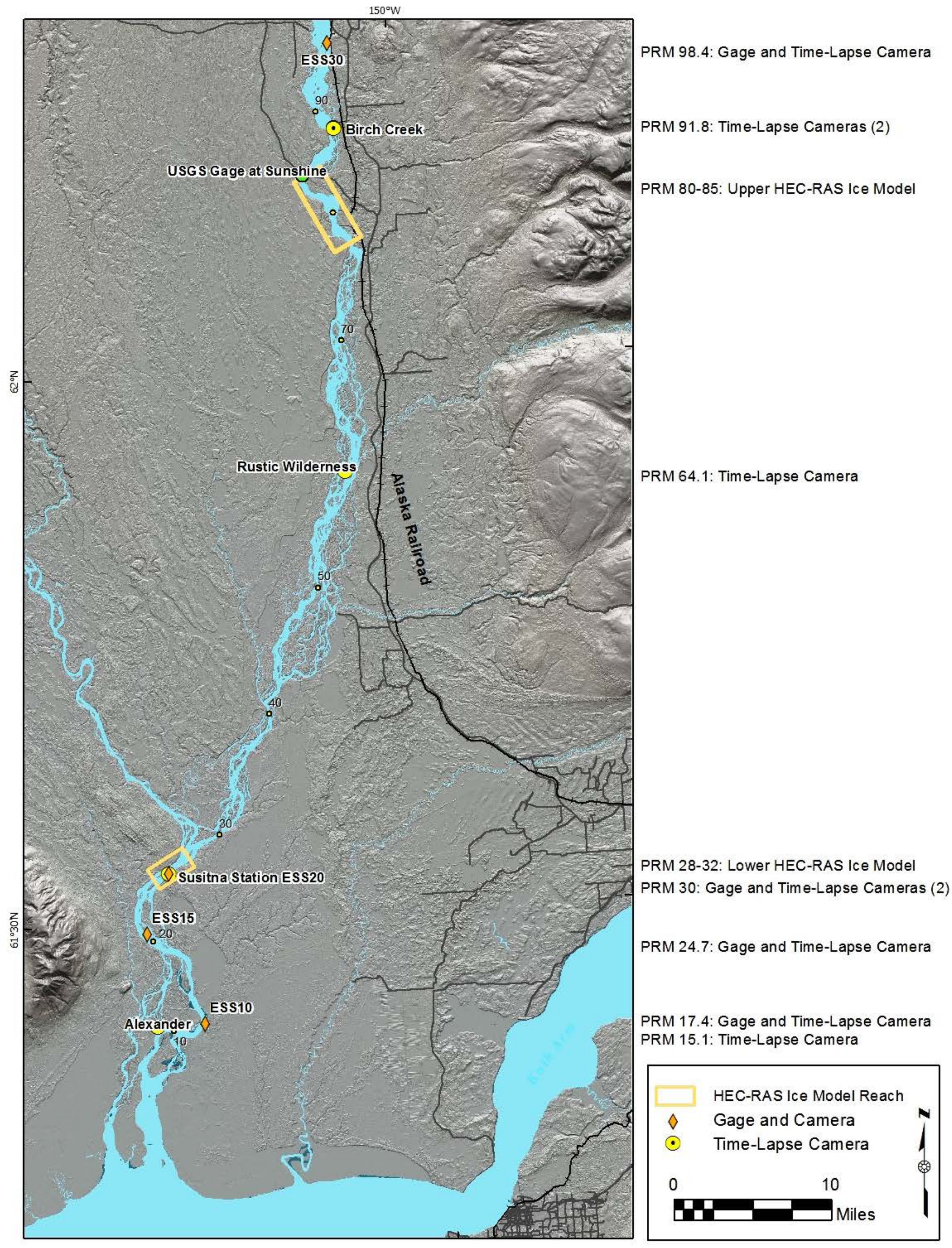

Figure 23. Ice Processes Study locations in Lower River.

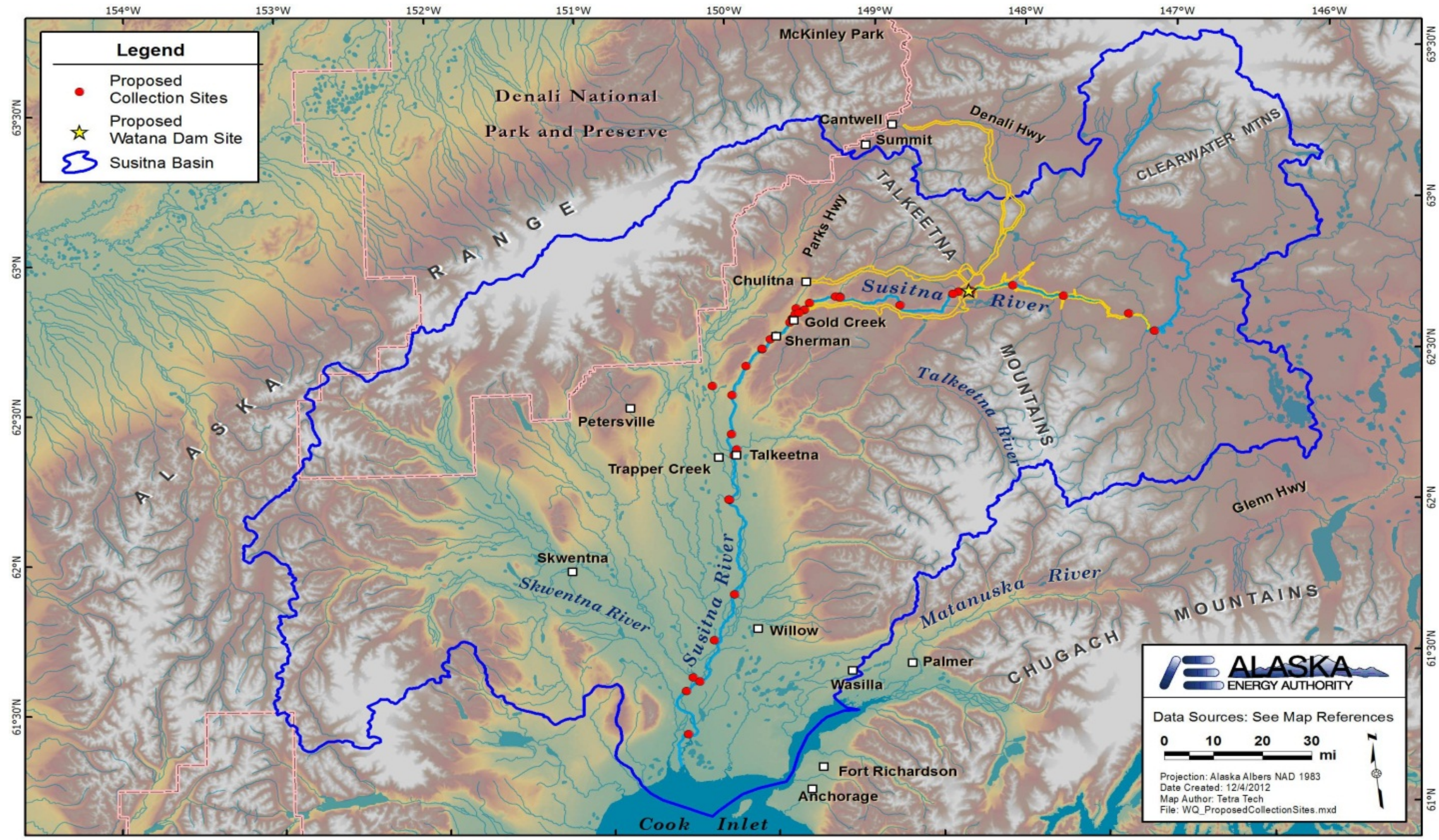

Figure 24. Proposed water quality sample locations for Susitna River.