ATTACHMENT 1

Proposed Study Plan

Susitna-Watana Hydroelectric Project

Susitna-Watana Instream Flow Study (SWIFS)
2013-2014 Study Plans

Alaska Energy Authority

Draft Version – March 20, 2012

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1. INTRODUCTION

The Alaska Energy Authority (AEA) is preparing a License Application that will be submitted to the Federal Energy Regulatory Commission (FERC) for the Susitna-Watana Hydroelectric Project (Project) using the Integrated Licensing Process (ILP). The Project is located on the Susitna River, an approximately 300-mile long river in the Southcentral region of Alaska. The Project's dam site will be located at River Mile (RM) 184. The proposed Project would be located on the Susitna River at RM 184, which is roughly 90 river miles northeast of the community of Talkeetna. As currently envisioned, the Project would include a large dam with a 20,000-acre (ac), 39-mi long reservoir. The type and height of dam construction are still being evaluated as part of on-going engineering feasibility studies, but early comparisons have demonstrated that it will most likely be a roller-compacted concrete structure. The dam has a nominal crest elevation at elevation (El.) 2,025 ft mean sea level (msl) corresponding with a maximum height of approximately 700 ft above the foundation and a crest length of approximately 2,700 ft. Following completion of the studies mentioned above, a nominal crest elevation up to El. 2,125 ft msl may be proposed in the license application, corresponding to a maximum dam height of up to 800 ft above the foundation. Preliminary studies have indicated the surface powerhouse should have three generating units and have a nominal installed capacity of 600 megawatts (MW). However, optimization studies are ongoing and the capacity of the Project eventually proposed for licensing could extend up to 800 MW.

Project construction and operation, as described in the Pre-application Document (PAD, AEA 2011), would have an effect on the flows downstream of the dam, the degree of which will ultimately depend on its' final design and operating characteristics. With a proposed elevation of 700 ft resulting in the creation of a 39 mi. long reservoir (20,000 acre) and a nominal generating capacity of 600 MW (PAD AEA 2011), the project would potentially change the timing and magnitude of flows in the river below the powerhouse. The potential alteration in the timing and magnitude of flows in a river can influence downstream resources/processes, including fish and aquatic biota and their habitats, channel form and function including sediment transport, water quality, ice dynamics and riparian and wildlife communities, all of which have been alluded to in the PAD (AEA 2011).

The potential operational flow induced effects of the Project will need to be carefully evaluated as part of the licensing process. This study plan describes the Susitna-Watana Instream Flow Study (SWIFS) that will be conducted to characterize and evaluate these effects. The plan includes a statement of objectives, a description of the technical framework that is at the foundation of the SWIFS, the general methods that will be applied, and the study nexus to the

Project. This plan should be viewed as preliminary and will be subject to revision and refinements based on agency and stakeholder review and comment. In particular, at this stage in its development, the SWIFS has not identified specific study sites nor the methods and analytical procedures that will be applied to the study. These details and others will be added subsequent to further review of existing information and via agency discussions. The results of this study and of other proposed studies will provide information needed to support the FERC's National Environmental Policy Act (NEPA) analysis for the Project license.

2. SUSITNA RIVER REACHES

The Susitna River has been characterized into three segments corresponding to an Upper River segment representing that portion of the watershed above the Watana Dam site at River Mile 184; a Middle River segment (extending from RM 184 downstream through Devil Canyon ending at RM 94 to the confluence of the Chulitna River) representing the section of river immediately below the Project that would likely experience the greatest effects of flow regulation caused by Project operations; and a Lower River segment (extending from the Chulitna River [RM 94] to Cook Inlet [RM 0]) that is over 90 miles downstream of the Project and which receives inflows from two large river systems that would likely serve to mollify to some extent the effects of flow regulation (Figure 1). These segments were described in the Aquatics Data Gap Report prepared by HDR (2011) as summarized below.

UPPER RIVER

The "upper river includes the upper Susitna and McLaren Rivers, which arise directly from large temperate glaciers of the Alaska Range. Their upper reaches traverse the wide valley south of the Alaska Range in broad, braided channels. Approximately 60 miles downstream, the Tyone River, draining the Lake Louise and Susitna Lake basins, and the Oshetna River, draining the northern Talkeetna Mountains, join the Susitna. The river then turns 90 degrees towards the west and enters Vee Canyon. Through the Vee and Watana Canyons, the river is mostly confined to a single thread channel characterized by a series of rapids.

MIDDLE RIVER

The "middle river" encompasses the 90-mile reach between the proposed Watana Dam site and the Chulitna River confluence, located at RM 94. The river flows from Watana Canyon into Devil Canyon, the narrowest and steepest gradient reach on the Susitna River. In Devil Canyon, constriction creates extreme hydraulic conditions including deep plunge pools, drops, and high velocities. The Devil Canyon rapids form a partial barrier to the migration of anadromous fish; only a few adult Chinook salmon have been observed upstream of Devil Canyon. Downstream of Devil Canyon, the middle Susitna River widens but remains essentially a single channel with stable islands, occasional side channels, and sloughs.

LOWER RIVER

The "lower river" describes the approximate 94-mile reach between the Chulitna River confluence and Cook Inlet (RM 0). An abrupt change in channel form occurs where the Chulitna River joins the Susitna River near the town of Talkeetna. The Chulitna River drains a smaller area than the middle Susitna River at the confluence, but drains higher elevations (including Denali and Mount Foraker) and many more glaciers. 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. For several miles downstream of the 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 planforms with multiple side channels and sloughs. Major tributaries drain the western Talkeetna Mountains (the Talkeetna River, Montana Creek, Willow Creek, Kashwitna River), the Susitna lowlands (Deshka River), and the Alaska Range (Yentna River). The Yentna River is the largest lower river tributary, supplying about 40 percent of the mean annual flow at the mouth.

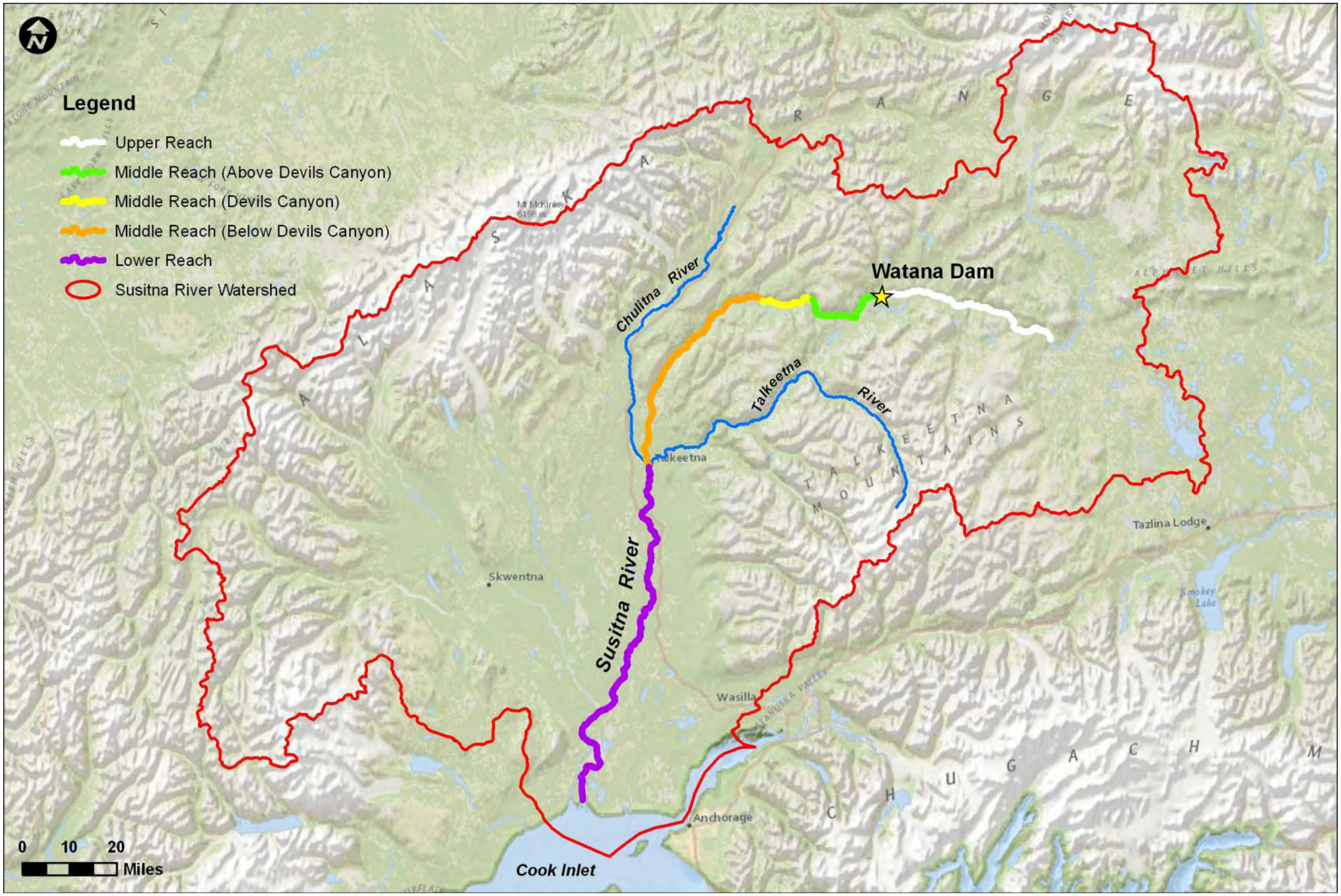

Figure 1. Map of the Susitna River influenced by Susitna-Watana Hydroelectric Project

3. HABITAT TYPES

During the 1980s studies, the riverine related habitats of the Susitna River were divided into six macro-habitat categories consisting of mainstem, side channel, side slough, upland slough, tributaries, and tributary mouths (Harza-Ebasco 1985). The distribution and frequency of these habitats varies longitudinally within the river depending in large part on its confinement by adjoining floodplain areas, size, and gradient. These habitat feature types are depicted in Figure 2 which was taken from ADFG (1983) and Trihey (1982); the habitat types were described with respect to mainstem flow influence byHDR (2011) as follows:

- **Mainstem Habitats - S**ensitive to changes in main stem discharge since habitat conditions in terms of surface area, depth, and velocity vary continuously with discharge.
- **Side channels -** Less sensitive but are directly affected by mainstem discharge sufficient to breach the upstream ends of the channels. In general, side channels convey mainstem water more than 50 percent of the time during the summer, open water season.
- **Side sloughs -** Less responsive to mainstem discharge changes since flows sufficiently great to breach the upstream ends occur less than 50 percent of the time during the open water season. However, at lower discharge levels, the mainstem discharge may affect slough habitat conditions, particularly at the mouths, through backwater effects. Mainstem discharge less than that sufficient to breach the upstream end may also affect habitat conditions through the influence on groundwater upwelling.
- **Upland sloughs -** Relatively insensitive to mainstem discharge. The major effects on upland sloughs related to mainstem flow are changes in surface area, velocity, and depth due to backwater effects. Changes in mainstem discharge generally will not affect discharge or water quality parameters in the upland slough.
- **Tributaries -** Although continuous with the mainstem, tributary flows are not affected by changes in mainstem discharge. Although habitat conditions in the main channels of the tributaries are dependent only upon tributary discharge, the delta areas of the tributaries are in part influenced by mainstem flows.
- **Tributary mouth (and associated delta - *added*) -** Habitats occur at the confluence of the tributaries with the mainstem. The aerial extent of this habitat type is dependent not only upon mainstem discharge but also on tributary discharge. To some extent both mainstem and tributary discharge will affect the specific location of this habitat type.

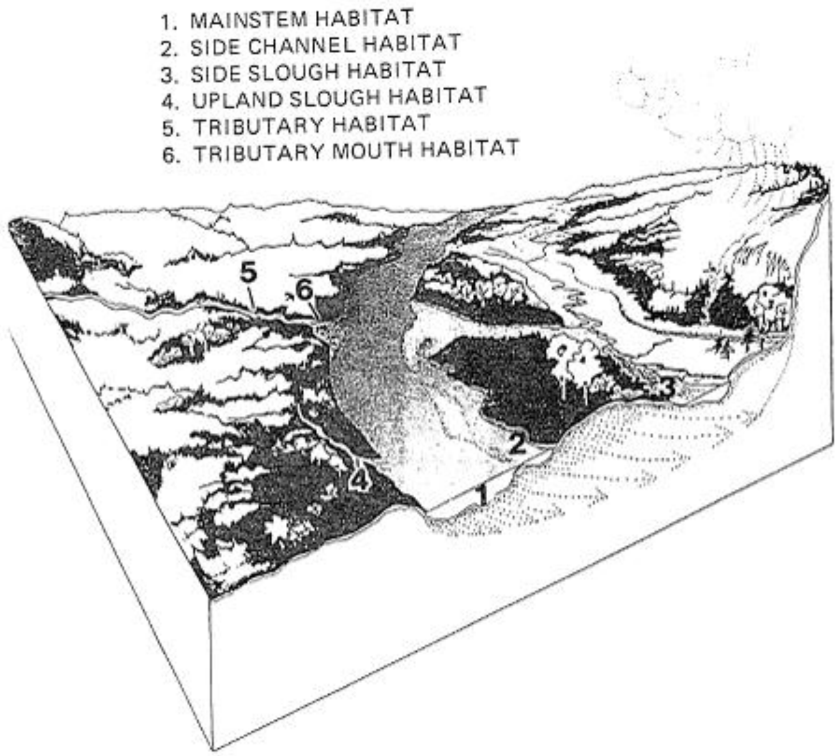

Figure 2. Habitat types identified in the middle reach of the Susitna River during the 1980s studies.

The studies completed in the 1980s demonstrated that these habitat types are utilized to varying degrees and at different times by different species, with some species seeming to prefer certain habitat types over others (Dugan et al. 1984). Importantly, there will likely be both inter- and intra- habitat:flow response differences between and among these habitat types, and each will require separate investigation. Fortunately, many of the studies conducted in the 1980s were directed toward understanding those relationships (e.g., Marshall et al. 1984) and thus, there is already an existing pool of information and data that will be applied in the development of the 2013-2014 studies.

4. FOCUS OF SWIFS

The 2013-2014 SWIFS plan is specifically directed toward establishing a contemporary understanding of important biological communities and associated habitats, and the hydrologic, physical, and chemical processes that are currently operating in the Susitna River that directly influence those resources. The focus of much of this work will be on establishing a set of analytical tools/models based on the best available information and data that can be used for defining both baseline conditions; i.e., how these resources are currently functioning under existing flow conditions, and how these resources and processes will respond to various alternative Project operations.

A foundation of the SWIFS analyses rests with the development of the Susitna Mainstem Flow Routing Model (HEC-ResSim; HEC-RAS; and/or other routing model) (MFRM) that will provide hourly flow and water surface elevation data at numerous locations longitudinally distributed throughout the length of the river extending from RM 184 downstream. A routing model will be developed based on transects that will be established and measured in 2012 as part the SWIFS program. There are currently 98 cross-sections proposed for measurement in 2012 extending from RM 184 downstream to RM 75 located approximately 22 miles downstream of the three rivers confluence (confluence of Chulitna River, Talkeetna River, and Susitna River); additional cross-sections may be added to capture specific features. Further data may be collected in 2013-2014 as necessary to refine the model. The output from this model will provide the fundamental input data to a suite of habitat specific and riverine process specific models that will be used to describe how the existing flow regime relates to and has influenced various resource elements (e.g., salmonid spawning and rearing habitats, invertebrate habitat, sediment transport processes, ice dynamics, large woody debris (LWD), the health and composition of the riparian zone). These same models will likewise be used to evaluate resource responses to different Project operational scenarios, again via output from the Routing Model, including various baseload and load following alternatives, as appropriate. As an unsteady flow model, the Routing Model will be capable of providing flow and water surface elevation information at each location on an hourly basis and therefore Project effects on flow can be evaluated on multiple time steps (hourly, daily, monthly) as necessary to evaluate different resource elements.

5. SWIFS ANALYTICAL FRAMEWORK

Figure 3 depicts the analytical framework of the SWIFS commencing with the Reservoir Operations Model (ROM) that will be used to generate alternative operational scenarios under different hydrologies. The ROM will provide the input data to the MFRM that will be used to predict hourly flow and water surface elevation data at multiple points downstream, taking into account accretion and flow attenuation. Coincident with the development of the MRFM, a series of biological and riverine process studies will be completed (other studies) to supplement the information collected in the 1980s as necessary to define reliable relationships between mainstem flow and riverine processes and biological resources. This will result in development of a series of flow sensitive models (e.g., models of selected anadromous and resident fish habitats by species and life stage, models to describe invertebrate habitats, temperature model, ice model, sediment transport model, turbidity model, large woody debris (LWD) recruitment model, others) that will be able to translate effects of alternative Project operations on the respective processes and biological resources. These resource and process effects will be location and habitat specific (e.g., responses are expected to be different in side sloughs versus mainstem versus side channel versus tributary delta versus riparian habitats) but there will also be a cumulative effect that translates throughout the entire length of the Susitna River. Different Project operations will likely affect different habitats and processes differently, both spatially and temporally. The habitat and process models will therefore be spatially discrete (e.g., by site, reach) and yet able to be integrated to allow for a holistic evaluation of each alternative operational scenario. This will allow for an Integrated Resource Analysis of separate operational scenarios that includes each resource element, the results of which can serve in a feedback capacity leading to new or modifications of existing operations scenarios. This will be important for defining Project operations that are the most compatible with resource objectives.

The SWIFS plan is focused on development of macro-habitat specific models that can reliably estimate flow-habitat response patterns for different species and life stages of fish and other aquatic biota. This will include a mainstem aquatic habitat model, side channel models, one or more side slough models (may vary by flow activation level), and a tributary mouth and delta model; riparian models will also be developed but are the subject of a specific riparian study plan. These models represent the core tools that will be used for assessing changes in aquatic habitats under alternative Project operational scenarios. The conceptual framework for these tools is depicted in Figure 3.

Several of the Project fish and aquatic resource studies (F-S1, S2, S4 proposed for 2012 and new studies for 2013-2014) will provide biological information to the respective models. This will include:

- Species periodicity information
- Distribution of species
- Relative abundance and density

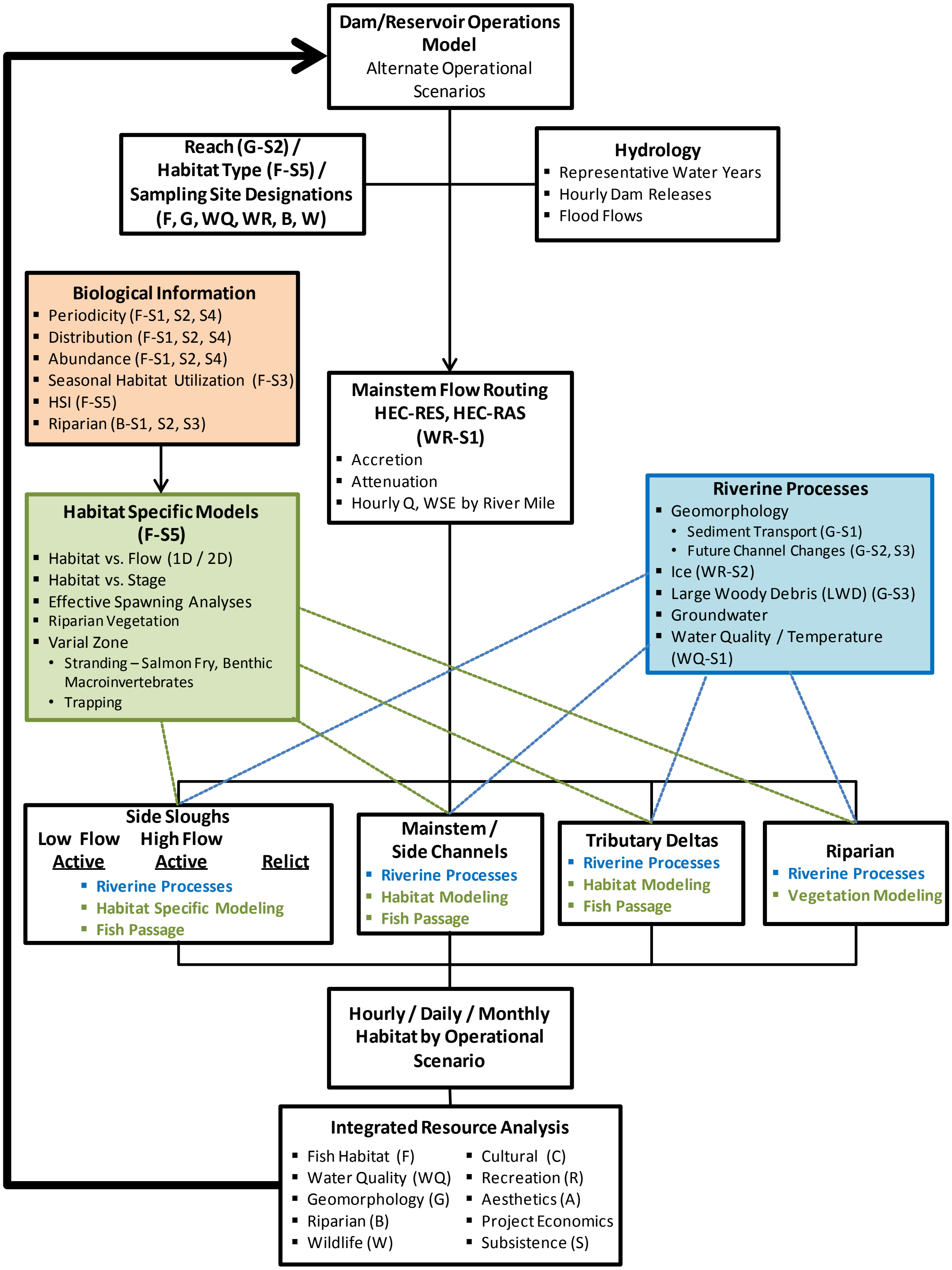

Figure 3. Conceptual framework for the Susitna –Watana Instream Flow Study (SWIFS) depicting linkages between habitat specific models and riverine processes that will lead to an integrated resource analysis.

- Habitat utilization over time (macro-and meso-habitat)
  - Adult migration (passage)
  - Adult holding
  - Spawning
  - Juvenile rearing (including overwintering)
- Habitat suitability data (microhabitat)

Fundamentally, these habitat specific models will provide a spatial and temporal representation of the physical characteristics considered biologically important as aquatic habitat in Susitna River. The physical characteristics considered in the model include (but are not limited to) the following:

- Water depth
- Water level fluctuations (including magnitude, frequency and rate of change)
- Water velocity
- Groundwater (upwelling/downwelling)
- Water temperature (temperature model)
- Substrate type (e.g., boulder, cobble, gravel, sand, fines, etc.)
- Cover for fish (including macrophytes, LWD, turbidity)

To the extent possible, groundwater –surface water interactions will be considered. These models will integrate the habitat-hydraulic modeling and biological information on the distribution, timing, abundance, and suitability of habitats to estimate a variety of metrics (habitat-flow responses, time series, habitat durations, passage conditions, varial zone areas and frequency of inundation and dewatering, incubation conditions [temperature]) that will be used to compare the effects of alternative operational scenarios.

These models may/will likely require different measurement techniques depending on habitat types, flow conditions, and logistical considerations. In some cases, these parameters will be estimated along transects selected to describe representative and distinct habitats. This transect data may serve as the basis for development of 1-D hydraulic models linked with habitat that can be used to develop habitat-flow relationships by species and life stage (e.g., PHABSIM). For areas of special ecological significance, a segment of an entire habitat type may be topographically mapped allowing development of 2 dimensional hydraulic models that can be linked with habitat. This will provide for a more detailed spatial characterization of habitats and how they change with flows. In other cases, a more direct, empirically based approach may be used for evaluating habitat-flow responses. This may involve repetitive measurements of a systematically established grid over representative habitat features, similar to what was done as part of the 1980s studies. Table 1 lists 13 sites that were modeled using a combination of techniques (PHABSIM-IFG-2 and IFG-4; RJHAB) and the flows that were then determined to be "overtopping" discharges (i.e., flows at which mainstem flow entered upstream ends of the respective habitat types). These sites are depicted in Figure 4.

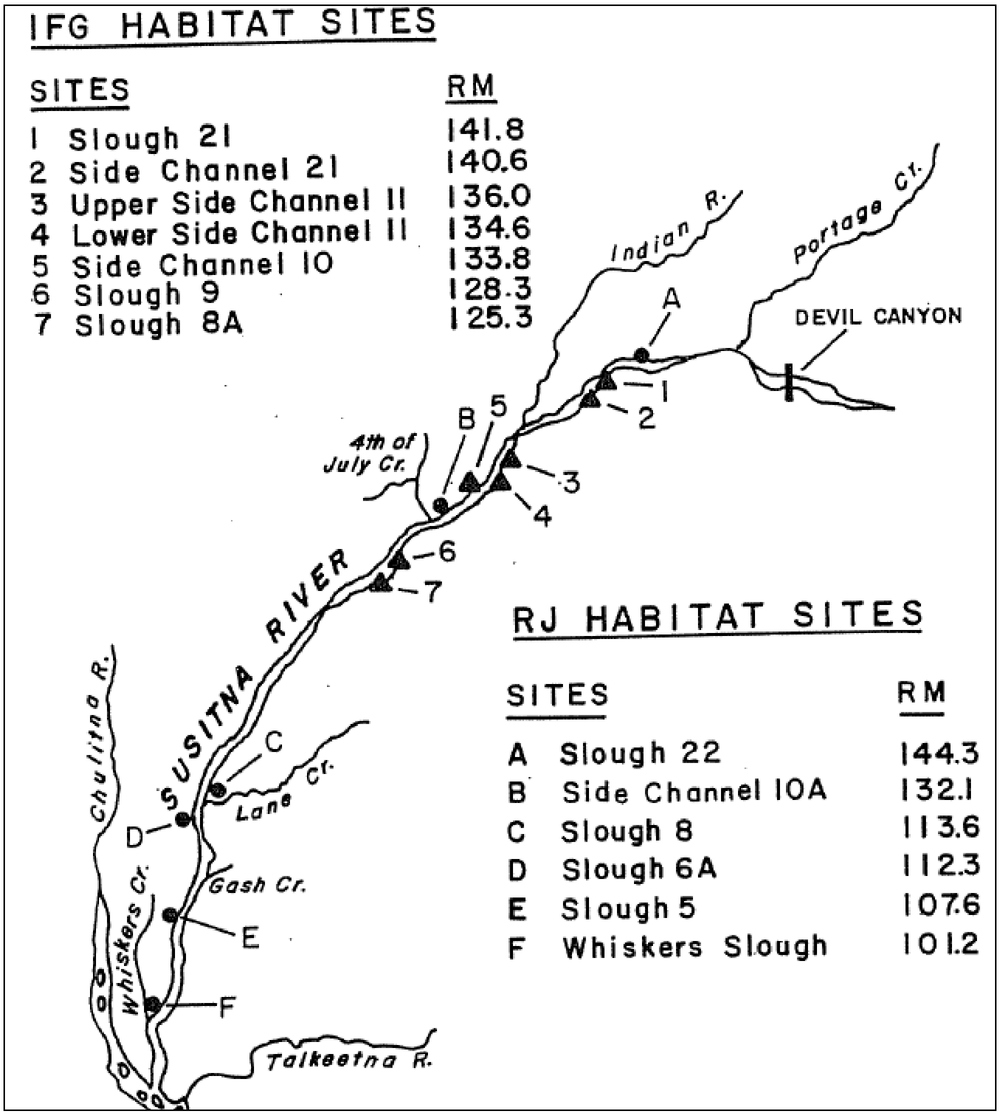

Figure 4. Location of sloughs and side channels modeled during 1980s studies. Source Estes and Vincent-Lang (1984).

Table 1. Selected sites measured and models applied in the reach of the Susitna River extending below Devil Canyon to Chulitna River during the 1980s studies. Source Estes and Vincent-Lang (1984). Mainstem flows that overtopped respective habitats are also displayed.

Site	Model Applied	Overtopping Discharge (cfs)
Lower side channel 11	IFG-2	5,000
Side channel 10A	RJHAB	9,000
Side channel 21	IFG-4	9,000
Upper side channel 11	IFG-4	13,000
Slough 9	IFG-4	16,000
Slough 21	IFG-4	18,000/23,000
Side channel 10	IFG-4	19,000
Slough 22	RJHAB	20,000
Whiskers Slough	RJHAB	22,000
Slough 8	RJHAB	25,000
Slough 8A	IFG-4	33,000
Slough 5	RJHAB	Upland slough
Slough 6A	RJHAB	Upland slough

It is anticipated that some/many of these sites as well as others that were surveyed in the 1980s will be re-surveyed during the 2013-2014 studies. Review of the 1980s studies reveals that site selection and methods applications were based on careful evaluations of site characteristics including the physical dimensions of habitats as well as their biological values. Methods were selected and used that provided for development of habitat-specific flow response relationships that were to be used for evaluating the 1980s Project and operations. Some of those same sites and same methods may again prove useful for evaluating project operations effects of the newly proposed Watana Hydroelectric Project. The 2013-2014 SWIFS plan will capitalize and build on the information, methods, and relationships developed from those studies. The 2012 studies are focused on the careful review of this information with the objective of determining to what extent existing data can be applied to the 2013-2014 studies. Given that the data were collected nearly 30 years ago, the 2013-2014 studies will initially focus on re-establishing a subset of the same study sites and will proceed with analytical methods that mirror those applied in the 1980s, as well as where applicable, application of more rigorous and contemporary methods. This will allow for a comparative assessment of methods and at the same time enable a temporal comparison of resulting habitat-flow relationships (i.e., relationships derived for a given site in the 1980s versus relationships under current conditions). Depending on results, this may serve to highlight certain types of habitats for which reliance on 1980s relationships is still valid, while for others, additional, more contemporary data are necessary. This analysis will also be useful in a geomorphologic context for comparing channel geometries over time, and assuming fish surveys will likewise be completed in these sites, comparisons of fish species composition and relative abundance.

The 2013-2014 SWIFS will also involve an independent process for selecting sites, collecting data and developing specific habitat-flow models. This will be completed using modern cartographic and topographic mapping techniques coupled with GIS and remote sensing and high resolution aerial photo imagery. This will result in a much finer level of reach stratification than was completed in the 1980s and will, in addition to possibly selecting some of the same sites as used in the 1980s, will also result in selection of new study sites representative of the different habitat types. The goal will be to select a representative and statistically significant number of study sites to assess and determine flow-habitat relationships within each that can be used to infer relationships in other sites with similar habitat types. Integration of these habitat-type specific models and associated habitat-flow relationships with other riverine process models will allow for a system-wide assessment of alternative Project operational effects.

The following study efforts provide information for, or are components to, the aquatic habitat specific models (see Figure 3).

- *Habitat Mapping* (this study plan). This study component inventories and maps current aquatic habitat types in the Susitna River. The results will be used for selecting the location of study sites and transects/study segments.
- *Hydraulic Routing Model* (this study plan). This model will be developed from bathymetry data collected in 2012 and used to translate output from the Scenario Tool to water surface elevations and mean column velocity at each of the transects in the mainstem aquatic habitat model on an hourly basis.
- *Habitat Specific Models (*this study plan). Models specific to each of the individual habitat types (e.g. mainstem, side channel, side slough, etc.) will be developed based on field methods best suited for those habitats.
- *Habitat Suitability Criteria/Indices (HSC/HSI) Studies*[1] (this study plan). The results of these study efforts will be depth, velocity, substrate, upwelling, cover, colonization and

[1] The abbreviation HSI is used in this document to refer to either Habitat Suitability Index (HSI) models or Habitat Suitability Curves (HSC), depending on the context. HSI models provide a quantitative relationship between numerous environmental variables and habitat suitability. An HSI model describes how well each habitat variable individually and collectively meets the habitat requirements of the target species and lifestage, under the structure of Habitat Evaluation Procedures (USFWS 1980). Alternatively, HSC are designed for use in the Instream Flow

dewatering habitat suitability indices (HSI) for selected fish species and life stages, and macroinvertebrates. Suitability is an index value from 0.0 to 1.0, where 1.0 is optimal. HSC information will be used to translate physical characteristics under the different operational scenarios to an index of the amount of potential habitat that is suitable for the selected species.

- *Tributary Delta Habitats in Susitna River (this study).* This study will develop models to describe the effects of Project operations on habitats within tributary deltas to the mainstem river, both within the inundation zone in the upper Susitna River (above Watana Dam) and in the middle and lower rivers (below Watana Dam). Because tributaries contain a source of water separate from the mainstem river, development of hydraulic models for these streams will not be necessary. However, the study will consider potential changes in delta channel morphologies under different operational scenarios.
- *Riverine Process Studies* (separate). Separate studies will be completed that will evaluate Project operational effects on a variety of riverine processes, including sediment transport, water quality, ice, geomorphology, large woody debris (LWD) and riparian ecology.
- *Fish Distribution, Timing, and Abundance Studies* (other studies). These studies provide biological information on fish distribution, abundance and periodicity in the Susitna River using passive and active sampling methods and biotelemetry.

6. STUDY PLAN ELEMENTS

6.1 Nexus Between Project Operations and Effects on Resources

As described above, the operational strategy of the Susitna-Watana Hydroelectric Project could result in a variety of flow responses to the river below Watana Dam. These may include daily and seasonal changes in river stage that would vary longitudinally along the river. Having a clear understanding of habitat – flow responses of different habitats and biological resources present in and that use the river will be critical to evaluating potential project effects.

Incremental Methodology to quantify changes in habitat under various flow regimes (Bovee et al. 1998). HSC describes the instream suitability of habitat variables related only to stream hydraulics and channel structure. Both HSC and HSI models are scaled to produce an index between 0 (unsuitable habitat) and 1 (optimal habitat). Both models and habitat index curves are hypotheses of species-habitat relationships and are intended to provide indicators of habitat change, not to directly quantify or predict the abundance of target organisms. For the Susitna-Watana Hydroelectric Project aquatic habitat studies, HSC (i.e., depth, velocity and substrate/cover) and HSI (i.e., turbidity, duration of inundation and dewatering) models will be integrated to analyze the effects of alternate operational scenarios.

6.2 AGENCY RESOURCE MANAGEMENT GOALS

Several natural resources agencies have jurisdiction over aquatic species and their habitats in the Project area. These agencies will be using in part, the results of the Susitna River Mainstem Instream Flow Studies and other fish and aquatic studies to satisfy their respective mandates. The following agencies have provided comments in the context of FERC relicensing of the Susitna-Watana Hydroelectric Project and agency management goals related to habitat for aquatic species.

6.2.1 ALASKA DEPARTMENT OF FISH AND GAME

- Develop flow-habitat relationships with ability to assess observed "patchy" distribution of chum & sockeye spawning and juvenile rearing integrating fish behavioral based analyses (feeding niches, distance to cover and water edges, ground water influences, and/or water quality preferences, etc.);
- Development of site-specific HSCs for identified target species and life stages that is representative of habitat types, seasonal distribution, and inter-annual variability;
- Evaluation of winter habitat needs for identified target species and life stages; and
- Evaluation of surface – ground water fluxes in a representative sample of habitats used by fish and paired controlled sites. Parameters to investigate include source of origin, rates of exchange over time and space, relationship with mainstem flows, and water quality over time and space.

6.2.2 NATIONAL MARINE FISHERIES SERVICE

From the February 29, 2012 letter to AEA:

- Explain how the 2012 information will inform the licensing study plans, including how results from all interrelated studies (Aquatics, Water Resources, Instream Flow) will interact functionally and how study results will be shared between interrelated investigations;
- Incorporate climate change study and consideration into many, if not all, of the studies proposed;
- Examine whether the division of the Susitna River into three reaches based on likely project effects remains valid.

Specifically for the Instream Flow Planning Study (F-S5):

- Review of the 1980s studies for any instream flow analysis that related specifically to other instream flow factors in addition to hydraulics (velocity and depth) including:
  - flow and surface-groundwater exchange at various scales,
  - hydrology and function (frequency, timing, and duration of discharge),
  - geomorphic processes and maintenance,

- large wood recruitment,
- riparian and floodplain function and maintenance, and
- other topics relevant to fish-habitat utilization.

- Integrate the review of existing information with fish and geomorphic studies to look at the effects of daily flow fluctuations, particularly in winter, in the middle and lower river reaches.
- Assess winter operating flows as part of the 2012 studies under the Instream Flow Study Planning.
- Incorporate mapping of surface-groundwater exchange into the 2012 Instream Flow Planning Study, as this function may represent a critical feature that will be affected by project operations.
- In order to predict the entire range of likely effects of proposed project operations on Susitna River salmon, the following aspects should be studied in 2012 and extend beyond 2012, and should be addressed for all affected river reaches, including main-stem, off-channel, and hydrologically connected slough habitats:
  - Identify, locate, and characterize overwintering habitat for all species and life stages of Pacific salmon that are likely to be present, including redd locations;
  - Identify juvenile holding and migration habitats;
  - Identify and describe resident fish overwintering locations;
  - Estimate the potential for stranding or increased mortality related to changes in flow and temperature, water quality conditions, ice processes, and effects on habitat and geomorphic processes in the Susitna River under current conditions and under proposed operating conditions.

6.2.3 U.S. Fish and Wildlife Service

From the December 30, 2011 letter to AEA:

- Biometric review of biologic and hydrologic study results from the 1980s to assess the statistical validity of the 1980s Su-hydro study results for applicability to proposed studies for the Susitna-Watana project.
- Establish cross-sections for the lower reach, determine the hydraulic connection between the Susitna River and sloughs and off-channel habitats, and incorporate them into the hydrologic model to quantify and evaluate the effect of project operations on the lower reach (as climate and other conditions change within the watershed)
- Monitor flow and sediment in the Chulitna and Talkeetna Rivers, and in Gold Creek to quantify and evaluate individual tributary flow contributions and sediment loads and assess the potential effect of project operations on lower reach habitats and functions.

- Quantify distribution of fish assemblages relative to available habitat and stream temperature at channel, reach, and spatial scales to assess and quantify fish assemblages relative to available habitats that may be affected by proposed project operations; there are approximately 20 fish species in the Susitna River and little information known about their distribution.
- Collect longitudinal thermal imaging data in all Susitna River study reaches to assess and quantify important aquatic habitats (e.g., thermal refugia) that may be affected by proposed project operations.

From the February 10, 2012 letter to AEA:

- Conduct fish habitat forming process studies on the minimum temporal scale of 5 years, which equates to the typical life cycle of Chinook salmon, and ADFG-designated stock of concern.
- Establish a schedule for analysis of data obtained in 2012 and a framework for how to incorporate the 2012 data into 2013-2014 study plans.
- Assess winter base flows beginning in 2012 under the Instream Flow 2012 Study Planning, Water Resources Study Planning, and in the Aquatic Resources Study Planning.
- Assess base flows as they relate to mainstem winter habitats (including adult spawning and juvenile fish overwintering locations, and the potential for stranding or increased mortality or condition related to changes in flow and water temperature), water quality conditions, ice processes, and habitat and geomorphic processes in the Susitna River under current conditions and under the proposed operation.
- Conduct thermal imagery in 2012 throughout the Susitna River mainstem to identify important thermal habitats that may be utilized for spawning, refugia, or as overwintering areas.
- Utilize 2-D hydrodynamic model(s) at a mesohabitat, reach, and basin wide scale; specifically, a 2-D model that can be used to predict physical processes to spatially represent variation in input variables, and how those variables change temporally and spatially under differing flows, and that also include a sensitivity analysis.

Regarding the Instream Flow Planning Study (F-S5):

- The discussion of and selection of a model or series of models of 1-D or 2-D nature must be made prior to finalizing habitat studies.
- Conduct the studies in such a manner as to ensure the habitat suitability curve development uses actual suitability data and is not dominated by best professional consensus.
- A better understanding is needed of how the instream flow study relates to the routing model or uses its own calibrated flow model. Concern is that the overall routing model may

have significant variation in water level between cross-sections depending on their placement in relation to the habitat cross-sections. Location in pools or riffles and within these features or braided section will vary the water level of a certain flow and may not correctly interpret the water level of a habitat cross-section.

- Anticipate that the habitat study will have its own cross-sections and flow analysis separate from the routing model. Realize that some selected locations may not be adequate once fieldwork is performed, so flexibility is needed to select new spots as needed for 2013 and 2014.
- Create a map for distribution that overlaps the original routing and habitat cross-sections with recent aerial imagery to begin to understand their spatial location and orientation and begin discussing 2012 study locations.
- Locate any groundwater/surface water exchange studies in the review of the 1980s studies. Confirm whether any of these studies included mapping of groundwater upwelling area along the river for gaining and losing reaches.
- Conduct at least a large-scale thermal temperature study along the river to note groundwater upwelling locations and relate it to the habitat study areas and cross-section surveys.

From the February 21, 2012 letter to AEA, regarding the Adult Salmon Distribution and Habitat Utilization Study (F-S3):

- Expand study methods to ensure characterization of spawning habitat utilization in the lower river reaches in addition to the Middle Reach to allow for a more comprehensive assessment of potential impacts of the project on salmon spawning habitats throughout the length of the Susitna River.
- This study (F-S3) should be fully integrated with instream flow and geomorphic studies to assess the effects of daily flow fluctuations, particularly in fall and winter.

6.2.4 U.S. Department of the Interior

From the January 12, 2012 letter to FERC:

- Conduct investigations to:
    - Fully characterize the fish assemblages throughout the Susitna River and its tributaries,
    - Document seasonal distribution of fish and habitat use at all life stages, and
    - Verify the upper extent of anadromy by species.
- These studies need to be conducted in all three reaches (as defined in the Aquatic Data Gap Analysis), including upstream of Devil's Canyon and upstream of the proposed dam site.

- Identify the hydrologic conditions in which Devil's Canyon may or may not be a barrier to upstream fish passage.
- Place gaging stations at appropriate locations as soon as possible to generate sufficient data for meaningful analysis.
- Stream flow evaluations for the project should include projections of the potential effects of climate change on the timing and magnitude of discharges.
- Conduct an investigation of potential streamflow response to glacier change over the proposed operational life of the project to better understand the potential impacts.
- Identify the existence, range, and potential response of native resident and anadromous species to the current and future managed flow regimes.
- Develop habitat suitability criteria for native resident and anadromous species.
- Identify the existence, range, and potential response of invasive species to the current and future managed flow regimes, both with and without the project.
- Develop an inventory of introduced species (including existing species and species potentially introduced by the construction and operation of the proposed project), including their range, habitat needs, and potential effect on important native species.

6.2.5 References Pertaining to Resource Agency Management Goals

National Oceanic and Atmospheric Administration/National Marine Fisheries Service (NOAA/NMFS). 2012. Letter from J.W. Balsiger to W. Dyok (AEA) regarding: Susitna-Watana Hydroelectric Project (P-14241) 2012 Study Meetings. February 29, 2012.

U.S. Department of the Interior. 2012. Letter from P. Bergmann to K.D. Bose (FERC) regarding: COMMENTS on the Notice of Application for Preliminary Permit: Susitna-Watana Hydroelectric Project (FERC Project No. 14241-000). January 12, 2012.

U.S. Fish and Wildlife Service (USFWS). 2011. Letter from A.G. Rappoport to S. Fisher-Goad (AEA) regarding: Proposed 2012 pre-licensing studies for the Susitna-Watana Hydroelectric Project, FERC Project No. 14241-0000. December 30, 2011.

U.S. Fish and Wildlife Service (USFWS). 2012. Letter from A.G. Rappoport to S. Fisher-Goad (AEA) regarding: 2012 pre-licensing draft study plans for the Susitna-Watana Hydroelectric Project, FERC Project No. 14241-0000. February 10, 2012.

U.S. Fish and Wildlife Service (USFWS). 2012. Letter from A.G. Rappoport to S. Fisher-Goad (AEA) regarding: Comments on an additional 2012 draft study plan for the Susitna-Watana Hydroelectric Project, FERC Project No. 14241-0000. February 21, 2012.

7. STUDY GOALS AND OBJECTIVES

The goal of the SWIFS and its component study efforts is to provide quantitative indices of the existing natural flow regime and alternative future Project operational scenarios on aquatic habitats in the mainstem Susitna River and associated side channels, side sloughs, upland sloughs, and tributary mouths. The objectives of the study are as follows:

1. Develop modeling approaches to quantify the seasonal habitat versus flow and other parameter relationships for aquatic species, life stages and/or guilds, within the different habitat types of the Susitna River.
2. Use the habitat versus flow/other parameter relationships to develop time series and effective habitat analysis appropriate for quantifying existing conditions and a range of with-Project conditions; the time scale for this analysis will be based on proposed Project operations and may include hourly, daily, weekly, or seasonal time steps.
3. Select transects for 1-D modeling and/or segments for 2-D modeling to measure and model mainstem Susitna River habitat types.
4. Identify the time periods, flow/other parameter conditions and life stages when habitat may be a limiting factor for aquatic species.
5. Develop new, or modify existing, Habitat Suitability Criteria (HSC) curves for selected target species and life stages.
6. Develop a set of integrated habitat-specific aquatic habitat models (i.e., mainstem, side channel, side slough, upland slough, tributary mouth, etc.) that can be linked with riverine process models that produces a time series of data for a variety of biologically relevant metrics under alternative operational scenarios. These metrics include (but are not necessarily limited to):
    - water surface elevations at selected river locations;
    - water velocities within transect subdivisions (cells) over a range of flows;
    - ground water (upwelling/downwelling);
    - varial zone areas;
    - frequency and duration of exposure/inundation of the varial zone at selected locations;
    - habitat quantities by species and life stage within respective habitat types;
    - water temperature characteristics; etc.
7. Conduct a variety of post-processing comparative analyses derived from the output metrics estimated under the habitat specific aquatic habitat models. These include (but are not necessarily limited to):

- comparisons of habitat quantity and quality (e.g., habitat exceedance plots)
- ramping rates (e.g., changes in flow versus time);
- juvenile fish stranding/trapping;
- habitat sustainability (effective habitat analysis);
- distribution and abundance of benthic macroinvertebrates under alternative operational scenarios.

8. Develop a hydraulic routing model that estimates water surface elevations and average water velocity along modeled transects on an hourly basis under alternative operational scenarios.

9. Map the current aquatic habitats in the Susitna River both above and below the Watana Dam.

7.1 NEED FOR STUDY

Summary of Existing Information

Substantial information exists for the Susitna River that was collected and analyzed as part of the 1980s studies. The extent and details of many of those studies were provided in the Draft Environmental Impact Statement (DEIS 1984) for the previous project (FERC No. 7114) along with companion appendices and attachments in the way of ADFG reports. Some of that information was cited and summarized in the HDR (2011) gap analysis report; however, there has never been a thorough review of the studies and underlying data. The gap analysis did provide for an initial listing of salient reports and data that warrant more detailed evaluations. The References section of this plan contains some of the more relevant documents that were identified. As noted by HDR (2011), instream flow studies of the Susitna River were conducted by the then Alaska Power Authority (APA) for the previous hydroelectric project (FERC No. 7114) that was proposed in the early 1980s. Those study efforts focused on establishing the relationships between physical variables, fluvial processes and fish resources in the middle Susitna River. Faced with the complexity of the number of environmental variables involved and the number of species of fish which inhabit the middle Susitna River, it was deemed necessary to focus only on the most important physical variables and carefully identified fish resources which were most sensitive to project-related changes (Trihey & Associates and Entrix 1985b). Inspection of the 1980s report confirms that the majority of efforts were focused on the Middle River portion of the Susitna River.

Need for Additional Information

The gap analysis presented in HDR (2011) outlines the major elements required in an instream flow study. Although substantial data and information were collected in the 1980s, those data are approximately 30 years old and therefore additional information needs to be collected to provide a contemporary understanding of the baseline conditions existing in the Susitna River. In addition, the configuration and proposed operations of the Project have changed and must be evaluated within the context of the existing environmental setting. This includes consideration of potential load following effects on important fish and aquatic habitats both downstream and upstream of the Watana Dam. This evaluation needs to extend for the entire length of the Susitna River below the Watana Dam that is affected by the Project, including the reach of river below the confluence of the Chulitna and Talkeetna rivers, as appropriate. Potential effects of proposed Project operations on aquatic habitats and biota and potential benefits and impacts of alternative operational scenarios have not been quantitatively analyzed. The aquatic habitat specific models will provide an integrated assessment of the effects of Project operations on biological resources and riverine processes. These models will provide an analytical framework for assessing alternative operational scenarios and quantitative metrics that will aid in comparing alternatives that may lead to refinements in proposed Project operations. Project effects will be quantified using indices of potential habitat rather than estimates of the number of fish produced or lost under alternative operational scenarios.

7.2 DETAILED DESCRIPTION OF STUDY

7.2.1 Study Area

The study area includes the entire portion of the Susitna River that would be affected by the construction and operation of the Watana Hydroelectric Project. For purposes of this study, the study area has been preliminarily divided into the following five reaches (Figure 1):

- Upper Reach — Susitna River extending upstream from Watana Dam site to upper extent of river influenced by Watana Reservoir (RM 184 and above)
- Middle Reach (Above Devils Canyon) – Susitna River from Watana Dam site to upper end of Devils Canyon (RM-184 to RM163)
- Middle Reach (Devils Canyon) — Susitna River from upper to lower end of Devils Canyon (RM 163 to RM 150)
- Middle Reach (Below Devils Canyon) – Susitna River extending from below Devils Canyon to confluence of Chulitna and Talkeetna rivers (three rivers) (RM-150 to RM- 94); this reach may require further division;
- Lower Reach — Susitna River extending below Talkeetna River to mouth (RM 94 to RM 0)

Further refinement of these reach designations will occur as part of the Stratification task under the 2012 geomorphology study plans.

7.2.2 Description of Study Components

The Aquatic Habitat Specific Models will likely consist of the following components (these components will be refined based on agency and stakeholder review):

- Habitat Mapping
- Hydraulic Routing
- Habitat-Specific Models Development
- Habitat Suitability Criteria (HSC) or Habitat Suitability Indices (HSI) development for fish and possibly benthic macroinvertebrates

7.2.2.1 Habitat Mapping

The aquatic habitat specific models will be used to evaluate the effects of alternative Susitna-Watana Hydroelectric Project operational scenarios on aquatic habitats and biota in the Susitna River. One of the initial model development tasks will be the selection of sites and establishment of transects or detailed study segments. These transects/study segments will be representative of habitat conditions based on channel morphology and major habitat features. Transects/study segments may also be selected to describe distinct habitat features that are important to aquatic biota (e.g., known areas of groundwater influence; spawning habitats, rearing habitats, etc.). In order to select these transects/study segments, specific information on both channel morphology and other important habitat features within the Susitna River will be needed. This information will allow AEA and agency and stakeholders to decide on the number and placement of transects/study segments to best represent the system within the modeling platform.

The Habitat Mapping study component provides the critical information needed about the distribution of major and distinct habitat features in the study area to select these areas for the Aquatic Habitat Specific Models.

- **Proposed Methodology**

  The distribution and proportion of major habitat types in the Susitna River will be identified using analyses of bathymetric data, aerial photography, site-specific habitat and biological surveys (e.g., 1980s studies), and agency and study participants' knowledge of the Project area. This effort will be coordinated with other riverine process studies. The location and distribution of distinct habitat types, areas of intense fish spawning activity/rearing will also be identified using available information and the results of site-specific surveys. The specific tasks likely to be involved in this study component include the following (subject to revision and refinement following agency review):

- Channel Typing

  Use bathymetric data and aerial mapping techniques to determine the proportion of major channel types by reach and for the total analysis area.

- Wetted Width Calculations

  Apply Geographical Information System (GIS) database to calculate wetted widths of channel at selected locations representing different habitat types, under different flow conditions.

- Wetted Surface Area Calculations

  Use GIS analysis to calculate by reach the total wetted surface area of the Susitna River channel under different flow conditions.

- Aquatic Habitat Mapping

  Using aerial photography, map existing main channels, side channels, side sloughs, upland sloughs, tributary mouths and other salient habitat features that are aligned with the Susitna River under different flow conditions.

- Interviews

  Interview relicensing participants, local biologists, anglers, guides and other personnel familiar with the Project area and identify areas supporting fish spawning/rearing and other areas of concentrated biological activity.

- Data Compilation

  Compile information on channel type, width, depth, surface area, aquatic habitat types, and concentrated biological activity to determine the location and distribution of representative and distinct habitats.

- **Work Products**

The Habitat Mapping study component will include but not be limited to the following work products:

- Map and tabular summary of channel types
- Map and tabular summary of habitat types
- Map and tabular summary of areas of known groundwater influence and other areas of special ecological importance
- Tabular summary of wetted width and wetted surface area calculations

- Documentation of interviews

  These work products and other results of the aquatic habitat mapping study will be compiled and presented in a draft and final study report.

7.2.2.2 Hydraulic Routing

Details of the Hydraulic Routing model are provided in a separate Study Plan.

7.2.2.3 Habitat-Specific Models Development

This study component develops the core structures of the aquatic habitat specific models. However, formal development of these models will require careful evaluation of existing data and information as well as focused discussions with technical representatives from agencies and stakeholders. For purposes of this preliminary Study Plan, it has been assumed these models would involve completion of the following generalized steps that would lead to formal model development. Implicitly, these models will rely in part on information and technical analyses performed in other study components as a basis for developing model structures (e.g., Habitat Mapping; other riverine process studies).

- **General Approach – Proposed Methodology**

  Development of the models will involve completion of a series of tasks as noted below.

  - Transect/Study Segment Selection

    In coordination with licensing participants and riverine process study leads, use the results of the Habitat Mapping study component to select transects/study segments within each of the selected habitat types identified in the Susitna River to describe habitat conditions based on channel morphology and major habitat features. Additional habitat transects/segments will be selected to describe distinct habitat features such as groundwater areas, spawning and rearing habitats, overwintering habitats, distinct tributary mouths/deltas, and potential areas vulnerable to fish trapping/stranding. The transects used for defining the flow routing model (See Study) will also be integrated into this analysis.

  - Agency/Stakeholder Site Reconnaissance

    Conduct a site reconnaissance with personnel from agencies, tribes and other stakeholders to review river reaches, select candidates study sites and potential transect/study segment locations, and discuss options for model development.

  - Model Selection: Field Surveys and Data Collection

Once study sites and transects/study segments have been identified, detailed field surveys will begin. These will be tailored based on habitat types to be measured and the selected models to be used. It is likely this will involve a combination of 1-D and 2-D modeling approaches as well as application of empirically based methods such as the RJHAB model applied in the 1980s studies (ADFG 1984L). The RJHAB model was used to assess/model the effects of flow alterations on juvenile fish habitat for off-channel areas. Selection of specific methods is a high priority issue and will be addressed as part of 2012 studies. Table 2 provides a listing of potential models/methods that will be considered as part of the SWIFS.

Table 2. Assessment of physical and biological processes and potential habitat modeling techniques*.

	Habitat Types			
Physical & Biological Processes	**Mainstem**	**Side Channel**	**Slough**	**Tributary Mouths**
Spawning	PHAB/VZM	PHAB	PHAB/HabMap	PHAB/RFR
Incubation	RFR/VZM	PHAB	PHAB/HabMap	PHAB/RFR
Juvenile Rearing	PHAB/RFR	PHAB	PHAB/HabMap	PHAB/RFR
Adult Holding	RFR	RFR	NA??	NA??
Macroinvertebrates	VZM/WP	VZM/WP	PHAB/HabMap/WP	NA??
Standing/Trapping	VZM	VZM	VZM/WP	VZM/WP
Upwelling/Downwelling	FLIR	HabMap/FLIR	HabMap/FLIR	HabMap/FLIR
Temperature	WQ	WQ	WQ	WQ
Ice Formation	IceProcesses/WQ/RFR	IceProcesses/WQ/RFR	HabMap/Open leads	NA

PHAB-Physical Habitat Simulation Modeling (1D, 2D, and empirical); VZM-Varial Zone Modeling; RFR-River Flow Routing Modeling; FLIR- Forward-looking Infrared Imaging; HabMap-Surface Area Mapping; WQ-Water Quality Modeling; WP-Wetted Perimeter Modeling

* A detailed description of each of the habitat models listed will be provided in a separate document.

Regardless of specific methods, field surveys will likely involve measurement of water velocities, water depths, water surface elevations, bottom profiles/topography, substrate characteristics, and other relevant data (e.g., upwelling, water temperature) under different flow conditions. One of the tasks for 2012 will be to evaluate and determine specific flow targets for these field surveys.

- **Hydraulic – Habitat Model Integration**

  Integrate each of the developed habitat models into the hydraulic routing model to translate changes in Susitna River flows based on Project operations into changes in habitats. These models will represent the core analytical tools for assessing potential project effects on aquatic resources and riverine processes and will be used to complete standard time series analysis, habitat duration analysis, etc.

- **Varial Zone Model**

  Develop a varial zone habitat model to quantify the magnitude, frequency and duration of the channel area that may be exposed to inundation and dewatering. The varial zone analysis will be conducted by discrete portions of each of the habitat types (e.g., mainstem, side channel, sloughs, etc.) using an hourly time step integrated over a specified period that considers fluctuations in water surface elevations that occurred during the period. The varial zone is defined as the area between the high water surface elevation and the low water surface elevation for a given project operating range using a span of time periods reflective of the aquatic species and life stage of interest. The selection of time periods to define the upper and lower extent of the varial zone for the Project will be coordinated with licensing participants. Information on the rate of colonization, dewatering mortalities and conditions supporting suitable habitats for organisms of interest will be developed as part of the HSC/HSI study component. Figures 5 and 6 illustrate the concept of a varial zone and the framework for the varial zone model.

  In general, this model will allow for the analysis of the risk of immediate and delayed dewatering mortality due to relatively short-term flow alterations.

- **Habitat Weighted Usable Area/Habitat Metrics**

  The models will be used to translate changes in water surface elevation/flow at each of the measured transects/study segments into changes in depth, velocity, substrate, cover and other potential habitat (e.g., turbidity, upwelling). Linking this information with HSC/HSI curves will allow for translation of changes in hydraulic conditions resulting from Project operations into indices of habitat suitability (see the Habitat Suitability Indices Development study component described below). This will allow for the quantification of habitat areas containing suitable habitat indices for target species and life stages of interest for each alternative operational scenario, respectively.

- **Post-Processing**

  Use the hydraulic-routing and habitat models to process output from the Project operations model. This will be done for each scenario and hydrologic period and will allow for the quantification of Project operation effects on:

  - Habitat areas (for each habitat type – mainstem, side channel, slough, etc.) by species and life stage;
  - Varial zone area;
  - Effective spawning areas for fish species of interest (i.e., spawning sites remain wetted through egg hatching);
  - Other riverine processes

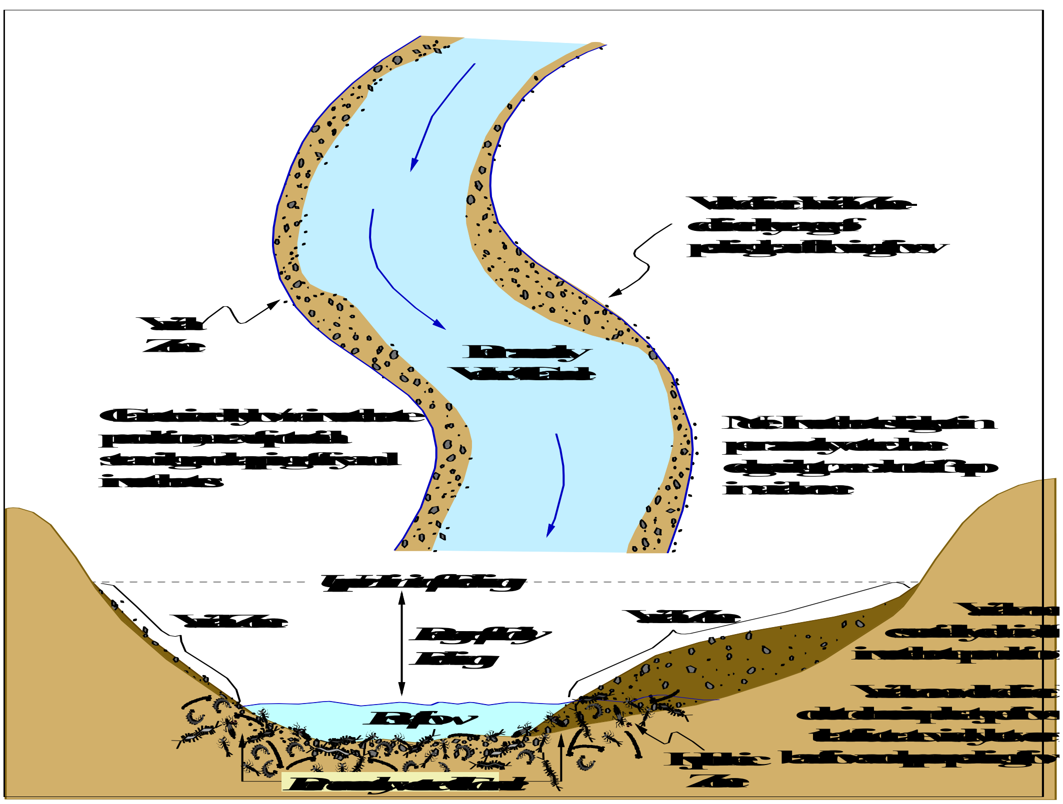

Figure 5. Schematic diagram illustrating the formation of a varial zone within a river channel.

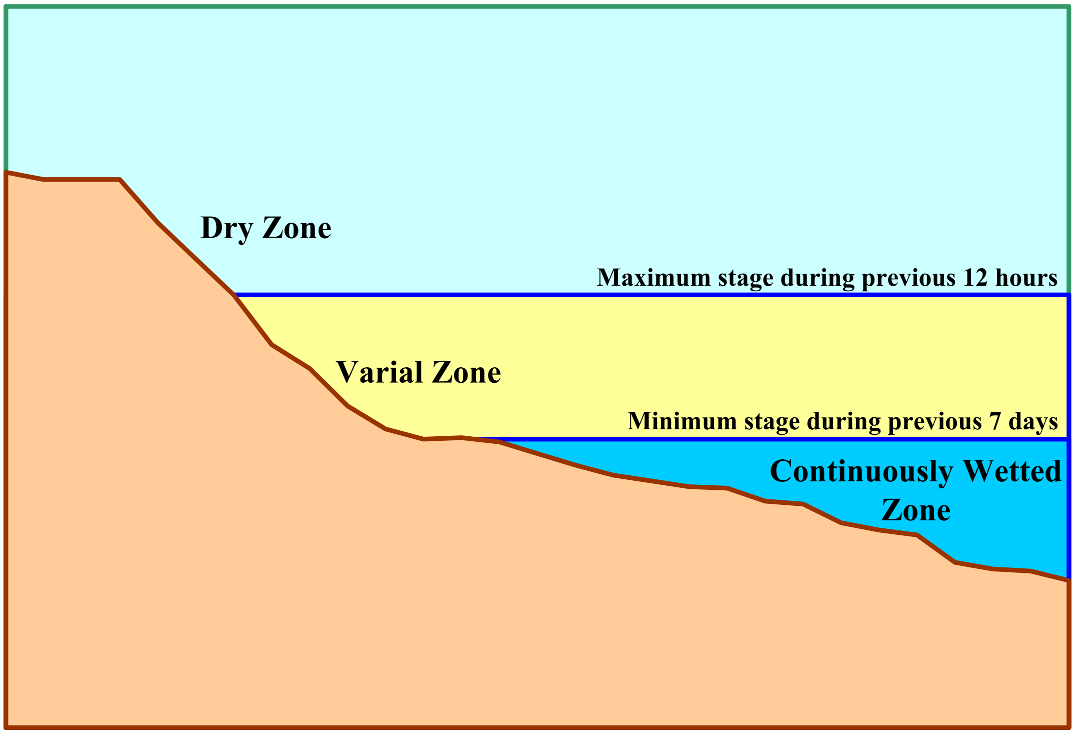

Figure 6. Conceptual framework of the Varial Zone Model.

The various indices of Project effects on aquatic habitats will be summarized and tabulated to allow ready comparison of the effects of an existing operations scenario to alternative operational scenarios. It is anticipated that the varial zone analysis will be used as a primary indicator of the effects of operational scenarios related to relatively short-term flow alterations. Analyses of habitat area will be developed for each species and life stage of interest (or as combinations of species via habitat guilds), and the results will be used in part for identifying the spatial distribution of potential habitats. Each indicator of environmental effect will be tallied separately, and the relative importance of the effects of Project operations on various aquatic resources can be determined independently by interested parties.

- **Work Products**

  At a minimum, draft reports will be prepared at the end of each year of study that will describe the methods and results of the SWIFS components completed during that year. The reports will also present recommendations for future studies. It is anticipated there will be many other technical reports prepared throughout the duration of the SWIFS including those that describe Methods Selection, Site Selection, HSC development, Model Development and Analysis, etc. These will be defined as part of the 2012 study.

7.2.2.4 Habitat Suitability Criteria/Habitat Guilds Development

HSC/HSI curves represent an assumed functional relationship between an independent variable, such as depth, velocity, and substrate, and the response of a species life stage to a gradient of the independent variable (suitability), which is expressed over a scale of 0.0 (poor habitat) to 1.0 (best habitat) (Bovee 1982). In traditional instream flow studies, HSC curves for depth, velocity, substrate and/or cover are combined in a multiplicative fashion to rate the suitability of discrete areas of a stream for use by a species and life stage of interest. HSC curves translate hydraulic and channel characteristics into measures of overall habitat suitability in the form of weighted usable area (WUA). Depending on the extent of data available, HSC curves can be developed from the literature, or from physical and hydraulic measurements made in the field in areas used by the species and life stages of interest (Bovee 1986). HSC curves for the Susitna-Watana Hydroelectric Project will be based on three levels of information consisting of 1) new site specific data collected for selected target species and life stages (seasonally if possible); 2) existing site specific data collected from the Susitna River during the 1980s studies; 3) site specific data collected from other Alaska rivers and streams; and 4) HSC curves, data and information from other streams and systems outside of Alaska.

For use in the mainstem aquatic habitat model, HSC curves for some species (e.g., benthic macroinvertebrates, fry) will also need to be developed to describe the response of aquatic organisms to relatively short-term flow fluctuations. In some cases, the development and application of Habitat Guild curves may be appropriate where species utilization of particular habitat types overlap, and therefore the focus of the analysis becomes more on meso-habitat-types (e.g. riffle, run, pool, etc.) than on species micro-habitat use. The following sections describe the general approaches that will be used in development of HSC curves for fish and benthic macroinvertebrates.

- **Fish HSC**

  The fish community in the Susitna River is dominated by anadromous and non-anadromous salmonids, although numerous non-salmonid species are also present (See Table 3). Selection of specific target species for which HSC curves will need to be developed will be done in collaboration with agency and stakeholder representatives.

- **Proposed Methodology**

  For purposes of this preliminary study plan, it is assumed the development of HSC will involve the following steps.

- *Develop Draft HSC Curves*. Develop draft HSC curves for target species and life stages using 1980s data as well as other available scientific literature for those species. Habitat suitability information will address fish responses to changes in depth, velocity, substrate, cover, groundwater, turbidity, indices of stranding and trapping (depressions and isolated pools), rates of colonization and stranding and trapping mortality.
- *Develop a Periodicity Table*. Develop a species and life stage periodicity table applicable to the different reaches of the Susitna River. The periodicity information will be used to define temporal and spatial changes in fish species distribution, identify time periods when various life stages (e.g., young fish) are present and potentially affected by Project operations, and assist in development of the aquatic habitat modeling efforts.
- *Collect Site-Specific Habitat Suitability Information*. Collect site-specific habitat suitability information using HSC-focused biotelemetry, spawning survey field efforts, and fish sampling studies supplemented by information from previous surveys. Habitat use information (i.e., water depth, velocity, substrate type, upwelling, cover, etc.) will be collected at the location of each identified target fish and life stage. If available, a minimum of 50 habitat use observations will be collected for each target species life stage. However, the actual number of measurements targeted for each species and life stage will be based on a statistical analysis that considers variability and uncertainty.
- *Habitat Utilization Frequency Histogram/ Habitat Preference*. Develop a histogram (i.e., bar chart) for each of the habitat parameters (e.g., depth, velocity, substrate, cover, groundwater use, etc.) using the site-specific field observations. The histogram developed using field observations will be compared to the draft HSC curves and literature-based HSC curves. Consideration will also be given to developing HSC curves that are not habitat availability biased (e.g., developed when/where a wide range of habitat availability exists).

Table 3. Common names, scientific names, life history strategies, and Susitna usage of fish and potential fish species within the lower, middle, and upper Susitna River, based on sampling during the 1980s (from HDR 2011)

Common Name	Scientific Name	Life History	Susitna Usage
Arctic grayling	*Thymallus arcticus*	F	O, R, P
Dolly Varden	*Salvelinus malma*	A,F	O, P
Humpback whitefish	*Coregonus pidschian*	A,F	O, R, P
Round whitefish	*Prosopium cylindraceum*	F	O, M2, P
Burbot	*Lota lota*	F	O, R, P
Longnose sucker	*Catostomus catostomus*	F	R, P
Sculpin	*Cottid*	M1, F	P
Eulachon	*Thaleichthys pacificus*	A	M2, S
Bering cisco	*Coregonus laurettae*	A	M2, S
Threespine stickleback	*Gasterosteus aculeatus*	A,F	M2, S, R, P
Arctic lamprey	*Lethenteron japonicum*	A,F	O, M2, R, P
Chinook salmon	*Oncorhynchus tshawytscha*	A	M2, R
Coho salmon	*Oncorhynchus kisutch*	A	M2, S, R
Chum salmon	*Oncorhynchus keta*	A	M2, S
Pink salmon	*Oncorhynchus gorbuscha*	A	M2
Sockeye salmon	*Oncorhynchus nerka*	A	M2, S
Rainbow trout	*Oncorhynchus mykiss*	F	O, M2, P
Northern pike	*Esox lucius*	F	P
Lake trout	*Salvelinus namaycush*	F	U
Pacific lamprey	*Lampetra tridentata*	A,F	U
Alaska blackfish	*Dallia pectoralis*	F	U

A = anadromous
M1 = marine
F = freshwater
O=overwintering
R=rearing
P=present
M2 = migration
S=spawning
U=unknown

- *Stakeholder and Expert Panel.* At some point in the analysis, convene a panel of licensing participants and, if desired, regional experts (agency, tribal, industry and university researchers) to review the HSC data and select final curve sets to be used in the aquatic habitat specific models.

- **Work Products**
  The final work product of this study effort will consist of HSC curves for the target fish species and life stages, and/or habitat guilds. Separate draft reports will be prepared that describe survey methods, results of 2012 review of 1980s HSC data, results of 2013 and 2014 sampling efforts, and discussion of recommendations for final HSC selection. A final report describing survey methods and results and the final selection of HSC curves will be prepared at the end of 2014.

Composite Schedule

The schedule for completing all components of the Mainstem Aquatic Habitat Model is provided in Table 4. A flow chart depicting the overall work flow and schedules for completion of the SWIFS is provided in Figure 7.

7.3 CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

Habitat Mapping. Studies regarding habitat mapping are commonly conducted at many hydroelectric projects as part of FERC licensing (e.g., Watershed GeoDynamics 2005, R2 Resource Consultants 2003, R2 Resource Consultants 2004). Mapping surveys will utilize protocols similar to those performed at other hydroelectric projects.

Hydraulic Unsteady Flow Routing. One-dimensional unsteady flow hydraulic models are commonly used to route flow and stage fluctuations through rivers and reservoirs. Examples of public-domain computer models used to perform these types of processes include FEQ (USGS 1997), FLDWAV (U.S. National Weather Service 1998), UNET (U.S. Army Corps of Engineers 2001), and HEC-RAS (U.S. Army Corps of Engineers 2002a, 2002b, and 2002c). The HEC-RAS model has proven to be very robust under mixed flow conditions (subcritical and supercritical), as will be expected in the Susitna River. The HEC-RAS model also has the capability of automatically varying Manning's "n" with stage through the use of the equivalent roughness option. Another feature of HEC-RAS is the capability of varying Manning's "n" on a seasonal basis. The need for this capability may arise in the Susitna River related to winter ice formation and spring decay and ice out, with the river being ice-free during other periods of time. The robust performance and flexibility of HEC-RAS make this model an appropriate choice for routing stage fluctuations downstream from the proposed Project dam.

Table 4. Schedule for development of all components of the Mainstem Aquatic Habitat Model.

Activity	2012				2013				2014			
	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4Q
Technical Consultant Selection	▲											
Refine and Finalize Study Plan		---▲	--▲---	------								
Agency Stakeholder Site Visit			--▲									
Study Site Selection (mainstem, slough, side channels, etc.)			---▲									
Review of 1980s Data and Information		------	------	-----●								
Model Selection by habitat type (1-D, 2-D, mapping, etc.)			------	--●								
Hydraulic Routing: data collection and reporting		------	------	-----●	------	------	------	------	------	------	------	------
Hydraulic Routing: develop executable model			------	------	------	------	------	------	------	------	------	------
HSC/Periodicity Fish: Review literature and 1980s reports			------	-----●	------	------	------	------	------	------	------	------
HSC Fish: Field data collection (summer, fall, winter) (both years)			▲	▲	------	---▲	--▲---	---▲	------	--▲---	--▲--	▲
Habitat Mapping (GIS, aerial videography, aerial photography)		------	------	------	------	------	------	------				
Habitat Surveys (side channels, sloughs, mainstem)					------	------	------	------	------	------	------	------
Collect Velocities and depths (Hydraulic models - 3 flows)					▲	▲	▲					
Develop groundwater/surface flow models				------	------	------	------	------				
Hydraulic Model Integration and Calibration							------	------				
Varial Zone Model and Downramping Analysis								------	------	------		
Habitat Modeling								------	------	------		
Alternate Scenario Post-Processing								------	------	------		
Reporting				●				●●				●●

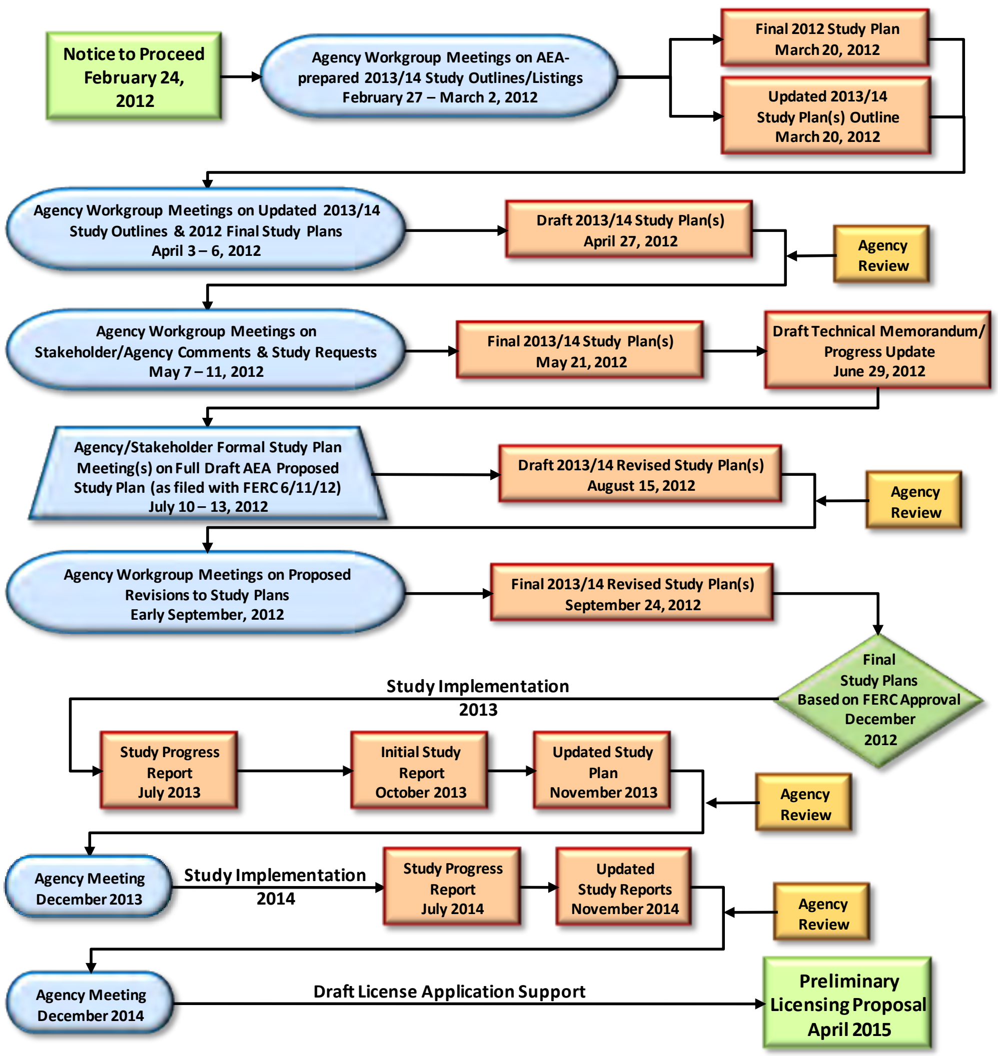

Figure 7. General work flow and key deliverable dates for the Susitna – Watana Instream Flow Study

***Mainstem, Side channel, and Slough Habitat Models*.** Physical habitat models are often used to evaluate alternative instream flow regimes in rivers (e.g., the Physical Habitat Simulation [PHABSIM] modeling approach developed by the U.S. Geological Survey; Bovee 1998, Waddle 2001). Methods available for assessing instream flow needs vary greatly in the issues addressed, their intended use, their underlying assumptions, and the intensity (and cost) of the effort required for the application. Many techniques, ranging from those designed for localized site or specific applications to those with more general utility have been used. The summary review reports of Wesche and Rechard (1980), Stalnaker and Arnette (1976), EA Engineering, Science and Technology (1986), the proceedings of the Symposium on Instream Flow Needs (Orsborn and Allman eds. 1976), Electric Power Research Institute (2000), and more recently the Instream

Flow Council (Annear et al. 2004) provide more detailed information on specific methods. The methods proposed in the SWIFS will likely include a combination of approaches depending on habitat types (e.g., mainstem, side channel, slough, etc.) and the biological importance of those types. During the 1980s studies, methods were designed to focus on both mainstem and off-channel habitats, although mainstem analysis was generally limited to near-shore areas. Both PHABSIM based models and juvenile salmon rearing habitat models were employed and will be considered as part of the SWIFS plan. It is likely that more rigorous approaches and intensive analysis will be applied to habitats determined as representing especially important habitats for salmonid production. It is also likely this will include both 1-D in some cases 2-D hydraulic modeling that can be linked to habitat based models. Incorporation of a groundwater component into the models will provide the basis for evaluating how Project operations may alter groundwater patterns that could influence habitat utilization of sloughs and other groundwater influenced habitat types. The proposed modeling approach is consistent with the use of physical habitat models used at other hydroelectric projects to assess the effects of alternative operational scenarios on aquatic habitat.

HSC and HSI Development. HSI curves have been utilized by natural resources scientists for over two decades to assess the effects of habitat changes on biota. HSI curves were developed by the USFWS for use with fish and wildlife (see http://www.nwrc.usgs.gov/wdb/pub/hsi), but their usage has also included periphyton and wetland tree habitats (e.g., Tarboton et al. 2004). The proposed method for the development and verification of HSI curves is analogous to the methods described in Bovee (1982; 1986) and USFWS (1981). The proposed fish sampling and observation methods will be consistent with those described in Murphy and Willis (1996) and will consider methods previously used in the 1980s (e.g., Suchanek et al. 1984). The proposed use of and expert panel to develop and verify fish HSI curves is modified from that described by Crance (1987) and has been applied in FERC licensing/relicensing studies of other projects.

7.4 CONSULTATION WITH AGENCIES, TRIBES, AND OTHER STAKEHOLDERS

Input regarding the issues to be addressed in the SWIFS has been provided by licensing participants during numerous workgroup meetings, commencing in late 2011; see Susitna. In 2012, workgroup meetings were held in January and February during which resource issues were identified and discussed and objectives of the instream flow studies were defined. Various agencies (USFWS, NMFS, ADFG, etc.) have provided written comments specific to this study which have been considered and will be addressed as part of this plan. This study plan is designed to meet the objectives as noted in Section 4 above, but is subject to refinement based on further discussions during workgroup meetings to occur in April, May, June, July and August.

7.5 PROGRESS REPORTS, INFORMATION SHARING, AND TECHNICAL REVIEW

Licensing participants will have opportunities for study coordination through regularly scheduled meetings, reports and, as needed, technical subcommittee meetings. Reports are planned for preparation at the end of 2013 and 2014 for each of the study components. Licensing participants will have the opportunity to review and comment on these reports. Workgroup meetings are planned to occur on at least a quarterly basis, and workgroup subcommittees will meet or have teleconferences as needed.

7.6 ANTICIPATED LEVEL OF EFFORT AND COST

The effort and ultimate costs associated with the SWIFS plan will be contingent on the final design of the studies, frequency and duration of sampling, methods and analytical techniques that will be applied, and logistical considerations. An estimate of effort and cost will be presented in later versions of the SWIFS plan.

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