Susitna-Watana Hydroelectric Project Document
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Title: 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	**SuWa 250**
Author(s) – Personal:	
Author(s) – Corporate: Geo-Watershed Scientific and R2 Resource Consultants, Inc.	
AEA-identified category, if specified: September 30, 2014 technical memorandum filings	
AEA-identified series, if specified:	
Series (ARLIS-assigned report number): Susitna-Watana Hydroelectric Project document number 250	**Existing numbers on document:**
Published by: [Anchorage, Alaska] : Alaska Energy Authority, [2014]	**Date published:** September 2014
Published for: Alaska Energy Authority	**Date or date range of report:**
Volume and/or Part numbers: Attachment C	**Final or Draft status, as indicated:**
Document type: Technical memorandum	**Pagination:** 136 p. in various pagings
Related work(s): Cover letter to this report: Susitna-Watana Hydroelectric Project, FERC Project no. 14241-000; Third set of 2014 technical memoranda for Initial Study Plan meeting. (SuWa 247) Attachments A-B (SuWa 248-249) and D-F (SuWa 251-253)	**Pages added/changed by ARLIS:** Added cover letter (3 pages)
Notes:	

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SUSITNA-WATANA HYDRO

September 30, 2014

Ms. Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

Re: Susitna-Watana Hydroelectric Project, Project No. 14241-000

Third Set of 2014 Technical Memoranda for Initial Study Plan Meetings

Dear Secretary Bose:

As the Alaska Energy Authority (AEA) explained in its September 17, 2014 filing with the Federal Energy Regulatory Commission (Commission or FERC) for the proposed Susitna-Watana Hydroelectric Project, FERC Project No. 14241 (Project), the June 3, 2014 Initial Study Report (ISR) provided for AEA to prepare certain technical memoranda and other information based on 2014 work. In accordance with Commission Staff direction, on September 17 and September 26, AEA filed and distributed the first and second sets of technical memoranda and other information generated during the 2014 study season.

With this letter, AEA is filing and distributing the third set of technical memoranda generated during the 2014 study season, as described below.

This third set of technical memoranda includes:

- Attachment A: *Baseline Water Quality Study (Study 5.5) and Water Quality Modeling Study (Study 5.6), Water Quality and Lower River Modeling Technical Memorandum*. This technical memorandum evaluates water quality data collected during 2013 and 2014 for adequacy in representation of current riverine conditions. This Technical Memorandum further includes an assessment of whether to extend the Water Quality Modeling Study's riverine model below PRM 29.9.

- Attachment B: *Mercury Assessment and Potential for Bioaccumulation Study (Study 5.7), Evaluation of Continued Mercury Monitoring Beyond 2014 Technical Memorandum*. This technical memorandum evaluates the need for continued monitoring of mercury data beyond 2014 and whether the existing data collection efforts are sufficient to satisfy objectives for characterizing baseline mercury conditions in the Susitna River and tributaries (Revised Study Plan (RSP) Section 5.7.1).

- Attachment C: *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.* This technical memorandum provides an overview of the types of data and information that are being collected to support the Task 6 activities of the Groundwater Study, and describes the methods and techniques that are being applied in analyzing the data leading to development of response functions to be used for evaluating Project operational effects. The TM centers on the analysis for FA-128 (Slough 8A) and to a lesser extent FA-138 (Gold Creek) and represents an expansion of the presentation materials provided during the Proof of Concept meetings held on April 15-17, 2014.

- Attachment D: *Groundwater Study (Study 7.5), Groundwater and Surface-Water Relationships in Support of Riparian Vegetation Modeling Technical Memorandum*. This technical memorandum provides an overview of the types of data and information that are being collected to support the Task 5 activities within the Groundwater Study, and describes the methods and techniques that are being applied in analyzing the data leading to development of response functions for evaluating Project operational effects. The TM provides analysis objectives for FA-115 (Slough 6A) as a primary example of upland versus riverine dominated groundwater conditions. Additional examples are shown for FA-128 (Slough 8A) and FA-138 (Gold Creek).

- Attachment E: *Salmon Escapement Study (Study 9.7), 2014 Implementation and Preliminary Results Technical Memorandum*. This technical memorandum describes 2014 implementation (including methods and variances) of and preliminary results from the Salmon Escapement Study.

- Attachment F: *Cook Inlet Beluga Whale Study Plan (Study 9.17), 2015 Implementation Plan Technical Memorandum.* This implementation plan describes the methods for study activities proposed for 2015 that would implement the Cook Inlet Beluga Whale Study (instead of those described in RSP Section 9.17.1).

AEA appreciates the opportunity to provide this additional information to the Commission and licensing participants, which it believes will be helpful in determining the appropriate development of the 2015 study plan as set forth in the ISR. If you have questions concerning this submission please contact me at wdyok@aidea.org or (907) 771-3955.

Sincerely,

Wayne Dyok
Project Manager
Alaska Energy Authority

Attachments

cc: Distribution List (w/o Attachments)

Attachment C

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

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

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

Geo-Watersheds Scientific and R2 Resource Consultants, Inc.

September 2014

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APPENDICES

Appendix A. Hydrologic Stations Primary Station Purpose, Location and Data Collection Parameters

Appendix B. April 2014 Discharge Measurements

Appendix C. 2014 Groundwater Study Response Analysis Time-lapse Image Data at Site ESSFA128-1

LIST OF ACRONYMS AND SCIENTIFIC LABELS

Abbreviation	Definition
AEA	Alaska Energy Authority
°C	Degrees centigrade
Cfs	Cubic feet per second
Cm	Centimeter
FA	Focus Area
FERC	Federal Energy Regulatory Commission
Fps	Feet per second
GW	Groundwater Study
GW/SW	Groundwater/Surface Water
GWS	Geo-Watersheds Scientific
LB	Left Bank
mg/L	Milligrams per liter
Mw	Megawatts
NTU	Nephelometric Turbidity Units
IFS	Instream Flow Study
ISR	Initial Study Report
PRM	Project River Mile
NAVD88	North American Vertical Datum of 1988
RB	Right Bank
RSP	Revised Study Plan
RPD	Riparian Process Domain
TM	Technical Memorandum
WSE	Water Surface Elevation

1. INTRODUCTION

1.1. Project Description

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. 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 Project River Mile (PRM) 187.1. The Project would include a large dam with an approximately 24,000-acre, 42-mile long reservoir. The Project construction and operation would have an effect on the flows downstream of the dam site, the degree of which will ultimately depend on final Project design and operations.

The Project may contain up to four turbines capable of generating 150-200 megawatts (MW) of power each such that the total power capacity could be 800 MW. The Project reservoir is expected to fill during the summer months (May – August), when runoff from snow melt and rainfall is greatest, to maximize power generation capability during the winter months (October – April) when energy demand is high. As a result, seasonal changes to Susitna River streamflow conditions during Project operations may include lower discharges during the summer reservoir refill period and higher discharges during the winter relative to current hydrologic conditions. In addition to these seasonal changes, the Project may be operated in a load-following mode to meet energy demands on an hourly basis. During load-following operations, the amount of water released from the reservoir would cycle daily according to energy demands such that higher volumes would be released during peak-load hours relative to off-peak hours. Seasonal and daily/hourly changes to Susitna River hydrology would influence downstream aquatic and riparian resources and processes related to groundwater conditions and groundwater surface water conditions. As a result, AEA developed and the FERC approved (FERC 2013) a detailed Groundwater Study (GW) plan (contained as Section 7.5 in the December 14, 2012 Revised Study Plan [RSP]; see AEA 2012) containing nine specific tasks that were collectively designed to evaluate the potential effects of Project operations on groundwater resources.

Task 6 of the GW plan centers on defining groundwater/surface water (GW/SW) relationships associated with upwelling/downwelling areas in relation to spawning, incubation, and rearing habitats within selected Focus Areas[1]. This task is linked with the Fish and Aquatics Instream Flow Study (FA-(IFS) (RSP 8.5) with one of the objectives being the development of GW/SW response functions for different locations within a FA that can be used to assess potential changes in GW/SW interactions resulting from different Project operational scenarios. These relationships will provide estimates of groundwater flow that will be integrated into the SRH-2D models (Tetra Tech 2014) and the habitat-flow models and used to evaluate how spawning and

[1] Focus Areas are specific geographic areas within the Middle Segment of the Susitna River that were selected to be intensively evaluated across multiple resource disciplines (RSP 8.5.4.2.1.2) There are ten Focus Areas located in the Middle Segment of the river (see R2 Resource Consultants 2013). The Task 6 GW investigations were concerned with seven of the FAs including FA-104 (Whiskers Slough), FA-113 (Oxbow 1), FA-115 (Slough 6A), FA-128 (Slough 8A), FA-138 (Gold Creek), FA-141 (Indian River), and FA-144 – (Slough 21), with studies concentrated in FA-104, FA-128 and FA-138.

incubation habitats (as influenced by GW flows) change as a result of Project Operations. Furthermore, the GW analysis completed within the FAs will provide a better understanding of how GW/SW relationships operate more broadly and will be used to draw inferences regarding Project operational effects at other locations within the Middle Segment of the river.

This Technical Memorandum (TM) provides an overview of the types of data and information that are being collected to support the Task 6 GW/SW activities, and describes the methods and techniques that are being applied in analyzing the data leading to development of response functions to be used for evaluating Project operational effects. The TM centers on the analysis for FA-128 (Slough 8A) and to a lesser extent FA-138 (Gold Creek) and represents an expansion of the presentation materials provided during the Proof of Concept (POC) meetings held on April 15-17, 2014. During those meetings, information concerning the locations and methods for data collection were presented, as well as preliminary data plots illustrating trends in groundwater levels and water temperatures over time and in relation to mainstem discharge. However, details concerning data analysis techniques and response function development were not presented, and hence are included as part of this TM. An important qualifier of this TM is that although site specific data have been used, the data analysis techniques and the results presented herein are all subject to revision as additional data are collected and alternative analytical techniques are employed.

1.2. Study Background

The Susitna River is a large glacial river that exhibits large hydrologic changes at hourly, daily, and seasonal temporal scales. Susitna River discharge is typically the highest during the snowmelt period in spring and early summer (June – August) and large, short-term fluctuations in flow volumes often occur during summer in response to air temperature changes and precipitation events. Mean monthly Susitna River streamflow for June, July, and August during water years 1950 – 2010 ranged between 21,430 – 26,290 cfs (USGS Gold Creek gage #15292000) (Curran 2012). During the open-water period, Susitna River streamflow is fed primarily by surface and glacial runoff and water turbidity levels are high (> 200 nephelometric turbidity units [NTU]) due to suspended glacial silt. Susitna River discharge levels typically decline during September through November and are lowest during December through April when the channel is largely ice covered. Mean monthly Susitna River streamflow for December through April during water years 1950 – 2010 ranged between 1,303 – 1,893 cfs (USGS Gold Creek gage #15292000) (Curran 2012). Winter streamflow is fed primarily by groundwater and consequently discharge is stable and water turbidity is low (<10 NTU).

1.2.1. Importance of Groundwater to Fish Habitat in the Susitna River

Many studies have shown the proclivity of salmonid species to utilize areas of groundwater upwelling for spawning and egg incubation. Durst (2000) summarized some of the more recent studies on this with a focus on Alaska rivers and pointed out the obvious survival benefits of groundwater upwelling as providing warmer winter temperatures to prevent freezing of eggs and promote embryogenesis, and sustained or increased intergravel flows that transport needed dissolved oxygen to and metabolic wastes from the developing embryos. Studies have documented groundwater use by kokanee salmon (*Oncorhynchus nerka*) (Garrett et al. 1998), chum salmon (Barton 1992, Kogl 1965, Geist et al. 2002) and sockeye salmon (Lorenz and Eiler

1989), as well as several char species including bull trout (*Salvenline malma*) (Baxter and McPhail 1999; Baxter and Hauer 2000) and brook trout (*S. fontinalis*) (Blanchfield and Ridgeway 1997; Benson 1953).Durst (2000) suggested that in a general sense, the importance of upwelling areas to maintenance of healthy fish populations has not been fully appreciated by fisheries and land managers. For example, in the Tanana River, Barton (1992) noted that the relatively numerous and small spawning areas in the main stem of the river cumulatively contribute significantly to the total available spawning area for Tanana Basin fall chum salmon. Garrett et al. (1998) concurred on the importance of upwelling areas to fish and suggested that managers consider affording special consideration to such areas.

Special consideration of groundwater upwelling as being an important component of fish habitat was given as part of the 1980s studies of the Su-Hydro Project. As noted in R2's (2013a) review of the 1980s data, the importance of groundwater to fish and fish habitat in the Susitna River was first identified during studies when spawning salmon were observed to be associated with areas of groundwater upwelling. Trihey (1982) evaluated 13 of those areas and found that intergravel temperatures at those locations were higher and more stable than surface temperatures. Differences in intergravel dissolved oxygen concentrations were found between areas of groundwater upwelling and adjoining areas of surface flow, with concentrations generally lower in the upwelling areas.

Vining et al. (1985) suggested that upwelling was the single most important feature in maintaining the integrity of incubation in slough habitats of the Susitna River as well as localized areas in side channel habitats. The importance of groundwater on fish habitat was noted as being especially important during the winter time owing to its' warming effects and benefits associated with temperature constancy and egg development and survival. Vining et al. (1985) found that salmon embryos located in macrohabitats that were most directly affected by Susitna River main channel stage fluctuations and that lacked groundwater upwelling developed more slowly and were more susceptible to high embryo mortality than areas with groundwater influence (Vining et al. 1985). Freezing and desiccation were the two primary sources of embryo mortality associated with the non-groundwater influenced areas. In addition to the importance to incubating salmon eggs, groundwater inflows to sloughs were also considered important as overwintering habitat (Dugan et al. 1984) that provided warmer water temperatures resulting in areas that were ice-free. Specific groundwater upwelling locations were mapped at a number of survey locations in the Middle and Lower River as part of the 1980s studies; Estes and Schmidt (1983, Appendix F) reported the location of approximately 90 upwelling sites in the Middle River.

Efforts to define GW/SW relationships were likewise completed during the 1980s studies with emphasis placed on selected slough habitats (Slough 8A, Slough 9, and Slough 11)[2] where salmon had been observed spawning (R&M 1985; Beaver 1984). Those studies highlighted differences in discharge and temperature relationships that are inherent between the different slough locations. The results of those studies were used in part to make an informed evaluation of potential Su-Hydro Project effects on groundwater conditions (Entrix 1986), as well as to

[2] Slough 8A is contained within Focus Area FA-128; Slough 11 is contained within Focus Area-138. Slough 9 is outside of the defined Focus Areas.

identify potential mitigation options for protecting or replacing important habitats influenced by groundwater (Woodward Clyde 1984).

1.2.2. Susitna-Watana Project Groundwater Studies

The current Susitna-Watana GW studies associated with Task 6 (Study 7.5, Section 7.5.4.5) have been built around the solid base of information concerning the importance of groundwater upwelling on fish habitats provided by the 1980s studies. The study elements have been closely coordinated with the IFS-FA program (Study 8.5) including the winter studies (R2 2013b; R2 2014a, b), the IFS-Riparian program (Study 8.6) and other resource studies associated with Ice Processes (Study 7.6), Water Quality (Study), and Fluvial Geomorphology (Study 6.6), and are designed to provide a set of analytical tools that can be used to evaluate potential Project operational effects on groundwater flows and associated fish habitats.

Task 6 is especially interested in determining the potential effects Project operations may have on groundwater flows associated with important fish habitats. Such effects will likely vary spatially, seasonally and will be highly dependent on specific Project operational characteristics. In a general sense, the types of groundwater related response functions that may occur as a result of Project induced increases and/or decreases in discharge and stage include:

- Decreases or increases in the rate of groundwater upwelling from the adjacent floodplain.
- Modifications in the amounts of relatively warm, stable, upwelling habitat when side channels are breached or disconnected by mainstem flow.
- Changes in the rate of groundwater flows associated with hydraulic gradients between main channel and off-channel habitats.

1.3. Technical Memorandum Objectives

The objectives of this TM are to report the general data collection activities that were completed in 2014 to support Task 6 activities, present examples of data analysis using FA-128 (Slough 8A) as a primary example and FA-138 (Gold Creek) secondarily, and describe plans for data collection in 2015. The TM covers study objectives specific to the IFS-FA evaluations and how they relate to groundwater and surface water (GW/SW) interactions. Select examples from FA-138 (Gold Creek) are also shown and discussed to demonstrate the analysis approaches over a greater range of lateral-habitat hydrologic conditions.

2. STUDY AREA

As established by RSP Section 7.5.3, the overall study area related to groundwater processes includes primarily the Middle River Segment of the Susitna River that extends from PRM 102.4 to PRM 187.1 as well as portions of the Lower River Segment associated with domestic wells and riparian transect locations in the Lower River, and the lower most portion of the Upper River Segment near the proposed dam site associated with potential groundwater changes relative to reservoir construction and operations. Figure 2.0-1 shows these river segments and the general

watershed boundary of the Susitna River. Figure 2.0-2 shows the location of Instream Flow Study (Section 8.5, 8.6) Focus Areas and geomorphic reaches for the Middle River Segment. This TM is concerned with two of the Focus Areas in the Middle River Segment, FA-128 (Slough 8A) (Figure 2.0-3 through Figure 2.0-6) and FA-138 (Gold Creek) (Figure 2.0-7 through Figure 2.0-9).

3. METHODS

As noted above, the overall goal of this study component is to collect information and data to analyze and define GW/SW interactions and processes at a number of Focus Area locations important for aquatic resource evaluations, with this TM centered on FA-128 (Slough 8A) and to a lesser extent FA-138 (Gold Creek) (see ISR 7.5.5.6 for specific methods employed at all Focus Areas). Focus Area results will ultimately be used to extrapolate effects to other aquatic habitats at the river segment scale. The methods employed as part of the analysis are described below and include field efforts to collect water surface elevation and discharge data, as well as collection of stationary and aerial imagery to allow visual assessments of surface flow (evidenced by turbid water) and groundwater (clear water) interactions. Methods are also presented that describe the types of data analysis that were used to evaluate data collected in FA-128 and FA-138 and define various GW/SW relationships both in terms of stage, flow and water temperature.

Ultimately, various hydraulic and physical models, including surface water hydraulic (1-D and 2-D), geomorphic reach analyses, and ice processes will be integrated as needed to allow assessment of physical process controls of select habitat assessed (see Study 8.5) under both existing conditions and Project operational scenarios. The results of the GW study will be used to draw appropriate inferences on GW/SW processes at the river segment and geomorphologic scale.

As described in the Initial Study Report (ISR), empirical data are being collected at five Focus Areas (FA-104 (Whiskers Slough), FA-113 (Oxbow 1); FA-115 (Slough 6A), FA-128 (Slough 8A); and FA-138 (Gold Creek) to define GW/SW interactions relative to the IFS-FA studies (see ISR 7.5, Figures 4.5-2, 4.5-3, 4.5-5, and 4.5-6). The data collection stations established within each Focus Area serve multiple study needs with some of the stations collecting measurements of groundwater level and water quality (temperature and conductivity), some stations collecting measurements of surface water levels, discharge and water quality, and some fixed stations collecting time lapse photographs to document flow condition changes over time (see Figure 4.5-1 of ISR 7.5 for station naming conventions).

3.1. Hydrology Observations

3.1.1. Water Surface Elevations and Water Temperature Measurements

Water surface elevations are being measured at both groundwater and surface-water stations within each of the Focus Areas as listed in ISR 7.5 Table 1 through Table 8 and shown in ISR 7.5 Figures 4.5-12 through 4.5-24. The stations for FA-128 and FA-138 are shown in Figure 2.0-3 through Figure 2.0-9) and include 23 groundwater measurement locations and 17 surface-water

measurement locations in FA-128, and 7 and 10 locations respectively for FA-138. These measurements are intended to provide data at the different stations including those associated with specific transects for analysis of GW/SW interactions taking place over the range of hydrologic conditions from summer through fall freeze-up, winter, and spring snowmelt and breakup.

At stations with pressure transducers (PTs), manual water level measurements were made to help process the continuous data and apply data shifts and corrections as needed due to potential movement of the PT. The PTs used for the study also record water temperature at the location of the sensor. In addition, intergravel water temperature profiles were measured via placement of thermistor strings that recorded temperatures at different depths within the substrate. Depending on the complexity of the hydrologic station, PTs are either part of the overall sensors measured by Campbell Scientific Inc. CR1000 or CR200X data loggers, or are self-logging pressure transducers at groundwater and surface-water stations where fewer measurements are required.

Manual water level measurement in surface-water stations are frequently made by level-loop surveying. Level-loop surveys are performed with optical survey levels and measurement goals for level loop closures are 0.02 ft. There are three to four reference elevation benchmarks to use for summer and winter surveying at a majority of the stations. These benchmarks have had at least one measurement point surveyed by RTK survey methods to establish sea level datum at each station.

All groundwater wells including those installed in FA-128 and FA-138 were installed by drive point methods with pre-drilling to help installation. The wells all have the top of galvanized casing protected by enclosures that have survey measurement control marks on them. These measurement locations are surveyed by level loop survey methods and used as a reference point to measure the depth to groundwater in the well.

In 2014, 42 staff gages were installed in various Focus Areas and other locations in a combined effort between GW Task 5 (IFS-Riparian) and GW Task 6 (IFS-FA) to provide various study crews the ability to take water level readings at these locations. FA-128 had 8 staff gages installed, and FA-138 had 8 gages installed. This same approach was successfully used in the 1980s Susitna studies. These locations are all in lateral side channels, sloughs and beaver ponds where they require less maintenance during the summer ice free hydrologic period.

Listings of all groundwater and surface-water stations used in the GW study are provided in Appendix A, Table 1 through Table 8 which are organized by Focus Area or PRM. The station information tables include both stations and sensors installed in 2013 and in new data collection sites established in August 2014. One non-Focus Area location is included at PRM 112 (Slough 6).

3.1.2. Discharge Measurements

Winter discharge measurements were taken during two periods, March 3-16, 2014 and April 1-13, 2014 at selected locations in FA-104 (Whiskers Slough), FA-128 (Slough 8A) and FA-138 (Gold Creek). Measurements were recorded in open water and ice covered areas within side channel, side slough and upland slough habitats. Discharge was measured at eight locations in

FA-104 (Whiskers Slough), five locations in FA-128 (Slough 8A) and at six sites in FA-138 (Gold Creek) (Table 3.1-1). Measurement locations were established in habitats with substantial groundwater influence and known fish habitat use during winter.

An additional series of end-of-winter discharge measurements to document groundwater recharge or discharge in surface water features were made from April 16-26, 2014 in the same three Focus Areas noted above. Table 3.1-2 shows a summary of the discharge measurement results; detailed computational sheets for each discharge measurement are contained in Appendix B. For these measurements, channel sections were chosen that had no or minimal ice and snow conditions, so an open channel measurement could be made. Paired measurements were made in select areas to measure the difference in discharge for certain channel reaches. In some locations, the characteristics of the slough or side channels did not allow this and individual locations were measured. Because the goal of these measurements was to measure small differences in groundwater for groundwater recharge to the sloughs or side channels, triplicate measurements were made at some locations when field logistics allowed.

The discharge measurements were made following the USGS procedures reported in Turnipseed and Sauer, 2010. Water velocities were measured with a USGS Type Price AA mechanical discharge meter with magnetic head or USGS Type Pygmy discharge meter with magnetic head, either of which is attached to a wading rod. The Price AA meter was used if the depths were greater than 1.0 feet. If the depths were between 0.3 and 1.0 feet, the Pygmy meter was used. If depths are less than 0.3 feet, the discharge in the segment was not measured. An AquaCalc Pro Plus electronic notebook was used to connect to the meter at the top of the wading rod and collect all meter data and make calculations of the velocity, discharge and other calculations.

A series of late summer discharge measurements were likewise collected in FA-128 (Slough 8A) during the week of September 22-26, 2014. These locations have been established in 2014 to collect discharge measurements for development of rating curves to develop estimates of discharge from stage data collected at many of the surface water stations. The location of discharge measurements are also shown in the Focus Area data collection parameters information presented in Appendix A, Table 1 through Table 8.

3.1.3. Land-based and Aerial Photographic Imagery

Visual documentation of water levels and other hydrologic features is available at the Focus Areas via a series of land-based stationary time lapse cameras (see Figure 2.0-3 through Figure 2.0-9 for locations in FA-128 and FA-138). Photographs from these cameras can be used in part to help document the distribution of flows within a Focus Area over time, and the connectivity of specific channels to mainstem flows, as evidenced by the presence or absence of turbid water (see Appendix C for example of time lapse photographs taken from FA-128 (Slough 8A) at site ESSFA128-1 under different flow conditions).

In addition, aerial surveys were completed during a number of the field efforts to photo document conditions in all the surface-water sloughs and side channels, beaver ponds and other hydrologic features in each Focus Area. These empirical photographic data sets help document ice and snow cover conditions during winter conditions, changes in channel conditions, changing

beaver dam and channel changing activities, and the general characteristics of the surface-water features in each Focus Area.

3.2. Analysis Methods

The below sections describe general data collection and preliminary data analysis methods used in this TM. The analysis considered four main periods where hydrologic conditions and related GW/SW interactions may vary. These periods are defined as Fall Freeze Up, Winter (ice cover), Spring Break-Up, and Summer (ice free) and are depicted in Figure 3.2-10, which also shows the period of record daily mean flow statistics for the Susitna River at Gold Creek USGS gaging station (15292000) (USGS, 2014). Using these seasons to help describe GW/SW interactions is important as the hydrologic processes and boundary conditions change over the seasons, as does fish species and life stage periodicity.

3.2.1. Empirical Analysis Methods

As an initial step in the FA-128 and FA-138 analysis, water level and temperature data were plotted together in various combinations to examine relationships between groundwater conditions and adjacent surface water features. Time series plots were then used at different time scales to show response changes between GW/SW systems. The primary information used to study these interactions is water levels as relative pressure (water height) gradients are the foremost process driving interactions. Temperature data were also used as indicators of GW/SW mass interaction, since temperatures differ between groundwater and surface water. Manual discharge measurements in channels were used to measure groundwater recharge to surface water bodies (upwelling or gaining stream reaches) or discharge from surface water to groundwater (downwelling or losing stream reaches).

For the GW Study, the study design consisted of a transect with two wells on either side of the surface-water feature of interest (slough, side channel). Water elevations in the surface water feature and each groundwater location across the transect were used to develop a 2-D cross section view of GW/SW interactions. By comparing the difference between groundwater and surface water levels across the transect, hydraulic gradients or water table slopes can be calculated from aquifer positions to determine the horizontal and vertical flow direction, and the extent of GW upwelling or SW downwelling between surface water and adjacent aquifers. Empirical data comparisons between different types of lateral aquatic habitats and hydrologic conditions were used to understand and characterize the range of GW/SW interactions taking place across Focus Areas.

3.2.2. Functional Relationships with Susitna River Flow

A primary objective of this TM is to show analytical approaches and examples of the relationships between Susitna River flow conditions and lateral aquatic habitat areas that are influenced by groundwater conditions. The flow conditions for the Susitna River were taken from the Susitna River at Gold Creek gage location for 2013 and 2014 (Figure 3.2-11 and Figure 3.2-12). Discharge data (15 minute) were used to compare with stage conditions at aquatic transect and other hydrology stations and associated groundwater wells. Temperature data from these same sites were also used to understand the hydrologic conditions at each site.

Pairs of Susitna River at Gold Creek discharge and lateral aquatic habitat water level conditions were then chosen for analysis. FA-128 (Slough 8A) was used for the primary development of the analysis method, with additional stations used from the two aquatic stations in FA-138 (Gold Creek) to help provide further examples of the analysis methods.

As part of this analysis, the lateral habitat areas were first divided into three main hydrologic categories to help establish relationships that could be transferred to other lateral aquatic habitat areas outside of the Focus Areas. These categories are defined as;

- Riverine Hydrology Dominated
    - Flow, stage, and water quality conditions in lateral habitats are predominantly influenced by mainstem flow, stage, and water quality conditions.
- Transitional Hydrology Dominated
    - Due to seasonal and event related flow conditions, the flow, stage and water quality conditions in lateral habitats vary between riverine and upland dominated sources of flow.
- Upland (or Hillslope) Dominated
    - Flow, stage and water quality conditions in lateral habitats are predominantly influenced by sources of groundwater and surface water that originate in upland areas.

All of the above hydrologic classifications are impacted by groundwater, but the degree and characteristics of river effects on GW/SW interactions varies. The above classifications fit into the concept of hydrologic landscapes (Winter, 2001).

Once empirical data were QA/QC checked they were plotted and specific flow intervals used for the analysis. For this, data were primarily used from rising and falling limbs on the discharge hydrographs of the Gold Creek gage. Peaks that represented single snowmelt (upper basin) or precipitation events were chosen and compared with hourly data selected from within a greater range of conditions. After visually inspecting data, portions of the data sets were then analyzed with a statistical program TableCurve 2D (SYSTAT, 2002), to define linear relationships for the flows of interest at each site.

3.2.3. Groundwater Modeling

In addition to the analysis of empirical data that are presented in this TM, 2-dimensional (2D) cross-sectional groundwater models are being developed for each of the aquatic transects in FA-138 (Gold Creek), FA-128 (Slough 8A), and FA-104 (Whiskers Slough). These models will provide a better understanding of GW/SW interactions and how they vary across different types of lateral aquatic habitats under natural flow conditions. In addition to the 2D modeling efforts, FA-128 (Slough 8A) was selected for development of a 3-dimensional (3D) model for use in the Task 5 IFS-Riparian studies and for comparative purposes with the 2D models.

For this, the USGS modeling package MODFLOW (Feinstein et al. 2012; Maddock et al. 2012; USGS 2005) was selected for use based on guidance in ASTM D6170 "Standard Guide for Selecting a Groundwater Modeling Code" (ASTM, 2010). ASTM standard D5981 is being used to help develop calibration goals and procedures for groundwater modeling efforts (ASTM 2008).

To date, elevation surveying has been completed at each transect to provide the upper land surface boundary and location of monitoring wells and other empirical observation points. Methods for integrating input data from the 1-dimensional (1D) HEC-RAS model (summer, ice-free) (ISR 8.5; Appendix K (R2 2014c)) are under development. The 2D hydraulic models will be used to develop synthetic stage-discharge relationships at the groundwater modeling transects for specific flow conditions simulated by the 2D hydraulic models. During fall freeze-up, winter, and spring breakup, output from the Ice Processes Study River1D model will be used for future stage input.

3.3. Deviations from Study Plan

The GW study methods were implemented as described in the Study Plan with only some variances in schedule for tasks not related to field activities (see ISR Study 7.5, Section 4.5).

4. RESULTS

4.1. Hydrology Observations

Hydrologic observations of GW/SW interactions and related data have been made in FA-128 (Slough 8A) since late summer 2013 and have covered the four primary seasons for the annual hydrologic year (Figure 3.2-10). One Station (ESSFA128-1) (Figure 2.0-5) was established as part of the 2012/13 winter studies conducted by IFS 8.5, FDA 9.6 and GW 7.5 and measured end-of-winter 2013 conditions as well as spring snow and breakup in 2013. The 2013/14 winter season was intensely monitored by the network of groundwater and surface water stations in FA-128 (Slough 8A), FA-138 (Gold Creek) and other relevant Focus Areas. The hydrology conditions observed during the winter of 2013/14 were substantially different in FA-128 (Slough 8A) and FA-138 (Gold Creek) with both Focus Areas experiencing lateral habitat flooding by mid-winter ice jams in the 2013/14 winter that did not occur in the 2012/13 winter. During the April late-winter field trip 2014 surface discharge was measured to characterize groundwater recharge (upwelling) to select lateral habitats (Table 3.1-2).

An early snowmelt and breakup period was measured in late April and early May. This was followed by a period of lower water level conditions in late May and early June with typical summer precipitation stage events in June through August. Additional water level, discharge and water quality data were collected in September 2014 to help characterize the end of the summer 2014 hydrologic period.

4.1.1. FA-128 (Slough 8A)

The hydrology data collected in FA-128 (Slough 8A) in 2013 and 2014 covered a broad range of hydrologic conditions. Figure 2.0-3 shows the general location of FA-128 (Slough 8A) and Inset B (Figure 2.0-5) shows the location of the lower aquatic transect at ESGFA128-13 (Figure 4.1-13), which is downstream of the confluence between Slough 8A and Middle Side Channel 8A. The cross-section profile for this transect shown in Figure 4.1-13 is oriented with the viewer looking downstream. ESGFA128-13 is located on the Left Bank (LB) side of the channel and ESGFA128-20 is located on the right

Groundwater station ESGFA128-21 is located at the far end of the Right Bank (RB) side of the channel to help measure the groundwater slope along the transect from the direction of the Susitna River. The GW/SW conditions are not symmetrical between the LB and RB sides of the channel. Figure 4.1-14 shows the groundwater levels and surface-water stage for all stations in this transect. Groundwater and surface-water levels generally follow similar patterns, though there are various periods were the gradients are reversed. Multiple events occurred at the end of 2013 where breaching flows entered Middle Side Channel 8A resulting in increased water levels at the study reach. The late precipitation events in October 2013 were precipitation stage changes. Low water conditions were measured in November and December 2013. This is the time period where water levels may be lowest, before fall ice jams and winter ice development results in increased stage levels.

Mid-Winter ice jams in the main stem created beaching stage (not flow) conditions that resulted in mid-winter flooding of Middle Side Channel 8A in January 2014, first with a small event, followed by the peak event for the winter period in the middle of January. Surface water conditions rose over adjacent groundwater conditions, reversing the hydraulic gradients during this period. Both groundwater and surface-water levels were higher during the middle of winter than during the summer high-water season in 2014, with the exception of spring snowmelt and break-up flooding that occurred in early May 2014. Following the spring snowmelt and break-up period, water levels in the channel and adjacent groundwater dropped to low levels. During the summer of 2014, water levels increased starting in mid-June and continued to increase with varying stage conditions in July, dropping back to lower water levels with minor precipitation peaks.

The groundwater and surface water temperature data for the period of record is shown in Figure 4.1-15. The surface water temperature is affected by breaching flows from the mainstem Susitna River and reached water temperatures a little over 16ºC in August of 2013. The summer conditions in 2014 were cooler with temperatures only reaching about 12ºC in July. The surface-water temperatures dropped rapidly as the summer period ended in 2013 and conditions transitioned into the early winter freeze-up period. The breaching winter stage conditions in January kept surface-water temperatures near 0ºC for the rest of the winter period in 2014. In general groundwater temperatures were highest at ESGFA128-21, which also has higher groundwater levels. The two wells on the LB side of the channel indicate colder surface-water is discharging (downwelling) to groundwater on this side of the channel. Warmer groundwater conditions in ESGFA128-20 coincide with higher groundwater levels compared with the side channel, indicating warmer groundwater is coming into the channel on the RB side. The streambed temperature profile string at this section (Figure 4.1-16) indicates that during winter

conditions, this is a discharge section (stream reach) to groundwater, with temperatures in the stream bed to 100 cm close to 0ºC for most of the winter period.

The upper aquatic transect is located near the center of Slough 8A at the ESGFA128-7 station (Figure 2.0-5). This station has different hydrology characteristics compared to the lower aquatic transect in Middle Side Channel 8A. The cross-sectional profile for this channel is shown in Figure 4.1-17. There are two groundwater wells on the RB side of the slough and two groundwater wells on the LB side. Slough water level, temperature and streambed temperature profiles are measured by the ESGFA128-7 station. The groundwater and surface-water levels for this section are shown in Figure 4.1-18. Surface-water stage varies less than in the lower Middle Side Channel 8A. This portion of Slough 8A is above any backwater influences from the side channel. Breaching flows from the Susitna River occur at higher flow conditions and were measured in August and September of 2013. Local precipitation had a minor influence on water levels in October of 2013, and subsequently water level conditions in the slough were fairly constant until breaching stage conditions due to ice in the main channel flooded Slough 8A in mid-January and again in mid-February. Between these two events, there were likely overtopping stage conditions at the upper end of Slough 8A. After these winter events, the stage conditions in Slough 8A returned to a steady condition, only slightly higher than the water level conditions before winter flooding occurred. The spring snowmelt and ice jam flooding from the Susitna River created breaching flow and stage conditions in early May for a brief period. Following the flooding event, water levels were variable, due to snowmelt runoff into the slough. Data from the summer period is inferred from the adjacent wells (ESGFA128-18, ESGFA128-19) as the spring breakup flooding and the resulting ice damage tore out the surface-water pressure transducer and damaged the well closest to the slough on the RB (ESGFA128-7 W1), along with the streambed temperature profile sensor from this site.

The groundwater and surface-water period of record water temperature for the upper aquatic section is shown in Figure 4.1-19. The groundwater temperatures on both sides of the slough are generally warmer than the surface water in the slough for most of the winter. With increasing day light in March the slough water temperatures start increasing and showing diurnal temperature variation with steadily increasing temperatures through the beginning of May, when spring breakup and ice jam flooding tore out the sensors in the slough. The small channel on the RB side of the Slough (Figure 4.1-17) has an impact on groundwater temperatures that recharge the slough from the right bank side. This is seen during February 2014 when ice jam breaching stage conditions resulted in flooding of this channel and a rapid drop in groundwater temperatures in ESGFA128-7 W2 during the flow due to the flooding of cold main channel water coming down the slough (Figure 4.1-18). The streambed temperature conditions also reflect the reversals in groundwater gradients in January 2014 for a brief time and later in February 2014 for more than a week (Figure 4.1-20). The stream bed conditions indicate groundwater upwelling in this section, except for the transient conditions during flooding. The temperature profile sensor string was pulled out by spring breakup flooding and reinstalled in late August 2014.

An additional station located upstream of the upper aquatic transect is ESGFA128-6, which is at the end of the upper Riparian Transect. This station records surface-water stage in Slough 8A, just upstream of a small beaver dam (approximate height is about 1.5 feet) and an adjacent groundwater well to the slough. Groundwater and surface water levels are shown in Figure 4.1-

21 and water temperature in Figure 4.1-22. The site is located on the RB side of the slough and is influenced by surface water stage changes in the main channel. This results in the gradient between groundwater and the slough to be increasing during the early winter months when ice jams are forming and increasing stage levels are occurring in the main channel and late winter decreasing gradients as stages drop in the main channel. During this time the slough levels are relatively stable except when overtopping stage conditions are flooding the slough, as seen briefly in January and more notably in February 2014. Water temperature differences between groundwater and the slough show groundwater conditions to be warmer through the winter until solar heating of the slough surface water starts to increase in March and becomes warmer than adjacent groundwater in early April 2014. During the summer months, groundwater temperatures are steadily rising but cooler than the surface water in the slough.

Winter discharge measurements were made in April 21, 2014 at two locations on Slough 8A at the same stage conditions to measure the difference in flow. Table 3.1-1 shows the summary information for discharge measurements presented in Appendix B. The average discharge measured at the upstream end of the slough at location S8AX2US was 0.76 cubic feet per second (cfs). The downstream location was just below the upper aquatic transect at S8AX2DS and the average measured flow was 6.04 cfs. The difference in flow, or recharge to the slough from groundwater along this reach of Slough 8A was 5.28 cfs. The amount of recharge to the slough will vary with GW/SW gradients, which are being measured in the aquatic transects and interpreted from the other data collection stations in the Focus Area.

4.1.2. FA-138 (Gold Creek)

Select data are presented for FA-138 (Gold Creek) to enable comparisons in groundwater and surface water responses between Slough 11 and Upper Side Channel 11 (in FA-138) and Slough 8A and Middle Side Channel 8A (in FA-128).

Water levels in Slough 11 and adjacent wells on the RB are shown in Figure 4.1-23. Only one breaching event in December 2011 impacted Slough 11 during the study period as a response to river freeze-up and early winter ice jams in the main channel. The groundwater relationships with water levels in the slough vary over the hydrologic seasons, but in general the slough acts as a drain and is lower than adjacent groundwater conditions except for the overtopping winter stage conditions and some variation during winter related to ice formation in the channel with variations in air temperature. The water temperature varies slightly at this location from a low temperature just above 2ºC and highs near 5ºC (Figure 4.1-24). The warmer groundwater recharging the slough (upwelling) helps keep open water conditions in the slough for most of the winter period.

Water level and temperature measurements for Upper Side Channel 11 and adjacent wells located at ESGFA138-2 are depicted in Figure 4.1-25 and Figure 4.1-26, respectively. In general, water levels at this lateral habitat area illustrate a strong relationship to stage conditions in the main channel of the Susitna River (Figure 4.1-25). During early winter ice-jam flooding of Upper Side Channel 11, water level increased rapidly and varied throughout January and February 2014. A steady recession in water level condition occurred in the groundwater wells until the winter low period in mid-April. The surface water pressure transducer was damaged by

ice in late January 2014 and replaced in late June 2014. Groundwater temperature trends follow similar patterns to those wells in Slough 11 (Figure 4.1-26).

4.2. Functional Relationships of Surface and Groundwater Levels to Susitna River Flow

The analysis of hydrologic data for FA-128 (Slough 8A) and FA-138 (Gold Creek) indicate that the response of groundwater levels to mainstem stage and flows in the Susitna River varies over space and hydrologic time period negating the ability to define a single uniform response function applicable to all areas. This was likewise noted during the 1980s studies of both Slough 8A and Slough 11 (R&M 1985). As part of the exploratory analysis of these relationships, the hydrology data previously discussed was used with flow data from the Susitna River at Gold Creek USGS gage record (USGS 2014) to evaluate how lateral habitats may respond to changes in flow and stage in the Susitna River. For this TM, the analysis was limited to the open-water periods of the hydrograph, but ultimately both open-water and ice-covered periods will be evaluated.

There are a number of analytical approaches that are being considered for application to the different data sets, including statistical (e.g., linear and non-linear models) and physical based methods (including utilization of MODFLOW). These are being evaluated as part of the GW analysis and will be applied based on data type, data suitability and specific IFS objectives (e.g., need for groundwater discharge data at selected locations in Focus Area for SRH-2D input, versus need for groundwater temperature data at different locations). The objective for this TM was to first, highlight empirically derived relationships between surface water elevations at two locations in FA-128 and groundwater elevations at one location in FA-128 with Susitna River discharge (based on Gold Creek gage) and then demonstrate how those data and data from FA-138 could be used to develop predictive response functions to evaluate Project effects. Ultimately, the development of these types of functions will need to be done with consideration for their transferability to areas outside of the Focus Areas.

4.2.1. FA-128 (Slough 8A)

The hydrologic relationships for select hydrologic conditions between the flow in the Susitna River at Gold Creek and stage in Middle Side Channel 8A at the lower aquatic transect are shown in Figure 4.2-27. The use of selected comparison points show a period during low Susitna River flows levels (below about 18,000 cfs) when there is no clear relationship to flow in the main channel and stage conditions are controlled by groundwater inflow. Above this point the relationship characteristics show a difference between rising and falling stage conditions in the mainstem and between 2013 and 2014. The lower pattern of data points is from 2013. The upper pattern is from 2014. A potential shift in the channel may have occurred between the two time periods.

At the lower end of Slough 8A, just above the confluence with Middle Side Channel 8A water levels are measured at station ESSFA128-1. Figure 4.2-28 shows the response pattern between the flow at the Susitna River at Gold Creek and the lower end of Slough 8A. This portion of the slough is in the backwater influence of Middle Side Channel 8A and shows a similar pattern of response as Middle Side Channel 8A. The stage conditions are impacted by backwater

conditions up to approximately 18,000 cfs and the response to rising and falling discharge and stage conditions is uniform until approximately 30,000 cfs on the Susitna River at Gold Creek.

In the upper aquatic cross section a well that was located adjacent to the slough and on the LB (ESGFA128-18, Figure 4.2-29) was used for comparison. This reach of Slough 8A is above any backwater influences from the Middle Side Channel 8A. At this location, there is no indication of a response relationship until the mainstem Susitna River reaches about 36,000 cfs. Stage conditions below about 36,000 cfs in the Susitna River remain around 575 feet above sea level.

As an additional step to understanding how mainstem flow influences Focus Area FA-128 (Slough 8A), Susitna flow at Gold Creek was compared to water surface elevations in the ESGFA128-13 side channel location downstream of slough 8A. The entire 2014 ice-free season was examined on an hourly basis from break-up in early May through the latest data downloads on September 4, 2014. This represents a continuous record during the ice-free season that will be expanded in forthcoming analyses to include the entire flow recession period until freeze-up (September through November). The relationship between Susitna River flow at Gold Creek and the ESGFA128-13 water surface elevation showed a threshold response over this period (Figure 4.2-30). Below about 16,000 cfs, 128-13 surface water elevation changed slightly, ranging between 570.3 and 570.5 ft. However, above 16,000 cfs the stage response was linearly related to Susitna mainstem flow and rose steadily from 570.2 and 573.8 ft. Linear regression was highly significant for flow and stage relationships above and below the 16,000 cfs threshold ($p < 0.0001$), but explained more of the relationship above 16,000 cfs ($R^2 = 0.99$) compared to below the 16,000 cfs threshold ($R^2 = 0.15$).

4.2.2. FA-138 (Gold Creek)

Susitna River at Gold Creek flow was also compared to water surface elevations in the ESGFA138-2 Upper Side Channel 11 location within Focus Area FA-138 (Gold Creek) (Figure 4.2-31). This analysis included the ice free period from July 31 2013 to September 5 2014. The relationship between Susitna Flow at Gold Creek and the ESGFA138-2 water surface elevation showed three flow and stage responses over this period. Below 9,000 cfs, ESGFA138-2 surface water elevation changed very slightly, ranging less than a tenth of a foot between 682.3 and 682.3. From 9,000 to 15,000 cfs, flow increased linearly from 682.3 to 683.3 ft while above 15,000 cfs 138-2 water elevation increased over three feet from 683.3 to 686.6. Linear regression was highly significant for flow and stage relationships for each flow range and stage range. ($p < 0.0001$), but explained more of the relationship above 15,000 cfs ($R^2 = 0.99$) compared to 9,000 to 15,000 cfs ($R^2 = 0.97$) or below 9,000 cfs ($R^2 = 0.15$).

4.3. GW/SW Relationships to Aquatic Habitat Functions

A further step in the analysis serves to illustrate GW/SW dynamics in two locations, FA 128-13 (noted in Figure 2.0-5) and FA138-2 (noted in Figure 2.0-8), respectively, with contrasting downwelling and upwelling and hydrologic conditions as evidenced by thermal gradients. These gradients are biologically significant in that they can influence egg and alevin development and survival during the late fall, winter, and spring break-up periods. Understanding the GW/SW dynamics under natural flow conditions will be important for determining how these dynamics may change with Project operations. These and other intermediary types of GW/SW dynamics

are likely present within each of the Focus Areas and will be evaluated through further data analysis.

4.3.1. ESGFA128-13 – Middle Side Channel 8A– Downwelling Dynamics

ESGFA128-13 in the Lower Side Channel below Slough 8A represents a downwelling site where water temperatures in surface and sub-surface are near freezing throughout the winter period (Figure 4.3-32). Sub-surface water and well temperatures dropped from ~4ºC to less than 1ºC in late November and remained low until break-up in early May. The exception to consistently low temperatures was a slight temperature increase (to 1-2ºC) during mid-January associated with a stage increase and a brief positive hydraulic gradient (i.e., when well WSE > surface water WSE from Jan 01 to Jan 14). After this brief warming event, temperatures in surface and sub-surface waters remained low for the next three months. Surface temperatures increased at a greater rate in May while sub-surface sites remained ~2ºC. Consistent warming of surface and sub-surface waters was observed in late June and was associated with increases in Susitna River mainstem flow as well as surface water elevation stages (WSE). Maximum temperatures for surface and sub-surface waters coincided with maximum Susitna River mainstem flow (>40,000 cfs) in late June and early July. Well temperature response generally lagged behind surface water, reaching a maximum in late August. All well, surface and sub-surface water temperatures declined at a similar rate in early September to the end of the period of record. Overall, the average winter temperature (November 1, 2013 to May 1, 2014) at presumed embryo incubation depths (-20 to -50 cm) was 0.5ºC and average annual temperature at these depths was 3.0ºC. This type of information will feed into the effective spawning and incubation habitat models.

4.3.2. ESGFA138-2 – Upper Side Channel 11 – Upwelling Dynamics

ESGFA138-2 in Upper Side Channel 11 represents an upwelling site where water temperatures remain above freezing for most of the winter period (2-4ºC, see Figure 4.3-33). The exception is between December 11 and 19, 2013 when water from the mainstem flow breached the side channel, the surface and well water surface elevations (WSE) increased approximately six feet, and water temperatures through the streambed profile dropped to near freezing (0 to 1ºC). Following this event, water temperatures in the sub-surface returned to warmer temperatures (2-4 ºC) until the break-up period in early May when surface and streambed profile temperatures again decreased to near freezing (0 to 1ºC). Following the breakup period, near surface and surface temperatures rose steadily, but the deeper profile between -50 and -100 cm remained below 5 ºC. Over the entire annual period, sub-surface temperatures were related to the differential between well and surface water elevations. During most of the winter period, well WSE was greater than surface WSE (a positive vertical hydraulic gradient), and upward groundwater flow to the stream maintained warm sub-surface temperature similar to groundwater temperatures (~4ºC). Again, the exception was during breaching flows in December when surface WSE was greater than well WSE, and sub-surface temperatures were driven by downwelling from surface water. Overall, the average winter temperature (Nov 1 to May 1) at embryo incubation depth (-20 to -50 cm) was 3.5ºC and average annual temperature at these depths was 3.2ºC.

5. GROUNDWATER AND SURFACE WATER RELATIONSHIPS IN LATERAL HABITATS

The results of the current analysis support the same general conclusion reached during the 1980s studies that:

"The results of the present study (1980s studies) do not permit a single model to be formulated which can describe the discharge and temperature variations which are observed at each of the various sloughs studied. The hydraulic and thermal behavior of each slough is substantially different from that of other sloughs studied" (Harza-Ebasco, 1984).

Variability in GW/SW responses relative to mainstem flow was observed temporally at the same locations and spatially at different locations within each Focus Area, as well as between Focus Areas. However, the results presented herein have served to highlight some of the more important mechanisms by which groundwater and surface water conditions can be influenced by Susitna River flows.

These include the occurrence of breaching flows that may occur frequently relative to side channel habitats; infrequently in slough habitats. Depending on their timing, magnitude and duration, the occurrence of these flows during biologically sensitive periods could for example influence overall egg survival and/or fry emergence timing within a given habitat location via changes in water temperatures. Thus, determining how Project operations may influence the frequency of these types of flows will be important for determining overall project effects.

Another apparent influencing mechanism pertains to winter freeze-up and ice disturbance, during which stage increases can create substantial relatively short-term pulses in GW and SW levels. This process can impart some of the same effects as breaching flows in terms of temperature alterations. Of note too is the relatively low flow, stable conditions that occur during winter periods when ice is not an influencing factor. During these times, the contribution of groundwater to sloughs and side channels becomes the most pronounced and potentially most influential to prevailing biological elements.

The analysis presented in this TM that was centered on FA-128 (Slough 8A) and FA-138 (Gold Creek) has contributed to the overall understanding of GW/SW interactions and other (e.g., local precipitation) mechanisms and types of functional relationships that can be derived from empirical data. Both of the response functions for FA-128 (Figure 4.2-30) and for FA-138 (Figure 4.2-31) suggest that the influence of mainstem versus groundwater flows varies depending on certain threshold or breaching flows in the mainstem river. In the case of FA-128 (Figure 4.2-30), this threshold occurs when mainstem flows > 16,000 cfs. At flows < 16,000 cfs, the flow in that particular location is governed largely by groundwater. For FA-138 (Figure 4.2-31), three separate relationships were identified: (1) flows < 9,000 cfs in which groundwater is the dominant flow; (2) flow relationships between about 9,000 cfs and 15,000 cfs that are mainstem controlled; and (3) flow relationships > 15,000 cfs where the relationship between Susitna River at Gold Creek flow and stage in the side channel change slope. Analysis is ongoing to identify these types of relationships at other locations within these and other Focus Areas.

Establishment of these types of relationships will be important for analyzing Project effects over time. For example, the general range of operations of the Project during the winter months is anticipated to be from about 5,000 to 11,000 cfs, a period when natural flow conditions are generally at their lowest (average winter-time flows at Gold Creek < 2,000 cfs). Thus, during the winter months such flows would be substantially higher than what would naturally occur, but in terms of the lateral habitats, may still be below the threshold flows for which main channel flows become dominant. When project operation flows are below breaching thresholds, they would have little to no effect on lateral habitats in terms of additional main channel flows, but the hydraulic gradients imparted by the higher than normal main channel flows would likely be greater and may result in increased upwelling zones within those habitats. In these transitional types of areas, the temperatures associated with the upwelling areas would likely represent combinations of groundwater and riverine source water.

The accompanying thermal analysis (based on temperature data collected from October 2013 to early September 2014) for the two locations demonstrated two extremes in terms of areas that are subject to downwelling and upwelling conditions. While Slough 8A within FA-128 (Slough 8A) is a known spawning area, the location of the ESGFA128-13 station is below the confluence of the Middle Side Channel 8A which received substantial flow from the Susitna mainstem (R2 2014b). As a result, this mainstem water dominated the sub-surface dynamics of the side channel. An overall negative vertical hydraulic gradient at this location (Surface water WSE > Groundwater WSE), indicates that downwelling from the surface water is the dominant hydrologic pathway. Surface water movement from the side channel to the ESGFA128-13 well may also maintain low well temperatures at ESGFA128-13 throughout the winter period. Groundwater temperatures in the ESGFA128-13 W1 and W2 well positions during mid-winter (~1ºC) were colder than ESGFA128-20 and ESGFA128-21 wells (2-4ºC; Figure 2.0-5) positioned on the opposite side of the transect. Although wells ESGFA128-20 and ESGFA128-21 are located on an island between slough 8A and the main channel, they appear to be less affected by mainstem flow. The downwelling dynamics at the ESGFFA128-13 side channel position resulted in greater temperature variability throughout the year. Winter temperatures were near freezing, but surface and sub-surface temperatures increased after mid-June. Although the average annual temperatures at incubation depth (3ºC) was likely adequate to support embryo development, cold winter temperatures (Nov to May 1 average = 0.5ºC) that were often near freezing or even supercooled to below freezing would result in slower development and potential embryo mortality at this site. These flow and temperature dynamics highlight how cold temperatures from Susitna mainstem flow can influence off-channel habitats throughout the winter period.

In contrast, Upper Side Channel 11 in FA-138 (Gold Creek), which is a known chum salmon spawning area was demonstrated to contain an area of upwelling. Many juvenile salmonids were documented during summer and winter studies in this channel by studies FDA 6.5 and IFS 8.5 (R2 2014b; R2 and LGL 2014a, b), and chum fry were observed emerging from the substrate in April 2014 (R2 2014b) Sub-surface temperatures at FA-138 were higher throughout the winter period (Nov to May 1 average = 3.5ºC) and upwelling dynamics in this off-channel habitat may be crucial for survival and successful development of salmon embryos as well as juvenile rearing. Nevertheless, winter groundwater elevation and surface-water stage and temperature time series records also demonstrate how hydrologic variability can result in pulses of cold sub-surface temperatures in a dominant upwelling site. Surface water elevations increased rapidly

during mid-December from breaching likely associated with mainstem ice formation following an early December warming event. During this breaching period, sub-surface temperatures became isothermic and supercooled throughout much of the 100 cm sub-surface profile, dropping to below freezing for a six day period. Such conditions are not conducive to embryo development, but the extent of embryo impacts is dependent on the duration of occurrence as well as the specific location of embryos within the substrate relative to the cold temperatures. Since fry emergence was observed during April at this location, at least some (perhaps the majority) of the salmon embryos were able to survive throughout the winter period.

More broadly, the analysis has identified dominant hydrologic periods that need to be considered in terms of GW/SW relationships (Figure 5.0-34). High flow or downwelling periods may result in cold or warm temperature conditions in the sub-surface. Cold sub-surface conditions are observed when ice jams divert cold water from mainstem flows or generate backwater effects to raise surface water elevations across a broad area. An increase in the hydraulic head or pressure from rising surface waters forces water to infiltrate into the hyporheic zone and outward from the channel to the surrounding groundwater aquifer. Overall, ice disturbance effects may occur during fall freeze-up, mid-winter or spring break-up ice jams. Conversely, warm sub-surface water may also be associated with high stage and downwelling periods from summer high flow periods when Susitna water temperatures often reach an annual maximum (Tetra Tech and URS 2013). The types and degree of influence that groundwater has within a given lateral habitat will vary depending on the specific hydrologic period. In the low stage period during winter and late summer (see bottom panel in Figure 34), groundwater levels, elevated from local precipitation or stored from prior mainstem flow events, are greater than surface water elevations and upwelling conditions would dominant flow in lateral habitats. During the freeze-up and ice-jam periods, groundwater dominance may alternate with surface water dominance depending on the degree of ice staging. The spring break-up period represents a time of transition for lateral habitats that are groundwater low-stage dominated to those riverine high-stage dominated as ice-out occurs and flows increase. And finally, during mid-summer when flows are normally high, mainstem flows dominate but can become less important during late summer as flow recedes.

Despite seasonal changes in hydrology due to ice disturbance and flooding, lateral habitats with groundwater influence and upwelling act to moderate sub-surface temperature dynamics by maintaining temperatures above freezing during winter as well as attenuating the rise in temperature during the summer period. The two sets of analysis presented in this TM demonstrate how mainstem flow rates, seasonal ice disturbance, and local GW/SW hydrologic conditions in off-channel habitats can influence sub-surface temperature conditions that are critical for embryo development, and the reproductive success of anadromous salmonids and resident fish species. The overall extent to which lateral habitats will be modified under Project operations depends on the relative change of winter and summer mainstem flows, the change in mainstem temperatures during winter and summer, and the extent and duration of ice disturbance during freeze-up, mid-winter and break-up periods.

6. PLANS FOR 2015

The GW studies associated with Task 6 will continue in 2015 with a focus on a) collection of hydrologic data (surface and groundwater) within FA-104 (Whiskers Slough), FA-113 (Oxbow

1), FA-115 –(Slough 6A), FA-128 (Slough 8A), FA-138 (Gold Creek), FA-141 (Indian River), and FA-144 (Slough 21); b) continued analysis of empirical data and development of GW/SW relationships; c) completion of MODFLOW modeling to support data analysis; and d) development of specific groundwater related parameter inputs needed to support the IFS-FA models as well as other modeling efforts (e.g., Water Quality Model (Study 5.6); Fluvial Geomorphology Model (Study 6.6); Ice Processes (Study 7.6).

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8. TABLES

Table 3.1-1. Locations of discharge measurements recorded in FA-104 (Whiskers Slough), FA-128 (Slough 8A) and FA-138 (Gold Creek) during March and April 2014.

Site	Focus Area	Habitat Type	Site Location Description
FA104-PIT	104	SS	Whiskers slough at ESGFA104-9-W2
FA104-SL 3B	104	SC	Slough 3B near WS50-WQ5-OG
FA104 SL INL	104	SS	Whiskers Slough Inlet
FA104-10	104	SC	Whiskers Side Channel at ESGFA104-10-W1
FA104-5	104	SS	Whiskers Slough at ESGFA104-5
FA104-ET	104	SC	Whiskers East Side Channel near inlet
FA104-E	104	SC	Whiskers East Side Channel
FA104-SL 3A	104	US	Slough 3A
FA128-SL 8A INL	128	SS	Slough 8A Inlet below camp
FA128-18 SL 8A	128	SS	Slough 8A upstream ESGFA128-18-W1
FA128-SC	128	SC	Side channel downstream of ESGFA128-13-W1
FA128-SL A	128	SS	Slough A
FA128-HM	128	US	Half-moon slough
FA138-4 USC11	138	SC	Upper Side Channel 11
FA138-SL 11 GC	138	SS	Upper Side Channel 11 inlet
FA138-SL 13	138	SS	Slough 13
FA138-SC 11	138	SC	Lower Side Channel below Slough 11 outlet
FA138-3 SL 11	138	SS	Slough 11 near ESGFA138-3
FA138-SL 11 INL	138	SS	Inlet Slough 11

* SC = Side Channel, SS = Side slough, US = Upland Slough

Table 3.1-2. Instream Flow Study discharge measurement summary table.

Susitna-Watana: Groundwater Study; Stream Discharge Measurments

Discharge Measurment Location	Date and Time (AST)	Latitude	Longitude	Discharge (cfs)	Comments
FA-138 (Gold Creek)					
FA138 S11XUS	4/18/14 14:42	62.76243	149.70079	0.62	Located on Slough 11 above the low beaver dam that is directly above ESGFA138-1
FA138 S11XUS	4/19/14 10:32	62.76243	149.70079	0.47	
FA138 S11XUS	4/18/14 12:56	62.76243	149.70079	0.68	
			Average Discharge =	**0.58**	
FA138 S11XDS	4/18/14 10:20	62.75670	149.70626	1.04	Located on Slough 11, just below ESGFA138-1
FA138 S11XDS	4/18/14 16:23	62.75670	149.70626	0.96	
FA138 S11XDS	4/19/14 8:59	62.75670	149.70626	0.77	
			Average Discharge =	**0.87**	
			Difference between upstream and downstream flow=	***0.29 cfs***	
FA-128 (Slough 8A)					
FA128 S8AX2US	4/21/14 13:04	62.66788	149.88809	0.91	
FA128 S8AX2US	4/21/14 11:24	62.66788	149.88809	0.73	Located at FSSFA128-38, on upstream end of Slough 8A, just below upper pool.
FA128 S8AX2US	4/21/14 11:16	62.66788	149.88809	0.78	
			Average Discharge =	**0.76**	
FA128 S8AX2DS	4/21/14 16:10			5.68	Located on Slough 8A just below ESGFA128-7
FA128 S8AX2DS	4/21/14 15:22			6.34	
FA128 S8AX2DS	4/21/14 15:07			5.74	
			Average Discharge =	**6.04**	
			Difference between upstream and downstream flow=	***5.28 cfs***	
FA-104 (Whiskers Slough)					
FA104 WCXUS	4/17/14 10:10	62.38622	150.16292	3.4	Located upstream in Whiskers Creek
FA104 WCXUS	4/17/14 11:12	62.38622	150.16292	3.71	
FA104 WCXUS	4/17/14 10:38	62.38622	150.16292	3.7	
			Average Discharge =	**3.60**	
FA104 WCXDS	4/17/14 13:22	62.37687	150.17191	4.59	Located downstream of ESSFA104-23 and just above pool at mouth of Whiskers Creek
FA104 WCXDS	4/17/14 14:16	62.37687	150.17191	4.52	
FA104 WCXDS	4/17/14 15:46	62.37687	150.17191	4.7	
			Average Discharge =	**4.60**	
			Difference between upstream and downstream flow=	***1.00 cfs***	
FA104 S3AUS	4/16/14 9:40	62.38961	150.14813	0.68	Located in Slough 3A, upstream of the old wooden bridge (now washed out)
FA104 S3AUS	4/16/14 12:30	62.38961	150.14813	0.69	
FA104 S3AUS	4/16/14 11:20	62.38961	150.14813	0.68	
			Average Discharge =	**0.68**	
FA104 S3ADS	4/16/14 13:50	62.38638	150.15438	nd	Flow velocity below detection limit. Location is in Slough 3A, below wooden bridge
			Average Discharge =	**nd**	
			Difference between upstream and downstream flow=	***Undetermined***	
ESGFA104-9	4/26/14 13:08	62.37626	150.17091	31.79	Located below the confluence of Whiskers Slough and Whiskers Creek
ESGFA104-9	4/26/14 13:03	62.37626	150.17091	33.77	
			Average Discharge =	**32.78**	

9. FIGURES

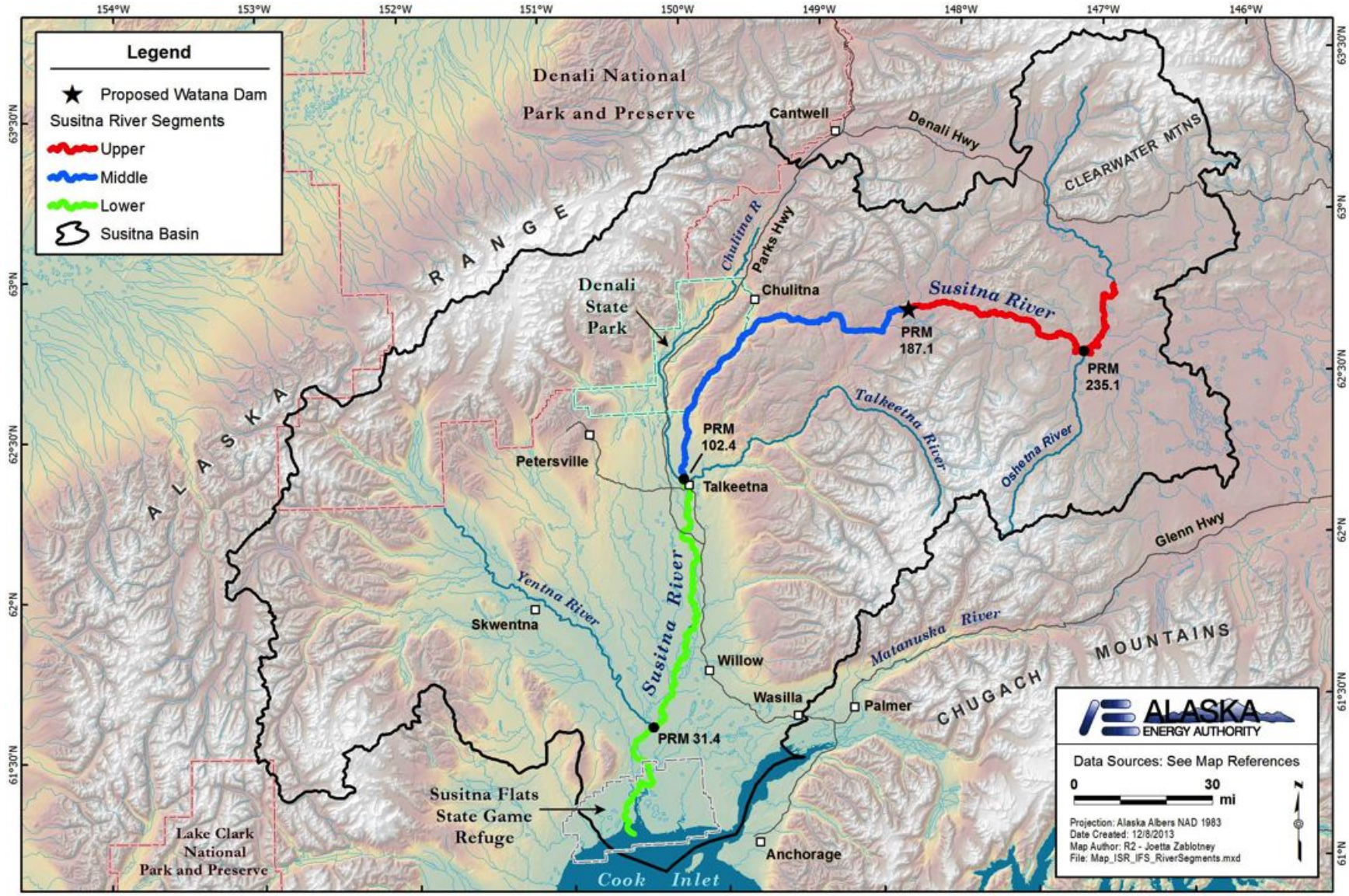


Figure 2.0-1. Susitna Watershed basin boundaries, showing the Project designation of upper, middle and lower river segments.

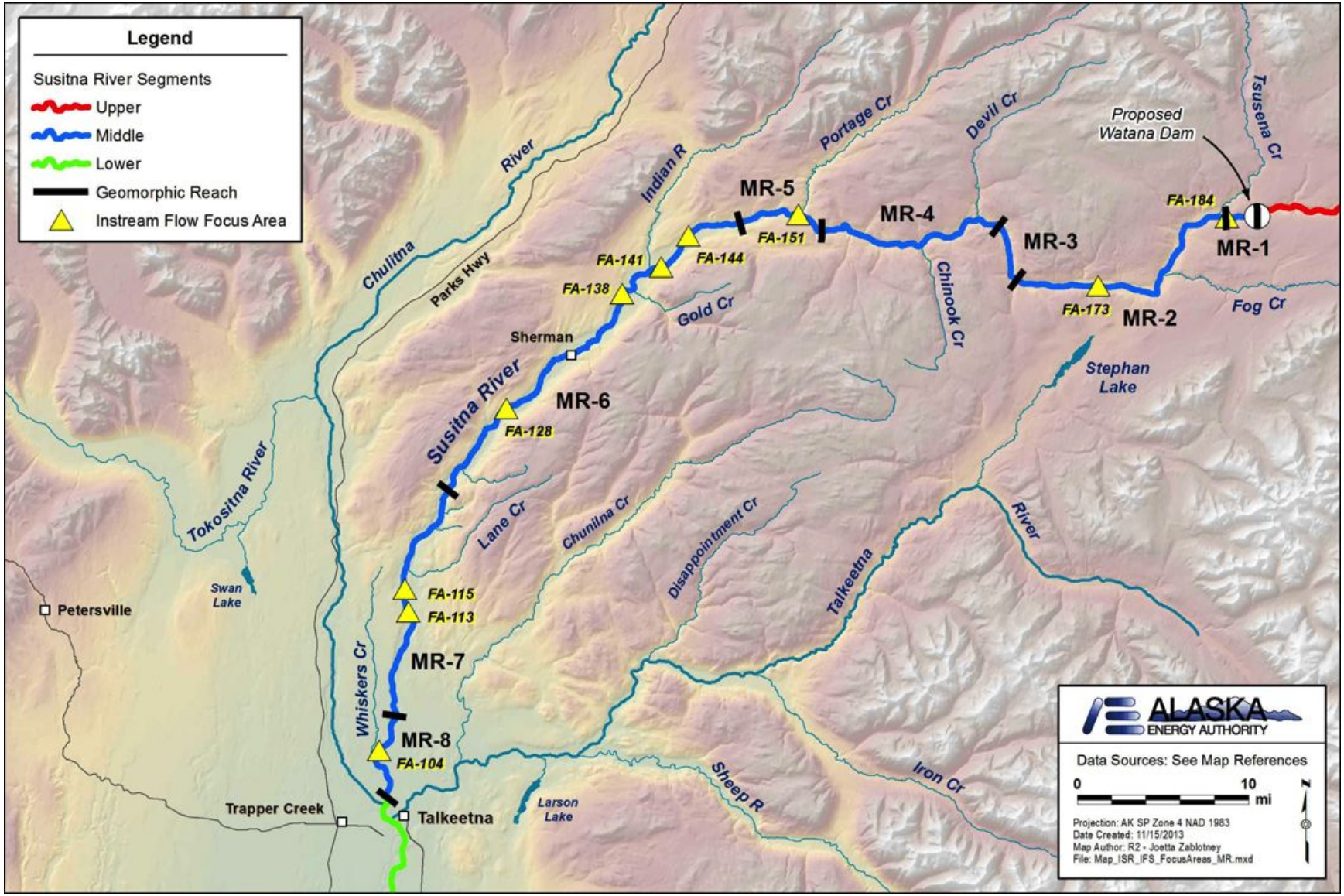


Figure 2.0-2. Susitna Watershed Middle River Segment, with geomorphic reaches and Focus Areas indicated.

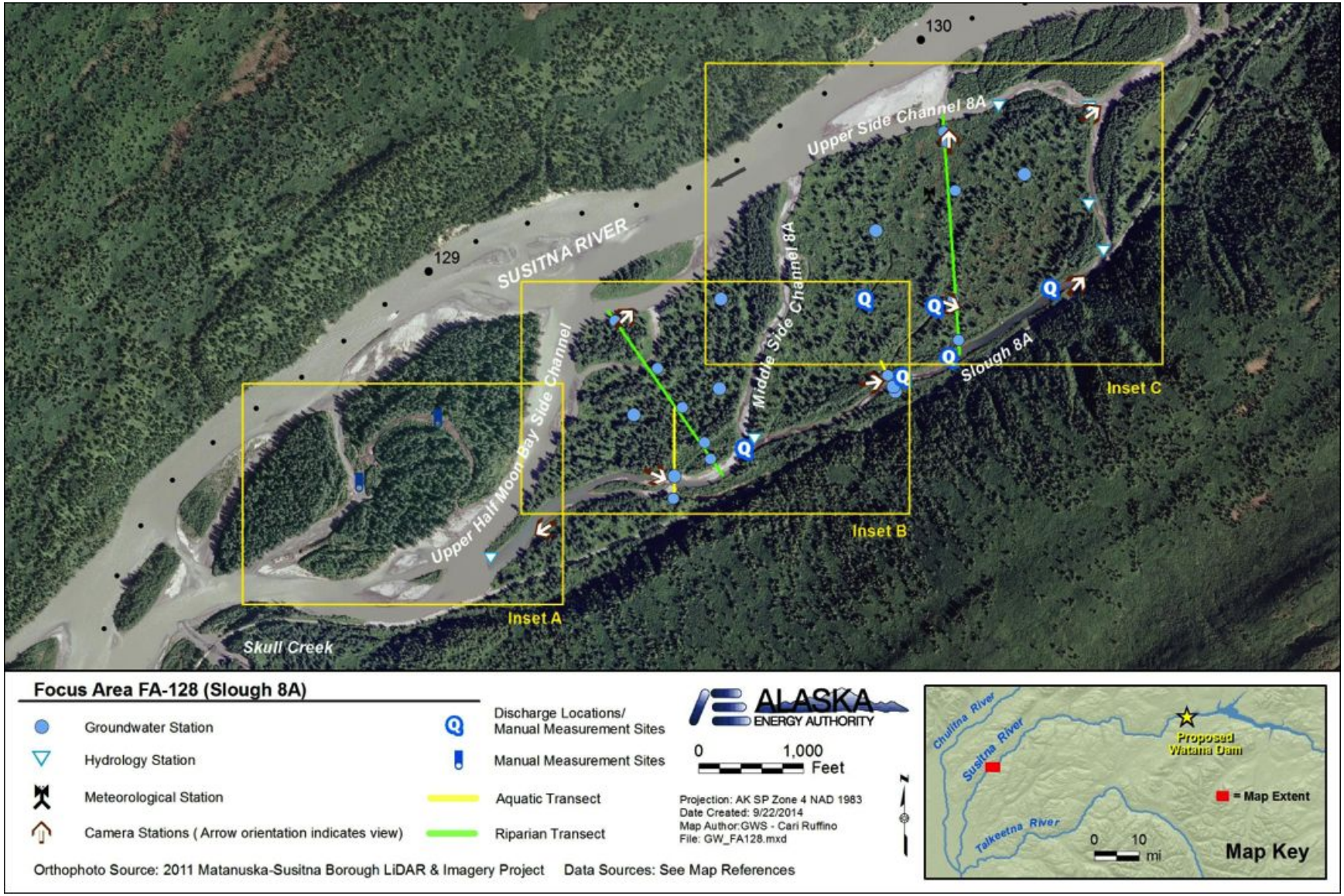


Figure 2.0-3. General location of FA-128 (Slough 8A) Focus Area, showing major data collection stations and aquatic and riparian transects.

Figure 2.0-4. Inset A shows locations of aquatic transect stations with continuously measured parameters at FA-128 (Slough 8A) Focus Area.

Figure 2.0-5. Inset B shows locations of aquatic transect stations with continuously measured parameters at FA-128 (Slough 8A) Focus Area.

Figure 2.0-6. Inset C shows locations of aquatic transect stations with continuously measured parameters at FA-128 (Slough 8A) Focus Area.

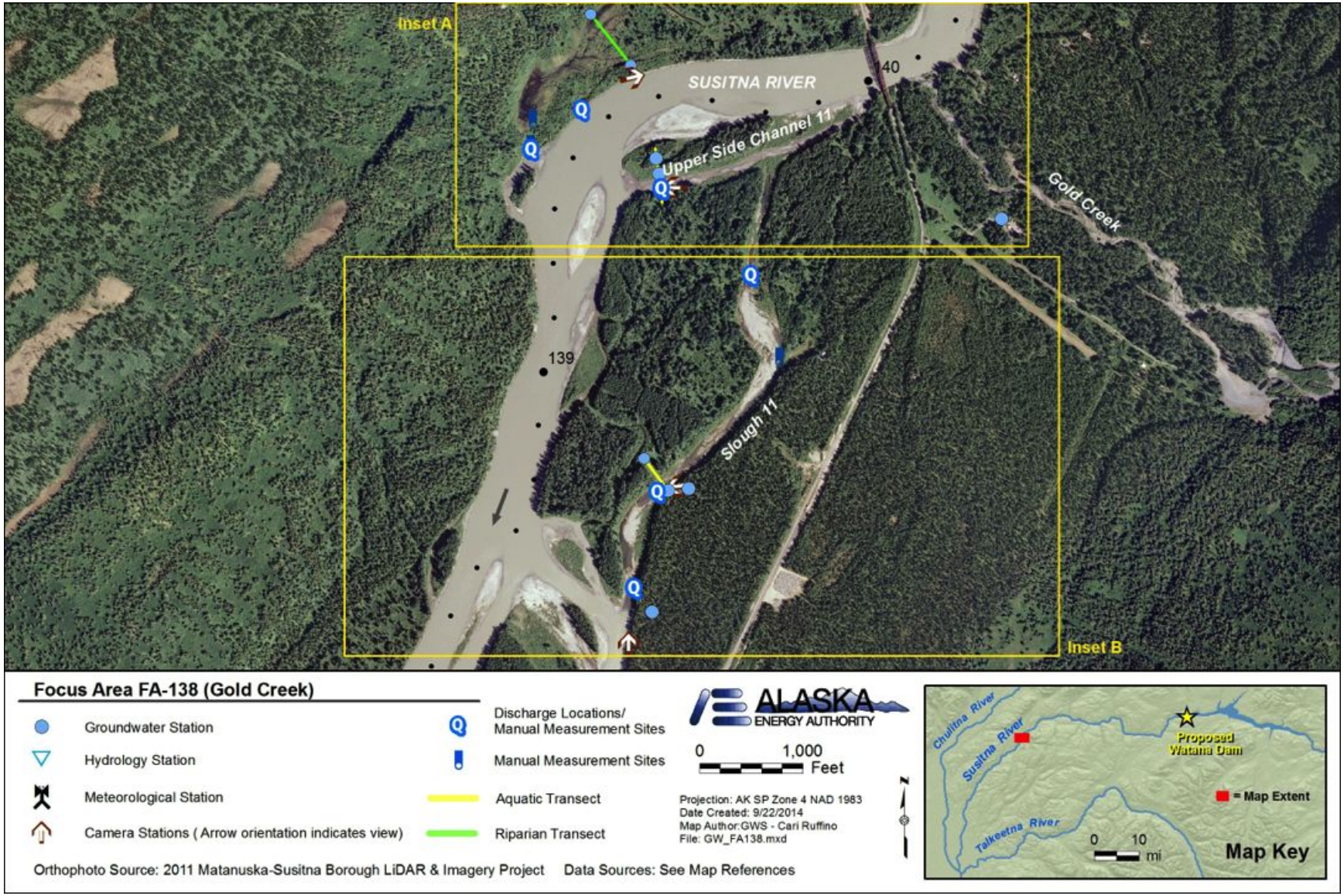


Figure 2.0-7. General location of FA-138 (Gold Creek) Focus Area, showing major data collection stations and aquatic and riparian transects.

Figure 2.0-8. Inset A shows locations of aquatic transect stations with continuously measured parameters at FA-138 (Gold Creek) Focus Area.

Figure 2.0-9. Inset B shows locations of aquatic transect stations with continuously measured parameters at FA-138 (Gold Creek) Focus Area.

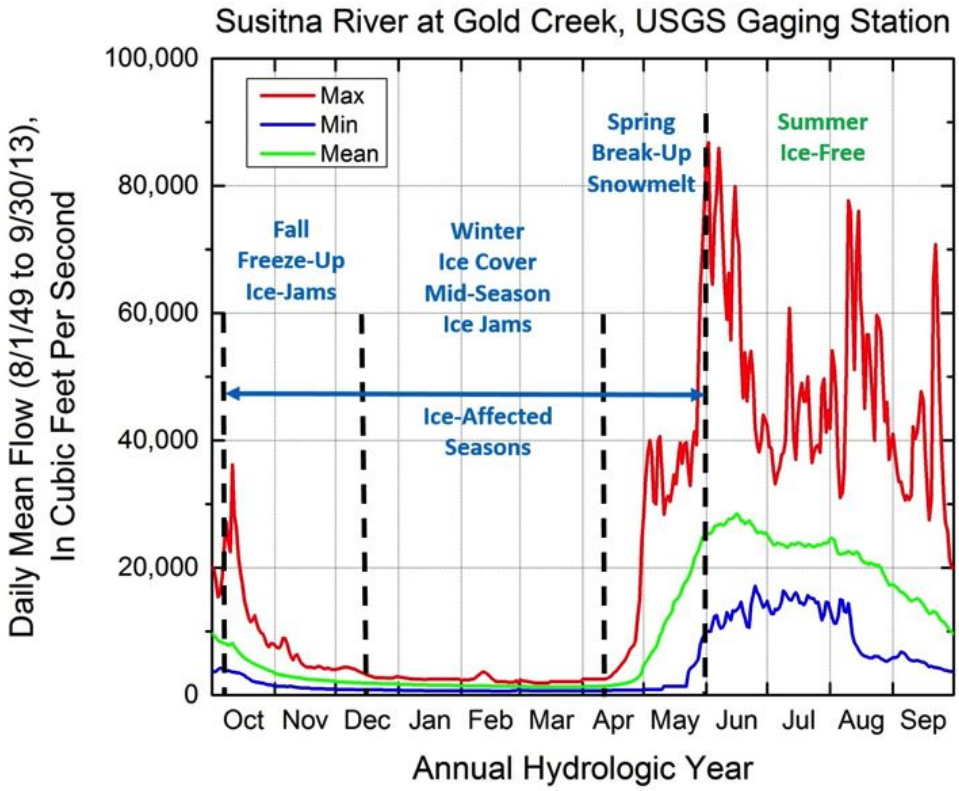


Figure 3.2-10. Period of Record Flow Conditions for Susitna River at Gold Creek and Annual Hydrologic Periods.

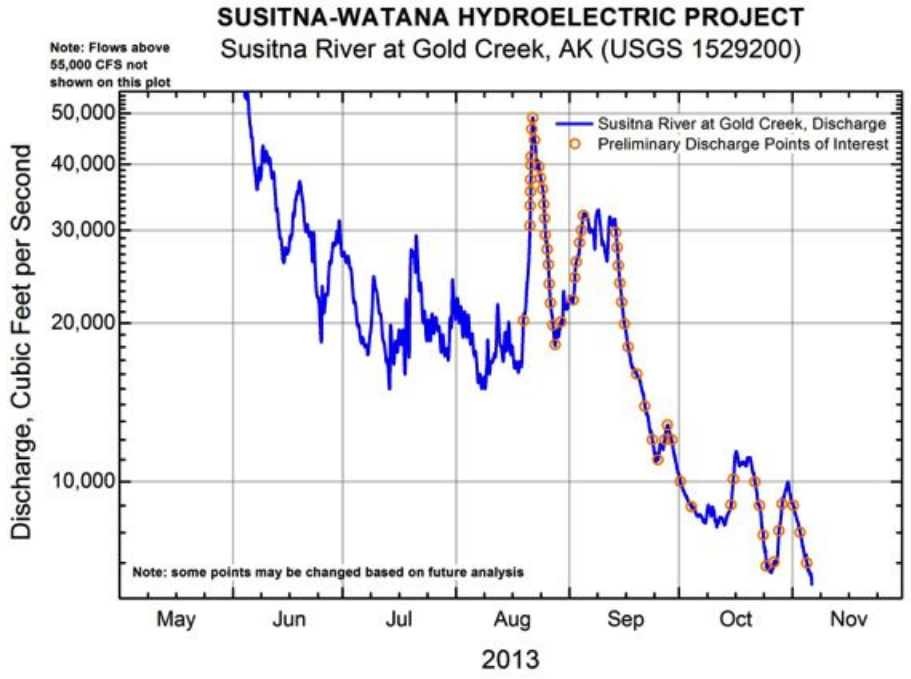


Figure 3.2-11. 2013 Discharge hydrograph for the Susitna River at Gold Creek (USGS 1529200) with selected periods (points of interest) shown used for response function analysis.

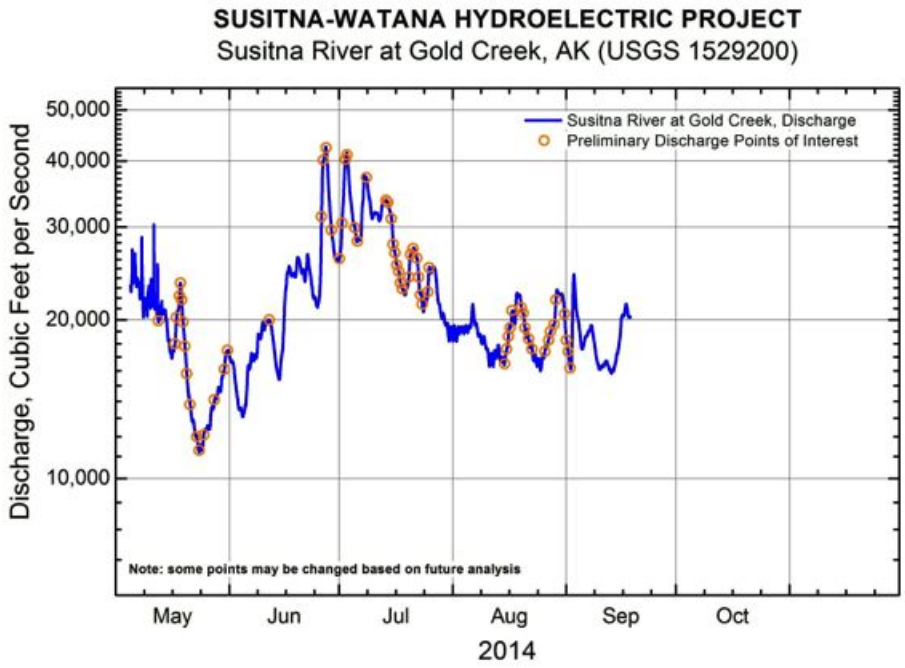


Figure 3.2-12. 2014 Discharge hydrograph for the Susitna River at Gold Creek (USGS 1529200) with selected periods (points of interest) shown used for response function analysis.

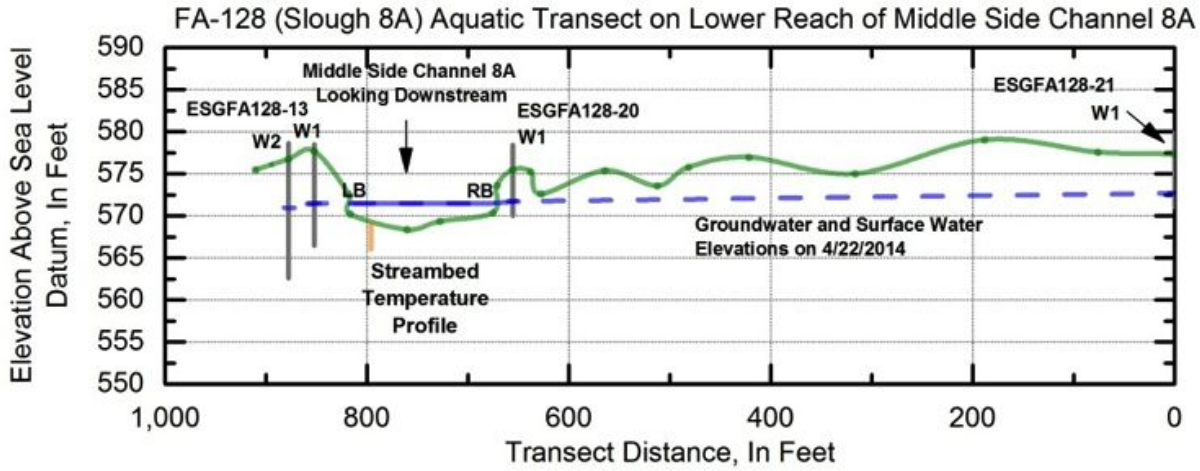


Figure 4.1-13. Cross-section diagram showing Lower Aquatic Transect on Middle Side Channel 8A, with groundwater stations ESGFA128-13, ESGFA128-20, and ESGFA128-21. Wells are shown and water levels and channel water level for April 22, 2014.

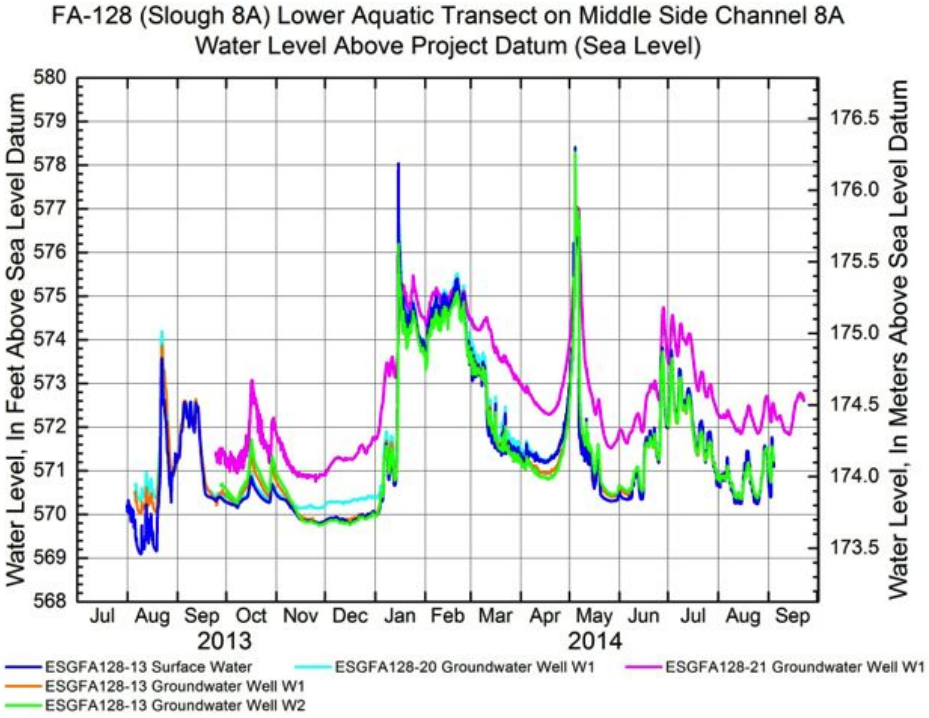


Figure 4.1-14. Groundwater Station ESGFA128-13 groundwater levels in wells adjacent to Middle Side Channel 8A and surface-water stage in Middle Side Channel 8A, and groundwater levels from wells at ESGFA128-20 and ESGFA128-21.

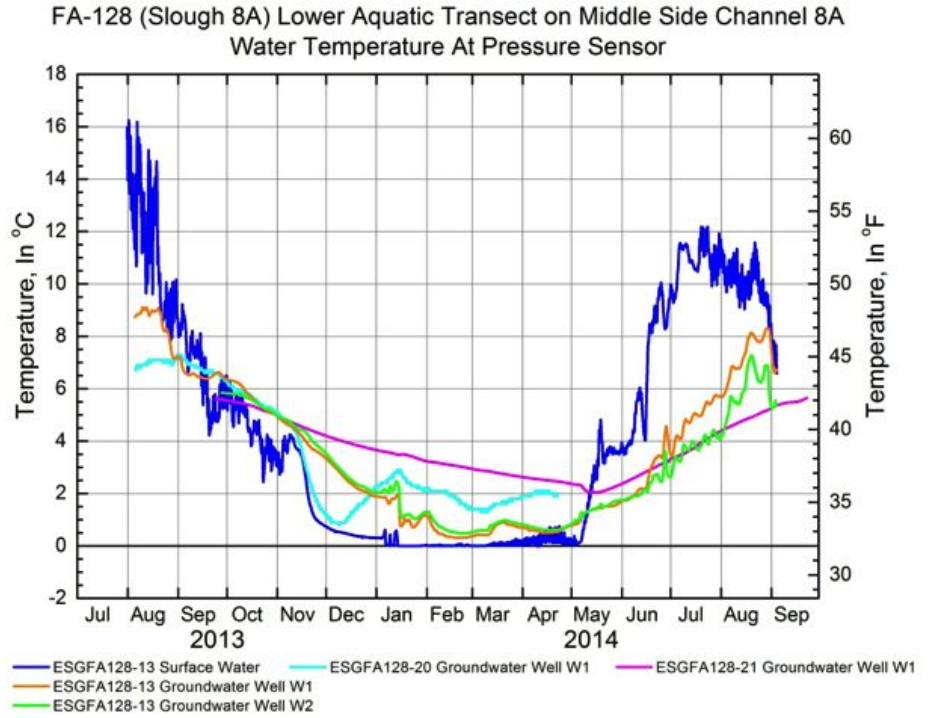


Figure 4.1-15. Groundwater Station ESGFA128-13 groundwater temperature in wells adjacent to Middle Side Channel 8A and surface-water temperature in Middle Side Channel 8A, and groundwater temperature from wells at ESGFA128-20 and ESGFA128-21.

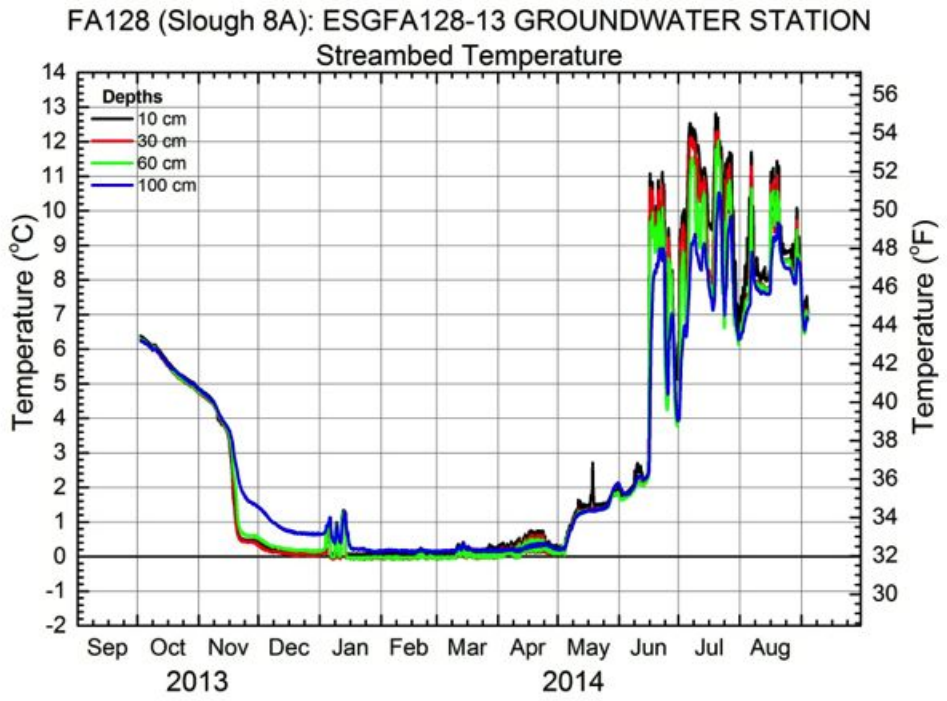


Figure 4.1-16. Groundwater Station ESGFA128-13 select streambed temperature profile measurements in Middle Side Channel 8A.

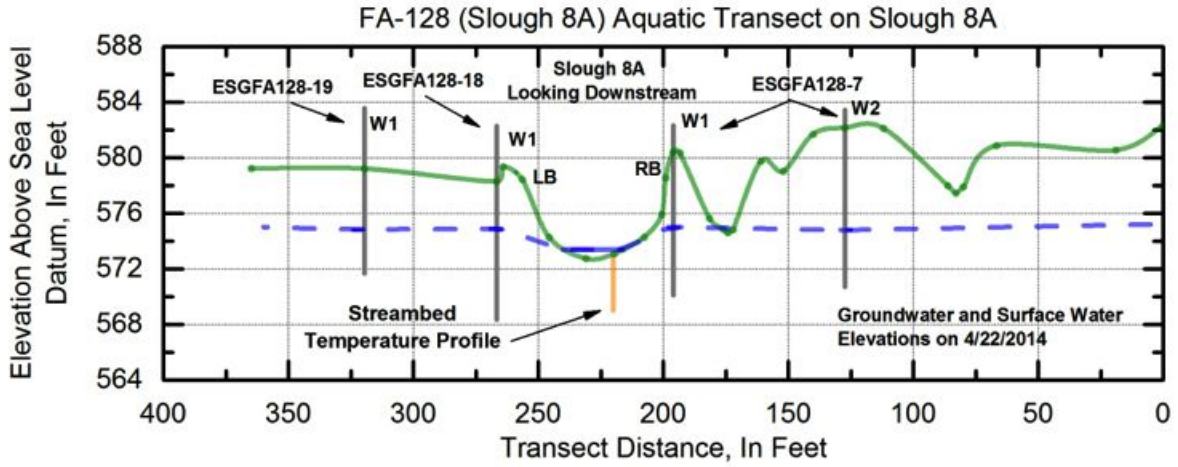


Figure 4.1-17. Cross-section diagram showing Upper Aquatic Transect on Slough 8A, with groundwater stations ESGFA128-7, ESGFA128-18, and ESGFA128-19. Wells are shown and water levels and channel water level for April 22, 2014.

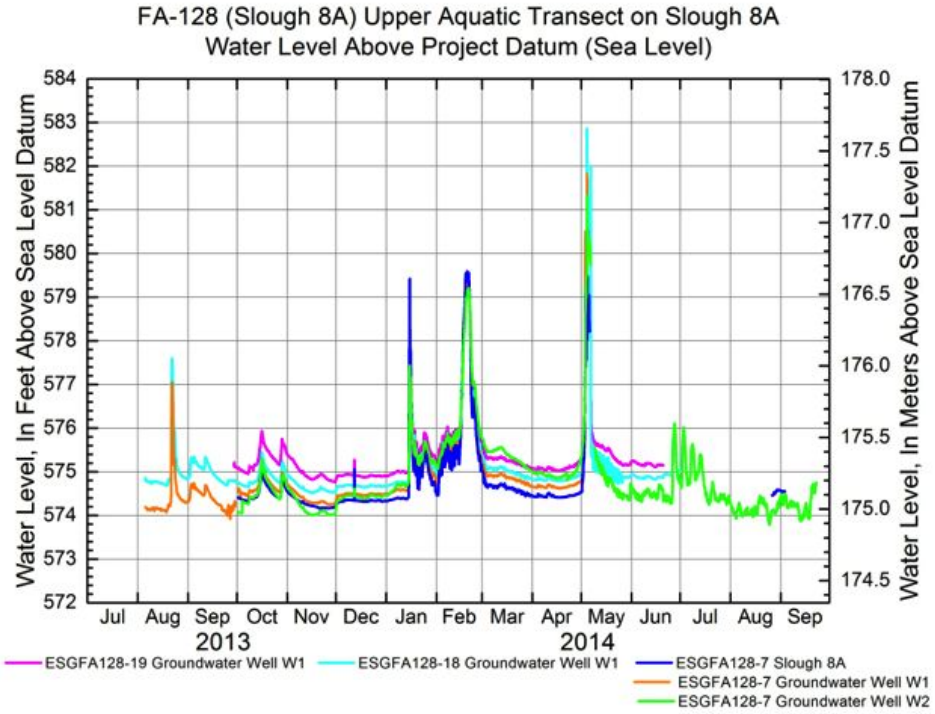


Figure 4.1-18. Groundwater Station ESGFA128-7 groundwater levels in wells adjacent to Slough 8A and surface-water stage in Slough 8A, and groundwater levels from wells at ESGFA128-18 and ESGFA128-19.

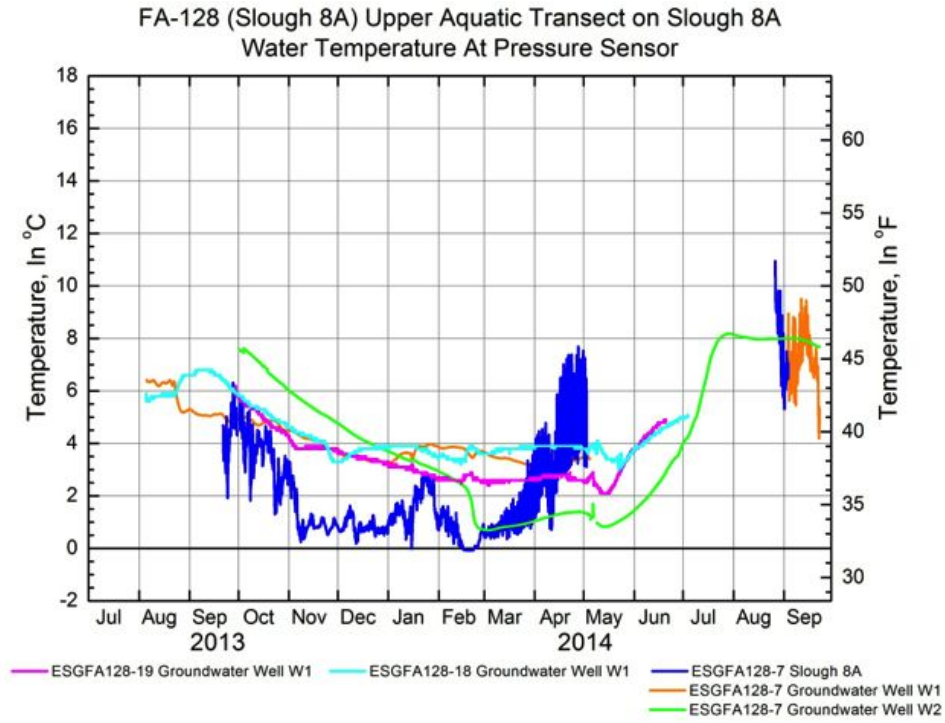


Figure 4.1-19. Groundwater Station ESGFA128-7 groundwater temperature in wells adjacent to Slough 8A and surface-water temperature in Slough 8A, and groundwater temperature from wells at ESGFA128-18 and ESGFA128-19.

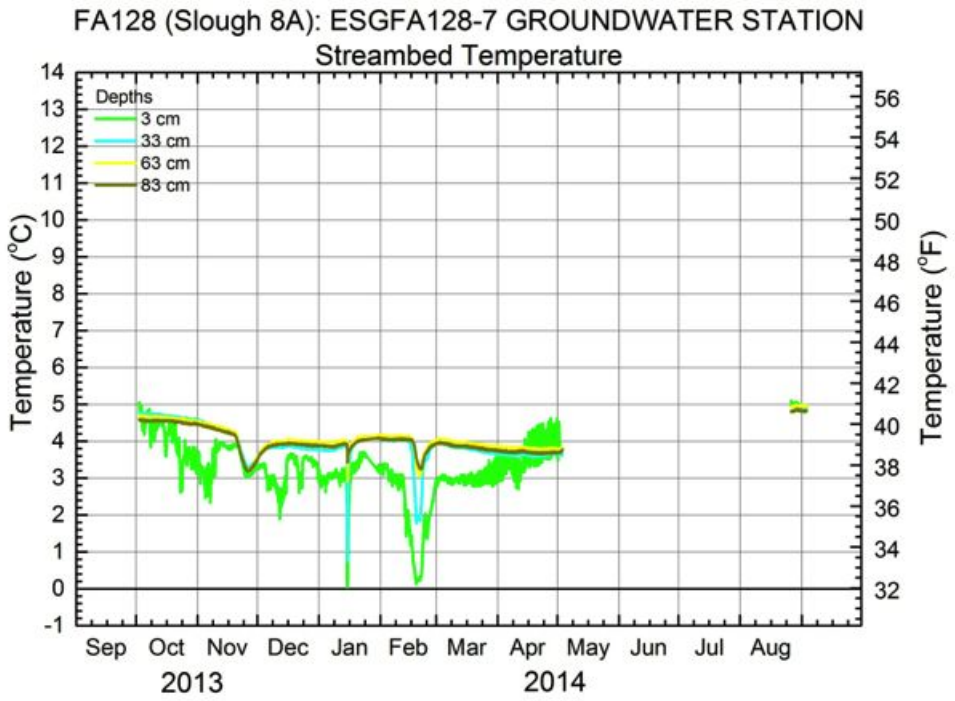


Figure 4.1-20. Groundwater Station ESGFA128-7 select streambed temperature profile measurements in Slough 8A.

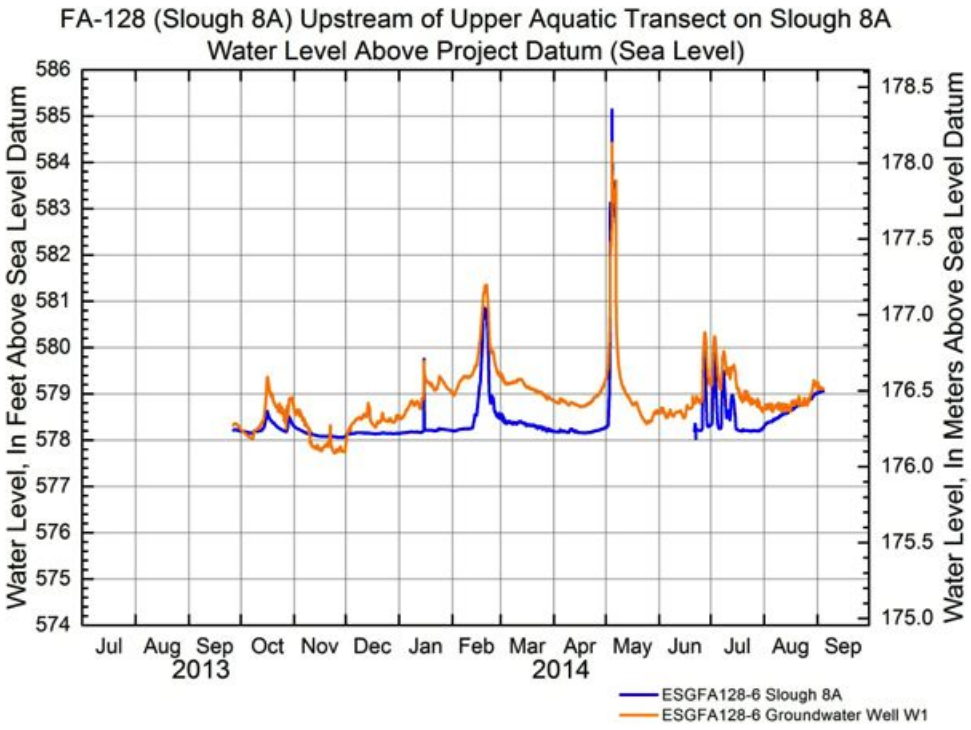


Figure 4.1-21. Groundwater Station ESGFA128-6 groundwater levels in wells adjacent to Slough 8A and surface-water stage in Slough 8A, and groundwater levels from wells at ESGFA128-18 and ESGFA128-19.

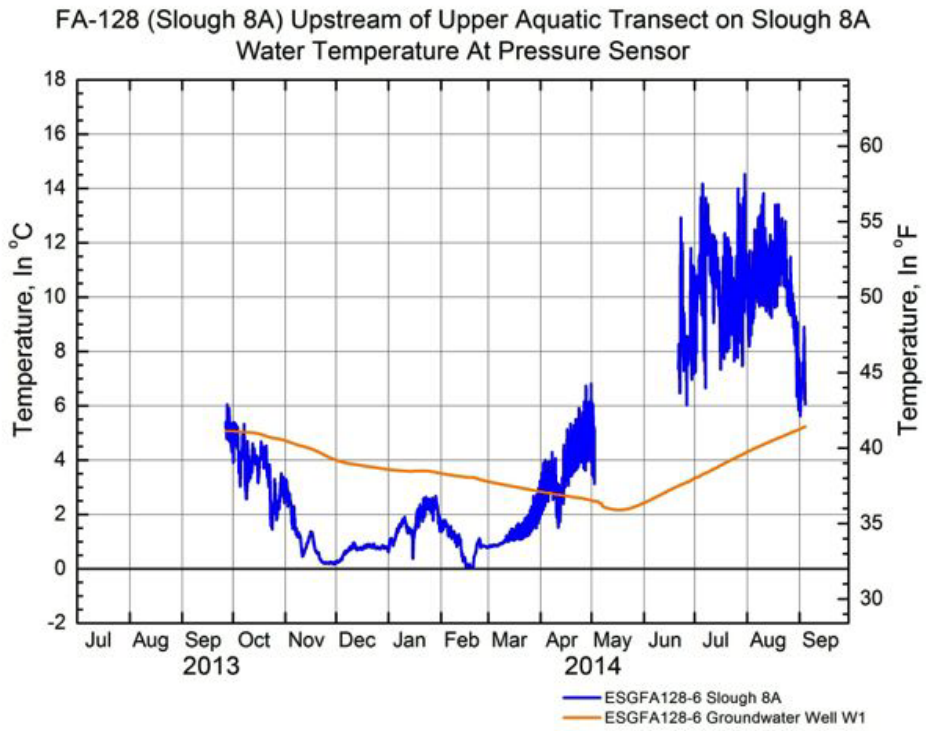


Figure 4.1-22. Groundwater Station ESGFA128-6 groundwater temperature in wells adjacent to Slough 8A and surface-water temperature in Slough 8A, and groundwater temperature from wells at ESGFA128-18 and ESGFA128-19.

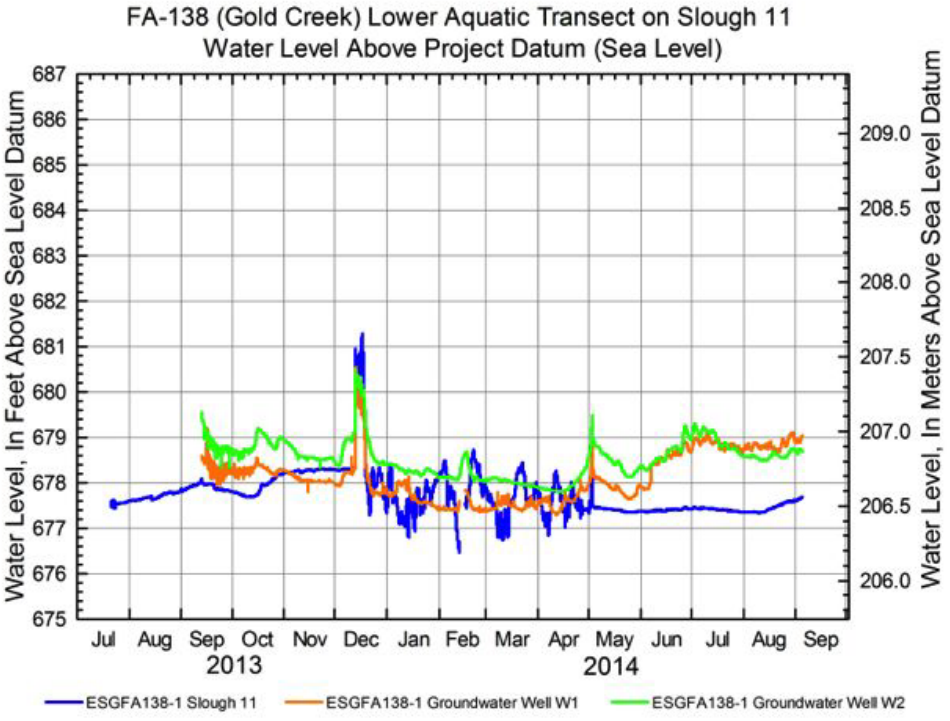


Figure 4.1-23. Groundwater Station ESGFA138-1 groundwater levels in wells adjacent to Slough 11 and surface-water stage in Slough 11.

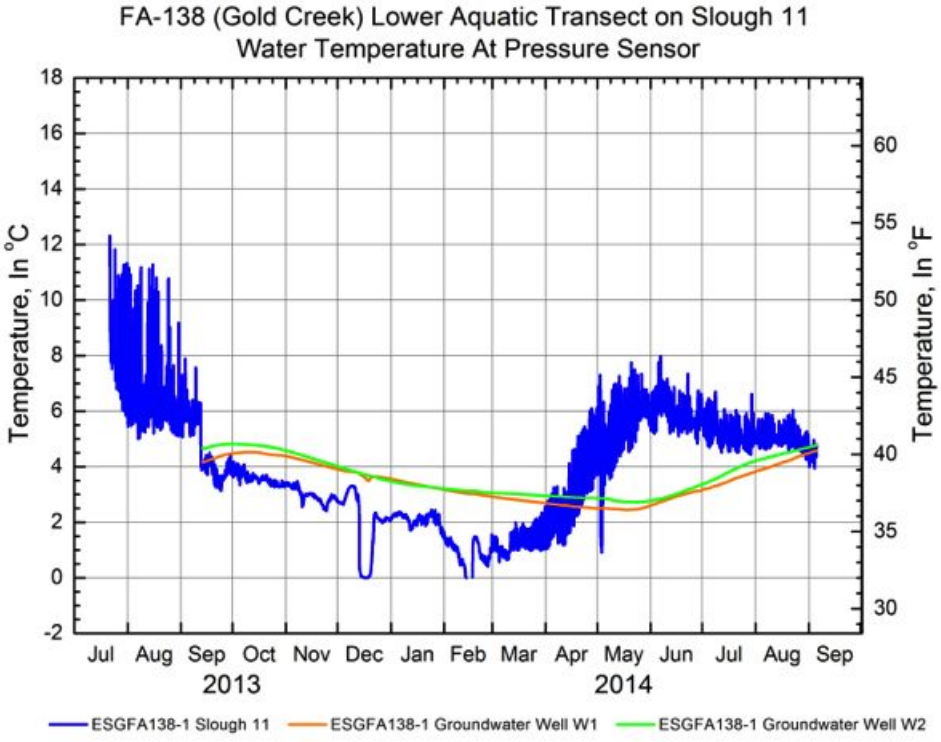


Figure 4.1-24. Groundwater Station ESGFA138-1 groundwater temperature in wells adjacent to Slough 11 and surface-water temperature in Slough 11.

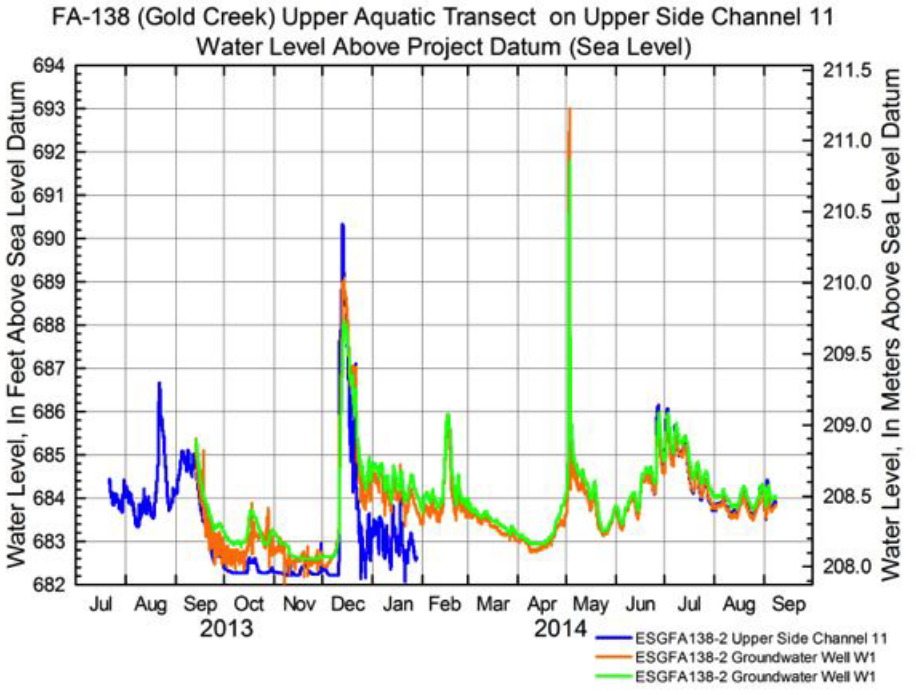


Figure 4.1-25. Groundwater Station ESGFA138-2 groundwater levels in wells adjacent to Slough 11 and surface-water stage in Slough 11.

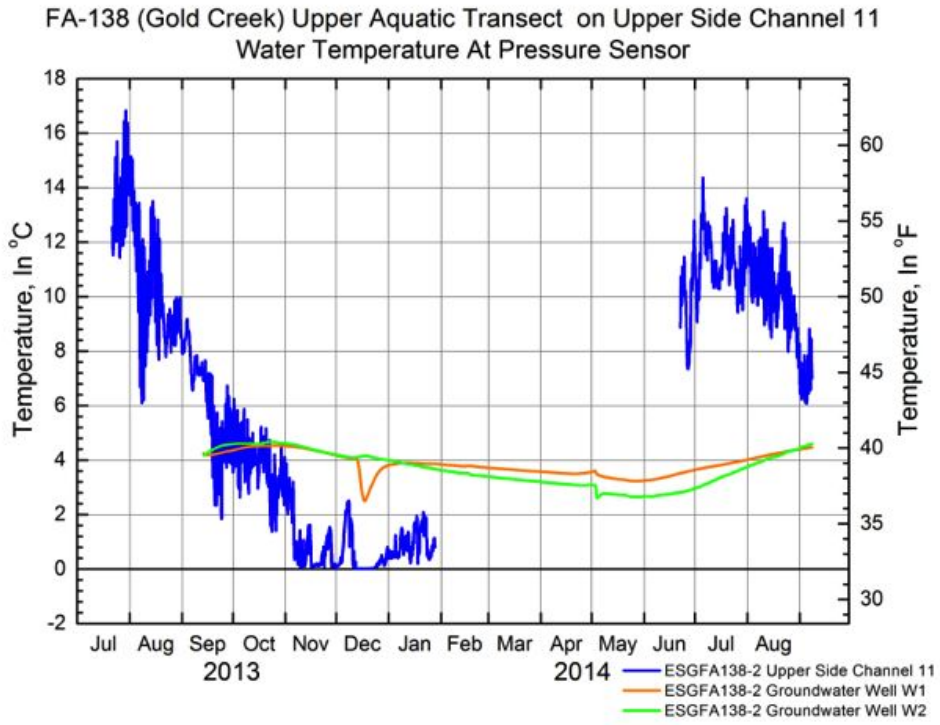


Figure 4.1-26. Groundwater Station ESGFA138-2 groundwater temperature in wells adjacent to Slough 11 and surface-water temperature in Slough 11.

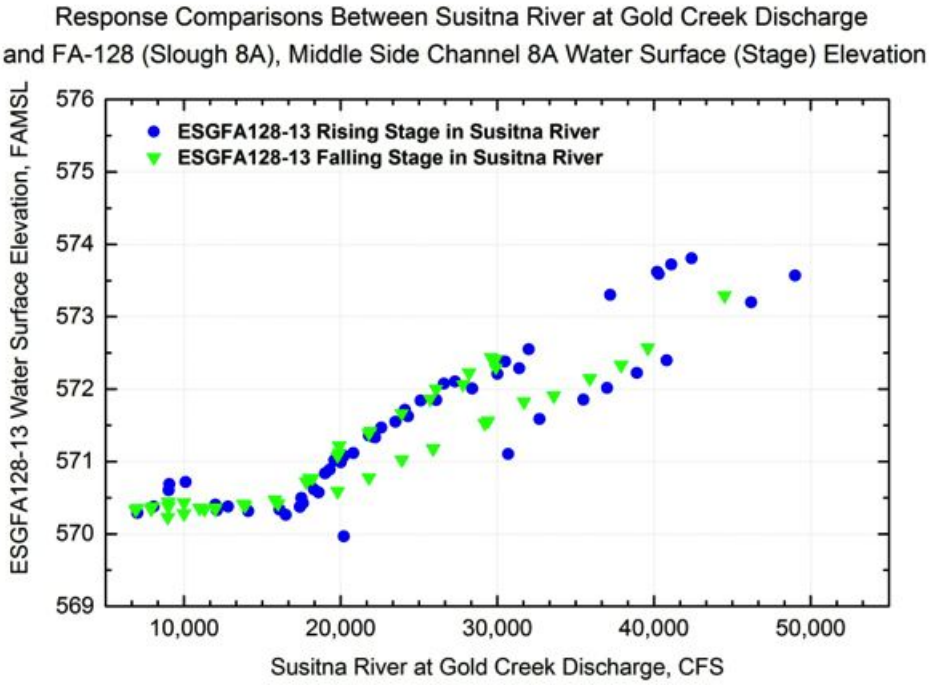


Figure 4.2-27. Susitna River at Gold Creek (USGS 1529200) discharge compared with Middle Side Channel 8A stage conditions on the Lower Aquatic Transect in FA-128 (Slough 8A) at ESGFA128-13. Selected data are from summer (ice-free) conditions.

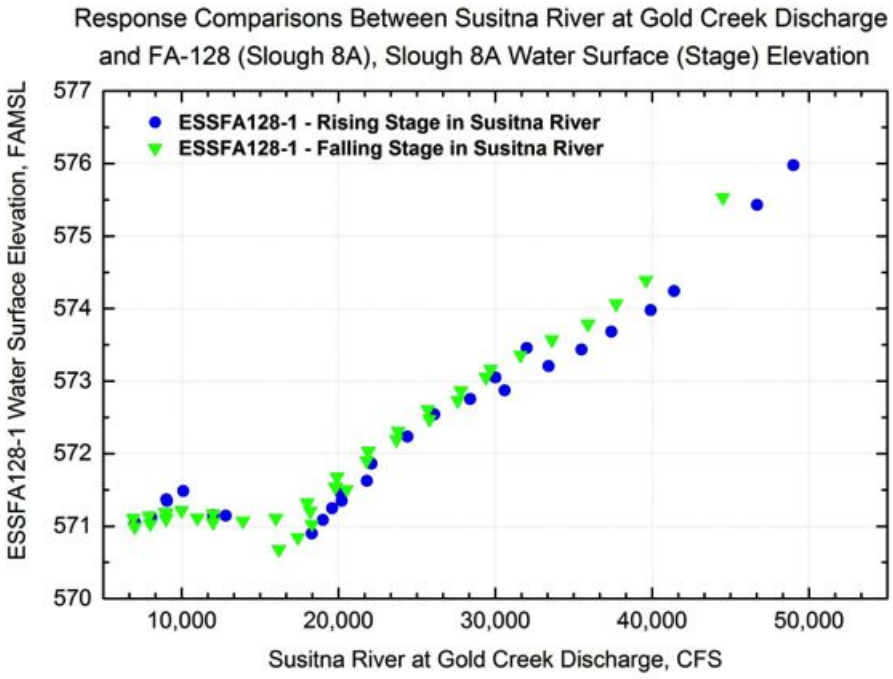


Figure 4.2-28. Susitna River at Gold Creek (USGS 1529200) discharge compared with Slough 8A stage conditions above confluence with the Middle Side Channel 8A and the Lower Aquatic Transect in FA-128 (Slough 8A) at ESSFA128-1. Selected data are from summer (ice-free) conditions.

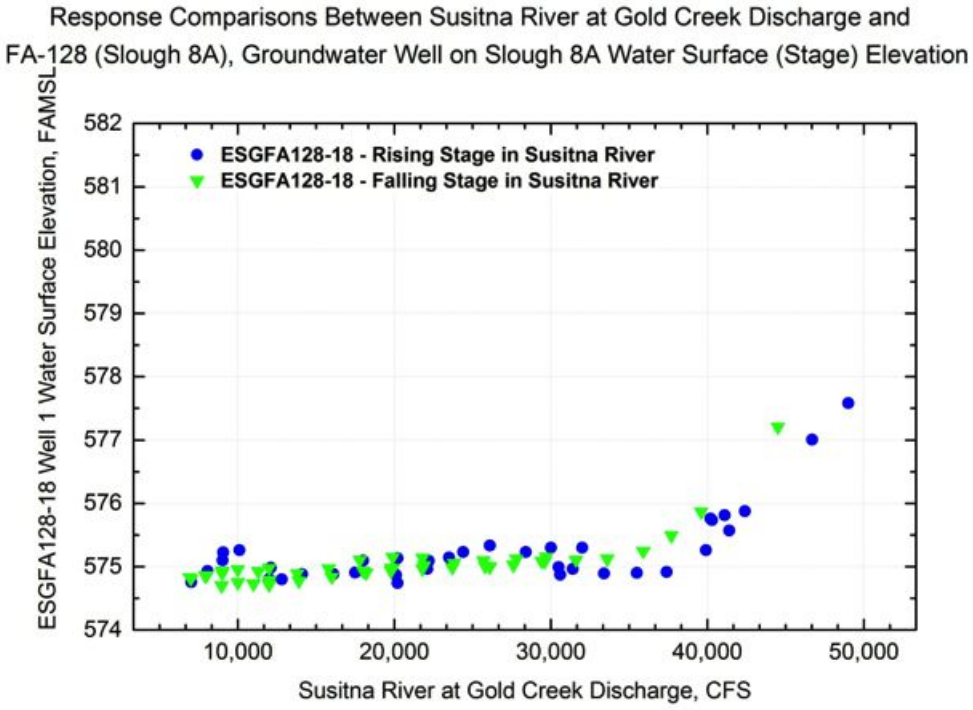


Figure 4.2-29. Susitna River at Gold Creek (USGS 1529200) discharge compared with Slough 8A adjacent groundwater conditions at the Upper Aquatic Transect in FA-128 (Slough 8A) at ESGFA128-18. Selected data are from summer (ice-free) conditions.

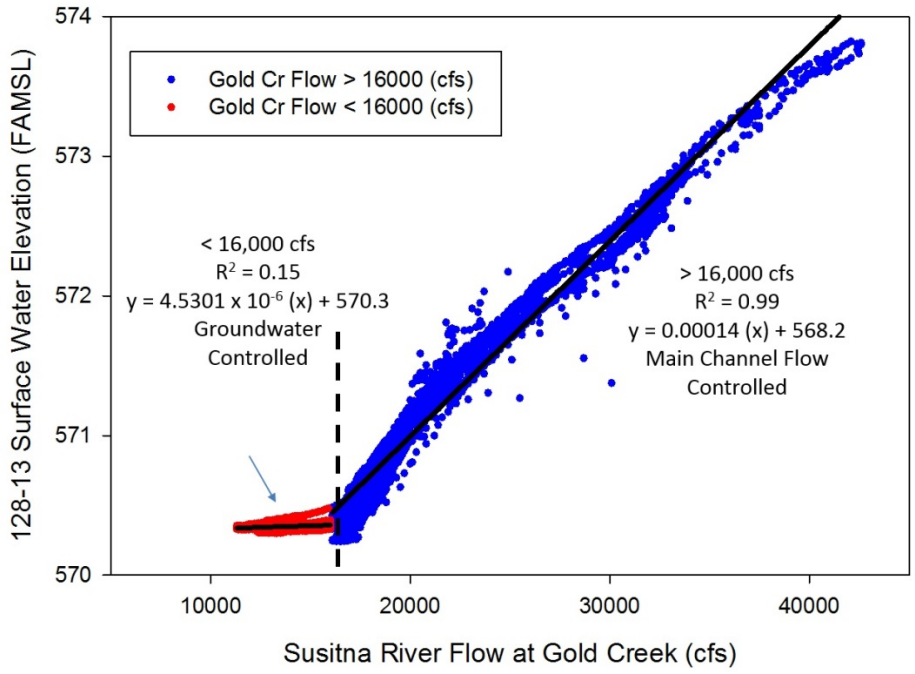


Figure 4.2-30. Analysis example for the response between flow conditions at Susitna River at Gold Creek and the Middle Side Channel 8A located at the Lower Aquatic Transect in FA-128 (Slough 8A). The example demonstrates the relationship of stage data for summer (ice free conditions).

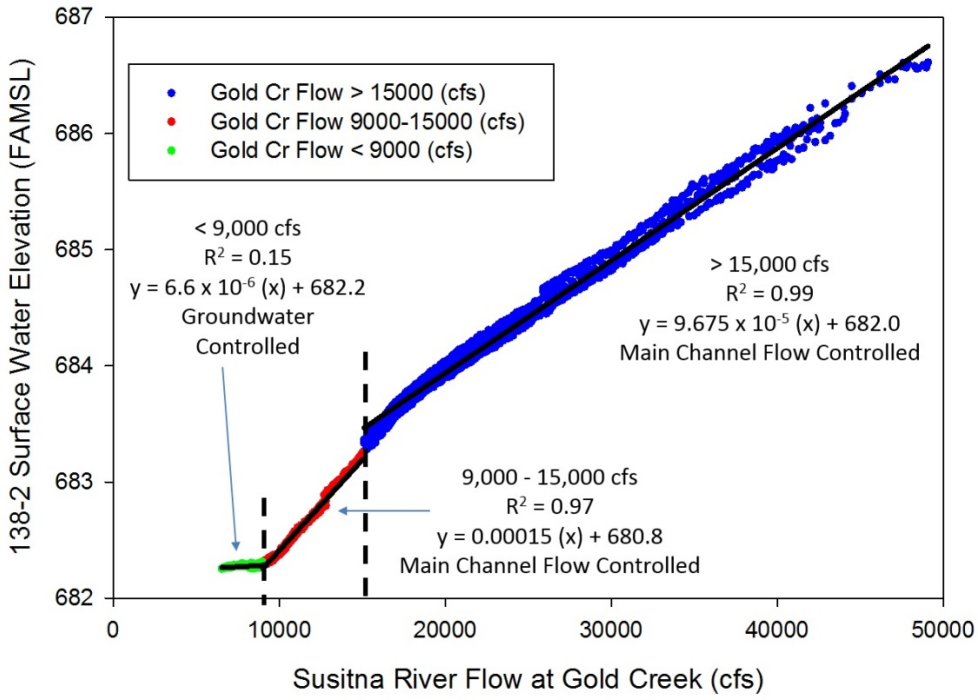


Figure 4.2-31. Analysis example for the response between flow conditions at Susitna River at Gold Creek and the Upper Side Channel 11 located at the Upper Aquatic Transect in FA-138 (Slough 11). The example demonstrates the relationship of stage data for summer (ice free conditions).

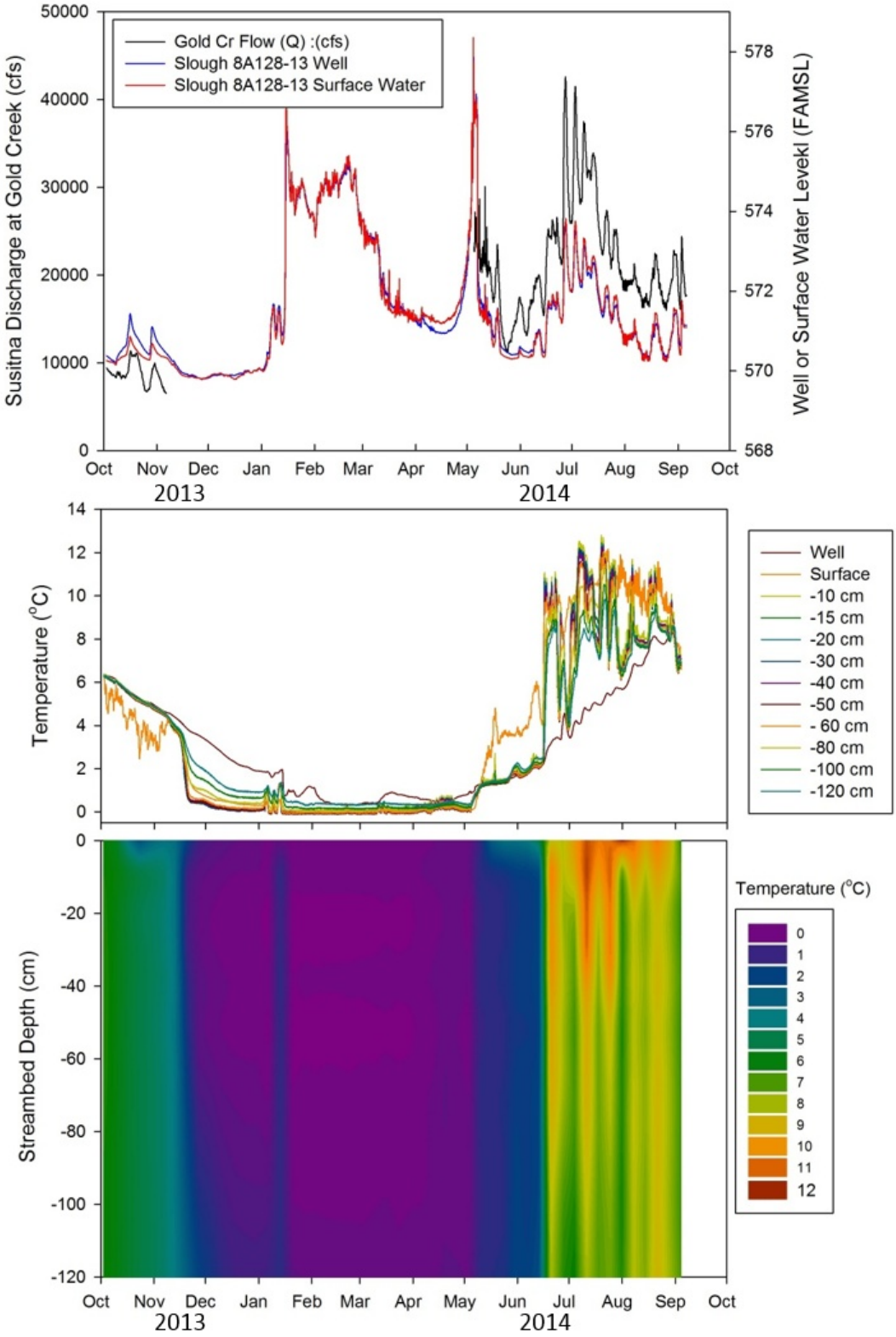


Figure 4.3-32. Downwelling example in Middle Side Channel 8A in FA-128 (Slough 8A) showing groundwater and surface-water levels, stream-bed temperatures, and thermal profile of the stream bed conditions through the major hydrologic periods.

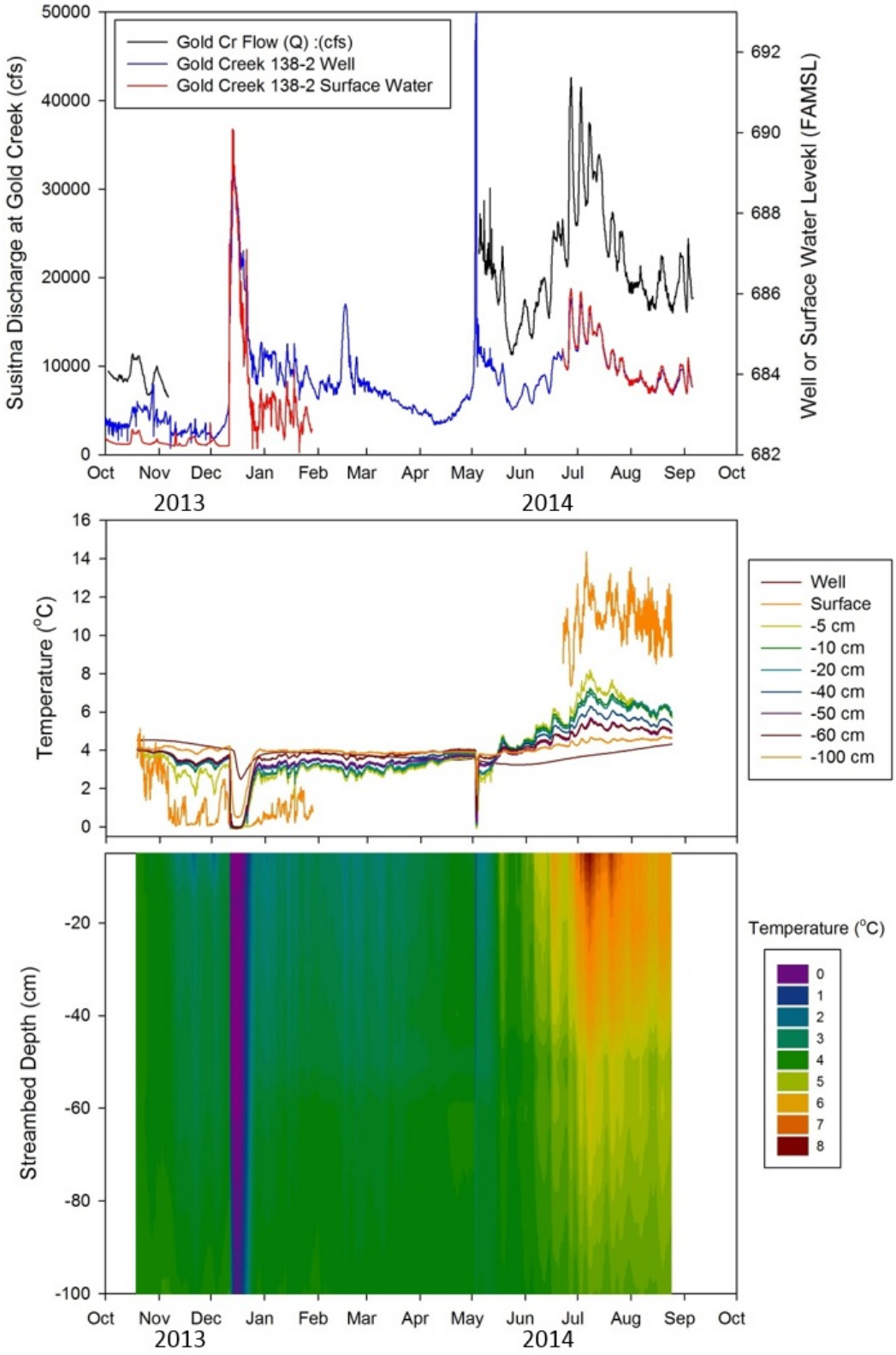


Figure 4.3-33. Upwelling example in Upper Side Channel 11 in FA-138 (Gold Creek) showing groundwater and surface-water levels, stream-bed temperatures, and thermal profile of the stream bed conditions through the major hydrologic periods.

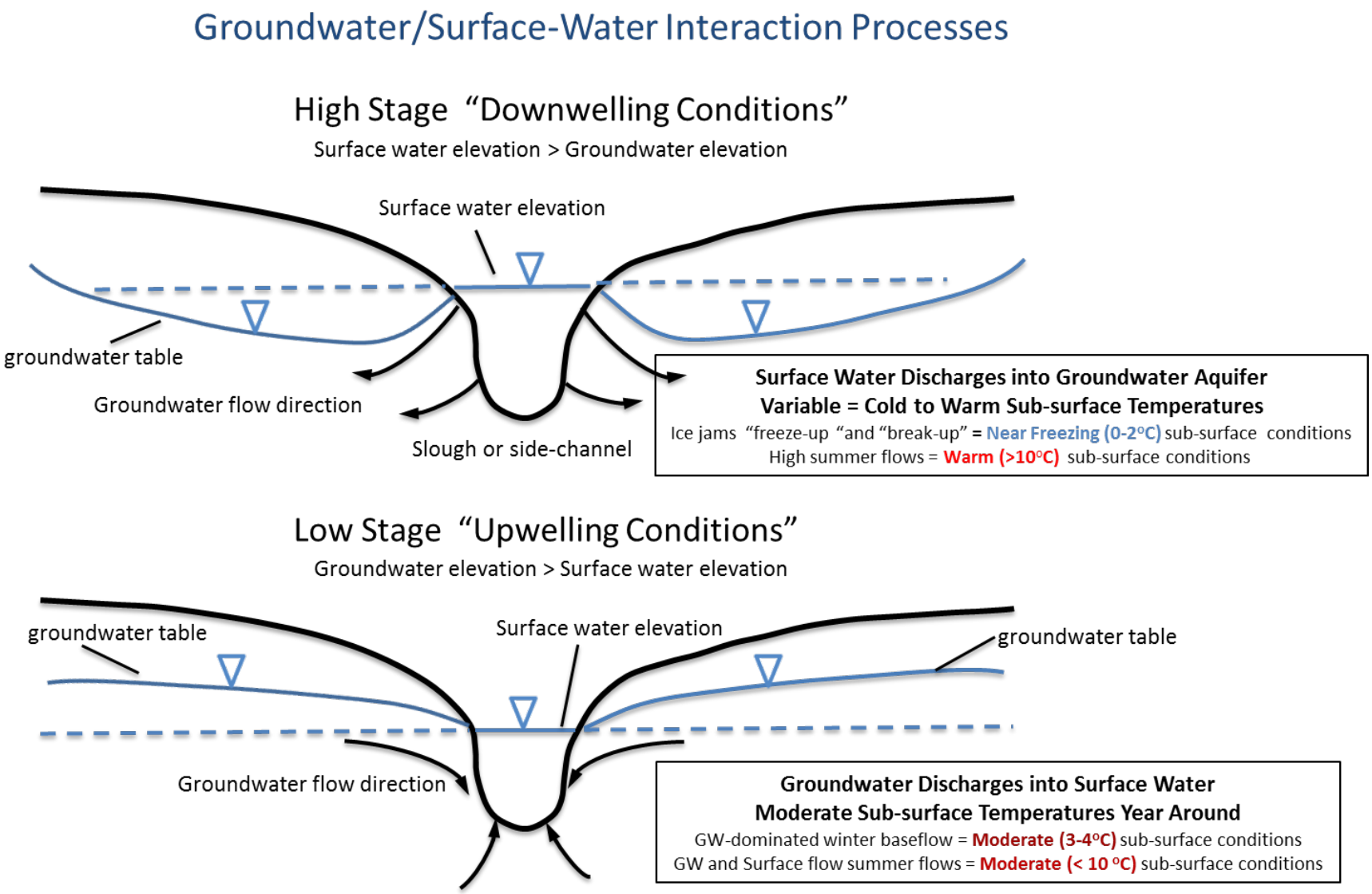


Figure 5.0-34. Conceptual model of groundwater-surface water interactions and the thermal regime occurring under high stage and low stage conditions within lateral habitats of the Susitna River.

APPENDIX A. HYDROLOGIC STATIONS PRIMARY STATION PURPOSE, LOCATION AND DATA COLLECTION PARAMETERS

Table 1. Groundwater Study primary station purpose, location and data collection parameters for hydrologic stations at FA-144 (Slough 21).

SuWa Groundwater Study
Focus Area Station Locations
Last Update: 20140912 HESnyderman

Note: The following are QC3 station coordinates for data collection stations in Focus Areas (FA). Specific locations for wells, surface-water pressure transducers, and other sensors are provided in other files.

Data Collection Parameters: air temperature, AT; camera images, Cam; groundwater level, GWL; groundwater temperature, GWT; groundwater conductivity GWC; net radiation, NR, relative humidity, RH; sap flow, SF; soil heat flux, SHF; soil-moisture profile, SMP; soil-temperature profile, SoTP; streambed temperature profile, STP; summer precipitation, SP; solar radiation, SR; surface-water conductivity, SWC, surface-water height, GH; manual surface-water height, WSE; surface-water temperature, WT; wind direction, WD; wind speed, WS; manual discharge, Q. A (#) indicates more than one measurement location.

Focus Area: FA-144 (Slough 21)

Station Short Names	Station Primary Purpose	Latitude	Longitude	Data Collection Parameters
ESSFA144-1	Surface Water	62.81376	149.57600	WSE, Q
ESSFA144-2	Surface Water	62.81475	149.57397	WSE
ESSFA144-3	Surface Water	62.81541	149.57479	WSE, Q
ESSFA144-4	Surface Water	62.80708	149.59206	WSE

Table 2. Groundwater Study primary station purpose, location and data collection parameters for hydrologic stations at FA-141 (Indian River).

SuWa Groundwater Study
Focus Area Station Locations
Last Update: 20140912 HESnyderman

Note: The following are QC3 station coordinates for data collection stations in Focus Areas (FA). Specific locations for wells, surface-water pressure transducers, and other sensors are provided in other files.

Data Collection Parameters: air temperature, AT; camera images, Cam; groundwater level, GWL; groundwater temperature, GWT; groundwater conductivity GWC; net radiation, NR, relative humidity, RH; sap flow, SF; soil heat flux, SHF; soil-moisture profile, SMP; soil-temperature profile, SoTP; streambed temperature profile, STP; summer precipitation, SP; solar radiation, SR; surface-water conductivity, SWC, surface-water height, GH; manual surface-water height, WSE; surface-water temperature, WT; wind direction, WD; wind speed, WS; manual discharge, Q. A (#) indicates more than one measurement location.

Focus Area: FA-141 (Indian River)

Station Short Names	Station Primary Purpose	Latitude	Longitude	Data Collection Parameters
ESSFA141-1	Surface Water	62.78816	149.65007	WSE
ESSFA141-2	Surface Water	62.79001	149.64375	WSE
ESSFA141-3	Surface Water	62.78137	149.69116	WSE
ESSFA141-4	Surface Water	62.78030	149.68943	WSE
ESSFA141-5	Surface Water	62.77985	149.68854	WSE

Table 3. Groundwater Study primary station purpose, location and data collection parameters for hydrologic stations at FA-138 (Gold Creek).

SuWa Groundwater Study
Focus Area Station Locations
Last Update: 20140912 HESnyderman

Note: The following are QC3 station coordinates for data collection stations in Focus Areas (FA). Specific locations for wells, surface-water pressure transducers, and other sensors are provided in other files.

Data Collection Parameters: air temperature, AT; camera images, Cam; groundwater level, GWL; groundwater temperature, GWT; groundwater conductivity GWC; net radiation, NR, relative humidity, RH; sap flow, SF; soil heat flux, SHF; soil-moisture profile, SMP; soil-temperature profile, SoTP; streambed temperature profile, STP; summer precipitation, SP; solar radiation, SR; surface-water conductivity, SWC, surface-water height, GH; manual surface-water height, WSE; surface-water temperature, WT; wind direction, WD; wind speed, WS; manual discharge, Q. A (#) indicates more than one measurement location.

Focus Area: FA-138 (Gold Creek)

Station Short Names	Station Primary Purpose	Latitude	Longitude	Data Collection Parameters
ESGFA138-1	Groundwater	62.75758	149.70694	AT, GWL(2), GWT(2), GH, WT, STP, SWC, SP, WSE, Q
ESGFA138-2	Groundwater	62.76464	149.70595	GWL(2), GWT(2), GH, WT, STP, SWC, WSE, Q
ESGFA138-3	Groundwater	62.75675	149.70559	GWL, GWT
ESGFA138-4	Groundwater	62.76513	149.70604	GWL, GWT
ESGFA138-5	Groundwater	62.76555	149.70621	GWL, GWT
ESGFA138-6	Groundwater	62.76934	149.70984	GH, WT
ESGFA138-7	Groundwater	62.76779	149.70720	GH, WT
ESCFA138-8	Camera	62.75268	149.70792	Cam
ESCFA138-9	Camera	62.75686	149.70529	Cam
ESCFA138-10	Camera	62.76477	149.70522	Cam
ESCFA138-11	Camera	62.76770	149.70755	Cam
ESSFA138-12	Surface Water	62.76659	149.71334	WSE
ESSFA138-13	Surface Water	62.76579	149.71357	WSE, Q
ESSFA138-14	Surface Water	62.75670	149.70626	WSE, Q
ESSFA138-15	Surface Water	62.76243	149.70079	WSE, Q
ESSFA138-16	Surface Water	62.75416	149.70764	WSE, Q
ESSFA138-17	Surface Water	62.76027	149.69916	WSE, Q

Table 4. Groundwater Study primary station purpose, location and data collection parameters for hydrologic stations at FA-128 (Slough 8A).

SuWa Groundwater Study
Focus Area Station Locations
Last Update: 20140912 HFSnyderman

Note: The following are QC3 station coordinates for data collection stations in Focus Areas (FA). Specific locations for wells, surface-water pressure transducers, and other sensors are provided in other files.

Data Collection Parameters: air temperature, AT; camera images, Cam; groundwater level, GWL; groundwater temperature, GWT; groundwater conductivity GWC; net radiation, NR, relative humidity, RH; sap flow, SF; soil heat flux, SHF; soil-moisture profile, SMP; soil-temperature profile, SoTP; streambed temperature profile, STP; summer precipitation, SP; solar radiation, SR; surface-water conductivity, SWC, surface-water height, GH; manual surface-water height, WSF; surface-water temperature, WT; wind direction, WD; wind speed, WS; manual discharge, Q. A (ff) indicates more than one measurement location.

Focus Area: FA-128 (Slough 8A)

Station Short Names	Station Primary Purpose	Latitude	Longitude	Data Collection Parameters
FSSFA128-1	Surface Water	62.66384	149.90494	AT, GH, WT, STP, Cam, WSF, Q
FSGFA128-2	Groundwater	62.67204	149.89403	GWL, GWT, GH, WT
FSGFA128-3	Groundwater	62.67179	149.89390	GWL, GWT, SF
FSGFA128-4	Groundwater	62.67049	149.89341	GWL, GWT
FSGFA128-5	Groundwater	62.66765	149.89352	GWL, GWT, GH, WT, SF, WSF, Q
FSGFA128-6	Groundwater	62.66660	149.89320	GWL, GWT, GH, WT
FSGFA128-7	Groundwater	62.66550	149.89707	GWL(2), GWT(2), GWC, GH, WT, SWC, STP, WSF, Q
ESMFA128-8	Meteorological	62.67052	149.89485	AT, RH, SMP, SR, SoTP, SHF, WD, WS
FSGFA128-9	Groundwater	62.66349	149.90730	GWL(2), GWT(2), SF
FSGFA128-10	Groundwater	62.66393	149.90766	GWL, GWT, SF
FSGFA128-11	Groundwater	62.66596	149.91077	GWL, GWT, GH, WT
FSGFA128-12	Groundwater	62.66711	149.91272	GWL, GWT, GH, WT
FSGFA128-13	Groundwater	62.68626	149.90953	GWL(2), GWT(2), GWC, GH, WT, SWC, STP
FSSFA128-14	Surface Water	62.67271	149.89112	GH, WT
FSSFA128-15	Surface Water	62.67273	149.88573	GH, WT
FSSFA128-16	Surface Water	62.67015	149.88548	GH, WT
FSSFA128-17	Surface Water	62.66888	149.88480	GH, WT
FSGFA128-18	Groundwater	62.66538	149.89694	GWL, GWT
FSGFA128-19	Groundwater	62.66525	149.89681	GWL, GWT
FSGFA128-20	Groundwater	62.66305	149.90938	GWL, GWT
FSGFA128-21	Groundwater	62.66485	149.90892	GWL, GWT
FSGFA128-22	Groundwater	62.66088	149.91993	GH, WT
FSGFA128-23	Groundwater	62.66466	149.91168	GWL, GWT
FSGFA128-24	Groundwater	62.66534	149.90681	GWL, GWT

Table 4. Groundwater Study primary station purpose, location and data collection parameters for hydrologic stations at FA-128 (Slough 8A), continued.

SuWa Groundwater Study
Focus Area Station Locations
Last Update: 20140912 HFSnyderman

Note: The following are QC3 station coordinates for data collection stations in Focus Areas (FA). Specific locations for wells, surface-water pressure transducers, and other sensors are provided in other files.

Data Collection Parameters: air temperature, AT; camera images, Cam; groundwater level, GWL; groundwater temperature, GWT; groundwater conductivity GWC; net radiation, NR, relative humidity, RH; sap flow, SF; soil heat flux, SHF; soil-moisture profile, SMP; soil-temperature profile, SoTP; streambed temperature profile, STP; summer precipitation, SP; solar radiation, SR; surface-water conductivity, SWC, surface-water height, GH; manual surface-water height, WSF; surface-water temperature, WT; wind direction, WD; wind speed, WS; manual discharge, Q. A (ff) indicates more than one measurement location.

Focus Area: FA-128 (Slough 8A)

Station Short Names	Station Primary Purpose	Latitude	Longitude	Data Collection Parameters
FSGFA128-25	Groundwater	62.66767	149.90671	GWL, GWT
FSGFA128-26	Groundwater	62.66946	149.89789	GWL, GWT
FSGFA128-27	Groundwater	62.67092	149.88946	GWL, GWT
FSCFA128-29	Camera	62.67251	149.88567	Cam
FSCFA128-30	Camera	62.66804	149.88652	Cam
FSCFA128-31	Camera	62.66549	149.89812	Cam
FSCFA128-32	Camera	62.66754	149.89376	Cam
FSCFA128-33	Camera	62.67179	149.89376	Cam
FSCFA128-34	Camera	62.66719	149.91216	Cam
FSCFA128-35	Camera	62.66307	149.91039	Cam
FSCFA128-36	Camera	62.66167	149.91676	Cam
FSSFA128-37	Surface Water	62.66764	149.89858	WSF, Q
FSSFA128-38	Surface Water	62.66788	149.88809	WSF, Q
FSSFA128-39	Surface Water	62.66289	149.92729	WSF
FSSFA128-40	Surface Water	62.66469	149.92282	WSF

Table 5. Groundwater Study primary station purpose, location and data collection parameters for hydrologic stations at FA-115 (Slough 6A).

SuWa Groundwater Study
Focus Area Station Locations
Last Update: 20140912 HESnyderman

Note: The following are QC3 station coordinates for data collection stations in Focus Areas (FA). Specific locations for wells, surface-water pressure transducers, and other sensors are provided in other files.

Data Collection Parameters: air temperature, AT; camera images, Cam; groundwater level, GWL; groundwater temperature, GWT; groundwater conductivity GWC; net radiation, NR, relative humidity, RH; sap flow, SF; soil heat flux, SHF; soil-moisture profile, SMP; soil-temperature profile, SoTP; streambed temperature profile, STP; summer precipitation, SP; solar radiation, SR; surface-water conductivity, SWC, surface-water height, GH; manual surface-water height, WSE; surface-water temperature, WT; wind direction, WD; wind speed, WS; manual discharge, Q. A (#) indicates more than one measurement location.

Focus Area: FA-115 (Slough 6A)

Station Short Names	Station Primary Purpose	Latitude	Longitude	Data Collection Parameters
ESMFA115-1	Meteorological	62.51892	150.12688	AT, RH, SMP, SR, SoTP, SHF, GWL(2), GWT(2), WD, WS
ESGFA115-2	Groundwater	62.51929	150.13084	GWL, GWT, GH, WT
ESGFA115-3	Groundwater	62.51905	150.12550	GWL, GWT, GH, WT
ESGFA115-4	Groundwater	62.51906	150.12470	GWL, GWT
ESGFA115-5	Groundwater	62.51876	150.12258	GWL, GWT, GH, WT
ESGFA115-6	Groundwater	62.51868	150.12135	GWL, GWT
ESGFA115-7	Groundwater	62.51863	150.12064	GWL, GWT, GH, WT
ESGFA115-8	Groundwater	62.51914	150.12948	GWL, GWT
ESCFA115-11	Camera	62.51933	150.13072	Cam
ESCFA115-12	Camera	62.51896	150.12046	Cam
ESCFA115-13	Camera	62.51507	150.12476	Cam
ESCFA115-14	Camera	62.51357	150.12182	Cam
ESSFA115-15	Surface Water	62.51543	150.12440	WSE, Q
ESSFA115-16	Surface Water	62.51414	150.12244	WSE
ESSFA115-17	Surface Water	62.51746	150.12512	WSE, Q
ESSFA115-18	Surface Water	62.51806	150.12353	WSE, Q
ESSFA115-19	Surface Water	62.51704	150.12990	WSE
ESSFA115-20	Surface Water	62.51676	150.12446	WSE

Table 6. Groundwater Study primary station purpose, location and data collection parameters for hydrologic stations at FA-113 (Oxbow 1).

SuWa Groundwater Study
Focus Area Station Locations
Last Update: 20140912 HESnyderman

Note: The following are QC3 station coordinates for data collection stations in Focus Areas (FA). Specific locations for wells, surface-water pressure transducers, and other sensors are provided in other files.

Data Collection Parameters: air temperature, AT; camera images, Cam; groundwater level, GWL; groundwater temperature, GWT; groundwater conductivity GWC; net radiation, NR, relative humidity, RH; sap flow, SF; soil heat flux, SHF; soil-moisture profile, SMP; soil-temperature profile, SoTP; streambed temperature profile, STP; summer precipitation, SP; solar radiation, SR; surface-water conductivity, SWC, surface-water height, GH; manual surface-water height, WSE; surface-water temperature, WT; wind direction, WD; wind speed, WS; manual discharge, Q. A (#) indicates more than one measurement location.

Focus Area: FA-113 (Oxbow 1)

Station Short Names	Station Primary Purpose	Latitude	Longitude	Data Collection Parameters
ESGFA113-1	Groundwater	62.48947	150.10515	GWL(2), GWT(2), STP, GH(2), WT(2), WSE, Q
ESCFA113-2	Camera	62.49253	150.10396	Cam
ESCFA113-3	Camera	62.48663	150.09798	Cam
ESCFA113-4	Camera	62.48896	150.10530	Cam
ESSFA113-5	Surface Water	62.49643	150.11112	WSE
ESSFA113-6	Surface Water	62.49245	150.11003	WSE
ESSFA113-7	Surface Water	62.48762	150.10106	WSE, Q

Table 7. Groundwater Study primary station purpose, location and data collection parameters for hydrologic stations at PRM 112 (Slough 6).

SuWa Groundwater Study
Focus Area Station Locations
Last Update: 20140922 HFSnyderman

Note: The following are QC3 station coordinates for data collection stations). Specific locations for wells, surface-water pressure transducers, and other sensors are provided in other files.

Data Collection Parameters: air temperature, AT; camera images, Cam; groundwater level, GWL; groundwater temperature, GWT; groundwater conductivity GWC; net radiation, NR, relative humidity, RH; sap flow, SF; soil heat flux, SHF; soil-moisture profile, SMP; soil-temperature profile, SoTP; streambed temperature profile, STP; summer precipitation, SP; solar radiation, SR; surface-water conductivity, SWC, surface-water height, GH; manual surface-water height, WSF; surface-water temperature, WT; wind direction, WD; wind speed, WS; manual discharge, Q. A (ff) indicates more than one measurement location.

Focus Area: PRM 112 (Slough 6)

Station Short Names	Station Primary Purpose	Latitude	Longitude	Data Collection Parameters
FSSPRM112-1	Surface Water	62.47251	150.11835	WSF
FSSPRM112-2	Surface Water	62.47065	150.11506	WSF
FSSPRM112-3	Surface Water	62.46607	150.11689	WSF

Table 8. Groundwater Study primary station purpose, location and data collection parameters for hydrologic stations at FA-104 (Whiskers Slough).

SuWa Groundwater Study
Focus Area Station Locations
Last Update: 20140912 HESnyderman

Note: The following are QC3 station coordinates for data collection stations in Focus Areas (FA). Specific locations for wells, surface-water pressure transducers, and other sensors are provided in other files.

Data Collection Parameters: air temperature, AT; camera images, Cam; groundwater level, GWL; groundwater temperature, GWT; groundwater conductivity GWC; net radiation, NR, relative humidity, RH; sap flow, SF; soil heat flux, SHF; soil-moisture profile, SMP; soil-temperature profile, SoTP; streambed temperature profile, STP; summer precipitation, SP; solar radiation, SR; surface-water conductivity, SWC, surface-water height, GH; manual surface-water height, WSE; surface-water temperature, WT; wind direction, WD; wind speed, WS; manual discharge, Q. A (#) indicates more than one measurement location.

Focus Area: FA-104 (Whiskers Slough)

Station Short Names	Station Primary Purpose	Latitude	Longitude	Data Collection Parameters
ESSFA104-1	Surface Water	62.37676	150.16934	AT, GH, WT, STP, Cam
ESMFA104-2	Meteorological	62.37863	150.17190	AT, RH, SMP, SR, SoTP, SHF, GWL, GWT, WD, WS
ESGFA104-3	Groundwater	62.37934	150.17373	GWL, GWT
ESGFA104-4	Groundwater	62.37908	150.17363	GWL, GWT, SF
ESGFA104-5	Groundwater	62.37810	150.17029	GH(2), WT(2), GWL, GWT, WSE, Q
ESGFA104-6	Groundwater	62.37800	150.16912	GWL(2), GWT(2), SF
ESGFA104-7	Groundwater	62.37764	150.16822	GWL, GWT, SF
ESGFA104-8	Groundwater	62.37692	150.16562	GWL, GWT, SF, GH, WT
ESGFA104-9	Groundwater	62.37626	150.17091	GWL(2), GWT(2), GH, WT, STP, SWC, WSE, Q, other
ESGFA104-10	Groundwater	62.38402	150.15125	GWL(2), GWT(2), GH, WT, STP(2)
ESGFA104-11	Groundwater	62.37622	150.16996	GWL, GWT
ESGFA104-12	Groundwater	62.37622	150.16996	GWL, GWT
ESGFA104-13	Groundwater	62.37824	150.17100	GWL, GWT
ESCFA104-16	Camera	62.37457	150.16850	Cam
ESCFA104-17	Camera	62.37676	150.17157	Cam
ESCFA104-18	Camera	62.37943	150.16961	Cam
ESCFA104-19	Camera	62.37986	150.16679	Cam
ESCFA104-20	Camera	62.38351	150.15477	Cam
ESCFA104-21	Camera	62.38388	150.15211	Cam
ESCFA104-22	Camera	62.38180	150.16376	Cam
ESSFA104-23	Surface Water	62.38638	150.15438	WSE, Q
ESSFA104-24	Surface Water	62.37948	150.16329	WSE, Q

APPENDIX B. APRIL 2014 DISCHARGE MEASUREMENTS

Table 1. Groundwater Study discharge measurements at FA-138 (Gold Creek), location S11XUS, April 18-19, 2014.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: S11XUS / FA-138 (Gold Creek)
Purpose: Slough Discharge
Date: 4/18/14 Time: 1256

Location:	Slough 11 upstream from ESGFA138-1. N62.75862 W149.70235					Crew:	JamesS, RC-Willis
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~40°F
Method:	0.6					Measurement Set:	1st section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
12:56	0.00		0.00		0.00		0.00		1.00	0.00	0.00	0.00	0.0
12:59	2.00		0.48		0.80		0.00		2.00	1.60	0.00	0.00	0.0
13:00	4.00		0.36		0.60		0.00		2.00	1.20	0.00	0.00	0.0
13:02	6.00		0.27		0.45		0.00		2.00	0.90	0.00	0.00	0.0
13:54	8.00		0.33		0.55		0.00		1.75	0.96	0.00	0.00	0.0
13:52	9.50		0.00		0.00		0.00		1.00	0.00	0.00	0.00	0.0
13:55	10.00		0.36		0.60		0.00		1.25	0.75	0.00	0.00	0.0
14:33	12.00		0.45		0.75		0.00		1.25	0.94	0.00	0.00	0.0
14:08	12.50		0.38		0.64		0.07		0.50	0.32	0.07	0.02	3.3
13:59	13.00		0.43		0.71		0.11		0.50	0.36	0.11	0.04	5.7
14:02	13.50		0.45		0.75		0.09		0.50	0.38	0.09	0.03	4.9
13:11	14.00		0.42		0.70		0.11		0.50	0.35	0.11	0.04	5.6
14:13	14.50		0.41		0.69		0.13		0.50	0.35	0.13	0.04	6.6
14:11	15.00		0.42		0.70		0.13		0.50	0.35	0.13	0.05	6.6
14:15	15.50		0.42		0.70		0.14		0.50	0.35	0.14	0.05	7.2
13:14	16.00		0.42		0.70		0.13		0.50	0.35	0.13	0.05	6.6
14:17	16.50		0.40		0.67		0.14		0.50	0.34	0.14	0.05	6.9
14:19	17.00		0.50		0.83		0.10		0.50	0.42	0.10	0.04	6.1
14:21	17.50		0.48		0.80		0.10		0.50	0.40	0.10	0.04	5.8
13:16	18.00		0.48		0.80		0.12		0.50	0.40	0.12	0.05	7.0
14:23	18.50		0.43		0.71		0.11		0.50	0.36	0.11	0.04	5.7
14:25	19.00		0.44		0.74		0.12		0.50	0.37	0.12	0.04	6.5
14:26	19.50		0.44		0.73		0.00		0.50	0.37	0.00	0.00	0.0
14:28	20.00		0.44		0.73		0.12		0.75	0.55	0.12	0.07	9.6
14:31	21.00		0.36		0.60		0.09		0.75	0.45	0.09	0.04	5.9
14:30	21.50		0.00		0.00		0.00		0.50	0.00	0.00	0.00	0.0
13:20	22.00		0.42		0.70		0.00		1.25	0.88	0.00	0.00	0.0
13:23	24.00		0.53		0.89		0.00		2.00	1.78	0.00	0.00	0.0

Table 1. Groundwater Study discharge measurements at FA-138 (Gold Creek), location S11XUS, April 18-19, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: S11XUS / FA-138 (Gold Creek)
Purpose: Slough Discharge
Date: 4/18/14 Time: 1256

Location:	Slough 11 upstream from ESGFA138-1. N62.75862 W149.70235					Crew:	JamesS, RC-Willis
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~40°F
Method:	0.6					Measurement Set:	1st section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
13:26	26.00		0.55		0.91		0.00		2.00	1.82	0.00	0.00	0.0
13:28	28.00		0.54		0.90		0.00		2.00	1.80	0.00	0.00	0.0
13:30	30.00		0.51		0.85		0.00		2.00	1.70	0.00	0.00	0.0
13:31	32.00		0.50		0.84		0.00		2.00	1.68	0.00	0.00	0.0
13:32	34.00		0.50		0.84		0.00		2.00	1.68	0.00	0.00	0.0
13:33	36.00		0.44		0.73		0.00		2.00	1.46	0.00	0.00	0.0
13:34	38.00		0.37		0.62		0.00		2.00	1.24	0.00	0.00	0.0
13:35	40.00		0.39		0.65		0.00		2.00	1.30	0.00	0.00	0.0
13:37	42.00		0.38		0.64		0.00		2.00	1.28	0.00	0.00	0.0
13:38	44.00		0.47		0.79		0.00		2.00	1.58	0.00	0.00	0.0
13:39	46.00		0.55		0.91		0.00		2.00	1.82	0.00	0.00	0.0
13:40	48.00		0.72		1.20		0.00		2.00	2.40	0.00	0.00	0.0
13:41	50.00		0.57		0.95		0.00		2.00	1.90	0.00	0.00	0.0
13:42	52.00		0.72		1.20		0.00		2.00	2.40	0.00	0.00	0.0
13:44	54.00		0.82		1.37		0.00		2.00	2.74	0.00	0.00	0.0
13:48	56.00		0.48		0.80		0.00		2.00	1.60	0.00	0.00	0.0
13:49	58.00		0.22		0.36		0.00		1.25	0.45	0.00	0.00	0.0
13:50	58.50		0.00		0.00		0.00		0.25	0.00	0.00	0.00	0.0
Totals									**58.50**	**44.29**		**0.68**	**100.0**

Table 1. Groundwater Study discharge measurements at FA-138 (Gold Creek), location S11XUS, April 18-19, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: S11XUS / FA-138 (Gold Creek)
Purpose: Slough Discharge
Date: 4/18/14 Time: 1442

Location:	Slough 11 upstream from ESGFA138-1. N62.75862 W149.70235					Crew:	JamesS, RC-Willis
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~40°F
Method:	0.6					Measurement Set:	2nd section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
14:42	0.00		0.00		0.00		0.00		3.00	0.00	0	0.00	0.0
14:44	6.00		0.27		0.45		0.00		6.00	2.70	0	0.00	0.0
14:47	12.00		0.44		0.74		0.00		3.50	2.59	0	0.00	0.0
15:54	13.00		0.42		0.70		0.06		0.75	0.53	0.06	0.03	5.1
15:51	13.50		0.42		0.70		0.13		0.50	0.35	0.13	0.05	7.4
14:49	14.00		0.44		0.74		0.14		0.50	0.37	0.14	0.05	8.4
14:53	14.50		0.43		0.72		0.11		0.50	0.36	0.11	0.04	6.4
14:54	15.00		0.42		0.70		0.13		0.50	0.35	0.13	0.05	7.4
14:58	15.50		0.41		0.69		0.13		0.50	0.35	0.13	0.04	7.3
15:00	16.00		0.42		0.70		0.15		0.50	0.35	0.15	0.05	8.5
15:02	16.50		0.42		0.70		0.10		0.50	0.35	0.1	0.04	5.7
15:07	17.00		0.37		0.62		0.12		0.50	0.31	0.12	0.04	6.0
15:11	17.50		0.47		0.78		0.11		0.50	0.39	0.11	0.04	7.0
15:13	18.00		5.10		8.50		0.00		0.50	4.25	0	0.00	0.0
15:15	18.50		0.48		0.80		0.12		0.50	0.40	0.12	0.05	7.8
15:16	19.00		0.47		0.79		0.00		0.50	0.40	0	0.00	0.0
15:19	19.50		0.42		0.70		0.10		0.50	0.35	0.1	0.04	5.7
15:21	20.00		0.41		0.69		0.09		0.50	0.35	0.09	0.03	5.0
15:22	20.50		0.42		0.70		0.10		0.50	0.35	0.1	0.04	5.7
15:24	21.00		0.38		0.64		0.13		0.50	0.32	0.13	0.04	6.7
15:26	21.50		0.37		0.61		0.00		0.50	0.31	0	0.00	0.0
15:27	22.00		0.42		0.70		0.00		0.75	0.53	0	0.00	0.0
15:28	23.00		0.42		0.70		0.00		1.50	1.05	0	0.00	0.0
15:29	25.00		0.55		0.92		0.00		2.00	1.84	0	0.00	0.0
15:31	27.00		0.48		0.80		0.00		2.00	1.60	0	0.00	0.0
15:32	29.00		0.48		0.80		0.00		2.00	1.60	0	0.00	0.0
15:33	31.00		0.48		0.80		0.00		2.50	2.00	0	0.00	0.0
15:34	34.00		0.49		0.82		0.00		3.00	2.46	0	0.00	0.0

Table 1. Groundwater Study discharge measurements at FA-138 (Gold Creek), location S11XUS, April 18-19, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Purpose: Slough Discharge
Site Name: S11XUS / FA-138 (Gold Creek)
Date: 4/18/14 Time: 1442

Location:	Slough 11 upstream from ESGFA138-1. N62.75862 W149.70235					Crew:	JamesS, RC-Willis
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~40°F
Method:	0.6					Measurement Set:	2nd section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
15:33	31.00		0.48		0.80		0.00		2.50	2.00	0	0.00	0.0
15:34	34.00		0.49		0.82		0.00		3.00	2.46	0	0.00	0.0
15:35	37.00		0.41		0.68		0.00		3.00	2.04	0	0.00	0.0
15:36	40.00		0.37		0.62		0.00		3.00	1.86	0	0.00	0.0
15:37	43.00		0.45		0.75		0.00		3.00	2.25	0	0.00	0.0
15:38	46.00		0.60		1.00		0.00		3.50	3.50	0	0.00	0.0
15:38	50.00		0.53		0.89		0.00		4.00	3.56	0	0.00	0.0
15:40	54.00		0.81		1.35		0.00		4.00	5.40	0	0.00	0.0
15:41	58.00		0.24		0.40		0.00		2.25	0.90	0	0.00	0.0
15:42	58.50		0.00		0.00		0.00		0.25	0.00	0	0.00	0.0
Totals									**58.50**	**46.29**		**0.62**	**100.0**

Table 1. Groundwater Study discharge measurements at FA-138 (Gold Creek), location S11XUS, April 18-19, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: S11XUS / FA-138 (Gold Creek)
Purpose: Slough Discharge
Date: 4/19/14 Time: 10:32

Location:	Slough 11 upstream from ESGFA138-1. N62.75862 W149.70235					Crew:	JamesS, RC-Willis
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~40°F
Method:	0.6					Measurement Set:	3rd section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
10:32	0.00		0.00		0.00		0.00		1.50	0.00	0	0.00	0.0
10:33	3.00		0.38		0.63		0.00		3.00	1.89	0	0.00	0.0
10:34	6.00		0.24		0.40		0.00		2.50	1.00	0	0.00	0.0
10:36	8.00		0.30		0.50		0.00		1.50	0.75	0	0.00	0.0
10:38	9.00		0.32		0.53		0.00		1.00	0.53	0	0.00	0.0
10:39	10.00		0.36		0.60		0.00		0.75	0.45	0	0.00	0.0
10:43	10.50		0.43		0.72		0.10		0.50	0.36	0.1	0.04	7.7
10:45	11.00		0.47		0.78		0.00		0.50	0.39	0	0.00	0.0
10:47	11.50		0.47		0.79		0.11		0.50	0.40	0.11	0.04	9.3
10:49	12.00		0.45		0.75		0.10		0.50	0.38	0.1	0.04	8.0
10:50	12.50		0.42		0.70		0.11		0.50	0.35	0.11	0.04	8.2
10:52	13.00		0.47		0.78		0.09		0.50	0.39	0.09	0.04	7.5
10:55	13.50		0.47		0.78		0.06		0.50	0.39	0.06	0.02	5.0
10:56	14.00		0.44		0.73		0.12		0.50	0.37	0.12	0.04	9.4
10:58	14.50		0.42		0.70		0.15		0.40	0.28	0.15	0.04	9.0
10:59	14.80		0.42		0.70		0.12		0.30	0.21	0.12	0.03	5.4
11:02	15.10		0.42		0.70		0.12		0.30	0.21	0.12	0.03	5.4
11:03	15.40		0.42		0.70		0.12		0.45	0.32	0.12	0.04	8.1
11:05	16.00		0.42		0.70		0.13		0.45	0.32	0.13	0.04	8.8
11:07	16.30		0.42		0.70		0.11		0.50	0.35	0.11	0.04	8.2
11:09	17.00		0.48		0.80		0.00		0.85	0.68	0	0.00	0.0
11:11	18.00		0.43		0.72		0.00		1.00	0.72	0	0.00	0.0
11:14	19.00		0.47		0.79		0.00		1.50	1.19	0	0.00	0.0
11:15	21.00		0.37		0.62		0.00		2.00	1.24	0	0.00	0.0
11:16	23.00		0.43		0.71		0.00		2.50	1.78	0	0.00	0.0
11:17	26.00		0.54		0.90		0.00		3.00	2.70	0	0.00	0.0
11:19	29.00		0.50		0.83		0.00		3.00	2.49	0	0.00	0.0
11:20	32.00		0.48		0.80		0.00		3.00	2.40	0	0.00	0.0

Table 1. Groundwater Study discharge measurements at FA-138 (Gold Creek), location S11XUS, April 18-19, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: S11XUS / FA-138 (Gold Creek)
Purpose: Slough Discharge
Date: 4/19/14 Time: 10:32

Location:	Slough 11 upstream from ESGFA138-1. N62.75862 W149.70235					Crew:	JamesS, RC-Willis
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~40°F
Method:	0.6					Measurement Set:	3rd section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
11:21	35.00		0.48		0.80		0.00		3.00	2.40	0	0.00	0.0
11:21	38.00		0.42		0.70		0.00		3.00	2.10	0	0.00	0.0
11:22	41.00		0.42		0.70		0.00		3.00	2.10	0	0.00	0.0
11:23	44.00		0.48		0.80		0.00		3.00	2.40	0	0.00	0.0
11:25	47.00		0.60		1.00		0.00		3.00	3.00	0	0.00	0.0
11:26	50.00		0.53		0.88		0.00		3.00	2.64	0	0.00	0.0
11:27	53.00		0.78		1.30		0.00		3.00	3.90	0	0.00	0.0
11:28	56.00		0.30		0.50		0.00		2.75	1.38	0	0.00	0.0
11:29	58.50		0.00		0.00		0.00		1.25	0.00	0	0.00	0.0
Totals									**58.50**	**42.42**		**0.47**	**100.0**

Table 2. Groundwater Study discharge measurements at FA-138 (Gold Creek), location S11XDS, April 18-19, 2014.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: S11XDS / FA-138 (Gold Creek)
Purpose: Slough Discharge
Date: 4/18/14 Time: 10:20

Location:	Slough 11 appx 50ft downstream of ESGFA 138-1 pressure transducer					Crew:	Jshinas, RC-Willis
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~40° F
Method:	0.6					Measurement Set:	1st section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
10:20	0.00		0.00		0.00		0.00		1.00	0.00	0	0.00	0.0
10:22	1.00		0.12		0.20		0.00		1.00	0.20	0	0.00	0.0
10:24	2.00		0.16		0.26		0.00		1.00	0.26	0	0.00	0.0
10:24	3.00		0.15		0.25		0.00		1.00	0.25	0	0.00	0.0
10:27	4.00		0.13		0.22		0.00		1.00	0.22	0	0.00	0.0
10:29	5.00		0.19		0.32		0.00		1.00	0.32	0	0.00	0.0
10:30	6.00		0.22		0.36		0.00		1.00	0.36	0	0.00	0.0
10:32	7.00		0.24		0.40		0.00		1.00	0.40	0	0.00	0.0
10:34	8.00		0.57		0.95		0.00		1.00	0.95	0	0.00	0.0
10:36	9.00		0.90		1.50		0.00		1.00	1.50	0	0.00	0.0
10:37	10.00		0.96		1.60		0.00		1.00	1.60	0	0.00	0.0
10:39	11.00		1.01		1.68		0.00		1.00	1.68	0	0.00	0.0
10:41	12.00		0.79		1.32		0.00		1.00	1.32	0	0.00	0.0
10:43	13.00		0.66		1.10		0.00		1.00	1.10	0	0.00	0.0
10:48	14.00		0.66		1.10		0.00		1.00	1.10	0	0.00	0.0
10:50	15.00		0.66		1.10		0.06		1.00	1.10	0.06	0.07	6.3
10:52	16.00		0.60		1.00		0.13		1.00	1.00	0.13	0.13	12.5
10:56	17.00		0.58		0.97		0.08		1.00	0.97	0.08	0.08	7.5
10:57	18.00		0.46		0.77		0.00		1.00	0.77	0	0.00	0.0
11:00	19.00		0.41		0.69		0.06		1.00	0.69	0.06	0.04	4.0
11:02	20.00		0.47		0.79		0.08		1.00	0.79	0.08	0.06	6.1
11:05	21.00		0.45		0.75		0.07		1.00	0.75	0.07	0.05	5.0
11:06	22.00		0.63		1.05		0.00		1.00	1.05	0	0.00	0.0
11:08	23.00		0.80		1.33		0.16		1.00	1.33	0.16	0.21	20.4
11:11	24.00		0.80		1.33		0.00		1.00	1.33	0	0.00	0.0
11:13	25.00		0.62		1.03		0.18		1.00	1.03	0.18	0.19	17.8
11:14	26.00		0.50		0.83		0.00		1.00	0.83	0	0.00	0.0
11:16	27.00		0.47		0.78		0.14		1.00	0.78	0.14	0.11	10.5

Table 2. Groundwater Study discharge measurements at FA-138 (Gold Creek), location S11XDS, April 18-19, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: S11XDS / FA-138 (Gold Creek)
Purpose: Slough Discharge
Date: 4/18/14 Time: 10:20

Location:	Slough 11 appx 50ft downstream of ESGFA 138-1 pressure transducer					Crew:	Jshinas, RC-Willis
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~40° F
Method:	0.6					Measurement Set:	1st section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
11:18	28.00		0.41		0.68		0.00		1.00	0.68	0	0.00	0.0
11:21	29.00		0.39		0.65		0.08		1.00	0.65	0.08	0.05	5.0
11:22	30.00		0.31		0.52		0.00		1.00	0.52	0	0.00	0.0
11:24	31.00		0.34		0.57		0.09		1.00	0.57	0.09	0.05	4.9
11:26	32.00		0.28		0.47		0.00		1.00	0.47	0	0.00	0.0
11:27	33.00		0.23		0.38		0.00		1.00	0.38	0	0.00	0.0
11:28	34.00		0.17		0.29		0.00		1.00	0.29	0	0.00	0.0
11:29	35.00		0.12		0.20		0.00		1.00	0.20	0	0.00	0.0
11:29	36.00		0.11		0.19		0.00		1.00	0.19	0	0.00	0.0
11:30	38.00		0.11		0.18		0.00		1.00	0.18	0	0.00	0.0
11:31	39.00		0.09		0.15		0.00		1.00	0.15	0	0.00	0.0
11:31	40.00		0.09		0.15		0.00		1.00	0.15	0	0.00	0.0
11:32	41.00		0.09		0.15		0.00		1.00	0.15	0	0.00	0.0
11:32	42.00		0.12		0.20		0.00		1.00	0.20	0	0.00	0.0
11:33	43.00		0.09		0.15		0.00		1.00	0.15	0	0.00	0.0
11:34	44.00		0.06		0.10		0.00		1.00	0.10	0	0.00	0.0
Totals					**0.5**				**44.00**	**28.71**		**1.04**	**100.0**

Table 2. Groundwater Study discharge measurements at FA-138 (Gold Creek), location S11XDS, April 18-19, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: S11XDS / FA-138 (Gold Creek)
Purpose: Slough Discharge
Date: 4/18/14 Time: 16:23

Location:	Slough 11 appx 50ft downstream of ESGFA 138-1 pressure transducer					Crew:	Jshinas, RC-Willis
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~40° F
Method:	0.6					Measurement Set:	2nd section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
16:23	0.00		0.00		0.00		0.00		1.00	0.00	0	0.00	0.0
16:23	2.00		0.16		0.26		0.00		2.00	0.52	0	0.00	0.0
16:25	4.00		0.13		0.22		0.00		1.50	0.33	0	0.00	0.0
16:27	5.00		0.19		0.31		0.00		1.00	0.31	0	0.00	0.0
16:28	6.00		0.24		0.40		0.00		1.00	0.40	0	0.00	0.0
16:30	7.00		0.33		0.55		0.00		1.00	0.55	0	0.00	0.0
16:31	8.00		0.60		1.00		0.00		1.00	1.00	0	0.00	0.0
16:33	9.00		0.85		1.41		0.00		1.00	1.41	0	0.00	0.0
16:34	10.00		0.97		1.62		0.00		1.00	1.62	0	0.00	0.0
16:34	11.00		0.91		1.51		0.00		1.00	1.51	0	0.00	0.0
16:38	12.00		0.81		1.35		0.00		1.00	1.35	0	0.00	0.0
16:46	13.00		0.68		1.13		0.06		0.75	0.85	0.06	0.05	5.3
16:48	13.50		0.66		1.10		0.07		0.50	0.55	0.07	0.04	4.0
16:49	14.00		0.62		1.04		0.00		0.75	0.78	0	0.00	0.0
16:51	15.00		0.60		1.00		0.09		0.75	0.75	0.09	0.07	7.0
16:53	15.50		0.58		0.96		0.11		0.50	0.48	0.11	0.05	5.5
16:55	16.00		0.44		0.73		0.12		0.50	0.37	0.12	0.04	4.6
16:56	16.50		0.35		0.58		0.14		0.50	0.29	0.14	0.04	4.2
16:58	17.00		0.39		0.65		0.09		0.50	0.33	0.09	0.03	3.0
16:59	17.50		0.40		0.67		0.00		0.50	0.34	0	0.00	0.0
17:00	18.00		0.39		0.65		0.00		0.75	0.49	0	0.00	0.0
17:01	19.00		0.50		0.83		0.00		1.00	0.83	0	0.00	0.0
17:05	20.00		0.66		1.10		0.07		0.75	0.83	0.07	0.06	6.0
17:07	20.50		0.78		1.30		0.09		0.50	0.65	0.09	0.06	6.1
17:09	21.00		0.79		1.31		0.11		0.45	0.59	0.11	0.06	6.8
17:11	21.40		0.90		1.50		0.00		0.50	0.75	0	0.00	0.0
17:13	22.00		0.78		1.30		0.09		0.55	0.72	0.09	0.06	6.7
17:14	22.50		0.72		1.20		0.15		0.30	0.36	0.15	0.05	5.6

Table 2. Groundwater Study discharge measurements at FA-138 (Gold Creek), location S11XDS, April 18-19, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: S11XDS / FA-138 (Gold Creek)
Purpose: Slough Discharge
Date: 4/18/14 Time: 16:23

Location:	Slough 11 appx 50ft downstream of ESGFA 138-1 pressure transducer					Crew:	Jshinas, RC-Willis
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~40° F
Method:	0.6					Measurement Set:	2nd section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
17:16	22.60		0.69		1.15		0.17		0.25	0.29	0.17	0.05	5.1
17:18	23.00		0.63		1.05		0.15		0.35	0.37	0.15	0.06	5.7
17:19	23.30		0.58		0.97		0.00		0.30	0.29	0	0.00	0.0
17:20	23.60		0.55		0.92		0.00		0.35	0.32	0	0.00	0.0
17:22	24.00		0.50		0.83		0.00		0.70	0.58	0	0.00	0.0
17:24	25.00		0.47		0.78		0.14		0.75	0.59	0.14	0.08	8.5
17:26	25.50		0.44		0.73		0.14		0.50	0.37	0.14	0.05	5.3
17:27	26.00		0.43		0.72		0.00		0.75	0.54	0	0.00	0.0
17:29	27.00		0.39		0.65		0.09		0.75	0.49	0.09	0.04	4.6
17:30	27.50		0.32		0.54		0.00		0.50	0.27	0	0.00	0.0
17:32	28.00		0.32		0.54		0.00		0.75	0.41	0	0.00	0.0
17:34	29.00		0.26		0.43		0.09		0.75	0.32	0.09	0.03	3.0
17:35	29.50		0.29		0.48		0.00		0.75	0.36	0	0.00	0.0
17:37	30.50		0.25		0.42		0.00		1.25	0.53	0	0.00	0.0
17:38	32.00		0.18		0.30		0.00		1.75	0.53	0	0.00	0.0
17:41	34.00		0.12		0.20		0.09		1.50	0.30	0.09	0.03	2.8
17:46	35.00		0.10		0.17		0		1.50	0.26	0	0.00	0.0
17:46	37.00		0.06		0.10		0		2.00	0.20	0	0.00	0.0
17:47	39.00		0.06		0.10		0		2.50	0.25	0	0.00	0.0
17:48	42.00		0.03		0.05		0		2.50	0.13	0	0.00	0.0
17:48	44.00		0.00		0.00		0		1.00	0.00	0	0.00	0.0
Totals									**44.00**	**26.29**		**0.96**	**100.0**

Table 2. Groundwater Study discharge measurements at FA-138 (Gold Creek), location S11XDS, April 18-19, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: S11XDS / FA-138 (Gold Creek)
Purpose: Slough Discharge
Date: 4/18/14 Time: 16:23

Location:	Slough 11 appx 50ft downstream of ESGFA 138-1 pressure transducer					Crew:	Jshinas, RC-Willis
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~40° F
Method:	0.6					Measurement Set:	2nd section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
16:23	0.00		0.00		0.00		0.00		1.00	0.00	0	0.00	0.0
16:23	2.00		0.16		0.26		0.00		2.00	0.52	0	0.00	0.0
16:25	4.00		0.13		0.22		0.00		1.50	0.33	0	0.00	0.0
16:27	5.00		0.19		0.31		0.00		1.00	0.31	0	0.00	0.0
16:28	6.00		0.24		0.40		0.00		1.00	0.40	0	0.00	0.0
16:30	7.00		0.33		0.55		0.00		1.00	0.55	0	0.00	0.0
16:31	8.00		0.60		1.00		0.00		1.00	1.00	0	0.00	0.0
16:33	9.00		0.85		1.41		0.00		1.00	1.41	0	0.00	0.0
16:34	10.00		0.97		1.62		0.00		1.00	1.62	0	0.00	0.0
16:34	11.00		0.91		1.51		0.00		1.00	1.51	0	0.00	0.0
16:38	12.00		0.81		1.35		0.00		1.00	1.35	0	0.00	0.0
16:46	13.00		0.68		1.13		0.06		0.75	0.85	0.06	0.05	5.3
16:48	13.50		0.66		1.10		0.07		0.50	0.55	0.07	0.04	4.0
16:49	14.00		0.62		1.04		0.00		0.75	0.78	0	0.00	0.0
16:51	15.00		0.60		1.00		0.09		0.75	0.75	0.09	0.07	7.0
16:53	15.50		0.58		0.96		0.11		0.50	0.48	0.11	0.05	5.5
16:55	16.00		0.44		0.73		0.12		0.50	0.37	0.12	0.04	4.6
16:56	16.50		0.35		0.58		0.14		0.50	0.29	0.14	0.04	4.2
16:58	17.00		0.39		0.65		0.09		0.50	0.33	0.09	0.03	3.0
16:59	17.50		0.40		0.67		0.00		0.50	0.34	0	0.00	0.0
17:00	18.00		0.39		0.65		0.00		0.75	0.49	0	0.00	0.0
17:01	19.00		0.50		0.83		0.00		1.00	0.83	0	0.00	0.0
17:05	20.00		0.66		1.10		0.07		0.75	0.83	0.07	0.06	6.0
17:07	20.50		0.78		1.30		0.09		0.50	0.65	0.09	0.06	6.1
17:09	21.00		0.79		1.31		0.11		0.45	0.59	0.11	0.06	6.8
17:11	21.40		0.90		1.50		0.00		0.50	0.75	0	0.00	0.0
17:13	22.00		0.78		1.30		0.09		0.55	0.72	0.09	0.06	6.7
17:14	22.50		0.72		1.20		0.15		0.30	0.36	0.15	0.05	5.6

Table 2. Groundwater Study discharge measurements at FA-138 (Gold Creek), location S11XDS, April 18-19, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: S11XDS / FA-138 (Gold Creek)
Purpose: Slough Discharge
Date: 4/18/14 Time: 16:23

Location:	Slough 11 appx 50ft downstream of ESGFA 138-1 pressure transducer					Crew:	Jshinas, RC-Willis
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~40° F
Method:	0.6					Measurement Set:	2nd section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
17:16	22.60		0.69		1.15		0.17		0.25	0.29	0.17	0.05	5.1
17:18	23.00		0.63		1.05		0.15		0.35	0.37	0.15	0.06	5.7
17:19	23.30		0.58		0.97		0.00		0.30	0.29	0	0.00	0.0
17:20	23.60		0.55		0.92		0.00		0.35	0.32	0	0.00	0.0
17:22	24.00		0.50		0.83		0.00		0.70	0.58	0	0.00	0.0
17:24	25.00		0.47		0.78		0.14		0.75	0.59	0.14	0.08	8.5
17:26	25.50		0.44		0.73		0.14		0.50	0.37	0.14	0.05	5.3
17:27	26.00		0.43		0.72		0.00		0.75	0.54	0	0.00	0.0
17:29	27.00		0.39		0.65		0.09		0.75	0.49	0.09	0.04	4.6
17:30	27.50		0.32		0.54		0.00		0.50	0.27	0	0.00	0.0
17:32	28.00		0.32		0.54		0.00		0.75	0.41	0	0.00	0.0
17:34	29.00		0.26		0.43		0.09		0.75	0.32	0.09	0.03	3.0
17:35	29.50		0.29		0.48		0.00		0.75	0.36	0	0.00	0.0
17:37	30.50		0.25		0.42		0.00		1.25	0.53	0	0.00	0.0
17:38	32.00		0.18		0.30		0.00		1.75	0.53	0	0.00	0.0
17:41	34.00		0.12		0.20		0.09		1.50	0.30	0.09	0.03	2.8
17:46	35.00		0.10		0.17		0		1.50	0.26	0	0.00	0.0
17:46	37.00		0.06		0.10		0		2.00	0.20	0	0.00	0.0
17:47	39.00		0.06		0.10		0		2.50	0.25	0	0.00	0.0
17:48	42.00		0.03		0.05		0		2.50	0.13	0	0.00	0.0
17:48	44.00		0.00		0.00		0		1.00	0.00	0	0.00	0.0
Totals									**44.00**	**26.29**		**0.96**	**100.0**

Table 3. Groundwater Study discharge measurements at FA-128 (Slough 8A), location S8AX2US, April 21, 2014.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: S8AX2US / FA-128 (Slough 8A)
Purpose: Slough Discharge
Date: 4/21/14 Time: 11:16

Location:	Slough 8A appx. 500ft below upsteam bend.				Crew:	JamesS, RyanC-W
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft		Weather:	Sunny, ~50° F
Method:	0.6				Measurement Set:	1st upstream measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
11:16	0.00		0.00		0.00				1.50	0.00	0.00	0.00	0.0
11:18	3.00		0.35		0.58				3.00	1.74	0.00	0.00	0.0
11:20	6.00		0.61		1.02				2.00	2.04	0.00	0.00	0.0
11:23	7.00		0.61		1.02				1.00	1.02	0.00	0.00	0.0
11:26	8.00		0.43		0.72				0.75	0.54	0.09	0.05	6.3
12:25	8.50		0.45		0.75				0.50	0.38	0.13	0.05	6.3
11:21	9.00		0.43		0.72				0.50	0.36	0.15	0.05	6.9
12:27	9.50		0.41		0.69				0.50	0.35	0.15	0.05	6.7
11:27	10.00		0.43		0.71				0.50	0.36	0.16	0.06	7.3
12:31	10.50		0.42		0.70				0.50	0.35	0.17	0.06	7.7
11:29	11.00		0.51		0.85				0.38	0.32	0.17	0.05	7.0
12:35	11.25		0.51		0.85				0.25	0.21	0.21	0.04	5.7
12:22	11.50		0.51		0.85				0.25	0.21	0.17	0.04	4.6
12:33	11.75		0.53		0.88				0.25	0.22	0.16	0.04	4.5
11:30	12.00		0.50		0.84				0.25	0.21	0.16	0.03	4.3
12:20	12.25		0.53		0.89				0.25	0.22	0.15	0.03	4.3
12:18	12.50		0.53		0.89				0.38	0.33	0.15	0.05	6.4
11:32	13.00		0.54		0.90				0.38	0.34	0.16	0.05	6.9
12:17	13.25		0.54		0.90				0.25	0.23	0.12	0.03	3.5
12:13	13.50		0.54		0.90				0.38	0.34	0.00	0.00	0.0
11:34	14.00		0.48		0.80				0.50	0.40	0.11	0.04	5.7
12:10	14.50		0.45		0.75				0.50	0.38	0.00	0.00	0.0
11:35	15.00		0.41		0.68				0.75	0.51	0.09	0.05	5.9
11:37	16.00		0.39		0.65				1.00	0.65	0.00	0.00	0.0
11:38	17.00		0.38		0.63				1.00	0.63	0.00	0.00	0.0
11:39	18.00		0.38		0.63				1.00	0.63	0.00	0.00	0.0
11:41	19.00		0.37		0.61				1.50	0.92	0.00	0.00	0.0
11:43	21.00		0.43		0.71				2.00	1.42	0.00	0.00	0.0

Table 3. Groundwater Study discharge measurements at FA-128 (Slough 8A), location S8AX2US, April 21, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: S8AX2US / FA-128 (Slough 8A)
Purpose: Slough Discharge
Date: 4/21/14 Time: 11:16

Location:	Slough 8A appx. 500ft below upsteam bend.					Crew:	JamesS, RyanC-W
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~50° F
Method:	0.6					Measurement Set:	1st upstream measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
11:44	23.00		0.36		0.60				2.50	1.50	0.00	0.00	0.0
11:45	26.00		0.26		0.43				3.00	1.29	0.00	0.00	0.0
11:47	29.00		0.21		0.35				3.00	1.05	0.00	0.00	0.0
11:48	32.00		0.19		0.32				3.00	0.96	0.00	0.00	0.0
11:50	35.00		0.24		0.40				3.00	1.20	0.00	0.00	0.0
11:51	38.00		0.31		0.51				3.00	1.53	0.00	0.00	0.0
11:52	41.00		0.30		0.50				3.00	1.50	0.00	0.00	0.0
11:53	44.00		0.24		0.40				3.00	1.20	0.00	0.00	0.0
11:54	47.00		0.28		0.47				3.00	1.41	0.00	0.00	0.0
11:56	50.00		0.30		0.50				3.00	1.50	0.00	0.00	0.0
11:58	53.00		0.31		0.51				3.00	1.53	0.00	0.00	0.0
11:59	56.00		0.31		0.52				3.00	1.56	0.00	0.00	0.0
12:01	59.00		0.23		0.39				3.00	1.17	0.00	0.00	0.0
12:02	62.00		0.18		0.30				3.00	0.90	0.00	0.00	0.0
12:03	65.00		0.12		0.20				2.50	0.50	0.00	0.00	0.0
12:03	67.00		0.00		0.00				1.00	0.00	0.00	0.00	0.0
Totals									**67.00**	**34.09**		**0.78**	**100.0**

Table 3. Groundwater Study discharge measurements at FA-128 (Slough 8A), location S8AX2US, April 21, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID:	GW Task 7 Winter Studies	Site Name:	S8AX2US / FA-128 (Slough 8A)
Purpose:	Slough Discharge	Date: 4/21/14	Time: 11:24

Location:	Slough 8A appx. 500ft below upsteam bend					Crew:	Jshinas, RC-Willis
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~50° F
Method:	0.6					Measurement Set:	2nd section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
11:24	0.00		0		0.00		0.00		1.50	0.00	0	0.00	0.0
11:26	3.00		0.36		0.60		0.00		2.50	1.50	0	0.00	0.0
11:28	5.00		0.408		0.68		0.00		2.00	1.36	0	0.00	0.0
11:38	7.00		0.588		0.98		0.00		1.25	1.23	0	0.00	0.0
12:20	7.50		0.528		0.88		0.00		0.40	0.35	0	0.00	0.0
12:22	7.80		0.42		0.70		0.12		0.25	0.18	0.12	0.02	2.9
11:37	8.00		0.432		0.72		0.14		0.35	0.25	0.14	0.04	4.8
12:24	8.50		0.426		0.71		0.14		0.38	0.27	0.14	0.04	5.1
12:25	8.75		0.42		0.70		0.16		0.25	0.18	0.16	0.03	3.8
11:34	9.00		0.438		0.73		0.15		0.38	0.27	0.15	0.04	5.6
12:27	9.50		0.438		0.73		0.11		0.50	0.37	0.11	0.04	5.5
12:30	10.00		0.468		0.78		0.14		0.38	0.29	0.14	0.04	5.6
12:33	10.25		0.468		0.78		0.16		0.25	0.20	0.16	0.03	4.3
12:31	10.50		0.504		0.84		0.12		0.38	0.32	0.12	0.04	5.2
11:42	11.00		0.492		0.82		0.12		0.38	0.31	0.12	0.04	5.0
12:44	11.25		0.486		0.81		0.16		0.25	0.20	0.16	0.03	4.4
12:37	11.50		0.486		0.81		0.19		0.25	0.20	0.19	0.04	5.3
12:45	11.75		0.468		0.78		0.15		0.25	0.20	0.15	0.03	4.0
12:40	12.00		0.522		0.87		0.15		0.25	0.22	0.15	0.03	4.5
12:46	12.25		0.498		0.83		0.16		0.25	0.21	0.16	0.03	4.5
12:41	12.50		0.498		0.83		0.19		0.25	0.21	0.19	0.04	5.4
12:48	12.75		0.534		0.89		0.16		0.25	0.22	0.16	0.04	4.9
11:45	13.00		0.54		0.90		0.10		0.38	0.34	0.1	0.03	4.6
12:51	13.50		0.54		0.90		0.12		0.38	0.34	0.12	0.04	5.5
12:56	13.75		0.516		0.86		0.11		0.25	0.22	0.11	0.02	3.2
12:53	14.00		0.492		0.82		0.14		0.38	0.31	0.14	0.04	5.9
12:54	14.50		0.504		0.84		0.00		0.50	0.42	0	0.00	0.0
11:49	15.00		0.432		0.72		0.00		1.25	0.90	0	0.00	0.0

Table 3. Groundwater Study discharge measurements at FA-128 (Slough 8A), location S8AX2US, April 21, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Purpose: Slough Discharge
Site Name: S8AX2US / FA-128 (Slough 8A)
Date: 4/21/14 Time: 11:24

Location:	Slough 8A appx. 500ft below upsteam bend					Crew:	Jshinas, RC-Willis
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~50° F
Method:	0.6					Measurement Set:	2nd section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
11:50	17.00		0.384		0.64		0.00		2.00	1.28	0	0.00	0.0
11:52	19.00		0.39		0.65		0.00		2.50	1.63	0	0.00	0.0
11:53	22.00		0.468		0.78		0.00		3.00	2.34	0	0.00	0.0
11:55	25.00		0.318		0.53		0.00		3.00	1.59	0	0.00	0.0
11:57	28.00		0.231		0.39		0.00		3.00	1.17	0	0.00	0.0
11:58	31.00		0.15		0.25		0.00		3.00	0.75	0	0.00	0.0
12:00	34.00		0.198		0.33		0.00		3.00	0.99	0	0.00	0.0
12:01	37.00		0.3		0.50		0.00		3.00	1.50	0	0.00	0.0
12:03	40.00		0.312		0.52		0.00		3.00	1.56	0	0.00	0.0
12:04	43.00		0.21		0.35		0.00		3.00	1.05	0	0.00	0.0
12:06	46.00		0.282		0.47		0.00		3.00	1.41	0	0.00	0.0
12:08	49.00		0.354		0.59		0.00		2.50	1.48	0	0.00	0.0
12:09	51.00		0.312		0.52		0.00		2.50	1.30	0	0.00	0.0
12:11	54.00		0.258		0.43		0.00		3.00	1.29	0	0.00	0.0
12:13	57.00		0.258		0.43		0.00		3.00	1.29	0	0.00	0.0
12:14	60.00		0.234		0.39		0.00		3.00	1.17	0	0.00	0.0
12:15	63.00		0.12		0.20		0.00		3.50	0.70	0	0.00	0.0
12:15	67.00		0		0.00		0.00		2.00	0.00	0	0.00	0.0
Totals									**67.00**	**33.52**		**0.73**	**100.0**

Table 3. Groundwater Study discharge measurements at FA-128 (Slough 8A), location S8AX2US, April 21, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID:	GW Task 7 Winter Studies	Site Name:	S8AX2US / FA-128 (Slough 8A)
Purpose:	Slough Discharge	Date:	4/21/14 Time: 13:04

Location:	Slough 8A appx. 500ft below upstream bend.				Crew:	Jshinas, RC-Willis	
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft		Weather:	Sunny, ~50° F	
Method:	0.6				Measurement Set:	3rd section measurement	

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
13:04	0.00		0		0.00		0.00		1.50	0.00	0	0.00	0.0
13:05	3.00		0.366		0.61		0.00		3.00	1.83	0	0.00	0.0
13:06	6.00		0.498		0.83		0.00		2.25	1.87	0	0.00	0.0
13:10	7.50		0.54		0.90		0.07		1.00	0.90	0.07	0.06	6.9
13:08	8.00		0.432		0.72		0.17		0.38	0.27	0.17	0.05	5.1
13:12	8.25		0.42		0.70		0.15		0.25	0.18	0.15	0.03	2.9
13:14	8.50		0.45		0.75		0.17		0.25	0.19	0.17	0.03	3.5
13:15	8.75		0.432		0.72		0.17		0.25	0.18	0.17	0.03	3.4
13:16	9.00		0.432		0.72		0.15		0.38	0.27	0.15	0.04	4.5
13:18	9.50		0.426		0.71		0.22		0.38	0.27	0.22	0.06	6.4
13:20	9.75		0.42		0.70		0.20		0.25	0.18	0.2	0.04	3.9
13:22	10.00		0.438		0.73		0.17		0.38	0.27	0.17	0.05	5.1
13:24	10.50		0.48		0.80		0.14		0.38	0.30	0.14	0.04	4.6
13:26	10.75		0.498		0.83		0.14		0.25	0.21	0.14	0.03	3.2
13:27	11.00		0.486		0.81		0.19		0.25	0.20	0.19	0.04	4.2
13:30	11.25		0.492		0.82		0.21		0.25	0.21	0.21	0.04	4.7
13:29	11.50		0.492		0.82		0.15		0.25	0.21	0.15	0.03	3.4
13:32	11.75		0.492		0.82		0.16		0.25	0.21	0.16	0.03	3.6
13:33	12.00		0.492		0.82		0.12		0.38	0.31	0.12	0.04	4.1
13:34	12.50		0.492		0.82		0.15		0.38	0.31	0.15	0.05	5.1
13:37	12.75		0.51		0.85		0.16		0.25	0.21	0.16	0.03	3.7
13:36	13.00		0.51		0.85		0.16		0.38	0.32	0.16	0.05	5.6
13:39	13.50		0.54		0.90		0.12		0.50	0.45	0.12	0.05	5.9
13:40	14.00		0.45		0.75		0.15		0.38	0.28	0.15	0.04	4.6
14:04	14.25		0.48		0.80		0.13		0.25	0.20	0.13	0.03	2.9
13:42	14.50		0.426		0.71		0.09		0.38	0.27	0.09	0.02	2.6
13:43	15.00		0.42		0.70		0.00		0.75	0.53	0	0.00	0.0
13:44	16.00		0.396		0.66		0.00		1.00	0.66	0	0.00	0.0

Table 3. Groundwater Study discharge measurements at FA-128 (Slough 8A), location S8AX2US, April 21, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: S8AX2US / FA-128 (Slough 8A)
Purpose: Slough Discharge
Date: 4/21/14 Time: 13:04

Location:	Slough 8A appx. 500ft below upstream bend.					Crew:	Jshinas, RC-Willis
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~50° F
Method:	0.6					Measurement Set:	3rd section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
13:45	17.00		0.36		0.60		0.00		1.50	0.90	0	0.00	0.0
13:46	19.00		0.372		0.62		0.00		2.50	1.55	0	0.00	0.0
13:47	22.00		0.42		0.70		0.00		3.00	2.10	0	0.00	0.0
13:48	25.00		0.3		0.50		0.00		3.50	1.75	0	0.00	0.0
13:49	29.00		0.21		0.35		0.00		4.00	1.40	0	0.00	0.0
13:51	33.00		0.15		0.25		0.00		4.00	1.00	0	0.00	0.0
13:52	37.00		0.3		0.50		0.00		4.00	2.00	0	0.00	0.0
13:53	41.00		0.24		0.40		0.00		4.00	1.60	0	0.00	0.0
13:54	45.00		0.228		0.38		0.00		4.00	1.52	0	0.00	0.0
13:55	49.00		0.33		0.55		0.00		4.00	2.20	0	0.00	0.0
13:56	53.00		0.3		0.50		0.00		4.00	2.00	0	0.00	0.0
13:57	57.00		0.27		0.45		0.00		4.00	1.80	0	0.00	0.0
13:58	61.00		0.192		0.32		0.00		4.00	1.28	0	0.00	0.0
13:59	65.00		0.06		0.10		0.00		3.00	0.30	0	0.00	0.0
13:59	67.00		0		0.00		0.00		1.00	0.00	0	0.00	0.0
Totals									**67.00**	**32.65**		**0.91**	**100.0**

Table 4. Groundwater Study discharge measurements at FA-128 (Slough 8A), location S8AX2DS, April 21, 2014.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: S8AX2DS / FA-128 (Slough 8A)
Purpose: Slough Discharge
Date: 4/21/14 Time: 15:07

Location:	Slough 8A appx. 200ft below PIT tag array.					Crew:	JamesS, RyanC-W
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~50° F
Method:	0.6					Measurement Set:	1st downstream section

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
15:07	0		0		0				0.50	0.00	0	0.00	0.0
15:11	1		0.3		0.5				1.00	0.50	0.14	0.07	1.2
15:15	2		0.24		0.4				1.00	0.40	0.12	0.05	0.8
15:16	3		0.21		0.35				1.00	0.35	0.33	0.12	2.0
15:18	4		0.24		0.4				1.00	0.40	0.22	0.09	1.5
15:19	5		0.258		0.43				1.00	0.43	0.25	0.11	1.9
15:20	6		0.3		0.5				1.00	0.50	0.2	0.10	1.7
15:22	7		0.3		0.5				1.00	0.50	0.25	0.13	2.2
15:23	8		0.3		0.5				1.00	0.50	0.42	0.21	3.7
15:24	9		0.252		0.42				1.00	0.42	0.43	0.18	3.1
15:25	10		0.3		0.5				1.00	0.50	0.28	0.14	2.4
15:30	11		0.3		0.5				1.00	0.50	0.25	0.13	2.2
15:31	12		0.312		0.52				1.00	0.52	0.27	0.14	2.4
15:32	13		0.348		0.58				1.00	0.58	0.31	0.18	3.1
15:34	14		0.318		0.53				1.00	0.53	0.29	0.15	2.7
15:36	15		0.36		0.6				1.00	0.60	0.37	0.22	3.9
15:37	16		0.36		0.6				1.00	0.60	0.36	0.22	3.8
15:38	17		0.3		0.5				1.00	0.50	0.38	0.19	3.3
15:41	18		0.36		0.6				1.00	0.60	0.42	0.25	4.4
15:43	19		0.384		0.64				1.00	0.64	0.42	0.27	4.7
15:44	20		0.36		0.6				1.00	0.60	0.31	0.19	3.2
0.656944	21		0.354		0.59				1.00	0.59	0.43	0.25	4.4
15:47	22		0.378		0.63				1.00	0.63	0.35	0.22	3.8
15:48	23		0.39		0.65				1.00	0.65	0.4	0.26	4.5
15:49	24		0.372		0.62				0.75	0.47	0.56	0.26	4.5
16:07	24.5		0.372		0.62				0.50	0.31	0.48	0.15	2.6
15:51	25		0.36		0.6				0.50	0.30	0.46	0.14	2.4
16:05	25.5		0.3		0.5				0.50	0.25	0.32	0.08	1.4

Table 4. Groundwater Study discharge measurements at FA-128 (Slough 8A), location S8AX2DS, April 21, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: S8AX2DS / FA-128 (Slough 8A)
Purpose: Slough Discharge
Date: 4/21/14 Time: 15:07

Location:	Slough 8A appx. 200ft below PIT tag array.					Crew:	JamesS, RyanC-W
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~50° F
Method:	0.6					Measurement Set:	1st downstream section

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
15:52	26		0.3		0.5				0.75	0.38	0.26	0.10	1.7
15:53	27		0.33		0.55				1.00	0.55	0.31	0.17	3.0
15:54	28		0.3		0.5				1.00	0.50	0.32	0.16	2.8
15:55	29		0.3		0.5				1.00	0.50	0.42	0.21	3.7
15:56	30		0.3		0.5				1.00	0.50	0.34	0.17	3.0
15:58	31		0.276		0.46				1.50	0.69	0.23	0.16	2.8
16:00	33		0.24		0.4				1.50	0.60	0.37	0.22	3.9
16:01	34		0.18		0.3				1.00	0.30	0.24	0.07	1.3
16:01	35		0		0				0.50	0.00	0	0.00	0.0
Totals									**35.00**	**17.38**		**5.74**	**100.0**

Table 4. Groundwater Study discharge measurements at FA-128 (Slough 8A), location S8AX2DS, April 21, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID:	GW Task 7 Winter Studies	Site Name:	S8AX2DS / FA-128 (Slough 8A)
Purpose:	Slough Discharge	Date:	4/21/14 Time: 15:22

Location:	Slough 8A appx. 200ft below PIT tag array.				Crew:	JamesS, RyanC-Willis	
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft		Weather:	Sunny, ~50° F	
Method:	0.6				Measurement Set:	2nd downstream measurement	

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
15:22	0		0.00		0.00		0.00		0.50	0.00	0	0.00	0.0
15:24	1		0.30		0.50		0.18		1.00	0.50	0.18	0.09	1.4
15:26	2		0.22		0.37		0.28		1.00	0.37	0.28	0.10	1.6
15:28	3		0.24		0.40		0.29		1.00	0.40	0.29	0.12	1.8
15:30	4		0.25		0.42		0.31		1.00	0.42	0.31	0.13	2.1
15:31	5		0.30		0.50		0.32		1.00	0.50	0.32	0.16	2.5
15:33	6		0.31		0.51		0.27		1.00	0.51	0.27	0.14	2.2
15:34	7		0.29		0.49		0.27		1.00	0.49	0.27	0.13	2.1
15:36	8		0.31		0.51		0.39		1.00	0.51	0.39	0.20	3.1
15:37	9		0.27		0.45		0.52		1.00	0.45	0.52	0.23	3.7
15:39	10		0.30		0.50		0.36		1.00	0.50	0.36	0.18	2.8
15:40	11		0.28		0.46		0.41		1.00	0.46	0.41	0.19	3.0
15:42	12		0.33		0.55		0.31		1.00	0.55	0.31	0.17	2.7
15:43	13		0.34		0.57		0.34		1.00	0.57	0.34	0.19	3.1
15:44	14		0.25		0.42		0.55		1.00	0.42	0.55	0.23	3.6
15:45	15		0.33		0.55		0.36		1.00	0.55	0.36	0.20	3.1
15:49	16		0.27		0.45		0.19		1.00	0.45	0.19	0.09	1.3
15:50	17		0.31		0.51		0.36		1.00	0.51	0.36	0.18	2.9
15:52	18		0.36		0.60		0.45		1.00	0.60	0.45	0.27	4.3
15:53	19		0.34		0.57		0.43		1.00	0.57	0.43	0.25	3.9
15:55	20		0.35		0.58		0.32		1.00	0.58	0.32	0.19	2.9
15:56	21		0.35		0.58		0.41		1.00	0.58	0.41	0.24	3.8
15:57	22		0.37		0.62		0.40		1.00	0.62	0.4	0.25	3.9
15:59	23		0.41		0.68		0.41		1.00	0.68	0.41	0.28	4.4
16:00	24		0.36		0.60		0.51		1.00	0.60	0.51	0.31	4.8
16:01	25		0.38		0.64		0.43		1.00	0.64	0.43	0.28	4.3
16:03	26		0.33		0.55		0.28		1.00	0.55	0.28	0.15	2.4
16:04	27		0.36		0.60		0.37		1.00	0.60	0.37	0.22	3.5

Table 4. Groundwater Study discharge measurements at FA-128 (Slough 8A), location S8AX2DS, April 21, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: S8AX2DS / FA-128 (Slough 8A)
Purpose: Slough Discharge
Date: 4/21/14 Time: 15:22

Location:	Slough 8A appx. 200ft below PIT tag array.					Crew:	JamesS, RyanC-Willis
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~50° F
Method:	0.6					Measurement Set:	2nd downstream measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
16:05	28		0.25		0.41		0.36		1.00	0.41	0.36	0.15	2.3
16:06	29		0.24		0.40		0.47		1.00	0.40	0.47	0.19	3.0
16:07	30		0.23		0.38		0.46		1.00	0.38	0.46	0.17	2.8
16:09	31		0.24		0.40		0.40		1.00	0.40	0.4	0.16	2.5
16:10	32		0.25		0.41		0.52		1.00	0.41	0.52	0.21	3.4
16:11	33		0.22		0.37		0.42		1.00	0.37	0.42	0.16	2.5
16:12	34		0.21		0.35		0.40		1.00	0.35	0.4	0.14	2.2
16:13	35		0.00		0.00		0.00		0.50	0.00	0	0.00	0.0
Totals									**35.00**	**16.90**		**6.34**	**100.0**

Table 4. Groundwater Study discharge measurements at FA-128 (Slough 8A), location S8AX2DS, April 21, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID:	GW Task 7 Winter Studies	Site Name:	S8AX2DS / FA-128 (Slough 8A)
Purpose:	Slough Discharge	Date:	4/21/14 Time: 16:10

Location:	Slough 8A appx. 200ft below PIT tag array.				Crew:	JamesS, RyanC-Willis	
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft		Weather:	Sunny, ~50° F	
Method:	0.6				Measurement Set:	3rd downstream measurement	

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
16:10	0		0.00		0.00		0.00		0.50	0.00	0.00	0.00	0.0
16:13	1		0.30		0.50		0.21		1.00	0.50	0.21	0.11	1.8
16:15	2		0.21		0.35		0.17		1.00	0.35	0.17	0.06	1.0
16:17	3		0.22		0.37		0.35		1.00	0.37	0.35	0.13	2.3
16:18	4		0.25		0.42		0.14		1.00	0.42	0.14	0.06	1.0
16:19	5		0.26		0.43		0.23		1.00	0.43	0.23	0.10	1.7
16:21	6		0.30		0.50		0.21		1.00	0.50	0.21	0.11	1.8
16:22	7		0.28		0.46		0.26		1.00	0.46	0.26	0.12	2.1
16:23	8		0.30		0.50		0.47		1.00	0.50	0.47	0.24	4.1
16:25	9		0.26		0.44		0.52		1.00	0.44	0.52	0.23	4.0
16:26	10		0.30		0.50		0.17		1.00	0.50	0.17	0.09	1.5
16:28	11		0.28		0.46		0.27		1.00	0.46	0.27	0.12	2.2
16:29	12		0.32		0.54		0.31		1.00	0.54	0.31	0.17	2.9
16:30	13		0.36		0.60		0.34		1.00	0.60	0.34	0.20	3.6
16:31	14		0.31		0.51		0.39		1.00	0.51	0.39	0.20	3.5
16:33	15		0.36		0.60		0.38		1.00	0.60	0.38	0.23	4.0
16:34	16		0.27		0.45		0.29		1.00	0.45	0.29	0.13	2.3
16:35	17		0.31		0.51		0.41		1.00	0.51	0.41	0.21	3.7
16:42	18		0.00		0.00		0.44		1.00	0.00	0.44	0.00	0.0
16:43	19		0.35		0.58		0.45		1.00	0.58	0.45	0.26	4.6
16:45	20		0.34		0.56		0.34		1.00	0.56	0.34	0.19	3.3
16:46	21		0.30		0.50		0.43		1.00	0.50	0.43	0.22	3.8
16:47	22		0.36		0.60		0.43		1.00	0.60	0.43	0.26	4.5
16:49	23		0.41		0.69		0.34		1.00	0.69	0.34	0.23	4.1
16:50	24		0.34		0.56		0.54		1.00	0.56	0.54	0.30	5.3
16:51	25		0.36		0.60		0.43		1.00	0.60	0.43	0.26	4.5
16:52	26		0.33		0.55		0.21		1.00	0.55	0.21	0.12	2.0
16:53	27		0.36		0.60		0.38		1.00	0.60	0.38	0.23	4.0

Table 4. Groundwater Study discharge measurements at FA-128 (Slough 8A), location S8AX2DS, April 21, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: S8AX2DS / FA-128 (Slough 8A)
Purpose: Slough Discharge
Date: 4/21/14 Time: 16:10

Location:	Slough 8A appx. 200ft below PIT tag array.					Crew:	JamesS, RyanC-Willis
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~50° F
Method:	0.6					Measurement Set:	3rd downstream measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
16:54	28		0.30		0.50		0.38		1.00	0.50	0.38	0.19	3.3
16:55	29		0.30		0.50		0.41		1.00	0.50	0.41	0.21	3.6
16:57	30		0.27		0.45		0.36		1.00	0.45	0.36	0.16	2.9
16:58	31		0.25		0.41		0.40		1.00	0.41	0.40	0.16	2.9
16:59	32		0.24		0.40		0.48		1.00	0.40	0.48	0.19	3.4
17:00	33		0.24		0.40		0.42		1.00	0.40	0.42	0.17	3.0
17:01	34		0.15		0.25		0.21		1.00	0.25	0.21	0.05	0.9
17:01	35		0.00		0.00		0.00		0.50	0.00	0.00	0.00	0.0
Totals									**35.00**	**16.29**		**5.68**	**100.0**

Table 5. Groundwater Study discharge measurements at FA-104 (Whiskers Slough), location WCXUS, April 17, 2014.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: WCXUS / FA104 (Whiskers Slough)
Purpose: Slough Discharge
Date: 4/17/14 Time: 10:10

Location:	Whiskers Creek upstream. N62.38623 W15016292				Crew:	DanR, RyanC-W
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft		Weather:	sunny, ~ 45°F
Method:	0.6				Measurement Set:	1st section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
10:10	0.00		0.00		0.00		0.00		0.20	0.00	0	0.00	0.0
10:11	0.40		0.03		0.05		0.51		0.50	0.03	0.51	0.01	0.4
10:13	1.00		0.18		0.30		0.39		0.80	0.24	0.39	0.09	2.8
10:14	2.00		0.25		0.41		0.51		0.75	0.31	0.51	0.16	4.6
10:46	2.50		0.23		0.39		0.63		0.50	0.20	0.63	0.12	3.6
10:16	3.00		0.21		0.35		0.57		0.75	0.26	0.57	0.15	4.4
10:17	4.00		0.22		0.36		0.65		0.75	0.27	0.65	0.18	5.2
10:49	4.50		0.20		0.33		0.74		0.38	0.12	0.74	0.09	2.7
11:06	4.75		0.19		0.32		0.78		0.25	0.08	0.78	0.06	1.8
10:19	5.00		0.19		0.31		0.70		0.63	0.19	0.7	0.14	4.0
10:20	6.00		0.19		0.32		0.64		0.75	0.24	0.64	0.15	4.5
10:52	6.50		0.25		0.41		0.60		0.50	0.21	0.6	0.12	3.6
10:21	7.00		0.25		0.41		0.69		0.50	0.21	0.69	0.14	4.2
10:53	7.50		0.25		0.42		0.63		0.50	0.21	0.63	0.13	3.9
10:23	8.00		0.28		0.46		0.70		0.50	0.23	0.7	0.16	4.7
10:55	8.50		0.28		0.47		0.63		0.50	0.24	0.63	0.15	4.4
10:26	9.00		0.29		0.48		0.66		0.50	0.24	0.66	0.16	4.7
10:57	9.50		0.30		0.50		0.60		0.50	0.25	0.6	0.15	4.4
10:27	10.00		0.28		0.47		0.66		0.50	0.24	0.66	0.16	4.6
10:59	10.50		0.29		0.49		0.61		0.50	0.25	0.61	0.15	4.4
10:29	11.00		0.28		0.47		0.64		0.50	0.24	0.64	0.15	4.4
11:01	11.50		0.28		0.47		0.59		0.50	0.24	0.59	0.14	4.1
11:03	12.00		0.25		0.42		0.52		0.50	0.21	0.52	0.11	3.2
11:01	12.50		0.00		0.00		0.00		0.50	0.00	0	0.00	0.0
11:09	13.00		0.22		0.37		0.46		0.75	0.28	0.46	0.13	3.8
10:33	14.00		0.23		0.38		0.32		1.00	0.38	0.32	0.12	3.6
10:35	15.00		0.24		0.40		0.26		1.00	0.40	0.26	0.10	3.1
10:36	16.00		0.31		0.51		0.19		1.00	0.51	0.19	0.10	2.9

Table 5. Groundwater Study discharge measurements at FA-104 (Whiskers Slough), location WCXUS, April 17, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: WCXUS / FA104 (Whiskers Slough)
Purpose: Slough Discharge
Date: 4/17/14 Time: 10:10

Location:	Whiskers Creek upstream. N62.38623 W15016292					Crew:	DanR, RyanC-W
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	sunny, ~ 45°F
Method:	0.6					Measurement Set:	1st section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
10:38	17.00		0.36		0.60		0.13		1.00	0.60	0.13	0.08	2.3
10:39	18.00		0.39		0.65		0.00		1.00	0.65	0	0.00	0.0
10:40	19.00		0.41		0.68		0.00		1.00	0.68	0	0.00	0.0
10:40	20.00		0.06		0.10		0.00		0.80	0.08	0	0.00	0.0
10:42	20.60		0.00		0.00		0.00		0.30	0.00	0	0.00	0.0
Totals									**20.60**	**8.25**		**3.40**	**100.0**

Table 5. Groundwater Study discharge measurements at FA-104 (Whiskers Slough), location WCXUS, April 17, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: WCXUS / FA104 (Whiskers Slough)
Purpose: Slough Discharge
Date: 4/17/14 Time: 10:38

Location:	Whiskers Creek upstream. N62.38623 W15016292					Crew:	DanR, RyanC-W
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	sunny, ~ 45°F
Method:	0.6					Measurement Set:	2nd section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
10:38	0.00		0.00		0.00		0.00		0.38	0.00	0	0.00	0.0
10:39	0.75		0.15		0.25		0.55		0.50	0.13	0.55	0.07	1.9
10:41	1.00		0.16		0.26		0.15		0.63	0.16	0.15	0.02	0.7
10:43	2.00		0.23		0.39		0.61		0.75	0.29	0.61	0.18	4.8
11:41	2.50		0.20		0.33		0.63		0.50	0.17	0.63	0.10	2.8
10:44	3.00		0.23		0.38		0.74		0.50	0.19	0.74	0.14	3.8
11:40	3.50		0.20		0.33		0.61		0.50	0.17	0.61	0.10	2.7
10:46	4.00		0.22		0.37		0.76		0.50	0.19	0.76	0.14	3.8
11:38	4.50		0.20		0.33		0.77		0.50	0.17	0.77	0.13	3.4
10:47	5.00		0.13		0.22		0.73		0.75	0.17	0.73	0.12	3.3
10:48	6.00		0.19		0.32		0.77		0.75	0.24	0.77	0.18	5.0
11:35	6.50		0.19		0.32		0.69		0.50	0.16	0.69	0.11	3.0
10:50	7.00		0.26		0.43		0.69		0.50	0.22	0.69	0.15	4.0
11:34	7.50		0.26		0.43		0.69		0.50	0.22	0.69	0.15	4.0
10:51	8.00		0.27		0.45		0.71		0.38	0.17	0.71	0.12	3.2
11:32	8.25		0.28		0.47		0.70		0.25	0.12	0.7	0.08	2.2
11:31	8.50		0.29		0.49		0.66		0.38	0.18	0.66	0.12	3.3
10:55	9.00		0.28		0.46		0.66		0.50	0.23	0.66	0.15	4.1
11:29	9.50		0.30		0.50		0.64		0.50	0.25	0.64	0.16	4.3
11:26	10.00		0.31		0.51		0.57		0.50	0.26	0.57	0.15	3.9
11:27	10.50		0.31		0.51		0.57		0.50	0.26	0.57	0.15	3.9
10:56	11.00		0.29		0.49		0.64		0.38	0.18	0.64	0.12	3.2
11:24	11.25		0.30		0.50		0.66		0.25	0.13	0.66	0.08	2.2
11:19	11.50		0.26		0.43		0.51		0.38	0.16	0.51	0.08	2.2
10:57	12.00		0.27		0.45		0.59		0.50	0.23	0.59	0.13	3.6
11:18	12.50		0.25		0.42		0.52		0.50	0.21	0.52	0.11	2.9
10:59	13.00		0.29		0.48		0.49		0.50	0.24	0.49	0.12	3.2
11:16	13.50		0.31		0.51		0.45		0.50	0.26	0.45	0.11	3.1

Table 5. Groundwater Study discharge measurements at FA-104 (Whiskers Slough), location WCXUS, April 17, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: WCXUS / FA104 (Whiskers Slough)
Purpose: Slough Discharge
Date: 4/17/14 Time: 10:38

Location:	Whiskers Creek upstream. N62.38623 W15016292					Crew:	DanR, RyanC-W
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	sunny, ~ 45°F
Method:	0.6					Measurement Set:	2nd section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
11:00	14.00		0.26		0.43		0.41		0.50	0.22	0.41	0.09	2.4
11:14	14.50		0.23		0.39		0.32		0.50	0.20	0.32	0.06	1.7
11:02	15.00		0.24		0.40		0.24		0.75	0.30	0.24	0.07	1.9
11:03	16.00		0.25		0.42		0.18		1.50	0.63	0.18	0.11	3.1
11:06	18.00		0.39		0.65		0.09		1.50	0.98	0.09	0.09	2.4
11:10	19.00		0.29		0.48		0.00		1.25	0.60	0	0.00	0.0
11:10	20.50		0.00		0.00		0.00		0.75	0.00	0	0.00	0.0
Totals									**20.50**	**8.22**		**3.70**	**100.0**

Table 5. Groundwater Study discharge measurements at FA-104 (Whiskers Slough), location WCXUS, April 17, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: WCXUS / FA104 (Whiskers Slough)
Purpose: Slough Discharge
Date: 4/17/14 Time: 11:12

Location:	Whiskers Creek upstream. N62.38623 W15016292					Crew:	DanR, RyanC-W
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	sunny, ~ 45°F
Method:	0.6					Measurement Set:	3rd section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
11:12	0.00		0.00		0.00		0.00		0.25	0.00	0	0.00	0.0
11:13	0.50		0.12		0.20		0.52		0.50	0.10	0.52	0.05	1.4
11:16	1.00		0.15		0.25		0.47		0.50	0.13	0.47	0.06	1.6
11:17	1.50		0.16		0.27		0.69		0.50	0.14	0.69	0.09	2.5
11:18	2.00		0.24		0.40		0.68		0.50	0.20	0.68	0.14	3.7
11:19	2.50		0.24		0.40		0.64		0.50	0.20	0.64	0.13	3.5
11:21	3.00		0.20		0.33		0.46		0.50	0.17	0.46	0.08	2.0
11:23	3.50		0.24		0.40		0.71		0.50	0.20	0.71	0.14	3.8
11:24	4.00		0.21		0.35		0.76		0.50	0.18	0.76	0.13	3.6
11:26	4.50		0.21		0.35		0.76		0.50	0.18	0.76	0.13	3.6
11:27	5.00		0.19		0.31		0.71		0.50	0.16	0.71	0.11	3.0
11:28	5.50		0.19		0.32		0.72		0.50	0.16	0.72	0.12	3.1
11:29	6.00		0.19		0.32		0.79		0.50	0.16	0.79	0.13	3.4
11:31	6.50		0.20		0.33		0.70		0.50	0.17	0.7	0.12	3.1
11:33	7.00		0.26		0.43		0.70		0.50	0.22	0.7	0.15	4.1
11:34	7.50		0.26		0.43		0.60		0.50	0.22	0.6	0.13	3.5
11:35	8.00		0.28		0.47		0.65		0.50	0.24	0.65	0.15	4.1
11:37	8.50		0.29		0.49		0.59		0.50	0.25	0.59	0.14	3.9
11:38	9.00		0.29		0.48		0.60		0.50	0.24	0.6	0.14	3.9
11:39	9.50		0.30		0.50		0.58		0.50	0.25	0.58	0.15	3.9
11:40	10.00		0.30		0.50		0.57		0.50	0.25	0.57	0.14	3.8
11:41	10.50		0.31		0.51		0.58		0.50	0.26	0.58	0.15	4.0
11:43	11.00		0.29		0.49		0.60		0.50	0.25	0.6	0.15	4.0
11:44	11.50		0.27		0.45		0.56		0.50	0.23	0.56	0.13	3.4
11:45	12.00		0.30		0.50		0.55		0.50	0.25	0.55	0.14	3.7
11:47	12.50		0.26		0.43		0.50		0.50	0.22	0.5	0.11	2.9
11:48	13.00		0.27		0.45		0.42		0.40	0.18	0.42	0.08	2.0
11:49	13.30		0.26		0.44		0.40		0.50	0.22	0.4	0.09	2.4

Table 5. Groundwater Study discharge measurements at FA-104 (Whiskers Slough), location WCXUS, April 17, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: WCXUS / FA104 (Whiskers Slough)
Purpose: Slough Discharge
Date: 4/17/14 Time: 11:12

Location:	Whiskers Creek upstream. N62.38623 W15016292					Crew:	DanR, RyanC-W
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	sunny, ~ 45°F
Method:	0.6					Measurement Set:	3rd section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
11:51	14.00		0.22		0.36		0.36		0.70	0.25	0.36	0.09	2.4
11:53	14.70		0.23		0.39		0.28		0.75	0.29	0.28	0.08	2.2
11:55	15.50		0.24		0.40		0.24		0.90	0.36	0.24	0.09	2.3
11:57	16.50		0.34		0.56		0.17		1.00	0.56	0.17	0.10	2.6
11:59	17.50		0.38		0.63		0.15		1.00	0.63	0.15	0.09	2.6
12:00	18.50		0.42		0.70		0.00		1.25	0.88	0	0.00	0.0
12:01	20.00		0.12		0.20		0.00		1.05	0.21	0	0.00	0.0
12:01	20.60		0.00		0.00		0.00		0.30	0.00	0	0.00	0.0
Totals									**20.60**	**8.53**		**3.71**	**100.0**

Table 6. Groundwater Study discharge measurements at FA-104 (Whiskers Slough), location WCXDS, April 17, 2014.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: WCXDS / FA-104 (Whiskers Slough)
Purpose: Slough Discharge
Date: 4/17/14 Time: 13:22

Location:	Whiskers Creek, stream of confluence with 3A. N62.37687 W150.17124					Crew:	DanR, RyanC-W
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~45°F
Method:	0.6					Measurement Set:	1st section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
13:22	0.00		0.00		0.00		0.00		0.50	0.00	0.00	0.00	0.0
13:25	1.00		0.30		0.50		0.37		1.00	0.50	0.37	0.19	4.0
13:27	2.00		0.37		0.62		0.00		1.00	0.62	0.00	0.00	0.0
13:28	3.00		0.38		0.63		0.00		1.00	0.63	0.00	0.00	0.0
13:30	4.00		0.36		0.60		0.00		1.00	0.60	0.00	0.00	0.0
13:32	5.00		0.38		0.63		0.22		1.00	0.63	0.22	0.14	3.0
13:33	6.00		0.38		0.63		0.55		0.75	0.47	0.55	0.26	5.7
13:34	6.50		0.40		0.67		0.45		0.50	0.34	0.45	0.15	3.3
13:36	7.00		0.46		0.76		0.53		0.50	0.38	0.53	0.20	4.4
13:37	7.50		0.41		0.69		0.46		0.50	0.35	0.46	0.16	3.5
13:38	8.00		0.47		0.79		0.35		0.50	0.40	0.35	0.14	3.0
13:40	8.50		0.49		0.82		0.34		0.50	0.41	0.34	0.14	3.0
13:41	9.00		0.44		0.74		0.35		0.50	0.37	0.35	0.13	2.8
13:43	9.50		0.48		0.80		0.50		0.50	0.40	0.50	0.20	4.4
13:45	10.00		0.50		0.83		0.49		0.50	0.42	0.49	0.20	4.4
13:46	10.50		0.52		0.87		0.44		0.50	0.44	0.44	0.19	4.2
14:01	11.00		0.47		0.78		0.52		0.50	0.39	0.52	0.20	4.4
14:04	11.50		0.56		0.93		0.63		0.40	0.37	0.63	0.23	5.1
14:06	11.80		0.46		0.77		0.75		0.30	0.23	0.75	0.17	3.8
14:08	12.10		0.46		0.77		0.89		0.30	0.23	0.89	0.21	4.5
14:09	12.40		0.43		0.71		0.77		0.30	0.21	0.77	0.16	3.6
14:10	12.70		0.45		0.75		0.78		0.30	0.22	0.78	0.18	3.8
14:12	13.00		0.38		0.63		0.85		0.30	0.19	0.85	0.16	3.5
14:13	13.30		0.38		0.63		0.83		0.30	0.19	0.83	0.16	3.4
14:15	13.60		0.36		0.60		0.72		0.35	0.21	0.72	0.15	3.3
14:16	14.00		0.37		0.62		0.79		0.40	0.25	0.79	0.20	4.3
14:22	14.40		0.41		0.68		0.65		0.40	0.27	0.65	0.18	3.9
14:24	14.80		0.38		0.63		0.71		0.40	0.25	0.71	0.18	3.9

Table 6. Groundwater Study discharge measurements at FA-104 (Whiskers Slough), location WCXDS, April 17, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: WCXDS / FA-104 (Whiskers Slough)
Purpose: Slough Discharge
Date: 4/17/14 Time: 13:22

Location:	Whiskers Creek, stream of confluence with 3A. N62.37687 W150.17124					Crew:	DanR, RyanC-W
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~45°F
Method:	0.6					Measurement Set:	1st section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
14:25	15.20		0.37		0.61		0.70		0.40	0.24	0.70	0.17	3.7
14:27	15.60		0.42		0.70		0.28		0.40	0.28	0.28	0.08	1.7
14:29	16.00		0.29		0.48		0.31		0.45	0.22	0.31	0.07	1.5
14:30	16.50		0.18		0.30		0.00		0.50	0.15	0.00	0.00	0.0
14:31	17.00		0.14		0.23		0.00		0.50	0.12	0.00	0.00	0.0
14:31	17.50		0.12		0.20		0.00		0.50	0.10	0.00	0.00	0.0
14:32	18.00		0.00		0.00		0.00		0.25	0.00	0.00	0.00	0.0
Totals									**18.00**	**11.06**		**4.59**	**100.0**

Table 6. Groundwater Study discharge measurements at FA-104 (Whiskers Slough), location WCXDS, April 17, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: WCXDS / FA-104 (Whiskers Slough)
Purpose: Slough Discharge
Date: 4/17/14 Time: 14:16

Location:	Whiskers Creek, stream of confluence with 3A. N62.37687 W150.17124					Crew:	DanR, RyanC-Willis
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~45°F
Method:	0.6					Measurement Set:	2nd section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
14:16	0.00		0.00		0.00		0.00		0.13	0.00	0	0.00	0.0
14:17	0.25		0.24		0.40		0.26		0.35	0.14	0.26	0.04	0.8
14:19	0.70		0.28		0.46		0.41		0.48	0.22	0.41	0.09	2.0
14:20	1.20		0.32		0.53		0.38		0.55	0.29	0.38	0.11	2.5
14:22	1.80		0.29		0.49		0.23		0.55	0.27	0.23	0.06	1.4
14:23	2.30		0.41		0.68		0.00		0.60	0.41	0	0.00	0.0
14:24	3.00		0.37		0.62		0.00		0.60	0.37	0	0.00	0.0
14:25	3.50		0.40		0.66		0.00		0.75	0.50	0	0.00	0.0
14:26	4.50		0.35		0.58		0.12		0.85	0.49	0.12	0.06	1.3
14:28	5.20		0.38		0.63		0.28		0.65	0.41	0.28	0.11	2.5
14:29	5.80		0.43		0.72		0.49		0.65	0.47	0.49	0.23	5.1
14:31	6.50		0.40		0.66		0.42		0.60	0.40	0.42	0.17	3.7
14:32	7.00		0.43		0.71		0.48		0.50	0.36	0.48	0.17	3.8
14:34	7.50		0.41		0.69		0.58		0.40	0.28	0.58	0.16	3.5
14:35	7.80		0.36		0.60		0.54		0.35	0.21	0.54	0.11	2.5
14:38	8.20		0.52		0.86				0.20	0.17	0	0.00	0.0
14:37	8.20		0.52		0.86				0.00	0.00	0	0.00	0.0
14:43	8.20		0.52		0.86		0.33		0.20	0.17	0.33	0.06	1.3
14:54	8.60		0.51		0.85				0.20	0.17	0	0.00	0.0
14:51	8.60		0.51		0.85				0.00	0.00	0	0.00	0.0
14:55	8.60		0.51		0.85		0.36		0.30	0.25	0.36	0.09	2.0
14:59	9.20		0.47		0.79		0.36		0.70	0.55	0.36	0.20	4.4
15:01	10.00		0.48		0.80		0.50		0.60	0.48	0.5	0.24	5.3
15:03	10.40		0.47		0.79		0.56		0.35	0.28	0.56	0.15	3.4
15:04	10.70		0.48		0.80		0.48		0.30	0.24	0.48	0.12	2.6
15:10	11.00		0.48		0.80		0.51		0.40	0.32	0.51	0.16	3.6
15:12	11.50		0.57		0.95		0.59		0.38	0.36	0.59	0.21	4.7
15:33	11.75		0.44		0.73		0.65		0.25	0.18	0.65	0.12	2.6

Table 6. Groundwater Study discharge measurements at FA-104 (Whiskers Slough), location WCXDS, April 17, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: WCXDS / FA-104 (Whiskers Slough)
Purpose: Slough Discharge
Date: 4/17/14 Time: 14:16

Location:	Whiskers Creek, stream of confluence with 3A. N62.37687 W150.17124					Crew:	DanR, RyanC-Willis
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~45°F
Method:	0.6					Measurement Set:	2nd section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
15:13	12.00		0.44		0.74		0.84		0.32	0.24	0.84	0.20	4.5
15:14	12.40		0.43		0.72		0.81		0.35	0.25	0.81	0.20	4.5
15:16	12.70		0.41		0.69		0.86		0.25	0.17	0.86	0.15	3.3
15:18	12.90		0.38		0.63		0.87		0.23	0.14	0.87	0.12	2.7
15:19	13.15		0.34		0.56		0.93		0.25	0.14	0.93	0.13	2.9
15:20	13.40		0.32		0.53		0.82		0.38	0.20	0.82	0.16	3.6
15:22	13.90		0.29		0.48		0.76		0.50	0.24	0.76	0.18	4.0
15:23	14.40		0.33		0.55		0.63		0.55	0.30	0.63	0.19	4.2
15:25	15.00		0.38		0.63		0.77		0.45	0.28	0.77	0.22	4.8
15:38	15.30		0.35		0.58		0.67		0.28	0.16	0.67	0.11	2.4
15:26	15.55		0.36		0.60		0.59		0.30	0.18	0.59	0.11	2.4
15:28	15.90		0.29		0.48		0.37		0.35	0.17	0.37	0.06	1.4
15:29	16.25		0.20		0.33		0.10		0.55	0.18	0.1	0.02	0.4
15:30	17.00		0.13		0.22		0.00		0.88	0.19	0	0.00	0.0
15:30	18.00		0		0.00		0.00		0.50	0.00	0	0.00	0.0
Totals									**18.00**	**10.83**		**4.52**	**100.0**

Table 6. Groundwater Study discharge measurements at FA-104 (Whiskers Slough), location WCXDS, April 17, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: WCXDS / FA-104 (Whiskers Slough)
Purpose: Slough Discharge
Date: 4/17/14 Time: 15:46

Location:	Whiskers Creek, stream of confluence with 3A. N62.37687 W150.17124					Crew:	DanR, RyanC-W
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~45°F
Method:	0.6					Measurement Set:	3rd section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
15:46	0.00		0.00		0.00		0.00		0.25	0.00	0.00	0.00	0.0
15:47	0.50		0.26		0.43		0.00		0.75	0.32	0.00	0.00	0.0
15:48	1.50		0.30		0.50		0.17		0.88	0.44	0.17	0.07	1.6
16:28	2.25		0.47		0.79		0.12		1.50	1.19	0.12	0.14	3.0
16:30	4.50		0.36		0.60		0.16		1.88	1.13	0.16	0.18	3.8
15:50	6.00		0.44		0.73		0.35		0.90	0.66	0.35	0.23	4.9
16:24	6.30		0.41		0.68		0.37		0.32	0.22	0.37	0.08	1.7
16:26	6.65		0.37		0.62		0.42		0.35	0.22	0.42	0.09	1.9
15:56	7.00		0.46		0.76		0.50		0.29	0.22	0.50	0.11	2.3
15:58	7.23		0.41		0.68		0.56		0.62	0.42	0.56	0.24	5.0
16:00	8.24		0.51		0.85		0.28		0.98	0.83	0.28	0.23	4.9
16:01	9.18		0.48		0.80		0.36		0.83	0.66	0.36	0.24	5.1
16:02	9.90		0.49		0.81		0.59		0.50	0.40	0.59	0.24	5.0
16:04	10.17		0.50		0.83		0.53		0.52	0.44	0.53	0.23	4.9
16:06	10.95		0.49		0.81		0.54		0.54	0.43	0.54	0.23	5.0
16:08	11.24		0.57		0.95		0.58		0.43	0.40	0.58	0.23	5.0
16:09	11.80		0.44		0.74		0.68		0.47	0.34	0.68	0.23	5.0
16:10	12.17		0.40		0.66		0.84		0.42	0.28	0.84	0.23	5.0
16:11	12.64		0.37		0.61		0.82		0.46	0.28	0.82	0.23	4.9
16:12	13.09		0.43		0.72		0.83		0.38	0.27	0.83	0.23	4.8
16:13	13.40		0.41		0.69		0.79		0.44	0.30	0.79	0.24	5.1
16:15	13.97		0.29		0.49		0.87		0.55	0.27	0.87	0.23	5.0
16:16	14.50		0.37		0.61		0.74		0.52	0.31	0.74	0.23	4.9
16:17	15.00		0.37		0.62		0.85		0.45	0.28	0.85	0.23	5.0
16:18	15.39		0.36		0.60		0.66		0.58	0.35	0.66	0.23	4.9
16:20	16.16		0.20		0.33		0.21		0.80	0.27	0.21	0.06	1.2

Table 6. Groundwater Study discharge measurements at FA-104 (Whiskers Slough), location WCXDS, April 17, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: WCXDS / FA-104 (Whiskers Slough)
Purpose: Slough Discharge
Date: 4/17/14 Time: 15:46

Location:	Whiskers Creek, stream of confluence with 3A. N62.37687 W150.17124					Crew:	DanR, RyanC-W
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~45°F
Method:	0.6					Measurement Set:	3rd section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
16:21	17.00		0.14		0.23		0.00		0.92	0.21	0.00	0.00	0.0
16:21	18.00		0.00		0.00		0.00		0.50	0.00	0.00	0.00	0.0
Totals									**18.00**	**11.14**		**4.70**	**100.0**

Table 7. Groundwater Study discharge measurements at FA-104 (Whiskers Slough), location 3AUS, April 16, 2014.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Purpose: Slough Discharge
Site Name: S3AUS / Whiskers Slough
Date: 4/16/14 Time: 9:40

Location:	Slough 3A upstream location.					Crew:	Dan R, Ryan C-W
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~35°F, calm
Method:	0.6					Measurement Set:	3rd upstream section

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
9:40	0		0		0				0.25	0.00	0	0.00	0.0
9:41	0.5		0.252		0.42				0.38	0.16	0.18	0.03	4.2
11:01	0.75		0.258		0.43				0.25	0.11	0.22	0.02	3.5
9:43	1		0.3		0.5				0.25	0.13	0.2	0.03	3.7
10:22	1.25		0.3		0.5				0.19	0.10	0.29	0.03	4.1
11:08	1.38		0.294		0.49				0.13	0.06	0.26	0.02	2.3
9:45	1.5		0.324		0.54				0.13	0.07	0.29	0.02	2.9
11:06	1.63		0.294		0.49				0.13	0.06	0.28	0.02	2.5
10:24	1.75		0.318		0.53				0.19	0.10	0.31	0.03	4.5
9:47	2		0.312		0.52				0.15	0.08	0.44	0.03	5.1
11:12	2.05		0.3		0.5				0.06	0.03	0.42	0.01	2.0
10:51	2.13		0.312		0.52				0.08	0.04	0.44	0.02	2.5
11:10	2.2		0.3		0.5				0.06	0.03	0.46	0.01	2.0
10:27	2.25		0.312		0.52				0.09	0.05	0.36	0.02	2.5
10:50	2.38		0.312		0.52				0.13	0.07	0.36	0.02	3.4
9:48	2.5		0.312		0.52				0.13	0.07	0.43	0.03	4.1
10:48	2.63		0.312		0.52				0.13	0.07	0.31	0.02	3.0
10:45	2.75		0.3		0.5				0.13	0.06	0.35	0.02	3.2
10:46	2.88		0.3		0.5				0.13	0.06	0.35	0.02	3.2
9:50	3		0.33		0.55				0.13	0.07	0.46	0.03	4.7
10:43	3.13		0.33		0.55				0.13	0.07	0.36	0.02	3.6
10:30	3.25		0.312		0.52				0.13	0.07	0.53	0.03	5.1
10:41	3.38		0.3		0.5				0.13	0.06	0.53	0.03	4.9
9:53	3.5		0.312		0.52				0.13	0.07	0.52	0.03	5.0
10:39	3.63		0.348		0.58				0.13	0.07	0.39	0.03	4.2
10:32	3.75		0.36		0.6				0.12	0.07	0.35	0.03	3.7
10:37	3.87		0.366		0.61				0.13	0.08	0.31	0.02	3.5
9:54	4		0.312		0.52				0.19	0.10	0.27	0.03	3.9

Table 7. Groundwater Study discharge measurements at FA-104 (Whiskers Slough), location 3AUS, April 16, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Purpose: Slough Discharge
Site Name: S3AUS / Whiskers Slough
Date: 4/16/14 Time: 9:40

Location:	Slough 3A upstream location.					Crew:	Dan R, Ryan C-W
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~35°F, calm
Method:	0.6					Measurement Set:	3rd upstream section

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
10:34	4.25		0.312		0.52				0.25	0.13	0.14	0.02	2.7
9:57	4.5		0.27		0.45				0.38	0.17	0	0.00	0.0
9:58	5		0.354		0.59				2.75	1.62	0	0.00	0.0
0.415972	5.5		0.3		0.5				2.50	1.25	0	0.00	0.0
0.418056	6		0.306		0.51				2.25	1.15	0	0.00	0.0
0.41875	6.5		0.24		0.4				2.00	0.80	0	0.00	0.0
0.419444	7		0.228		0.38				1.75	0.67	0	0.00	0.0
0.420833	7.5		0.186		0.31				1.50	0.47	0	0.00	0.0
0.421528	8		0.15		0.25				1.25	0.31	0	0.00	0.0
0.422222	8.5		0.114		0.19				1.00	0.19	0	0.00	0.0
0.422222	9		0.03		0.05				0.75	0.04	0	0.00	0.0
0.422917	9.5		0.018		0.03				0.50	0.02	0	0.00	0.0
0.422917	10		0		0				0.25	0.00	0	0.00	0.0
Totals									**7.50**	**3.89**		**0.68**	**100**

Table 7. Groundwater Study discharge measurements at FA-104 (Whiskers Slough), location 3AUS, April 16, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: S3AUS / Whiskers Slough
Purpose: Slough Discharge
Date: 4/16/14 Time: 1120

Location:	Slough 3A upstream location.				Crew:	Dan R, Ryan C-W
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft		Weather:	Sunny, ~35°F, calm
Method:	0.6				Measurement Set:	4th upstream section

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
11:20	0.00		0.00		0		0		0.20	0.00	0	0.00	0.0
11:24	0.40		0.19		0.32		0.12		0.33	0.10	0.12	0.01	1.8
11:26	0.65		0.25		0.42		0.16		0.35	0.15	0.16	0.02	3.4
11:33	1.10		0.26		0.43		0.27		0.25	0.11	0.27	0.03	4.3
12:05	1.15		0.28		0.46		0.32		0.08	0.03	0.32	0.01	1.6
11:34	1.25		0.29		0.49		0.26		0.13	0.06	0.26	0.02	2.3
11:36	1.40		0.30		0.50		0.27		0.18	0.09	0.27	0.02	3.5
11:38	1.60		0.30		0.50		0.28		0.20	0.10	0.28	0.03	4.1
11:29	1.80		0.29		0.49		0.41		0.15	0.07	0.41	0.03	4.4
12:08	1.90		0.31		0.52		0.35		0.10	0.05	0.35	0.02	2.7
11:39	2.00		0.32		0.54		0.47		0.10	0.05	0.47	0.03	3.7
12:09	2.10		0.31		0.52		0.47		0.10	0.05	0.47	0.02	3.6
11:41	2.20		0.31		0.52		0.44		0.15	0.08	0.44	0.03	5.0
11:42	2.40		0.31		0.51		0.38		0.15	0.08	0.38	0.03	4.3
12:11	2.50		0.31		0.52		0.37		0.10	0.05	0.37	0.02	2.8
11:44	2.60		0.32		0.53		0.29		0.15	0.08	0.29	0.02	3.4
11:45	2.80		0.31		0.51		0.26		0.25	0.13	0.26	0.03	4.9
11:46	3.10		0.31		0.52		0.39		0.17	0.09	0.39	0.03	4.9
12:16	3.13		0.32		0.54		0.46		0.04	0.02	0.46	0.01	1.5
12:14	3.18		0.32		0.54		0.40		0.06	0.03	0.40	0.01	1.9
12:13	3.25		0.32		0.54		0.39		0.11	0.06	0.39	0.02	3.4
11:47	3.40		0.30		0.50		0.56		0.12	0.06	0.56	0.03	4.7
12:22	3.48		0.31		0.52		0.58		0.07	0.04	0.58	0.02	3.3
12:17	3.55		0.32		0.54		0.50		0.11	0.06	0.50	0.03	4.3
11:49	3.70		0.34		0.56		0.39		0.15	0.08	0.39	0.03	4.8
12:20	3.85		0.36		0.60		0.32		0.15	0.09	0.32	0.03	4.2
11:52	4.00		0.32		0.53		0.27		0.23	0.12	0.27	0.03	4.7
11:53	4.30		0.31		0.51		0.17		0.30	0.15	0.17	0.03	3.8

Table 7. Groundwater Study discharge measurements at FA-104 (Whiskers Slough), location 3AUS, April 16, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Purpose: Slough Discharge
Site Name: S3AUS / Whiskers Slough
Date: 4/16/14 Time: 1120

Location:	Slough 3A upstream location.					Crew:	Dan R, Ryan C-W
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~35°F, calm
Method:	0.6					Measurement Set:	4th upstream section

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
11:54	4.60		0.29		0.48		0.11		0.35	0.17	0.11	0.02	2.7
11:56	5.00		0.35		0.58		0.00		0.70	0.41	0	0.00	0.0
12:00	6.00		0.31		0.51		0.00		0.50	0.26	0	0.00	0.0
Totals									**6.00**	**2.92**		**0.68**	**100**

Table 7. Groundwater Study discharge measurements at FA-104 (Whiskers Slough), location 3AUS, April 16, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: S3AUS / FA-104 (Whiskers Slough)
Purpose: Slough Discharge
Date: 4/16/14 Time: 12:30

Location:	Slough 3A upstream.					Crew:	DanR, RyanC-W
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~45°F, calm
Method:	0.6					Measurement Set:	6th section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
12:30	0.00		0.00		0.00		0.00		0.25	0.00	0	0.00	0.0
12:32	0.50		0.21		0.35		0.00		0.35	0.12	0	0.00	0.0
12:33	0.70		0.26		0.44		0.13		0.20	0.09	0.13	0.01	1.7
12:35	0.90		0.26		0.43		0.20		0.20	0.09	0.2	0.02	2.5
12:37	1.10		0.30		0.50		0.26		0.20	0.10	0.26	0.03	3.8
12:38	1.30		0.31		0.51		0.28		0.20	0.10	0.28	0.03	4.2
12:40	1.50		0.32		0.53		0.29		0.20	0.11	0.29	0.03	4.5
12:44	1.70		0.30		0.50		0.32		0.20	0.10	0.32	0.03	4.7
12:46	1.90		0.31		0.52		0.34		0.15	0.08	0.34	0.03	3.9
13:22	2.00		0.32		0.53		0.45		0.10	0.05	0.45	0.02	3.5
12:47	2.10		0.31		0.51		0.47		0.10	0.05	0.47	0.02	3.5
13:24	2.20		0.31		0.52		0.44		0.10	0.05	0.44	0.02	3.3
12:49	2.30		0.30		0.50		0.44		0.15	0.08	0.44	0.03	4.8
12:50	2.50		0.31		0.52		0.38		0.15	0.08	0.38	0.03	4.3
13:27	2.60		0.31		0.52		0.34		0.10	0.05	0.34	0.02	2.6
12:52	2.70		0.32		0.53		0.36		0.15	0.08	0.36	0.03	4.2
12:54	2.90		0.35		0.58		0.34		0.15	0.09	0.34	0.03	4.3
13:28	3.00		0.32		0.54		0.42		0.10	0.05	0.42	0.02	3.3
12:56	3.10		0.33		0.55		0.40		0.15	0.08	0.4	0.03	4.8
12:57	3.30		0.31		0.52		0.50		0.13	0.07	0.5	0.03	4.7
13:35	3.35		0.31		0.52		0.51		0.05	0.03	0.51	0.01	1.9
13:34	3.40		0.31		0.52		0.34		0.05	0.03	0.34	0.01	1.3
13:31	3.45		0.31		0.52		0.54		0.05	0.03	0.54	0.01	2.0
12:58	3.50		0.31		0.52		0.47		0.13	0.07	0.47	0.03	4.4
13:00	3.70		0.36		0.60		0.39		0.20	0.12	0.39	0.05	6.8
13:02	3.90		0.37		0.62		0.32		0.20	0.12	0.32	0.04	5.8
13:03	4.10		0.33		0.55		0.28		0.20	0.11	0.28	0.03	4.5
13:05	4.30		0.31		0.52		0.19		0.20	0.10	0.19	0.02	2.9

Table 7. Groundwater Study discharge measurements at FA-104 (Whiskers Slough), location 3AUS, April 16, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: S3AUS / FA-104 (Whiskers Slough)
Purpose: Slough Discharge
Date: 4/16/14 Time: 12:30

Location:	Slough 3A upstream.					Crew:	DanR, RyanC-W
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny, ~45°F, calm
Method:	0.6					Measurement Set:	6th section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft²	Average velocity, ft/s	Discharge, ft³/s	Percent of total flow
13:06	4.50		0.31		0.52		0.14		0.20	0.10	0.14	0.01	2.1
13:08	4.70		0.28		0.47		0.00		0.25	0.12	0	0.00	0.0
13:09	5.00		0.35		0.58		0.00		0.40	0.23	0	0.00	0.0
13:10	5.50		0.30		0.50		0.00		0.75	0.38	0	0.00	0.0
13:11	6.50		0.24		0.40		0.00		1.25	0.50	0	0.00	0.0
13:13	8.00		0.12		0.20		0.00		1.50	0.30	0	0.00	0.0
13:14	9.50		0.12		0.20		0.00		1.00	0.20	0	0.00	0.0
13:14	10.00		0.00		0.00		0.00		0.25	0.00	0	0.00	0.0
Totals									**10.00**	**3.94**		**0.69**	**100.0**

Table 8. Groundwater Study discharge measurements at FA-104 (Whiskers Slough) at station ESGFA104-9, location WSX, April 26, 2014.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: ESGFA104-9 WSX / FA-104 (Whiskers Slough)
Purpose: Slough Discharge
Date: 4/26/14 Time: 13:08

Location:	ESGFA104-9 appx 50ft upstream of pressure transducer at PIT Tag arra					Crew:	JamesS, CariR
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny ~55°F
Method:	0.6					Measurement Set:	1st section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
13:08	0.00		0.00		0.00		0.00		1.00	0.00	0	0.00	0.0
13:13	2.00		0.43		0.72		0.40		2.00	1.44	0.4	0.58	1.8
13:16	4.00		0.54		0.90		0.41		2.00	1.80	0.41	0.74	2.3
13:18	6.00		0.60		1.00		0.68		2.00	2.00	0.68	1.36	4.3
13:21	8.00		0.63		1.05		0.61		2.00	2.10	0.61	1.28	4.0
13:23	10.00		0.75		1.25		0.59		2.00	2.50	0.59	1.48	4.6
13:25	12.00		0.75		1.25		0.86		1.50	1.88	0.86	1.61	5.1
13:26	13.00		0.72		1.20		0.76		1.00	1.20	0.76	0.91	2.9
13:28	14.00		0.72		1.20		0.72		1.00	1.20	0.72	0.86	2.7
13:30	15.00		0.75		1.25		0.72		1.00	1.25	0.72	0.90	2.8
13:31	16.00		0.78		1.30		0.67		1.00	1.30	0.67	0.87	2.7
13:36	17.00		0.78		1.30		0.64		1.00	1.30	0.64	0.83	2.6
13:38	18.00		0.72		1.20		0.38		1.00	1.20	0.38	0.46	1.4
13:40	19.00		0.72		1.20		0.70		1.00	1.20	0.7	0.84	2.6
13:41	20.00		0.72		1.20		0.68		1.00	1.20	0.68	0.82	2.6
13:43	21.00		0.75		1.25		0.70		1.00	1.25	0.7	0.88	2.8
13:44	22.00		0.81		1.35		0.74		1.00	1.35	0.74	1.00	3.1
13:47	23.00		0.81		1.35		0.68		1.00	1.35	0.68	0.92	2.9
13:49	24.00		0.84		1.40		0.34		1.00	1.40	0.34	0.48	1.5
13:50	25.00		0.87		1.45		0.70		1.00	1.45	0.7	1.02	3.2
13:52	26.00		0.84		1.40		0.54		1.00	1.40	0.54	0.76	2.4
13:54	27.00		0.90		1.50		0.60		1.00	1.50	0.6	0.90	2.8
13:55	28.00		0.84		1.40		0.49		1.00	1.40	0.49	0.69	2.2
13:57	29.00		0.78		1.30		0.74		1.00	1.30	0.74	0.96	3.0
13:58	30.00		0.78		1.30		0.54		1.00	1.30	0.54	0.70	2.2
13:59	31.00		0.69		1.15		0.59		1.00	1.15	0.59	0.68	2.1
14:01	32.00		0.72		1.20		0.69		1.00	1.20	0.69	0.83	2.6
14:02	33.00		0.78		1.30		0.66		1.00	1.30	0.66	0.86	2.7
14:03	34.00		0.75		1.25		0.68		1.00	1.25	0.68	0.85	2.7

Table 8. Groundwater Study discharge measurements at FA-104 (Whiskers Slough) at station ESGFA104-9, location WSX, April 26, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: ESGFA104-9 WSX / FA-104 (Whiskers Slough)
Purpose: Slough Discharge
Date: 4/26/14 Time: 13:08

Location:	ESGFA104-9 appx 50ft upstream of pressure transducer at PIT Tag arra					Crew:	JamesS, CariR
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny ~55°F
Method:	0.6					Measurement Set:	1st section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
14:04	35.00		0.78		1.30		0.49		1.00	1.30	0.49	0.64	2.0
14:06	36.00		0.00	13:03			0.56		1.00	0.00	0.56	0.00	0.0
14:07	37.00		0.78		1.30		0.62		1.00	1.30	0.62	0.81	2.5
14:10	38.00		0.75		1.25		0.58		1.50	1.88	0.58	1.09	3.4
14:12	40.00		0.78		1.30		0.49		2.00	2.60	0.49	1.27	4.0
14:14	42.00		0.66		1.10		0.35		2.00	2.20	0.35	0.77	2.4
14:16	44.00		0.66		1.10		0.48		2.00	2.20	0.48	1.06	3.3
14:17	46.00		0.66		1.10		0.46		2.00	2.20	0.46	1.01	3.2
14:18	48.00		0.00		0.00		0.00		2.00	0.00	0	0.00	0.0
14:22	50.00		0.36		0.60		0.09		2.00	1.20	0.09	0.11	0.3
14:22	52.00		0.00		0.00		0.00		1.00	0.00	0	0.00	0.0
Totals									**52.00**	**55.04**		**31.79**	**100.0**

Table 8. Groundwater Study discharge measurements at FA-104 (Whiskers Slough) at station ESGFA104-9, location WSX, April 26, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Site Name: ESGFA104-9 WSX / FA-104 (Whiskers Slough)
Purpose: Slough Discharge
Date: 4/26/14 Time: 13:03

Location:	ESGFA104-9 appx 50ft upstream of pressure transducer at PIT Tag arra					Crew:	JamesS, CariR
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny ~55°F
Method:	0.6					Measurement Set:	2nd section measurement

Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
13:03	0.00		0.00		0.00		0.00		1.00	0.00	0	0.00	0.0
13:05	2.00		0.43		0.72		0.41		2.00	1.44	0.41	0.59	1.7
13:09	4.00		0.54		0.90		0.27		2.00	1.80	0.27	0.49	1.4
13:10	6.00		0.60		1.00		0.63		2.00	2.00	0.63	1.26	3.7
13:14	8.00		0.72		1.20		0.65		2.00	2.40	0.65	1.56	4.6
13:16	10.00		0.75		1.25		0.54		2.00	2.50	0.54	1.35	4.0
13:17	12.00		0.75		1.25		0.65		2.00	2.50	0.65	1.63	4.8
13:19	14.00		0.78		1.30		0.74		1.50	1.95	0.74	1.44	4.3
13:20	15.00		0.78		1.30		0.72		1.00	1.30	0.72	0.94	2.8
13:22	16.00		0.78		1.30		0.74		1.00	1.30	0.74	0.96	2.8
13:24	17.00		0.75		1.25		0.58		1.00	1.25	0.58	0.73	2.1
13:25	18.00		0.72		1.20		0.43		1.00	1.20	0.43	0.52	1.5
13:26	19.00		0.69		1.15		0.75		1.00	1.15	0.75	0.86	2.6
13:28	20.00		0.72		1.20		0.74		1.00	1.20	0.74	0.89	2.6
13:29	21.00		0.78		1.30		0.76		1.50	1.95	0.76	1.48	4.4
13:31	23.00		0.78		1.30		0.79		1.50	1.95	0.79	1.54	4.6
13:32	24.00		0.79		1.32		0.47		1.00	1.32	0.47	0.62	1.8
13:35	25.00		0.84		1.40		0.46		1.00	1.40	0.46	0.64	1.9
13:36	26.00		0.84		1.40		0.53		1.00	1.40	0.53	0.74	2.2
13:38	27.00		0.90		1.50		0.68		1.00	1.50	0.68	1.02	3.0
13:39	28.00		0.84		1.40		0.62		1.00	1.40	0.62	0.87	2.6
13:41	29.00		0.84		1.40		0.60		1.00	1.40	0.6	0.84	2.5
13:42	30.00		0.84		1.40		0.56		1.50	2.10	0.56	1.18	3.5
13:44	32.00		0.78		1.30		0.69		2.00	2.60	0.69	1.79	5.3
13:45	34.00		0.78		1.30		0.55		2.00	2.60	0.55	1.43	4.2
13:46	36.00		0.84		1.40		0.57		2.00	2.80	0.57	1.60	4.7
13:48	38.00		0.78		1.30		0.70		1.50	1.95	0.7	1.37	4.0
13:49	39.00		0.78		1.30		0.63		1.00	1.30	0.63	0.82	2.4
13:50	40.00		0.78		1.30		0.36		1.50	1.95	0.36	0.70	2.1

Table 8. Groundwater Study discharge measurements at FA-104 (Whiskers Slough) at station ESGFA104-9, location WSX, April 26, 2014, continued.

Susitna-Watana Hydroelectric Project: Groundwater Study

Water Discharge Form

Project ID: GW Task 7 Winter Studies
Purpose: Slough Discharge
Site Name: ESGFA104-9 WSX / FA-104 (Whiskers Slough)
Date: 4/26/14 Time: 13:03

Location:	ESGFA104-9 appx 50ft upstream of pressure transducer at PIT Tag arra					Crew:	JamesS, CariR
Meter:	Pygmy w/ AquaCalc Pro+	Rod Type:	TopSet Rod 6ft			Weather:	Sunny ~55°F
Method:	0.6					Measurement Set:	2nd section measurement

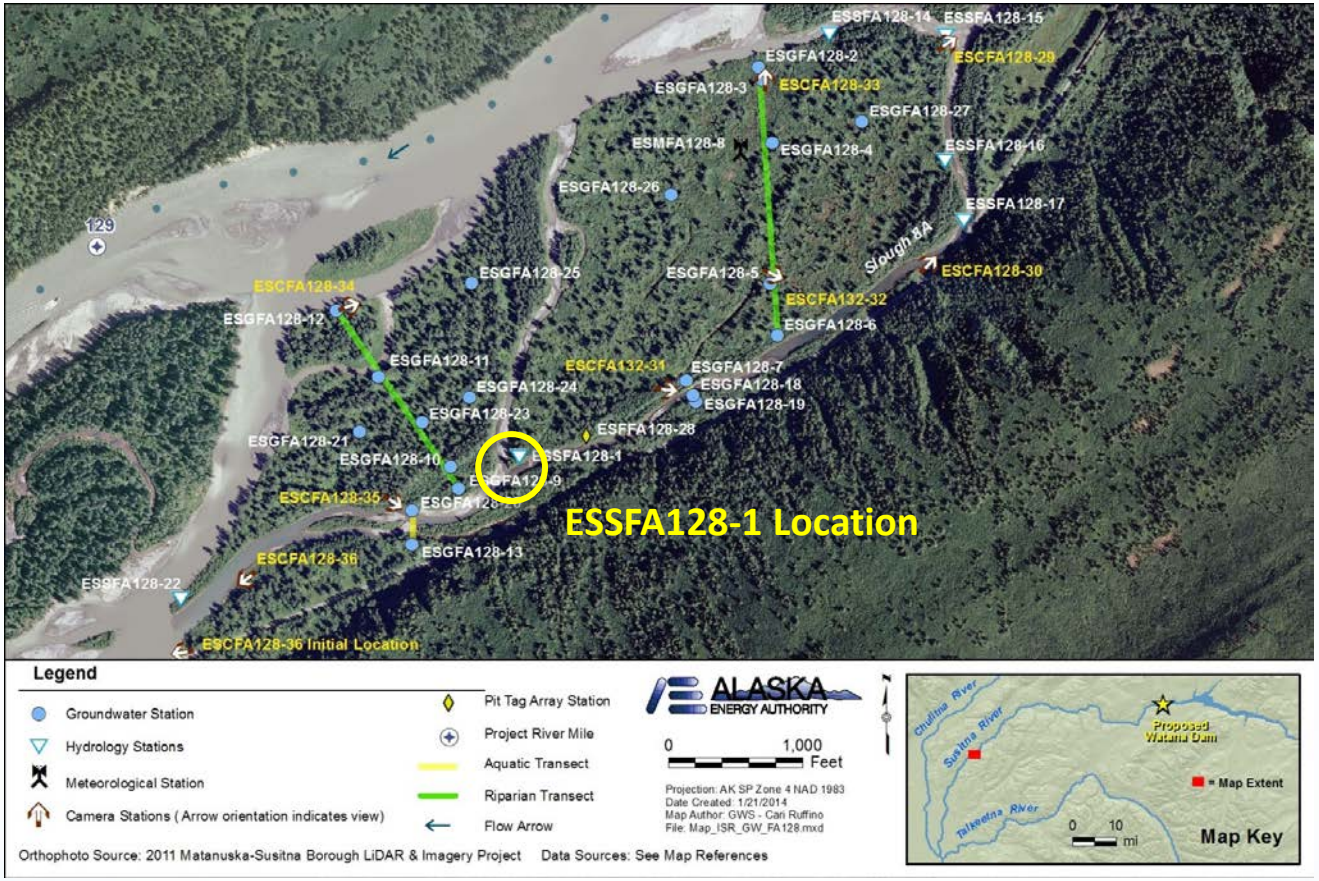
Time	Station/ Vertical	Depth from water surface to:			Effective Depth (D)	Velocity in ft/s at:			Partial vertical section computations				
		0.2D	0.6D	0.8D		0.2D	0.6D	0.8D	Width, ft	Area, ft^2	Average velocity, ft/s	Discharge, ft^3/s	Percent of total flow
13:51	42.00		0.78		1.30		0.26		2.00	2.60	0.26	0.68	2.0
13:53	44.00		0.69		1.15		0.43		2.00	2.30	0.43	0.99	2.9
13:54	46.00		0.66		1.10		0.45		2.00	2.20	0.45	0.99	2.9
13:55	48.00		0.67		1.12		0.32		2.00	2.24	0.32	0.72	2.1
13:58	50.00		0.43		0.72		0.11		7.00	5.04	0.11	0.55	1.6
13:59	62.00		0.66		1.10		0.00		6.00	6.60	0	0.00	0.0
Totals									**62.00**	**70.59**		**33.77**	**100.0**

APPENDIX C. 2014 GROUNDWATER STUDY RESPONSE ANALYSIS TIME-LAPSE IMAGE DATA AT SITE ESSFA128-1

The following set of images shows a time sequence of images from station ESSFA128-1, located in FA-128 (Slough 8A) on the lower portion of Slough 8, at the junction of Slough 8A and Middle Side Channel 8A. The station condition is influenced by backwater effects from the side channel under certain flow conditions.

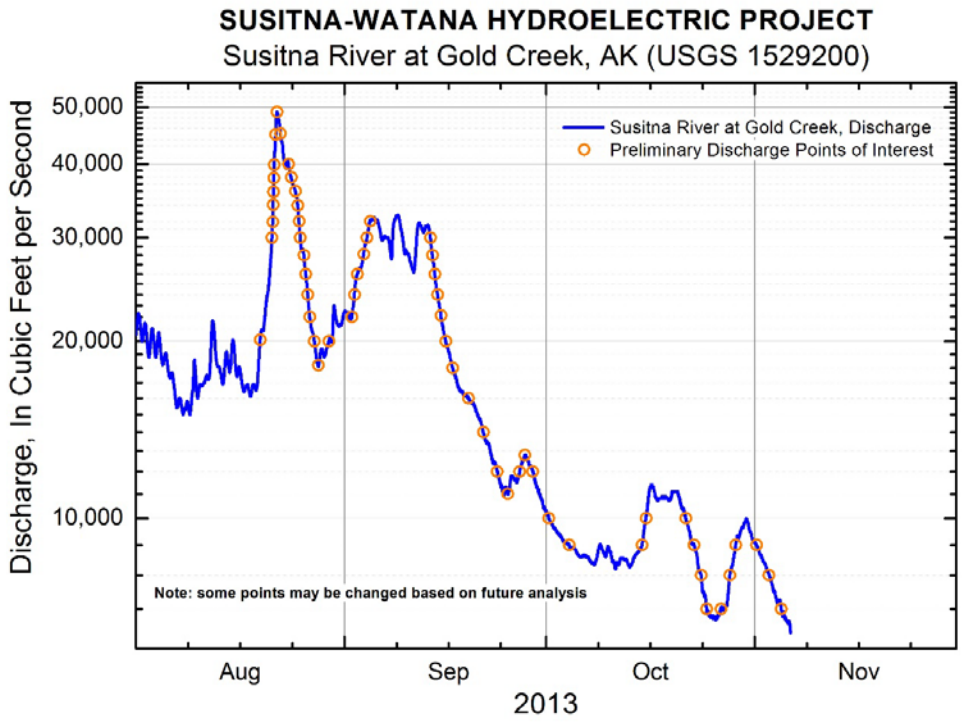
The image data series shows the surface-water conditions at each point of analysis being considered for evaluation of response functions.

The date and time in the headers of all images are in Alaska Standard Time (AST). Additional images may be available for other flow conditions.



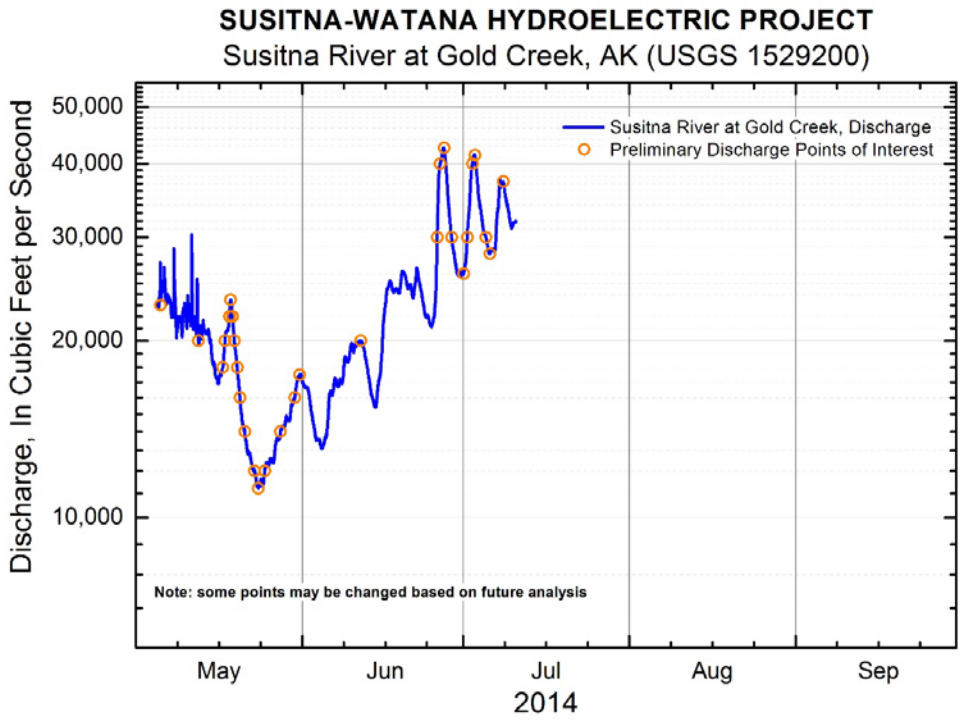
The following set of graphs and images show conditions on Slough 8A at the ESSFA128-1.

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



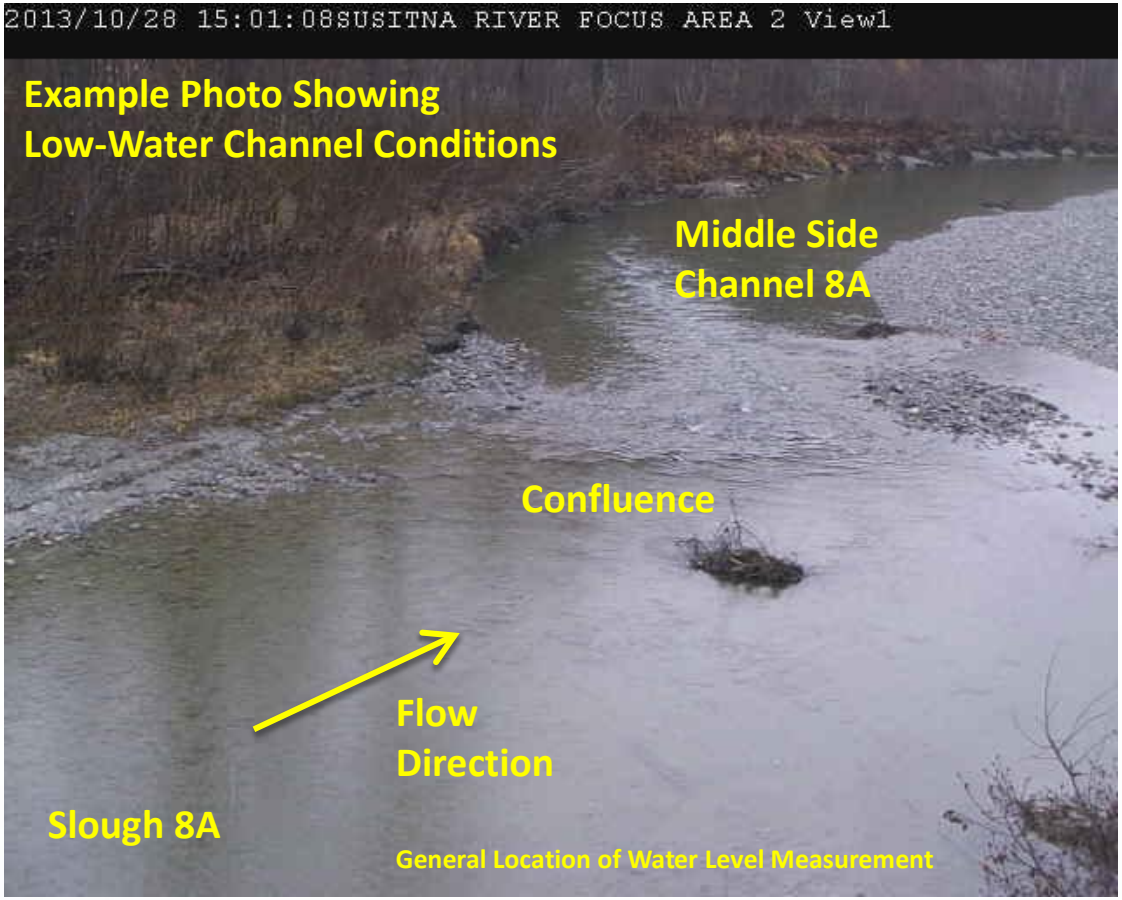
The following set of images show conditions on Slough 8A at the preliminary discharge points of interest for 2013.

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



The following set of images show conditions on Slough 8A at the preliminary discharge points of interest for 2014 (as of 20140716.

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



Susitna River at Gold Creek – Q = **8,070** CFS (**Rising**), Stage = 7.24 ft. @ 08:00 AST
ESSFA128-1 (Slough 8A) – Stage = 571.12 ft., Temperature = 3.3°C

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Susitna River at Gold Creek – Q = **20,200** CFS (**Rising**), Stage = 9.95 ft. @ 11:15 AST
ESSFA128-1 (Slough 8A) – Stage = 571.35 ft., Temperature = 7.8°C

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Susitna River at Gold Creek – Q = **30,600** CFS (**Rising**), Stage = 11.46 ft. @ 05:45 AST
ESSFA128-1 (Slough 8A) – Stage = 572.87 ft., Temperature = 7.9°C

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Susitna River at Gold Creek – Q = **41,400** CFS (**Rising**), Stage = 12.71 ft.@ 13:30 AST
ESSFA128-1 (Slough 8A) – Stage = 574.24 ft., Temperature = 8.3°C

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Susitna River at Gold Creek – Q = **49,000** CFS (**Peak**), Stage = 13.46 ft.@ 00:00 AST
ESSFA128-1 (Slough 8A) – Stage = 575.98 ft., Temperature = 8.5°C

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Susitna River at Gold Creek – Q = **39,600** CFS (**Falling**), Stage = 12.52 ft.@ 17:00 AST
ESSFA128-1 (Slough 8A) – Stage = 574.39 ft., Temperature = 9.2°C

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Susitna River at Gold Creek – Q = **29,400** CFS (**Falling**), Stage = 11.31 ft.@ 11:00 AST
ESSFA128-1 (Slough 8A) – Stage = 573.05 ft., Temperature = 6.1°C

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Susitna River at Gold Creek – Q = **21,800** CFS (**Falling**), Stage = 10.21 ft.@ 20:45 AST
ESSFA128-1 (Slough 8A) – Stage = 571.90 ft., Temperature = 7.0°C

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Susitna River at Gold Creek – Q = **24,400** CFS (**Rising**), Stage = 10.61 ft.@ 12:30 AST
ESSFA128-1 (Slough 8A) – Stage = 572.23 ft., Temperature = 6.5°C

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Susitna River at Gold Creek – Q = **30,000** CFS (**Rising**), Stage = 11.39 ft.@ 09:00 AST
ESSFA128-1 (Slough 8A) – Stage = 573.05 ft., Temperature = 6.2°C

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

Susitna River at Gold Creek – Q = **32,000** CFS (**Peak**), Stage = 11.64 ft.@ 21:00 AST
ESSFA128-1 (Slough 8A) – Stage = 573.46 ft., Temperature = 6.5°C

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

Susitna River at Gold Creek – Q = **29,700** CFS (**Falling**), Stage = 11.35 ft.@ 19:15 AST
ESSFA128-1 (Slough 8A) – Stage = 573.16 ft., Temperature = 6.4°C

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Susitna River at Gold Creek – Q = **21,900** CFS (**Falling**), Stage = 10.22 ft.@ 09:15 AST
ESSFA128-1 (Slough 8A) – Stage = 572.04 ft., Temperature = 4.6°C

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Susitna River at Gold Creek – Q = **18,000** CFS (**Falling**), Stage = 9.55 ft.@ 03:00 AST
ESSFA128-1 (Slough 8A) – Stage = 571.32 ft., Temperature = 5.1°C

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Susitna River at Gold Creek – Q = **16,000** CFS (**Falling**), Stage = 9.17 ft.@ 11:00 AST
ESSFA128-1 (Slough 8A) – Stage = 571.11 ft., Temperature = 4.4°C

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Susitna River at Gold Creek – Q = **13,900** CFS (**Falling**), Stage = 8.75 ft.@ 16:00 AST
ESSFA128-1 (Slough 8A) – Stage = 571.07 ft., Temperature = 4.4°C

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Susitna River at Gold Creek – Q = **12,000** CFS (**Falling**), Stage = 8.31 ft.@ 17:30 AST
ESSFA128-1 (Slough 8A) – Stage = 571.05 ft., Temperature = 4.9°C

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Susitna River at Gold Creek – Q = **8,960** CFS (**Falling**), Stage = 7.51 ft.@ 10:45 AST
ESSFA128-1 (Slough 8A) – Stage = 571.19 ft., Temperature = 3.7°C

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Susitna River at Gold Creek – Q = **7,030** CFS (**Rising**), Stage = 6.90 ft.@ 00:00 AST
ESSFA128-1 (Slough 8A) – Stage = 571.05 ft., Temperature = 3.0°C

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