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SUSITNA-WATANA HYDRO

Susitna-Watana Hydroelectric Project
(FERC No. 14241)

Study of Fish Passage Barriers in the Middle and Upper Susitna River and Susitna Tributaries Implementation Plan

Prepared for

Alaska Energy Authority

Prepared by

HDR, Inc.

May 15, 2013

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LIST OF ACRONYMS AND SCIENTIFIC LABELS

Abbreviation	Definition
Active floodplain	The flat valley floor constructed by a river during lateral channel migration and deposition of sediment under current climate conditions.
ADF&G	Alaska Department of Fish and Game
AEA	Alaska Energy Authority
Age-0 juvenile	The description of an organism that, in its natal year, has developed the anatomical and physical traits characteristically similar to the mature life stage, but without the capability to reproduce.
Algae	Single-celled organisms (as individual or cells grouped together in colonies) that contain chlorophyll-a and are capable of the photosynthesis.
Anadromous	Fishes that migrate as juveniles from freshwater to saltwater and then return as adults to spawn in freshwater.
APA	Alaska Power Authority
APA Project	APA Susitna Hydroelectric Project
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.
Bank	The sloping land bordering a stream channel that forms the usual boundaries of a channel. The bank has a steeper slope than the bottom of the channel and is usually steeper than the land surrounding the channel.
Bankfull stage (flow)	The discharge at which water completely fills a channel; the flow rate at which the water surface is level with the floodplain.
Bankfull width	The width of a river or stream channel between the highest banks on either side of a stream.
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.
Benthos (benthic)	Defining a habitat or organism found on the streambed or pertaining to the streambed (or bottom) of a water body.
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.
Break-up	Disintegration of ice cover.
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.
Catch per unit effort	The quantity of fish caught (in number or in weight) with one standard unit of fishing effort.
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.
Cross-section	A plane across a river or stream channel perpendicular to the direction of water flow.
Depth	Water depth at the measuring point (station).
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.

Abbreviation	Definition
et al.	"*et alia*"; and the rest
FERC	Federal Energy Regulatory Commission
Fishwheel	A device for catching fish which operates much as a water-powered mill wheel. A wheel complete with baskets and paddles is attached to a floating dock. The wheel rotates due to the current of the stream it is placed into. The baskets on the wheel capture fish traveling upstream. The fish caught in the baskets fall into a holding tank.
Flood	Any flow that exceeds the bankfull capacity of a stream or channel and flows out on the floodplain.
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.
Focus Area	Areas selected for intensive investigation by multiple disciplines as part of the AEA study program.
Fork length	A measurement used frequently for fish length when the tail has a fork shape. Projected straight distance between the tip of the snout and the fork of the tail.
Fry	A recently hatched fish. Sometimes defined as a young juvenile salmonid with absorbed egg sac, less than 60 mm in length.
Fyke net	Hoop nets are tubular shaped nets with a series of hoops or rings spaced along the length of the net to keep it open.
Geomorphic reach	Level two tier of the habitat classification system. Separates major hydraulic segments into unique reaches based on the channel's geomorphic characteristic.
Geomorphology	The scientific study of landforms and the processes that shape them.
Gillnet	With this type of gear, the fish are gilled, entangled or enmeshed in the netting. These nets may be used to fish on the surface, in midwater or on the bottom.
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.
Glacier geometry changes	Changes in the size or shape of a glacier over time.
Glide	An area with generally uniform depth and flow with no surface turbulence. Low gradient; 0-1 % slope.
GPS	global positioning system. A system of radio-emitting and -receiving satellites used for determining positions on the earth.
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.
Hook and line	A type of fishing gear consisting of a hook tied to a line.
Hoop net	Hoop nets are tubular shaped nets with a series of hoops or rings spaced along the length of the net to keep it open.
Ice cover	A significant expanse of ice of any form on the surface of a body of water.
ILP	Integrated Licensing Process
Inclined plane trap	This trap consists of a revolving screen suspended between two pontoons. Downstream migrant fish reaching the back of the trap are dropped into a live box

Abbreviation	Definition
	where they can later be enumerated.
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, ANSCA 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.
m	meter(s)
m^2	square meter(s)
Macroinvertebrate	An invertebrate animal without a backbone that can be seen without magnification.
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.
Major hydraulic segment	Level one tier of the habitat classification system. Separates the River into three segments: Lower River (RM 0-98), Middle River (RM 98-184), and Upper River (RM 184-233).
Mesh size	The size of holes in a fishing net.
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).
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.
Minnow trap	Normally composed of small steel mesh with 2-piece torpedo shape design, this trap is disconnected in the middle for easy baiting and fish removal.
N/A	not applicable *or* not available
Non-native	Not indigenous to or naturally occurring in a given area.
ºC	degrees Celsius
ºF	degrees Fahrenheit
Off-channel	Those bodies of water adjacent to the main channel that have surface water connections to the main river at some discharge levels.

Abbreviation	Definition
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.
Out-migrant trap	Several types of trapping equipment that can be used to estimate the abundance of downstream migrating anadromous salmonid smelts.
Overwintering	Freshwater habitat used by salmonids during the winter for incubation of eggs and eleven in the gravel and for rearing of juveniles overwintering in the stream system before migrating to saltwater the following spring.
pH	A measure of the acidity or basicity of a solution.
PIT	Passive Integrated Transponder tags used to individually identify animals and monitor their movements.
PM&E	protection, mitigation and enhancement
Pool	Slow water habitat with minimal turbulence and deeper due to a strong hydraulic control.
POW	Palustrian open water (ponds under 20 ac)
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
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.
Resident	Resident fish as opposed to anadromous remain in the freshwater environment year-round
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 corridor	A perennial, intermittent, or ephemeral stream and adjacent vegetative fringe. The corridor is the area occupied during high water and the land immediately adjacent, including riparian vegetation that shades the stream, provides input of organic debris, and protects banks from excessive erosion.
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

Abbreviation	Definition
	increased catches as a "run" of fish, a usage often independent of their migratory behavior.
Screw trap	A floating trap that relies on an Archimedes screw built into a screen covered cone that is suspended between two pontoons is used.
Seine (beach)	A fishing net that hangs vertically in the water with its bottom edge held down by weights and its top edge buoyed by floats. Seine nets can be deployed from the shore as a beach seine, or from a boat.
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,
Slope	The inclination or gradient from the horizontal of a line or surface.
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.
Smolt	An adolescent salmon which has metamorphosed and which is found on its way downstream toward the sea.
Smoltification	The physiological changes anadromous salmonids and trout undergo in freshwater while migrating toward saltwater that allow them to live in the ocean.
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.
Stratified sampling	A method of sampling from a population. In statistical surveys, when subpopulations within an overall population vary, it is advantageous to sample each subpopulation (stratum) independently. Stratification is the process of dividing members of the population into homogeneous subgroups before sampling.
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.
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.
Turbidity	The condition resulting from the presence of suspended particles in the water column which attenuate or reduce light penetration.
TWG	Technical Workgroup
Upland slough	Off-channel habitat characterization feature that is similar to a side slough, but contains a vegetated bar at the head that is rarely overtopped by mainstem flow. Has clear water.
Upper segment Susitna	The Susitna River upstream of the proposed Watana Dam Site at RM 184.
Watana Dam	The dam proposed by the Susitna-Watana Hydroelectric project. The approximately 750-foot-high Watana Dam (as measured from sound bedrock) would be located at river mile (RM) 184 on the Susitna River. The dam would block the upstream passage of Chinook salmon, possibly other salmon species, and resident fish that migrate through and otherwise use the proposed Watana Dam site and upstream habitat in the Susitna River and tributaries.

STUDY PLANS REFERRED TO IN THIS IMPLEMENTATION PLAN

RSP Section	Study Section
Geomorphology (RSP Section 6)	Fluvial Geomorphology Modeling below Watana Dam Study (Section 6.6)
Hydrology-Related Resources (RSP Section 7)	Groundwater Study (Study Section 7.5) Ice Processes in the Susitna River Study (Study Section 7.6)
Instream Flow (RSP Section 8)	Fish and Aquatics Instream Flow Study (Study Section 8.5)
Fish and Aquatic Resources (RSP Section 9)	Study of Fish Distribution and Abundance in the Upper Susitna River (Study Section 9.5) Study of Fish Distribution and Abundance in the Middle and Lower Susitna River (Study Section 9.6) Salmon Escapement Study (Study Section 9.7) Study of Fish Passage Feasibility at Watana Dam (Study Section 9.11) Study of Fish Passage Barriers in the Middle and Upper Susitna River and Susitna Tributaries (Study Section 9.12)

DRAFT

1. INTRODUCTION

On December 14, 2012, Alaska Energy Authority (AEA) filed with the Federal Energy Regulatory Commission (FERC) its Revised Study Plan (RSP), which included 58 individual study plans (AEA 2012). Included within the RSP was the Study of Fish Passage Barriers in the Middle and Upper Susitna River and Susitna Tributaries, Section 9.12. RSP Section 9.12 focuses on the methods for locating, describing, and assessing potential fish passage barriers in the Middle and Upper Susitna River that could be created or eliminated as a result of Project construction and operation. RSP 9.12 provided goals, objectives, and proposed methods for identification, classification, measurement, and analysis of potential fish passage barriers.

On February 1, 2013, FERC staff issued its study determination (SPD) for 44 of the 58 studies, approving 31 studies as filed and 13 with modifications. RSP Section 9.12 was one of the 13 approved with modifications.

In accordance with FERC's study plan determination, recommended modifications are addressed in detail in this implementation plan. Any area not discussed within this implementation plan will remain as detailed in the RSP.

2. FERC STAFF RECOMMENDATION

In its February 01, 2013 SPD FERC recommended the following.

> *We recommend that AEA assess discharge conditions at the streamflow gages established by AEA closest to Devils Canyon and near the dam site during the time periods when salmon are documented to successfully pass upstream of the Devils Canyon passage impediment in 2013 and 2014 (via radio-tagging as set forth in study 9.7, salmon escapement), and document the results in the initial and updated study reports.*
>
> *We do not recommend use of any of AEA's criteria set forth in section 9.12.4.4 of the RSP for excluding study sites from the Middle River passage barrier evaluation. Instead, we recommend that AEA prepare and file a detailed plan by no later than June 15, 2013, that provides the additional information described below on implementation of the study within the Middle River study area.*
>
> 1) *A specific schedule for completing the following Middle River study components proposed for future development in consultation with the TWG as set forth in section 9.12.4 of the RSP: (a) identifying fish species to be included in the passage barrier study; (b) defining the passage criteria for the identified fish species; (c) selecting the number and location of study sites for each element of study implementation; and (d) filing the results of items (a), (b), and (c).*
>
> 2) *A description of how the effects of load-following during the winter ice-cover period on salmonid juvenile and fry passage (e.g., depth, velocity, potential ice blockages) from mainstem into off-channel habitats would be evaluated.*

3) *A description of the specific methods as set forth in section 9.12.4.5 (e.g., 2-dimensional modeling, or other unspecified modeling approach) that would be applied at the off-channel and tributary delta locations selected for the depth barrier analysis. This would include an explanation of the proposed methods and study sites for the open-water period for adult and juvenile fish, and the ice-cover period for juvenile fish.*

4) *A description of a subsample of tributary deltas and off-channel habitat entrances within Middle River focus areas where velocity measurements will be taken to determine if velocity barriers to juvenile salmonids (particularly salmonid fry) would be created at tributary deltas and off-channel habitat entrances by modifications to river stage and discharge through proposed project operations.*

5) *Documentation that a draft plan and schedule were provided to FWS, NMFS, and any other TWG participants at least 30 days prior to the due date of the plan and schedule (allowing at least 15 days for comment); a description of how FWS', NMFS', or other TWG participant's comments are incorporated into the final plan; and an explanation for why any of FWS', NMFS', or other TWG participant's comments are not incorporated into the final plan.*

3. GOALS AND OBJECTIVES

Study goals and objectives of this implementation plan are the same as those described in RSP 9.12.

4. STUDY AREA

The study area for this implementation plan is the same as described in RSP 9.12.

5. BACKGROUND AND EXISTING INFORMATION

The background and existing information for this implementation plan is the same as described in RSP 9.12.

6. FISH PASSAGE THROUGH DEVILS CANYON

The February 1, 2013 Study Plan Determination states:

> *We recommend that AEA assess discharge conditions at the streamflow gages established by AEA closest to Devils Canyon and near the dam site during the time periods when salmon are documented to successfully pass upstream of the Devils Canyon passage impediment in 2013 and 2014 (via radio-tagging as set forth in study 9.7, salmon escapement), and document the results in the initial and updated study reports.*

As recommended by FERC (2013a), AEA will rely primarily on data collection and analysis under RSP Section 9.7 – Salmon Escapement Study to assess potential effects of the Project on passage of adult salmon through Devils Canyon.

Devils Canyon is a narrow rock-walled canyon extending from approximately PRM 154 to PRM 165. Within this 11 mile distance, three locations (sections of river) were identified where investigators suspected that at least partial impediments to adult salmon passage likely occur (as based on observations of holding behavior and some fish not continuing further upstream), and probably depending on flow level. These three locations are numbered in an upstream direction as potential impediments 1, 2, and 3. Within these general areas there are sections for which it is speculated that velocities could exceed the swimming capabilities of adult salmon. Figure1a shows the general locations of these suspected impediments. Figure 1b is an example of a location within Impediment 1 where a velocity blockage could be created at a high river discharge.

Results from AEA's 2012 studies on salmon passage through Devils Canyon are reported in Adult Salmon Distribution and Habitat Utilization Study (AEA 2013b). Chinook salmon was the only species identified migrating upstream of any of the three suspected impediments in Devils Canyon (PRM 154–165). One tagged sockeye salmon and one tagged chum salmon approached the farthest downstream impediment (Impediment 1) but did not migrate above it. Of the 313 radio tagged Chinook salmon that were tagged at Curry and moved above the "Gateway" station at PRM 140, 23 (7 percent) migrated above Impediment 1, 20 (6 percent) above Impediment 2, and 10 (3 percent) above Impediment 3. Four (1 percent) of these Chinook salmon had final destinations upstream of the Project dam site. Of the Chinook salmon tagged in the Lower River and that subsequently migrated upstream past the Lane Creek station (PRM 117), three migrated above Impediment 1; of these, two migrated above Impediment 3. All radio-tagged fish that approached Impediment 2 successfully passed above it.

In 2012, of all 26 tagged Chinook salmon (Lower and Middle River tagging-sites combined) that migrated upstream of Impediment 1, seven eventually migrated back downstream of Devils Canyon and were assigned to Portage Creek as a final destination. From the 12 tagged Chinook salmon (Lower and Middle River tagging-sites combined) that migrated upstream of Impediment 3, five eventually migrated back downstream of Devils Canyon and were assigned to Portage (4) or Chinook Creek (1) as a final destination. Chinook salmon migrated through the Devils Canyon impediments from July 7 to July 20. Average daily discharge of the Susitna River at Gold Creek (RM 136) ranged from 17,300–31,100 cubic feet per second (cfs) when Chinook salmon passed Impediment 1, 17,300–21,300 cfs when fish passed Impediment 2, and 17,300–19,000 cfs when fish passed Impediment 3.

RSP 9.7- Salmon Escapement Study radio tracking elements will be expanded in 2013. The number of tags applied in the Lower River will be increased from approximately 450 to 700 Chinook salmon. Additional tags will increase the potential for more tagged Chinook salmon to pass through Devils Canyon when compared to 2012. In the Middle River, 2013 efforts will attempt to shift some of the Chinook salmon tagging at Curry (PRM 123.6) to an area at the entrance of Devils Canyon (~PRM 164.8); this has the potential to double the number of tagged fish in the Canyon compared to 2012. Fixed-station telemetry sites in 2013 will have the same number of locations (3) within Devils Canyon as in 2012 and will have similar level of aerial surveying. However, 2013 efforts will have new fixed stations on the Susitna River at Fog

Creek, Watana Dam site, and Watana Creek to document the movement of tagged fish that have passed Devils Canyon and continue their migration upstream.

Mean daily discharge records during the time of attempted passage by radio-tagged salmon will be obtained from both the USGS Gold Creek stream gage and one or more of the AEA stream gages located in the Devils Canyon Area (ESS55 or ESS60). The gage closest to the impediment will be used or discharge will be prorated between the two gages to obtain the most accurate discharge estimate at the impediment at the time of attempted passage. Discharges during both successful and unsuccessful passage by radio-tagged fish will be compared to modeled post-Project discharges during the period when adult salmon would be attempting to pass through Devils Canyon.

Studies described above will contribute substantially to the understanding and evaluation of potential Project effects on salmon passage through Devils Canyon.

All field data collection will be conducted as part of RSP Section 9.7 and RSP Section 8.5 - Hydraulic Routing and Operations Modeling.

7. PREPARE A DETAILED PLAN

The February 1, 2013 Study Plan Determination states:

> *We do not recommend use of any of AEA's criteria set forth in section 9.12.4.4 of the RSP for excluding study sites from the Middle River passage barrier evaluation. Instead, we recommend that AEA prepare and file a detailed plan by no later than June 15, 2013, that provides the additional information described below on implementation of the study within the Middle River study area.*

AEA is fulfilling this recommendation by providing this implementation plan.

7.1. Study Component Consultation

The February 1, 2013 Study Plan Determination states:

> *A specific schedule for completing the following Middle River study components proposed for future development in consultation with the TWG as set forth in section 9.12.4 of the RSP: (a) identifying fish species to be included in the passage barrier study; (b) defining the passage criteria for the identified fish species; (c) selecting the number and location of study sites for each element of study implementation; and (d) filing the results of items (a), (b), and (c).*

The requested elements are addressed below in the order presented.

7.1.1. (a) Identify Fish Species to be Included in Passage Barrier Study

Given the interdependencies between the barriers assessment and ISF physical habitat data collection, AEA proposes that target species for the fish barrier studies be the same as, or a sub-

set of, those selected for Instream Flow Habitat Modeling (RSP 8.5). For planning purposes, target species proposed in RSP 8.5 were assumed to include Chinook, coho, chum, and sockeye salmon, rainbow trout, arctic grayling, Dolly Varden, burbot, longnose sucker, humpback whitefish, and round whitefish. These target species were selected because of they are generally considered the most sensitive to habitat loss through manipulation of flows in the Susitna River. All of theses species also have been identified as target species for RSP Section 9.11 - Study of Fish Passage Feasibility at Watana Dam. RSP 9.11 target species selection was first based on presence of the species in the Upper River, secondly on the following three criteria, and thirdly in consultation with the Fish Passage Technical Team at their workshop on April 9 and 10, 2013. Aspects of these criteria used by the Fish Passage study team are also useful for selecting target species for passage barrier studies.

- ***The species exhibits migratory behavior*** – Fish passage has a greater importance to species that may exhibit migratory behavior as part of their natural life history compared to fish that exhibit only localized movement, especially when the migration is necessary to complete the life cycle of the species.
- ***The species has high relative abundance*** – Species that are relatively abundant in the Upper River and its tributaries would theoretically utilize fish passage facilities with greater frequency than less abundant species, disregarding other criteria (e.g., migratory behavior).
- ***The species is important to commercial, sport, or subsistence fisheries*** – Species that are harvested in commercial, sport, or subsistence fisheries have added importance with regard to the study of fish passage feasibility.

Since submittal of RSP 8.5, AEA and the Technical Workgroup (TWG) have engaged in meetings to initiate discussions of target species for HSC development and inclusion in instream flow habitat modeling. At the March 27 TWG meeting (AEA 2013a), AEA presented a proposed species priority list for HSC development (Figure 2). In subsequent meetings during 2013, the Instream Flow Technical Team will meet to finalize target species and life stage for which HSC will be developed. AEA proposes that selection of target species for fish passage analysis occur toward the end of the HSC development process. Technical Team members, licensing participants, and AEA will have gained substantial knowledge of species and lifestage utilization of off-channel habitats, seasonal movement into and out of off-channel habitats, and microhabitat (depth and velocity) selection. This information will be informative to the refinement of target species selection and passage criteria.

7.1.2. (b) Define Passage Criteria for Identified Fish Species

Basic categories of fish passage criteria include water depth, water velocity, and fish leaping ability. The majority of passage criteria are based on the demonstrated swimming ability of a species/lifestage in a laboratory, or in some cases, under controlled natural conditions.

The onus for most research on adult swimming ability is related to upstream fish passage at manmade structures such as fishways, low head dams, weirs, and culverts. Most information on juvenile and fry swimming ability is related to entrainment (open diversions) and impingement (fish screens), of downstream migrating salmonids. Swim speed is the primary criterion developed from these studies. Although information exists, depth criterion for fry and juvenile

salmonids is less researched. Although criteria are available for some of the proposed non-salmonids target species, swimming capabilities for non-salmonids is the least researched.

AEA is in the process of collating existing information on passage criteria for the fish Passage Feasibility Study. Draft appendices summarizing these data have been developed for most of the target species listed above and data will be summarized for the remaining species in Q2 of 2013. These materials are being developed in collaboration with the Fish Passage Technical Team. AEA proposes to use this information to inform passage criteria for the barrier study. Any additional information necessary for the barriers assessment will be collated and summarized in Q3 and Q4 of 2013. AEA proposes that consultation with Licensing Participants regarding refinement of fish passage criteria occurs during TWG Habitat Suitability Criteria development meetings scheduled for late 2013. This timing would benefit passage criteria discussions because of the knowledge gained from the HSC development process regarding species/lifestage use of different off-channel habitat types and from HSC field observations.

7.1.3. (c) Select Number and Location of Study Sites for each Element of Study Implementation

Study elements and respective schedules for study site selection are presented below. Detailed descriptions of these study elements and study sites are provided in this implementation plan.

Study Element	Schedule for Study Site Selection
Adult salmon passage in Upper River tributaries	Seventy nine tributaries (study sites) were selected and surveyed for Chinook salmon barriers in 2012 (AEA 2013b). Follow-up surveys at a sub-set of these tributaries are schedule for July 2014. No additional tributaries for fish passage barrier studies in the Upper River are proposed.
Adult salmon passage through Devils Canyon	Impediment locations and radio-tracking stations were established in 2012 for studies of salmon passage at Devils Canyon (AEA 2013c). No additional tracking stations within the Devils Canyon area are proposed.
Intensive study of passage at off-channel and tributary deltas for adult and juvenile/fry lifestages in Middle River Focus Areas during ice-free and ice-cover periods.	The number and location of all Focus Areas, within which all intensive study of fish passage will occur, will be determined as part of the implementation of RSP Section 8.5 - Fish and Aquatics Instream Flow Study and filed with FERC by May 31, 2013.
Identification and Location of physical	In 2013, AEA proposes to ground survey 10

barriers to fish passage in tributaries outside of Middle River Focus Areas.

tributaries for physical barriers within the zone of hydrologic influence (ZHI[1]) in the Middle River below Devils Canyon. These tributaries are listed below in Section 7.5.2.

7.1.4. (d) File Results of Items (a), (b), and (c)

The results of these implementation ideas will be included within the RSP Section 9.12 study reports filed with the Commission.

7.1.5. Schedule Overview

Requirement	Process	Proposed Schedule for Consultation
Define Fish Species	Define as part of instream flow target species selection	Q1-Q2, 2013
Define Criteria	Define immediately following instream flow HSC development	Q1-Q2, 2014
Select Number and Location of Fish Passage Study Sites	Locations of all study sites are proposed in this detailed implementation plan.	To be determined in final Implementation Plan

7.2. Effects of Load-following on Passage during Ice-cover Periods

A description of how the effects of load-following during the winter ice-cover period on salmonid juvenile and fry passage (e.g., depth, velocity, potential ice blockages) from mainstem into off-channel habitats would be evaluated.

RSP 9.12 will rely on data collected by the intensive, multidisciplinary studies in Focus Areas to evaluate the effects of load-following on juvenile and fry passage at off-channel habitats during the ice cover period. These studies include:

- RSP 7.6 - Ice Processes in the Susitna River Study
- RSP 7.5 - Groundwater Study
- RSP 8.5 - Fish and Aquatics Instream Flow Study
  - Hydraulic Routing and Operations Modeling;
  - Winter Habitat Use Sampling;
  - Periodicity;
  - Habitat-Specific Model Development

[1] The ZHI (zone of hydrologic influence) is defined as the approximated section of tributary extending from the Susitna River's modeled water's edge at a 1.5 year flow return interval downstream to the tributary's confluence with the Susitna River at a base flow.

- RSP 9.6 - Study of Fish Distribution and Abundance in the Middle and Lower Susitna River

An example of co-location of winter studies in Focus Areas is illustrated in Figure 3.

To study the effects of load-following on fish passage in the Middle River, AEA will use the River1D predictive ice, hydrodynamic, and thermal model to simulate time-variable flow routing, heat-flux processes, seasonal water temperature variation, frazil ice development, ice transport processes, and ice-cover growth and decay.

The River1D model will be used to simulate conditions in the Middle River due to various project operating scenarios and predict changes in water temperature, frazil ice production, ice cover formation, elevation and extent of ice cover, and flow hydrograph. The model will also be used to predict ice cover stability, including potential for jamming, under load-following fluctuations. For the spring melt period, the model will be used to predict ice-cover decay, including the potential for break-up jams. Proposed operating scenarios will include, at a minimum, the load-following scenario described in the Pre-Application Document (PAD) and a base-load scenario.

For Focus Areas, AEA will model and characterize ice processes using either River1D or River2D models. The appropriate model will be selected on the basis of which model better simulates the characteristics at the particular study location. The objective of this modeling will be to evaluate project effects on smaller scale habitat in the focus areas to provide physical data on winter habitat for Study 8.5 (fish and aquatics instream flow) and Study 9.12 (fish passage barriers).

As discussed by FERC (2013a), accuracy of hydrodynamic modeling during the ice-cover periods may or may not be sufficient to predict passage conditions at the small, local scale. FERC states:

> *…it's not clear if the winter model can accurately predict stage-discharge relationships and streamflow velocities at a scale that is fine enough to evaluate the effects of daily flow fluctuations during proposed winter load-following operations on fish passage conditions from the mainstem into off-channel habitats…While AEA's proposed fish passage barrier study plan does not appear to specifically address this issue, we assume the intensive, multidisciplinary study elements that would be implemented within the focus areas would provide some information to evaluate fish passage conditions between the mainstem and off-channel habitats under ice cover and load-following operations.*

The following is a discussion of multidisciplinary methods proposed by AEA to address FERC's comment.

The hydraulic data to be derived from the Focus Area ice models will be determined on a case-by-case basis by the needs of instream flow, geomorphology, fish passage, and other studies, but will include at a minimum: extent of inundation; flow stages; and, velocities for post-Project winter conditions under load-following and base-load scenarios.

Initial modeling results of load-following effects on stage indicate that in an *ice-free* channel Project load-following (maximum load following OS-1 scenario) in January would result in a daily stage cycle (fall and rise) of 1.0 to 1.5 feet at the Susitna stream gage near Gold Creek

(AEA 2013d). These initial modeling results also indicate that during the winter months, the average stage during *ice-free* periods, in the vicinity of Gold Creek, will be approximately 3.5 feet higher with the Project than under existing ice-free periods. Figure 4 illustrates these initial results.

The rise in stage described above is applicable to the ice-free period. Effects of load-following on river stage during ice-cover periods will likely be much different than under ice-free periods. One key finding of the 1980s modeling effort (Watana Dam only scenario) was that winter water surface elevations under ice would generally be 2–7 feet higher under project conditions (RSP 7.6). The combination of a predicted rise in stage due to winter Project flow releases and a predicted rise in stage due to ice-cover would be a 5-10 feet.

Obvious from these initial studies, but important to note is the dramatic difference in scale between predicted increases in river stage (depth) of several feet under Project operations, and the minimum depth criteria for juvenile and fry salmonid passage of 2 - 3 inches. At least for depth predictions, initial results indicate that model error can be large and still have sufficient accuracy to predict that depth would exceed 3 inches.

As highlighted by FERC above and discussed in more detail in Section 7.3.1 below, ice-process modeling may not provide detailed and accurate information at the micro scale. The study does, however, exhaust scientific methodologies and resources to provide data within the current bounds of research. Further, in combination with other multidisciplinary studies in Focus Areas, the models will be useful for predicting and evaluating effects of ice process on fish passage at the macro scale.

As discussed by FERC (2013a), for the purposes of the passage studies, stage and velocity model predictions for post-Project winter conditions under load-following and base-load scenarios will be augmented with other winter-period multidisciplinary study elements.

AEA does not propose any field data collection in RSP 9.12 for this study element. All field data collection will be conducted as proposed in other RSP's, as described above.

7.3. Description of Study Sites and Modeling Methods

> *A description of the specific methods as set forth in section 9.12.4.5 (e.g., 2-dimensional modeling, or other unspecified modeling approach) that would be applied at the off-channel and tributary delta locations selected for the depth barrier analysis. This would include an explanation of the proposed methods and study sites for the open-water period for adult and juvenile fish, and the ice-cover period for juvenile fish.*

Several environmental variables may affect adult and juvenile fish passage in sloughs, side channels, and tributary deltas. Although some variables are the same, there are additional variables during ice-cover periods not present during ice-free periods. In general, at a given passage reach the water conditions (depth and velocity) interact with conditions of the channel (length and uniformity and substrate size) to characterize the passage conditions that a particular fish encounters when attempting to migrate into, within, and out of a slough, side channel, or tributary delta. The likelihood of a particular fish successfully navigating through a difficult passage reach will depend on these environmental conditions as well as the individual

capabilities and condition of the fish. These fish passage variables will be studied in Focus Areas using 1D and 2D models.

7.3.1. Proposed Study Sites for Modeling

As recommended by FERC (2013a), AEA will locate fish passage barrier intensive sampling sites for both the ice-free and ice-cover periods within the selected Focus Areas. Ice-free data collection includes a larger number and diversity of sample locations at off-channel and tributary deltas. Ice-cover sample sites within Focus Areas will be fewer in number. Fewer ice-cover sample sites are planned because of the inherent difficulties of measuring and modeling ice process and associated hydrodynamic conditions that control fish passage.

With input from the RSP 9.12 study lead, Focus Area study sites for modeling juvenile passage during the ice-cover period will be selected as part of RSP 7.6 - Ice Processes in the Susitna River Study and RSP 8.5 - Fish and Aquatics Instream Flow Study. One objective of the Ice Processes study is to develop detailed models and characterizations of ice processes at instream flow Focus Areas in order to provide physical data on winter habitat for the instream flow study. This study objective directly supports study site and modeling needs for juvenile fish passage during ice-cover periods. In its April 1, 2013 study plan determination (FERC 2013b) FERC concluded that:

> *AEA's proposed focus area selection for the purposes of the ice processes study is consistent with accepted methods (section 5.9(b)(6)), and should provide information necessary to support the design of the project, assess environmental effects, and evaluate proposed environmental measures (section 5.9(b)(5)). If the agencies conclude that the initial study results or any other available study results suggest that it is still necessary to include additional ice-specific focus areas, they could be requested in 2014 or in subsequent study years after a showing of good cause as specified in sections 5.15(d) and 5.15(e) of the Commission's regulations.*

Selection of proposed study sites for modeling adult and juvenile fish passage during the ice-free period is described in Section 7.4, below.

7.3.2. Modeling Methods for Ice-free Periods

Depth and velocity passage for adults and juveniles in sloughs, upland sloughs, side channels, and at tributary delta mouths in Focus Areas will be assessed following concepts similar to ADF&G (1984b) in which depth, velocity, substrate, and length of the passage reach were considered together to determine successful or unsuccessful passage into and within these habitats. Data collection and modeling methods, including two-dimensional modeling, not available in the 1980s, will be applied in the current studies.

As discussed by FERC (2013a), for fish passage during ice-free periods, AEA will rely on 2D modeling already being conducted in Focus Areas under Section 6.6 - Fluvial Geomorphology Modeling below Watana Dam Study and 8.5 - Fish and Aquatics Instream Flow Study. The specific 2D models will be selected from a list of candidate models in coordination with other studies and the licensing participants. As specified by FERC (2013b), AEA's schedule for

selecting the 2D model will be described in a technical memorandum prepared in the second quarter of 2013. The 2-D model selected will be applied over the full extent of all Focus Areas.

As described in RSP 8.5, the 2-D model will utilize a variable mesh (also referred to as flexible mesh). A variable mesh allows a finer mesh to be used in areas where either the information desired or the condition being modeled requires higher spatial resolution (RSP 6.6.4). For off-channels and tributary deltas, velocities, bathymetry, and substrate will be modeled at a fine mesh grid size of 2m x 2m. Figure 5 is an example of fine mesh 2D modeling at off-channel passage sites and coarse mesh modeling in the open water areas.

As in the ADF&G 1980s studies, passage in off-channel reaches requires evaluation under three types of hydraulic conditions: breaching, backwater, and local discharge. The two-dimensional model, coupled with the flow routing model and the groundwater model will be used to evaluate passage conditions over the full range of pre- and post-Project flow conditions. To the extent possible, passage criteria will be input to the 2D habitat model, yielding an integrated analysis tool.

7.3.3. Modeling Methods for Ice-cover Periods

As described above in Section 7.2, ice-cover passage barrier modeling will rely on the river ice-process model developed as part of RSP 7.6 - Ice Processes in the Susitna River Study. The river ice-process model will rely on the River 1D hydrodynamic flow routing/thermal model to determine large-scale changes to ice-cover timing and structure, and under-ice discharges including stage fluctuations.

Ice-process studies will include 2D modeling at the Focus Area below Devils Canyon (where there will likely be an ice-cover post-project to model), 1D modeling at Focus Areas upstream of Devils Canyon for existing conditions, and using the open-water results for proposed conditions.

One objective of the ice processes study is to develop detailed models and characterizations of ice processes at instream flow Focus Areas in order to provide more detailed physical data on winter habitat for the instream flow study. RSP 7.6 Ice Processes study objective directly supports study site and modeling needs for juvenile fish passage during ice-cover periods. In its study plan determination, FERC (2013b) concluded that:

> *AEA's proposed modeling approach should provide the information necessary to describe project effects with respect to ice processes to a degree which is consistent with generally accepted practices in the scientific community (section 5.9(b)(6)) and, if effectively implemented, is expected to be able to satisfy the study objectives.*
>
> *If the initial results of the 2013 or 2014 study seasons (as documented in the initial study report) indicate that the model does not adequately evaluate project effects, and it becomes clear on the basis of the results that other procedures should be followed in order to meet the study objectives, then alternative methods and/or procedures could be added in 2014 or in subsequent study years (sections 5.15(d) and 5.15(e)).*

In addition to the ice-process modeling, AEA will rely on multidisciplinary data collection in Focus Areas to assess potential effects of the Project on salmonid juvenile and fry passage during the ice-cover period. Other multidisciplinary studies include: RSP 6.6 - Fluvial Geomorphology

Modeling below Watana Dam Study and RSP 7.5 - Groundwater Study. Subsections from RSP 8.5 - Fish and Aquatics Instream Flow Study include: Hydraulic Routing and Operations Modeling, Winter Habitat Use Sampling, Periodicity, and Habitat-Specific Model Development.

The ice processes study in 2013/2014 is planning repeat aerial observations at each focus area, about 10 transects will be measured for ice thickness, frazil thickness, and water depth, and time-lapse photography will be taken of a small portion of the area, including open-leads. For all of the Focus Areas, ice thickness and elevation will be measured and inlets to side channels and sloughs will be observed to qualitatively document any throughflow. Throughflow discharges will be taken but only at the major side channels. The feasibility and application of ground penetrating radar (GPR) will be investigated to determine if it will provide sufficient resolution to determine frazil ice accumulations. This would provide broader and more continuous measure of bed-fast ice thickness and floating solid ice thickness, than relying on auger holes.

Factors that affect fish passage are much more difficult to physically measure and much more difficult to model for ice-cover than for ice-free conditions. The controlling forces over depth, velocity, and the presence of potential obstructions are much different in ice-cover versus ice-free conditions. Ice formation, including surface ice, frazil ice, and anchor ice can all physically obstruct access into and out of off-channel habitats. Ice formations can reroute water flow, thereby dewatering an access passageway that would otherwise be present under ice-free conditions. An example of this is the blockage of water flow to an inlet of a side slough or side channel, such that slough outflow is then insufficient for fish to access the off-channel habitat. Localized passage conditions, such as a shllow riffle at the entrance of a slough, are extremely dynamic and are virtually unpredictable during ice-cover periods. The presence of frazil and structure ice appears or disappears in a matter of hours or days; likely opening up or closing fish passageways at the same frequency. Passage opportunities might be improved at some locations during winter Project operation due to the projected increase in river stage while at other locations increase in stage might contribute to the degradation of passage conditions (ice thickening at the inlets and outlets of off-channels).

These difficulties and uncertainties are noted here to bring attention to the difference in scale between evaluations of fish passage in ice-cover versus ice-free conditions. Passage conditions during ice-free periods can be observed and measured directly and modeled to the micro scale (tenths of feet and velocity). Whereas, passage conditions during ice-cover periods are generally not visible, very difficult to measure (the areal extent of the sample site might be the diameter of an ice auger bit), and are modelable at a lesser resolution.

While ice-process modeling and winter Focus Area studies may provide some information at the micro scale, they will likely be more useful for predicting and evaluating potential structural, spatial, and temporal changes to fish passage at the macro scale. Some macro scale evaluations during the ice-cover period include:

- Potential change in the timing of ice formation and breakup in relation to migration periodicities of juvenile salmonids;
- Potential change in the thickness and elevation of ice at the inlets and outlets of off-channels and tributary deltas;
- Potential for blockages created by unstable or thickened ice from frequent flow fluctuations;

- Potential changes in the formation and longevity of ice-free leads at slough entrances;
- Potential changes in the depth of ice cover into and within off-channel habitats; i.e. changes in passageways beneath the ice; and
- Potential changes in ice-process in sloughs due to changes in the dominant source of through flow.

AEA sees this research approach as a viable application of current, reasonably feasible scientific application to address the issue. AEA does not propose any hydrodynamic or ice modeling under RSP 9.12 for this study element. All hydrodynamic or ice modeling will be conducted as proposed in other RSP's, as described above.

7.4. Description of Ice-free Off-channel and Tributary Delta Study Sites

A description of a subsample of tributary deltas and off-channel habitat entrances within Middle River focus areas where velocity measurements will be taken to determine if velocity barriers to juvenile salmonids (particularly salmonid fry) would be created at tributary deltas and off-channel habitat entrances by modifications to river stage and discharge through proposed project operations.

As recommended by FERC, AEA will locate fish passage study sites in Focus Areas. As described in RSP 6.6, Section 6.6.1.2.4, the use of Focus Areas is to conduct concentrated interdisciplinary studies at selected areas within the study area. Such areas represent specific sections of the river that will be investigated across resource disciplines and will provide for an overall understanding of interrelationships of river flow dynamics on the physical, chemical, and biological factors that influence fish habitat. Focus Areas will involve portions of the Susitna River and its floodplain where detailed study efforts will be jointly conducted by the Fish and Aquatics Instream Flow (RSP 8.5), Riparian Instream Flow (RSP 8.6), Geomorphology (RSP 6.5), Ice Processes (RSP7.6), Groundwater (RSP 7.5), Characterization and Mapping of Aquatic Habitats (Section 9.9) studies, and Fish Passage Barriers (RSP 9.12). The Focus Areas will allow for a highly integrated, multidisciplinary effort to be conducted for evaluating potential Project effects on key resource areas across a range of representative sites.

As required by FERC, final selection of ten Focus Areas will be completed by May 31, 2013 (2013b).

FERC (2013b) states:

We recommend that AEA: (1) consult with the TWG and select an appropriate focus area within MR-2 to eliminate from the study; (2) consult with the TWG and establish an additional focus area in geomorphic reach MR-7 that is sufficient for conducting interdisciplinary studies, possibly near Lower McKenzie Creek or below Curry on old Oxbow II; and (3) file a detailed description of the changes to the proposed focus area locations in MR-2 and MR-7 by May 31, 2013, and include in the filing documentation of consultation with NMFS, FWS, and Alaska DFG, including how the agency comments were addressed.

The ten Focus Areas under consideration include a large number and diversity of side channels, side sloughs, upland sloughs, and tributary deltas that in sum would be representative of passage conditions at off-channel and tributary deltas in the Middle River. The ten Focus Areas being considered include a total of 34 side channels, 8 side sloughs (one with a beaver pond), 13 upland sloughs (one with a beaver pond), 2 macrohabitat backwaters, and 10 tributary mouths/deltas. The inlets to these off-channel habitats will be modeled using 2D or 1D hydraulic models as described in Section 6.3, above. Table 1 is a tally of off-channel and tributary deltas by Focus Area. The domain for 2D modeling for each off-channel will extend from the mouth up to and including the inlet or head of each off-channel as illustrated in Figure 5. This domain will cover the fish entrance to the off-channel and breaching zone of the off channel, as well as the entire length of the channel. The 2D modeling domain for tributary deltas will include the entire delta within the zone of hydrologic influence.

Final hydrodynamic model selection in Focus Areas will occur as part of RSP 6.6 and 8.5 study plan determination and modification process.

FERC (2013b) states:

> *Both one-dimensional and two-dimensional modeling approaches are consistent with accepted practices for implementing an instream flow study using PHABSIM (section 5.9(b)(6)). We note, however, that AEA does not identify in the RSP the specific locations where one-dimensional versus two-dimensional modeling would be applied, except for noting that two-dimensional modeling would be applied within some focus areas. NMFS is concerned that there may be disagreements about the selection of the appropriate habitat-specific models and the specific locations where one-dimensional and two-dimensional modeling would be applied. In our analysis and recommendations for Study 6.6 (geomorphology modeling), we are recommending that AEA file by the end of the second quarter of 2013, its proposed technical memorandum that summarizes the specific models and locations where one-dimensional and two-dimensional modeling would be applied pursuant to Study 8.5 and Study 6.6.*

AEA does not propose any data collection or hydrodynamic modeling under RSP 9.12 for this study element. All data collection and hydrodynamic modeling will be conducted as proposed in other RSPs, as described above.

7.5. Identification and Location of Existing Physical Barriers to Fish Passage

This study element is in accordance with the first two goals and objectives of RSP 9.12.

1. Locate and categorize all existing fish passage barriers (e.g., falls, cascade, beaver dam, road or railroad crossings) located in selected tributaries in the Middle and Upper Susitna River (Middle River tributaries to be determined during study refinement).
2. Identify and locate using GPS the type (permanent, temporary, seasonal, partial) and characterize the physical nature of any existing fish barriers located within the Project's zone of hydrologic influence.

7.5.1. Middle and Upper River

Tributaries above Devils Canyon (inclusive and upstream of Cheechako Creek) were surveyed by helicopter in 2012, followed by ground surveys of some barriers that could not be positively classified as a barrier from the air. Methods and results of these surveys are reported in AEA (2013b) 2012 Upper Susitna River Fish Distribution and Habitat Study, Fish Passage Barriers Assessment.

Seventy-nine drainages were surveyed throughout the study area between Devils Canyon and Oshetna River. A total of 43 potential fish passage barriers were identified from the helicopter within 29 of the 79 drainages surveyed (more than one barrier was identified on some tributaries). Of these 43 barriers, a total of 35 definitive passage barriers were identified within 24 tributaries, the majority of which had falls with a vertical height greater than 10 feet and that could be visually estimated from the helicopter. Three of the 35 barriers were surveyed from the ground with a range finder to determine vertical and horizontal distances from the crest to the plunge pool and were confirmed as barriers to fish passage. An additional 8 features, within 7 tributaries, were identified as potential fish passage barriers having falls heights visually estimated to be near 10 feet or other apparent elements of passage barriers such as multiple chutes and/or cascades and warranted further investigation; however, their challenging locations in canyons precluded safely landing the helicopter for ground surveys.

During the 2013 and 2014 study seasons, subject to obtaining access authorization and necessary permits, AEA will attempt on-the-ground measurement of the 8 features that could not be positively identified from the air in 2012. On-the-ground measurement will depend on reasonably safe access. Accessible features will be measured using the methods as described in Alaska Department of Natural Resources (ADNR 2007) and Powers and Orsborn (1984). The geometry of the obstacle will be surveyed including measurements of barrier height, leap distance, and depth of leaping pool at an estimated high and low flow. The barrier will be photographed and its location fixed with GPS. If the obstacle is clearly not a barrier, its location and basic dimensions will be noted with no further measurements.

Also, during the 2013 and 2014 study seasons, subject to obtaining access authorization and necessary permits, AEA will determine the crest elevation of all barriers within the inundation zone and will measure on-the-gound dimensions of barriers within the reservoir elevation varial zone. On-the-ground measurements assume reasonably safe access.

AEA proposes to conduct foot surveys for physical barriers and intensive hydrodynamic modeling studies for velocity and depth barriers within the zone of hydrologic influence at 20 named and unnamed tributaries in the Middle River below Devils Canyon (Table 2). This will include intensive study of ten tributary deltas in Focus Areas as described above in sections 7.2, 7.3, and 7.4. In 2013, AEA proposes to conduct foot surveys for physical barriers within the ZHI of the remaining 10 primary Middle River tributaries below Devils Canyon (Table 2). Foot survey field methods will be those described in RSP 9.12, Section 9.12.4.4.4. In addition to methods described in RSP Section 9.12.4.4.4, data collection on deltas of these 10 tributaries will include: tributary thalweg length; thalweg depth and velocity profile (longitudinal), stream gradient; dominant and subdominant substrate; and photographs from several angles of the delta and tributary. Several of these tributaries will be gaged (Table 2).

7.6. Study of Fish Passage Barriers in the Lower River

Investigation and evaluation of fish passage barriers in the Lower River will follow a phased approach in which studies of barriers in the Middle River will be used to determine the need and design for 2014 barrier studies in the Lower River (FERC 2013a). Other studies to be conducted in 2013 that will contribute to determining the need for barrier studies in the Lower River are RSP 9.6 – Fish Distribution and Abundance in the Middle and Lower Rivers, RSP 8.5 – Fish and Aquatics Instream Flow Study, RSP 6.5 – Geomorphology Study, and the Flow Routing Model (RSP 8.5). If 2013 results, as presented in the Initial Study Report, indicate that the Project will cause significant adverse effects on fish passage into tributaries and off-channel habitats in the Middle River then additional study sites will be added in the Lower River in 2014, or in subsequent study years (FERC 2013a).

7.7. Documentation of Consultation

Documentation that a draft plan and schedule were provided to FWS, NMFS, and any other TWG participants at least 30 days prior to the due date of the plan and schedule (allowing at least 15 days for comment); a description of how FWS', NMFS', or other TWG participant's comments are incorporated into the final plan; and an explanation for why any of FWS', NMFS', or other TWG participant's comments are not incorporated into the final plan.

This section will be completed by AEA prior to submission of the final implementation plan to FERC.

8. REFERENCES CITED

ADF&G (1984b). Susitna Hydro Aquatic Studies, Report No.3: Aquatic habitat and instream flow investigations, May - October 1983 (Review Draft). Chapter 6: An evaluation of passage conditions for adult salmon in sloughs and side channels of the Middle Susitna River. Prepared for Alaska Power Authority, Anchorage, AK.

AEA (Alaska Energy Authority). 2012. Susitna-Watana Hydroelectric Project No 14241-000. Revised Study Plan (RSP) submitted to FERC December 2012.

—. 2013a. R2 Resource Consultants PowerPoint presentation – slide 23. Update on Habitat Suitability Criteria Development. March 27, 2013 Technical Workgroup Meeting, Anchorage, AK.

—. 2013b. Susitna-Watana Hydroelectric Project No 14241-000. First Year Study Report – 2012 Upper Susitna River Fish Distribution and Habitat Study - Fish Passage Barriers Assessment.

—. 2013c. First Year Study Report – 2012 Adult Salmon Distribution and Habitat Utilization Study.

—. 2013d. Susitna-Watana Hydroelectric Project No 14241-000. First Year Study Report – 2012 Open Water HEC-RAS Flow Routing Model.

— 2013e. Susitna-Watana Hydroelectric Project No 14241-000. Technical Memorandum. Selection of Focus Areas and Sites in the Middle and Lower Susitna River for Instream Flow and Joint Resources Studies – 2013 -2014. March 1, 2013.

FERC (Federal Energy Regulatory Commission). Office of Energy Projects. 2013a. February 01, 2013 Study Plan Determination for the Susitna-Watana Hydroelectric Project No 14241-000. Federal Energy Regulatory Commission.

— . 2013b. April 01, 2013 Study Plan Determination for the Susitna-Watana Hydroelectric Project No 14241-000. Federal Energy Regulatory Commission.

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9. TABLES

Table 1. Tally of off-channel habiats and tributary deltas in Middle River Focus Areas.

Focus Area	Side Channel	Side Slough	Upland Slough	Backwater	Tributary Mouth	Total
104	7	2	1		1	11
113	2		1		2	5
115	1		3	1	1	6
128	8	1	1		1	11
138	3	1	2			6
141	1		1	1	1	4
144	6	1	2		1	10
151					1	1
173	4	3	2		2	11
184	2					2
Total	34	8	13	2	10	67

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Table 2. Named and unnamed tributaries in the Middle River selected for fish passage barrier investigation.

Project Rivemile (PRM)	Tributary Name	Geomorphic Reach	Focus Area	Intensive Study in Focus Area	Identify and Locate Potential Barriers in ZHI[1]	Documented in Anadromous Waters Catalog	Historical Data Available	Proposed for FDA Fish Sampling in 2013	Approximate Length of ZHI[1] (mi)	Drainage Area (mi[2])
184.6	Tsusena Creek	MR-2			2012		X	Yes		145.3
179.3	Fog Creek	MR-2			2012	X	X	Yes		144.1
174.3	Unnamed	MR-2	FA173	X	2012			No		
173.8	Unnamed	MR-2	FA173	X	2012			Possible		
164.8	Devil Creek	MR-4			2012		X	Yes		74.8
160.5	Chinook Creek	MR-4			2012	X	X	Yes		24.7
155.9	Cheechako Creek	MR-4			2012	X	X	Yes		
152.3	Portage Creek	MR-5	FA151	X		X	X	Yes	0.19	178.6
148.3	Jack Long Creek	MR-6			X	X	X	Yes	0.03	
144.6	Unnamed	MR-6	FA144	X				Yes	0.01	
142.1	Indian River	MR-6	FA141	X		X	X	Yes	0.14	86.2
140.1	Gold Creek	MR-6			X	X	X	Yes	0.15	23.7
134.3	Fourth of July	MR-6			X	X	X	Yes	0.12	
134.1	Sherman Creek	MR-6			X	X	X	Yes	0.02	
128.1	Skull Creek	MR-6	FA128	X		X	X	Yes	0.04	
127.3	Fifth of July Creek	MR-6			X	X	X	Yes	0.01	
124.4	Deadhorse Creek	MR-6			X	X	X	Yes	0.18	6.5
121.4	Little Portage	MR-7			X	X	X	Yes	0.12	2.4
120.2	McKenzie Creek	MR-7			X	X	X	Yes	0.02	2.3
119.7	Lower McKenzie	MR-7			X		X	Yes	0.16	
117.2	Lane Creek	MR-7			X	X	X	Yes	0.11	10.4
115.4	Unnamed	MR-7	FA115	X				Yes	0.12	
115.0	Gash Creek	MR-7	FA 113	X		X	X	Yes	0.01	
114.9	Slash Creek	MR-7	FA 113	X		X	X	Yes	0.02	
113.7	Unnamed	MR7	FA 113	X						
110.5	Chase Creek	MR-7			X	X	X	Yes	0.17	
105.1	Whiskers Creek	MR-8	FA104	X		X	X	Yes	0.33	17.2

DRAFT

10. FIGURES

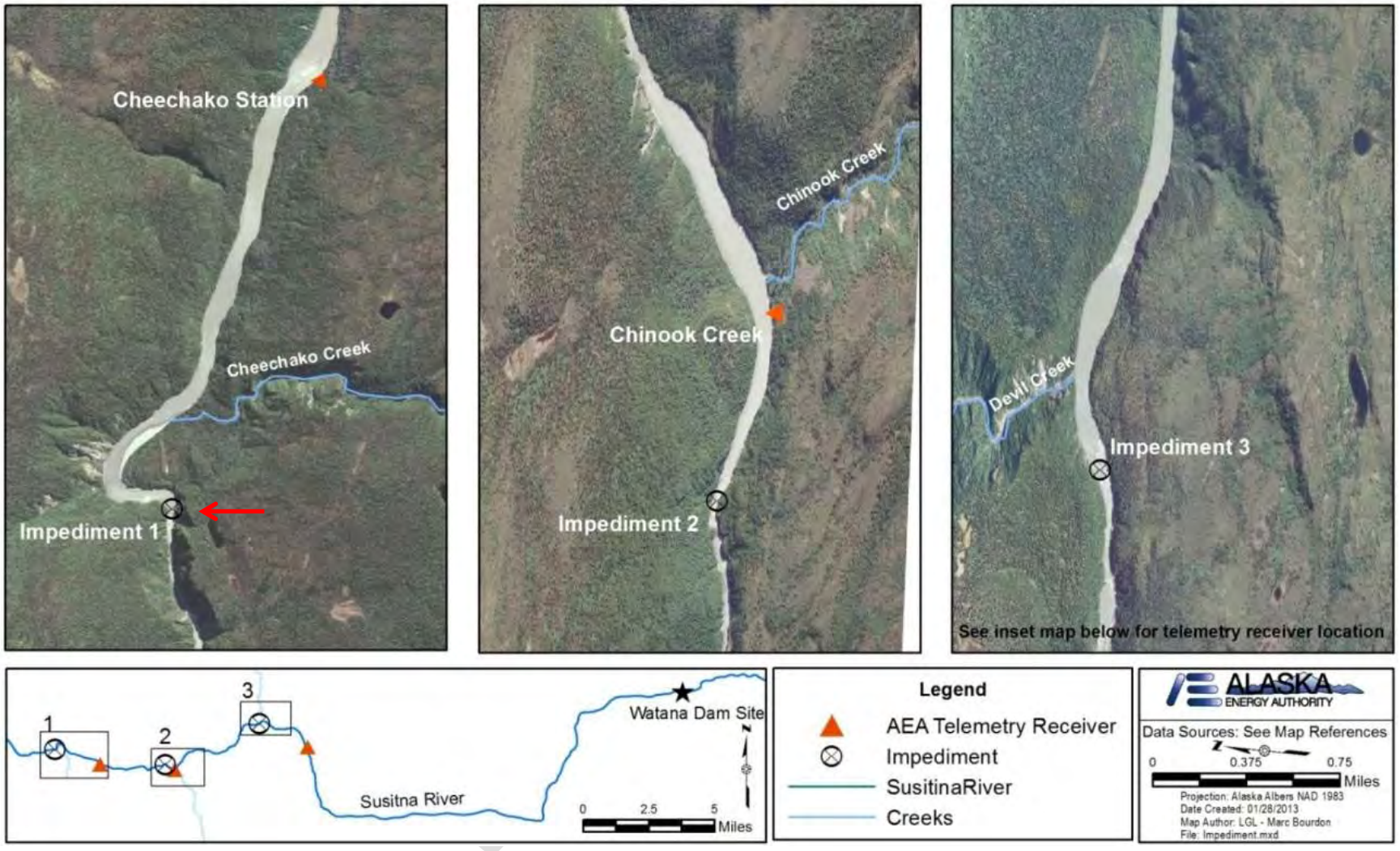

Figure 1a. Three potential impediment areas (Impediments 1, 2, and 3) to fish passage on the Susitna River located between Portage and Devil creeks at the top end of the Middle River Segment (AEA 2013c).

Figure 1b. Example of a location within Impediment area 1 where a velocity barrier could be created at a high river discharge. Photo at PRM 154.8, September 11, 2012, at 11,600cfs (provisional) at Gold Creek.

Proposed HSC Curve Development Priority23

Common Name	Low	Moderate	High
Arctic grayling			X
Dolly Varden		X	
Humpback whitefish		X	
Round whitefish	X		
Burbot		X	
Longnose sucker		X	
Sculpin	X		
Eulachon		X	
Bering cisco	X		
Threespine stickleback	X		
Arctic lamprey	X		
Chinook salmon			X
Coho salmon			X
Chum salmon			X
Pink salmon			X
Sockeye salmon			X
Rainbow trout			X
Northern pike	X		
Lake trout	X		

Figure 2. Proposed HSC curve development priority (AEA 2013a).

Figure 3. Example of proposed winter fish habitat use sampling sites at the Skull Creek Complex in the Middle Susitna River Segment (AEA 2013e).

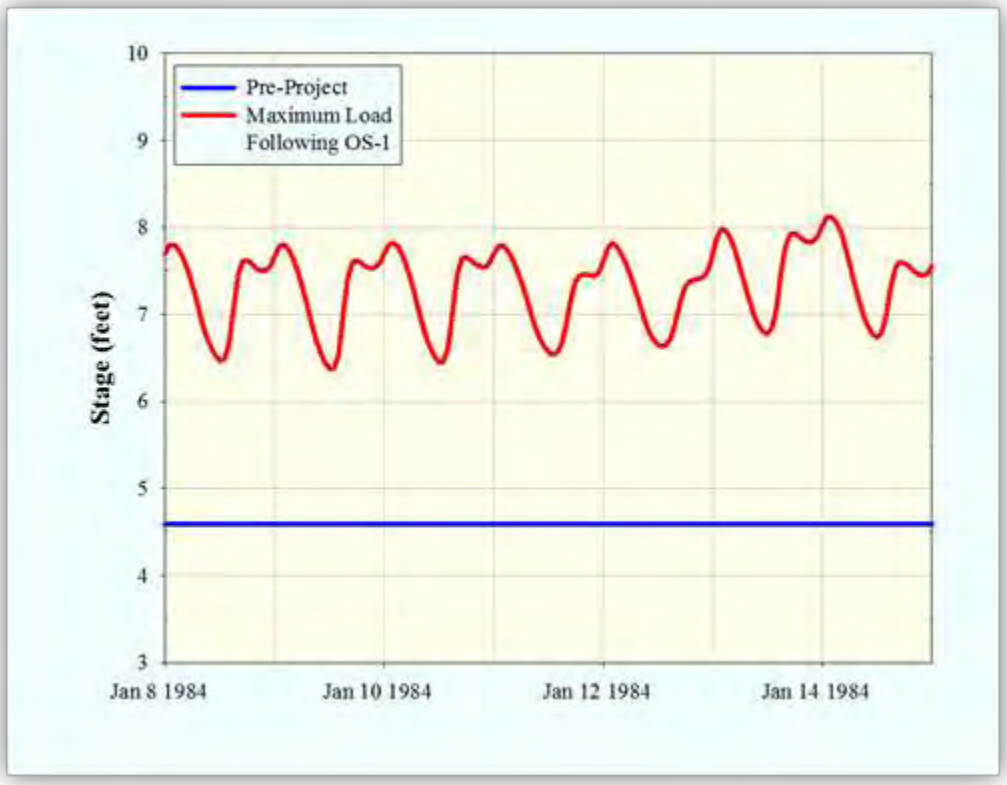

Figure 4. Predicted stage hydrographs in the Susitna River at Gold Creek (USGS 15292000) under Pre-Project and Maximum Load Following OS-1 conditions during the week of January 8 to 14, 1984. Actual results may differ from those depicted as a result of ice formation in the river (AEA 2013d).

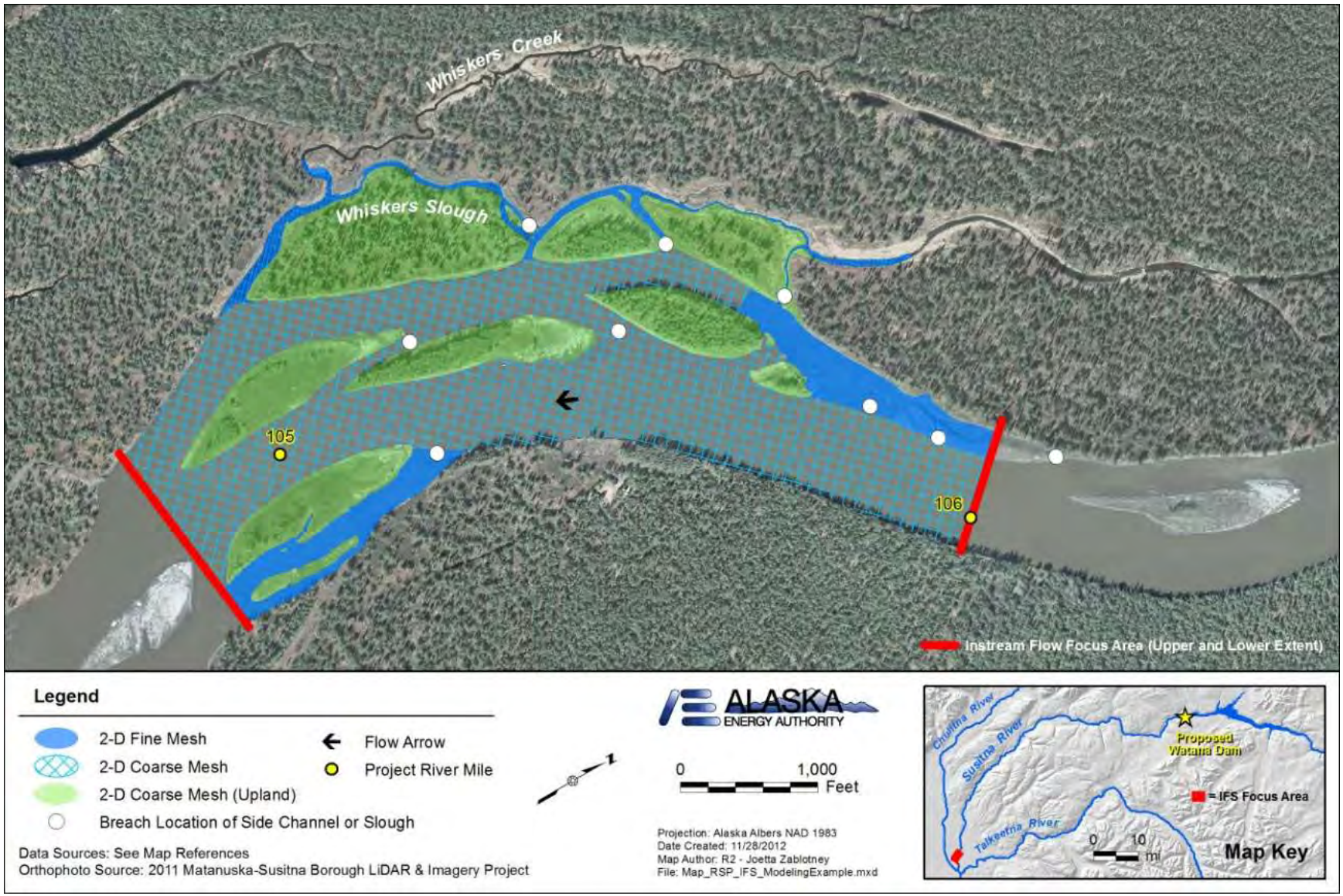

Figure 5. Conceptual layout of 2-D coarse and fine mesh modeling within the proposed Whiskers Slough Focus Area.