

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

**Fish and Aquatics Instream Flow Study
Study Plan Section 8.5**

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

Prepared for

Alaska Energy Authority



SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

R2 Resource Consultants

November 2015

TABLE OF CONTENTS

1. Introduction.....	1
2. Background	2
2.1. Purpose of Study	2
2.2. Study Components	3
3. Status, Highlighted Results, and Achievements.....	4
4. Summary of Study 8.5 Documents	6
5. New Study Documentation Supplementing the ISR.....	12
6. Variances	13
6.1. 2013 Study Season	13
6.2. 2014 Study Season	16
7. Study Plan Modifications	19
7.1. Modifications Identified in ISR.....	19
7.2. Modifications Identified since the June 2014 ISR	21
8. Steps to Complete the Study	22

1. INTRODUCTION

Section 1 (Part A) of the June 2014 Initial Study Report (ISR) for this Fish and Aquatics Instream Flow Study (IFS) (Study Plan 8.5) details the development of this study from the Revised Study Plan (RSP) in 2012, through the end of the 2013 study season. Section 7 of the ISR (Part C), filed in June 2014, sets forth Alaska Energy Authority's (AEA) plan and schedule, at that time, for completing this study and meeting the objectives of the RSP.

As detailed in Section 2 of the ISR Part D Overview, various circumstances have required AEA to extend the original timeframe for completing the Commission-approved Study Plan. However, AEA has made meaningful progress with Study 8.5 since filing of the ISR in June 2014. As detailed below, AEA's recent activities for Study 8.5 have consisted of the following:

- Bathymetry and stage data were collected at additional mainstem Susitna River transects and incorporated into a revised version of the Open-water Flow Routing Model (OWFRM) (RSP Section 8.5.4.3).
- Additional river stage and flow data were collected at tributary gaging stations (RSP Section 8.5.4.4).
- Additional physical and hydraulic data to conduct two-dimensional (2-D) modeling were collected at Focus Areas (RSP Section 8.5.4.6).
- Additional Habitat Suitability Criteria (HSC) data were collected (RSP Section 8.5.4.5).
- Physical and biological information developed during the 2013-2014 winter period were summarized in a Technical Memorandum (R2 Resource Consultants. 2014. *2013-2014 Instream Flow Winter Studies*. Susitna-Watana Hydroelectric Project, FERC No. P-14241 Submittal: September 17, 2014, Attachment H, Study 8.5 Technical Memorandum).
- In response to the 04/01/13 FERC Study Plan Determination, relationships between fish abundance and specific microhabitat variables were evaluated and reported in a Technical Memorandum (R2 Resource Consultants. 2014. *Evaluation of Relationships between Fish Abundance and Specific Microhabitat Variables*. Susitna-Watana Hydroelectric Project, FERC No. P-14241 Submittal: September 17, 2014, Attachment G, Study 8.5 Technical Memorandum).
- Participated in ISR meetings on October 17, 2014 to discuss the preliminary IFS study results and the plans for completing the study. The emphasis for this meeting was on any modifications of the Study Plan in light of the progress of the Study Plan and data collected.
- Submitted a Study Implementation Report November 2015 that summarized Study 8.5 activities since June 2014. Five appendices to the SIR described updates to Winter Studies, OWFRM 2.8, 2014 boat Acoustic Doppler Current Profiler (ADCP) methods, multivariate HSC, and substrate, cover and salmon spawning Geographical Information System (GIS) coverage for Focus Areas below Devils Canyon.

The primary purpose of this Part D Supplemental Information to the ISR is to report on the implementation of the Study Plan from the filing of the ISR in June 2014 through the filing of this ISR Part D. In light of this additional implementation, this Part D also identifies AEA's plans for completing the IFS (Study 8.5) in a manner that meets the objectives of the Commission-approved Study Plan.

2. BACKGROUND

2.1. Purpose of Study

The goal of the IFS (Study 8.5) and its component study efforts is to provide quantitative indices of existing aquatic habitats that enable a determination of the effects of alternative Project operational scenarios.

The study objectives are established in RSP Section 8.5.1.2:

- Map the current aquatic habitat in main channel and off-channel habitats of the Susitna River affected by Project operations. This objective will be completed as part of the Characterization and Mapping of Aquatic Habitats Study (Study 9.9).
- Select study areas and sampling procedures to collect data and information that can be used to characterize, quantify, and model mainstem and lateral Susitna River habitat types at different scales. This objective will be completed via a collaborative process with the other resource studies (Riparian Instream Flow [Study 8.6], Groundwater [Study 7.5], Geomorphology [Studies 6.5 and 6.6], Water Quality [Studies 5.5 and 5.6], and Fish and Aquatics studies [Studies 9.6]), and is described in ISR Study 8.5, Part A, Section 4.
- Develop a mainstem OWFRM that estimates water surface elevations and average water velocity along modeled transects on an hourly basis under alternative operational scenarios. See ISR Study 8.5, Part A, Sections 4.4 and 5.3.
- Develop site-specific HSC and Habitat Suitability Indices (HSI) for various species and life stages of fish for biologically relevant time periods selected in consultation with the Technical Workgroup (TWG). Criteria will include observed physical phenomena that may be a factor in fish preference (e.g., depth, velocity, substrate, embeddedness, proximity to cover, groundwater influence, and turbidity). If study efforts are unable to develop robust site-specific data, HSC/HSI will be developed using the best available information and selected in consultation with the TWG. See ISR Study 8.5, Part A, Sections 4.5 and 5.5.
- Develop integrated aquatic habitat models that produce a time series of data for a variety of biological metrics under existing conditions and alternative operational scenarios. These metrics may include (but are not limited to) the following:
 - Water surface elevation at selected river locations
 - Water velocity within study areas subdivisions (cells or transects) over a range of flows during seasonal conditions

- Length of edge habitats in main channel and off-channel habitats
 - Habitat area associated with off-channel habitats
 - Clear water area zones
 - Effective spawning and incubation habitats
 - Varial zone areas
 - Frequency and duration of exposure/inundation of the varial zone at selected river locations
 - Habitat suitability indices
- Evaluate existing conditions and alternative operational scenarios using a hydrologic database that includes specific years or portions of annual hydrographs for wet, average, and dry hydrologic conditions and warm and cool Pacific Decadal Oscillation (PDO) phases. See ISR Study 8.5, Part A, Sections 4.3 and 5.4.
 - Coordinate instream flow modeling and evaluation procedures with complementary study efforts, including Riparian Instream Flow (Study 8.6), Geomorphology (Studies 6.5 and 6.6), Groundwater (Study 7.5), Baseline Water Quality (Study 5.5), Fish Passage Barriers (Study 9.12), and Ice Processes (Study 7.6)
 - Develop a Decision Support System-type framework to conduct a variety of post-processing comparative analyses derived from the output metrics estimated under aquatic habitat models. These include (but are not limited to) the following:
 - Seasonal juvenile and adult fish rearing
 - Habitat connectivity
 - Spawning and egg incubation
 - Juvenile fish stranding and trapping
 - Ramping rates
 - Distribution and abundance of benthic macroinvertebrates

2.2. Study Components

This study consists of the following components:

- IFS Analytical Framework
- River Stratification and Study Area Selection
- Hydrologic Data Analysis
- Reservoir Operations and Open-water Flow Routing Model\

- Habitat Suitability Criteria Development
- Habitat-Specific Model Development
- Temporal and Spatial Habitat Analyses
- Instream Flow Study Integration

3. STATUS, HIGHLIGHTED RESULTS, AND ACHIEVEMENTS

The IFS study, which consists of eight study components, was initiated in 2013 in accordance with the Study Plan and resulted in the selection of study areas and study sites that are being used across resource disciplines. Major field efforts were associated with collection of mainstem Susitna and tributary hydrology data, bathymetry and topographic data, HSC/ HSI fish habitat data (winter and open-water periods), and characterization of substrates and cover. The following specific tasks were completed in 2013 and reported in ISR Study 8.5, Part A, Sections 4-6 and Parts A and C Appendices to the June 2014 ISR:

- Hydrology data collection included streamflow and/or water surface elevation measurements at 13 mainstem hydrology stations in 2012, 8 mainstem stations in 2013, and 13 tributary sites in 2013. Streamflow, water surface elevation, or bathymetry data were also collected at 167 mainstem transects over both the 2012 and 2013 field seasons. These data were used in developing and refining the OWFRM.
- Bathymetric, ADCP, and substrate/cover characterization surveys were completed for seven of the ten Focus Areas; data will be used in development of a 2-D hydraulic model that will be used in a Physical Habitat Simulation (PHABSIM) related analysis to develop habitat-flow relationships for target fish species and life stages.
- Version 2.0 of the OWFRM was developed and used by riverine resource disciplines for planning studies and implementation of field activities.
- A total of 68 HSC data collection sites were randomly selected for collection of HSC field data to quantify microhabitat use by spawning and freshwater ‘rearing’ (juvenile resident or anadromous fish) or ‘holding’ (adult resident fish) life stages of target fish species. During each survey, both microhabitat utilization (water depth, velocity, substrate composition, turbidity, and cover) and availability data were collected during each sampling event. A total of 1,433 observations of site-specific habitat use was recorded during 2013 HSC surveys of the Middle Susitna River Segment (MR). A total of 3,297 measurements of habitat availability was collected from within each of seven Focus Areas below Devils Canyon and from additional areas located outside of the Focus Areas. Collection of habitat availability data allows modeling of fish presence/absence as a function of single or multiple parameters (e.g., water depth, velocity, cover, water quality, temperature, and groundwater upwelling) using availability measurements at locations of where fish were not observed, and utilization measurements at locations where fish were observed.

- Pilot winter studies were initiated during 2012–2013 to monitor water quality and stage conditions at salmon spawning locations and to record fish habitat use. The 2012–2013 pilot study was conducted at two areas in the MR that contain a diversity of habitat types with groundwater influence, that have documented fish utilization, and that are accessible to and from Talkeetna during winter. Sites used for fish observation in each Focus Area consisted of open water and ice-covered areas in side slough, upland slough, and tributary habitats, while fish capture efforts occurred entirely in open water areas in side channel, side slough, and upland slough habitats.
- Physical and hydrologic surveys completed in the Lower Susitna River Segment (LR) consisted of the collection of field data at one-dimensional (1-D) single transect locations that will be used for defining habitat-flow relationships. LR field data collection during 2013 consisted of three site visits (June, August and September) at the LR-1 fish habitat sites to coincide with high, moderate and low flow conditions.
- Preliminary hydraulic model calibrations using HEC-RAS were completed for two of the LR fish habitat sites located in LR-1 to provide analysis to be presented at the Proof of Concept meetings. The hydraulic modeling results were imported into PHABSIM and an example of the habitat modeling output was generated using available habitat suitability criteria. Examples of weighted useable area and a habitat time series analysis were presented at the Proof of Concept meetings in April 2014.

The study team has completed the following activities for Study 8.5 since the June 2014 filing of the ISR:

- Following methods described in the Commission-approved Study Plan, collected bathymetry, velocity, stage, substrate, and cover data at FA-151 (Portage Creek) (ISR Study 8.5, Part C, Section 7.3).
- Collected supplemental physical/hydraulic data at seven Focus Area features below Devils Canyon (ISR Study 8.5, Part C, Section 7.3).
- Conducted aerial salmon spawning surveys at Focus Areas below Devils Canyon to validate salmon spawning habitat metrics (ISR Study 8.5, Part C, Section 7.3).
- Collected winter stage and water temperature at side channels and sloughs within select Focus Areas (ISR Study 8.5, Part C, Section 7.3).
- Calibrated 1-D hydraulic models at LR PHABSIM transects measured in 2013 (ISR Study 8.5, Part C, Section 7.3).
- Collected stage and flow data at tributary gaging stations installed in 2013 and installed and monitored six more gaging stations (ISR Study 8.5, Part C, Section 7.4).
- Collected bathymetry-water surface elevation (WSE) at 63 mainstem Susitna River transects and incorporated transect and 2014 Light Detection and Radar (LiDAR) data into Version 2.8 of the OWFRM that is calibrated from the proposed dam site (Project River Mile [PRM] 187.1) downstream to PRM 80 (ISR Study 8.5, Part C, Section 7.4).

- Completed second season of data collection of HSC data in MR Focus Areas below Devils Canyon, and first season HSC data collection in LR and in MR Focus Areas above Devils Canyon (i.e., FA-173 [Stephan Lake Complex] and FA-184 [Watana Dam]) (ISR Study 8.5, Part C, Section 7.3).
- Demonstrated process for developing multivariate HSC and prepared multivariate HSC curves for all species and life stages with sufficient site-specific observations. The revised HSC curves incorporate site-specific habitat utilization data from 2012, 2013, and 2014 surveys. (ISR Study 8.5, Part C, Section 7.5).
- Completed a detailed evaluation of the comparison of fish abundance measures with specific microhabitat variable measurements; analysis was developed in response to the April 1, 2013 FERC Study Plan Determination and summarized in a Technical Memorandum (Evaluation of Relationships between Fish Abundance and Specific Microhabitat Variables) submitted to the Federal Energy Regulatory Commission (FERC) on September 17, 2014 and discussed at the October 17, 2014 ISR meetings.
- Collected and evaluated physical and biological information collected during late winter 2013/2014 and 2014 spring breakup and open-water transition period; analysis was summarized in a Technical Memorandum (2013-2014 Instream Flow Winter Studies) submitted to the FERC on September 17, 2014.

4. SUMMARY OF STUDY 8.5 DOCUMENTS

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

Title	Date	Description	Link
8.5. Fish and Aquatics Instream Flow Study (Revised Study Plan)	12/14/2012	This document presents the plan for this study, including goals, objectives, the study area, and proposed methods for the Fish and Aquatics Instream Flow Study.	RSP for Study 8.5
Draft Technical Memorandum, Selection of Focus Areas and Study Sites in the Middle and Lower Susitna River for Instream Flow and Joint Resource Studies – 2013 and 2014	1/31/2013	Summary of the evaluation process, habitat mapping analysis, and preliminary selection of Middle River Focus Areas and Lower River PHABSIM sites. This technical memorandum was prepared in response to the 1/17/2013 FERC Study Plan Determination Schedule that specified delivery of three IFS-related analyses.	Initial Draft Focus Area Selection

Title	Date	Description	Link
Open-water Flow Routing Model Results Tech Memo with Appendix 1: WR-S1 Reservoir and River Flow Routing Model Transect Data Collection Study	1/31/2013	This technical memo described the goals, study area, summary of existing information, methods, and initial results (Version 1) of the Open-water Flow Routing Model. The appendix provides 2012 hydrologic study methods, data analysis, results, discussion, and conclusion for surveying and hydrologic data. Hydrologic data includes bathymetry of cross sectional profiles, water surface elevations, Acoustic Doppler Current Profiler (ADCP) discharge measurements, water slope, and continuous stage hydrographs at gaging stations. This technical memorandum was prepared in response to the 1/17/2013 FERC Study Plan Determination Schedule that specified delivery of three IFS-related analyses.	OWFRM 1.0 and Hydrology
Technical Memorandum, Selection of Focus Areas and Study Sites in the Middle and Lower Susitna River for Instream Flow and Joint Resource Studies – 2013 and 2014	3/1/2013	Supporting documentation of the Middle River Focus Areas and Lower River PHABSIM sites proposed in the Revised Study Plan. This technical memorandum was prepared in response to the 1/17/2013 FERC Study Plan Determination Schedule that specified delivery of three IFS-related analyses. Several adjustments to the Middle River Focus Areas were later implemented in response to the 4/1/ 2013 FERC Study Plan Determination.	Proposed Focus Area Selection
Compendium Sections 1-2: 2012 Instream Flow Planning Study, Summary Review of Susitna River Aquatic and Instream Flow Studies Conducted in the 1980s with Relevance to Proposed Susitna –Watana Dam Project –2012: A Compendium of Technical Memoranda. Section 1: Introduction and Section 2: Brief History of the 1980s Susitna Project.	3/25/2013	This Compendium of TMs contains 6 TMs and 3 Appendices. The first 2 sections provide an introduction/overview of the TMs and a brief history of the 1980s Susitna Project. The other TMs are described separately.	Compendium of 1980s IFS Studies
Compendium Section 3: River Stratification and Study Site Selection Process: 1980s Studies and 2013-2014 Studies	3/25/2013	Describes the process that was used during the Su-Hydro 1980s studies and then how that process factored into the stratification and classification approach being proposed for the Susitna- Watana 2013-2014 studies.	1980s IFS Site Selection Process
Compendium Section 4: Summary of Fish Distribution and Abundance Studies Conducted During the 1980s Su-Hydro Project	3/25/2013	Summarizes salient information concerning the 1980s (1981-1985) studies and includes a discussion of methods used, study sites sampled, and general results on a species basis. The TM is complementary to the fish data synthesis TM (filed with FERC 3/1/2013)	1980s Fish Distribution

Title	Date	Description	Link
		which should be referred to for more detailed information on the 1980s Su-Hydro fish studies.	
Compendium Section 5: Selection of Target Species and Development of Species Periodicity Information for the Susitna River	3/25/2013	Summarizes the studies completed in the 1980s that served to identify target species and the periodicities of their life stages, and provides summary information concerning the proposed methods for updating as part of the 2013-2014 studies.	1980s Target Fish Species and Periodicity
Compendium Section 6: Habitat Suitability Curve Development Studies for the Susitna River	3/25/2013	Summarizes readily available HSC information that may be relevant to the Susitna-Watana Instream Flow Study (IFS), with a primary focus on information collected during the 1980s Su-Hydro studies. However, other relevant (i.e., from Alaska) HSC data were also compiled and presented, and as well, a summary of HSC efforts related to the current Susitna-Watana IFS that were conducted in 2012 and are proposed for 2013-2014.	1980s HSC
Compendium Section 7: Review of Habitat Modeling Methods Applicable for the Susitna River	3/25/2013	Describes the types of models that were used as part of the 1980s Su-Hydro studies and summarizes the methods and models that are being proposed as part of the 2013-2014 Susitna-Watana IFS studies.	1980s IFS Habitat Modeling
Compendium Section 8: Biologically Relevant Physical Processes in the Susitna River	3/25/2013	Describes the processes that were identified in the Susitna River during the 1980s Su-Hydro studies that were considered biologically relevant, and how those processes may be influenced by flow regulation. This is followed by a brief discussion of how the 2013-2014 studies will be addressing these processes.	1980s Riverine Processes
Appendix 3 Summary of 1980s Instream Flow Habitat Modeling Sites	03/25/2013	Lists IFS study sites identified in the 1980s studies and associated fish distribution and habitat characteristics of each site	1980s IFS Study Sites
FERC's Study Plan Determination for Study 8.5	4/01/2013	This document presents FERC approval of Study 8.5, which approved AEA's Revised Study Plan with recommended adjustments.	FERC SPD for Study 8.5
Adjustments to Middle River Focus Areas Technical Memorandum	5/31/2013	Detailed description of the final Middle River Focus Areas including changes developed in response to 4/01/2013 FERC Study Plan Determination.	Final Middle River Focus Areas
Draft Initial Study Report for Study 8.5	2/3/2014	This draft of the ISR summarized the study methods and variances during the 2013 study season, and presented preliminary data collected for Study 8.5. This draft ISR was later republished as Part A of the final ISR.	Draft ISR for Study 8.5 (File 1) Draft ISR for Study 8.5 (File 2) Draft ISR for Study 8.5 (File 3) Draft ISR for Study 8.5 (File 4) Draft ISR for Study 8.5 (File 5)

Title	Date	Description	Link
Initial Study Report for Study 8.5	6/3/2014	This document is the Initial Study Report (Parts A, B and C) for Study 8.5. Part A republishes the Draft ISR. Part B identifies supplemental information and errata in Part A. Part C presents study modifications and plans for completing the study.	ISR Part A for Study 8.5 (File 1) ISR Part A for Study 8.5 (File 2) ISR Part A for Study 8.5 (File 3) ISR Part A for Study 8.5 (File 4) ISR Part A for Study 8.5 (File 5) ISR Part B for Study 8.5 ISR Part C for Study 8.5 (File 1) ISR Part C for Study 8.5 (File 2)
ISR 8.5 Part A, Appendix A: Hydrologic Methods	6/3/2014	This appendix summarizes field methods and lists initial sites for collecting hydrologic data under Study 8.5 (IFS). It is supplemented by additional technical memos describing methods implemented in 2013 and 2014 (see Section 5).	Hydrologic Methods ISR Part A for Study 8.5 (File 3)
ISR 8.5 Part A, Appendix B: Biological Cues Study	6/3/2014	This appendix describes the results of an analysis of potential relationships between hydrological variables and biological responses of salmon species that may be relevant to the Susitna River. This study component was developed in response to agency suggestions regarding the Deshka and Yentna rivers (RSP 8.5.4.5.1), but the study was shifted to the Taku and Stikine rivers in consultation with a technical working group. This study component is complete.	Biological Cues ISR Part A for Study 8.5 (File 3)
ISR 8.5 Part A, Appendix C: Moving Boat ADCP Measurements	6/3/2014	This appendix provides details on field data collection and analysis procedures using a moving-boat Acoustic Doppler Current Profiler (ADCP) in 2013. A separate technical memorandum is provided on methods employed in 2014.	2013 Moving Boat ADCP ISR Part A for Study 8.5 (File 3)
ISR 8.5 Part A, Appendix D: GINA Initial Study Report 8.5 Data Files	6/3/2014	This appendix lists data files used to develop Part A of the ISR that are available on the Geographic Information Network of Alaska.	Data Files Posted to GINA ISR Part A for Study 8.5 (File 4)
ISR 8.5 Part A, Appendix E: Tributary Gaging Site Schematics	6/3/2014	This appendix provides schematic drawings of the tributary gaging sites.	Trib Gaging Site Schematics ISR Part A for Study 8.5 (File 4)
ISR 8.5 Part A, Appendix F: Tributary Gaging Representative Site Photos	6/3/2014	This appendix provides photographic images of tributary gaging sites.	Trib Gaging Site Photos ISR Part A for Study 8.5 (File 4)
ISR 8.5 Part A, Appendix G: HSC Histogram Plots	6/3/2014	This appendix provides histograms based on 2013 HSC field data.	HSC Histogram Plots ISR Part A for Study 8.5 (File 5)
ISR 8.5 Part A, Appendix H: Periodicity Tables	6/3/2014	This appendix provides an initial summary of species and life stage periodicity based on 1980s data and preliminary results of 2013 data.	Periodicity Table ISR Part A for Study 8.5 (File 5)

Title	Date	Description	Link
ISR 8.5 Appendix I: Lower River Hydraulic Model Calibration	6/3/2014	This appendix provides hydraulic modeling details for two instream flow study sites in the Lower River Segment (Birch Creek and PRM 97).	LR Hydraulic Model Calibration ISR Part A for Study 8.5 (File 5)
ISR 8.5 Part C, Appendix J: Representative Years	6/3/2014	This appendix outlines the methods and results to select a final set of representative years for analysis. This study component is complete.	Representative Years ISR Part C for Study 8.5 (File 1)
ISR 8.5 Part C, Appendix K: Hydrology and Version 2 Open-water Flow Routing Model	6/3/2014	Describes interim Version 2 of the OWFRM and Hydrology methods, data, modeling development process, and results for mainstem data collection, tributary gaging, and winter gaging. This appendix is superseded by the Study 8.5, SIR Appendix B: Version 2.8 of the OWFRM.	OWFRM 2.0 and Hydrology ISR Part C for Study 8.5 (File 1)
ISR 8.5 Part C, Appendix L: 2012-2013 Instream Flow Winter Pilot Studies	6/3/2014	This appendix describes the results of the pilot IFS winter studies (2012-2013).	2013-2013 Winter Studies ISR Part C for Study 8.5 (File 2)
ISR 8.5 Part C, Appendix M: Habitat Suitability Curve Development	6/3/2014	This appendix provides detailed field and data analysis procedures used to develop draft HSC for Chum Salmon spawning and Coho Salmon fry based on site-specific habitat utilization and availability data collected in 2013.	Draft HSC for Two Lifstages ISR Part C for Study 8.5 (File 2)
ISR 8.5 Part C, Appendix N: Middle River Fish Habitat and Riverine Modeling: Proof of Concept	6/3/2014	This appendix describes the April 15-17, 2014 technical team meetings designed to demonstrate application of the suite of riverine models using two key biological metrics (effective salmon spawning/incubation and juvenile salmonid rearing). These meetings, termed Proof of Concept, outlined the step-wise procedures being used to evaluate effects of Project operations on riverine processes and fish habitat.	River Modeling Proof of Concept ISR Part C for Study 8.5 (File 2)
ISR 8.5 Part C, Appendix O: Fish Habitat Modeling in Lower River	6/3/2014	This appendix provides fish habitat modeling results for one Lower River instream flow study site (Birch Creek). This appendix is a companion document to Part C, Appendix I that provided hydraulic modeling details for two instream flow study sites in the Lower River Segment (Birch Creek and PRM 97).	LR Modeling ISR Part C for Study 8.5 (File 2)
Evaluation of Relationships between Fish Abundance and Specific Microhabitat Variables Technical Memorandum	9/17/2014	Detailed evaluation of the comparison of fish abundance measures with specific microhabitat variable measurements where sampling overlaps. Developed in response to April 1, 2013 FERC Study Plan Determination.	Fish and Microhabitat Variables

Title	Date	Description	Link
2013-2014 Instream Flow Winter Studies Technical Memorandum	9/17/2014	Describes the study methods and field activities, and summarizes data and information collected during the 2013-2014 Winter Studies component of Study 8.5 (IFS).	2013-2014 IFS Winter Studies
Initial Study Report Meetings. October 17, 2014 (Parts A and B)	11/14/2014	Transcripts and AEA's agenda and PowerPoint presentations for the ISR meeting concerning the Project fish and aquatics instream flow study.	Transcripts from ISR Meeting Materials from ISR Meeting
Fish and Aquatics Instream Flow Study (8.5) – 2014-2015 Study Implementation Report	11/06/2015	AEA's Study Implementation Report: a summary of progress in implementing the Instream Flow Study since June 2014.	2014-2015 SIR for Study 08.05 (File 1) 2014-2015 SIR for Study 08.05 (File 2)
SIR 8.5 Appendix A: Instream Flow Winter Studies	11/06/2015	Incorporates late winter 2013/2014 and 2014 spring break-up and open-water transition period.	2014-2015 SIR for Study 08.05 (File 3)
SIR 8.5 Appendix B: Open-water Hydrology Data Collection and Open-water Flow Routing Model (Version 2.8)	11/06/2015	This appendix provides an updated version of the OWFRM (Version 2.8) that represents a final model for the contains OWFRM Version 2.8 and Hydrology methods, data, and modeling development process for mainstem data collection, tributary gaging, and OWFRM as available and developed through Fall 2014.	2014-2015 SIR for Study 08.05 (File 4)
SIR 8.5 Appendix C: 2014 Moving Boat Acoustic Doppler Current Profiler (ADCP) Measurements	11/06/2015	This appendix provides supplemental details on field data collection and analysis procedures employed in 2014 for moving-boat Acoustic Doppler Current Profiler (ADCP) measurements.	2014-2015 SIR for Study 08.05 (File 5)
SIR 8.5 Appendix D: Habitat Suitability Curve Development	11/06/2015	This appendix proposes multivariate HSC for 12 species/life stages based on 2013 and 2014 data and provides additional detail on data analysis procedures. Comparisons of habitat use between river segments (Lower and Middle River segments) and season (summer and winter) are also presented as histogram plots for each species and life stage with sufficient observations.	2014-2015 SIR for Study 08.05 (File 6)
SIR 8.5 Appendix E: Fish Habitat Modeling Data: Surficial Substrate and Cover Characterization and Salmon Spawning Observations by Focus Area	11/06/2015	This appendix provides GIS polygons describing the distribution of surficial substrates, cover characterizations, and observed salmon spawning sites for the eight Middle River Focus Areas below Devils Canyon. These data will be used in modeling of fish habitat in the Middle River to evaluate Project effects.	2014-2015 SIR for Study 08.05 (File 7) 2014-2014 SIR for Study 08.05 (File 8)

5. NEW STUDY DOCUMENTATION SUPPLEMENTING THE ISR

The following table identifies and describes additional reports and other documents that update, refine, or otherwise supplement certain sections of the ISR pertaining to this Study 8.5, during AEA's continued implementation of the Study Plan since the ISR was filed in June 2014.

ISR Reference	Description
Part A, Section 4	This section is updated by Study Implementation Report Section 4, describing the 2014-2015 Study Plan Implementation.
Part A, Section 5	This section is updated by Study Implementation report Section 5, describing the results of the 2014-2015 Study Plan Implementation.
Part A, Section 6	This section is updated by SIR Study 8.5, Section 6: Discussion
Part B	This ISR document provides supplemental information and errata to the ISR Part A
Part C, Section 7	This section is superseded by ISR Study 8.5, Part D, Section 8: Steps to Complete the Study and SIR Study 8.5, Section 7: Conclusion.
Part A, Appendix A	Hydrologic Methods. This Appendix provides details on hydrology data collection methods that are consistent with the Commission-approved Study Plan. It is supplemented by Technical Memoranda describing field methods for moving boat Acoustic Doppler Current Profiler (ADCP) measurements (2013 methods in Part A, Appendix C and 2014 methods in SIR Appendix C). This Appendix is also supplemented by information presented on tributary gaging sites (Part A, Appendix E and F, and SIR Study 8.5, Appendix B).
Part A, Appendix C	2013 Moving Boat ADCP Measurements. This Appendix provides details on field data collection and analysis procedures employed in 2013. A separate Technical Memorandum is provided on methods employed in 2014: 2014 Moving Boat Acoustic Doppler Current Profiler (ADCP) Measurements. SIR Study 8.5, Appendix C.
Part A, Appendix D	GINA Initial Study Report 8.5 Data Files. This Appendix lists data files used to develop Part A of the ISR that are available on the Geographic Information Network of Alaska. This information is updated by Study 8.5 SIR, Table 5-1 (Summary of the QC3 data files used in support of this SIR and its appendices that have been delivered to GINA and are publically available).
Part A, Appendix E	Tributary Gaging Site Schematics. This Appendix is superseded by Open-water Hydrology Data Collection and Open-water Flow Routing Model (Version 2.8), SIR Study 8.5, Appendix B.
Part A, Appendix F	Tributary Gaging Representative Site Photos. This Appendix provides photographic images of tributary gaging sites. It is supplemental to Part A, Appendices A and E.
Part A, Appendix G	HSC Histogram Plots. This appendix provides histograms based on 2013 data; the histogram plots in Appendix G are superseded by histogram plots in the Technical Memorandum on Habitat Suitability Criteria Development, SIR Study 8.5, Appendix D.
Part A, Appendix H	Periodicity Tables. This Appendix provides an initial summary of species and life stage periodicity based largely on information from the 1980s licensing studies and information provided in ADF&G reports developed prior to the current licensing effort. These preliminary tables will be updated with information developed by Study 9.6 (Fish Distribution and Abundance in the Middle and Lower Susitna River) and Study 8.5 (IFS).
Part A, Appendix I	Lower River Hydraulic Model Calibration. This Appendix provides hydraulic modeling details for two instream flow study sites in the Lower River Segment (Birch Creek and PRM 97). This appendix is a companion document to Part C, Appendix O that provides fish habitat modeling results for the Birch Creek site.

ISR Reference	Description
Part C, Appendix K	Hydrology and Version 2 Open-water Flow Routing Model. This appendix is superseded by: Open-water Hydrology Data Collection and Open-water Flow Routing Model (Version 2.8), SIR Study 8.5, Appendix B.
Part C, Appendix L	2012-2013 Instream Flow Winter Pilot Studies. This Appendix describes the results of the pilot winter studies and is supplemented by the September 17, 2014 filing of the 2013-2014 Winter Studies report, and a report on 2014-2015 Winter Studies activities (SIR Study 8.5, Appendix A).
Part C, Appendix M	Habitat Suitability Curve Development. This Appendix provides detailed field and data analysis procedures used to develop draft HSC for Chum Salmon spawning and Coho Salmon fry. This appendix is superseded by the SIR Study 8.5, Appendix D (Habitat Suitability Criteria Development) that proposes multivariate HSC for 12 species/life stages and provides greater detail on data analysis procedures.
Part C, Appendix O	Fish Habitat Modeling in Lower River. This Appendix provides fish habitat modeling results for one Lower River instream flow study site (Birch Creek). This appendix is a companion document to Part C, Appendix I that provided hydraulic modeling details for two instream flow study sites in the Lower River Segment (Birch Creek and PRM 97).
September 17, 2014 Filing of Technical Memoranda	2013-2014 Instream Flow Winter Studies, Fish and Aquatics Instream Flow Study (Study 8.5). This Technical Memorandum supplements the results of the 2012-2013 pilot winter studies (Part C, Appendix L), and is supplemented by the report on 2014-2015 Winter Studies activities (SIR Study 8.5, Appendix A).
2014-2015 SIR, Appendix A	2014-2015 Instream Flow Winter Studies. This Technical Memorandum supplements the results of the 2012-2013 pilot winter studies (Part C, Appendix L), and the September 17, 2014 filing of the 2013-2014 Winter Studies report.
2014-2015 Appendix B	SIR, Open-water Hydrology Data Collection and Open-water Flow Routing Model (Version 2.8). This Appendix includes 2013 and 2014 data and supersedes Part C, Appendix K, Hydrology and Version 2 Open-water Flow Routing Model.
2014-2015 Appendix C	SIR, 2014 Moving Boat Acoustic Doppler Current Profiler (ADCP) Measurements. This appendix provides supplemental details on field data collection and analysis procedures employed in 2014. A separate Technical Memorandum is provided on methods employed in 2013: Part A, Appendix C.
2014-2015 Appendix D	SIR, Habitat Suitability Criteria Development. This Appendix proposes multivariate HSC for 12 species/life stages and provides greater detail on data analysis procedures; this appendix supersedes Part A, Appendix G (HSC Histogram Plots) and Part C, Appendix M that provided draft HSC for Chum Salmon spawning and Coho Salmon fry.
2014-2015 Appendix E	SIR, This appendix provides GIS polygons describing the distribution of surficial substrates, cover characterizations, and observed salmon spawning sites for the eight Middle River Focus Areas below Devils Canyon. These data supplement results presented in ISR Study 8.5, Part A, Section 5.5.4.

6. VARIANCES

6.1. 2013 Study Season

The following variances are reported in the June 2014 ISR.

- The Study Plan indicated 13 mainstem water-level recording stations would be maintained in 2013 (RSP Section 8.5.4.3.1). After calibration and validation of the Version 1 OWFRM, and in response to land owner access issues, five stations were not maintained in 2013 (ISR Study 8.5, Part A, Section 4.4.2).
- The Study Plan indicated continuous stage measurements would be collected in the mainstem (RSP Section 8.5.4.3.1). Due to ice damage, flooding and land access issues, some short and long-term data gaps of water stage exist for eight hydrology locations (ISR Study 8.5, Part A, Section 4.3.2).
- The Study Plan indicated continuous gaging would be installed at Fog Creek and Portage Creek (RSP Section 8.5.4.4.1.1). Due to land access issues, these were not installed in 2013 (ISR Study 8.5, Part A, Section 4.3.2).
- The Study Plan indicated that specific representative years and the duration of the continuous flow record would be selected by AEA in consultation with the TWG in Q3 2013 (RSP Section 8.5.4.4.1.2). This selection was discussed at the November 13-15, 2013 Riverine Modelers meeting and Q4 2013 TWG meeting. (ISR Study 8.5, Part A, Section 4.3.2). The recommended representative years and the rationale for selection were presented at the April 15-17, 2014 Proof of Concept (POC) meeting and described in ISR Study 8.5, Part C, Appendix J.
- The Study Plan indicated that hydrologic parameters for IHA analysis would be developed in consultation with the TWG in Q3 2013 and interim results of IHA-type analysis would be presented in the ISR (RSP Section 8.5.4.4.1.3). A description of the initial proposed methodology is provided in ISR Study 8.5, Part A, Section 5.3, and Part C, Section 7.3 and will undergo continued discussion and coordination with the TWG (ISR Study 8.5, Part A, Section 4.3.2). An Instream Flow Study (IFS) Technical Team (TT) meeting occurred on March 21, 2014 which reviewed candidate metrics and proposed analysis for Indicators of Hydrologic Alteration (IHA) and Environmental Flow Component (EFC).
- The Study Plan indicated that HSC sample sites would be stratified and randomly selected from within the MR and LR (RSP Section 8.5.4.5.1.1.3). Due to access restrictions, the MR was limited to habitat areas between Portage Creek and Three Rivers Confluence. Due to flow related delays in completing the habitat mapping surveys and the desire to focus sampling in 2013 on the MR, the LR was not sampled in 2013 (ISR Study 8.5, Part A, Section 4.5.2).
- The Study Plan indicated spawning redd dimensions would be collected (RSP Sections 8.5.4.5.1.1.4 and 8.5.4.5.1.1.5). These were collected in 2012 but in 2013 deemed unnecessary for developing evaluation metrics (ISR Study 8.5, Part A, Section 4.5.2).
- The Study Plan indicated that substrate size (dominant, sub-dominant, and percent dominant) would be characterized in accordance with a Wentworth grain size scale modified to reflect English units (RSP Sections 8.5.4.5.1.1.4, 8.5.4.5.1.1.5, 8.5.4.5.1.1.6.1, and 8.5.4.6.1.2.4). Field personnel found it impracticable to attempt to

accurately differentiate gravel composition into three size classes in turbid water conditions and used two instead (ISR Study 8.5, Part A, Section 4.5.2).

- The Study Plan indicated that location in water column, focal point, and mean column velocity would be measured using a Price AA current meter (RSP Section 8.5.4.5.1.1.6.1). Most fish captures occurred using electrofishing, seining or a combination of the two methods which precluded the identification of fish focal point position within the water column (ISR Study 8.5, Part A, Section 4.5.2).
- The Study Plan indicated that mesohabitat type would be recorded for fish observation/capture points (RSP Section 8.5.4.5.1.1.6.1). However, this was not done during the field surveys but will be completed after the mesohabitat mapping task is complete by applying GIS data layers containing the location of HSC fish use observations to denote mesohabitat types (ISR Study 8.5, Part A, Section 4.5.2).
- The Study Plan indicated that field surveys would be conducted at potential stranding and trapping areas on an opportunistic basis following up to three flow reduction events during 2013 (RSP Section 8.5.4.5.1.2.2). During a May 17, 2013 Technical Team meeting, participants indicated that site-specific stranding and trapping studies should be a low priority. Because the Project does not yet exist, the effects of Project-induced flow fluctuations cannot be directly studied in the Susitna River. Some opportunistic observations of potential stranding and trapping areas were recorded during substrate classification surveys conducted during falling river stage conditions in September 2013, but the observations did not follow robust survey protocols. Although specific stranding and trapping surveys were not conducted in 2013, this change is not expected to adversely impact achieving Project objectives. As discussed and documented during the May 17, 2013 TWG meeting, ramping criteria developed in Washington State (Hunter, M.A. 1992. Hydropower flow fluctuations and salmonids: a review of the biological effects, mechanical causes, and options for mitigation. Washington Department of Fisheries, Technical Report No. 119) will be proposed as fallback criteria during Project effects analyses.
- The Study Plan indicated that 2012-2013 winter study results would be distributed to the TWG by Q3 2013 (RSP Section 8.5.4.5.1.2.1). The results were presented and discussed during an IFS TT meeting in March 2014 (ISR Study 8.5, Part A, Section 4.5.2 and Part C, Appendix L).
- The Study Plan indicated that macroinvertebrate sampling would occur at six stations, each with three sites (one mainstem site and two off-channel sites associated with the mainstem site), for a total of 18 sites (RSP Section 8.5.4.5.1.2.3). This sampling occurred at five stations on the Susitna River, each station with three to five sites (establishing sites at all macrohabitat types present within the station), for a total of 20 sites (ISR Study 8.5, Part A, Section 4.5.2).
- The Study Plan indicated the Dëshka River Chinook Salmon and Yentna River Sockeye Salmon datasets would be examined for flow-dependent biological cues (RSP Section 8.5.4.5.1.3). Mainly due to lack of the necessary data, the Dëshka River and the Yentna River were not used for this study. Through further discussions with Alaska Department

of Fish and Game (ADF&G), the Taku River and Stikine River Chinook Salmon stocks were selected (ISR Study 8.5, Part A, Section 4.5.2).

- In their April 1, 2013 Study Plan Determination, the FERC requested that additional variables be compared to fish distribution and abundance: surface flow and groundwater exchange fluxes, dissolved oxygen (intergravel and surface water), macronutrients, temperature (intergravel and surface water), pH, dissolved organic carbon, alkalinity, and Chlorophyll-a. Depending on these relationships, additional HSC preference curves may be needed. Most of the data necessary to complete this analysis was still being processed and/or undergoing quality assurance checks and was not available as of June 2014 (ISR Study 8.5, Part A, Section 4.5.2 and Part C, Section 7.5.1.2.1). The results of the analysis were reported in a Technical Memorandum (Evaluation of Relationships between Fish Abundance and Specific Microhabitat Variables) submitted to FERC on September 17, 2014 and discussed at the October 17, 2014 ISR meetings.
- The Study Plan (R2 Resource Consultants. 2013. Selection of Focus Areas and Study Sites in the Middle and Lower Susitna River for Instream Flow and Joint Resource Studies – 2013 and 2014. Susitna-Watana Hydroelectric Project, FERC No. P-14241 Submittal: March 1, 2013, Attachment C, Joint Resource Study Technical Memorandum) indicated that 1-D PHABSIM sites in LR geomorphic reaches LR-1 and LR-2 would be surveyed in 2013. Sites in LR-1 were surveyed in 2013: (PRM97, PRM96, PRM95, Trapper Creek, Birch Creek, and Dshka River), but survey of sites in LR-2 including Sheep Creek and Caswell Creek between PRM 65 to PRM 70 was deferred to the next study year in order to evaluate the effectiveness of the model outputs and evaluate the need for additional sites (ISR Study 8.5, Part A, Section 4.6.2).
- The Study Plan indicated that an evaluation of the representativeness of the Lower River study areas was to occur by Q4 2013 [Technical Memorandum, *Selection of Focus Areas and Study Sites in the Middle and Lower Susitna River for Instream Flow and Joint Resource Studies – 2013 and 2014*]. This task was completed as part of the IFS TT POC Meetings, April 15-17, 2014; ISR Study 8.5, Part C, Section 7.6.
- The Study Plan indicated that the final approach and details concerning methods for conducting temporal analysis and Project operational scenarios would be discussed with the TWG in Q4 2013 (RSP Section 8.5.4.7.1.1). The general approaches to be used for the spatial analysis of the fish habitat models and the temporal analysis for the different resource models were discussed as part of the November 13-15, 2013 IFS TT Riverine Modelers meeting. More details concerning these methods are provided in this ISR and AEA discussed application of the temporal methods and presented options for the spatial analysis during the IFS TT POC meeting, April 15-17, 2014 (ISR Study 8.5, Part A, Section 4.7.2 and Part C, Section 7.7).

6.2. 2014 Study Season

As noted in Section 4 of the Study Completion Report for this study, the following variances occurred following the filing of the June 2014 ISR:

- While land access was not available for the three upper Focus Areas adjacent to CIRWG lands in 2013, this restriction was resolved in 2014 and AEA was able to complete detailed surveys in one of the three Focus Areas (FA-151-Portage Creek) in September 2014. However, work on FA-173 (Stephan Lake Complex) and FA-184 (Watana Dam) was deferred. Even so, this is not considered a variance because this study was designed to collect data over multiple years.
- The Study Plan indicated 13 mainstem water-level recording stations would be maintained in 2013-2014 (RSP Section 8.5.4.3.1). After calibration and validation of the Version 1 OWFRM, and in response to land owner access issues, five stations were not maintained in 2013 (ISR Study 8.5, Part A, Section 4.4.2). At least six of the original hydrology stations were maintained in 2014 for water level and temperature (ESS80 [PRM 225.0]; ESS70 [PRM 187.1]; ESS65 [PRM 176.5]; ESS55 [PRM 152.2]; ESS40 [PRM 107.2]; ESS30 [PRM 98.4]). All of the other remaining hydrology stations were maintained to record air temperature and camera images. While water-level recording was not continued at all 13 of the hydrology stations installed in 2012, data will be available at more than 13 mainstem water-level recording stations during some or all of 2014. Additional water-level recording stations were maintained in 2014 to address the specific needs of the fish habitat modeling efforts. For instance, during 2013, water level recording stations were installed in the mainstem Susitna River near the confluence of Trapper Creek (PRM 95.4), Birch Creek (PRM 93.3) and the Deshka River (PRM 44.9) and were maintained during 2014. Additional water-level recording stations were installed and maintained in 2014 in the mainstem Susitna River near the confluence of Sheep Creek (PRM 71.7) and Caswell Creeks (PRM 67.3). Additional water-level recording stations were also installed and maintained in the mainstem Susitna River in 2014 as needed to provide calibration data for MR Focus Areas. Given the availability of complete data sets at seven locations (three ESS stations and four United States Geological Survey [USGS] stations), and additional water-level recording stations installed in response to data needs at fish habitat Focus Areas and LR study sites, sufficient hydrology data will be available to achieve Study Plan objectives.
- The Study Plan indicated continuous gaging would be installed at Fog Creek and Portage Creek (RSP Section 8.5.4.4.1.1). Due to land access issues, these were not installed in 2013 (ISR Study 8.5, Part A, Section 4.3.2). Data has been collected on Portage Creek since June 2014. A continuous gage was installed on Fog Creek in summer 2014, but no rating curve could be established since a tree fell after the gage was installed affecting the site hydraulics. Instead, only spot measurement streamflow data were collected at Fog Creek. Data gaps associated with the lack of continuous gage data on Fog Creek will not significantly affect accretion calculations used in the OWFRM.
- The Study Plan indicated that HSC sample sites would be stratified and randomly selected from within the MR and LR (RSP Section 8.5.4.5.1.1.3). Due to access restrictions during 2013, HSC sampling was conducted in the MR Segment below Devils Canyon (PRM 151.8). No HSC sampling was conducted in the MR Segment above Devils Canyon, or in the LR Segment. In 2014, HSC sampling was conducted in the MR Segment above and below Devils Canyon and in the LR segment at two tributary complexes (Trapper/Birch creeks and Sheep/Caswell creeks). Additional HSC sampling

effort will be conducted in the MR Segment above Devils Canyon and in the LR Segment. These changes are not anticipated to adversely impact achieving Project objectives.

- The Study Plan indicated spawning redd dimensions would be collected (RSP Sections 8.5.4.5.1.1.4 and 8.5.4.5.1.1.5). These were collected in 2012 but in 2013 deemed unnecessary for developing evaluation metrics (ISR Study 8.5, Part A, Section 4.5.2).
- The Study Plan indicated that substrate size (dominant, sub-dominant, and percent dominant) would be characterized in accordance with a Wentworth grain size scale modified to reflect English units (RSP Sections 8.5.4.5.1.1.4, 8.5.4.5.1.1.5, 8.5.4.5.1.1.6.1, and 8.5.4.6.1.2.4). Field personnel found it impracticable to attempt to accurately differentiate gravel composition into three size classes in turbid water conditions and used two instead (ISR Study 8.5, Part A, Section 4.5.2).
- The Study Plan indicated that location in water column, focal point, and mean column velocity would be measured using a Price AA current meter (RSP Section 8.5.4.5.1.1.6.1). Most fish captures occurred using electrofishing, seining or a combination of the two methods which precluded the identification of fish focal point position within the water column (ISR Study 8.5, Part A, Section 4.5.2).
- The Study Plan indicated that field surveys would be conducted at potential stranding and trapping areas on an opportunistic basis following up to three flow reduction events during 2013-2014 (RSP Section 8.5.4.5.1.2.2). During a May 17, 2013 Technical Team meeting, participants indicated that site-specific stranding and trapping studies should be a low priority. Because the Project does not yet exist, the effects of Project-induced flow fluctuations cannot be directly studied in the Susitna River. Although specific stranding and trapping surveys were not conducted in 2014, this change is not expected to adversely impact achieving Project objectives. As discussed and documented during the May 17, 2013 TWG meeting, ramping criteria developed in Washington State (Hunter 1992) will be proposed as fallback criteria during effects analyses.
- The Study Plan indicated that macroinvertebrate sampling would occur at six stations, each with three sites (one mainstem site and two off-channel sites associated with the mainstem site), for a total of 18 sites (RSP Section 8.5.4.5.1.2.3). This sampling occurred at five stations on the Susitna River, each station with three to five sites (establishing sites at all macrohabitat types present within the station), for a total of 20 sites (ISR Study 8.5, Part A, Section 4.5.2).
- The Study Plan (R2 Resource Consultants. 2013. Selection of Focus Areas and Study Sites in the Middle and Lower Susitna River for Instream Flow and Joint Resource Studies – 2013 and 2014. Susitna-Watana Hydroelectric Project, FERC No. P-14241 Submittal: March 1, 2013, Attachment C, Joint Resource Study Technical Memorandum) indicated that 1-D PHABSIM sites in LR geomorphic reaches LR-1 and LR-2 would be surveyed in 2013. Sites in LR-1 (PRM97, PRM96, PRM95, Trapper Creek, and Birch Creek), and Deshka River (PRM 44.9) were surveyed in 2013, but survey of sites in LR-2 between PRM 65 to PRM 70 (including Sheep Creek and Caswell Creek) was deferred to the next study year in order to evaluate the effectiveness of the model outputs and

evaluate the need for additional sites (ISR Study 8.5, Part A, Section 4.6.2). Surveying of 1-D PHABSIM sites in LR-2 was not conducted in 2014; however, flow data were collected in Sheep and Caswell creeks and the Deshka River (Section 4.3) and HSC data were collected in LR-2 between PRM 65 to PRM 70. Surveying, hydraulic model calibration, and habitat modeling of LR-2 sites is needed to complete this study component; this change in schedule will not have a substantive effect on meeting study objectives.

- The Study Plan indicated that the final approach and details concerning methods for conducting temporal analysis and Project operational scenarios would be discussed with the TWG in Q4 2013 (RSP Section 8.5.4.7.1.1). The general approaches to be used for the spatial analysis of the fish habitat models and the temporal analysis for the different resource models were discussed as part of the November 13-15, 2013 IFS TT Riverine Modelers meeting. More details concerning these methods are provided in this ISR and AEA discussed application of the temporal methods and presented options for the spatial analysis during the IFS TT POC meeting, April 15-17, 2014 (ISR Study 8.5, Part A, Section 4.7.2 and Part C, Section 7.7).

7. STUDY PLAN MODIFICATIONS

7.1. Modifications Identified in ISR

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

- The Study Plan (RSP Section 8.5.4.3.1) identified that 13 hydrology stations identified in 2012 will be maintained in 2013 and 2014. However, several of the original hydrology stations established in 2012 were discontinued while other hydrology stations and hydrologic stage recorders were installed to address riverine modeling data needs. While water-level recording was not continued at all 13 of the hydrology stations installed in 2012, data will be available at more than 13 mainstem water-level recording stations during some or all of 2014. Given the availability of complete data sets at seven locations (three ESS stations and four USGS stations), and additional water-level recording stations installed in response to data needs at fish habitat Focus Areas and LR study sites, sufficient hydrology data will be available to achieve Study Plan objectives.
- To complete the tributary gaging tasks associated with this study component, AEA will implement the methods in the Study Plan (RSP Section 8.5.4.4.1). The RSP states that gaging stations will be added at selected tributaries to help provide additional hydrologic analysis for hydrologic and fisheries studies. These tributaries will include Fog Creek, Portage Creek, and Indian River. These gaging stations were intended to be installed in spring 2013 to help measure the spring snowmelt peaks. Hydrology gages were not installed at Fog Creek and Portage Creek in 2013 due to land access issues. Gaging was conducted at Fog Creek, Portage Creek, and Indian River in 2014. The delay in installing gages at Fog and Portage creeks will not significantly affect use of the data to achieve Study Plan objectives. RSP Section 8.5.4.4.1.2 identifies that five representative years

will be selected that represent, wet, average, and dry conditions, and warm and cool Pacific Decadal Oscillation phases in 2013. The topic of representative years was discussed at the November 13-15, 2013 IFS TT Riverine Modelers meeting, the Q4 2013 TWG meeting, and at the IFS TT POC meeting on April 15-17, 2014. AEA proposed 1981 (wet/warm), 1985 (average), and 1976 (dry/cold) as representative years in ISR Part C, Appendix J (Representative Years).

- IHA/EFC-type analyses will be used as indicators of Project effects by comparing hydrologic statistics describing Existing Conditions and Project operational scenarios. The RSP states that select hydrologic parameters, considered to be ecologically relevant to Susitna River resources, will be developed in consultation with the TWG in 2013, and that interim results of the IHA-type analyses will be presented in the ISR. AEA proposed a list of IHA/EFC metrics at the March 21, 2014 TWG meeting. Final metrics will be developed with input from the TWG and other resource disciplines after Version 3 of the Open-water Flow Routing Model is available in 2015. The OWFRM will translate hourly Project dam releases to downstream stations and is integral to conducting IHA/EFC-type analyses. A fully developed methodology is needed to complete the study component.
- In their SPD (FERC April 1, 2013 SPD, page B-85) FERC recommended that AEA file with the ISR the results of analyses to determine whether a relationship between specific microhabitat variables and fish abundance is evident. These microhabitat variables include: surface flow and groundwater exchange fluxes, dissolved oxygen (intergravel and surface water), macronutrients, temperature (intergravel and surface water), pH, dissolved organic carbon, alkalinity, and Chlorophyll-a. Depending on the results of the analysis, additional HSC/HSI curves may be needed. Most of the data necessary to complete these analyses were still being processed and/or undergoing quality assurance checks; these analyses could not be completed and included in the June 2014 ISR (Section 4.5.2 above). A detailed evaluation of the comparison of fish abundance measures with specific microhabitat variable measurements was summarized in a Technical Memorandum (Evaluation of Relationships between Fish Abundance and Specific Microhabitat Variables) filed with FERC on September 17, 2014.
- As described in ISR Study 8.5, Part A, Section 4.6.2, AEA is deferring LR-2 field studies. This schedule modification for completing the Study Plan for the LR will not impact AEA's ability to meet the objectives of the Study Plan. All other methods for LR fish habitat modeling will remain unchanged from the methods described in RSP Sections 8.5.4.2 through 8.5.4.7).
- Temporal analyses include extrapolating the results of 2-D modeling of Focus Area fish habitats from existing conditions (i.e., License Year 0) to future conditions (i.e., Years 25 and 50). Spatial analyses include applying 1-D and 2-D fish habitat model results from modeled to non-modeled areas. General approaches for temporal and spatial analysis were discussed during the November 13-15, 2013 IFS TT Riverine Modelers meeting, and were more specifically described during the IFS TT POC meeting on April 15-17, 2014. The final approaches for both the temporal and spatial analysis were to be provided in the ISR (RSP Section 8.5.4.7.1.3); and while discussion occurred during

implementation of the Study Plan in 2013 and early 2014, decisions on the final approaches were deferred to 2015.

7.2. Modifications Identified since the June 2014 ISR

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

- The Study Plan (R2 Resource Consultants. 2013. Selection of Focus Areas and Study Sites in the Middle and Lower Susitna River for Instream Flow and Joint Resource Studies – 2013 and 2014. Susitna-Watana Hydroelectric Project, FERC No. P-14241 Submittal: March 1, 2013, Attachment C, Joint Resource Study Technical Memorandum) indicated that 1-D PHABSIM sites in LR geomorphic reaches LR-1 and LR-2 would be surveyed in 2013. Sites in LR-1 were surveyed in 2013: (PRM97, PRM96, PRM95, Trapper Creek, Birch Creek, and Dshka River), but survey of sites in LR-2 including Sheep Creek and Caswell Creek between PRM 65 to PRM 70 was deferred to the next study year in order to evaluate the effectiveness of the model outputs and evaluate the need for additional sites (ISR Study 8.5, Part A, Section 4.6.2). Surveying of 1-D PHABSIM sites in LR-2 was not conducted in 2014; however, flow data were collected in Sheep and Caswell creeks and the Dshka River (Section 4.3) and HSC data were collected in LR-2 between PRM 65 to PRM 70. Surveying of 1-D PHABSIM sites in LR-2 and associated data analysis and modeling is needed to complete the study component.
- A reservoir operations model is needed to forecast a range of reservoir outflows associated with different operational scenarios that will be evaluated as part of the IFS. Originally HEC ResSim was used to simulate reservoir operations as described in the ISR Study 8.5, Section 4.4. As the model operational scenarios changed, it became apparent HEC ResSim could not adequately simulate conditions and a proprietary reservoir operations model was developed (MWH-ROM). This model is a water balance type of reservoir operation model that accounts for flow through the project reservoir, penstocks, and powerhouse on an hourly basis for the continuous 61-year period of record (Engineering Feasibility Report, Section 12.1.3.1, Reservoir Operation Model.).
- Temporal analyses include extrapolating the results of 2-D modeling of Focus Area fish habitats from existing conditions (i.e., License Year 0) to future conditions (i.e., Years 25 and 50). Spatial analyses include applying 1-D and 2-D fish habitat model results from modeled to non-modeled areas. General approaches for temporal and spatial analysis were discussed during the November 13-15, 2013 IFS TT Riverine Modelers meeting, and were more specifically described during the IFS TT POC meeting on April 15-17, 2014. The final approaches for both the temporal and spatial analysis were to be provided in the ISR (RSP Section 8.5.4.7.1.3); and while discussion occurred during implementation of the Study Plan in 2013 and early 2014, decisions on the final approaches are needed to complete the study component.

8. STEPS TO COMPLETE THE STUDY

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

AEA's plans for completing this study include the continued collection and analysis of data and information that will be used in development of the different resource models, and specifically the habitat-flow models. In addition, AEA will finalize methods for the temporal and spatial analysis of information, as well as the Decision Support System. More details are provided below by study component.

Additional hydrology data will continue to be collected. Remaining data collection efforts will focus on mainstem hydrology stations, mainstem transect data in the LR needed to fill data gaps in the OWFRM, remaining 1-D PHABSIM sites in the LR (PRM 65 to PRM 70), tributary gage data as needed to support Focus Area modeling, and measurement of the two remaining Focus Areas in the MR above Devils Canyon (FA-173 [Stephan Lake Complex] and FA-184 [Watana Dam]). In addition, inlet elevations will be measured at major MR side channels and sloughs to calculate breaching flows that affect habitat connectivity. The mainstem transect and tributary data will be used to refine and complete Version 3 of the Open-water Flow Routing Model. IHA and EFC parameters will continue to be reviewed with the agencies and will be finalized prior to completion of Version 3 of the Open-water Flow Routing model.

AEA plans to complete development of HSC/HSI curves/models for the MR and LR of the river. Two years of HSC sampling have been completed in the MR Focus Areas below FA-151 (Portage Creek), and one year of study has been completed in FA-151 (Portage Creek), two MR Focus Areas above Devils Canyon, and in the LR. An additional year of study will be completed in MR Focus Areas FA-151 (Portage Creek), FA-173 (Stephan Lake Complex), and FA-184 (Watana Dam), and in the LR. Remaining steps to complete the HSC/HSI study component include:

- Conduct HSC/HSI sampling in representative habitat types in the LR of the Susitna River in association with Trapper, Birch, Sheep, and Caswell creeks.
- Conduct HSC/HSI sampling in FA-151 (Portage Creek), FA-173 (Stephan Lake Complex), and FA-184 (Watana Dam).
- Develop final species and life stage specific periodicity tables for use in habitat modeling.
- Conduct Winter Studies including monitoring stage and water quality data at main channel and off-channel sites in FA-104, FA-128 and FA-138.
- Conduct winter sampling including fish observation, capture, and monitoring to discern seasonal habitat use patterns.

AEA will also continue working on the development of habitat-specific models in both the MR and LR following methods described in the Commission-approved Study Plan (RSP Sections 8.5.4.5 and 8.5.4.6). In the MR, these efforts will include:

- Collection of substrate and cover data within the remaining two Focus Areas above Devils Canyon (FA-173 [Stephan Lake Complex] and FA-184 [Watana Dam Site]).
- Finalization of 2-D hydraulic models in each of the eight Focus Areas that have already been surveyed between PRM 104 and PRM 151: (FA-104 [Whiskers Slough], FA-113 [Oxbow 1], FA-115 [Slough 6A], FA-128 [Slough 8A], FA-138 [Gold Creek], FA-141 [Indian River], FA-144 [Slough 21]), and FA-151 [Portage Creek]), and the two Focus Areas that have not yet been surveyed (FA-173 [Stephan Lake Complex] and FA-184 [Watana Dam]). The 2-D hydraulic models will be developed under Study 6.6 (Fluvial Geomorphology Modeling) but reviewed and potentially adjusted for use in habitat modeling.
- Finalization of the Visual Basic (VB) models and associated GIS tools to allow computation of HSC/HSI habitat evaluation metrics in MR Focus Areas over a range of flow conditions (ISR Study 8.5, Part A, Section 5.6.4.1).
- Final calibration and refinement of the Effective Spawning/Incubation and Salmon Rearing models as described in ISR Study 8.5, Part A, Section 5.6.4.2, and presented during the IFS TT POC meeting on April 15-17, 2014.
- Development of varial zone models for each of the ten Focus Areas (RSP Section 8.5.4.6.1.6)
- Development of habitat evaluation metrics for priority species and life stages using hydraulic/habitat models developed for MR Focus Areas.
- Analyzing breaching flows to quantify habitat connectivity of side channels and sloughs within MR Focus Areas; breaching flows will also be analyzed at major side channel and slough within the MR to evaluate the representativeness of Focus Area data. The IFS breaching flow analysis will be complementary to Study 9.12 (Barriers) that is designed to evaluate existing and future potential barriers to fish movement.

For the LR this will include:

- Finalization of open-water, 1-D hydraulic models in each of the six LR-1 PHABSIM sites that have already been surveyed: (PRM97, PRM96, PRM95, Trapper Creek, Birch Creek, and Deshka River).
- Identification of transect locations within targeted habitats for reach LR-2 in the vicinity of Sheep Creek and Caswell Creek.
- Collection of open-water field data to support fish habitat modeling at LR-2 fish habitat sites.
- Finalization of open-water, 1-D hydraulic models in the LR PHABSIM sites to be located in LR-2 between PRM 65 to PRM 70.
- Identification of priority species, life stages and periodicity for LR-1 and LR-2 to use for HSC curve development to apply to the fish habitat modeling.

- Calculation of weighted usable area (WUA) curves for each LR sites in LR-1 and LR-2 using calibrated PHABSIM models.
- Calculation of WUA time series of open-water habitat for LR-1 and LR-2 sites based on species and life stage periodicity for existing conditions and Project operational scenarios.
- Development of depth and velocity criteria for defining breaching, fish passage and connectivity conditions for the tributary mouths.
- Calculation of fish passage probabilities and percentage of time open-water connectivity is maintained to identify changes to timing, frequency or duration of conditions.

And finally, AEA will continue to work on development and finalization of methods for completing both the temporal and spatial analyses of data as described in ISR Study 8.5, Part C, Section 7.7., and in parallel, will be working in collaboration with the licensing participants in developing the Decision Support System that will be used for evaluating overall Project effects across resource disciplines and user groups. Proposed evaluation metrics and options for the DSS were discussed during the IFS TT Riverine Modelers meeting on November 13-15, 2013 and described in ISR Study 8.5, Part C, Section 7.8. AEA is also evaluating the feasibility of and methods for incorporating several key uncertainties associated with each riverine resource analysis.