

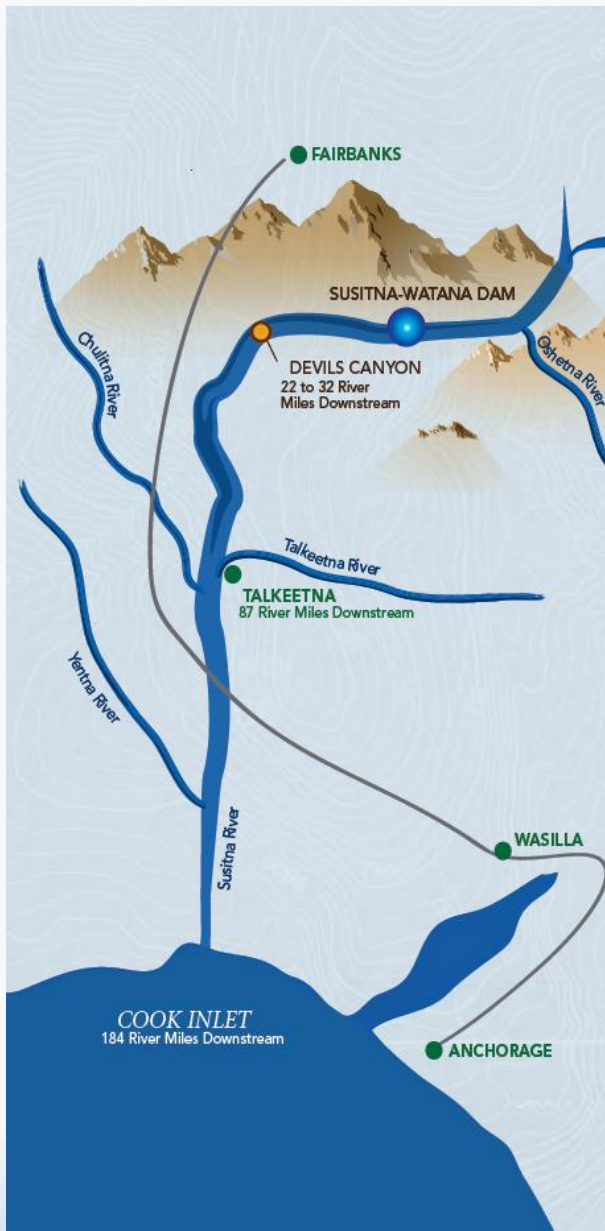
# Initial Study Report Meeting

## *Study 7.5 Groundwater*

*March 23, 2016*

Prepared by

R2 Resource Consultants  
Pacific Groundwater Group  
GW Scientific



# Study 7.5 Status

## ISR Documents

- Part A (*Methods, Results, and Discussion*): June 3, 2014
- Part B (*Part A Errata*): June 3, 2014
- Part C (*Executive Summary and Completing the Study*): June 3, 2014
- Additional Technical Memorandums: September 30, 2014
  - Preliminary Groundwater and Surface-Water Relationships in Lateral Aquatic Habitats within Focus Areas FA-128 (Slough 8A) and FA-138 (Gold Creek) in the Middle Susitna River
  - Groundwater and Surface-Water Relationships in Support of Riparian Vegetation Modeling
- Part D (*Supplemental Info*): November 6, 2015
- 2014-2015 Study Implementation Report: November 9, 2015
  - Appendix A: Preliminary Water Table Contour Maps for Focus Areas FA-104 (Whiskers Slough), FA-115 (Slough 6A), FA-128 (Slough 8A), and FA-138 (Gold Creek)
  - Appendix B: Preliminary MODFLOW Three Dimensional Groundwater Model for FA-128 (Slough 8A)
  - Appendix C: Summary Review of Susitna River Hydrogeologic Studies Conducted in the 1980s with Relevance to Proposed Susitna-Watana Dam Project and other Non-Project Related Studies
  - Appendix D: December 5, 2014 Technical Team Meeting Notes and Presentation

# Study 7.5 Status

- Completed intensive data collection at 4 Focus Areas and wells at riparian transects and other study sites.
- Developed a preliminary three-dimensional MODFLOW GW model for FA-128 (Slough 8A) (SIR, Appendix B)
- Completed a time series of water table maps for FA-104 (Whiskers Slough), FA-128 (Slough 8A), FA-115 (Slough 6A), and FA-138 (Gold Creek) that display water level contours under different seasonal conditions (SIR, Appendix A)
- Completed Existing Data Synthesis and literature review of the 1980s GW studies and supplemental contemporary information pertaining to GW/SW interactions (SIR, Appendix C)
- Continued work on preparing Upwelling / Springs Broad-Scale Mapping
- Completed two Technical Memoranda presenting results of preliminary GW/SW analysis that pertains to the RIFS Study 8.6 and the IFS Study 8.5 (September 30, 2014)

# Objectives

- **Synthesize historical and contemporary groundwater data** available for the Susitna River groundwater and groundwater dependent aquatic and floodplain habitat, including that from the 1980s and other studies including reviews of GW/SW interactions in cold regions
- Use the available groundwater data to characterize large-scale **geohydrologic process-domains/terrain** of the Susitna River (e.g., geology, topography, geomorphology, regional aquifers, shallow groundwater aquifers, GW/SW interactions)
- Assess the potential effects of Watana Dam/Reservoir on groundwater and groundwater-influenced aquatic habitats in the vicinity of the proposed dam
- Work with other resource studies to **map groundwater-influenced aquatic and floodplain habitat (e.g., upwelling areas, springs, groundwater-dependent wetlands) within the Middle River Segment** of the Susitna River including within selected Focus Areas (see Fish and Aquatic Instream Flow Study Section 8.5.4.2.1.2)
- Determine the **GW/SW relationships of floodplain shallow alluvial aquifers** within selected Focus Areas as part of the Riparian Instream Flow Study (Riparian Instream Flow Study, Section 8.6)
- Determine **GW/SW relationships of upwelling/downwelling in relation to spawning, incubation, and rearing habitat** (particularly in the winter) within selected Focus Areas as part of the Fish and Aquatics Instream Flow Study (Fish and Aquatic Instream Flow Study 8.5)
- **Characterize water quality (e.g., temperature, dissolved oxygen [DO], conductivity) of selected upwelling areas** that provide biological cues for fish spawning and juvenile rearing, in Focus Areas as part of the Fish and Aquatics Instream Flow Study (Fish and Aquatic Instream Flow Study (Study 8.5))
- **Characterize the winter flow** in the Susitna River and how it relates to GW/SW interactions
- Characterize the relationship between the Susitna River flow regime and **shallow groundwater users (e.g., domestic wells)**

# Components

- Existing Data Synthesis
- Geohydrologic Process-Domains
- Watana Dam/Reservoir
- Upwelling/Springs Broad-Scale Mapping
- Riparian Vegetation Dependency on Groundwater/Surface-Water Interactions
- Aquatic Habitat Groundwater/Surface-Water Interactions
- Water Quality in Selected Habitats
- Winter Groundwater/Surface-Water Interactions
- Shallow Groundwater Users

# Variances

The variances contained in the June 2014 ISR have been updated as follows:

- Objective 1 – The schedule for completion of the annotated bibliography and literature review was adjusted to be complete in 2015 (erroneously listed as 2014 in Oct 2014 .PPT). [This objective has now been met \(ISR Part D, Section 6; SIR, Section 4.1.1 and Appendix C\).](#)
- Objective 2 – The schedule for completion of the mapping of geohydrologic units and associated analysis will be completed in 2015 (erroneously listed as 2014 in Oct 2014 .PPT). [This objective will be completed once all necessary information has been assembled and reviewed \(ISR Part D, Section 6; SIR, Section 4.2.1\).](#)
- Objectives 5, 6, and 7 – The schedule for completion of the GW flow models, including model input and calibration data sets, files, and model documentation was rescheduled into 2015 for FA-128 (Slough 8A) and will occur sequentially for FA-104 (Whiskers Slough), FA-115 (Slough 6A), and FA-138 (Gold Creek) once all necessary information has been assembled and reviewed. [A preliminary MODFLOW model has been prepared for FA-128 \(Slough 8A\) \(ISR Part D, Section 6; SIR, Sections 4.5.6, 4.6.6, 4.7, and Appendix B\).](#)

# Variances

The variances contained in the June 2014 ISR have been updated as follows:

- Objective 7 – Water quality data from other studies completed in the first study year will be used in the next year of study to describe the differences between productive and non-productive habitat types. **This variance no longer applies - the analysis of relationships on microhabitat parameters that included water quality has been completed, with results presented in a Technical Memorandum (*Evaluation of Relationships between Fish Abundance and Specific Microhabitat Variables*, Study 8.5, FERC Submittal: September 17, 2014, Attachment G [R2 Resource Consultants]; ISR Part D, Section 6; SIR, Section 4.7.1).**

# Summary of Results

## Objectives 5 and 6

Susitna-Watana Hydroelectric Project  
(FERC No. 14241)

Groundwater Study  
(Study 7.5)

Groundwater and Surface-Water Relationships in  
Support of Riparian Vegetation Modeling

Technical Memorandum

Prepared for

Alaska Energy Authority

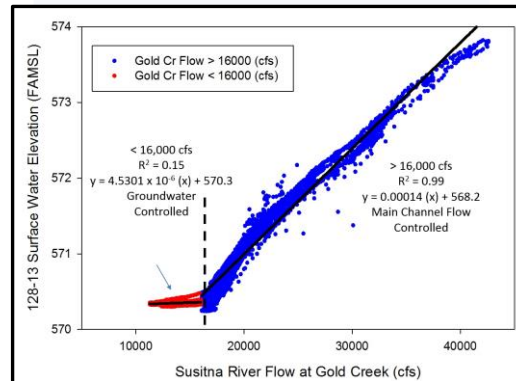


Prepared by

Geo-Watersheds Scientific and R2 Resource Consultants, Inc.

September 2014

- Two Technical Memoranda prepared depicting preliminary GW/SW relationships
- December 5, 2014 AEA held a Groundwater Study Technical Team Meeting to discuss and solicit questions from Licensing Participants regarding the October 2014 ISR meetings and on the two September 2014 TMs



Susitna-Watana Hydroelectric Project  
(FERC No. 14241)

Groundwater Study  
(Study 7.5)

Preliminary Groundwater and Surface-Water  
Relationships in Lateral Aquatic Habitats within  
Focus Areas FA-128 (Slough 8A) and FA-138 (Gold  
Creek) in the Middle Susitna River

Technical Memorandum

Prepared for

Alaska Energy Authority



Prepared by

Geo-Watersheds Scientific and R2 Resource Consultants, Inc.

September 2014



# Summary of Results – Objectives 5 through 9

(SIR Study 7.5, Section 4.5.5, <http://gis.suhydro.org/SIR/07-Hydrology/7.5-Groundwater/>)

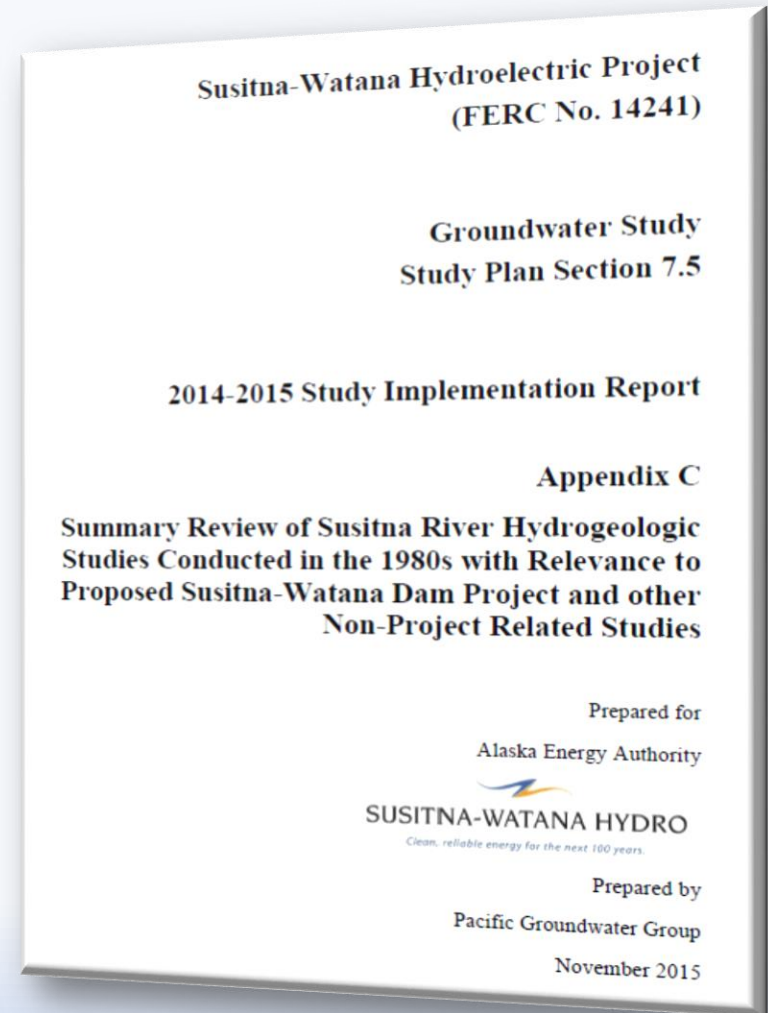
- Data collection has continued that will provide additional inputs for addressing Objectives 5, 6, 7, 8, and 9
- Monitoring has included a combination of telemetered wells, self-logging temperature and water level recorders, and remote cameras
- Intergravel water temperature and dissolved oxygen monitoring also continuing
- Quality control checks of existing data have continued



# Summary of Results

## Objective 1

- Existing Data Synthesis completed (SIR, Appendix C)
- 278 documents identified and screened; 18 determined relevant to GW/SW relationships; 12 contained Susitna River specific information
- Documents summarized and information gleaned pertaining to:
  - Aquifer extent and thickness
  - Aquifer properties (transmissivity, hydraulic conductivity, and storage)
  - Horizontal groundwater gradients and flow direction
  - Nature and extent of vertical groundwater gradients along the Susitna River
  - Groundwater and surface-water interactions within the Susitna River valley
- Table of aquifer properties prepared



# Summary of Results

## Objectives 5 and 6

Susitna-Watana Hydroelectric Project  
(FERC No. 14241)


Groundwater Study  
Study Plan Section 7.5

2014-2015 Study Implementation Report

Appendix A

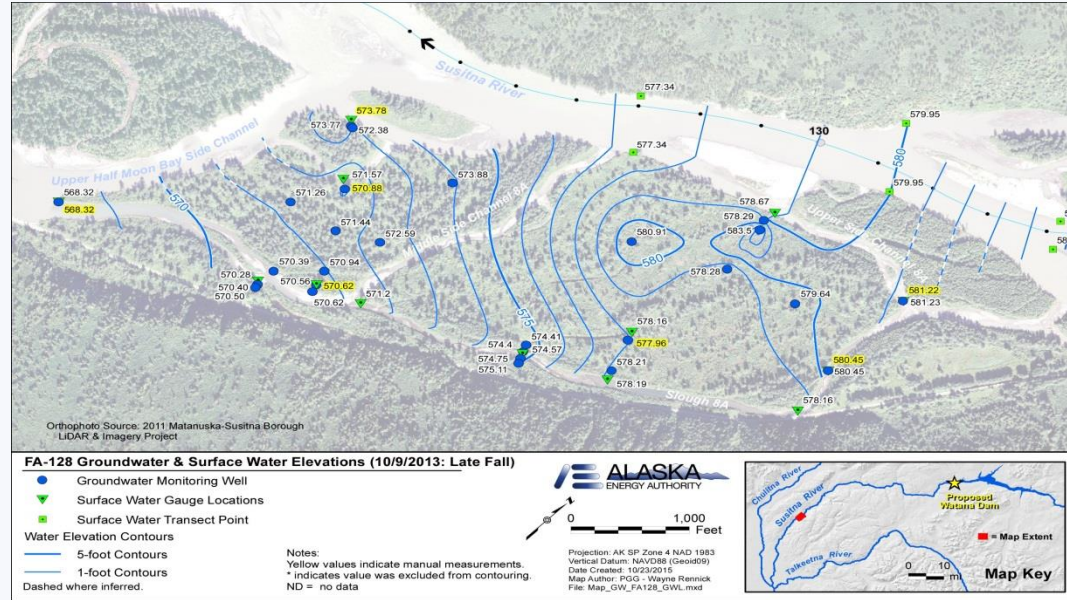
Preliminary Water Table Contour Maps  
for Focus Areas FA-104 (Whiskers Slough),  
FA-115 (Slough 6A), FA-128 (Slough 8A), and  
FA-138 (Gold Creek)

Prepared for  
Alaska Energy Authority



SUSITNA-WATANA HYDRO  
*Clean, reliable energy for the next 100 years.*

Prepared by  
Pacific Groundwater Group  
November 2015

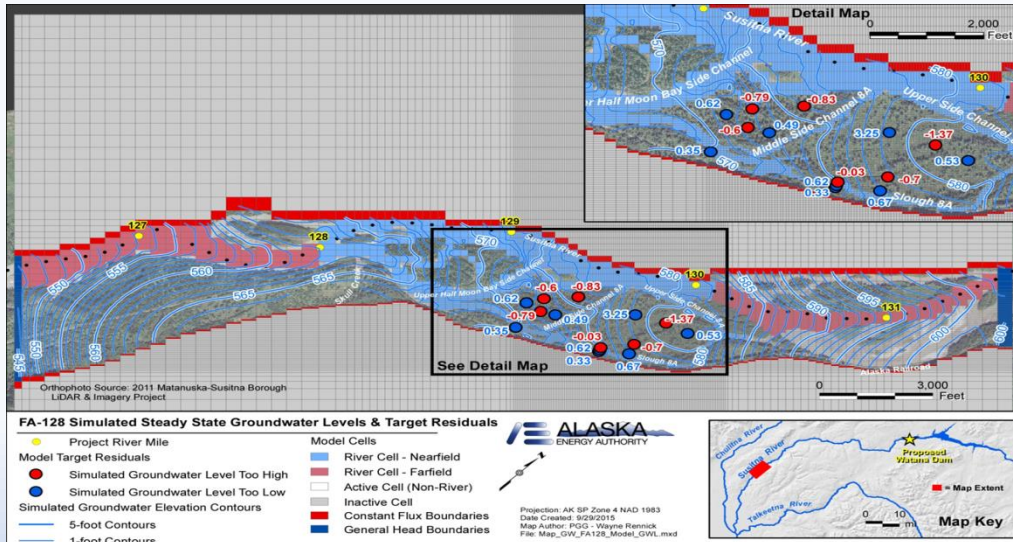


- Time series of water table maps completed (SIR, Appendix A)
- Six maps for FA-104 (Whiskers Slough) and FA-128 (Slough 8A); three for FA-138 (Gold Creek); two for FA-115 (Slough 6A)
- Maps constructed based on specific time periods

# Summary of Results

## Objectives 5 and 6

- Preliminary three-dimensional MODFLOW developed for FA-128 (Slough 8A) – includes steady state and transient model (SIR, Appendix B)
- Steady state model simulated average “Baseflow” conditions
- Transient model used steady state model to simulate spring melt flooding event



Susitna-Watana Hydroelectric Project  
(FERC No. 14241)

Groundwater Study  
Study Plan Section 7.5

2014-2015 Study Implementation Report

Appendix B

Preliminary MODFLOW Three Dimensional  
Groundwater Model for FA-128 (Slough 8A)

Prepared for  
Alaska Energy Authority

**SUSITNA-WATANA HYDRO**  
Clean, reliable energy for the next 100 years.

Prepared by  
Pacific Groundwater Group

October 2015

# Summary of Results

## Objective 7

Susitna-Watana Hydroelectric Project  
(FERC No. 14241)

Fish and Aquatics Instream Flow Study  
(Study 8.5)

Evaluation of Relationships between Fish Abundance  
and Specific Microhabitat Variables  
Technical Memorandum

Prepared for

Alaska Energy Authority



Prepared by

R2 Resource Consultants, Inc.

September 2014

- Substantial water quality data collected (Studies 4.5, 5.5, 7.5, and 8.5) (surface-water, GW wells, and adjoining areas)
- Baseline Water Quality Study (Study 5.5) completed
- *Evaluation of Relationships between Fish Abundance and Specific Microhabitat Variables*, Study 8.5 FERC Submittal: September 17, 2014, Attachment G [R2 Resource Consultants]) to fish abundance completed
- Sufficient water quality data have been collected and will be used with Fish Habitat models (Study 8.5), Water Quality models (Study 5.6), and the MODFLOW models (Study 7.5) to evaluate Project operational effects on SW and GW water quality conditions as they may influence aquatic habitats

# *AEA Proposed Modifications*

AEA is not proposing any modifications to the methods to complete this study.

# Steps to Complete the Study

*(ISR Part D, Section 8)*

## **Existing Data Synthesis – Study Objective 1**

Completed – See SIR, Appendix C.

## **Geohydrologic Process-Domains – Study Objective 2**

Define GW regional scale relationships to local flow systems in the Middle River and Lower River segments. Detailed analysis needed to determine processes at the Focus Area scale, which will provide indication of how those processes are functioning within the entire Middle River Segment.

## **Watana Dam / Reservoir – Study Objective 3**

Project Engineering Feasibility Studies and Geotechnical Investigations are continuing (see SIR, Sections 4.3.2, 5.3.3, and 5.4.3 for descriptions of methods and results); these efforts will meet study objectives.

## **Upwelling / Springs Broad-Scale Mapping – Study Objective 4**

Upwelling broad-scale mapping analysis is ongoing and will identify GW areas throughout the entire Middle River Segment of the Susitna River.

# Steps to Complete the Study

*(ISR Part D, Section 8)*

## **Riparian Vegetation Dependency on GW/SW Interactions – Study Objective 5**

Preliminary MODFLOW model has been developed for FA-128. Other steps to complete:

- Analysis of empirical GW and SW data collected to support RIFS (Study 8.6).
- Development of calibrated MODFLOW GW models in FA-128 (Slough 8A), FA-104 (Whiskers Slough), FA-115 (Slough 6A), and FA-138 (Gold Creek).
- Running OWFRM (Study 8.5) and SRH-2D hydraulic models (Study 6.6) for locations proximal to or within Focus Areas for different Project operational scenarios (open-water periods).
- Completion and running of the River1D and River2D Ice Processes models (Study 7.6) for locations proximal to or within Focus Areas for different Project operational scenarios (winter ice covered periods).
- Routing model outputs (open-water/ice covered) reflective of different Project operational scenarios through the respective MODFLOW models to evaluate GW/SW interactions.
- Provision of MODFLOW outputs and other GW/SW data specific to the Focus Areas to RIFS.
- Assist RIFS in using model outputs to characterize the natural floodplain vegetation GW and SW maintenance hydroregime, and evaluate Project operational effects on floodplain vegetation.



# Steps to Complete the Study

*(ISR Part D, Section 8)*

## **Aquatic Habitat GW/SW Interactions – Study Objective 6**

Preliminary MODFLOW model has been developed for FA-128. Other steps to complete:

- Analysis of empirical GW and SW data collected at locations to support IFS (Study 8.5).
- Development of calibrated MODFLOW GW models in FA-128 (Slough 8A), FA-104 (Whiskers Slough), FA-115 (Slough 6A), and FA-138 (Gold Creek).
- Running OWFRM (Study 8.5) and SRH-2D hydraulic models (Study 6.6) for locations proximal to or within Focus Areas for different Project operational scenarios (open-water periods).
- Completion and running of the River1D and River2D Ice Processes models (Study 7.6) for locations proximal to or within Focus Areas for different Project operational scenarios (winter ice covered periods).
- Routing model outputs (open-water and ice covered) reflective of different Project operational scenarios through the respective MODFLOW models to evaluate GW/SW interactions.
- Provision of MODFLOW outputs and other GW/SW data specific to Focus Areas for input into 2D PHABSIM Fish Habitat models (SIR Study 8.5, Sections 4.6 and 5.6); assess project effects on spawning and incubation habitats, overwintering rearing habitats, and overwintering egg incubation and embryo survival.

# Steps to Complete the Study

*(ISR Part D, Section 8)*

## **Water Quality in Selected Habitats – Study Objective 7**

- Incorporate GW/SW data within the Water Quality models (Study 5.6) and link model outputs (temperature, turbidity, DO) to 2-D Fish Habitat models (Study 8.5), and in terms of temperature to the MODFLOW models to evaluate Project operational effects.

## **Winter Groundwater / Surface-Water Interactions – Study Objective 8**

Continue collection of data at selected GW well stations during winter period. Other steps:

- Development of calibrated MODFLOW GW models in FA-128 (Slough 8A), FA-104 (Whiskers Slough), FA-115 (Slough 6A), and FA-138 (Gold Creek).
- Completion of the River1D and River2D Ice Processes models (Study 7.6).
- Routing outputs from River1D and River2D models (reflective of different winter-time Project operational scenarios) through MODFLOW models to evaluate effects on winter-time GW/SW interactions (including upwelling and downwelling).
- Linking MODFLOW outputs with 2-D PHABSIM Fish Habitat models to evaluate Project operational effects on GW/SW interactions and effects on overwintering rearing habitats and egg incubation and embryo survival.

# Steps to Complete the Study

*(ISR Part D, Section 8)*

## **Shallow Groundwater Users – Study Objective 9**

- Compile data from homeowner wells in combination with SW data collected on the mainstem Susitna River, and outputs from OWFRM (Study 8.5) and Ice Processes River1D (Study 7.6) hydrology models near well locations to evaluate potential Project operational effects on shallow GW wells within the Middle River Segment.
- Data from the two wells located near/within FA-138 (Gold Creek) may also prove useful during development of the MODFLOW model for that Focus Area.

# *Licensing Participants Proposed Modifications to Study 7.5?*

- Agencies
- CIRWG members and Ahtna
- Public