# Environmental Studies of Ambler Transportation Corridor, Alaska

**Final Report**


**D.L. Kane, E.K. Youcha, S.L. Stuefer, H. Toniolo, J.W. Homan, W.E. Schnabel, R.E. Gieck, E. Lamb, T. Tschetter, G. Myerchin-Tape**



**Prepared for the**
**Alaska Industrial Development and Export Authority**

**Water and Environmental Research Center**
**University of Alaska Fairbanks**
**Fairbanks, AK 99775**

**Report INE/WERC 15.14**
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## Front cover photo:

The continental divide of the Brooks Range, viewed from the south side.

## Recommended citation:

Kane, D.L., Youcha, E.K., Stuefer, S.L., Toniolo, H., Homan, J.W., Schnabel, W.E., Gieck, R.E., Lamb, E., Tschetter, T., and Myerchin-Tape, G. (2015). Environmental Studies of Ambler Transportation Corridor, Alaska. Final Report. University of Alaska Fairbanks, Water and Environmental Research Center, INE/WERC 15.14, Fairbanks, AK.

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## ABSTRACT

This research project was conceived originally as at least a 5-year project to collect and analyze environmental data along a proposed transportation corridor. Because of budget cuts to the state of Alaska, the project was terminated in the third year; therefore, this report does not address all of the objectives outlined in the original proposal. Much of the analysis was scheduled during the last year, when most of the data collection was completed. This report contains roughly 2 years of data collected at the eight hydrological/meteorological stations installed by the University of Alaska Fairbanks (UAF), Water and Environmental Research Center. The study encompassed the area from the Dalton Highway in the east to the village of Kobuk in the west to the continental divide of the Brooks Range in the north to latitude of 66.5°N in the south. Four of the station installations were on rivers near the southern border, where both stream and atmospheric measurements could be made. Four meteorological stations were installed at the headwaters of the Koyukuk, Alatna, Reed, and Kogoluktuk Rivers to quantify the impact of elevation on hydrological and meteorological processes. The headwaters of these south-draining streams receive more precipitation, which results in greater specific discharge generated from this area. During our period of observation, greater precipitation was observed in the western end of the study area. Floods, both snowmelt- and rainfall-generated, are common in this area.

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## ACKNOWLEDGMENTS AND DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the accuracy of the data and results presented herein. A majority of the data presented in this project was funded by grants from the Alaska Industrial Development and Export Authority (AIDEA) and the Alaska Department of Transportation and Public Facilities (ADOT&PF). Historical data collected on other research projects, such as by the U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service (USF&WS), National Park Service (NPS), National Weather Service (NWS), National Resource Conservation Service (NRCS), and other governmental agencies, were used as supporting data in this report for comparison/analyses purposes. We appreciate the U.S. Fish and Wildlife Service sharing their runoff data from the Koyukuk River near Bettles. We thank UAF staff, students, and faculty (Ken Irving, Robert Busey, Jordi Cristobal, Nathan Stephan, Everet Megli, John Keech, and Perrine Freydier) for their field data collection efforts during the project. The use of trade and firm names in this document is for the purpose of identification only and does not imply endorsement by UAF or any funding agency.

# CONVERSION FACTORS, UNITS, WATER QUALITY UNITS, VERTICAL AND HORIZONTAL DATUM, ABBREVIATIONS, AND SYMBOLS

## Conversion Factors

| Multiply | By | To obtain |
|---|---|---|
| | | |
| | Length | |
| inch (in.) | 25.4 | millimeter (mm) |
| inch (in.) | 2.54 | centimeter (cm) |
| foot (ft) | 0.3048 | meter (m) |
| mile (mi) | 1.609 | kilometer (km) |
| | | |
| | Area | |
| acre | 43560.0 | square feet ($ft^2$) |
| acre | 0.405 | hectare (ha) |
| square foot ($ft^2$) | 3.587e-8 | square mile ($mi^2$) |
| square mile ($mi^2$) | 2.590 | square kilometer ($km^2$) |
| | | |
| | Volume | |
| gallon (gal) | 3.785 | liter (L) |
| gallon (gal) | 3785.412 | milliliter (mL) |
| cubic foot ($ft^3$) | 28.317 | liter (L) |
| acre-ft | 1233.482 | cubic meter ($m^3$) |
| acre-ft | 325851.43 | gallon(gal) |
| gallon(gal) | 0.1337 | cubic feet ($ft^3$) |
| | | |
| | Velocity and Discharge | |
| foot per day (ft/d) | 0.3048 | meter per day (m/d) |
| square foot per day ($ft^2$/d ) | 0.0929 | square meter per day ($m^2$/d) |
| cubic foot per second ($ft^3$/s) | 0.02832 | cubic meter per second ($m^3$/sec) |
| | Water Density | |
| kilograms per cubic meter (kg/$m^3$) | 1/1000 | grams per cubic centimeter (g/$cm^3$) |
| grams per cubic centimeter (g/$cm^3$) | 1.94 | slugs per cubic foot (slugs/$ft^3$ |

## Units

In this report, both metric (SI) and English units were employed. The choice of "primary" units employed depended on common reporting standards for a particular property or parameter measured. The approximate value in the "secondary" units may also be provided in parentheses.

Thus, for instance, runoff was reported in cubic meters per second ($m^3/s$) followed by the cubic feet per second ($ft^3/s$) value in parentheses.

**Physical and Chemical Water-Quality Units:**

<u>Temperature:</u>

Water and air temperatures are given in degrees Celsius (°C) and in degrees Fahrenheit (°F). Degrees Celsius can be converted to degrees Fahrenheit by use of the following equation:

$$°F = 1.8(°C) + 32$$

<u>Milligrams per liter (mg/L) or micrograms per liter (µg/L)</u>:

Milligrams per liter is a unit of measurement indicating the concentration of chemical constituents in solution as weight (milligrams) of solute per unit volume (liter) of water. One thousand micrograms per liter is equivalent to one milligram per liter. For concentrations less than 7000 mg/L, the numerical value is the same as for concentrations in parts per million (ppm).

<u>Horizontal Datum</u>:

The horizontal datum for all locations in this report is the World Geodetic System of 1984 (WGS84).

<u>Vertical Datum</u>:

"Sea level" in the following report refers to either the WGS84 datum (for approximate elevations of station locations) or the NAD83 datum (ellipsoid height) for water level elevations (orthometric height in GEOID09AK is also available). Water level elevations for some rivers may also have arbitrary datums.

## ABBREVIATIONS, ACRONYMS, AND SYMBOLS

| | |
|---|---|
| ADCP | acoustic Doppler current profiler |
| ADOT&PF | Alaska Department of Transportation and Public Facilities |
| bgs | below ground surface |
| C | Celsius (°C) |
| cm | centimeter |
| d | day |
| F | Fahrenheit (°F) |
| ft | feet |
| GPS | Global Positioning System |
| HEC | Hydrologic Engineering Center |
| in. | inch |
| km | kilometers |
| m | meter |
| mg/L | milligrams per liter, equivalent to ppm |
| mi | mile |
| mm | millimeter |
| NCDC | National Climatic Data Center |
| NPS | National Park Service |
| NRCS | Natural Resources Conservation Service |
| NTU | nephelometric turbidity units |
| NWS | National Weather Service |
| QA/QC | quality assurance/quality control |
| RTK | real-time kinematic |
| s | second |
| SBAS | satellite based augmentation system |
| SSC | suspended sediment concentration |
| SWE | snow water equivalent |
| TDR | time domain reflectometry |
| TSS | total suspended solids |
| UAF | University of Alaska Fairbanks |
| USDA | U.S. Department of Agriculture |
| USFWS | U.S. Fish and Wildlife Service |
| USGS | U.S. Geological Survey |
| WAAS | Wide Area Augmentation System |
| WERC | Water and Environmental Research Center |

# 1 INTRODUCTION

The area of Central Alaska located on the south side of the Brooks Range and sandwiched between the continental divide in the Brooks Range and the Arctic Circle is a sparsely populated region, with a continental climate of moderately warm summers and cold winters. The Gates of the Arctic National Park and Preserve is centrally located in the Brooks Range and constitutes most of the mountains in the Brooks Range south of the continental divide from 149°W to 157°W longitude. The headwater streams between these two longitudes generally flow south out of the mountains and then veer to the west, eventually emptying into either the Bering Sea (Koyukuk River and tributaries via the Yukon River) or the Chukchi Sea (Kobuk River and tributaries). The major rivers draining this area are the Koyukuk, Alatna (enters the Koyukuk River downstream of Bettles near the village of Allakaket), Kobuk, Reed, Mauneluk, and Kogoluktuk, with the Koyukuk being larger than all the other rivers combined. The Koyukuk River is composed of several medium-sized rivers entering above or just below the village of Bettles: John, Malemute Fork John, Wild, North Fork of Koyukuk, Middle Fork of Koyukuk, and Dietrich. The terrain in this region varies from the mountains of the Brooks Range in the north to mixed rolling hills and low-lying wetlands underlain by permafrost in the south.

Presently, surface access to this area of the state is limited. Although the need for transportation routes for both people and supplies was recognized in the early 1900s (Brown, 2007), little has changed in the last 100 years. The Dalton Highway (from the Elliott Highway near Livengood to Deadhorse near the Arctic Ocean) on the region's eastern boundary is the only surface transportation connection with other main highways to the south.

Also limited in this area is long-term hydrological and meteorological data between the villages of Bettles and Kobuk. Starting with the era of gold prospecting around 1900, mineral exploration has been undertaken, especially in the western part of the study area east of the village of Ambler and south of the Gates of the Arctic National Park and Preserve. Various routes connecting the Ambler area to major shipping points have been proposed over the past few decades, including a couple of options to the west coast roughly paralleling the Kobuk River, a route to the south in the general direction of the village of Tanana on the Yukon River, and alternative routes from the Dalton Highway west to the Ambler area (with one route passing through the southern reaches of the Gates of the Arctic National Park and Preserve).

The proposed transportation corridor with the highest ranking at present extends from the Dalton Highway to the vicinity of the Ambler mining area, crossing from east to west outside the southern boundary of the Brooks Range. As presently proposed, part of the corridor could pass through the southwest corner of Gates of the Arctic National Park and Preserve. One of the stipulations in the Alaska National Interest Lands Conservation Act of 1980 (ANILCA) is that a transportation corridor can be constructed from the Dalton Highway to the mining area around the village of Kobuk, passing through the southwest corner of the preserve.

Like many other areas in Alaska, expansion of the road transportation system is limited by the lack of hydrological and meteorological data needed for Environmental Impact Statements (EIS) and preliminary and final designs. This study was initiated to provide some of that data. With a study duration of less than 5 years (the original length of the proposed study), answers to all of the questions will not be possible. For example, it is not possible statistically to take 5 or fewer years of streamflow data and predict a 100-year flood event. However, through data collection and some modeling, estimates in which we have confidence should be possible. Prior to UAF's involvement in this study, a decision was made that a route running east to west just south of the Brooks Range would be given the highest priority. Thus, we selected four streams to gauge and to install meteorological stations. As most runoff is generated from higher and steeper terrain, we installed an additional four meteorological stations at the headwaters of the studied river basins.

Presented in this interim report are hydrological and meteorological results from approximately 2½ years of data collection, June/July 2012 through September 2014. All hydrometeorological data collected and station photos are contained in DVDs at the end of this report. As indicated earlier, we originally had proposed to collect field data for 5 years (2012 to 2017).

## 2 STUDY AREA

The area of interest in this study ranges from the continental divide in the north to the Arctic Circle in the south and from the Dalton Highway in the east to the Ambler River catchment in the west (Figure 1 and Table 1). The Koyukuk River basin and its tributaries constitute a majority of the area contributing to the drainage upstream of the proposed Ambler transportation corridor; even the Alatna River to the west of the Koyukuk basin eventually drains into the Koyukuk River near the villages of Allakaket/Alatna downstream. The Koyukuk River drains into the Yukon River at the village of Koyukuk, before continuing on to the Bering Sea by way of the Yukon River. All of the rivers west of the Alatna River drain into the Kobuk River, which empties downstream into Kotzebue Sound (Chukchi Sea).

Table 2 shows some of the physical characteristics of the five catchments that were gauged: basin area ($km^2$), major aspect, minimum and maximum elevation (m), mean elevation (m), basin area in percent above 500 m (%), stream length (km), basin length (km), drainage density ($km/km^2$), and percentage of forest, shrub and barren (%). Elevations along the transportation corridor range from 100 to 400 m, with a decreasing trend to the west. The highest elevation in the headwaters of all streams in the study area is Mount Igikpak at 2600 m (8570 ft). Peak mountain elevations range from 1000 to 2500 m (3280 to 8200 ft).

The area is generally forested south of the Brooks Range and in the mountain valleys, ranging from 10 to 25% upstream of the transportation corridor. Treeless wetlands occupy some of the lowlands where the rivers leave the mountains. Most of the area is dominated with shrub vegetation, 50 to 75%. From 10 to 25% of the studied river basins are barren (mostly in the mountains).

All of the major rivers in this area mostly drain south, but some drift towards the east or west slightly. Except for South Fork Bedrock Creek (mean elevation of 452 m), both the range and mean of the elevation of the four larger watersheds studied (Koyukuk, Alatna, Reed, and Kobuk) are similar. This is shown more clearly in the hypsometry curves (Figure 3).

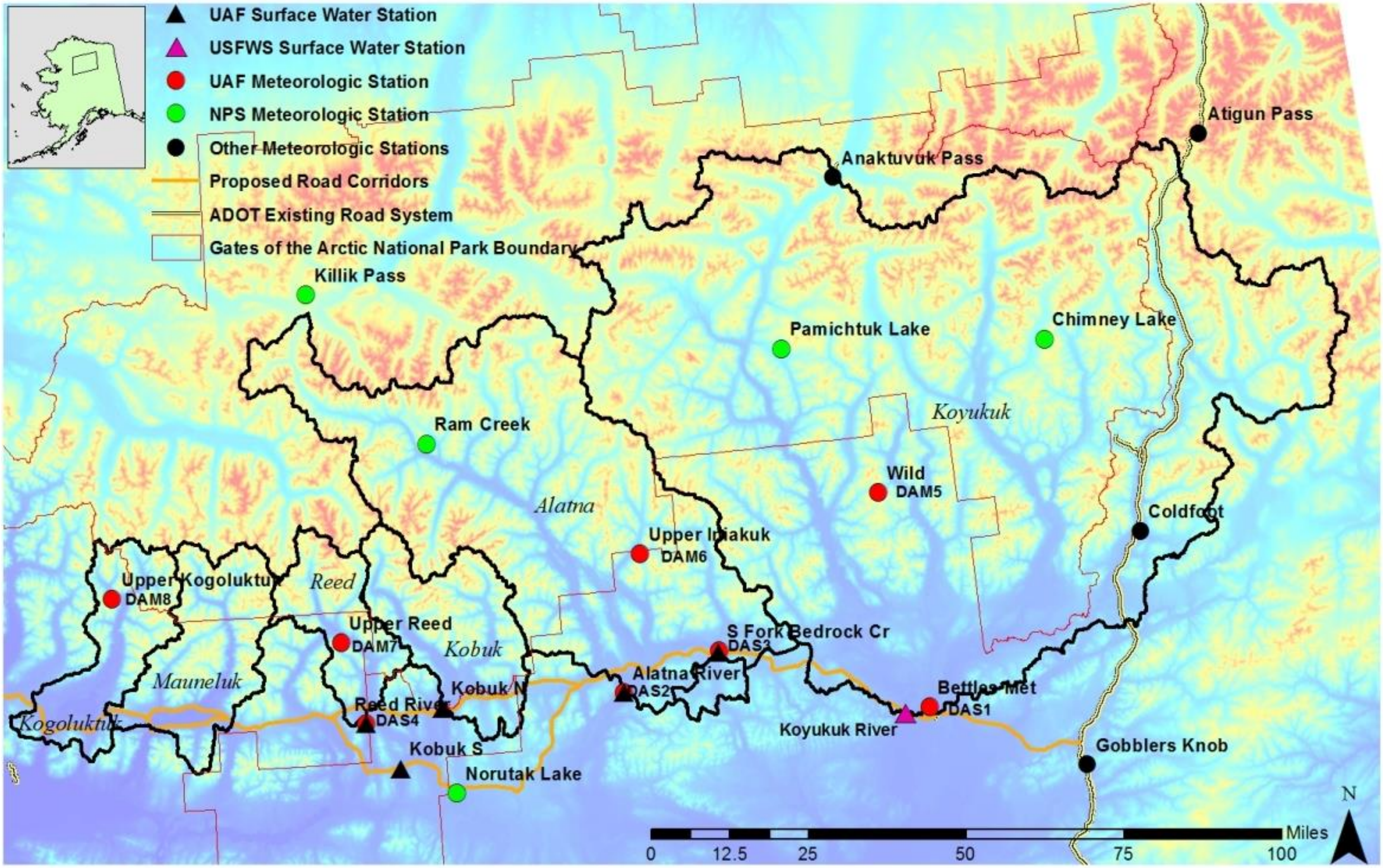



Figure 1. Study area showing the location of the river basins (black outlines) and hydro-meteorological stations in the region.

Table 1. Summary of Ambler Project meteorological and hydrological stations in the UAF/WERC network.

| Station Name | Station ID | Project | Basin Name | Elevation | Coordinates | Period of Record |
|---|---|---|---|---|---|---|
| Reed River (M,H) | DAS4 | AIDEA - Ambler | Kobuk | 158 m 520 ft | 66.9973°N 151.6772°W | July 2012 to Sept 2014 (H) & Aug 2015 (M) |
| Bettles (M,H) | DAS1 | AIDEA - Ambler | Koyukuk | 183 m 600 ft | 66.9064°N 151.6772°W | Sept 2012 to Sept 2014 (H) & Aug 2015 (M) |
| Alatna River (M,H) | DAS2 | AIDEA - Ambler | Alatna | 229 m 752 ft | 67.022°N 153.302°W | July 2012 to Sept 2014 (H) & Aug 2015 (M) |
| S. Fork Bedrock Cr. (M,H) | DAS3 | AIDEA - Ambler | Alatna | 256 m 841 ft | 67.0924°N 152.7292°W | July 2012 to Sept 2014 (H) & Aug 2015 (M) |
| Upper Kogoluktuk (M) | DAM8 | ADOT - Ambler | Kobuk | 518 m 1700 ft | 67.3071°N 156.2446°W | July 2012 to Aug 2015 |
| Upper Reed (M) | DAM7 | ADOT - Ambler | Kobuk | 640 m 2100 ft | 67.1853°N 154.9361°W | July 2012 to Aug 2015 |
| Upper Iniakuk (M) | DAM6 | ADOT - Ambler | Alatna | 838 m 2750 ft | 67.1354°N 153.1354°W | July 2012 to Aug 2015 |
| Wild (M) | DAM5 | ADOT - Ambler | Koyukuk | 1143 m 3750 ft | 67.4152°N 151.6837°W | July 2012 to Aug 2015 |

M = meteorological; H = hydrological

Table 2. Basin characteristics above the catchment of each stream where hydrologic observations were made (National Elevation Dataset for Alaska; Homer et al., 2007).

| Characteristic | Koyukuk | Alatna | Kobuk (North) | Reed | South Fork Bedrock Cr (Alatna Tributary) |
|---|---|---|---|---|---|
| Basin Area ($km^2$) | 18000 | 6300 | 1295 | 825 | 174 |
| Aspect | Southwest | South | Southwest | South | Northeast |
| Minimum Elevation (m) | 180 | 229 | 198 | 183 | 245 |
| Maximum Elevation (m) | 2245 | 2175 | 2053 | 2525 | 978 |
| Mean Elevation (m) | 848 | 842 | 743 | 819 | 452 |
| Basin Area above 500 m (%) | 80 | 80 | 70 | 77 | 28 |
| Stream Length (km) | 225 | 205 | 66 | 76 | 31 |
| Basin Length (km) | 160 | 130 | 50 | 53 | 19 |
| Drainage Density ($km/km^2$) | 0.87 | 0.80 | 0.73 | 0.63 | 0.73 |
| Forest (%) | 11 | 15 | 26 | 14 | 34 |
| Shrub (%) | 73 | 68 | 55 | 61 | 63 |
| Barren (%) | 14 | 16 | 17 | 23 | 0 |
| Other (%) | 2 | 1 | 2 | 2 | 3 |

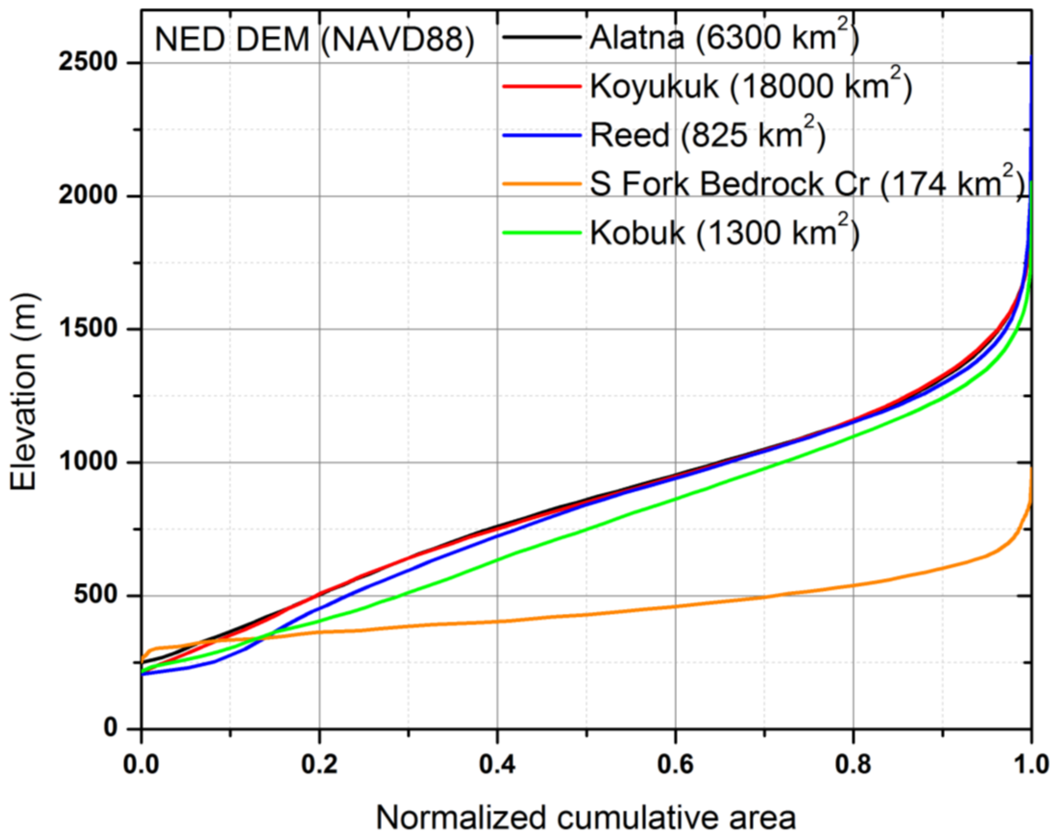



Figure 2. Hypsometric curves for the five streams where hydrologic observations were made on the south slope of the Brooks Range. The hypsometric curve for the Alatna drainage is partially hidden behind the curve for the Koyukuk drainage.

The area of the Koyukuk River basin in the eastern region of the study area is three times larger than the next largest basin, the Alatna. As one proceeds west in this region, the south-draining basins (for example, the Kobuk, Reed, Mauneluk, and Kogoluktuk) become smaller. The drainage area of the Reed River catchment (above our gauge site) is only 825 $km^2$ (319 $mi^2$). This is important when considering the response time of runoff peaks for major precipitation events.

# 3 METHODOLOGY AND EQUIPMENT

While some environmental data are being collected in and near the study area (U.S. Geological Survey [USGS] and U.S. Department of Agriculture, Natural Resources Conservation Service [USDA/NRCS]), most data reported and analyzed in this report have been collected by the University of Alaska Fairbanks, Water and Environmental Research Center (UAF, WERC). The first equipment installed in the field was associated with meteorological sites. Each site was instrumented to measure the following (see Table 3): warm season rainfall, continuous winter snow depth, air temperature, relative humidity, wind speed and direction, net radiation, and some soil properties. Thermistors and time domain reflectometry (TDR) probes were installed at most stations (unless too rocky) to measure shallow near-surface soil temperatures and volumetric soil moisture contents, respectively (the TDR probes only measure the unfrozen water content). Readings are normally taken every minute to get an average hourly value, which is recorded.

The next step in the overall effort was to install hydrological stations. The purpose of these stations was to obtain estimates of stream discharge (and water stage) near stream crossings along the proposed transportation corridor. The standard approach, which is to develop a stream stage–discharge relationship at the stream crossing of interest, involves installing pressure transducers in the stream to get a continuous record of river stage and making discharge measurements that can be related to the stage at the time of the observations (equipment used listed in Table 3). Ideally, discharge measurements are made over a wide range of water levels—something that is much easier to say than to accomplish. These sites are in remote areas, and usually observers are not present when high flows (and high stages) occur, especially during summer rainfall events. In general, UAF/WERC field staff is in the area (staying at nearby camps, Bettles for this study) throughout spring breakup, and staff attempts to gauge each day. However, weather still presents a problem for accessing remote field sites.

Table 3. Details of equipment used on the Ambler study.

| Category | Item | Model | Accuracy | Remarks |
|---|---|---|---|---|
| Met | Wind Direction | RM Young 05103 | ± 3 degrees | |
| Met | Wind Speed | RM Young 05103 | ± 0.3 m/s | |
| Met | Air Temperature | HC2S3 | ± 0.1 °C at 23°C | |
| Met | Air Relative Humidity | HC2S3 | ±0.8 % at 23°C | |
| Met | Snow Depth | SR50 or SR50A | ± 1 cm | |
| Met | Soil Moisture | CS650 | ± 3% VWC | |
| Met | Soil Temperature | US Sensor PR502J2 | ±0.05°C at 0-50°C | |
| Met | Barometric Pressure | CS106 | ± 1.5 mb @ −40 to +60 °C | |
| Met | Net Radiation | NR-Lite | | |
| Met | Rainfall | Tipping Bucket TE525MM or TE525WS | ± 1 % up to 10 mm/hr (and 1 in./hr) | |
| Met | Soil, Water Temperature, also Air Temperature backup | Alpha or YSI Thermistor | | |
| Hydro | Water Level | INW AquiStar SDI-12 | ± 0.5 cm (5 psi), ± 1.6 cm (15 psi) | vented to atmosphere |
| Hydro | Water Level, backup | Hobo U20 | ± 0.6 cm | absolute pressure, barometric corrections required |
| Hydro | Turbidity | OBS500, OBS3+ | | |
| Hydro | Suspended Sediment | ISCO 3700, Rickly DH76 | | |
| Hydro | ADCP, shallow | RDI StreamPro | | |
| Hydro | ADCP | RDI Rio Grande WHRZ1200 | | |
| Hydro | ADCP | Sontek River Surveyor S5 | | |
| Hydro | ADCP Software | WinRiver II and RiverSurveyor Live | | |
| Hydro | ADCP GPS Reference | Novatel Smart-V1 | | |
| Hydro | ADCP Manned Boat | Achilles 11-foot inflatable | | 15 HP motor, Kentucky-type mount |
| Hydro | ADCP Manned Boat | Cataraft | | 15 HP motor, tethered riverboat, StreamPro |
| Hydro | ADCP Manned Boat | Kayak inflatable 1-person | | StreamPro in well |
| Hydro | ADCP Trimaran | Oceanscience Riverboat | | |
| Hydro | Computer | Panasonic Toughbook CF19 | | |
| Station | Datalogger | CR1000 | | |
| Station | Camera | CC640 or PlantCam | | |
| Station | Radio | FreeWave FGR or DGR | | |
| Station | Solar Panel | Sharp 85 W, typical | | |
| Station | Batteries | Concorde 104 AH | | 4 batteries per station, 3 for repeaters |
| Station | Charge Controller | SunSaver 10 or 12 | | |
| Station | Tripod | CM110 | | |

## 3.1 Air Temperature and Relative Humidity

Air temperature and relative humidity are measured with a Campbell Scientific HC2S3 Temperature Relative Humidity Sensor. These probes are housed in a 12-gill self-aspirating radiation shield and mounted at a height of 2 m. The reported temperature operating range is -50°C to +50°C, with accuracy typically ±0.2°C and a worst-case accuracy of ±0.3°C. The relative humidity operating range is 0–100%, with accuracy at 20°C of ±0.8% from 0–90% and ±3% from 90–100%. Rime ice accumulations can affect the air temperature and especially the relative humidity reading. Accumulating rime insulates the sensors within the radiation shield, isolating them from ambient conditions. Should this occur, air temperature readings would be slightly affected in the time required to respond to changes in the ambient air temperature, and relative humidity would be greatly affected by being isolated from ambient conditions. Recorded relative humidity is related to the vapor pressure of the surface of the rime ice adhering to the radiation shield and the wire mesh inner enclosure surrounding the relative humidity sensor, and is not indicative of actual ambient conditions.

Additionally three Campbell Scientific 109 temperature probes were installed in a 6-gill radiation shield at a height of 2 m. The operating range of the three sensors is -50°C to +70°C. These sensors are used when the primary air temperature sensor (HC2S3) is malfunctioning.

## 3.2 Wind Speed and Direction

Wind speed is measured using an RM Young 05103-45-L anemometer, mounted at a height of 3 m. The starting threshold of the wind measurement is 1.0 m/s (2.2 mph), with an accuracy of ±0.3 m/s (0.6 mph) and operating range of 0–60 m/s (0–134 mph). The wind-direction vane range is 0–360° with ±3° accuracy and a starting threshold at 10° displacement of 1.1 m/s (2.2 mph). Field calibration tests of the wind speed sensors are difficult to obtain. Suspect sensors are replaced and sent to the manufacturer for calibration and replacement of bearings. Additionally, each year the heading of the wind-direction sensors is checked periodically by aiming the vane at four compass direction.

Problems of note occur at these unattended remote sites pertaining to wind speed and direction measurements. The most significant of these problems are rime ice and freezing precipitation that can alter the aerodynamics of the sensors and possibly stop them completely. Prolonged periods of calm and/or constant wind direction are rare at these stations and should not be considered in the data as indicators of these conditions. However, since the stations are unattended, it is possible that a calm period could occur. Rime ice and freezing precipitation can occur during any season, but they occur most commonly during late fall, winter, and spring when temperatures hover around the freezing point. Sensors are cleaned at each site visit, but due to the remoteness of the stations, visits are 6 to 12 months apart. Another problem, specific to the wind sensors, is perching birds. Since these sites are sometimes located in treeless terrain, large birds including ravens, rough-legged hawks, eagles, and snowy owls can damage vanes and anemometers by repeatedly perching on them. Perching rarely causes data loss, but may slightly affect the accuracy of the wind vanes if they are bent. The model used in this study is black and covered with an ice-resistant coating to minimize rime buildup.

## 3.3 Net Radiation

At all Amber stations, net radiation is measured with a Kipp and Zonen NR-Lite Net Radiometer. The operating range of the Kipp and Zonen instrument is ±2000 W $m^{-2}$; the instrument's sensitivity is reported as 10 μV $W^{-1}m^2$. The spectral response range is reported by the manufacturer as 0 to 100 μm. Temperature range for the instrument is -30° to 70°C (-22° to 158°F). The calibrated accuracy of this instrument, which was not reported by the manufacturer, varies with temperature, wind, and sensor symmetry. Sensor readings are corrected for errors caused at high wind speeds. The instrument is installed at a height of approximately 2 m and oriented to the south to minimize shadow effect from the mounting pole. Keeping the sensor level is a challenge, especially at summer's end when the active layer thaw is at a maximum. Net radiation values are only reported for the warm season due to snow and ice on the sensor during the cold season.

## 3.4 Summer Precipitation

Summer precipitation is recorded at each meteorological station with a Texas Electronics (TE) 525MM tipping-bucket gauge surrounded by an Alter (wind) shield. The gauge catches precipitation in a 10 in. (25.4 cm) diameter collector, and the water is funneled into the tipping bucket. Once the bucket is full of water, it tips and empties, and each tip is recorded by the datalogger. The gauge is typically installed at a height off the ground of 0.7–1.0 m (2.3–3.3 ft). The TE525MM resolution is 0.1 mm per tip, and the accuracy is 1% up to 25.4 mm/hr, +0 to -

2.5% for 25.4–50.8 mm/hr, and +0 to-3.5% (50.8–76.2 mm/hr), with greater undercatch as intensity increases; these specifications do not include the impact of wind or other environmental factors. A known problem with most precipitation gauges is the undercatch of precipitation. Undercatch may occur during low-intensity or trace rainfalls (not enough precipitation to tip the bucket, and evaporation occurs) or high-wind events during which the gauge alters the path of rain particles. Undercatch may also occur due to evaporative wetting losses from the gauge. We recognize this is a potential source of error, particularly for hydrological analysis and modeling of runoff, but have not yet examined the problem in detail for the Ambler stations. An additional potential error is due to the installation of the gauge. During site visits, we observed that the gauge is not level because it is attached to a single pole in the ground and the guy wires often become loose as the active layer thaws. Improvements to the installation are required to decrease potential measurement errors.

## 3.5 Cold Season Precipitation

Cold season precipitation (less sublimation) is represented by snow surveys performed at winter's end (Figure 3). The beginning of April is usually a good time to capture end-of-winter snow water equivalent (SWE) on the south side of the Brooks Range. March, April, and May are often the months of lowest monthly precipitation, and ordinarily, little further accumulation occurs between the end-of-winter snow surveys and the onset of ablation, although exceptions occur, for example, in 2013. Snow surveys are made at designated locations throughout the domain to determine snow depth, as well as vertically integrated density and SWE.

In addition to snow surveys, snow depths are collected throughout the winter at meteorological stations that are equipped with automated ultrasonic snow depth sensors (SR50 or SR50A). Snow depth sensor readings can be collected in near real time or downloaded in the field directly from a datalogger.

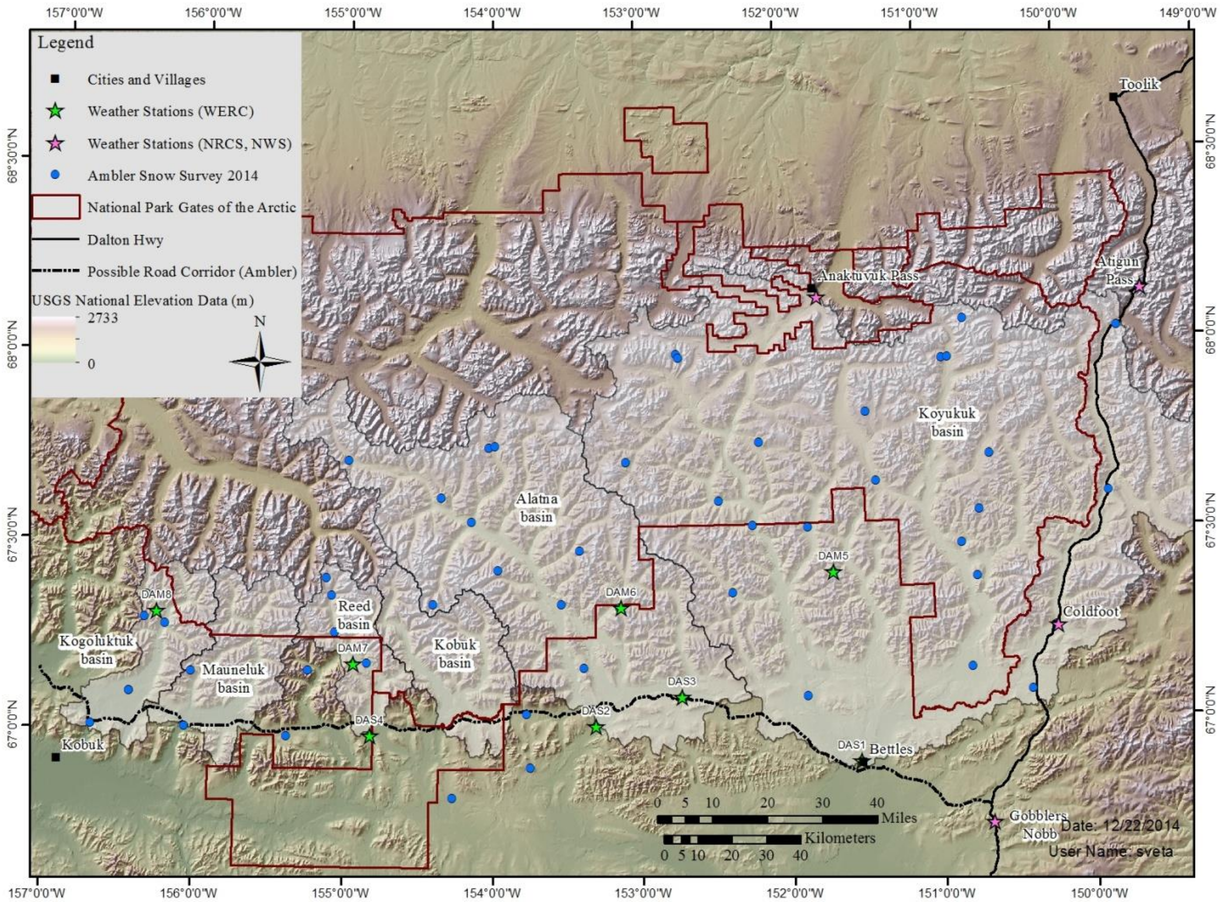



Figure 3. Location of the remote snow survey sites and weather stations in the watersheds south of the Brooks Range.

### 3.5.1 Snow survey

Our snow surveys include gravimetric SWE sampling and snow depth measurements collected over an area of 25 m by 25 m; this technique is often referred to as double sampling (Rovansek et al., 1993). The snowpack in Alaska is extremely heterogeneous, with snow depth being more variable than density (Benson and Sturm, 1993). When double sampling, many more snow depths can be made in the same amount of time as a single SWE measurement. Typically, double sampling yields an areal SWE estimate with a lower variance than is possible using collected snow cores only. Rovansek et al. (1993) showed that double sampling provides improved SWE estimates; they recommended sampling 12 to 15 snow depths for each snow core. This optimal ratio of snow depths to water equivalent, however, appeared to vary greatly (from 1 to 23), depending on site, weather, and snow conditions. Currently, we use an optimal ratio of 10; that is, 50 depths accompany 5 snow cores.

Snow cores are sampled using a fiberglass tube (Adirondack) with an inside area of 35.7 $cm^2$, equipped with metal teeth on the lower end to cut through dense layers of snow. The advantage of the Adirondack tube for a shallow snowpack is that its diameter is larger than many other types of snow tubes (e.g., the Mt. Rose); thus, it provides a larger sample of the shallow Arctic snowpack. To obtain a complete snow core, the Adirondack tube is pushed vertically through the snow while turning, until soil is encountered. At this point, snow depth is recorded. The tube is then driven further into the organic layer and tipped sideways, retaining a vegetation plug; this method ensures that the complete snow column was sampled. The vegetation plug is removed, and the snow is either collected in Ziploc® bags for weighing later in the laboratory or weighed directly in the field. Five snow cores are used to estimate the average snow density.

We use a constant 50 m length for the snow depth course, with a 1 m sampling interval along an L-shaped transect. Twenty-five depth measurements are made on each leg of the L; this strategy is used to account for the presence of snowdrifts in the area of measurement. The directions of measurement are chosen randomly.

Snow water equivalent is defined as

$$SWE = (SD * \rho_s) / \rho_w \quad (1)$$

where $\rho_s$ is average snow density from the 5 snow core samples, $\rho_w$ is water density, and *SD* is an average of 50 snow depths.

#### 3.5.1.1 Accuracy of snow survey observations

This section reports on the problems of measuring and processing observational snow data so that the reported dataset can be used properly. Snow density and SWE are estimated using snow core sampling. Woo (1997) showed that a larger tube diameter increases the accuracy of density determination; Woo also showed that the Canadian sampler (similar to the Adirondack in diameter) captures snow density within 5% of snow pit estimates. Our field comparison of snow density measurements with the Adirondack or with snow pit estimates gives similar results.

The accuracy of a single snow depth measurement depends on properties of the snowpack and underlying organic material (Figure 4). In the area of well-developed organics on top of mineral soils, snow depth is often overestimated (Stuefer et al., 2013). While measuring, the probe can easily penetrate low-density organic material, so this additional depth is sometimes incorporated inadvertently into the snow depth measurement (Figure 4a). Any type of correction to existing snow depth records is difficult to perform, because the error varies strongly from observer to observer and depends on snow and soil conditions at each site (Figure 4b).

Whereas tundra snow depths often show an overestimation error, snow core densities tend to be slightly underestimated. The difficulty in SWE accuracy interpretations is that actual accurate SWE is unknown. Comparing different sampling methods, Berezovskaya and Kane (2007) concluded that the SWE of tundra snow, estimated with the double sampling technique, has an error of ±10%.

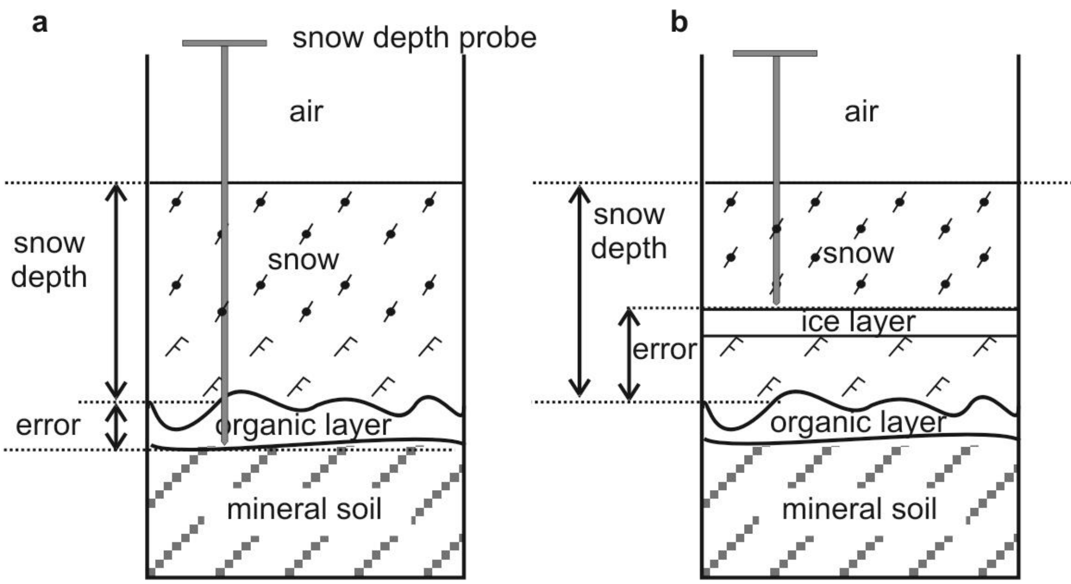



Figure 4. Schematic diagram of the snow depth measurements and possible errors associated with over- and underestimation of snow depth (Stuefer et al., 2013).

### 3.5.2 Snow depth sensors

During the 2012–2013 and 2013–2014 winters, automated snow depth measurements were recorded at eight meteorological stations (Table 4). Depth measurements from one USDA/NRCS SNOTEL site were also used. The snow depth sensor used was a Campbell Scientific Sonic Ranger SR50 or SR50(A). The only difference between the SR50 and SR50(A) is the housing that encases the ultrasonic sensor. The sensor emits a 50 kHz sound pulse and measures the time the pulse takes to return to the sensor. Ultrasonic sensors can measure the distance to any reflective surface like the ground or water, but the sensitivity of the SR50(A) is designed for measuring distance to a snow surface.

The method used for determining snow depth with the SR50 is subtraction. When no snow is on the ground, the distance measured is the sensor's height above the ground. When snow has accumulated under the sensor, the distance measured is to the snow surface. The difference between distance-to-ground and distance-to-snow surface yields snow depth. For example, if the sensor's height above the ground is 50 in. and 10 in. of snow accumulates, the new distance to surface will be 40 in. Hence, 40 in. subtracted from 50 in. gives a depth of 10 in. under the sensor. The ultrasonic pulse has a measurement cone circumference of 22° from the bottom of the sensor. The program for the SR50 records measurements at 1-minute intervals and reports hourly averages.

Table 4. Meteorological stations with an SR50 snow depth sensor included in this report.

| | **Site Name** | **General Location** |
|---|---|---|
| 1 | Bettles (DAS1) | Koyukuk River, Lowland |
| 2 | Alatna (DAS2) | Alatna River, Lowland |
| 3 | South Fork Bedrock (DAS3) | Alatna River, Lowland |
| 4 | Reed (DAS4) | Reed River, Lowland |
| 5 | Wild (DAM5) | Koyukuk River, Brooks Range |
| 6 | Upper Iniakuk (DAM6) | Alatna River, Brooks Range |
| 7 | Upper Reed (DAM7) | Reed River, Brooks Range |
| 8 | Upper Kogoluktuk (DAM8) | Kogoluktuk River, Brooks Range |
| 9 | Coldfoot (NRCS) | Koyukuk River, Forested Brooks Range |

#### 3.5.2.1 Accuracy of snow depth observations with snow depth sensor

Snow depth sensors track changes in snow depth well. The manufacturer-stated accuracy is ±1 cm or 0.4% of the distance to the snow surface from the sensor, whichever is greater (Campbell Scientific, Inc., 2008). Local air temperature is measured to correct for errors in distance measurements. The mounting height of a sensor can also influence the quality of data recorded, with too high of a mounting height resulting in noisy data, and too low of a mounting height resulting in the potential for snow depths to reach or bury the sensor. Our sensors are generally mounted at a height of 1.5 m. Inaccuracies can result from the difficulty of establishing a zero point, which is caused by tussocks/uneven ground, vegetation growth, neglecting periodic maintenance requirements (replacement of the sensor transducer), high wind, falling snow, low-density snow, blowing snow, and a change in sensor height due to ground heave.

Sonic snow depth records in this report were adjusted manually to account for field observations and erroneous data points. Brief periods of high winds, heavy snow, and/or blowing snow can cause the instrument to report inaccurate data. These brief periods of spurious data are excluded from the records. At the beginning and end of seasonal transition periods, there can be erroneous data due to underlying vegetation and uneven ground. During installation of sonic sensors and during subsequent station visits without snow on the ground, the ground surface under the snow sensors was trimmed of vegetation and leveled if possible. This practice resulted in improved clarity when deciphering the timing and amount of snow accumulation at the beginning and end of the season.

Diligent field practices are essential for accurate measurements, post-processing data corrections, and quality assurance/quality control (QA/QC) purposes. Field procedures used by UAF during site visits were as follows:

- During all site visits:
    - Inspect sensor and supporting structure for proper leveling and structural soundness.
    - Inspect sensor for corrosion; replace if necessary.
    - Measure the distance from the sensor to the ground.
- When clear of snow:
    - Trim vegetation under sensor and attempt to level ground.
- When snow covered:
    - Inspect for ice and frost on sensor.
    - Measure snow depth directly under the sensor.
    - Measure distance from sensor to snow surface.
    - Conduct snow survey near the sensor.

We usually visit these sites twice per year: once in the fall when there is no significant snow and once in the spring about the time of maximum SWE. If we visit these sites in the winter, we take all of the measurements just listed. On-site checks during field visits ensure proper operation and accuracy of the snow sensor.

## 3.6 Soil Temperature and Moisture

Soil temperature and unfrozen soil-moisture content data are monitored at eight stations in the hydrometeorological monitoring network. Soil-water content is monitored at each station with Campbell Scientific, Inc. CS650 TDR-type sensors at depths of near 10, 40, and 60 cm below ground surface (may vary slightly by location). Installation depths at some sites vary slightly due to the soil conditions during sensor installation. Soil-water content sensors are installed horizontally with minimal soil disturbance. Factory calibration is used to convert raw readings to volume-fraction water content. TDR-type sensors respond to the soil dielectric constant, and since ice has a dielectric constant similar to dry soil, the sensor effectively responds to changes in unfrozen soil-water content. For greatest accuracy, soil-water content sensors should be calibrated specifically to each soil, especially under conditions that depart from normal. Although the absolute soil-water content may differ from that given by the factory calibration, the relative water content and the behavior of phase change in relation to temperature should be accurate. Hourly readings of unfrozen soil-water content are recorded.

Soil temperature is monitored at each station with U.S. Sensor thermistors (Model PR502J2), mounted in a thermistor string at intervals to provide temperatures at 5, 10, 15, 30, 50, 70, 90, 110, 130, 150, 175, and 200 cm below the soil surface. A soil pit is dug to install the soil moisture sensors and shallow soil thermistors. The soil temperature string (deeper thermistors) is placed into a hole drilled into the bottom of the soil pit, and the evacuated soil is used to backfill the pit. Hourly readings of soil temperature are recorded. If a thermistor string could not be installed to a depth of 200 cm (because of bedrock), the thermistors at the bottom of the string were removed so that spacing of the thermistors from the ground surface to maximum depth remained the same.

## 3.7 Water Levels

Station locations are selected based on whether discharge can be safely and accurately measured during flood events and whether the site is conducive to establishing a stage-discharge relationship. Water level (also known as river stage) is measured continuously with pressure transducers, and discharge measurements are individual point measurements in time. Point measurements of water levels are also collected with traditional surveying equipment and staff gauges. A rating curve is developed to establish a relationship between the stage and the discharge to predict the discharge for the full range of stage observed. In addition to quantitative measurements, hourly photographs from cameras at the stations help us to evaluate the water levels in the rivers, observe ice conditions during breakup, and monitor the weather for field logistics.

Water levels are measured with two Instrumentation Northwest, Inc., Aquistar PT12 (SDI12) pressure transducers at each station, with one or two HOBO U20 water level logger pressure transducers for backup, located at or near the station. Measurements are made every 15 minutes, and an average water depth or pressure is reported. Water depth above the pressure transducer is reported by the datalogger and is converted into water level elevations (above the reference datum of NAD83/ellipsoid height) during post-processing. Benchmark elevations in orthometric height (GEOID09AK) are also available from the Alaska Department of Transportation and Public Facilities (ADOT&PF).

Manual water level measurements consist of staff gauge readings or "tape downs," which are measurements from the top of a reference point such as rebar to the water surface. The staff gauge and rebar are surveyed to the datum as well. These discrete measurements of water level are used to adjust the continuous pressure transducer data to the datum and for verification purposes.

Cameras located at the surface water station take an image every hour (or more frequently as needed) to capture the river stage and weather conditions. A StarDot Netcam XL camera is used, and images are transmitted to the base station and uploaded to the project website each hour. The photos are used during the field season to observe river stage and ice conditions, and to corroborate the pressure transducer data. If the pressure transducer is not working properly, we can review the photographs to confirm the river stage qualitatively.

The vertical datum in this study for water level elevations is NAD83 (the ellipsoid height) (or arbitrary in the case of Reed River and Kobuk River). Temporary benchmarks at the stations were established and surveyed by ADOT&PF using GPS techniques. Traditional level loop surveys are conducted on each trip to tie the water surface and staff gauges to the temporary benchmarks (with a known elevation).

Table 5 shows the accuracy specifications for the Aquistar and HOBO pressure transducers. Errors associated with the pressure transducer itself are generally less than 1 cm under ideal conditions. Additional errors associated with the pressure transducer unit may occur if the sensor does not have a secure installation and is moving in the water.

Table 5. Specifications for the pressure transducers used during the study.

| Sensor | Full Scale Range | Accuracy (typical) | Accuracy (typical) | Water Level Range |
|---|---|---|---|---|
| Aquistar | 0–15 PSI Gauge | 0.06% Full Scale | 0.009 PSIG, 0.6 cm | 0–10 m |
| Aquistar | 0–5 PSI Gauge | 0.06% Full Scale | 0.003 PSIG, 0.2 cm | 0–3.5 m |
| HOBO | 0–21 PSI Absolute | 0.075% Full Scale | 0.016 PSIA, 0.3 cm | 0–4 m |

The two largest errors with manually measuring water levels are (1) surveying and vertical datum issues and (2) mistakes during manual measurements (i.e., reading staff gauges). Staff gauges may be read incorrectly, but also they may be difficult to read because of wave action, which can yield an error in the water level of up to plus or minus several centimeters. We recognize that movement of the temporary benchmarks and staff gauges may occur from frost heave, ice damage, etc. Multiple level loop surveys and the use of static differential GPS surveys to compare the temporary benchmark elevations from year to year help pinpoint movement.

All water level measurements are affected by ice or snow in the channel, which displaces water. This is important to be aware of during spring breakup and the winter months, because during this time, the rating curve is not valid since the channel geometry can be altered significantly due to the presence of ice or snow. During spring breakup, we take discharge measurements as frequently as possible and do not rely solely on the rating curve to calculate continuous discharge. The shift in control during ice-affected measurements is visible in the rating curve; when the stage and discharge are plotted, the points will fall consistently above the rating curve (stage is higher for the same discharge when affected by ice).

## 3.8 Discharge Measurements

Both acoustic Doppler current profiler (ADCP) bottom tracking and ADCP global positioning system (GPS) options were used as the reference to measure river velocity. Usually, the GPS is preferred, but if technical problems occur with it, bottom tracking may be used. If bottom tracking is the reference, a test is conducted to determine if there is a moving bed and to correct the discharge for the moving bed. The GPS model used during measurements is the Novatel Smart V1-2US-L1. Typically, a base station is set up and a real-time kinematic (RTK) GPS is used, but satellite-based augmentation system (SBAS or WAAS) differential correction is also used and is considered acceptable (Wagner and Mueller, 2011). The horizontal position accuracy of the RTK is 0.2 m and 1.2 m when using SBAS/WAAS with the Novatel units.

The ADCPs used during the study period were the RDI StreamPro, RDI Rio Grande, and Sontek River Surveyor S5 unit. The StreamPro and River Surveyor S5 are most useful in shallow water (less than 5 m), and the Rio Grande is used if the water depth is greater than 5 m.

A stage-discharge relationship (rating curve) was developed to calculate the discharge for a range of stages at each river. The stage is plotted against the discharge, and a best-fit curve is fitted through the points (and represented by an equation) on both normal and logarithmic scales. We attempted to collect discharge measurements at various river stages in order to have a good rating curve relationship at all river stages. Extrapolation for low and high flows is necessary because measurements in these ranges of the curve are lacking. Caution is used in extrapolating the discharges at high stages due to changes in the control, or the channel configuration at the measurement reach, at high stage. Once the stage increases above the banks (over bankfull conditions) onto the floodplain, the channel geometry changes, and the stage-discharge relationship developed for the channel is no longer valid. In addition, since the geometry of the channel controls the relationship, we try to make the measurements in the same location each time. However, due to a dynamic river channel during breakup, it was not always possible to measure at the same river location each time. Changes in water flow paths at low versus high stage, multiple channels during high stage, and ice in the channel made it problematic to measure discharge at exactly the same location each time. Additionally, it is common to have a shifting or changing control (usually a physical structure such as a bedrock outcrop that prevents changes in the channel that would impact the stage-discharge relationship for a stream), and therefore, many measurements need to be made, along with adjustment to the rating curve. Shifts are applied to the rating curve when there is a change in channel shape or a change in control. Channel shape can change during spring breakup or summer flood events. Our rating curves and continuous discharge estimates are still considered preliminary because we only have a limited number of measurements to use on the rating curve.

The biggest challenge associated with making a good quality ADCP discharge measurement is locating a single straight parabolic cross section of the river with steady and uniform flow to perform the measurement. A bad measurement section normally results in poor data quality. This is primarily a problem during the spring flood when ice is present in the channels, flows may be high and unsteady, and the rivers consist of multiple channels.

Technical problems and limitations of the ADCP and associated equipment have other factors that degrade the quality of the measurement. Technical problems may include improper configuration of the ADCP, GPS problems, radio communication failures, and incorrect baud rates. Typical ADCP limitations include turbulent water, too much or too little sediment in the water column, a moving bed, or insufficient water depth for use of a particular ADCP. However, we think that ADCP measurements are far superior to traditional current meter measurements, because the number of ADCP velocity measurements through the cross section and water column is so much greater than could be measured with a conventional mechanical cup type current meter.

The following field procedures are performed before the ADCP discharge measurement is made:

- ADCP diagnostic and quality tests
- Compass calibration for GPS
- Assessment/description of the river reach characteristics for suitability of ADCP measurement
- Moving bed test

The following are reviewed during both quality assurance and quality control of the field-collected data:

- Measurement reach characteristics
- ADCP configuration
- Each transect and accompanying set of velocity contours for bad/lost velocity data
- Determination of percentage of flow that is measured vs. estimated
- Moving bed test and discharge, adjusting as needed

- Assessment of GPS quality if GPS is used
- Each transect, checking for consistency (discharge, area, width, boat speed, water speed, flow direction, measurement duration, etc.)
- The transect coefficient of variation, checking for discharge that is within 5% of other measurements
- The quality of the river stage data

After the measurement at a site is reviewed, a quality rating that is both qualitative and quantitative is assigned to that measurement. The quality rating is based on both the transect coefficient of variation (i.e., measurement repeatability) and the overall general quality of the measurement (such as the river reach characteristics, ADCP limitations, transect consistency). The quality rating given to each measurement is either excellent (2%), good (5%), fair (8%), or poor (10% or more). These quality ratings are carried over to the rating curve.

Errors in water level and discharge measurements propagate to the rating curve. We assign quality indicators to each measurement and use these during the rating curve development. The complex and dynamic nature of these river channels adds additional uncertainty to the rating curve. Changes in the discharge measurement location may occur due to changes in stage that result in river access problems (i.e., too shallow to drive a boat), braiding of the river channel, and even safety issues. The change in the measurement cross section is not ideal and results in more uncertainty (and shifts) in the rating curve; however, there is probably little measurable change in flow between the measurement sites (typically they are all within a kilometer of the station).

Additional errors may occur during extrapolation of the rating curve beyond the highest or lowest measured discharge. It is typical that none of the measurements or few occur at the highest flows (either for safety reasons or because we are not present during the high flows), so we extend the rating curve to these higher stage discharges. However, the rating curve may not be extended too high without consideration of the river cross section and changing controls.

## 3.9 Acoustic Doppler Current Profiler

Discharge measurements were conducted at or near the station on each river using the acoustic Doppler current profiler (ADCP) technique. Measurements are made by driving a motorized boat or paddling a non-motorized boat slowly across the river along a transect. A minimum of four transects are made per measurement (or a total measurement duration of 720 seconds in steady-state conditions), and an average discharge is calculated from the multiple transects. At times of high flow, transects may be at an oblique angle (diagonal and downstream direction) across the river. Transects were made from both the left-to-right-bank and the right-to-left-bank directions in order to calculate river discharge and determine any directional bias. When the coefficient of variation (standard deviation divided by the mean) of the measurements is less than 5%, an average discharge is calculated. If the coefficient of variation is greater than 5%, additional transects/measurements are made, or the length of time spent measuring during the transect is increased.

## 3.10 Suspended Sediments

Sediment concentration is a key hydraulic parameter when considering the overall character of a river. While fairly extensive research has been done on the sediment transport regimes of gravel rivers in temperate climates (Parker et al., 2007), an understanding of these processes in arctic systems is less complete. For larger rivers in the Arctic and subarctic, spring breakup is the major annual hydrologic event (Kane et al., 2003). The presence of snow and ice for most of 6 to 8 months of the year, coupled with rivers that may freeze to the bed in shallow areas, clearly differentiates the sediment transport regimes of rivers in northern regions from the sediment transport regimes of rivers in temperate regions. The impact of bed ice on bedload transport has been studied on the Kuparuk River (Oatley, 2002; Best et al., 2005; McNamara et al., 2008), where it was observed that the presence of ice on the bed during the spring flood significantly reduced bedload transport. The occurrence of ice during spring melt will also affect suspended sediment transport in a river. In the Canadian Arctic, this effect was seen to vary between rivers, depending on channel size and discharge rates (Forbes and Lamoureux, 2005).

### 3.10.1 River sediment

As part of a smaller, complementary study, the sediment dynamics of the Reed, Alatna, and Koyukuk Rivers were studied. In each of the rivers, the suspended sediment flux was quantified, as well as other key indicators of sediment transport. Limited sediment transport studies have been performed on major rivers in this part of the world due to challenging remote accessibility and weather conditions. Methods used to monitor suspended sediment transport in this study included the collection of suspended sediment samples through both automatic pump devices and depth-integrated sampling, the calculation of suspended sediment discharge from suspended sediment rating curves, turbidity measurements, bed sediment grain-size distributions, and observations of suspended sediment grain-size distributions.

### 3.10.2 Suspended sediment observations

Suspended sediment samples were taken with Isco 3700 Portable Autosamplers; grab samples were also taken on all rivers when staff was on site stream gauging, with the majority of these taken during breakup when autosamplers could not be deployed because of ice conditions. During spring breakup (when ice conditions allowed), Isco samples were taken every 6 hours; from early June to September, a sample was taken with the autosampler once daily at 15:00 AST. The samplers were moved multiple times throughout spring breakup, but were installed in permanent locations from June through September. During this time, the intake hose was clamped to rebar and located roughly 6 in. above the riverbed.

Several problems occurred with the autosamplers in the unpredictable environment that is the Alaska subarctic. It is unfeasible to suspend the intake at a constant height above the bed during breakup due to the debris and ice carried by the river, the frozen nature of the bed, and the high water levels. Large gaps occurred in the datasets throughout the period of this study. Iscos were disturbed by animals and knocked over by high flows, and they malfunctioned for various reasons. Two Iscos were deployed at each site, with each Isco taking a sample every 48 hours, staggered to have one sample per day. With this method, there can be 48 days of continuous data without a site visit, and if one sampler is disrupted, the density of sampling will be reduced, but a broad picture of sediment load can still be achieved with samples collected every other day. Despite the use of two samplers at each site, a large number of malfunctions occurred with the instruments, and large gaps occurred in the suspended sediment concentration (SSC) data.

Depth-integrated suspended sediment samples were also taken along the main channels using a Rickly Hydrological depth-integrating sampler (Model DH76) with a ¼ in. nozzle. By taking an average of two samples per day during breakup with the integrated sampler, a representation of sediment load throughout the water column can be achieved. This method also addresses the problem of the Isco hose being on the riverbed during breakup, allowing for comparison between the Isco and integrated samples to ensure that the Isco samples accurately represent the sediment load in the rivers. The goal was to establish a relationship between the Isco and depth-integrated samples with a rating curve for each river.

Samples taken by the Iscos and the integrated sampler are analyzed in the lab to determine SSC. Following ASTM Standard 3977-97, the samples are vacuum filtered through Whatman GF/C glass microfiber filters with a particle retention size of 1.2 μm. The percentage of organic matter in each sample is then determined using ASTM Standard 2974 (Test Method C), in which samples are placed in a muffle furnace at 440°C for 12 hours. For this study, only the inorganic solids, referred to as SSC, were considered.

### 3.10.3 Suspended sediment discharge

Suspended sediment discharge ($q_s$) is a frequent value used to quantify the total suspended sediment being transported over a specific period; $q_s$ is defined as suspend sediment concentration multiplied by discharge at the same point in time. The value used for SSC was taken in this case from the suspended sediment rating curves developed between discharge and the depth-integrated samples, while discharge was taken from the 15-minute discharge record available for the flow period on each river. Finally, the values for $q_s$ were calculated at 15-minute intervals for the entire flow season, and these values were then used to calculate the annual suspended sediment load.

### 3.10.4 Turbidity

Campbell Scientific 500 turbidity sensors were also installed at the Reed and Alatna River gauging sites, and at the Koyukuk River turbidity gauging site (roughly 1 km downstream of the gauging site). These sensors have both backscatter and sidescatter sensors, with the backscatter performing better at higher turbidity and the sidescatter better at measuring low turbidity. Operating at wavelengths of 850 nanometers (±5 nm), these sensors are capable of measuring turbidity levels from 0 to 4000 NTUs (nephelometric turbidity units). Turbidity readings have an accuracy of 2% of the reading or 0.5 NTU, whichever is greater. Installation involved mounting the sensor on rebar driven into the streambed, with the optics facing the middle of the channel and 180° away from the rebar. The sensor was installed roughly 15 cm above the channel bed on all three rivers, and in close proximity to the intake of the Isco sampler. Each turbidity sensor was electronically connected to the surface-water observation station datalogger at each river to record readings at 15-minute intervals; data were then transmitted via satellite phone telemetry and Internet capabilities back to UAF/WERC.

It was unknown how these sensors would perform in a remote arctic environment. In 2012, the turbidimeters were initially installed using the Campbell Scientific recommended program, which involved the shutter remaining closed and opening every 15 minutes for a reading. This proved to be ineffective in the rivers in this study, where fine silts and sands packed the instruments and made it impossible for the shutter to open for readings. As a result, data are available for a very limited time in 2012. In 2013, a new program was used with the sensor, in which the shutter remained open much of the time, only closing once per hour to clean the optical window. While this proved to be a much more effective method, there are still gaps due to instrument malfunction in 2013 and 2014.

### 3.10.5 Bed sediment distribution

The bed sediment distribution was calculated for each river using a taped grid of 1 m by 1 m on exposed gravel bars near the end of the spring fieldwork. Photographs of each grid were taken, with the sediments later measured and separated into size intervals. In the photographs, only those sediments large enough to be seen without magnification and unobscured by other sediments were measured. Nine rocks were brought back from each grid to precisely weigh and measure them in a lab.

### 3.10.6 Suspended sediment grain-size distribution

A selection of depth-integrated samples collected throughout the 2013 field season were sent to Particle Technology Labs for total suspended solids (TSS) and grain size analysis. The volume weighted $D_{50}$ was reported back in μm for each sample.

# 4 RESULTS

## 4.1 Historical Floods

The Koyukuk River and its tributaries as well as the Yukon River near the mouth of the Koyukuk are prone to flooding. Flooding can occur for various reasons: (1) from excess rainfall in summer, (2) from excess flows during years with high SWE, and (3) due to ice jams. Historical stream gauging in the Koyukuk River has been minimal, so documentation on past floods has been almost nonexistent. The Koyukuk River at the village of Hughes was gauged by the USGS from June 1960 to 1982.

In August of 1994, a large flood on the Koyukuk River due to excess rain extensively damaged the villages of Allakaket and Alatna, with some damage at the village of Hughes. This flood was generated by two major low-pressure systems: one centered during August 15 through 18 and another from August 23 to 27. The amount of precipitation upstream of the flooded villages was estimated at 4–5 in. for the first storm and 4½–5 in. for the second storm (oral and written communication by Paul Meyer, National Weather Service, cited in D. Meyer, 1995). As with runoff, precipitation data are very limited for this expansive area. The depth of flooding was 2 ft to more than 10 ft in Allakaket, from 8 ft to more than 10 ft in Alatna, and from 0 to more than 10 ft in Hughes (Meyer, 1995). Through indirect measurements after the storm, the USGS estimated the peak flow at 9350 $m^3$/sec (330,000 $ft^3$/sec) downstream of the confluence with the Kanuti River (Meyer, 1995). The USGS roughly estimated that this was a 100-year runoff event that was much larger than any flows gauged while the Koyukuk River was gauged at the village of Hughes.

There is oral evidence by residents of the three villages (reported by Meyer, 1995) of other major flood events, but there is little quantitative data such as flow rates, stages, and exact dates.

## 4.2 Climatology

Long-term meteorological and hydrological data have been collected at a few populated villages in the past. For example, air temperatures were collected during a 30-year period (1980 to 2010) at Bettles (66°55.15′N, 151°31.09′W), Wiseman (67°24.28′N, 150°7.35′W), and Chandalar Shelf (68°4.57′N, 149°35.09′W), located near the north–south-oriented Dalton Highway (see Table 6 through Table 8 and Figure 5). Elevation increases from south to north from Bettles (192 m, 630 ft) to Wiseman (366 m, 1201 ft) to Chandalar Shelf (995 m, 3265 ft). It is obvious from Figure 5 that monthly mean air temperatures differ little over this elevation change. Bettles and Wiseman, both at a lower elevations than Chandalar Shelf, are slightly warmer during the summer, with all three sites having similar monthly means. As expected, January is the coldest month and July is the warmest most. This pattern of air temperature is found in most of Interior Alaska where a continental climate prevails.

Table 6. Bettles Airport mean monthly air temperature (Normals) retrieved from NCDC.

| | Average Air Temperature | | Maximum Air Temperature | | Minimum Air Temperature | |
|---|---|---|---|---|---|---|
| | °C | °F | °C | °F | °C | °F |
| January | -23.3 | -10.0 | -19.0 | -2.2 | -27.7 | -17.9 |
| February | -20.6 | -5.0 | -15.3 | 4.5 | -25.8 | -14.5 |
| March | -15.3 | 4.4 | -8.5 | 16.7 | -22.2 | -8.0 |
| April | -4.8 | 23.3 | 1.3 | 34.3 | -10.9 | 12.3 |
| May | 6.9 | 44.4 | 12.6 | 54.6 | 1.2 | 34.2 |
| June | 14.7 | 58.5 | 20.7 | 69.3 | 8.7 | 47.6 |
| July | 15.4 | 59.7 | 21.0 | 69.8 | 9.8 | 49.6 |
| August | 11.4 | 52.5 | 16.7 | 62.1 | 6.1 | 42.9 |
| September | 4.8 | 40.6 | 9.4 | 48.9 | 0.2 | 32.3 |
| October | -7.3 | 18.9 | -3.6 | 25.6 | -11.1 | 12.1 |
| November | -18.3 | -1.0 | -14.4 | 6.0 | -22.3 | -8.1 |
| December | -20.9 | -5.7 | -16.7 | 1.9 | -25.2 | -13.4 |

Table 7. Wiseman mean monthly air temperature (Normals) retrieved from NCDC.

| | Average Air Temperature | | Maximum Air Temperature | | Minimum Air Temperature | |
|---|---|---|---|---|---|---|
| | °C | °F | °C | °F | °C | °F |
| January | -23.3 | -10.0 | -17.8 | -0.1 | -28.8 | -19.8 |
| February | -20.9 | -5.6 | -14.9 | 5.1 | -26.8 | -16.2 |
| March | -15.5 | 4.1 | -7.4 | 18.7 | -23.6 | -10.4 |
| April | -5.1 | 22.9 | 2.6 | 36.7 | -12.7 | 9.1 |
| May | 5.6 | 42.0 | 13.0 | 55.4 | -1.9 | 28.5 |
| June | 13.2 | 55.8 | 20.9 | 69.6 | 5.6 | 42.0 |
| July | 13.8 | 56.9 | 21.1 | 70.0 | 6.6 | 43.8 |
| August | 10.0 | 50.0 | 16.7 | 62.1 | 3.3 | 38.0 |
| September | 3.3 | 38.0 | 9.2 | 48.5 | -2.5 | 27.5 |
| October | -8.6 | 16.6 | -3.9 | 25.0 | -13.3 | 8.1 |
| November | -19.2 | -2.6 | -14.4 | 6.1 | -24.1 | -11.3 |
| December | -20.9 | -5.7 | -15.7 | 3.7 | -26.2 | -15.1 |

Table 8. Chandalar Shelf mean monthly air temperature (Normals) retrieved from NCDC.

| | Average Air Temperature °C | °F | Maximum Air Temperature °C | °F | Minimum Air Temperature °C | °F |
|---|---|---|---|---|---|---|
| January | -20.7 | -5.2 | -17.6 | 0.3 | -23.7 | -10.6 |
| February | -20.5 | -4.9 | -17.8 | -0.1 | -23.1 | -9.6 |
| March | -17.3 | 0.8 | -14.1 | 6.6 | -20.6 | -5.1 |
| April | -10.2 | 13.6 | -6.5 | 20.3 | -13.9 | 6.9 |
| May | 0.3 | 32.5 | 3.8 | 38.8 | -3.2 | 26.2 |
| June | 8.7 | 47.6 | 12.2 | 53.9 | 5.1 | 41.2 |
| July | 9.9 | 49.9 | 13.2 | 55.8 | 6.6 | 43.9 |
| August | 6.3 | 43.4 | 9.6 | 49.3 | 3.1 | 37.6 |
| September | -0.1 | 31.8 | 2.3 | 36.2 | -2.6 | 27.3 |
| October | -10.4 | 13.3 | -8.1 | 17.5 | -12.7 | 9.1 |
| November | -17.8 | 0.0 | -14.9 | 5.1 | -20.7 | -5.2 |
| December | -19.2 | -2.5 | -16.3 | 2.7 | -22.1 | -7.7 |

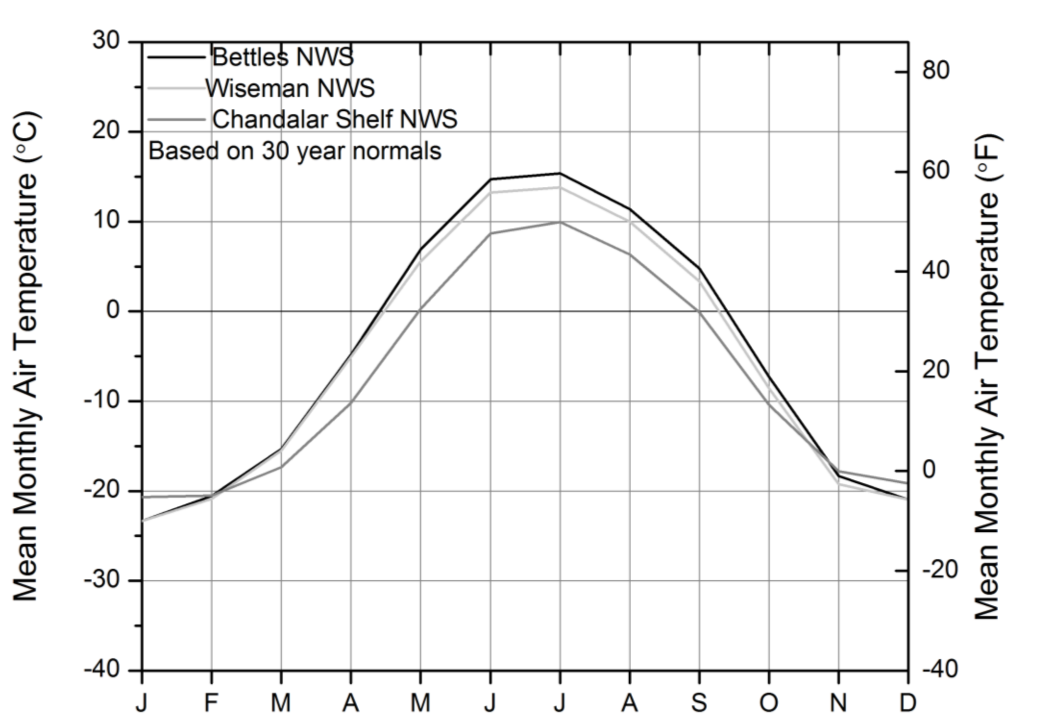



Figure 5. A plot of mean monthly air temperature for Bettles, Wiseman, and Chandalar Shelf, Alaska, from 1980 to 2010 (Source, NCDC).

Precipitation data were collected at the three stations along the Dalton Highway (Bettles, Wiseman, and Chandalar Shelf) during the same period, 1980 to 2010 (Table 9 through Table 11, Figure 6). The wettest months of the year are June, July, August, and September, with August and July the two that are wettest (July was the wettest for Wiseman; August was the wettest for Bettles and Chandalar Shelf). One-third of the annual precipitation falls as solid, and two-thirds falls as liquid. This ratio is similar to that on the north side of the Brooks Range and adjacent foothills. In Figure 7, cumulative mean monthly precipitation is shown. The steeper the slope of the three station curves (Bettles, Wiseman, and Chandalar Shelf), the greater the amount of precipitation. The mean annual precipitation from 1980 to 2010 for these three stations is about 350 mm (14 in.). While there is little variability in the precipitation amount at these three stations on a north–south transect, there is more variation from east to west in the study area. This variation will be shown later in the precipitation section. Although only one-third of the annual precipitation falls as snow (solid), it accumulates for 7 months, ensuring that a significant snowmelt runoff event will occur, with high probability that it will be the highest runoff event of the year.

The driest months are March and April at all three stations. This is also the case north of the continental divide of the Brooks Range.

Table 9. Bettles Airport mean monthly precipitation (Normals) retrieved from NCDC.

| | **Precipitation (mm)** | **Precipitation (in.)** |
|---|---|---|
| January | 20.3 | 0.80 |
| February | 21.6 | 0.85 |
| March | 14.7 | 0.58 |
| April | 15.2 | 0.60 |
| May | 22.3 | 0.88 |
| June | 35.6 | 1.40 |
| July | 59.9 | 2.36 |
| August | 67.1 | 2.64 |
| September | 48.5 | 1.91 |
| October | 26.4 | 1.04 |
| November | 23.4 | 0.92 |
| December | 23.4 | 0.92 |

Table 10. Wiseman mean monthly precipitation (Normals) retrieved from NCDC.

| | **Precipitation (mm)** | **Precipitation (in.)** |
|---|---|---|
| January | 23.4 | 0.92 |
| February | 21.6 | 0.85 |
| March | 9.7 | 0.38 |
| April | 14.7 | 0.58 |
| May | 27.7 | 1.09 |
| June | 46.0 | 1.81 |
| July | 61.7 | 2.43 |
| August | 54.1 | 2.13 |
| September | 42.4 | 1.67 |
| October | 20.8 | 0.82 |
| November | 18.5 | 0.73 |
| December | 22.1 | 0.87 |

Table 11. Chandalar Shelf mean monthly precipitation (Normals) retrieved from NCDC.

| | **Precipitation (mm)** | **Precipitation (in.)** |
|---|---|---|
| January | 18.0 | 0.71 |
| February | 19.3 | 0.76 |
| March | 9.7 | 0.38 |
| April | 14.0 | 0.55 |
| May | 21.3 | 0.84 |
| June | 47.0 | 1.85 |
| July | 52.6 | 2.07 |
| August | 54.6 | 2.15 |
| September | 35.8 | 1.41 |
| October | 25.7 | 1.01 |
| November | 21.3 | 0.84 |
| December | 19.6 | 0.77 |

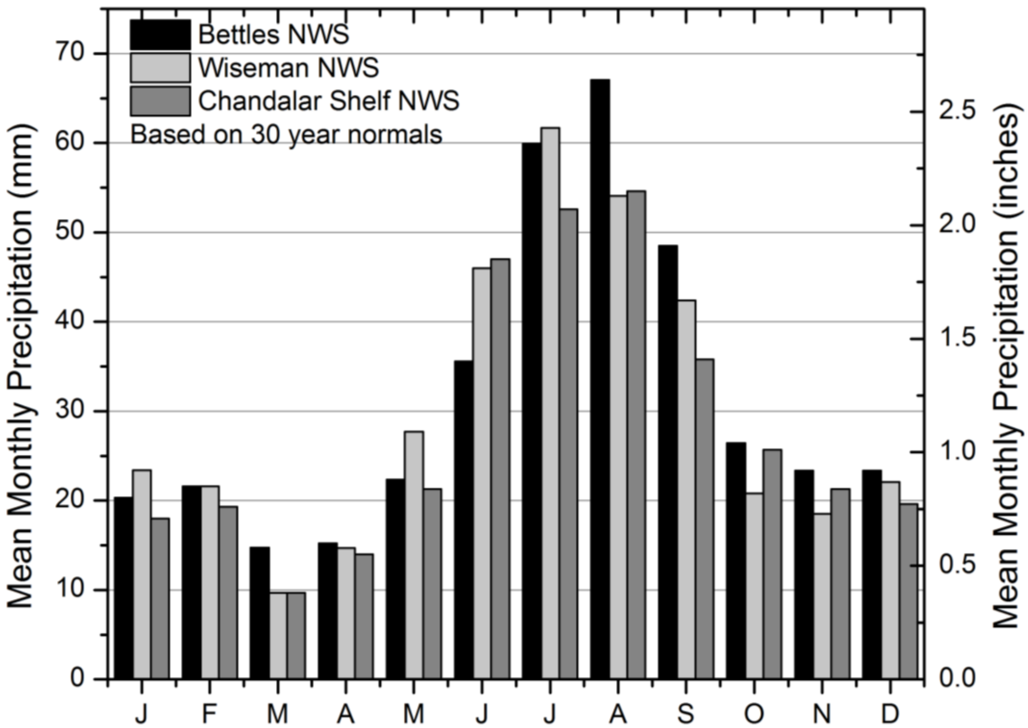



Figure 6. Plot of mean monthly precipitation for Bettles, Wiseman, and Chandalar Shelf, Alaska, from 1980 to 2010 (Source, NCDC).

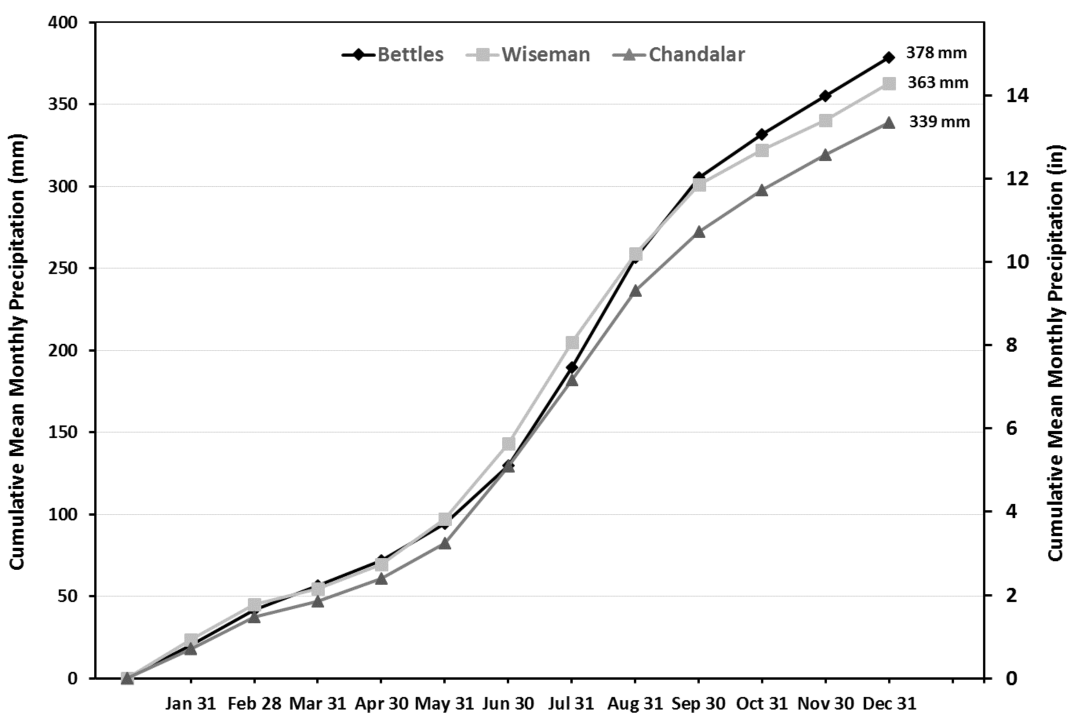



Figure 7. Cumulative mean monthly precipitation (1980 to 2010) on a north–south transect along the Dalton Highway.

The U.S. Department of Interior, Bureau of Land Management, has operated a warm season precipitation gauge at Norutak Lake (66°49.73′N, 154°19.28′W; 244 m, 800 ft) since 2003. This unattended site is approximately in the middle of the study area, on the southern boundary in the lowlands. The record for this site is relatively good except in 2013, when no data were collected. Still, the existing data (Figure 8) from this site give a good indication of the range and timing that can be expected in terms of warm season precipitation. The wettest summer, 2012, received almost 350 mm (14 in.), and the driest summer, 2004, received about 150 mm (6 in.). A plot of the cumulative average over the warm season for the 11-year record is shown in Figure 8. The average at summer's end is 240 mm (9.4 in.), with the steepest slope (most intense rainfall) occurring in July.

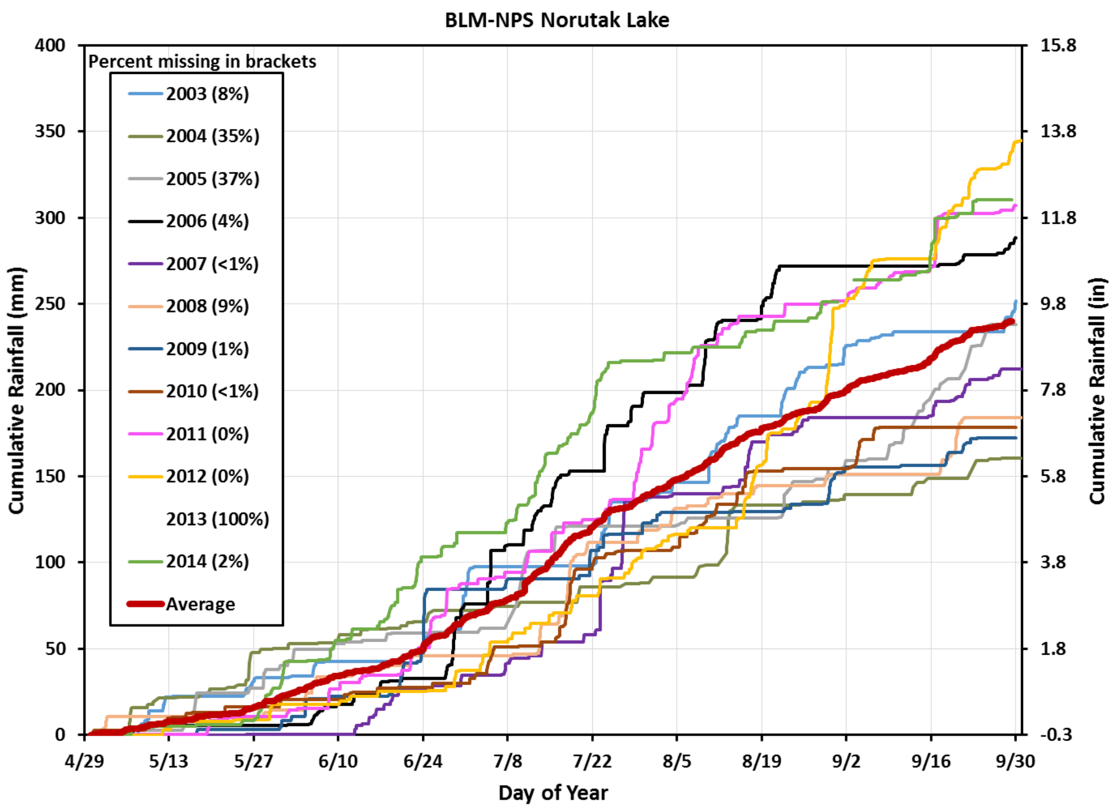



Figure 8. Warm season cumulative precipitation at Norutak Lake for 11 years; the average is indicated by the bold red line.

## 4.3 Air Temperature and Relative Humidity

Air temperature and relative humidity was measured at all the stations during the short duration of the study period. The four mountain stations (Wild, Upper Iniakuk, Upper Reed, Upper Kogoluktuk) had warmer winter temperatures and cooler summer temperatures when compared with the four lowland stations (Bettles, South Fork Bedrock Creek, Alatna, and Reed). Mean monthly air temperature was calculated for each month (Figure 9). The warmest months are June or July, and the coldest months are December, January, or February. In the study area, the coldest temperature in the lowlands was recorded in December 2012 at -47.1°C (-53°F) (Bettles); the warmest temperature was 31.2°C (88°F) (also in Bettles) in June 2013. Thus, in the warm season, the air temperature decreases with elevation, and in the cold season, an air temperature inversion occurs, with colder temperatures in the areas of low elevation. In the mountain region, the coldest temperature was -31.0°C (-24°F) (Wild) in January 2013, and the warmest temperature was 28.3°C (83°F) (Upper Kogoluktuk) in June 2013. The transition from the warm season to the cold season and vice versa occurs in early October (beginning of snow accumulation) and mid-April (ablation). The trend in air temperature data collected for over 30 years at Bettles, Wiseman, and Chandalar Shelf (reported in the Climatology section) has similar trends as the short-term air temperature data presented here, with cooler temperatures in the mountains in summer, and warmer temperatures in the mountains in winter.

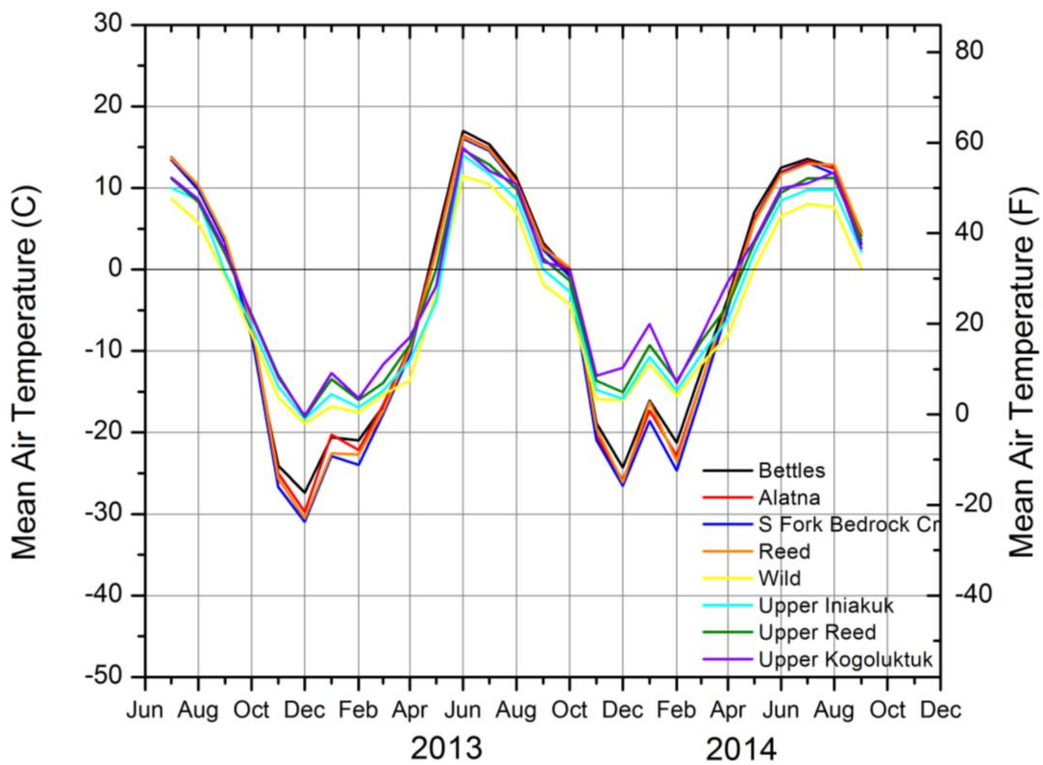



Figure 9. Mean monthly air temperature at stations in the Ambler network.

Relative humidity plays an important role in evapotranspiration; when the relative humidity is high, evapotranspiration is low (low vapor pressure gradient over the ground surface). In Figure

10, the average monthly relative humidity is plotted for a little over 2 years, from July 2012 to September 2014. The general trend is for high relative humidity (~80%) in the summer months with lower values (~50–70%) in the cold months. For both years, an initial drop in early winter, followed by a small rise in November/December and ending with another drop occurs in late winter. Part of this small mid-winter blip in relative humidity matches a small blip in mid-winter air temperature. It is not clear if other factors induce this variation in relative humidity. For a similar study on the Central Alaska North Slope, there was mid-winter variation in relative humidity, but nothing that matches the relative humidity pattern on the south side of the Brooks Range. The major difference in relative humidity on the north and south sides of the Brooks Range is that the relative humidity is generally higher on the north side in winter than on the south side. The months with the least monthly precipitation are in late winter and into spring (February, March, and April), and therefore it is not surprising that these months are prone to low relative humidity. Note that at low temperatures, although the relative humidity is high, there little moisture is in the atmosphere even at saturation (thus the term *relative*).

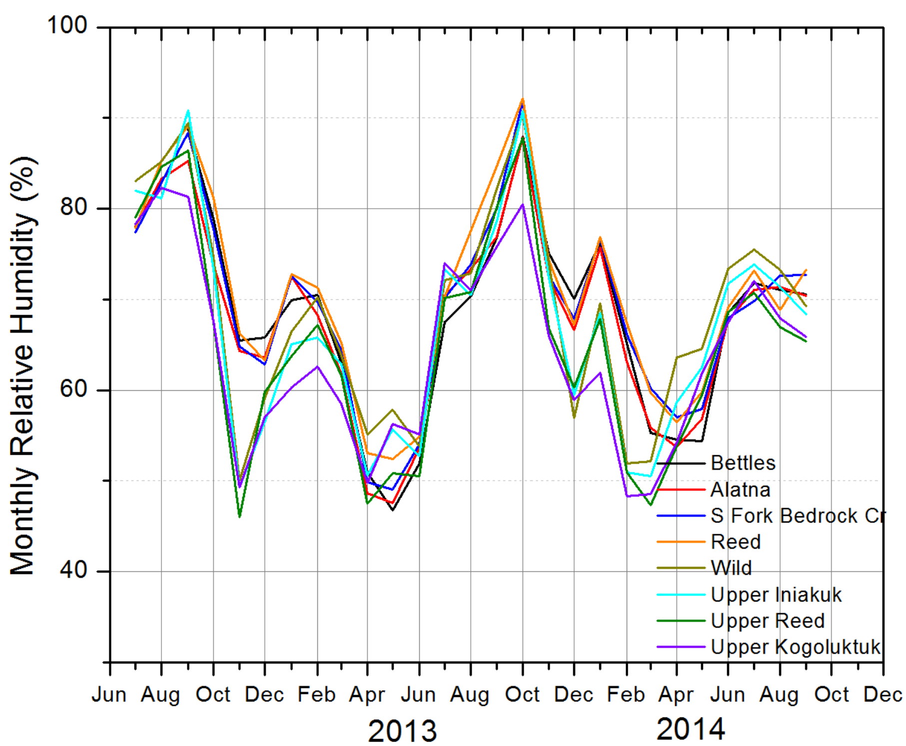



Figure 10. Mean monthly relative humidity during the period of observation at all 8 meteorological sites.

## 4.4 Net Radiation

Net radiation is the difference between the incoming radiation (positive) and the outgoing radiation (negative) for both shortwave and longwave. During the cold period, the difference is mainly negative, and during the warm period, the difference is mainly positive. Observations are not made during the cold period when snow and ice can accumulate on the surface of the sensor at these unattended sites. We are able to collect net radiation data from early April to October. Net radiation plays an important role in many hydrological processes where phase change plays a role: soil freezing and thawing, formation and decay of ice on surface water bodies, evapotranspiration, snowmelt, etc.

Peak average monthly net radiation values reach to 140 W/$m^2$ during the summer (usually in June around summer solstice) in the Ambler study area. The transition periods between warm and cold season are September and April. Figure 11 shows the monthly net radiation for late summer 2012 when the sites were installed, and the warm seasons for both 2013 and 2014. It is common for low-elevation sites to have a higher positive value than high-elevations sites. This relationship was found on the north side of the Brooks Range, also (Kane et al., 2014), where maximum monthly values were 125 W/$m^2$ on the Coastal Plain, 110 W/$m^2$ in the northern foothills, and 95 W/$m^2$ in the mountains. Considerable difference can occur from year-to-year, for example, wet cloudy or warm sunny summers.

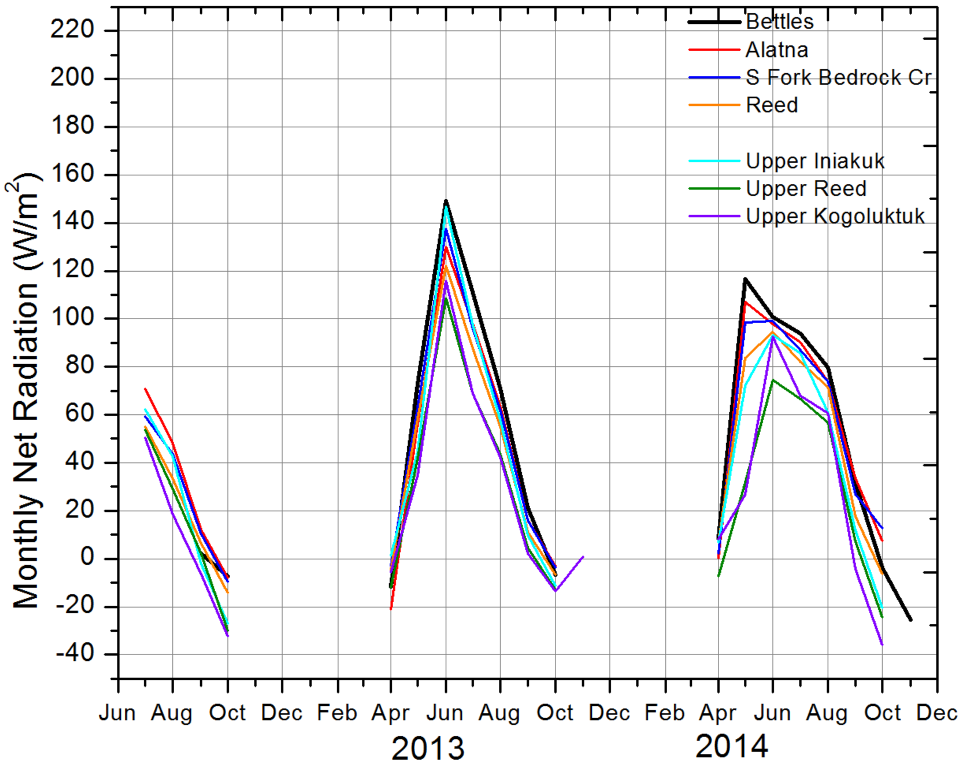



Figure 11. Warm season net radiation measured at all sites.

## 4.5 Wind Speed and Direction

As indicated earlier in the report, the eight meteorological stations were equipped with wind speed and direction sensors. The distribution of these stations is shown in Figure 3. In addition, partial data from three stations maintained by the National Park Service (NPS) in the heart of the Gates of the Arctic National Park and Preserve were available. For each station, a wind rose has been generated that summarizes wind activity statistics such as percent of time that winds of a certain range occur, the direction of wind events, the resultant vector, and the percent of time that calm periods occur. Three wind roses were generated for each site: annual, summer and winter (Appendix A).

In general, the highest winds are found at the higher elevations and the lowest winds are in the lowlands. Table 12 shows that the site with the highest average annual wind speed (5.1 m/s) is Upper Iniakuk (DAM 6, 838 m elevation); this site also has the highest average hourly wind speed (7.2 m/s) in summer. The windiest (4.9 m/s) winter location was one of the National Park Service sites (Killik) in the high Central Brooks Range. Bettles, at an elevation of 183 m, has the lowest overall wind speed of 0.6 m/s, the lowest summer average of 0.8 m/s, and the lowest winter average of 0.4 m/s. Not surprisingly, the areas with the most calm times coincide with those that have the lowest wind speeds (therefore, low elevations)—both summer and winter. About one-third of the time, Bettles, South Fork Bedrock Creek, Alatna, and Reed River reported calm conditions, and this is probably slightly overestimated because of the instrument threshold for initiating movement and the presence of rime ice. The threshold speed for the anemometers used (RM Young 05103-45-L) is listed as 1 m/s. Since these sites are unattended most of the year (they are usually visited twice per year: at winter's end when we measure SWE and late summer), no one is present to remove the rime and get the anemometer working again. It takes a high wind to put the anemometers back in working order. Until that happens, calm conditions are recorded.

The summer and winter wind roses in some cases show large seasonal changes in the prevailing winds. It is not uncommon for the prevailing wind in the summer to be from the opposite direction in winter (Figure 12 and Figure 13). Generally, it is windier in the summer than in the winter, with some exceptions (Figure 14).

Table 12. Summary of WRPLOT wind rose analysis for the period of record for July 2012 through September 2014. Summer period is May 1 through September 30, and winter period is October 1 through April 30. The direction of the resultant unit vector represents the mean wind direction (mean direction of the vectors), and the magnitude represents the frequency count for the mean direction (mean resultant vector length).

| Station | Overall Average Hourly Wind Speed (m/s) | Summer Average Hourly Wind Speed (m/s) | Winter Average Hourly Wind Speed (m/s) | Overall Calm Winds (%) | Summer Calm Winds (%) | Winter Calm Winds (%) | Overall Resultant Vector (degrees, %) | Summer Resultant Vector (degrees, %) | Winter Resultant Vector (degrees, %) | Total Data Count (hr) | Missing Data (hr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bettles (DAS1) | 0.6 | 0.8 | 0.4 | 39.4 | 25.0 | 43.7 | 341, 31 | 252, 10 | 348, 55 | 11628 | 2213 |
| Alatna River (DAS2) | 1.0 | 1.1 | 0.9 | 31.5 | 23.3 | 35.7 | 29, 29 | 267, 3 | 32, 56 | 22777 | 1321 |
| South Fork Bedrock Cr (DAS3) | 0.7 | 0.8 | 0.5 | 31.1 | 25.4 | 24.9 | 182, 32 | 199 ,26 | 168, 51 | 19680 | 4561 |
| Reed River (DAS4) | 0.9 | 1.1 | 0.6 | 34.3 | 22.1 | 40.0 | 302, 20 | 216, 4 | 308, 43 | 19746 | 2502 |
| Wild (DAM5) | 3.5 | 3.4 | 3.7 | 6.0 | 2.6 | 9.1 | 72, 14 | 200, 15 | 54, 36 | 19737 | 97 |
| Upper Iniakuk (DAM6) | 5.1 | 7.2 | 3.2 | 3.9 | 2.1 | 5.0 | 358, 16 | 147, 25 | 345, 50 | 19755 | 1256 |
| Upper Reed (DAM7) | 1.6 | 1.8 | 1.4 | 15.9 | 8.5 | 21.9 | 245, 23 | 226, 20 | 258, 28 | 10092 | 735 |
| Upper Kogoluktuk (DAM8) | 1.3 | 1.4 | 1.2 | 16.5 | 11.5 | 20.4 | 246, 39 | 226, 23 | 254, 55 | 10461 | 505 |
| Ram Creek (NPS) | N/A | 3.5 | N/A | N/A | 0.1 | N/A | N/A | 324, 12 | N/A | 4224 | 14402 |
| Chimney Lake (NPS) | 4.1 | 3.8 | 4.4 | 2.0 | 1.6 | 2.3 | 62, 23 | 143, 24 | 35, 43 | 18376 | 230 |
| Pamichtuk (NPS) | 3.8 | 3.7 | 3.7 | 3.1 | 1.8 | 3.0 | 97, 17 | 133, 20 | 52, 26 | 13611 | 5861 |
| Killik (NPS) | 4.5 | 4.1 | 4.9 | 1.4 | 1.3 | 1.4 | 8, 35 | 332, 3 | 10, 61 | 10373 | 381 |

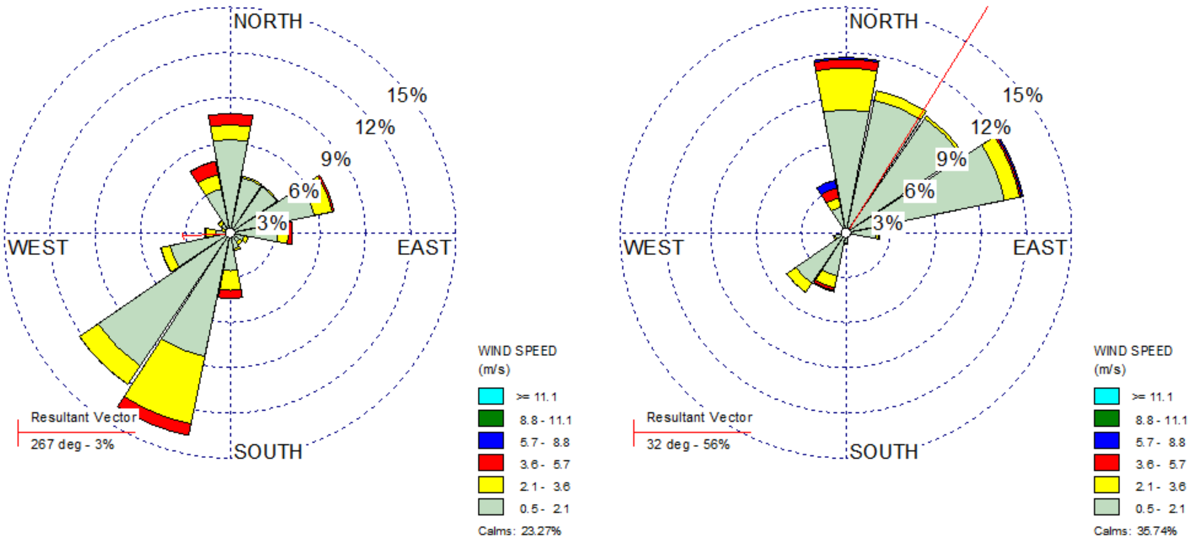



Figure 12. Alatna (DAS2) station a) summer and b) winter wind rose.

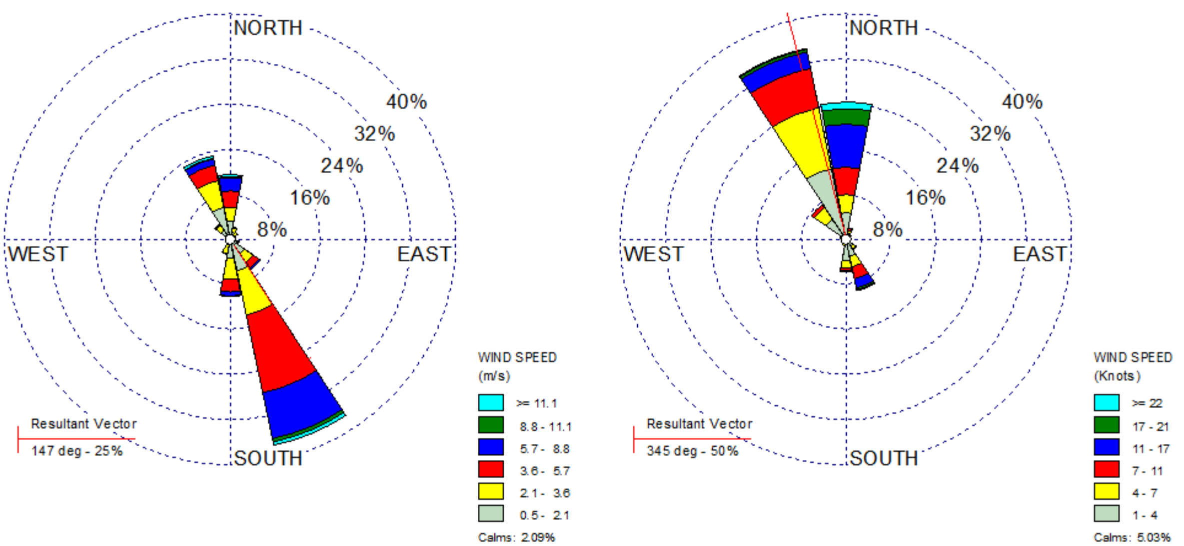



Figure 13.Upper Iniakuk (DAM6) station a) summer and b) winter wind rose.

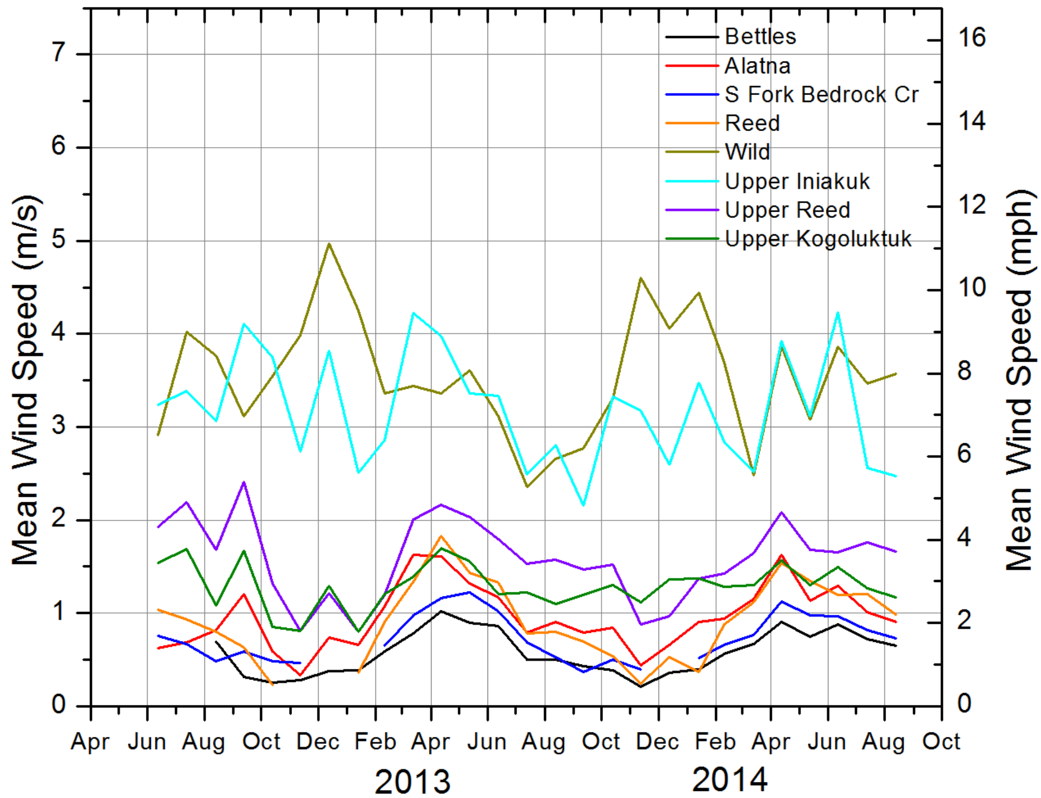



Figure 14. Mean monthly wind speed for stations in the Ambler network.

## 4.6 Annual Precipitation

As mentioned earlier, this region of the state is seriously deprived of hydrological data. In addition to the eight UAF stations installed in the study area (for individual station results see Appendix B), a few other precipitation gauges are located within or near the study area. The biggest contributor to the precipitation measurement pool is the USDA/NRCS, with four Wyoming shielded precipitation gauges at Gobbler's Knob (1998 to present), Bettles (1984 to present), Coldfoot (1996 to present), and Atigun Pass (1983 to present). The Wyoming gauge measures both solid and liquid precipitation and, therefore, cumulative annual precipitation; however, like all gauges, it undercatches the actual precipitation (Yang et al., 2000). Unlike most gauges, there is no relationship between undercatch amount and wind speed for solid precipitation (Yang et al., 2000).

## 4.7 Warm Season Precipitation

The cumulative warm season precipitation measurements were made at UAF's eight sites, four USDA/NRCS sites, and one remote automated weather system (RAWS), Norutak Lake (Figure 1). The duration of these measurements ranged from 2 to 32 years, the four USDA/NRCS gauges having record lengths of 17 to 32 years; RAWS, Norutak Lake, 12 years; and the remainder—UAF stations—2 to 2½ years.

As with all other meteorological data collected by UAF/WERC, warm season precipitation data were collected for the latter part of 2012 and the whole of the 2013 and 2014 summers. The data were typical except for the end of 2012 in the western reaches of the study area shortly after the site was installed, when significant rainfall occurred. The cumulative precipitation plots for the eight sites for part of 2012 (after early July) and all of 2013 and 2014 are shown in Appendix B. The vertical scale on each plot is the same to make comparison of events over the study area easier. The black line on each of these plots is the cumulative rainfall from when each site was installed in early July until freeze-up, 2012.

Each graph in Appendix B shows the temporal variation from year to year, but since there are only two complete warm seasons (2013 and 2014), not much is learned about year-to-year variation. Clearly, the partial plots of 2012 show that it was a year of relatively high precipitation compared with the other 2 years, except for the two farthest-east stations (Bettles and Wild). During a series of back-to-back low-pressure systems (Figure 18) in August and September 2012, considerable liquid precipitation fell, especially in the western part of the study area around the Upper Kogoluktuk and Upper Reed stations.

In Figure 15 through Figure 17, the cumulative precipitation for the three warm seasons (2012 is only partial) is shown. This indicates the spatial distribution of rainfall each year. A trend of more liquid precipitation at the higher elevations was observed, with a generally decreasing trend when traversing west to east, such that the stations could be ranked from highest to lowest in terms of warm season precipitation: Upper Kogoluktuk, Reed River, Upper Reed River, Wild, Alatna, South Fork Bedrock Creek, and Bettles (Upper Iniakuk was not operational during much of August and early September 2012). For two of the 3 years, the Reed River site had more warm season precipitation than the Upper Reed site, which is higher in elevation. This seems odd.

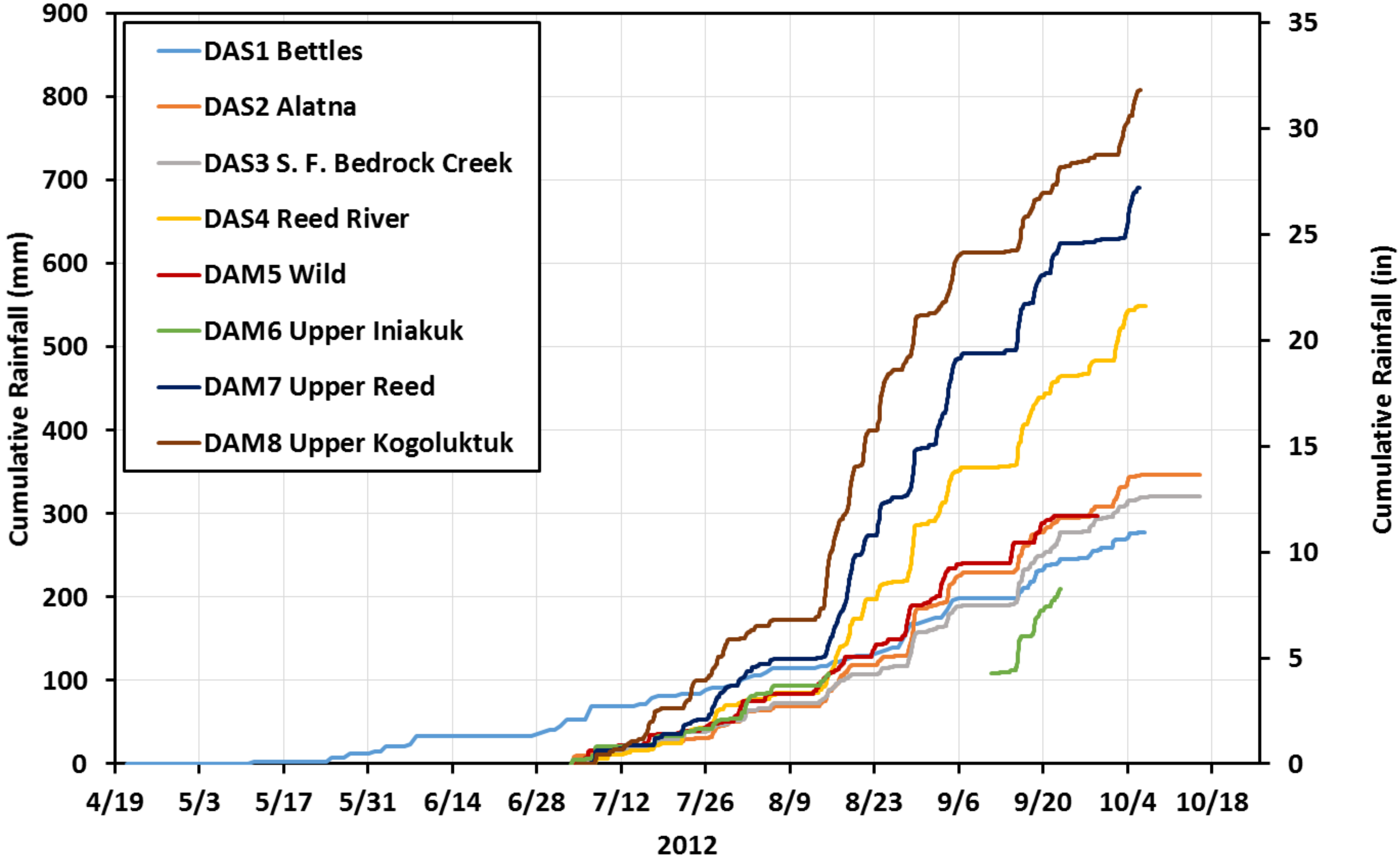



Figure 15. Cumulative rainfall at the UAF stations in 2012. A data gap occurs in the Upper Iniakuk record for late summer due to station malfunctions. Stations were not installed until late June 2012. Bettles NRCS data are substituted for DAS1-Bettles from May through July.

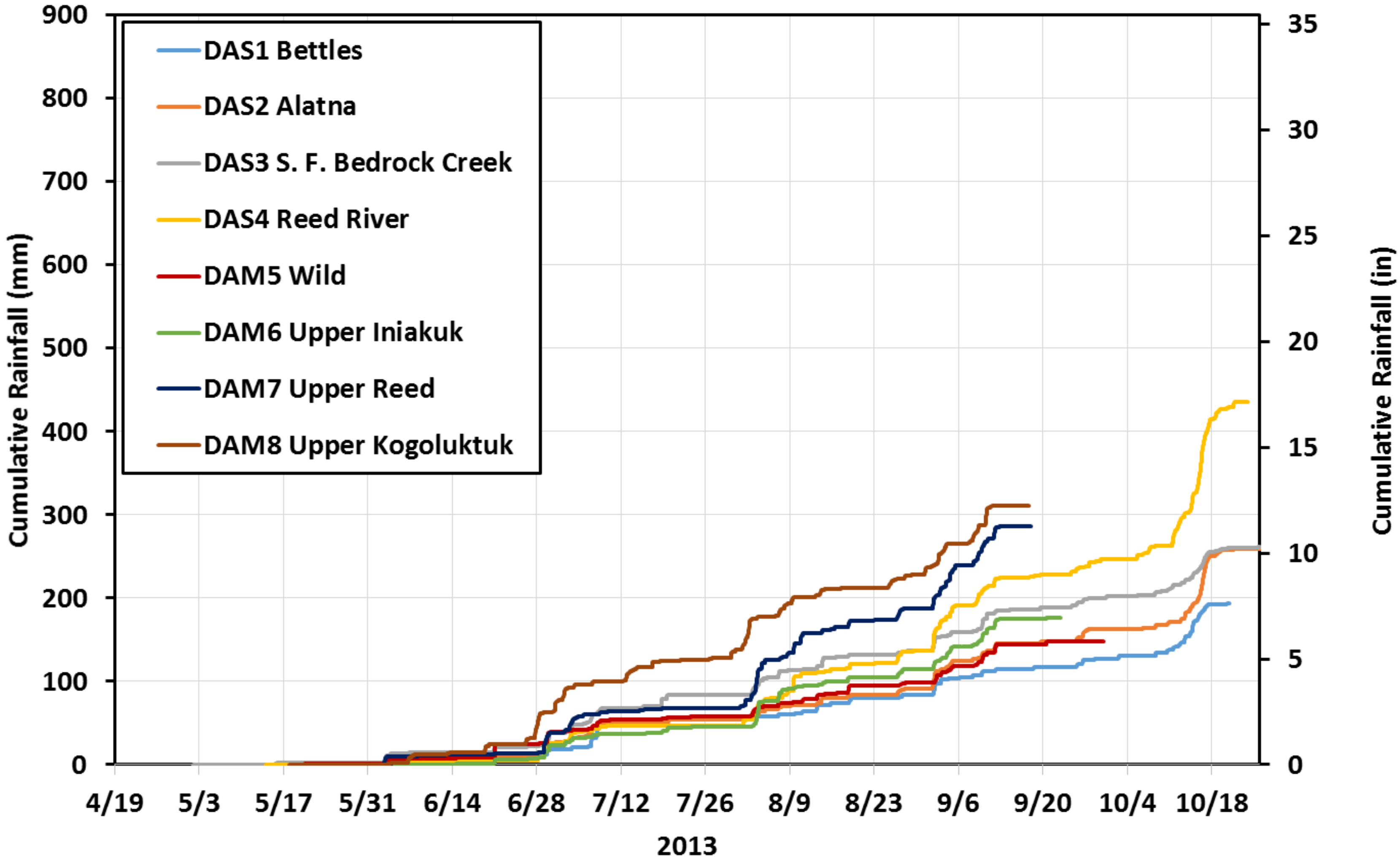



Figure 16.Cumulative rainfall at the UAF stations in 2013.

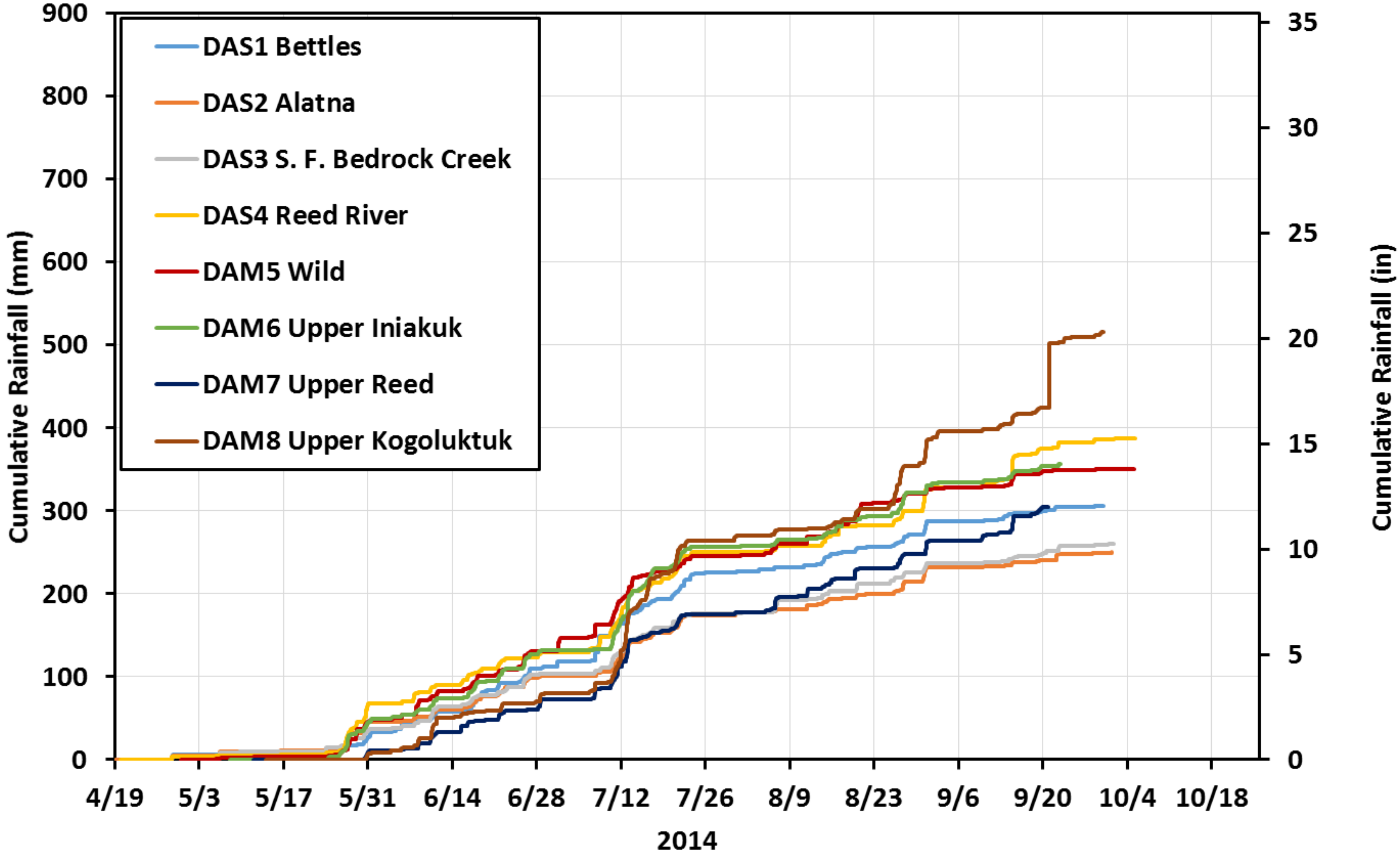



Figure 17.Cumulative rainfall at the UAF stations in 2014.

A remote precipitation gauge is operated during the warm season at Norutak Lake (66°47.8′N, 154°19.2′W, 217 m, 30 km south of Walker Lake), where data has been collected since 2003 by the NPS (Figure 8). The station was not operable in 2013, and during 2004 and 2005, over one-third of the data was missing. The result is that roughly 11 years of warm season precipitation has been collected at this location compared with 2 to 3 years at UAF sites. The three wettest summers were 2011, 2012, and 2014, while the three driest summers were 2004, 2009 and 2010 (2013 data are missing). This record would imply that the data we collected was of a relatively wet period. The red bold line in Figure 8 shows the average for the 11-year record. Although the 2012 cumulative warm season precipitation at the Norutak Lake gauge in mid-August was the lowest of the 11 years of available data, at freeze-up, the site had the highest warm season cumulative precipitation amount during the period of record. At summer's end, about 10 in. (~250 mm) of warm season precipitation should be expected on average in the Norutak Lake area.

One comparison we could make is between the long-term station at Kotzebue and the results from UAF's precipitation stations in the western Ambler area in 2012. Over 30 years of precipitation data have been collected at the Kotzebue Airport (near sea level), just west of the study area. An examination of observed monthly precipitation in May, June, July, August, and September versus mean monthly precipitation (over a 30-year period from 1980 to 2010) showed that the amount of departure from the monthly total for these 5 months of 2012 was May, 0.37, -0.04; June, 0.20, -0.38; July, 3.48, 2.03; August, 4.36, 2.18; September, 2.04, 0.46 (in.). At this sea level station, rainfall was 4.67 in. above normal for the months of July through September. May and June were the only months with below-normal rainfall (a 2-month total of -0.42 in.). The timing of the excess rainfall observed at Kotzebue matches the timing of high rainfall rates observed in the Ambler study area.

We have taken a closer look at the late summer 2012 rainfall (Table 13), performing one exercise that breaks out four periods of concentrated rainfall precipitation. These periods are generally separated by a short period of little or no rainfall for a few days. As mentioned before, a series of low-pressure systems followed roughly the same track (Figure 18) that delivered large amounts of perceptible water to the Ambler region. The four break-out durations were 08/14 to 08/27, 08/27 to 09/15, 09/15 to 09/24, and 09/24 to 10/06. In the last two columns of Table 13, the total storm precipitation for the four periods and the total warm season liquid precipitation are shown. The last row at the bottom of the table shows the same rainfall activity that took place at the Kotzebue Airport.

The most striking feature of Table 13 is the amount of precipitation at the Upper Kogoluktuk meteorological station. During the first intense period of precipitation (08/14 to 08/27), the Upper Kogoluktuk received almost 1 ft (11.9 in., 301 mm) of rainfall in a two-week period. Flooding was reported on the remote Kogoluktuk River (though no villages are located on this river), but there were no quantitative observations during the flooding. Overall, the highest precipitation amounts were at Upper Kogoluktuk (DAM8) and Upper Reed (DAM7), both in the mountains and in the western part of the study area. In Table 13, it can be seen that Bettles (DAS1) and Wild (DAM5) at the eastern end of the study area garnered the lowest amounts of precipitation. In general, the mountains, as expected, received more precipitation than the lower sites, and a decreasing trend was evident from west to east, such that lowland sites like Reed River (DAS4) received more precipitation than higher stations to the east.

For comparison purposes, we examined the precipitation pattern at the Kotzebue Airport at sea level to the west of the Ambler stations. The patterns were similar to the Kotzebue station, with 7.3 in. (186 mm) during the four rainy periods and 11.2 in. (284 mm) cumulative for all of the warm season. These values were similar to those at Bettles.

Table 13. Rainfall precipitation at each station relative to the series of storms in August and September 2012. Roughly four major periods of precipitation were broken out individually. Total rainfall during these storms and during that part of the warm season when measurements were made (sites installed in early July) is shown. In the last row, similar data from the Kotzebue Airport (outside the study area to the west) are shown. Bettles rainfall data is from the NRCS site.

| Station Name (ID) | Precipitation, mm (in.) | | | | | |
|---|---|---|---|---|---|---|
| | 08/14 to 08/27 | 08/27 to 09/15 | 09/15 to 09/24 | 09/24 to 10/06 | Storm Total | Warm Season Total |
| Bettles | 25 (1.0) | 58 (1.9) | 47 (1.9) | 32 (1.3) | 162 (6.4) | 278 (10.9) |
| South Fork Bedrock Creek (DAS3) | 35 (1.4) | 78 (3.1) | 92 (3.6) | 43 (1.7) | 248 (9.8) | 320 (12.6) |
| Alatna (DAS2) | 57 (2.2) | 101 (4.0) | 65 (2.6) | 52 (2.0) | 275 (10.8) | 347 (13.7) |
| Reed River (DAS4) | 133 (5.2) | 139 (5.5) | 107 (4.2) | 85 (3.3) | 465 (18.3) | 549 (21.6) |
| Wild (DAM 5) | 59 (6.3) | 98 (3.9) | 36 (1.4) | 21 (0.8) | 214 (8.4) | 298 (11.7) |

| Station Name (ID) | Precipitation, mm (in.) | | | | | |
|---|---|---|---|---|---|---|
| | 08/14 to 08/27 | 08/27 to 09/15 | 09/15 to 09/24 | 09/24 to 10/06 | Storm Total | Warm Season Total |
| Upper Iniakuk (DAM6) | NA | NA | NA | NA | NA | NA |
| Upper Reed (DAM7) | 194 (7.6) | 177 (7.0) | 129 ( 5.1) | 66 (2.6) | 566 (22.2) | 691 (27.2) |
| Upper Kogoluktuk (DAM8) | 301 (11.9) | 140 ( 5.5) | 103 (4.1) | 92 (3.6) | 636 (25.0) | 808 (31.8) |
| Kotzebue Airport NWS | 83 (3.3) | 46 (1.8) | 29 (1.1) | 28 (1.1) | 186 (7.3) | 284 (11.2) |

The weather pattern responsible for the late warm season precipitation is described in the following discussion. During early August 2012, a ridge of high pressure from the Bering Sea across northern Alaska into northwestern Canada blocked storms from the western Pacific Ocean, so that Interior Alaska and Northern Alaska were not affected. During this time, the storm track lay along the northern Gulf of Alaska into the Alaska Panhandle, British Columbia, and the Pacific Northwest. Beginning August 11, the high-pressure system moved west into western Canada forming a blocking high ridge from the northeast Pacific into the eastern Beaufort Sea. Combined with a stationary low-pressure system in eastern Siberia, this ridge began channeling a series of storms from the western Pacific Ocean through the Bering Sea and into the Alaska mainland. Persistent rainfall, heavy at times, began over the western Arctic and Alaska’s northwestern interior on August 12.

By August 18, 2012, a trough of three low-pressure systems stretched over 3000 km (1800 mi) from the Bering Sea northeastward to near the North Pole (Figure 18). The blocking high-pressure system had expanded and connected with a stationary high-pressure system centered over Greenland. These conditions persisted until early September. During this time, several storms passed northward along the west coast of Alaska. Short breaks in the rainfall occurred on August 20, 23, 26, and 31, as each storm passed northward over the Arctic Ocean. The weather pattern broke on September 7, as the low pressure moved into central Canada from the Arctic Ocean, forming a trough that ended the long rainy period.

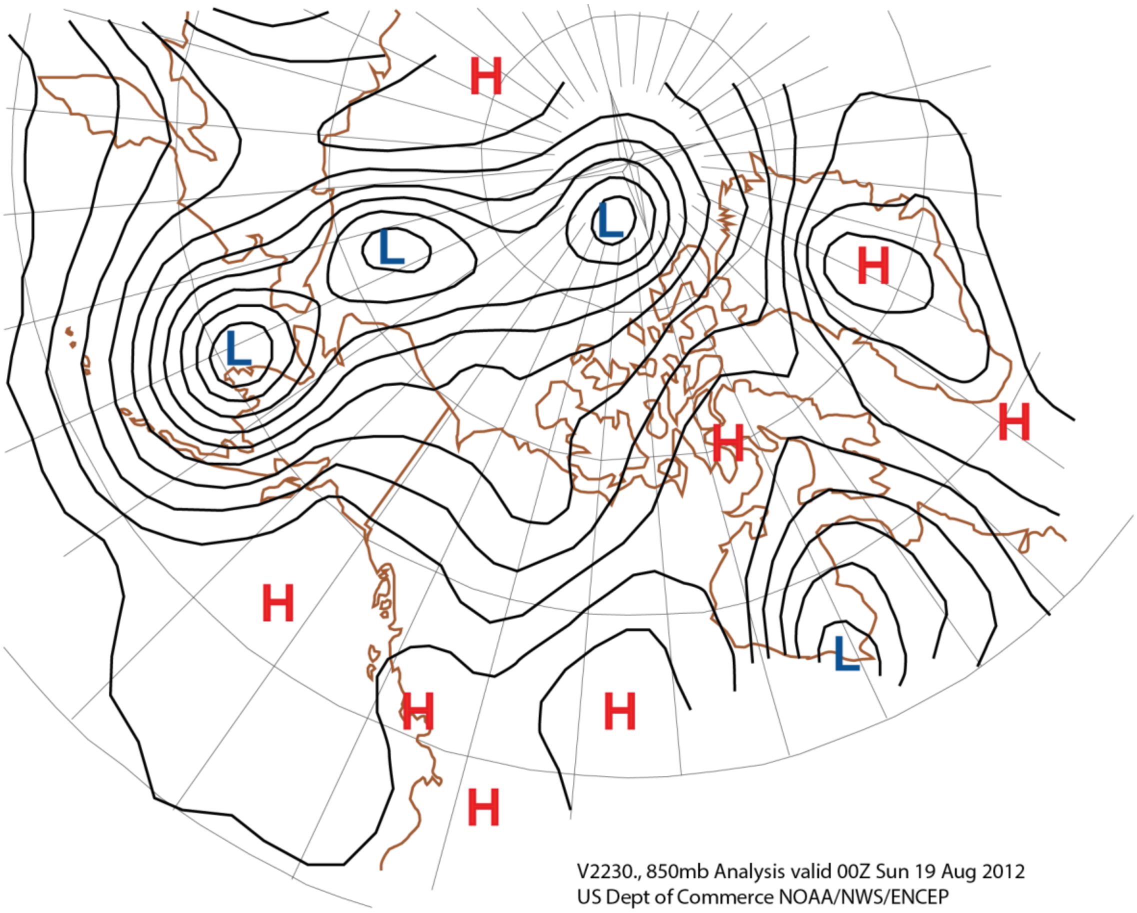



Figure 18. NOAA weather analysis 00Z (15:00 AST) August 19, 2012

Another period of significant rainfall occurred later, from mid-September into early October, as another blocking high-pressure system redeveloped across the northern Pacific Ocean and western Canada. This pattern of a blocking ridge of high pressure was responsible for the abundant precipitation observed in the Ambler area and surrounding areas from mid-August until early October 2012.

## 4.8 Cold Season Precipitation

Snow sensor data used in conjunction with snow survey data can enhance and expand the information gained from both sampling methods. Since an ultrasonic sensor records snow depth at a single point, the additional 50 snow depth measurements near each station represent local-scale variability relative to the measurement area under the SR50 sensor.

Eight meteorological stations (DAS1–DAS4 and DAM5–DAM8) with SR50 sensors were installed during summer 2012. Data from one USDA/NRCS SNOTEL site are also reported here

(Coldfoot). Snowpack data from the 2012–2013 winter were presented in Stuefer et al. (2014). During winter 2013–2014, SR50 measurements were recorded at the nine meteorological stations, and snow surveys were conducted at each of the stations at the end of winter, around the time of maximum snow accumulation (Table 14, Figure 19–Figure 27). The snow survey depths were quite variable, with a range in average snow depth of from 34 to 112 cm (Table 14). As a whole, however, snow depths in 2013–2014 were significantly greater than the 2012–2013 snowpack (Table 15). Table 16 compares the average snow survey depths for 2013–2014 and lists the percentage of difference from the maximum averages. All stations had greater snow depths during the 2014 end-of-winter snow surveys. Figure 28 and Figure 29 visually compares the annual variability.

In 2012–2013, snow accumulation initiated in the mountains months before lower elevations became snow-covered (Figure 29). Snow accumulation at all stations during the 2013–2014 winter consistently started around mid-September, albeit higher elevations received greater quantities of snow (Figure 19 through Figure 28). Throughout October, the snowpack remained relatively thin, with the exception of a snowfall event that took place in mid-October and then quickly melted at most stations. Wild (DAM5) and Upper Iniakuk (DAM6) were the only stations to maintain the bulk of their snowpack throughout October. During early November, all stations received the majority of their annual snowpack during one large storm event. Throughout the remainder of winter, the snowpack was in equilibrium, with several smaller storm events essentially offsetting compaction and settlement.

All stations reported good-quality SR50 snow depth data. Variability is evident, however, in terms of how well the automated snow depths represent local snow courses. Most of the snow course data (50 observed depths collected near the station during end-of-winter snow surveys) had tightly grouped snow depths, illustrating somewhat homogeneous snowpacks. Upper Iniakuk (DAM6), like the previous year, was the only station with greatly varying snow depths and, consequently, a heterogeneous snowpack (Figure 24). The remainder of the snow courses had averages that closely matched the automated snow depth measurements. Three stations (Reed River (DAS4), Wild (DAM5) and Coldfoot (NRCS) have averages extremely close to the automated snow depth measurements (Figure 22, Figure 23, and Figure 27). The snow courses at Bettles (DAS1), South Fork Bedrock (DAS3), and Upper Reed (DAM7) stations all had averages slightly above the SR50 snow depth measurements (Figure 19, Figure 21, and Figure 25), while Alatna (DAS2) and Upper Kogoluktuk (DAM8) had averages slightly below (Figure 20 and Figure 26). In summary, snow courses at three stations had very strong correlations with the SR50 measurements, five snow courses had slight variations from the automated measurements (three above and two below), and one station had extremely heterogeneous snow depths and little association with the station. This exemplifies the challenges associated with siting the sensor and using SR50 snow depth data for quantitative analysis.

Table 14. Snow depth information for 2013–2014 from meteorological stations and co-located snow surveys.

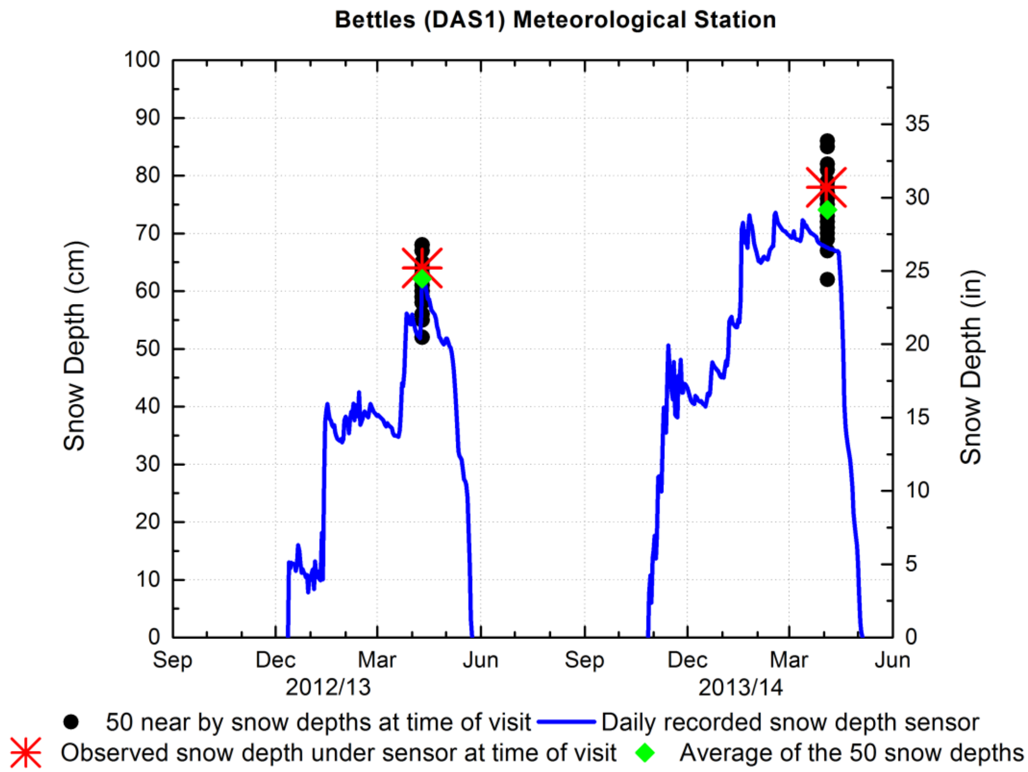
| Meteorological Station | Snow Survey Depth Range (cm) | Snow Survey Depth Ave. (cm) | Observed Depth Under SR50 (cm) | SR50 Reported Depth at Time of Observed Depth (cm) | Differerence Between Observed and SR50 Reported Depth (cm) |
|---|---|---|---|---|---|
| Bettles (DAS1) | 62-86 | 72 | 78 | 68 | 10 |
| Alatna (DAS2) | 63-94 | 80 | 88 | 87 | 1 |
| S Fork Bedrock (DAS3) | 60-105 | 81 | 74 | 74 | 0 |
| Reed (DAS4) | 80-109 | 97 | 95 | 96 | -1 |
| Wild (DAM5) | 24-45 | 34 | 32 | 33 | -1 |
| Upper Iniakuk (DAM6) | 19-112 | 58 | 68 | 66 | 2 |
| Upper Reed (DAM7) | 96-128 | 112 | 98 | 94 | 4 |
| Upper Kogoluktuk (DAM8) | 96-118 | 108 | 111 | 116 | -5 |
| Coldfoot April (NRCS) | 68-89 | 79 | 78 | 76 | 2 |

Table 15. Snow depth information for 2012–2013 from meteorological stations and co-located snow surveys. “NA” represents no measurement.

| Meteorological Station | Snow Survey Depth Range (cm) | Snow Survey Depth Ave. (cm) | Observed Depth Under SR50 (cm) | SR50 Reported Depth at Time of Observed Depth (cm) | Differerence Between Observed and SR50 Reported Depth (cm) |
|---|---|---|---|---|---|
| Bettles (DAS1) | 52-68 | 62 | 64 | 56 | 8 |
| Alatna (DAS2) | 31-69 | 51 | 51 | 49 | 2 |
| S Fork Bedrock (DAS3) | 54-82 | 65 | NA | 40 | NA |
| Reed (DAS4) | 50-73 | 57 | 34 | 37 | -3 |
| Wild (DAM5) | NA | NA | NA | 40 | NA |
| Upper Iniakuk (DAM6) | 12-92 | 56 | NA | 33 | NA |
| Upper Reed (DAM7) | 76-93 | 84 | 62 | 57 | 5 |
| Upper Kogoluktuk (DAM8) | 60-89 | 47 | 77 | 79 | -2 |
| Coldfoot March(NRCS) | 27-47 | 38 | NA | 31 | NA |
| Coldfoot April (NRCS) | 43-70 | 59 | NA | 48 | NA |

Table 16. Snow survey depth average for 2013–2014 and percentage of difference from the maximum averages for each station.

| | 2013 | | 2014 | |
|---|---|---|---|---|
| Meteorological Station | Snow Survey Depth Ave. (cm) | | Snow Survey Depth Ave. (cm) | |
| Bettles (DAS1) | 62 | -14% | 72 | - |
| Alatna (DAS2) | 51 | -37% | 80 | - |
| S Fork Bedrock (DAS3) | 65 | -20% | 81 | - |
| Reed (DAS4) | 57 | -41% | 97 | - |
| Wild (DAM5) | NA | NA | 34 | - |
| Upper Iniakuk (DAM6) | 56 | -4% | 58 | - |
| Upper Reed (DAM7) | 84 | -25% | 112 | - |
| Upper Kogoluktuk (DAM8) | 47 | -56% | 108 | - |
| Coldfoot April (NRCS) | 59 | -25% | 79 | - |
| Average | 60 | | 80 | |



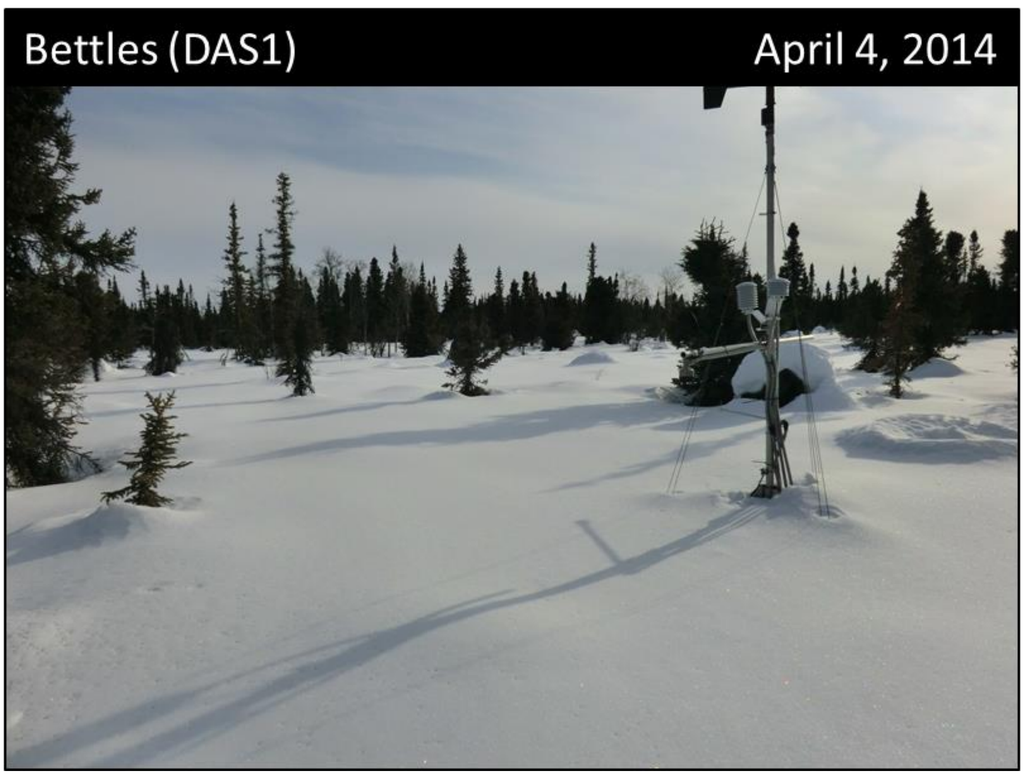




Figure 19. Bettles (DAS1) meteorological station daily (hourly averaged) recorded SR50 sensor snow depths, observed snow depth under the sensor at time of visit, 50 snow survey depths measured near sensor, and average of 50 depths, 2012–2014.

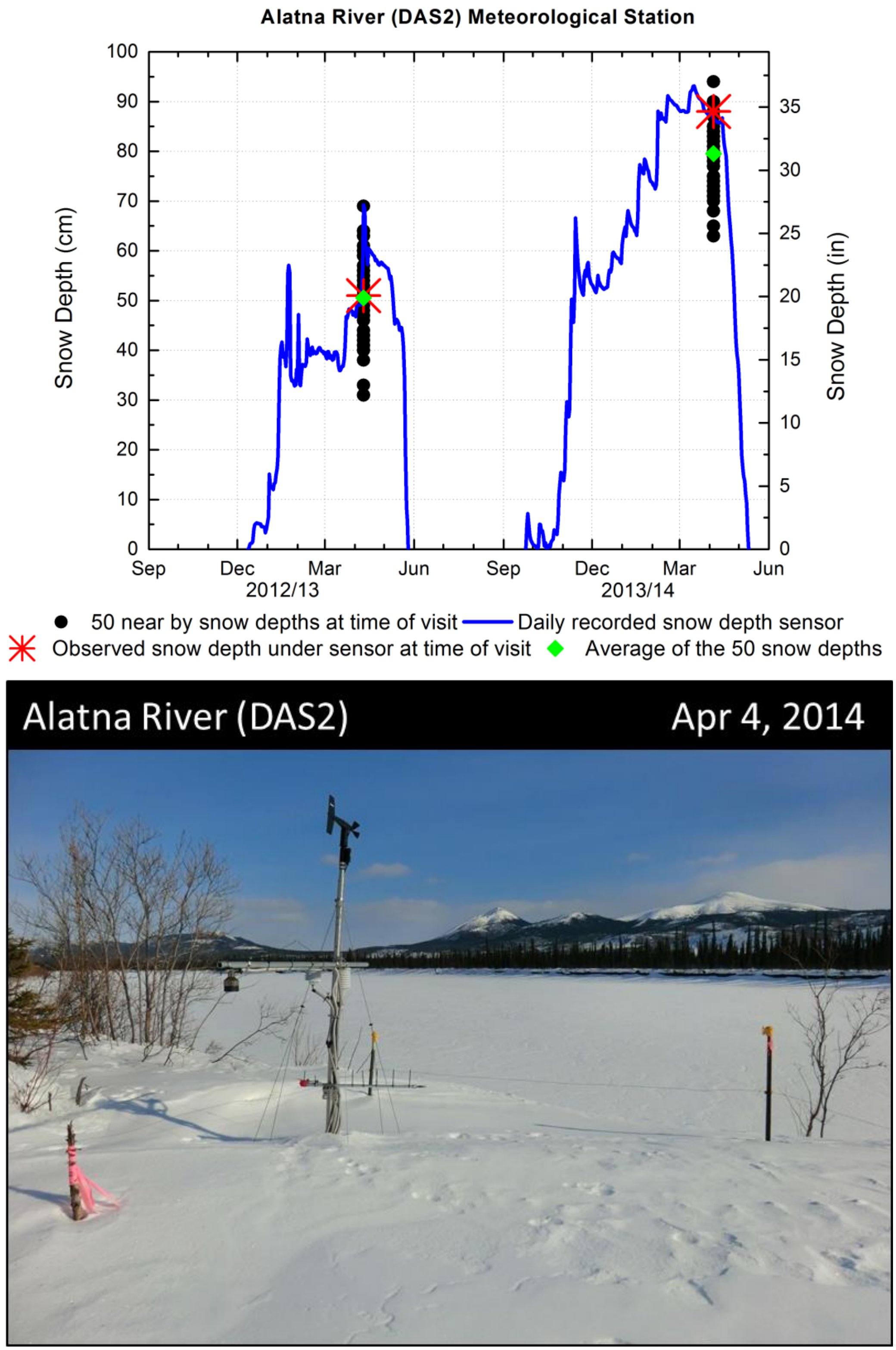



Figure 20. Alatna River (DAS2) meteorological station daily (hourly averaged) recorded SR50 sensor snow depths, observed snow depth under the sensor at time of visit, 50 snow survey depths measured near sensor, and average of 50 depths, 2012–2014.

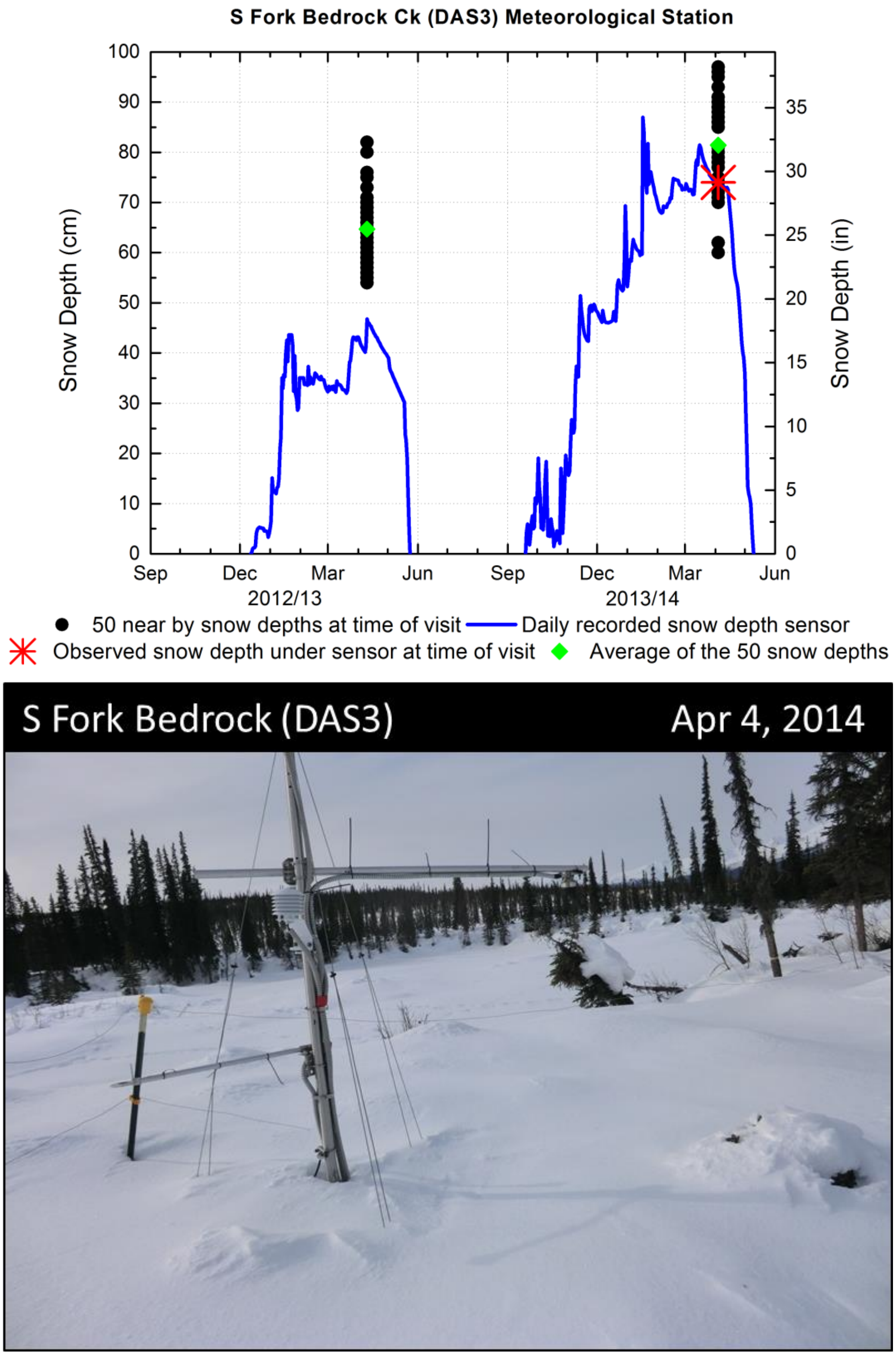



Figure 21. South Fork Bedrock Creek (DAS3) meteorological station daily (hourly averaged) recorded SR50 sensor snow depths, observed snow depth under the sensor at time of visit, 50 snow survey depths measured near sensor, and average of 50 depths, 2012–2014.

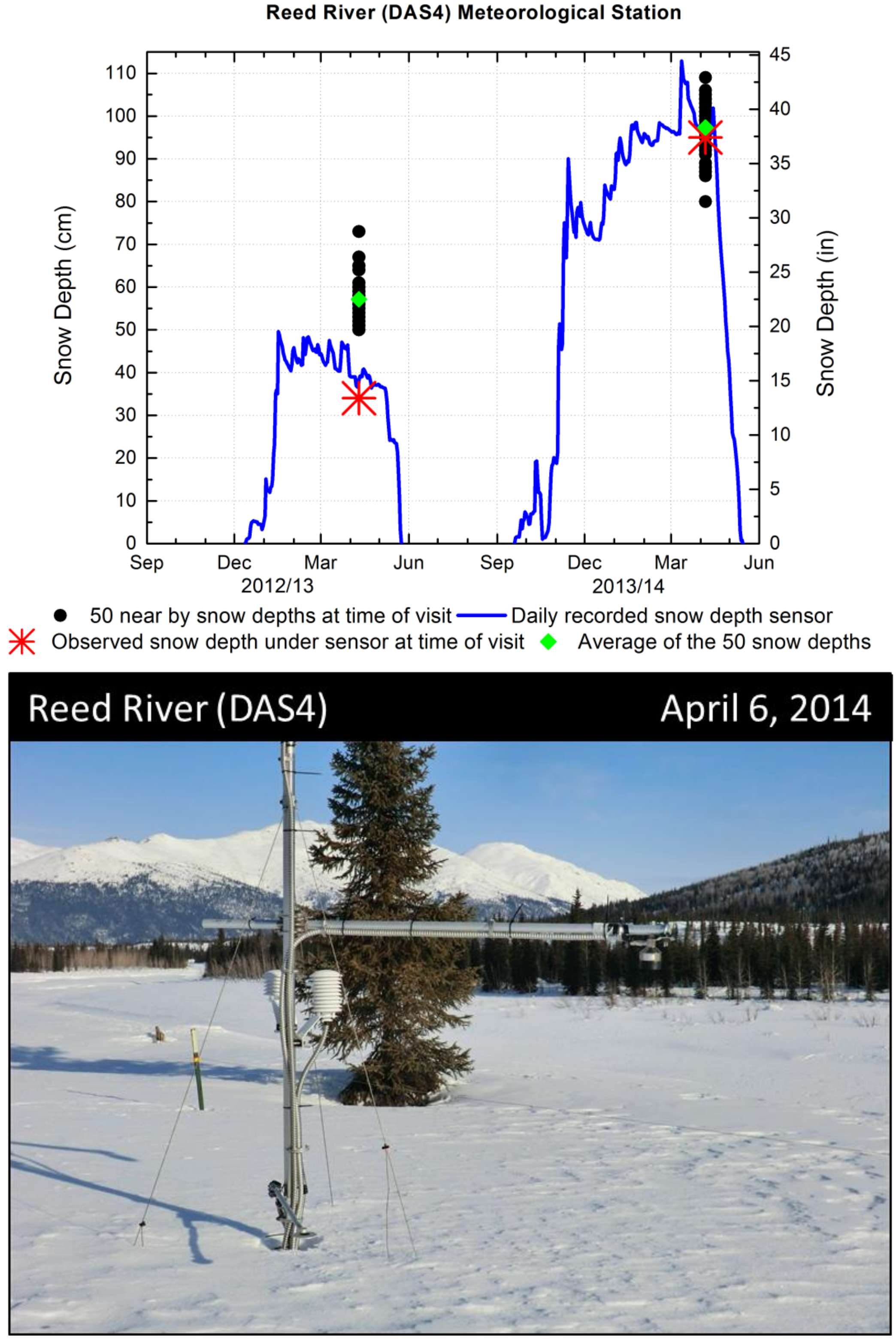



Figure 22. Reed River (DAS4) meteorological station daily (hourly averaged) recorded SR50 sensor snow depths, observed snow depth under the sensor at time of visit, 50 snow survey depths measured near sensor, and average of 50 depths, 2012–2014.

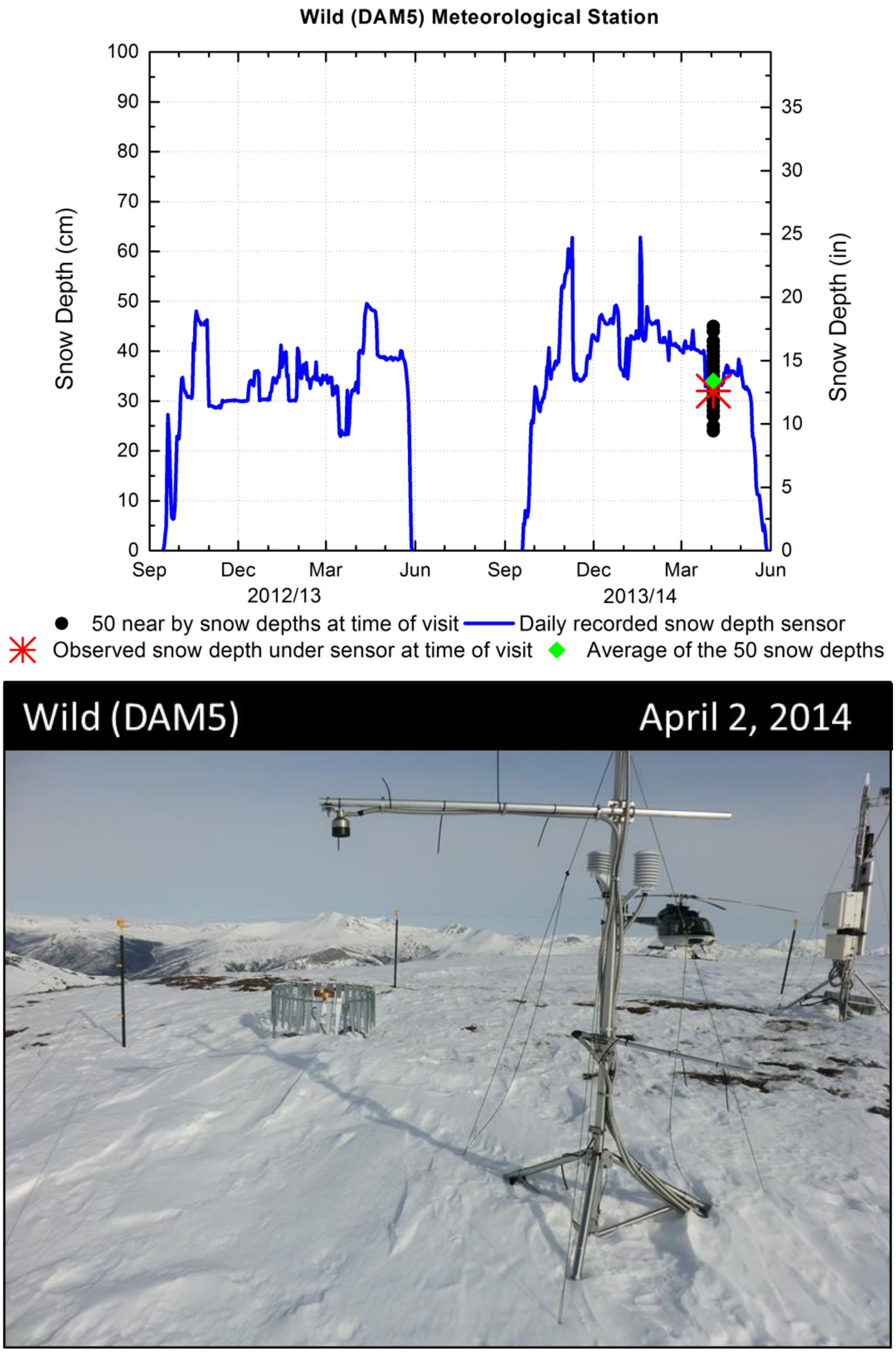
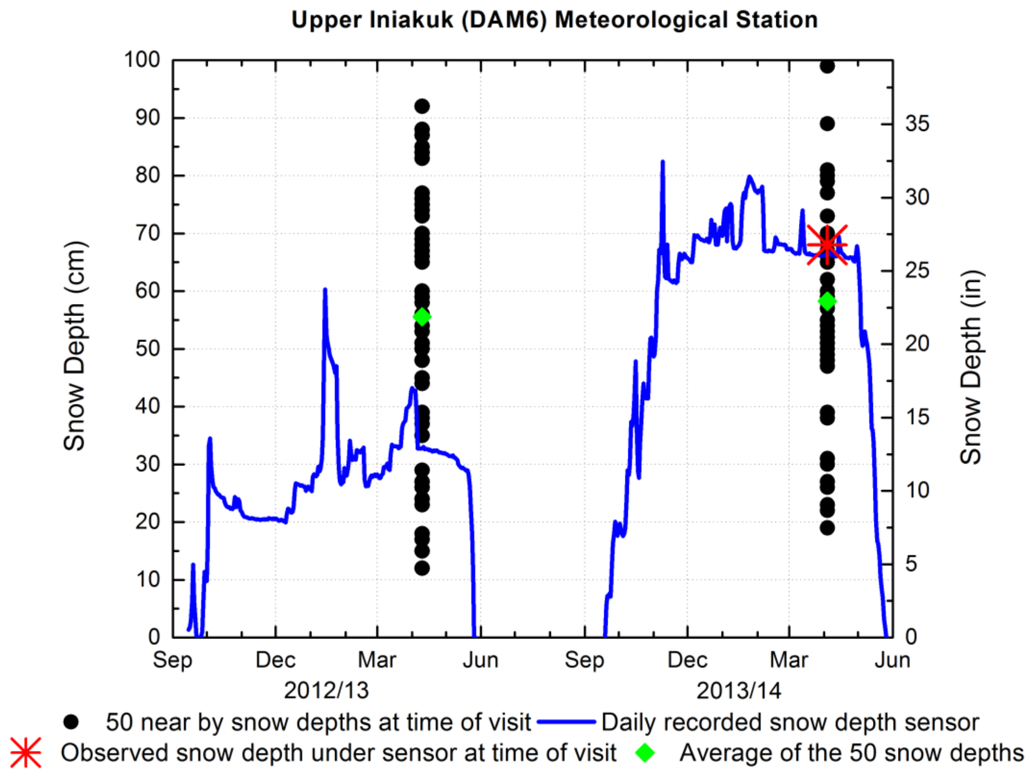



Figure 23. Wild (DAM5) meteorological station daily (hourly averaged) recorded SR50 sensor snow depths, observed snow depth under the sensor at time of visit, 50 snow survey depths measured near sensor, and average of 50 depths, 2012–2014.



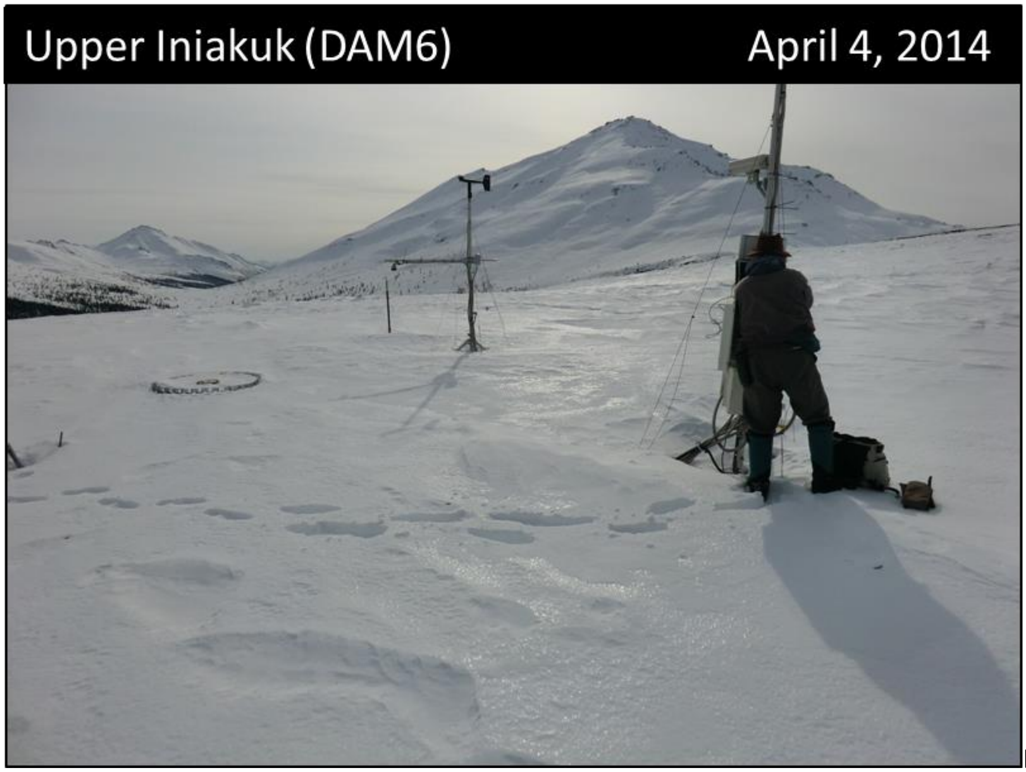




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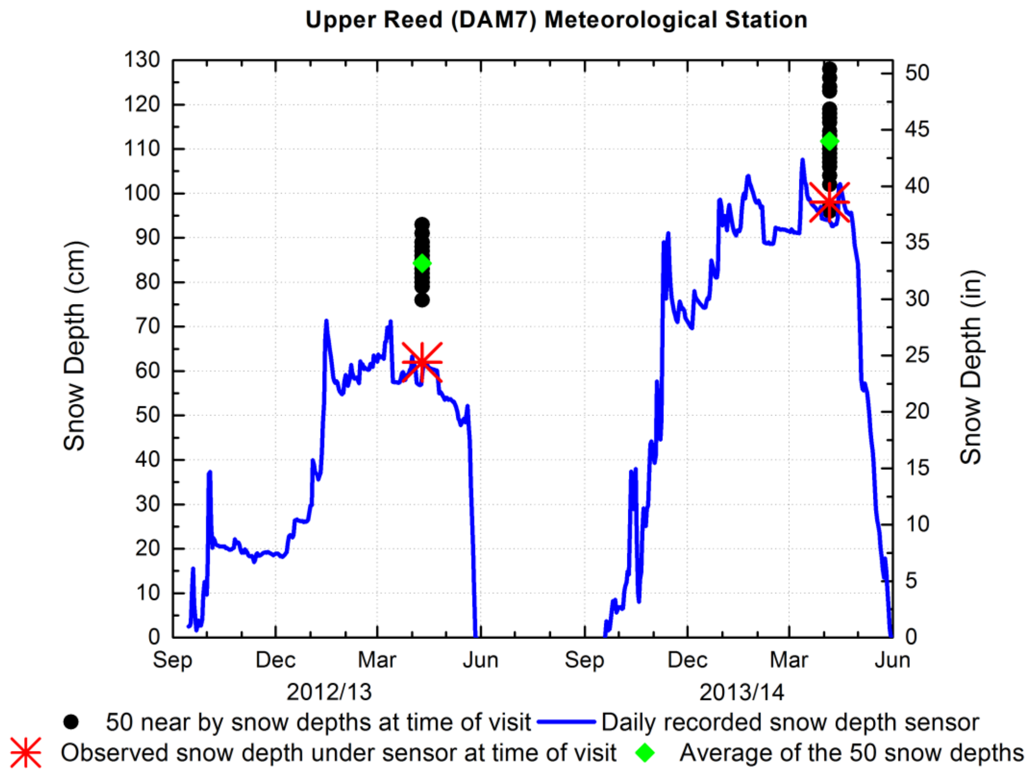
Figure 24. Upper Iniakuk (DAM6) meteorological station daily (hourly averaged) recorded SR50 sensor snow depths, observed snow depth under the sensor at time of visit, 50 snow survey depths measured near sensor, and average of 50 depths, 2012–2014.



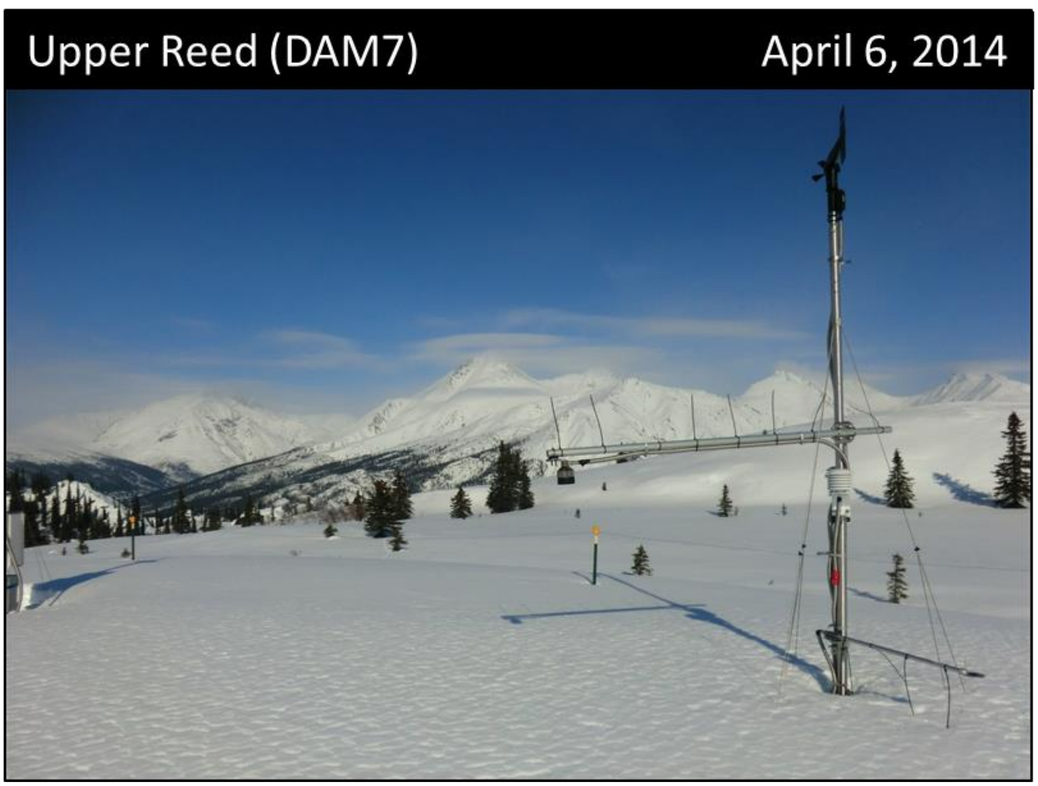




Figure 25. Upper Reed (DAM7) meteorological station daily (hourly averaged) recorded SR50 sensor snow depths, observed snow depth under the sensor at time of visit, 50 snow survey depths measured near sensor, and average of 50 depths, 2012–2014.

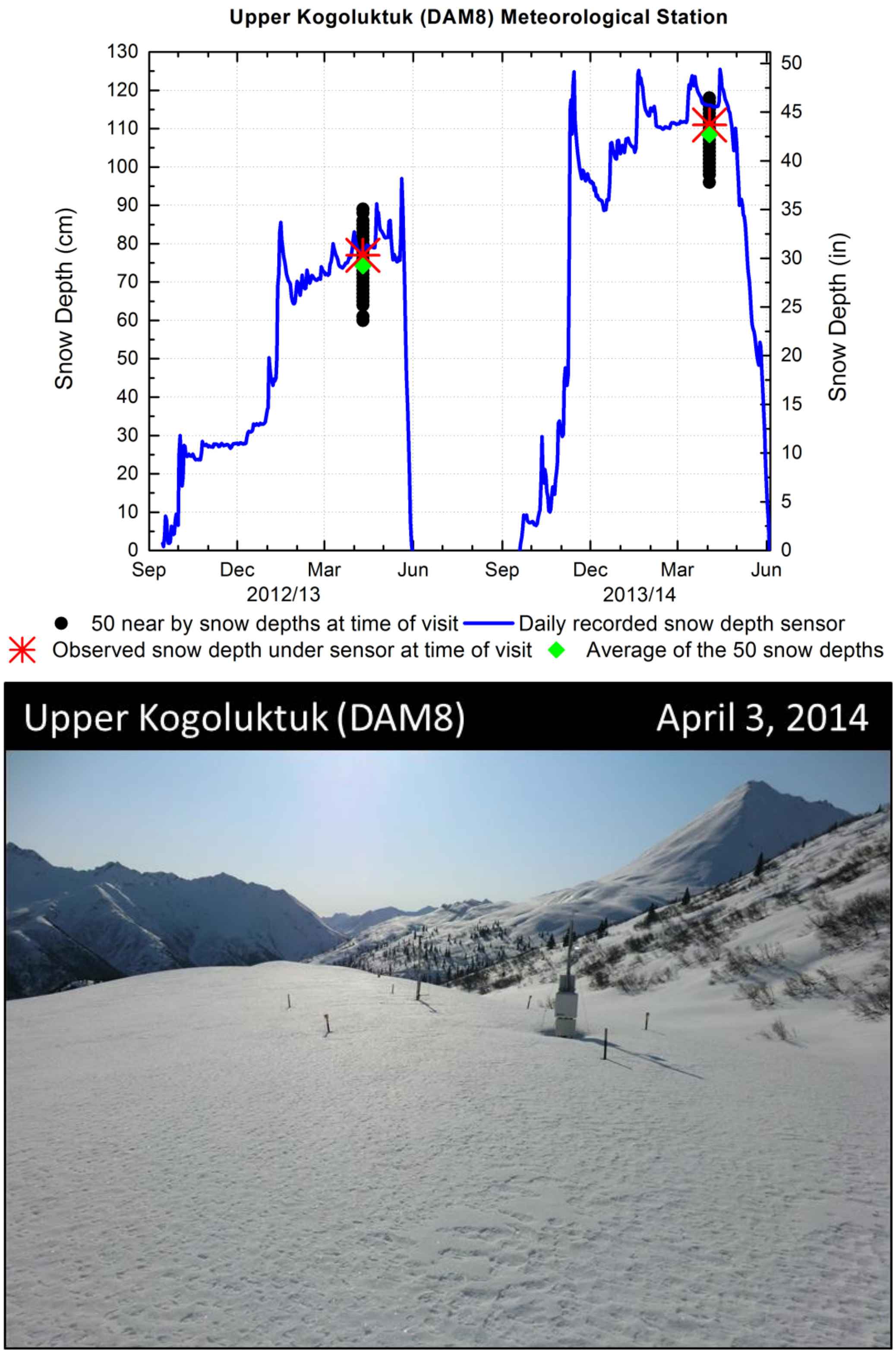
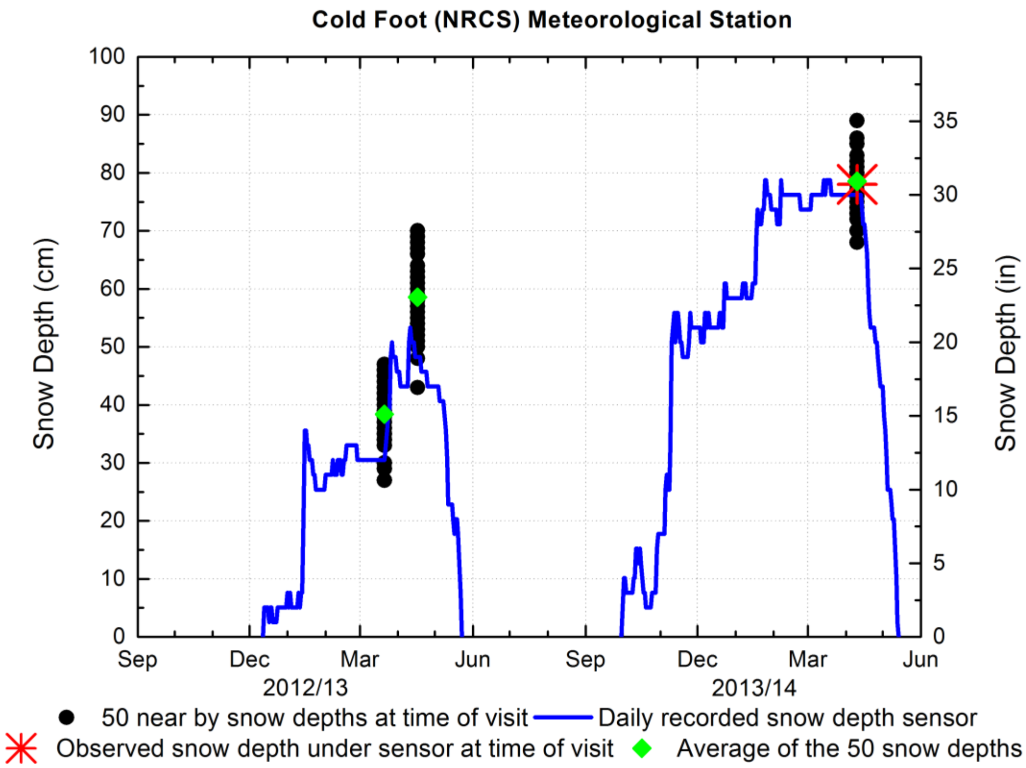



Figure 26. Upper Kogoluktuk (DAM8) meteorological station daily (hourly averaged) recorded SR50 sensor snow depths, observed snow depth under the sensor at time of visit, 50 snow survey depths measured near sensor, and average of 50 depths, 2012–2014.



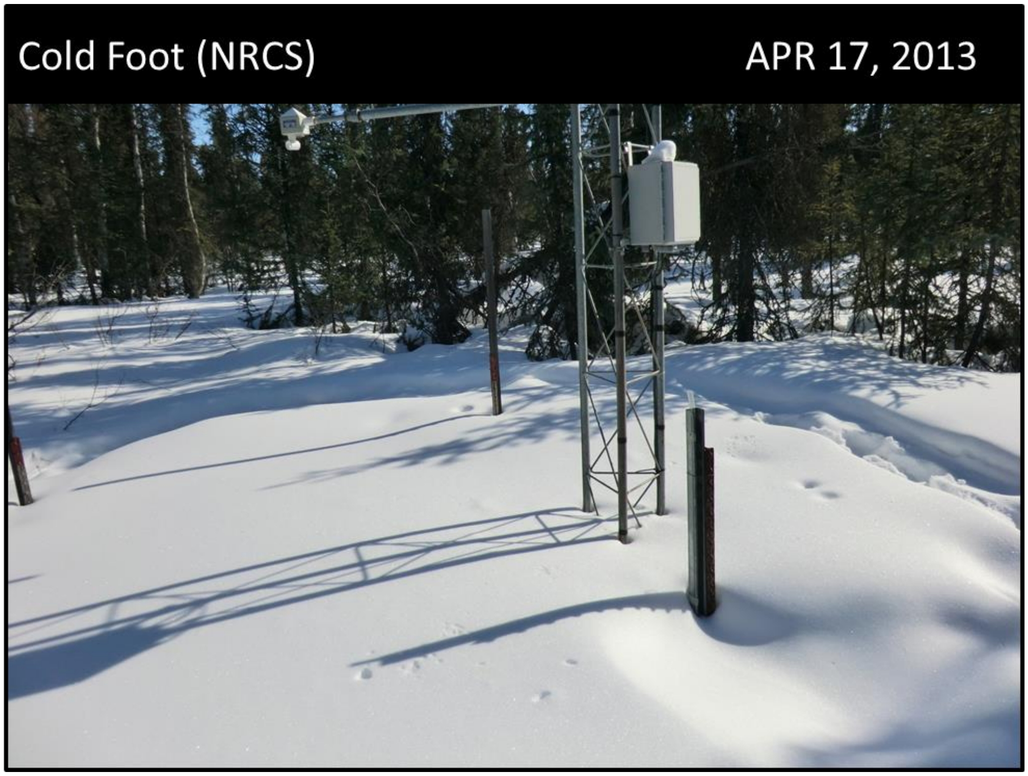




Figure 27. Cold Foot (NRCS) meteorological station daily (hourly averaged) recorded SR50 sensor snow depths, observed snow depth under the sensor at time of visit, 50 snow survey depths measured near sensor, and average of 50 depths, 2012–2014.

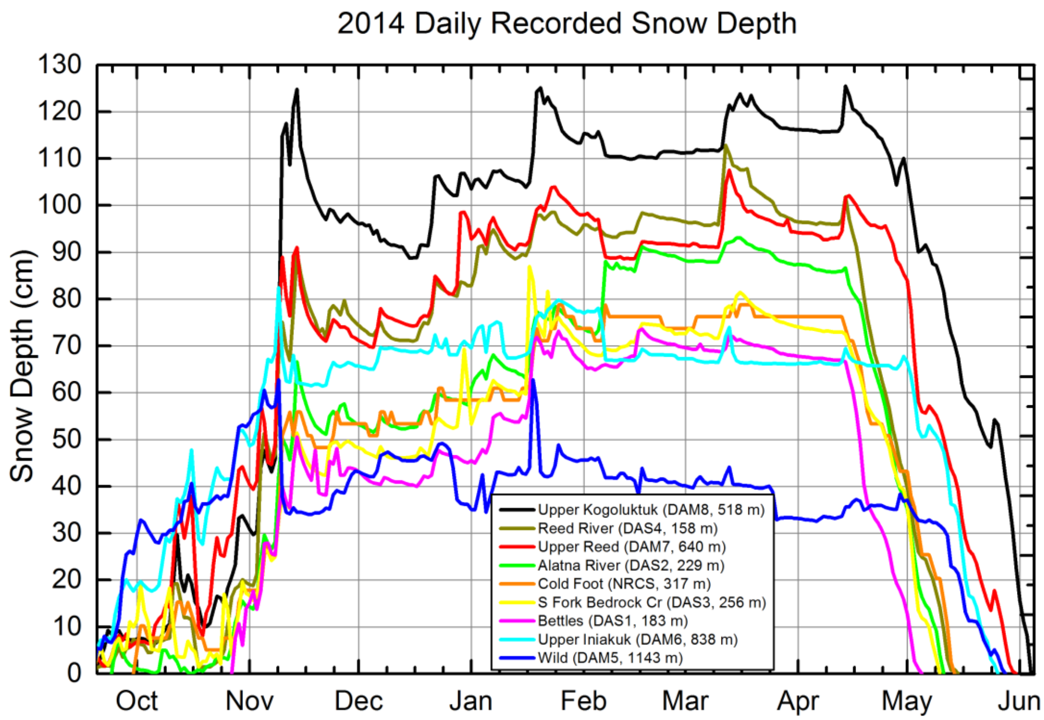



Figure 28. SR50 daily (hourly averaged) snow depths at the 9 meteorological stations during the 2013–2014 winter period. Station names, IDs, and elevations (in meters) are listed in the legend below the graph.

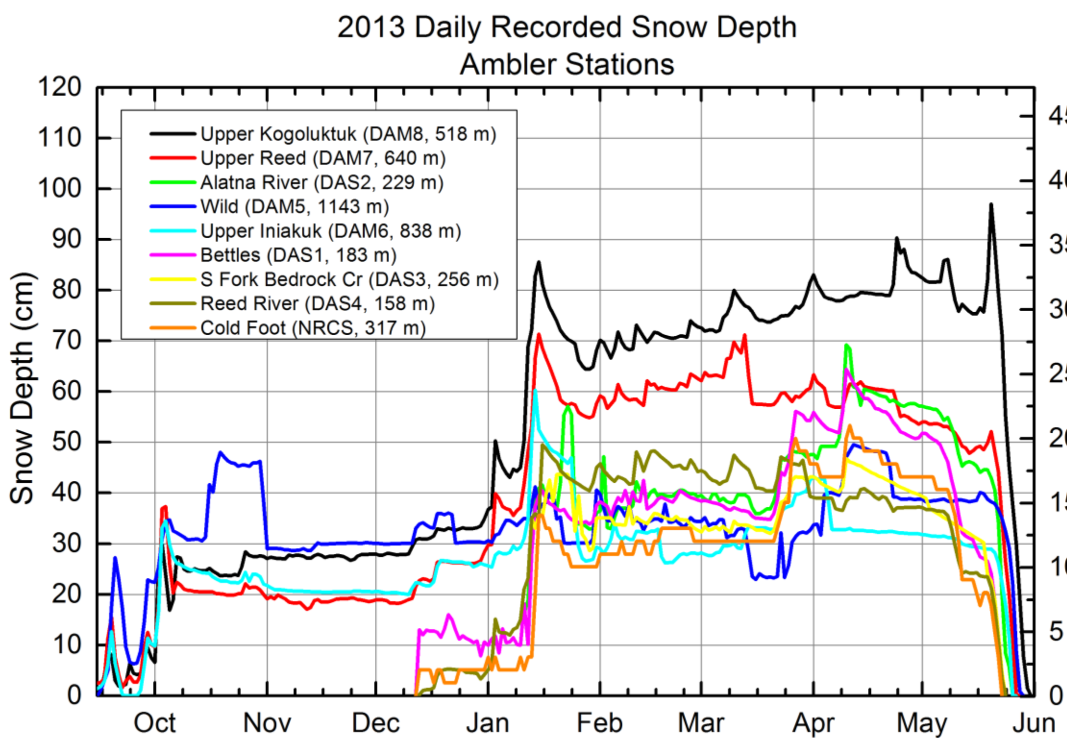



Figure 29. SR50 daily (hourly averaged) snow depths at the 9 meteorological during the 2012–2013 winter period. Station names, IDs, and elevations (in meters) are listed in the legend below the graph.

### 4.8.1 Snow ablation

*Snow ablation* is the term used to describe snowmelt or net decrease in SWE. Many northern watersheds retain winter precipitation for 7 to 8 months a year, with minor losses in SWE. Ablation occurs in that short period when winter precipitation is released to the hydrologic cycle. To capture ablation, snow surveys are conducted as frequently as possible (daily) during snowmelt. Ablation measurements were conducted at three locations in spring 2014: Alatna, South Fork Bedrock, and Reed (Table 17 and Table 18). Other than snow surveys conducted during site visits, ablation can be evaluated using SR50 sensors (Figure 30 and Figure 31). Most of the meteorological stations reported the onset of snowmelt around April 13, 2014. Snow disappeared the earliest at the four river stations (DAS1-4), while the snowpack at higher-elevation mountain sites took longer to melt (DAM5-8). The rate of snowmelt was not entirely correlated to snow depth, with deeper snowpacks at lower elevation melting faster than shallower snowpacks at higher elevations. Snow melted by June 5, 2014, at all meteorological stations. As a whole, snowmelt in 2014 was long and drawn out due to a cold spell in mid-May. The snowpack at Bettles (DAS1) ablated the fastest, but still required 21 days. At Upper Kogoluktuk, ablation persisted the longest (53 days), extended by a few small snowfall events. On average, melt lasted 35 days. In comparison, the 2013 snowmelt initiated a month later (May 18–20, 2013), only lasted an average of 7 days, and was completely gone before June 1, 2013 (Figure 31). The extended melt during 2014 was a product of great snow depths and colder May temperatures.

Table 17. Summary of snow ablation sites.

| Site Name | Period of Record | Comments |
|---|---|---|
| Alatna | 2013 & 2014 | Adjacent to the Alatna weather station. |
| South Fork Bedrock | 2013 & 2014 | Adjacent to the South Fork Bedrock weather station. |
| Reed | 2013 & 2014 | Adjacent to the Reed weather station. |

Table 18. End-of-winter snow water ablation (cm) at three Ambler Road Corridor project meteorological sites.

| Day-Month 2014 | DAS2<br>Alatna River 2014 | DAS 3<br>South Fork<br>Bedrock Creek 2014 | DAS4<br>Reed River 2014 |
|---|---|---|---|
| 1-May | | | |
| 2-May | | | |
| 3-May | | | |
| 4-May | | | |
| 5-May | 1.5 | 6.2 | |
| 6-May | | | 13.7 |
| 7-May | 1.2 | 5.5 | 14.8 |
| 8-May | | 4.1 | 11.2 |
| 9-May | | 4.1 | |
| 10-May | | | 10.6 |
| 11-May | | | 7.6 |
| 12-May | | | |
| 13-May | | | |
| 14-May | | | |
| 15-May | | | |
| 16-May | | | |
| 17-May | | | |
| 18-May | | | |
| 19-May | | | |
| 20-May | | | |
| 21-May | | | |
| 22-May | | | |
| 23-May | | | |
| 24-May | | | |

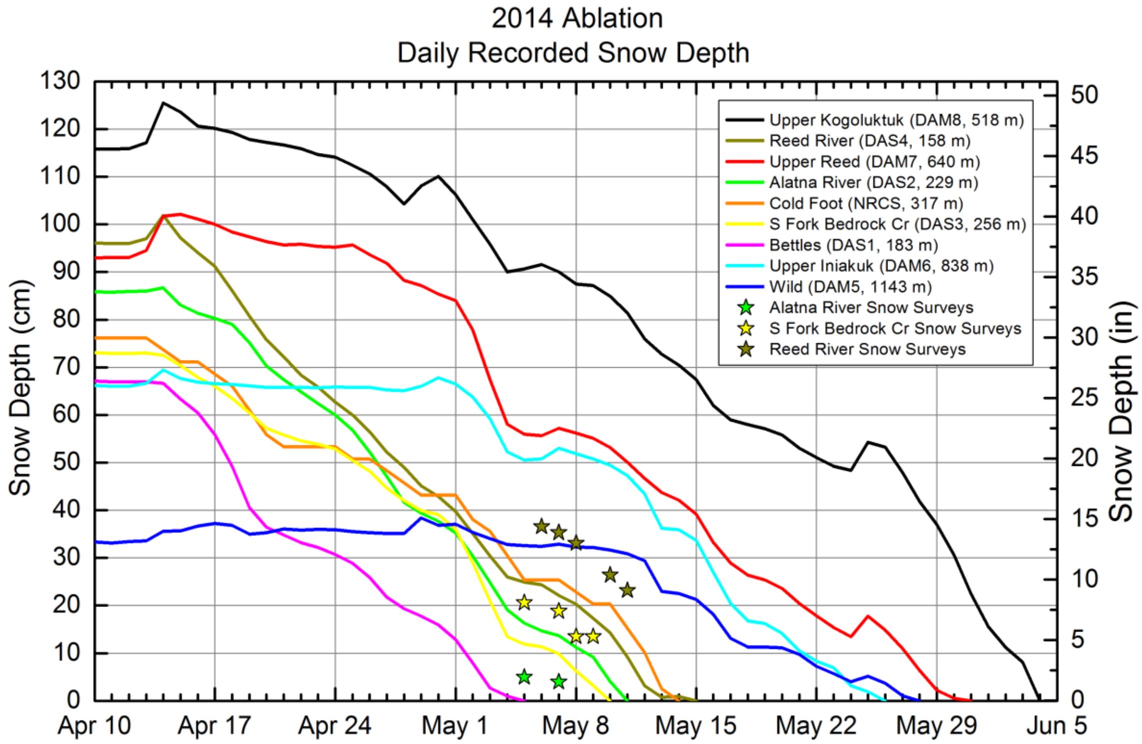



Figure 30. SR50 daily (hourly averaged) snow depths at the 8 meteorological stations during the 2014 ablation period. Station elevations (in meters) are listed in the legend.

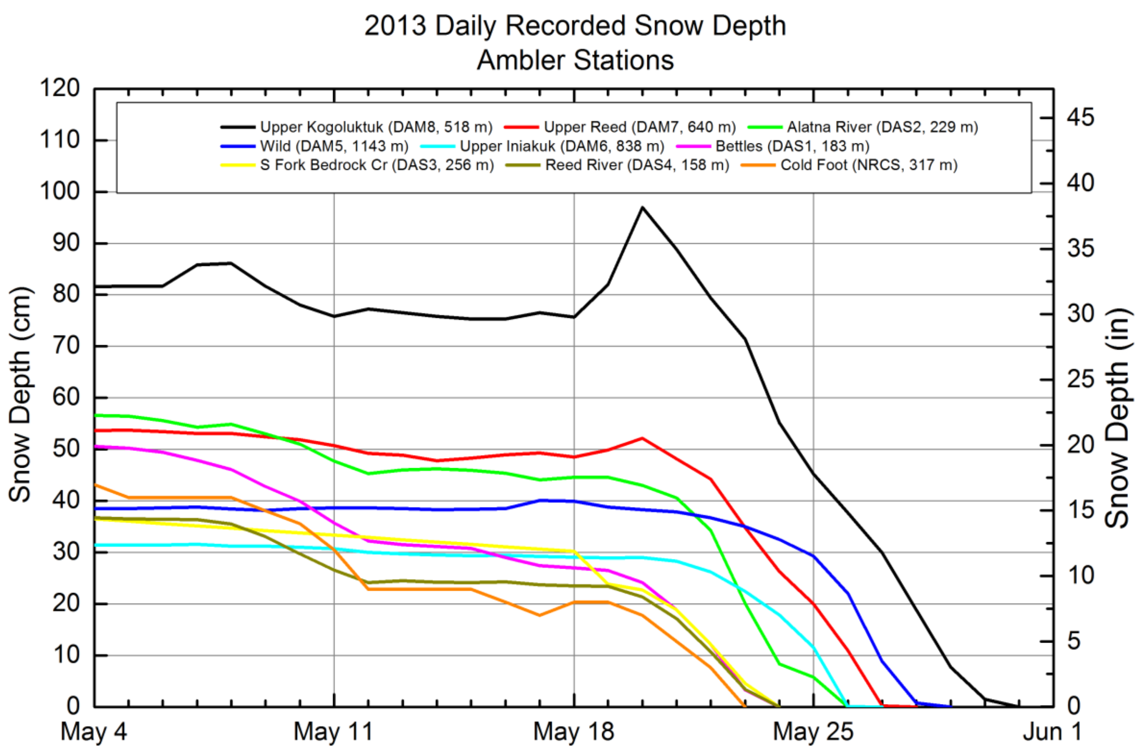



Figure 31. SR50 daily (hourly averaged) snow depths at the 8 meteorological stations during the 2013 ablation period. Station elevations (in meters) are listed in the legend.

### 4.8.2 Snow water equivalent (at winter's end, spatial distribution)

Snow survey sites are chosen to represent snow characteristics over a wide range of terrain conditions from 87 m to 1481 m. A complete list of snow survey sites and collected data for 2014 are presented in Appendix C. Figure 32 shows how the range of SWE variability increases with elevation; SWE values less than 15 cm can be found at any elevation on Figure 32, but deeper snowpack (30–35 cm in 2013 and 40–60 cm in 2014) was measured at higher elevations (above 700 m). The highest SWE (35 cm in 2013 and 58.7 cm in 2014) was measured in the western watersheds of the Alatna and Reed (Figure 33).

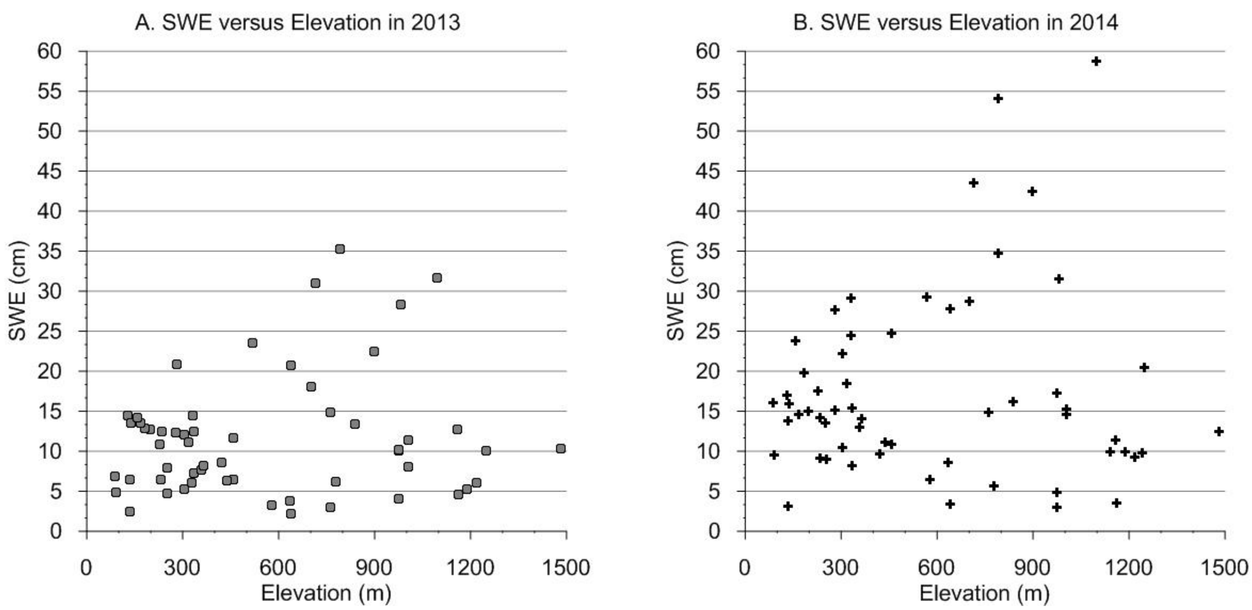



Figure 32. End-of-winter SWE (cm) variations with elevation in 2013 (left panel) and in 2014 (right panel).

Overall, 58 snow survey sites were visited in 2014. Similar to observations in 2013, relatively low SWE was measured in the Koyukuk River watershed (Figure 33). A visual interpretation of Figure 33 indicates increases in SWE from east to west. An exception to the increasing trend of SWE from east to west is in the low-lying Ambler Flats region in the west, an open, mostly treeless area where snow is blown away and redistributed during windy events.

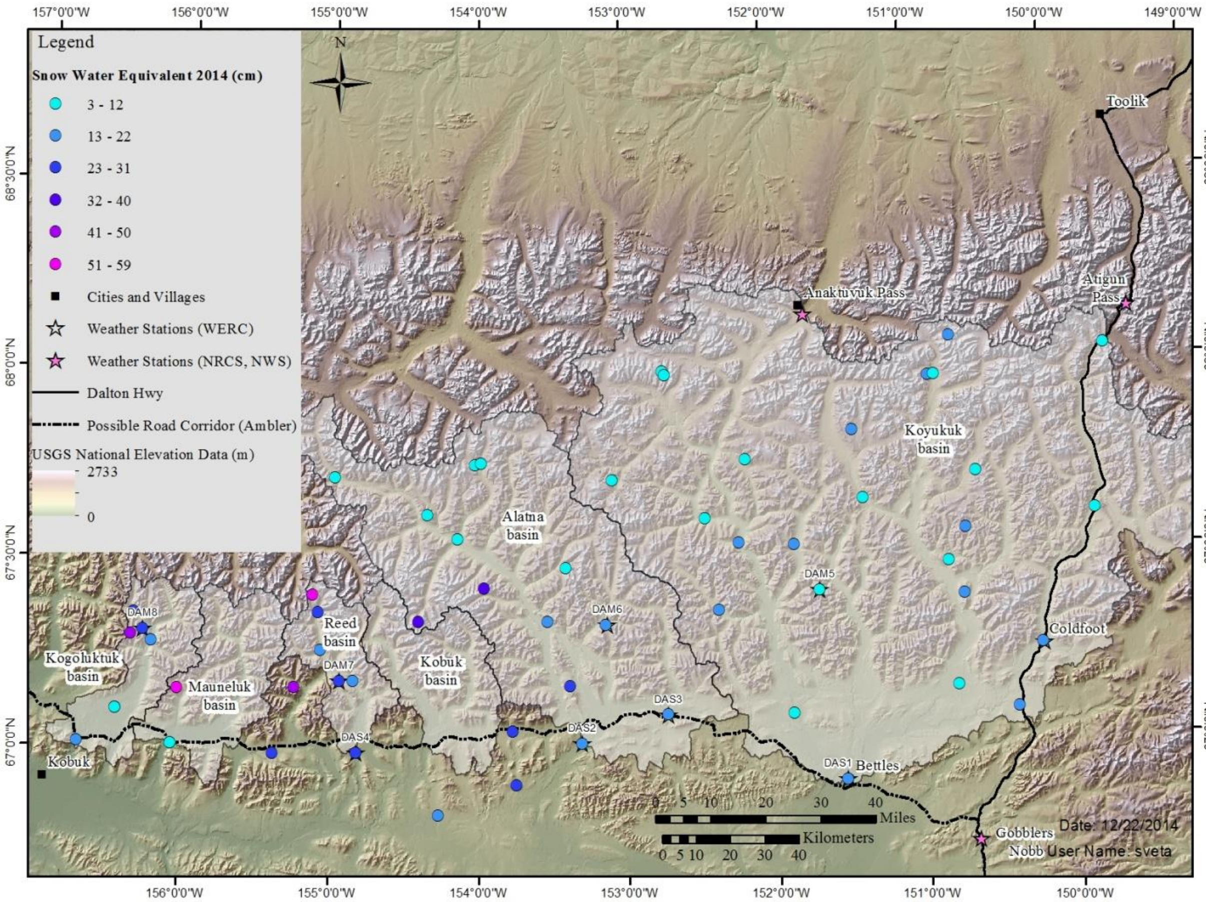



Figure 33. End-of-winter snow water equivalent in spring 2014.

### 4.8.3 Snow survey data at watershed scale

This section summarizes the snow data at watershed scale using a box and whisker plot, shown in Figure 34. In 2014, SWE is significantly higher than in 2013. Figure 34 provides a visual interpretation of the symmetry, variability, presence of outliers, and central tendency in the SWE data (median). The median corresponds to the middle SWE obtained from the data that were arranged from lowest value to highest value (probability of occurrence is 0.5), which can differ from the average SWE presented in Figure 34. By comparing variability in SWE in different watersheds plotted side-by-side, it can be seen that the Koyukuk River watershed has the lowest SWE variability; it also has the lowest amount of end-of-winter watershed SWE.

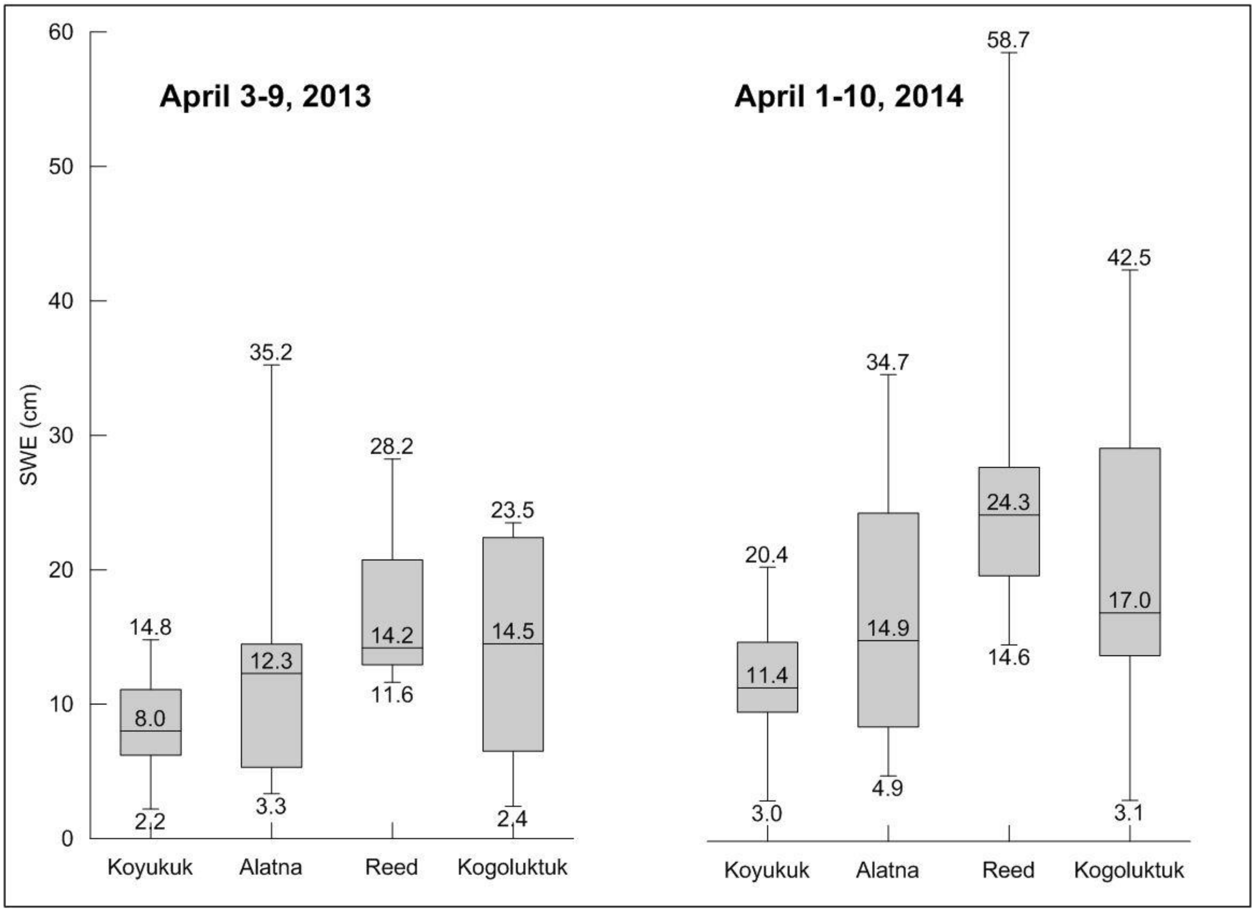



Figure 34. Box and whisker plot of SWE, April 2013 and 2014 (median is printed in each box; 25 and 75 quantiles represent the upper and lower boundaries of the box; maximum and minimum snow depth is shown by whisker).

Sample mean or average SWE is shown in Table 19. Median (Figure 34) and mean SWE are similar for some of the watersheds. Measurements of SWE in the Reed watershed are positively skewed (also small sample *n* = 6), suggesting that the median (SWE = 14.2 cm in 2013) is a better measure of central tendency than the sample mean (SWE = 16.9 cm in 2013).

Watershed-averaged SWE and snow depth show an increasing trend from east to west, from the Koyukuk basin to Reed basin (Table 19 and Table 20). However, similar data for the western Kogoluktuk catchment show a decrease from its eastern neighbor, the Reed watershed.

Table 19. Basin average snow water equivalent (SWE) for 2013 and 2014.

| Basin | Number of Sites | 2013 (adjusted) | | Percent of Last Year |
|---|---|---|---|---|
| | | SWE (cm) | Std. Dev. (cm) | |
| Koyukuk | 24 | 8.2 | 3.4 | No data |
| Alatna | 16 | 12.8 | 8.9 | No data |
| Reed | 6 | 16.9 | 6.4 | No data |
| Kogoluktuk | 7 | 13.9 | 8.7 | No data |

| Basin | Number of Sites | 2014 | | Percent of Last Year |
|---|---|---|---|---|
| | | SWE (cm) | Std. Dev. (cm) | |
| Koyukuk | 25 | 11.7 | 4.6 | 143 |
| Alatna | 15 | 16.3 | 9.4 | 127 |
| Reed | 6 | 28.2 | 15.6 | 167 |
| Kogoluktuk | 7 | 21.3 | 12.8 | 153 |

The average end-of-winter SWE in 2014 is significantly higher than in 2013. The 2014 end-of-winter SWE for the Koyukuk River watershed represents 143% of the previous year average SWE. The Reed River watershed had the highest percent of last year SWE (167%). A similar trend appears in the basin average snow depth (Table 20).

Table 20. Basin average measured snow depth for 2013 and 2014.

| Basin | Number of Sites | 2013 (not adjusted) | | Percent of Last Year |
|---|---|---|---|---|
| | | Snow Depth (cm) | Std. Dev. (cm) | |
| Koyukuk | 24 | 39.3 | 16.2 | No data |
| Alatna | 16 | 52.7 | 27.3 | No data |
| Reed | 6 | 65.8 | 17.6 | No data |
| Kogoluktuk | 7 | 47.0 | 20.8 | No data |

| Basin | Number of Sites | 2014 | | Percent of Last Year |
|---|---|---|---|---|
| | | Snow Depth (cm) | Std. Dev. (cm) | |
| Koyukuk | 25 | 52.2 | 21.3 | 133 |
| Alatna | 15 | 66.5 | 33.9 | 126 |
| Reed | 6 | 116.0 | 24.0 | 176 |
| Kogoluktuk | 7 | 79.1 | 36.6 | 168 |

Snow water equivalent is a product of snow depth and snow density. The next two pages are maps of their spatial distribution. Figure 35 shows end-of-winter snow depths, and Figure 36 shows densities. Sites with deep snowpacks also have high SWE and higher snow density (ALAT2, ALAT3, REED2, MAUN2, and KOGO2 in Appendix C).

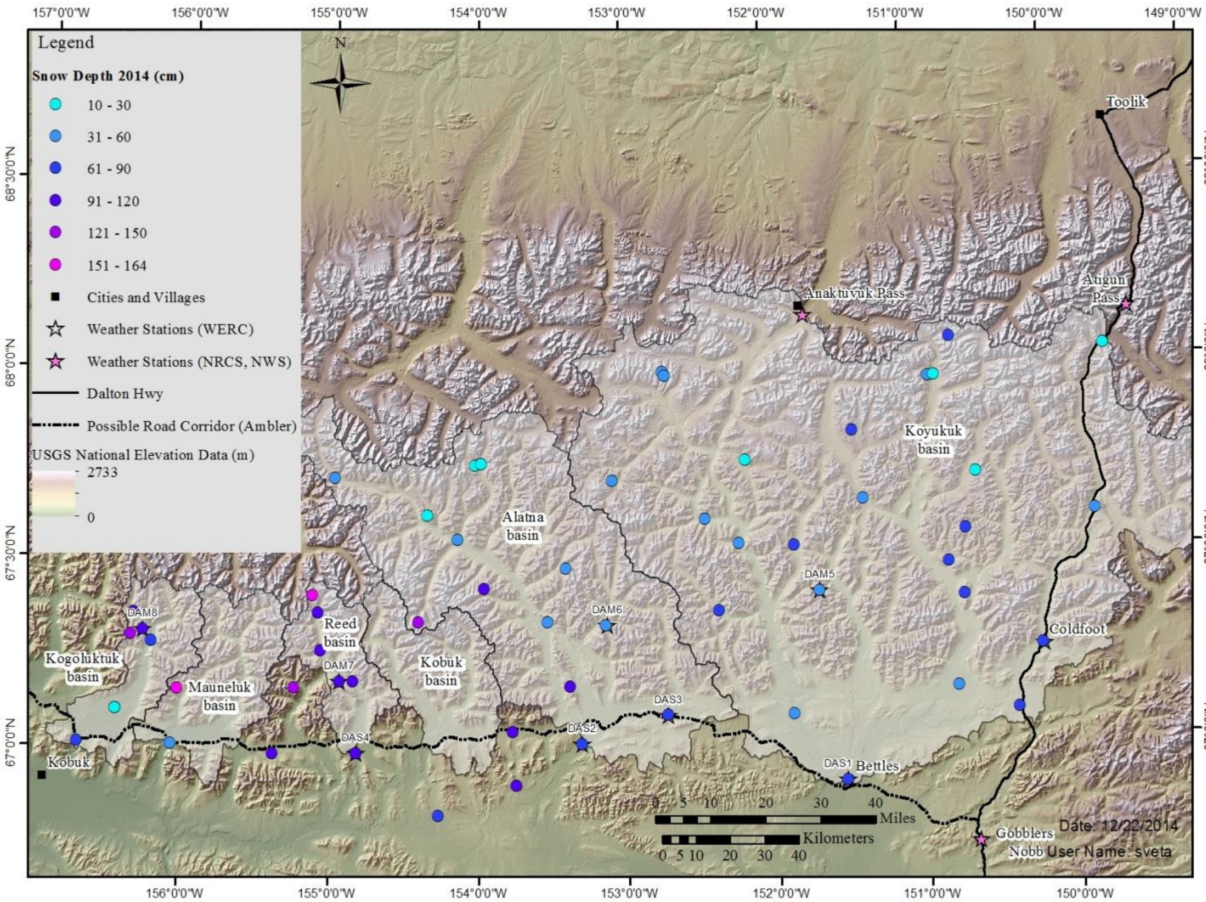



Figure 35. End-of-winter snow depth (cm) in spring 2014. Each point represents the average from 50 snow depths.

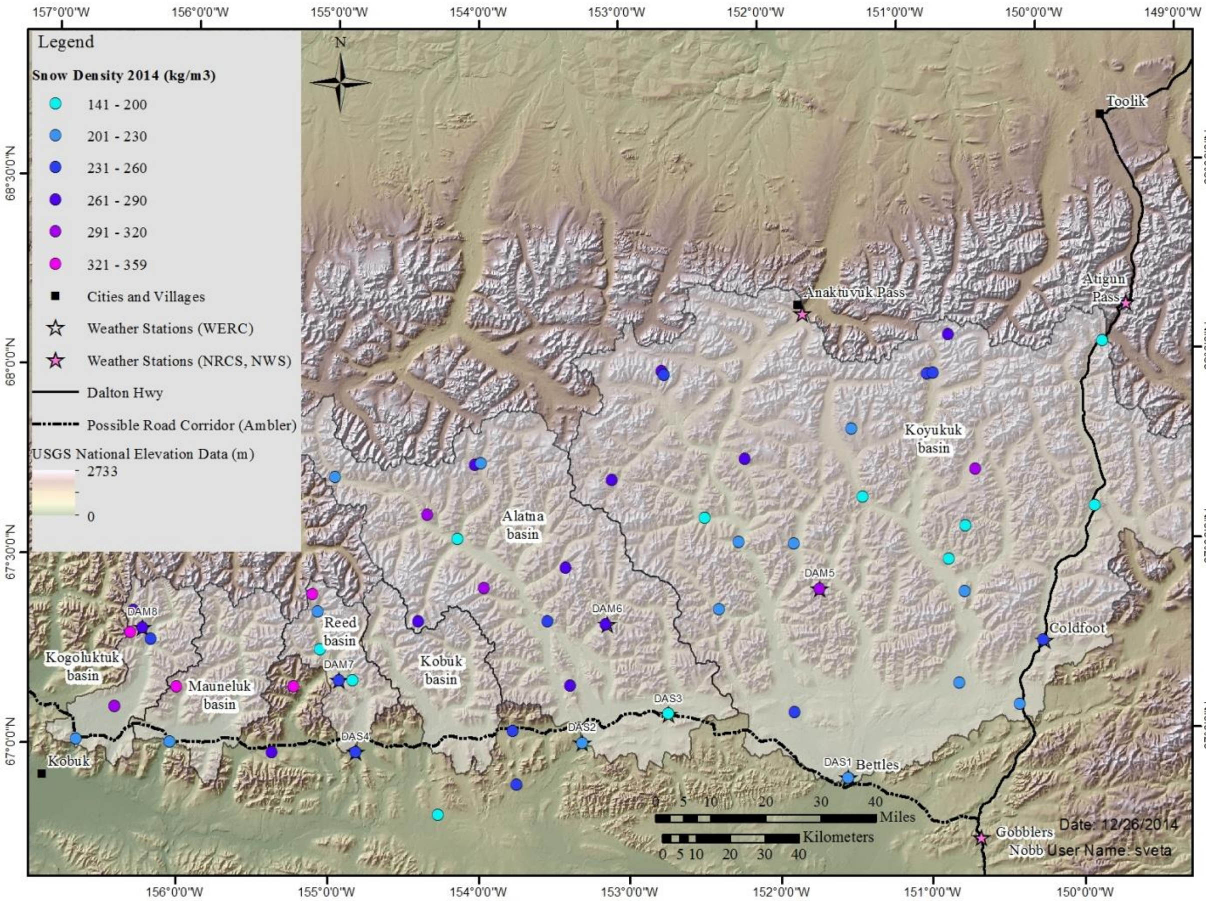



Figure 36. End-of-winter snow density (kg/m$^3$) in spring 2014. Each point represents the average from 5 measurements.

## 4.9 Soil

In fall 2012, soil temperature sensors were installed at all stations to a depth of up to 200 cm below ground surface. Soil moisture sensors were also installed, typically to a maximum depth of 60 cm below ground surface. Table 21 summarizes soil type and the sensor installation depths for each station. The purpose of this instrumentation was to get some idea of shallow subsurface conditions. Both soil temperatures and moisture content for South Fork Bedrock Creek (DAS3) are illustrated in Table 21; the plotted results for all other stations are shown in Appendix D.

Table 21 also gives a brief description of soil conditions. The four lower-elevation sites (DAS1–DAS4) near the rivers generally have alluvial soils, and the mountain sites have colluvial soils over shallow bedrock. The only site that definitely had permafrost when the sensors were installed was South Fork Bedrock Creek (DAS3), at approximately 40 cm depth. The only other locations where permafrost could have been present were in the mountains (Wild, DAM5; Upper Reed, DAM7), where bedrock was close to the surface. However, soil temperatures measured with thermistors during the summer showed the temperature above 0°C at 150 cm deep at both sites.

Table 21. Soil type and sensor installation details.

| Station Name | Soil Temperature Sensor Max. Depth (cm) | Soil Moisture Sensor Depths (cm) | Site Description | Soil Description |
|---|---|---|---|---|
| DAS1 - Bettles Met | 130 | 10, 40, 60 | Lowlands | Organic mat (0 - 15 cm) underlain by decomposed organic layer or peat (15-30 cm bgs) and sandy gravels (30cm +). |
| DAS2 - Alatna River | 200 | 10, 40, 60 | Lowlands | Organic layer (0 – 25 cm) underlain by wet, silty sand with variable organics (20-25 cm bgs). |
| DAS3 - South Fork Bedrock Creek | 200 | 10, 25, 40 | Lowlands | Organic layer (0-30 cm bgs) and partially decomposed moss/peat layer (30-40 cm bgs) underlain by sandy stream gravels and rock. Permafrost encountered at 38-40 cm bgs. Rocks/ gravel absent from 75-80 cm bgs. Gravels encountered again at 80 cm bgs. |
| DAS4 - Reed River | 175 | 10, 40, 60 | Lowlands | Thin organic layer (0 -5 cm) underlain by sandy gravel layer with cobbles. |
| DAM5 - Wild Met | 150 | 10, 40, 60 | Mountainous | Organic layer (0-15 cm bgs) underlain by gravelly silt. Decomposed, weathered bedrock encountered at 50 cm bgs and solid bedrock (grey rock with quartz veins) at 70 cm bgs. |
| DAM6 - Upper Iniakuk | 150 | 10, 40, 60 | Mountainous | Thin organic layer with mosses and lichens (0 - 5 cm) underlain by gravelly sand layer. |
| DAM7 - Upper Reed | 150 | 10, 25, 40 | Mountainous | Thin organic layer with mosses and lichens (0 - 10 cm) underlain by silty loam (10 cm - 1 m) and bedrock (1 m +). |
| DAM8 - Upper Kogoluktuk | 200 | 10, 40, 60 | Mountainous | Thin layer of organic material (5 cm) over unconsolidated coarse silty –sand, mixed with weathered bedrock. |

*bgs = below ground surface

Soil temperatures for 2 years for South Fork Bedrock Creek (DAS3) are shown in Figure 37; similar data for the other sites are shown in Appendix D. Soil sensors were installed in South Fork Bedrock Creek and all the other sites in early September 2012; data in Figure 37 are for two warm seasons and two cold seasons. South Fork Bedrock Creek is interesting because it shows that the temperatures at depth do not get above the freezing point (warm permafrost), although summer surface temperatures are quite warm. During the 2012 fall season, the soils cooled significantly but then abruptly warmed up in late December 2012/early January 2013. This is a period when the soils should be cooling rapidly and freezing at depth. The soil temperatures at depth stayed almost constant the remainder of winter until breakup. The thermistors near the surface showed four periods of cooling and warming from January 2013 to breakup that exactly coincided with cold high-pressure systems followed by warm low-pressure systems. The period of soil warming in mid-winter 2012/2013 is not due to higher air temperatures but to the insulating properties of winter snowfall. The snow depth plot for South Fork Bedrock Creek (Figure 21) shows that in winter of 2012/2013, no snow was on the ground under the sensor until late December, thus the extensive freezing of soils prior to snowfall.

Again in winter 2013/2014, the importance of a snow cover on soil temperature was demonstrated, but in a different way. In fall 2013, an early snowfall occurred in September when the soils were isothermal (~0°C) and freezing had not been initiated. During most of the winter, the soil temperature hovered just below freezing at this permafrost site; at winter's end, some freezing had occurred at depth. Similar patterns of winter soil temperature (warming in 2012/2013 and warm soils most of the winter 2013/2014) were observed at most other sites, with the exception of Wild (DAM5). The Wild (DAM5) site had more of expected soil temperatures, with cooling in the fall, zero-curtain as freezing begins and latent heat is released, and cooling during the remainder of winter. This pattern was followed both years, indicating early snow at this site and relatively constant snow depth over the winter. Both of these assumptions were correct (Figure 23). At all of the sites, decreases in soil temperature during periods of high pressure (clear weather) followed by periods of soil warming (geothermal heat escaping) were evident.

Three time domain reflectometer (TDR) probes were installed at each site (depth of installation varies depending on soil conditions). These probes measure the unfrozen soil water content. When soils freeze, the TDR probes measure just the unfrozen portion of the water. Fine-grained frozen soils (clays and silts) at a given freezing temperature have greater amounts of unfrozen water than coarse-grained soils (sand and gravel) have. Fine-grained soils usually have higher soil moisture content than coarse-grained soils. When soils either freeze or thaw (phase change), a big change occurs in the unfrozen soil moisture content. Gradual changes in the amount of unfrozen water also occur due to evapotranspiration, and more significant changes follow because of snowmelt and rainfall infiltration into the soils.

In addition to soil temperatures, Figure 37 shows the unfrozen water content at South Fork Bedrock Creek (DAS3) at three depths: 10, 25, and 40 cm. The following observations are made:

① Soil moisture content in summer is greater at depth.

② Winter unfrozen soil moisture content is quite low, implying that the soils here are relatively coarse.

③ Changes at depth (both during snowmelt and freeze-up) lag the response of the shallower soils.

Plots of the seven other sites can be found in Appendix D.

Where soils are well drained, such as at Bettles (DAS1), the measured unfrozen water contents are lower. A good set of contrasting data is that at Bettles (DAS1) and Alatna (DAS2). The unfrozen water content at the Alatna (DAS2) site hovers around 40% by volume most of the warm season, whereas at Bettles (DAS1), it is closer to 20% by volume except for right after snowmelt. Overall, the soil moisture content in the mountains (Appendix D) is lower than that observed at the sites along the river; this is due to coarser soils (weathered bedrock) at high elevations.

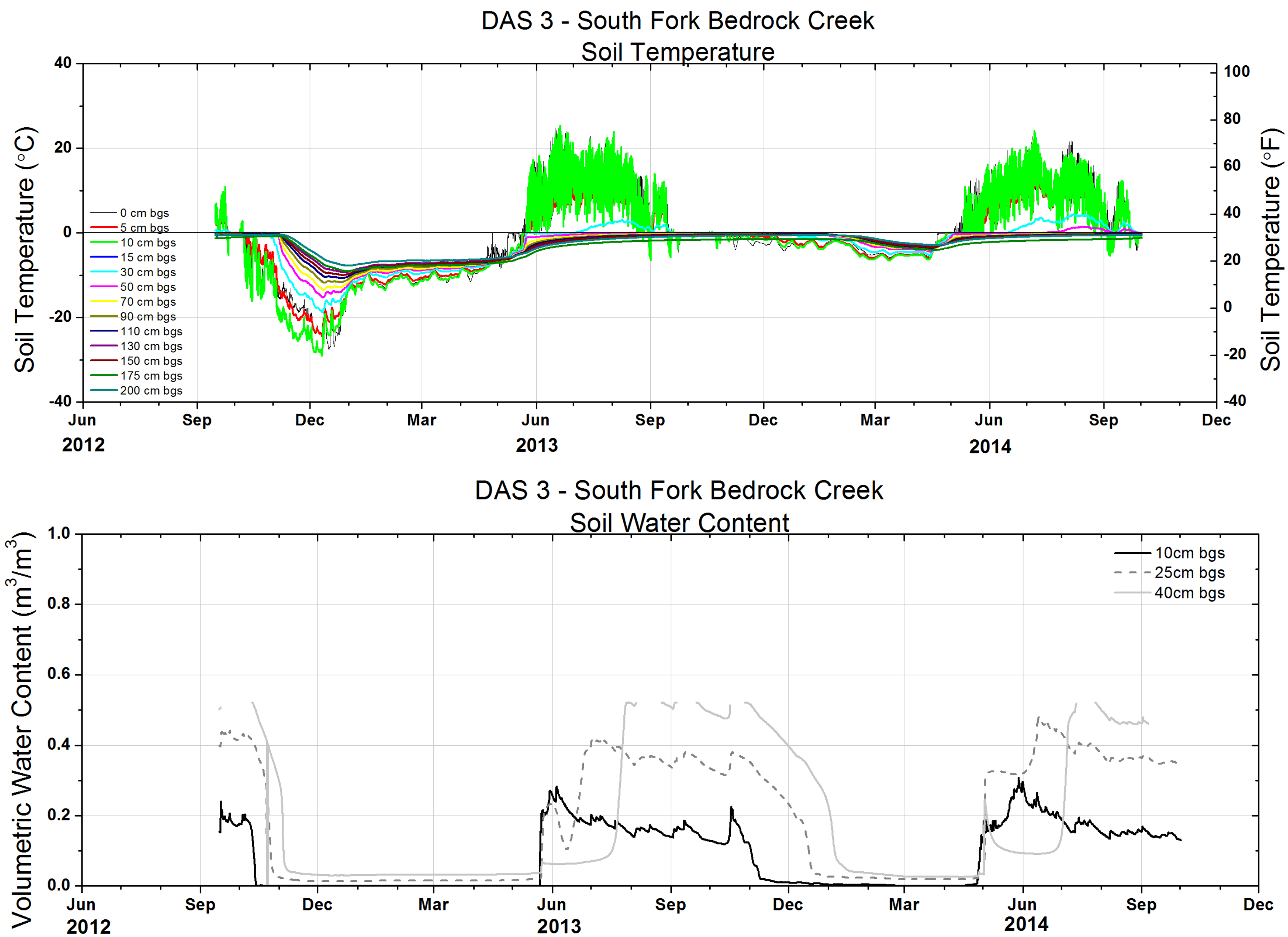



Figure 37. Soil temperature and soil moisture at South Fork Bedrock Creek station (DAS3).

## 4.10 Surface Water Hydrology

New hydrometeorological stations on Alatna River below the confluence with the Malemute Fork, South Fork Bedrock Creek (a tributary of the Malemute Fork of the Alatna River), and Reed River were installed in June 2012 to capture the spring snowmelt and summer/fall runoff events. Since 2010, runoff has been measured by the U.S. Fish and Wildlife Service (USFWS) on the Koyukuk River below the John River, near Old Bettles and the proposed ADOT&PF crossing. A sediment monitoring station was added by UAF on the Koyukuk River downstream from the USFWS station in 2013. Also in 2013, water level observation stations were set up at two sites on the Kobuk River to monitor river stage.

Continuous water levels are monitored in the watersheds during most of the spring breakup period, summer, and into fall. Beginning summer 2012, point discharge measurements are made several times during snowmelt and a few times during the summer on each river. To document the hydrologic activity more completely, we also have cameras, pointed at the river, at all hydrological stations.

During UAF's short observation period (2012–2014), several interesting hydrologic events were observed. We were fortunate to observe stage and measure rainfall during a large and widespread rainfall event in late summer 2012. We observed the entire (~3 weeks) spring breakup period in 2013 and part of it in 2014. Approximately 2–3 weeks are spent in the field during spring breakup to collect as many discharge measurements as possible and to document the most likely largest runoff event of the year. Numerous ice jams were observed on most of the rivers during the spring breakup period. We observed river stage and runoff during 2014, which was thought to be an above-average snowpack year with a moderately wet summer. The USDA/NRCS also reported the Koyukuk basin in 2014 (NRCS, 2014) as "much above normal with the sites closer to the Brooks Range being the highest" in snowpack.

### 4.10.1 Koyukuk River

The Koyukuk River basin originates in the Central Brooks Range and drains to the south and west, eventually flowing into the Yukon River. The watershed area is approximately 18,000 $km^2$ at the USFWS gauge site and includes flow from the North Fork Koyukuk, Middle Fork Koyukuk, Wild, and John Rivers. The basin elevation ranges from 180 m to 2245 m with an average basin elevation of 842 m. Above the USFWS gauge site at Old Bettles, approximately 80% of the basin lies in the mountainous region. The stream length to the gauge site is approximately 225 km (length mostly based on the North Fork Koyukuk reach). The majority of the basin consists of shrubs (74%), but 11% is forested and 14% is barren (Homer et al., 2007).

The USFWS gauge site on the Koyukuk River near Old Bettles (below the confluence with the John River) was installed in 2008 by USFWS, and continuous flow data became available in 2010. Individual measurements of discharge were made by both USFWS and UAF at the gauge site from 2012–2014. Within this large basin (Figure 1) are two UAF meteorological stations (Wild-DAM5 and Bettles-DAS1), the Bettles NRCS snow observation station, the Bettles Airport National Weather Service (NWS) station, and two NPS meteorological stations (Pamichtuk Lake and Chimney Lake). Additionally, the NRCS has Wyoming gauges at Atigun Pass and Coldfoot that are within the basin. The Gobbler's Knob Wyoming gauge is located nearby as well, at the southeast side of the Koyukuk basin. This section presents the results of stage and runoff data collected from 2010–2014, with UAF contributing to the record from 2012–2014. Additionally, a summary of UAF's field observations is presented for 2012, 2013, and 2014. The water level elevations and runoff hydrographs, collected prior to UAF involvement in the project, are shown in Figure 38 though Figure 41.

Snowmelt runoff is the primary event of the year, in terms of volume of flow. However, the annual peak flow of the Koyukuk River near Bettles may be snowmelt- or rainfall-generated. For the short period of record, in only two of the 5 years of available data did the annual peak flow occur during spring breakup. In addition, an ice jam was observed in 2013 at the proposed crossing. During the ice jam, stage was very high, and ice was deposited above the cutbank at the Old Bettles town site (more detail in Section 4.10.1.2).

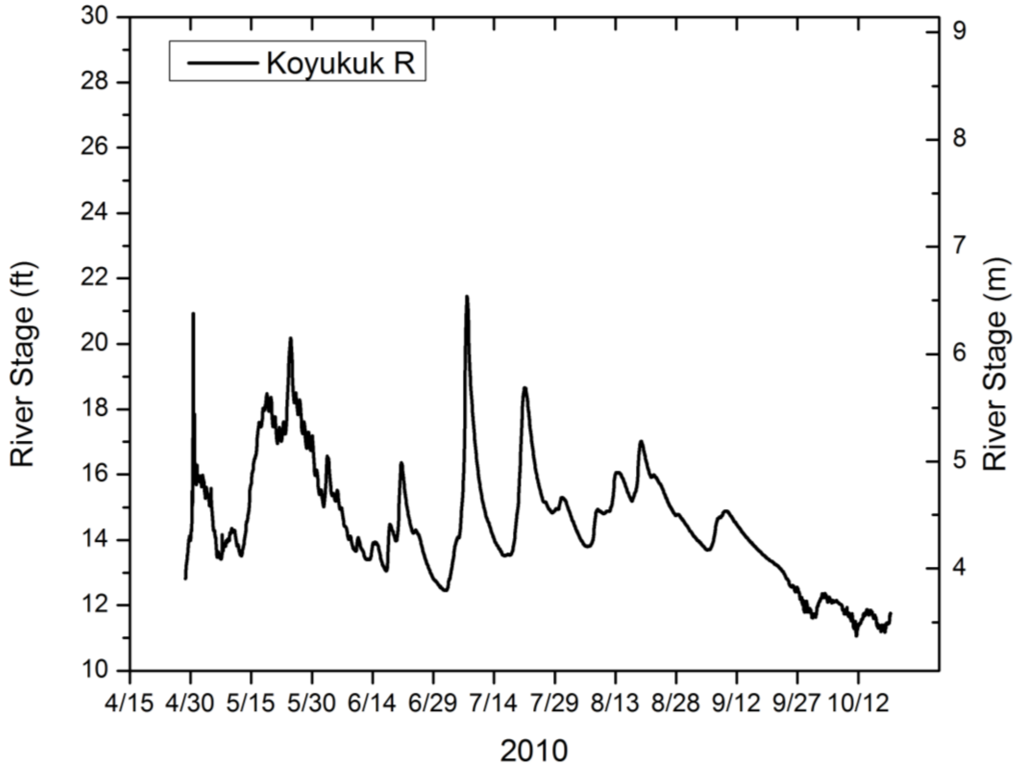



Figure 38. Koyukuk River at Old Bettles stage for 2010 (data courtesy of USFWS).

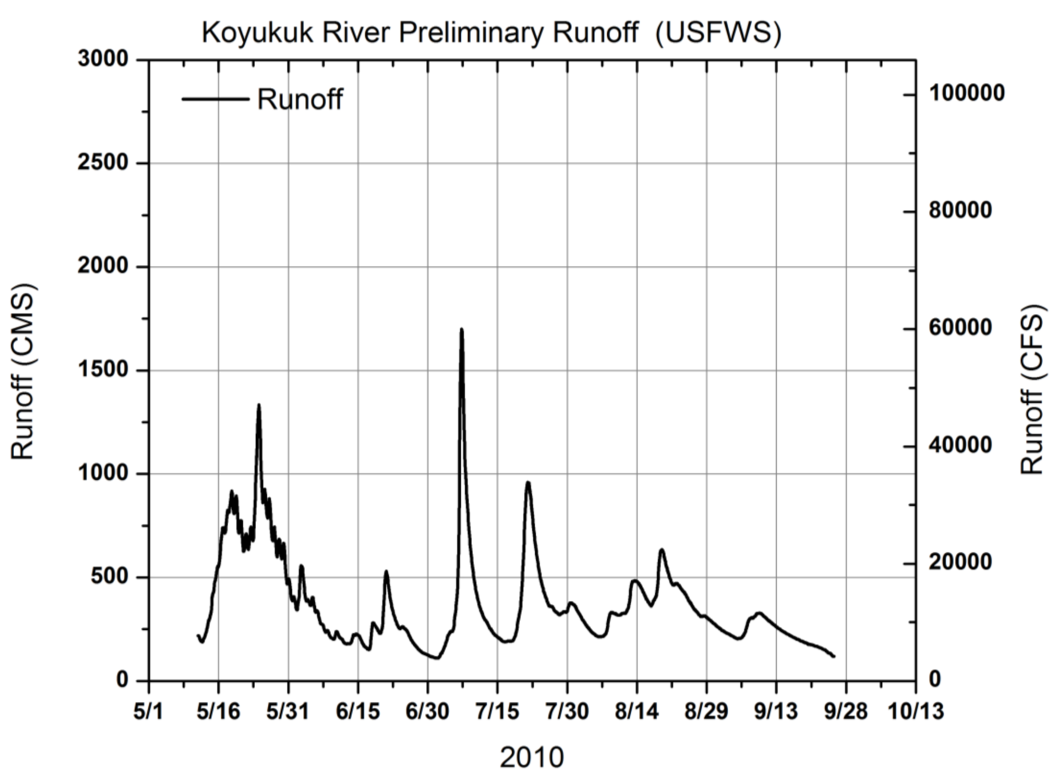



Figure 39. Koyukuk River at Old Bettles runoff for 2010 (data courtesy of USFWS).

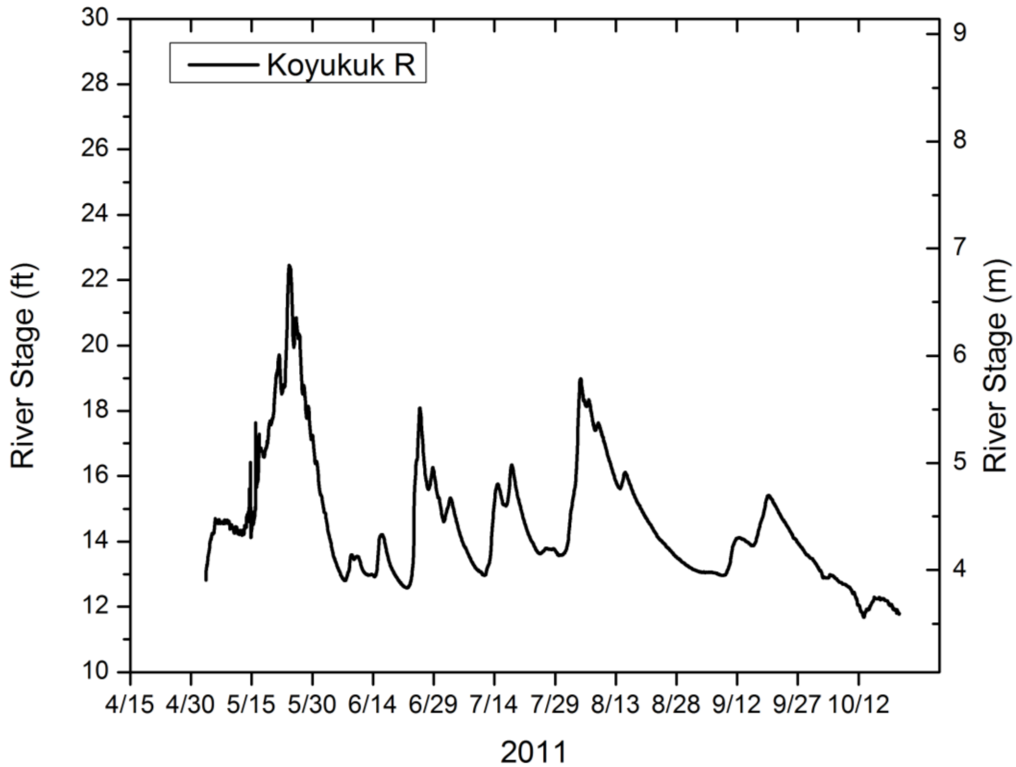



Figure 40. Koyukuk River at Old Bettles stage for 2011 (data courtesy of USFWS).

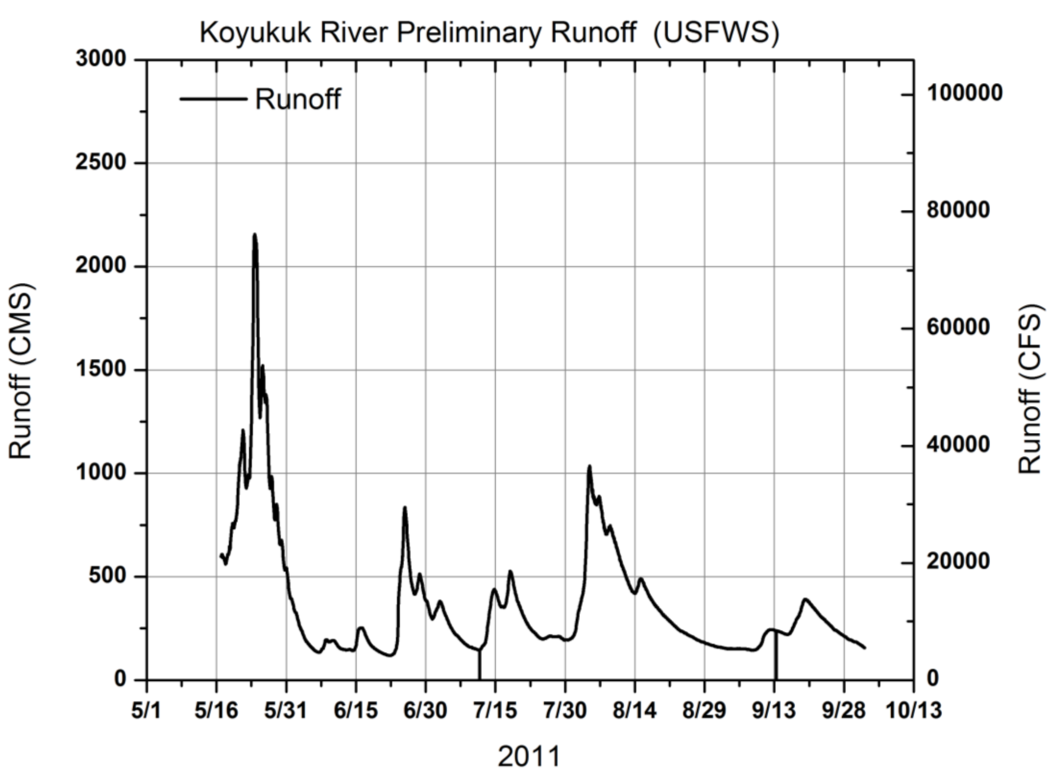



Figure 41. Koyukuk River at Old Bettles runoff for 2011 (data courtesy of USFWS).

Table 22 presents each discharge measurement and associated hydrologic information made by UAF during the study period. A more detailed summary of each discharge measurement is provided in Appendix E. Water slope was measured in front of Old Bettles and Manning's *n* was calculated on a couple of occasions.

Table 22. Discharge measurements for the Koyukuk River below John River station made by UAF, 2012–2014. The stage is reported in units above the arbitrary datum. Additional measurements are available from the USFWS.

| Date | No. | Discharge ($m^3/s$) | Discharge ($ft^3/s$) | Stage (m) | Stage (ft) | Msmt Rating (%) | Width (m) | Area ($m^2$) | Velocity (m/s) | Max Velocity (m/s) | Max Depth (m) | Avg Depth (m) | Water Slope | Manning's *n* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/23/2012 16:00 | 1 | 204 | 7200 | 4.15 | 13.63 | Fair | 170 | 305 | 0.66 | 1.37 | 3.26 | 1.79 | 0.000164 | 0.0285 |
| 7/28/2012 19:00 | 2 | 224 | 7890 | 4.23 | 13.87 | poor | 152 | 298 | 0.76 | 1.39 | 3.40 | 1.96 | | |
| 9/11/2012 14:45 | 3 | 634 | 22390 | 5.15 | 16.89 | Fair | 193 | 460 | 1.29 | 2.53 | 4.26 | 2.42 | 0.000388 | 0.0276 |
| 6/2/2013 14:45 | 4 | 737 | 26030 | n/a | n/a | poor | 166 | 423 | 1.76 | 4.86 | 4.80 | 2.60 | | |
| 6/3/2013 10:15 | 5 | 670 | 23660 | n/a | n/a | poor | 135 | 388 | 1.77 | 3.08 | 4.41 | 2.87 | | |
| 6/4/2013 10:15 | 6 | 753 | 26590 | n/a | n/a | poor | 187 | 468 | 1.64 | 3.47 | 4.18 | 2.57 | | |
| 6/5/2013 11:15 | 7 | 975 | 34430 | n/a | n/a | poor | 203 | 516 | 1.90 | 3.80 | 5.48 | 2.53 | | |
| 6/6/2013 9:15 | 8 | 647 | 22850 | n/a | n/a | poor | 183 | 431 | 1.59 | 4.68 | 4.21 | 2.47 | | |
| 7/10/2013 9:45 | 9 | 215 | 7590 | 4.03 | 13.22 | Fair | 122 | 256 | 0.76 | 1.57 | 3.28 | 2.10 | | |
| 7/13/2013 8:45 | 10 | 134 | 4730 | 3.89 | 12.75 | Fair | 172 | 252 | 0.51 | 1.07 | 3.24 | 1.47 | | |
| 9/5/2013 10:00 | 11 | 104 | 3670 | 3.75 | 12.30 | Fair | 111 | 194 | 0.53 | 1.27 | 3.24 | 1.74 | | |
| 5/6/2014 16:12 | 12 | 434 | 15330 | 4.96 | 16.27 | poor | 130 | 335 | 1.36 | 2.66 | 3.87 | 2.58 | | |
| 5/9/2014 10:50 | 13 | 198 | 6990 | 4.26 | 13.97 | poor | 120 | 215 | 1.00 | 1.84 | 3.54 | 1.79 | | |
| 5/11/2014 16:53 | 14 | 283 | 9990 | 4.44 | 14.57 | Fair | 120 | 230 | 1.32 | 2.25 | 3.04 | 1.92 | | |
| 5/13/2014 10:12 | 15 | 657 | 23200 | 5.26 | 17.25 | Fair | 129 | 336 | 2.07 | 3.51 | 3.90 | 2.61 | | |
| 5/16/2014 17:05 | 16 | 560 | 19780 | 5.07 | 16.64 | Fair | 125 | 341 | 1.67 | 4.43 | 4.23 | 2.73 | | |
| 5/19/2014 9:48 | 17 | 565 | 19950 | 5.06 | 16.60 | Fair | 133 | 345 | 1.72 | 4.84 | 3.97 | 2.60 | | |
| 5/20/2014 14:32 | 18 | 318 | 11230 | 4.51 | 14.80 | Fair | 124 | 285 | 1.16 | 2.13 | 3.57 | 2.29 | | |
| 5/22/2014 14:18 | 19 | 274 | 9680 | 4.41 | 14.46 | Fair | 115 | 253 | 1.11 | 2.28 | 3.34 | 2.20 | | |
| 5/25/2014 9:46 | 20 | 193 | 6820 | 4.12 | 13.51 | Fair | 115 | 194 | 1.03 | 2.18 | 2.79 | 1.69 | | |
| 7/23/2014 11:19 | 21 | 696 | 24580 | 5.32 | 17.45 | Fair | 148 | 422 | 1.63 | 3.32 | 4.87 | 2.85 | 0.000491 | 0.0273 |
| 9/6/2014 16:34 | 22 | 312 | 11010 | 4.52 | 14.83 | Fair | 126 | 285 | 1.08 | 2.00 | 3.44 | 2.25 | | |

Table 23 lists the maximum water level elevations for spring and summer runoff periods. The peak water level may be ice-affected during spring breakup. The elevations are referenced to an arbitrary datum established by the USFWS at the gauge site. Table 24 shows the estimated peak runoff for the spring and summer runoff periods.

Table 23. Estimated peak spring breakup and summer water level events for the Koyukuk River below John River station (USFWS site) for the period of record. The stage is reported in units above the arbitrary datum. Data courtesy of USFWS.

| Date | Peak Water Level Elevation (m) | Peak Water Level Elevation (ft) |
|---|---|---|
| Spring: April 30, 2010 | 6.38[1] | 20.93[1] |
| Summer: July 7, 2010 | 6.54 | 21.45 |
| Spring: May 24, 2011 | 6.84 | 22.45 |
| Summer: August 4, 2011 | 5.79 | 18.99 |
| Spring: May 24, 2012 | 6.12 | 20.08 |
| Summer: September 1, 2012 | 6.24 | 20.47 |
| Spring: May 26, 2013 | 8.77[2] | 28.78[2] |
| Summer: June 5, 2013 | 5.87 | 19.26 |
| Spring: May 3, 2014 | 7.02 | 23.02 |
| Summer: July 15, 2014[3] | 7.28 | 23.90 |

[1] Possible ice jam.
[2] Observed ice jam.
[3] Based on available data as of December 2014.

Table 24. Estimated peak runoff for the Koyukuk River below John River station for the period of record (data courtesy of USFWS).

| Date | Peak Runoff ($m^3/s$) | Peak Runoff ($ft^3/s$) |
|---|---|---|
| Spring: May 24, 2010 | 1330 | 46970 |
| Summer: July 7, 2010 | 1700 | 60030 |
| Spring: May 24, 2011 | 2160 | 76280 |
| Summer: August 4, 2011 | 1040 | 36730 |
| Spring: May 25, 2012 | 1300 | 45910 |
| Summer: September 1, 2012 | 1370 | 48380 |
| Spring: May 29, 2013[1] | 1850[1] | 65330[1] |
| Summer: June 5, 2013[2] | 1100[2] | 38850[2] |
| Spring: June 1, 2014 | 2180 | 76990 |
| Summer: July 15, 2014[3] | 2570 | 90760 |

[1] First available data; river was ice-affected, and discharge was not available during early breakup.
[2] Rain event in early summer.
[3] Based on available data as of December 2014.

#### 4.10.1.1 Koyukuk River summary – 2012

Continuous data collected in 2012 are shown in the plots in Figure 42 and Figure 43. A one-day trip in mid-May to the study area was conducted by UAF field staff to install time-lapse cameras at the proposed surface-water observation stations. When a time-lapse camera was installed on the Koyukuk River across from Old Bettles on May 17, the river had already started flowing (Figure 44 and Figure 45). By May 19, according to the camera, ice was no longer moving downstream. Based on camera images and the USFWS flow data, peak flow and stage occurred on May 25, 2012.

Summer 2012 had several large rain events in western Alaska that did not produce as much rain in the Koyukuk basin as occurred farther west. One of UAF's stations in western Alaska (Upper Kogoluktuk) reported over 400 mm of rain in about a 3-week period. However, our station in the Wild basin (at slightly higher elevation) only received about 160 mm during the same period. These late summer rain events, however, did produce two higher flow events in early September, as shown in the hydrographs in Figure 42 and Figure 43. These summer flow events slightly exceeded the spring breakup peak discharge.

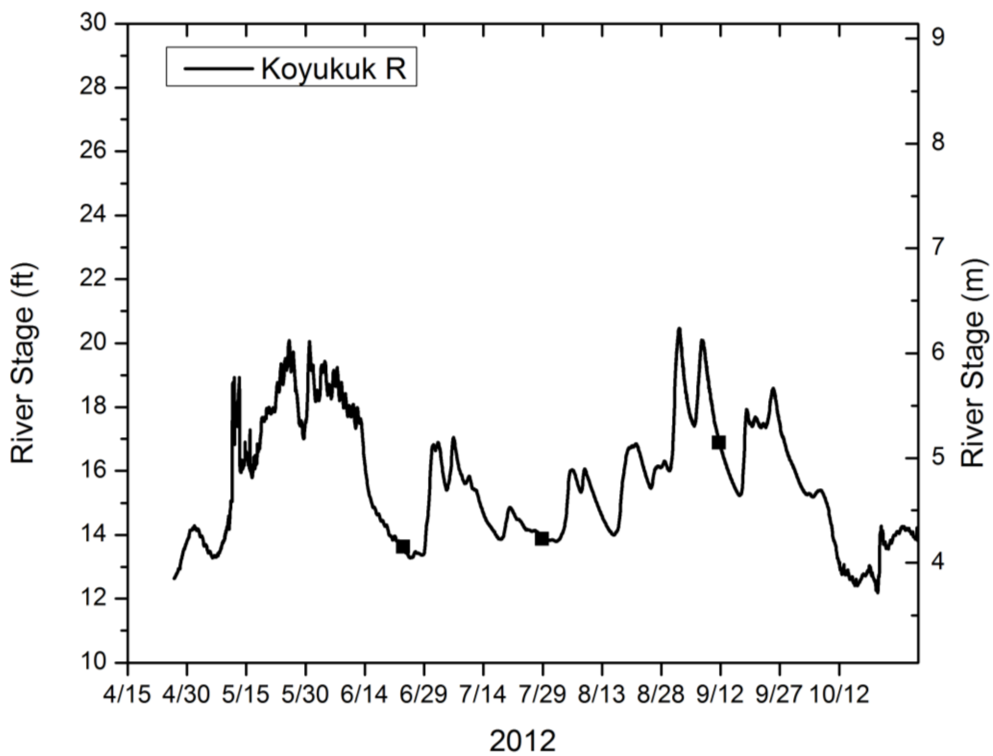



Figure 42. Koyukuk River at Old Bettles stage for 2012 (data courtesy of USFWS).

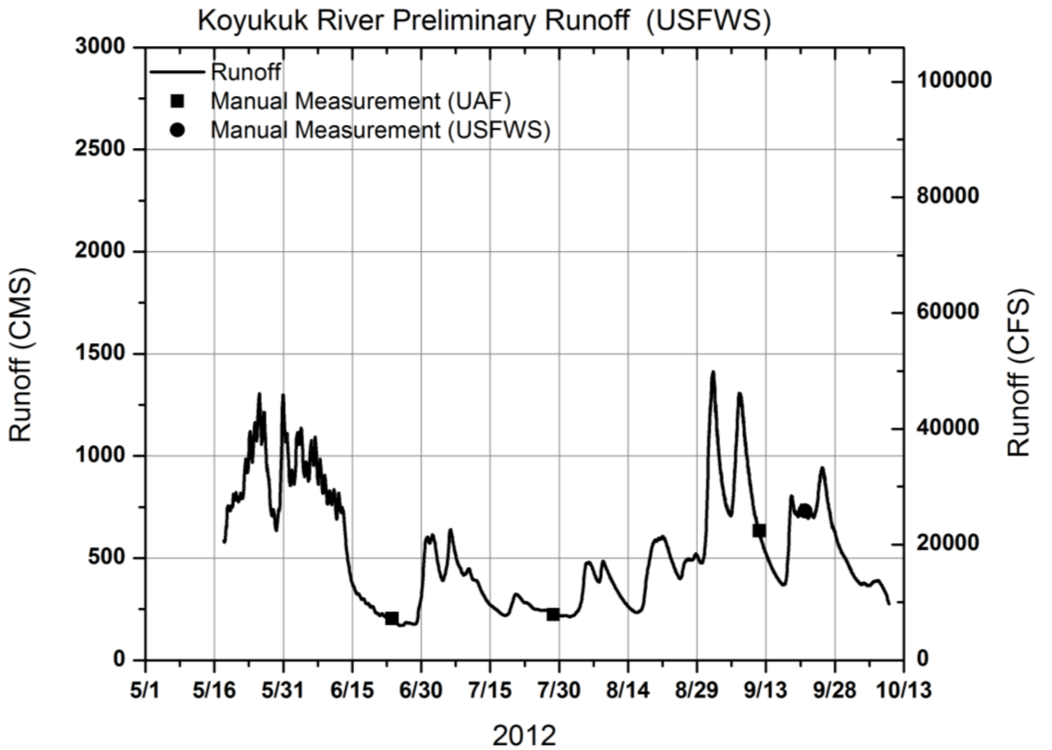



Figure 43. Koyukuk River at Old Bettles runoff for 2012 (data courtesy of USFWS).

Figure 44. Koyukuk River near Old Bettles on May 17, 2012, before peak flow. Ice is observed at the edge of the river, below the cutbank. The arrow indicates the direction of flow. Old Bettles is located about a half-mile downstream from the location of the photograph.

Figure 45. Koyukuk River near Old Bettles (circle) on May 17, 2012, a week before peak flow, showing ice chunks at the river's edge (below the cutbank) and floating in the water. The river already appears turbid.

#### 4.10.1.2 Koyukuk River summary – 2013

Continuous data collected in 2013 are shown in the plots in Figure 46 and Figure 47. Upon the UAF field staff's arrival on May 18, 2013, the Koyukuk River at Old Bettles was ice-covered (Figure 48). Some water began to flow over the ice by May 22, but most of the river ice during this early period melts in place (Figure 49). On May 25, breakup had progressed, with higher flows and large ice pans transported downstream. An ice jam developed the afternoon of May 25, 2013 (Figure 50 and Figure 51), with the ice front approximately 100 m upstream of Old Bettles. The ice jam at Old Bettles consisted roughly of 10% ice sheets, 30% large heavy pans, and 60% chunks of varying structural integrity (Figure 52 through Figure 55). The ice front moved downstream of Old Bettles several hundred meters by the morning of May 26, and by the evening of May 26, the jam released. During the ice jam, water levels rose dramatically and remained high until the ice jam moved downstream. The time-lapse cameras captured the ice jam and the rise in stage, and showed ice deposited above the cutbank at Old Bettles (Figure 54 through Figure 56). The highest stage recorded during the short period of record (2010–2014) occurred during this ice jam in 2013. Peak flow likely occurred shortly after the ice jam released. Floating ice persisted in the channel through May 27, and by May 28, the river was nearly ice-free (Figure 56 through Figure 59). The discharge at this site peaked on May 30. Figure 60 is a photograph showing the size of stranded ice on a gravel bar near the crossing. Summer 2013 was relatively uneventful and dry, with little runoff response to small rain events (Figure 46 and Figure 47).

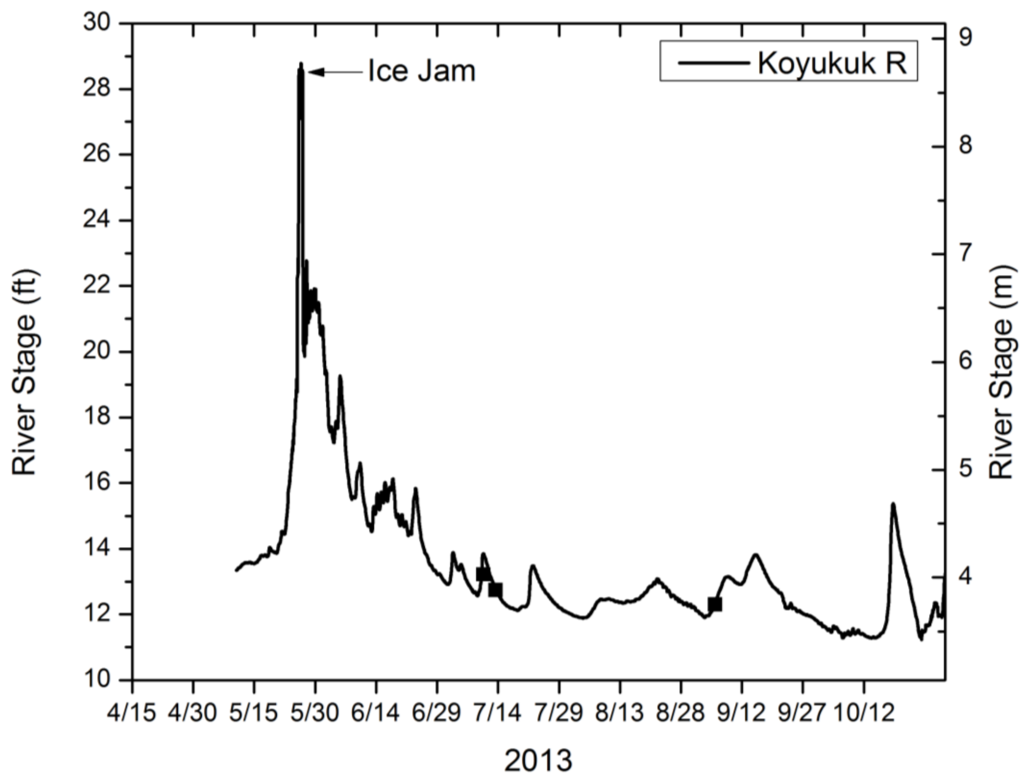



Figure 46. Koyukuk River at Old Bettles stage for 2013 (data courtesy of USFWS).

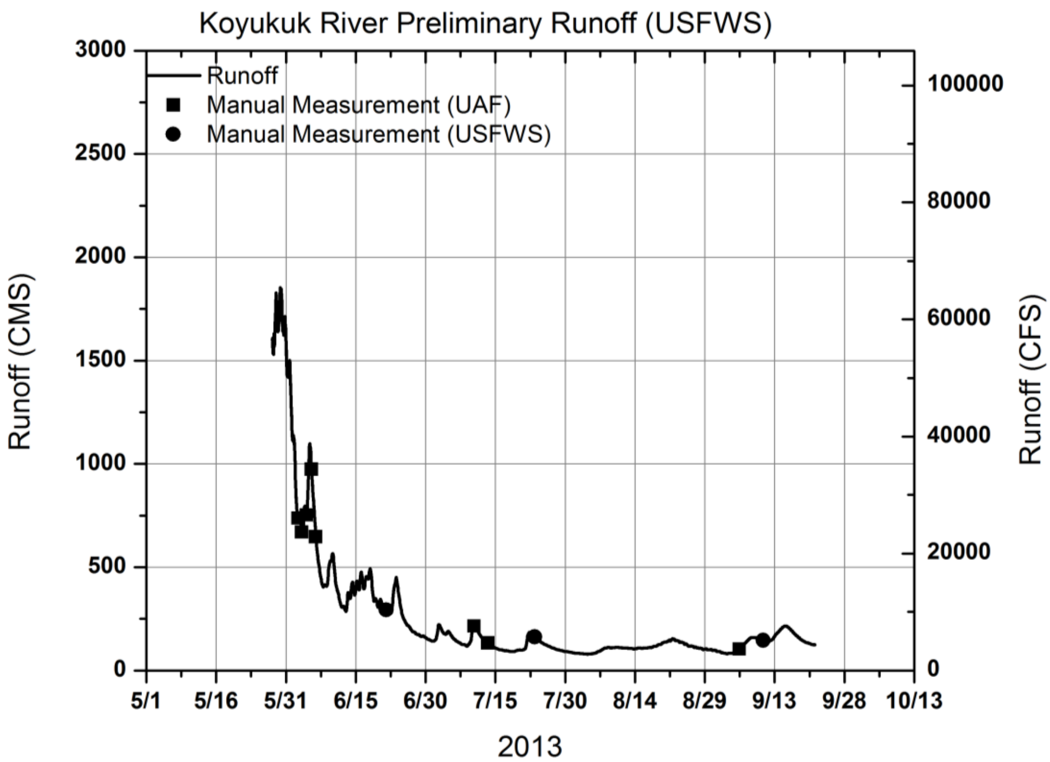



Figure 47. Koyukuk River at Old Bettles runoff for 2013 (data courtesy of USFWS).

Figure 48, Koyukuk River near Old Bettles, facing downstream. The river is covered by snow and ice on May 18, 2013.

Figure 49. On May 23, 2013, standing water on the Koyukuk River banks near Old Bettles (oval). The photograph is taken facing downstream.

Figure 50. Ice jam forms on the Koyukuk River near Old Bettles on May 25, 2013.

Figure 51. Flow condition upstream from Old Bettles (oval), morning of May 25, 2013.

Figure 52. Ice jam, during the afternoon, in front of Old Bettles (oval) on May 25, 2013.


Figure 53. Ice jam configuration on May 26, 2013. Old Bettles is shown in the oval.

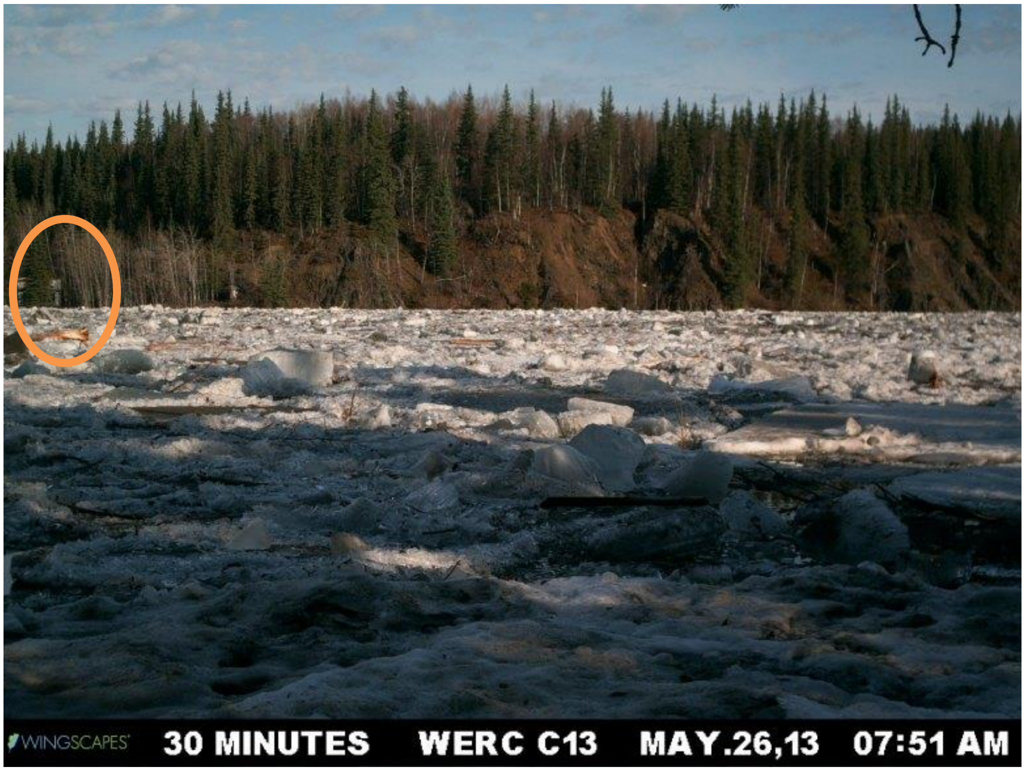


Figure 54. Ice jam at Koyukuk on the morning of May 26, 2013. For scale reference, see white house behind a spruce tree (oval).


Figure 55. Ice jam on the afternoon of May 26, 2013. The oval shows the ice at the level above the bottom of the white house.


Figure 56. By May 27, 2013, the ice had moved downstream and water levels declined. A large ice chunk is visible next to the white house (in the oval) above the cutbank.

Figure 57. Water level recedes on May 27, 2013, and ice blocks are deposited on the gravel bar upstream of Old Bettles (oval).

Figure 58. Flow configuration in the vicinity of Old Bettles (oval) on May 27, 2013. Ice is mainly moving along the right bank.

Figure 59. Flow is nearly ice-free on May 28, 2013, Old Bettles is indicated by oval.

Figure 60. Detailed view of ice blocks deposited on the gravel bar on May 30, 2013. UAF field staff setting up equipment for measuring streamflow.

Figure 61. Flow configuration on the Koyukuk near Old Bettles on June 1, 2013. The water is increasingly turbid; oval indicates Old Bettles.

Figure 62. Water level has receded on June 3, 2013. The John River (top center) comes into the Koyukuk River (upper right corner). Old Bettles is about a mile downstream of the confluence.

#### 4.10.1.3 Koyukuk River summary – 2014

The hydrographs for the Koyukuk River in 2014 are presented in Figure 63 and Figure 64. On April 30, 2014, air temperatures warmed to above freezing for about 5 days. Field staff from UAF arrived at the Koyukuk gauging site on May 6 and observed flowing water. Stranded ice was visible on the river's edge of the gravel bars, indicating that the initial river ice breakup had already occurred. Ice was not visible above the cutbanks (compared with 2013, where an ice jam in the area caused ice to be deposited above the cutbank at Old Bettles) (Figure 65 and Figure 66). On May 8, the John River was observed to have floating ice in the channel, but little ice remained in the channel of the Koyukuk above the confluence with the John River. By May 9, little ice remained in the Koyukuk River at Old Bettles, and water levels were very low. Snow cover was still 90% in the basin during this time. The photograph in Figure 67 shows the size of the stranded ice on the gravel bar near the gauging site. On May 11, stage increased slightly causing stranded ice and debris (tree logs) to move downstream. On May 12, a large amount of ice chunks was observed in the John River. By May 16, most of the valley bottoms were snow free, but snow remained in the foothills and mountain regions (over 75% snow cover remained within the basin). Little change in river discharge occurred during the month of May (see lower flows in the photograph in Figure 68 and the hydrograph in Figure 64), due to below-freezing temperatures in the higher elevations from May 5 through May 11 and again May 17 through May 27. The colder temperatures delayed snowmelt in much of the basin. Runoff finally increased on May 30 (Figure 64), after warm temperatures the last week in May accelerated snowmelt. When the spring peak flow finally occurred on June 1, UAF was not in the field to measure flow due to the lack of funds and available staff to extend the helicopter contract.

Summer 2014 was wet compared with summer 2013. The meteorological stations in the area (Wild, Bettles, Coldfoot, Gobbler's Knob, Atigun) received much more rainfall than in 2013. The hydrograph for 2014 reflects this with numerous runoff events throughout summer. The summer peak discharge on July 15 exceeded the spring breakup peak discharge. The spring breakup and summer discharges for 2014 were the highest recorded peak flows in the short period of record for this site.

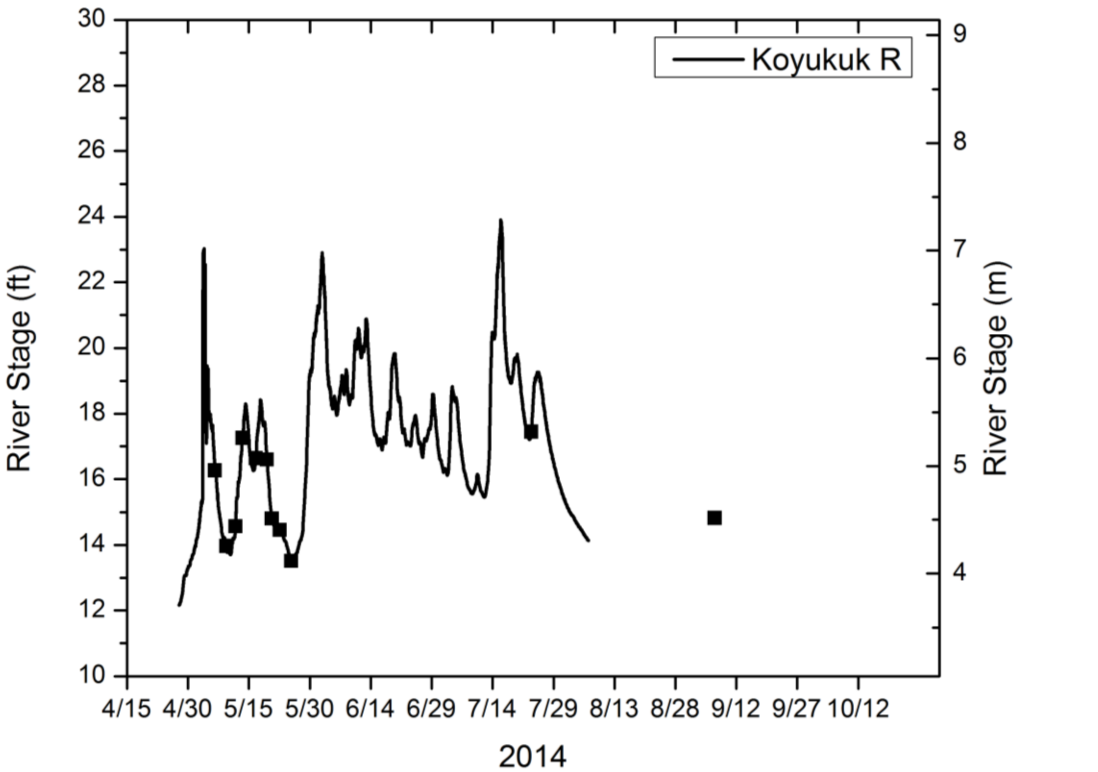



Figure 63. Koyukuk River at Old Bettles stage for 2014 (data courtesy of USFWS).

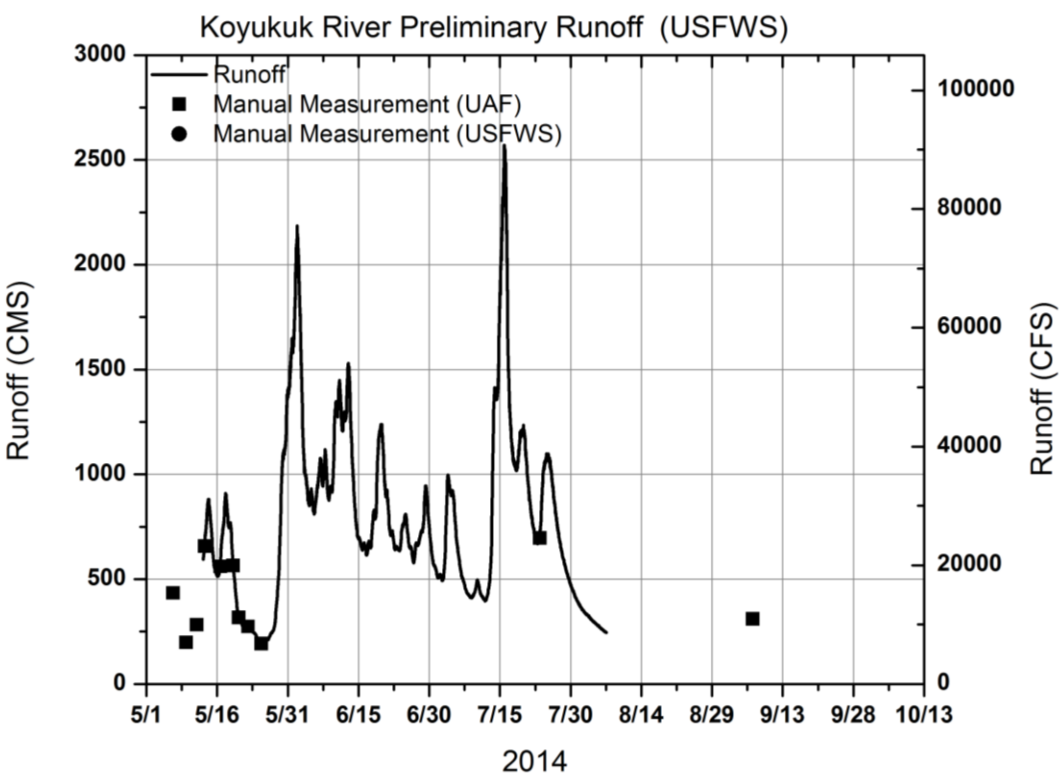



Figure 64. Koyukuk River at Old Bettles, runoff for 2011 (data courtesy of USFWS).


Figure 65. Koyukuk River from Old Bettles on May 7, 2014, facing north (upstream). The initial breakup front had already come through, and stranded ice is visible on the gravel bars. Ice was not deposited above the top of the banks during the initial breakup.


Figure 66. Koyukuk River above Old Bettles facing north (upstream) on May 7, 2014. Ice is visible along the rivers edges.


Figure 67. Koyukuk River one-quarter mile above Old Bettles on May 9, 2014, facing downstream. Ice chunks are visible along the edge of the gravel bar.

Figure 68. Koyukuk River near Old Bettles (oval) on May 15, 2014, facing north. Much of the snow in the valley bottoms is gone, but significant snow remains in the mountains.

### 4.10.2 Alatna River

The Alatna River originates in the Central Brooks Range and drains to the south, eventually flowing into the Koyukuk River at the villages of Alatna/Allakaket. The watershed area is approximately 6300 $km^2$ at the UAF gauge site, which is located just below the confluence with the Malemute Fork of the Alatna River (the Malemute Fork flows in from the eastern side of the basin). The basin elevation ranges from 229 m to 2175 m, with an average basin elevation of 842 m. Above the UAF gauge site, approximately 80% of the basin lies in the mountainous region. The stream length is approximately 205 km.

Within the basin are three UAF meteorological stations (Alatna River-DAS2, South Fork Bedrock Creek-DAS3, and Upper Iniakuk-DAM6) and one NPS meteorological stations (Ram Creek). Permafrost was not encountered in the borehole at the gauge site, but was encountered at nearby South Fork Bedrock Creek station.

Hydrographs for 2012 through 2014 are presented in Sections 4.10.2.1 through 4.10.2.3. The Alatna River (above the gauge site) is similar to the Koyukuk (above the gauge site) in that it is south-draining and much of the basin area lies in the mountains. Thus, the hydrographs for the two rivers are quite similar. Snowmelt is typically the primary event of the year in terms of total volume of runoff. Ice jams were observed in 2013 near the proposed crossing. Summer rain events cause runoff to increase dramatically, which was observed in fall 2012.

Table 25 shows the peak water level elevations for each year of the study. Table 26 summarizes each discharge measurement, with additional details in the measurement summary in Appendix E. Table 27 presents the estimated peak discharge during the spring and summer periods from 2012 through 2014. A few discharge measurements were also made in the Malemute Fork of the Alatna to examine the distribution of runoff and sediment load between the two forks of the river, but data are not presented in this report.

Table 25. Peak spring breakup and summer water level events for the Alatna River below the confluence of the Malemute Fork, 2012–2014. The stage is reported in units above the datum (ellipsoid, WGS84).

| **Date** | **Peak Water Level Elevation (m)** | **Peak Water Level Elevation (ft)** |
|---|---|---|
| Summer: August 31, 2012 | 210.36 | 690.16 |
| Spring: May 27, 2013 (from station camera images) | ~212.40[1,2] | 696.85 |
| Summer: June 5, 2013 | 209.55 | 697.50 |
| Spring: June 1, 2014 | 210.48 | 690.55 |
| Summer: June 10, 2014 | 209.87 | 688.55 |

[1] High watermark on May 27 was not surveyed/measured, but was very close to the temporary benchmark elevation according to time-lapse camera.
[2] High watermark during ice jam.

Table 26. Discharge measurements for the Alatna River below the confluence of the Malemute Fork, 2012–2014. The stage is reported in units above the datum (ellipsoid, WGS84).

| Date | No. | Discharge ($m^3/s$) | Discharge ($ft^3/s$) | Stage (m) | Stage (ft) | Msmt Rating (%) | Width (m) | Area ($m^2$) | Velocity (m/s) | Max Velocity (m/s) | Max Depth (m) | Avg Depth (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/22/2012 16:30 | 1 | 88 | 3108 | 208.39 | 683.70 | fair | 101 | 124 | 0.74 | 1.36 | 1.92 | 1.23 |
| 7/31/2012 17:30 | 2 | 123 | 4344 | 208.54 | 684.17 | fair | 112 | 154 | 0.81 | 1.62 | 2.60 | 1.37 |
| 9/12/2012 12:30 | 3 | 228 | 8052 | 209.07 | 685.94 | fair | 140 | 260 | 0.66 | 2.13 | 3.19 | 1.86 |
| 5/30/2013 10:00 | 4 | 642 | 22672 | 210.28 | 689.90 | fair | 155 | 448 | 1.45 | 2.79 | 4.62 | 2.92 |
| 5/31/2013 15:15 | 5 | 435 | 15362 | 209.79 | 688.29 | poor | 158 | 364 | 1.24 | 2.43 | 5.46 | 2.45 |
| 6/1/2013 10:00 | 6 | 370 | 13066 | 209.55 | 687.49 | fair | **132** | 326 | 1.14 | 2.45 | 5.37 | 2.56 |
| 6/6/2013 13:00 | 7 | 227 | 8016 | 208.93 | 685.45 | fair | 130 | 286 | 0.77 | 2.06 | 3.39 | 2.21 |
| 6/7/2013 9:45 | 8 | 179 | 6321 | 208.73 | 684.80 | fair | 129 | 244 | 0.78 | 1.99 | 2.92 | 1.90 |
| 7/11/2013 10:00 | 9 | 80 | 2825 | 208.25 | 683.24 | fair | 134 | 174 | 0.40 | 1.32 | 2.52 | 1.30 |
| 9/5/2013 12:30 | 10 | 76 | 2684 | 208.18 | 683.00 | fair | 130 | 186 | 0.35 | 1.19 | 2.24 | 1.43 |
| 5/15/2014 12:30 | 11 | 179 | 6321 | 208.68 | 684.66 | poor | 128 | 235 | 0.92 | 1.94 | 3.31 | 1.87 |
| 5/17/2014 9:30 | 12 | 305 | 10771 | 209.20 | 686.36 | poor | 135 | 315 | 0.91 | 2.57 | 3.33 | 2.33 |
| 5/19/2014 15:15 | 13 | 150 | 5297 | 208.60 | 684.37 | fair | 113 | 231 | 0.66 | 1.95 | 3.65 | 2.03 |
| 5/21/2014 11:45 | 14 | 108 | 3814 | 208.33 | 683.51 | fair | 116 | 200 | 0.52 | 1.69 | 2.59 | 1.72 |
| 5/23/2014 14:30 | 15 | 99 | 3496 | 208.28 | 683.33 | poor | 120 | 197 | 0.46 | 1.33 | 2.77 | 1.65 |
| 5/24/2014 9:45 | 16 | 96 | 3390 | 208.23 | 683.18 | poor | 105 | 175 | 0.44 | 1.58 | 3.23 | 1.67 |
| 7/22/2014 15:00 | 17 | 190 | 6710 | 208.83 | 685.13 | fair | 110 | 251 | 0.65 | 1.56 | 3.99 | 2.29 |
| 9/4/2014 9:15 | 18 | 99 | 3512 | 208.36 | 683.59 | fair | 129 | 187 | 0.45 | 1.31 | 2.12 | 1.44 |

Table 27. Estimated peak discharge, Alatna River below the confluence of the Malemute Fork.

| Date | Peak Runoff ($m^3$/s) | Peak Runoff ($ft^3$/s) |
|---|---|---|
| Summer: August 31, 2012 | 680 | 24,000 |
| Spring: ~May 29, 2013 | 760+ | 26,850+ |
| Summer: June 5, 2013 | 375 | 13,240 |
| Spring: June 1, 2014 | 735 | 26,000 |
| Summer: June 10, 2014 | 480 | 16,910 |

#### 4.10.2.1 Alatna River summary – 2012

Plots of stage and discharge for the Alatna River are presented in Figure 69 and Figure 70. A visit to the Alatna River near the proposed crossing on May 17, 2012, showed high river stage and floating ice in the water (Figure 71 and Figure 72). A time-lapse camera was installed; however, photographs were lost from the camera due to incorrect setup. The hydrometeorological station was installed in mid-June 2012, after spring breakup. A storm in western Alaska produced significant rainfall in late August; a corresponding increase in fall runoff is observed in the hydrograph (Figure 70). Unfortunately, rainfall data were not available at the Upper Iniakuk station (located in mid basin), but the Alatna River station recorded approximately 150 mm of rain from mid-August through mid-September, and at the nearby Upper Reed station (a high elevation station to the west), approximately 375 mm of rainfall was recorded. Considerably more rain fell at these sites from mid-September until freeze-up.

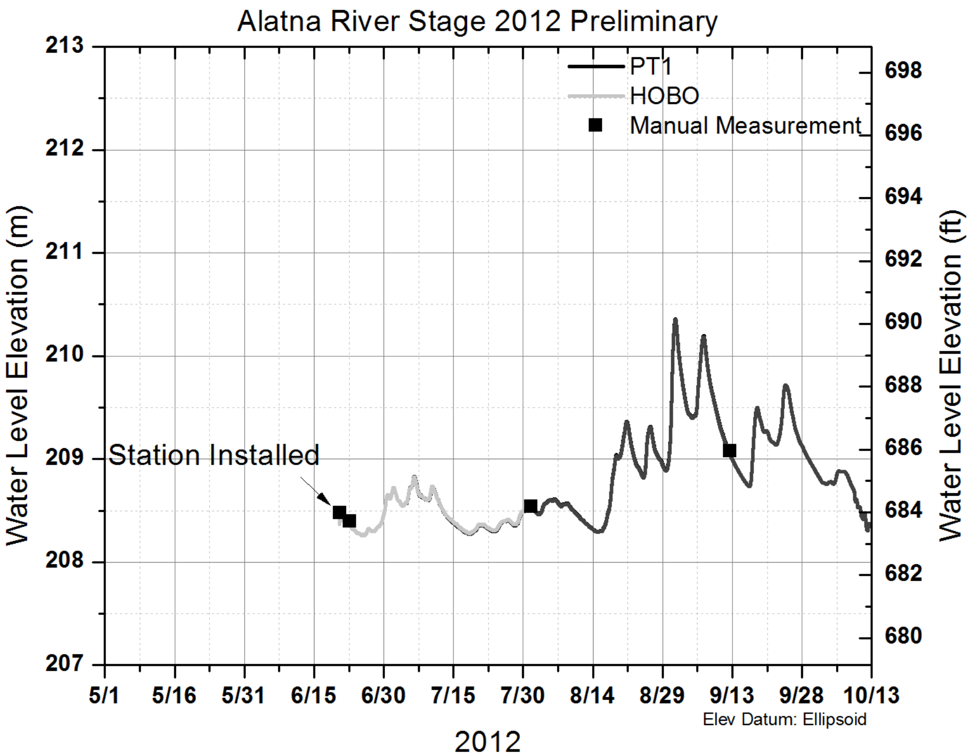



Figure 69. Water levels at the Alatna River station below the confluence with the Malemute Fork, 2012. Station was installed after the spring breakup period.

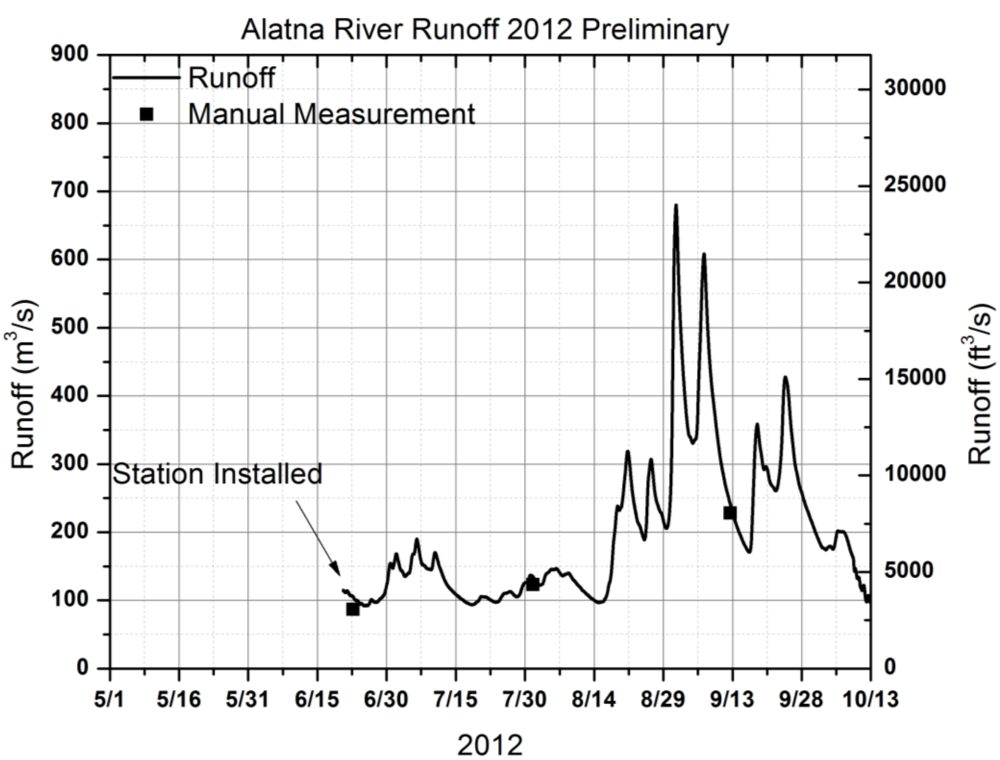



Figure 70 Runoff at the Alatna River station below the confluence with the Malemute Fork, 2012. Station was installed after the spring breakup period.

Figure 71. Photograph of the first site visit to the UAF Alatna River station on May 17, 2012, shows the high river stage. Arrow indicates flow direction.

Figure 72. Photograph during a site visit to the Alatna River shows high stage and floating ice on May 17, 2012.

#### 4.10.2.2 Alatna River summary – 2013

Figure 73 and Figure 74 show the continuous observations of river stage and runoff for the Alatna River in 2013. On May 18, 2013, UAF field staff first visited the Alatna station and observed snow and ice on the river (Figure 75). Ice deteriorated over the next several days, and finally on May 24, initial streamflow over ice began (Figure 76). An ice jam occurred on the Alatna River at the station on May 27, 2013, causing high water levels (Figure 77 through Figure 80). During breakup, water from Malemute Fork was less turbid than the Alatna channel, as shown in Figure 81 (taken on May 28) and further discussed in Section 5.3. On a site visit on May 28, UAF field staff found evidence of over bankfull river conditions, with large ice chunks above the elevation of the cutbank (Figure 82 through Figure 86). Pressure transducers had been moved by the ice on multiple occasions, and all stage data were deemed unusable prior to May 28. Measurements of streamflow were not made until the ice jam released and the river was safe to enter. By May 30, the river was no longer ice-affected (Figure 87), and water level began to rapidly decline shortly after (Figure 88). The peak stage occurred during the ice jam on May 27, but peak flow likely occurred a few days later on May 29. The highest stages recorded in the short study period occurred during over bankfull conditions during this ice jam. The rest of 2013 was relatively uneventful due to the lack of significant rainfall.

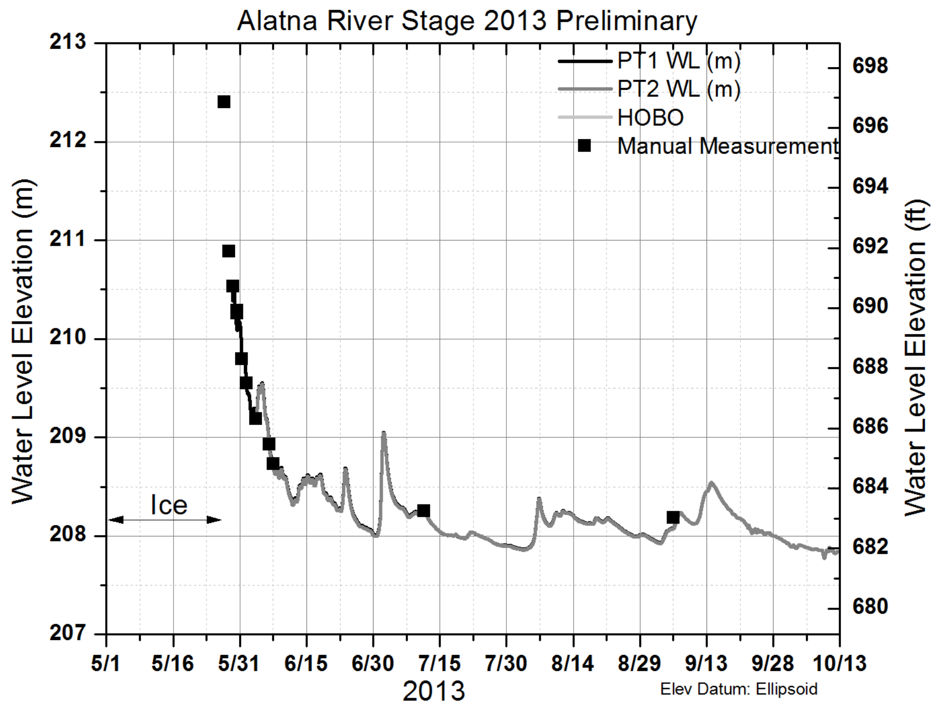



Figure 73. Water levels at the Alatna River station below the confluence with the Malemute Fork, 2013. Initial water level observations were very high due to an ice jam on May 27–28 near the station. Pressure transducer data are not available during early flows and ice jam due to lack of manual surveys of stage and movement of pressure transducers by ice.

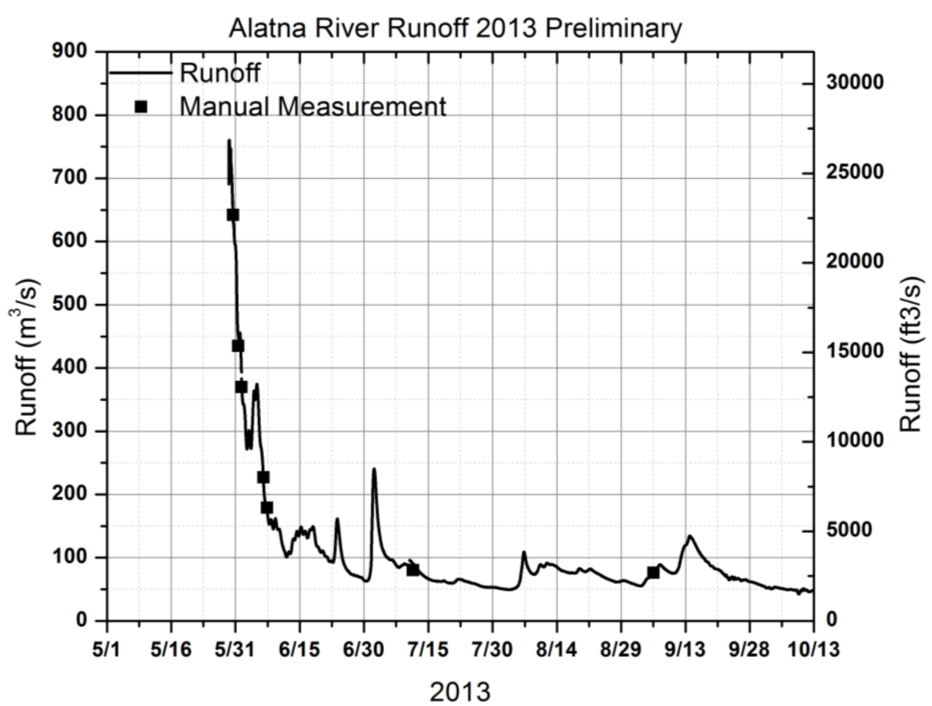



Figure 74. Runoff at the Alatna River station below the confluence with the Malemute Fork, 2013.

Figure 75. Most of stream covered by snow and ice on May 18, 2013, at the Alatna River. Standing water (over ice) near the banks. Triangle denotes weather station location.

Figure 76. Limited flow of water over ice on May 24, 2013 (triangle is meteorological station).

Figure 77. Small ice jam develops in the vicinity of the station on May 26, 2013 (triangle is meteorological station).

Figure 78. Ice blocks moving downstream on May 27, 2013. Flow is concentrated on the right bank.

Figure 79. Ice distribution near the station on May 27, 2013. Most of the ice is located on the right margin.


Figure 80. Alatna River is over bankfull on May 27, due to ice conditions.

Figure 81. Confluence of the Malamute Fork of the Alatna River (dark colored water coming in on left) and Alatna (silty water) on May 28, 2013. Interface between streams is well defined. The gauging site for the Alatna is a short distance downstream.

Figure 82. Ice blocks flowing and deposited on the bank near the Alatna station on May 28, 2013.

Figure 83. Ice blocks concentrated on the right margin on May 28, 2013.

Figure 84. Ice deposited above the river bank at the station on May 28, 2013.

Figure 85. During the afternoon, looking upstream from the station on May 28, 2013.

Figure 86. Detail of ice blocks near the Alatna station on May 28, 2013.

Figure 87. By May 30, 2013, the river has ice-free flow condition. Photograph taken downstream of the Alatna/Malemute Fork confluence.

Figure 88. By June 1, 2013, water level is receding in the stream (Alatna River station is the triangle).

Figure 89. Gravel bars exposed in the vicinity of the Alatna/Malemute Fork confluence on June 7, 2013. Malemute Fork (top left) and Alatna River (bottom). Note the difference in color. Water level is lower following snowmelt.

#### 4.10.2.3 Alatna River summary – 2014

Plots of stage and discharge for 2014 are shown in Figure 90 and Figure 91. In spring 2014, river ice remained on the Alatna River, the longest of the four other rivers considered in this study. Upon arrival on May 5, 2014, field staff found the river mainly ice-covered in front of the UAF station, with some standing open water in the middle of the channel. Water began flowing along the right bank on May 11, with the majority of flow appearing to originate in the Malamute Fork, not the main Alatna channel. A substantial amount of ice remained grounded on the gravel bar in front of the station until the evening of May 13, when water levels rose and flushed most of this ice downstream. Small increases in runoff occurred on May 14 and 18, with flows just under 300 $m^3$/s. The snowpack in much of the mid to upper basin remained because of colder temperatures. Flow remained low (roughly 85–100 $m^3$/s) from May 21 through 28. Water levels began to rise rapidly after temperatures finally increased at the end of May. Peak flow occurred on June 1, with a discharge of over 700 $m^3$/s; however, UAF was not present to make manual discharge measurements during the peak. These events were captured by a camera in front of the station (see Figure 92 to Figure 94). Prior to August, summer 2014 was relatively wet, and rainfall events in June and July caused water levels and flow to remain high through late July. The summer peak discharge was less than the spring breakup peak discharge.

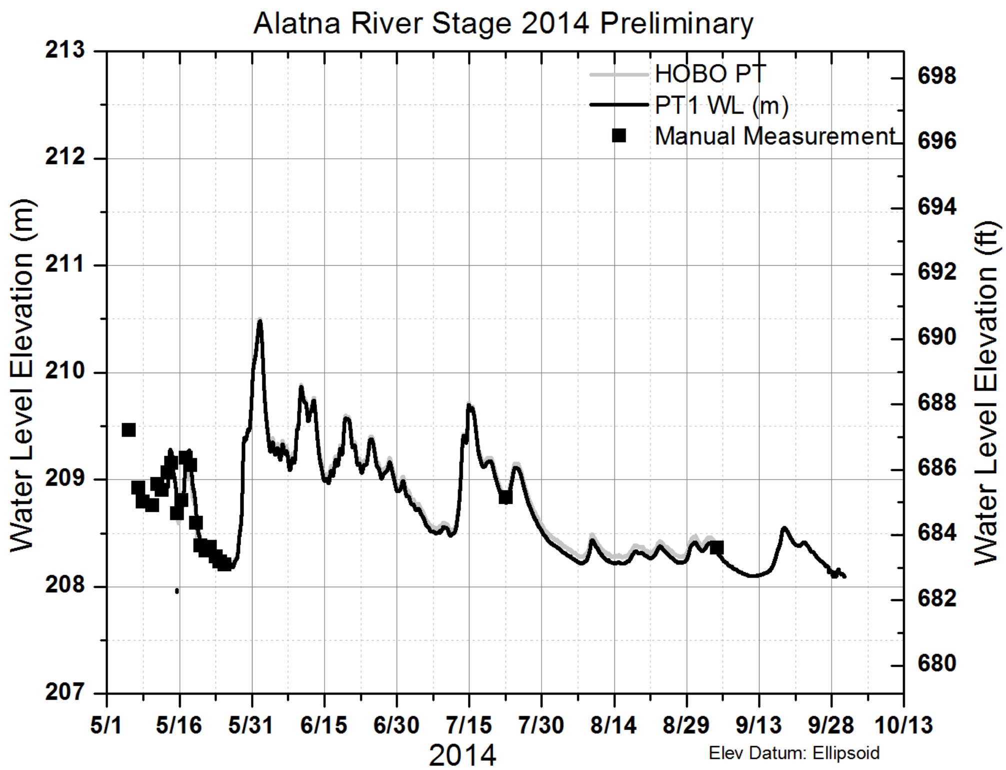



Figure 90. Water levels at the Alatna River station below the confluence with the Malemute Fork, 2014.

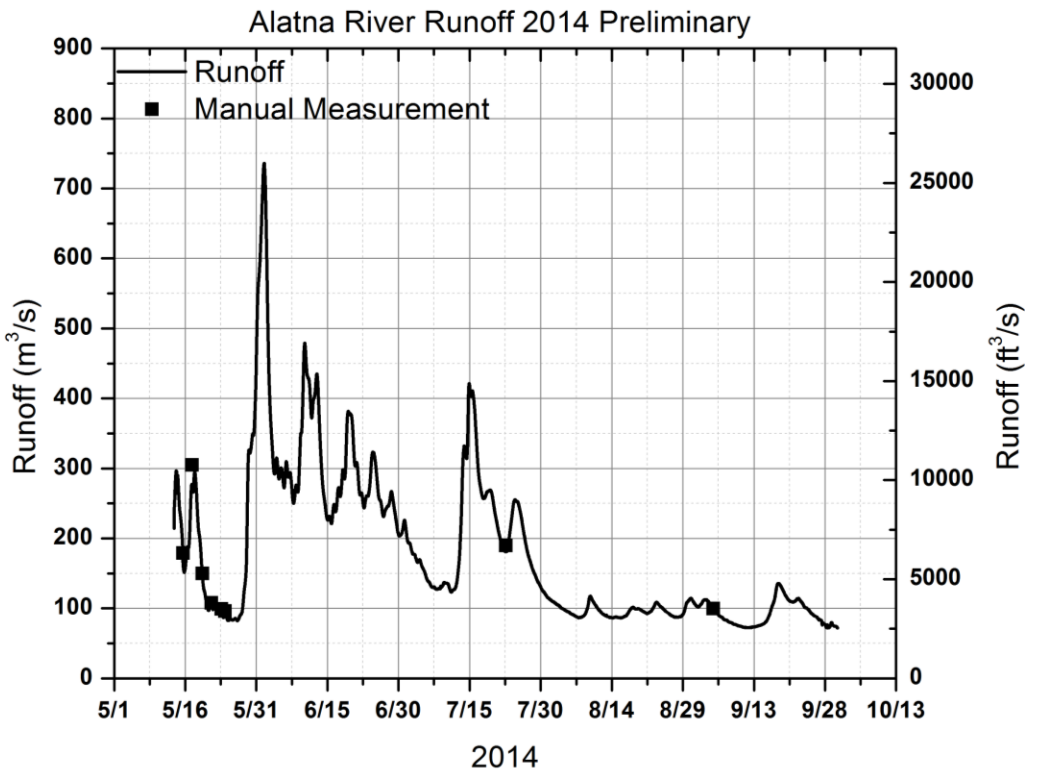



Figure 91. Runoff at the Alatna River station below the confluence with the Malemute Fork, 2014.


Figure 92. Alatna River on May 5, 2014, when the river was mainly ice-covered. Arrow indicates the flow direction.


Figure 93. Ice grounded on gravel bar in front of Alatna River station on May 12, 2014. Arrow indicates the flow direction.


Figure 94. Alatna River on May 31, 2014, during peak flows. Arrow indicates the flow direction.

### 4.10.3 South Fork Bedrock Creek (Alatna tributary)

The South Fork Bedrock Creek, a tributary of the Malemute Fork of the Alatna River, flows north/northeast from the Alatna Hills. The north-facing drainage has a basin area of 174 $km^2$ above the UAF gauge site. The basin elevation ranges from 245 m at the outlet to 978 m in the foothills, with an average basin elevation of 452 m. Only 28% of the basin area is above 500 m, and one-third of the basin is forested (Homer et al., 2007), in contrast to the other high gradient larger basins in the study, which drain from the Brooks Range. The stream length is 31 km. Since the basin is entirely north-facing, it is likely within a zone of permafrost, although this region is an area of discontinuous permafrost. Within the basin, there is one UAF meteorological station (DAS3, South Fork Bedrock Creek) at the gauge site. While installing soil temperature sensors at the station, permafrost was encountered at 40 cm below ground surface.

Hydrographs for 2012 through 2014 are presented in Sections 4.10.3.1 through 4.10.3.3. The basin is different from the other basins in the study area mostly due to its size, aspect, lower elevation, and lower gradient. Snowmelt is the likely the primary event of the year in terms of total volume of runoff, and it occurs more quickly than the other rivers examined. Due to its elevation and size, the basin has a shallower snowpack, and air temperatures are typically warmer in the lowlands, causing melt to be fast and at times earlier. The highest stages likely will occur during spring breakup, when the channel is ice-affected. Significant bottom ice was encountered for much of the breakup period. Summer rain events may also cause runoff to increase greatly; this was observed in 2012, but less so in 2013 and 2014.

Table 28 summarizes each discharge measurement, with additional details in Appendix E. Table 29 shows the peak water level elevations for the spring and summer periods. Table 30 presents the estimated peak discharge during the spring and summer periods from 2012 through 2014.

The rating curve (and thus estimates of continuous discharge) is considered very poor at this site due to the low number of rating measurements. Since bottom ice was present in the river channel for much of spring breakup, the rating curve is not valid until the end of breakup when the ice is gone. Additionally, no measurements were made at the highest river stage, so the rating curve is extrapolated at high stage. A strong diurnal fluctuation of stage was observed during breakup, but unfortunately, all of these measurements were made during the lower stages or were ice-affected.

Table 28. Discharge measurements for the South Fork of Bedrock Creek (Alatna River tributary) 2012–2014. The stage is reported in units above the datum (ellipsoid, WGS84).

| Date | No. | Discharge ($m^3/s$) | Discharge ($ft^3/s$) | Stage (m) | Stage (ft) | Msmt Rating (%) | Width (m) | Area ($m^2$) | Velocity (m/s) | Max Velocity (m/s) | Max Depth (m) | Avg Depth (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/21/2012 16:30 | 1 | 0.4 | 14 | 253.43 | 77.24 | poor | 9.4 | 2.83 | 0.14 | 0.18 | 0.22 | 0.38 |
| 8/1/2012 15:20 | 2 | 0.5 | 18 | 253.44 | 77.25 | poor | 8.5 | 2.63 | 0.20 | 0.20 | 0.27 | 0.40 |
| 9/15/2012 13:00 | 3 | 1.8 | 65 | 253.59 | 77.29 | poor | 12.3 | 5.75 | 0.32 | 0.32 | 0.44 | 0.63 |
| 5/25/2013 12:00 | 4 | 9.5 | 334 | 254.23 | 77.49 | poor | 17.8 | 6.70 | 1.40 | 1.51 | 2.45 | 0.73 |
| 5/26/2013 11:40 | 5 | 19.3 | 681 | 254.42 | 77.55 | poor | 18.0 | 8.56 | 2.26 | 2.43 | 3.94 | 0.87 |
| 5/27/2013 17:40 | 6 | 18.6 | 657 | 254.29 | 77.51 | poor | 16.8 | 9.30 | 1.98 | 2.19 | 3.51 | 1.01 |
| 5/29/2013 17:05 | 7 | 10.1 | 357 | 253.91 | 77.39 | poor | 15.5 | 10.50 | 0.96 | 1.04 | 2.03 | 1.15 |
| 6/2/2013 11:15 | 8 | 2.4 | 85 | 253.65 | 77.31 | poor | 11.7 | 5.90 | 0.41 | 0.42 | 1.37 | 1.02 |
| 7/11/2013 14:39 | 9 | 2.4 | 86 | 253.63 | 77.31 | poor | 13.1 | 7.60 | 0.32 | 0.33 | 0.44 | 0.84 |
| 9/5/2013 15:15 | 10 | 1.2 | 42 | 253.39 | 77.23 | poor | 11.9 | 4.40 | 0.27 | 0.32 | 0.44 | 0.50 |
| 5/6/2014 10:45 | 11 | 5.7 | 201 | 253.81 | 77.36 | poor | 13.0 | 5.95 | 0.96 | 1.08 | 2.14 | 0.63 |
| 5/8/2014 15:00 | 12 | 4.3 | 151 | 253.78 | 77.35 | poor | 12.4 | 6.96 | 0.61 | 0.62 | 1.87 | 1.05 |
| 5/9/2014 15:20 | 13 | 4.0 | 142 | 253.74 | 77.34 | fair | 13.5 | 7.10 | 0.57 | 0.58 | 1.74 | 1.07 |
| 5/10/2014 8:50 | 14 | 5.2 | 183 | 253.71 | 77.33 | fair | 12.6 | 7.37 | 0.70 | 0.73 | 1.77 | 1.02 |
| 5/12/2014 8:50 | 15 | 17.5 | 618 | 254.07 | 77.44 | poor | 18.3 | 14.10 | 1.24 | 1.28 | 2.59 | 1.20 |
| 5/13/2014 13:45 | 16 | 22.4 | 792 | 254.17 | 77.47 | fair | 16.6 | 15.27 | 1.47 | 1.47 | 2.86 | 1.34 |
| 5/14/2014 16:15 | 17 | 17.5 | 618 | 254.01 | 77.42 | poor | 17.7 | 13.88 | 1.26 | 1.27 | 2.49 | 1.20 |
| 5/17/2014 14:35 | 18 | 18.2 | 642 | 254.05 | 77.43 | fair | 16.9 | 13.77 | 1.32 | 1.36 | 2.60 | 1.22 |
| 5/18/2014 8:45 | 19 | 12.5 | 443 | 253.89 | 77.39 | fair | 17.0 | 11.62 | 1.08 | 1.13 | 2.43 | 1.06 |
| 5/22/2014 10:30 | 20 | 6.0 | 212 | 253.67 | 77.32 | fair | 17.1 | 8.62 | 0.70 | 0.75 | 1.70 | 1.05 |
| 9/6/2014 8:40 | 21 | 0.9 | 30 | 253.40 | 77.24 | poor | 13.8 | 4.40 | 0.19 | 0.19 | 0.29 | 0.51 |

Table 29. Peak spring breakup and summer water level events for the South Fork of Bedrock Creek (Alatna River tributary) 2012–2014. The stage is reported in units above the datum (ellipsoid, WGS84).

| Date | Peak Water Level Elevation (m) | Peak Water Level Elevation (ft) |
|---|---|---|
| Spring: May 18, 2012[1] | N/A | N/A |
| Summer: August 31, 2012 | 254.33 | 834.41 |
| Spring: May 27, 2013 | 254.78 | 835.89 |
| Summer: June 5, 2013 | 253.90 | 833.00 |
| Spring: May 13, 2014 | 254.40 | 834.64 |
| Summer: July 14, 2014 | 253.92 | 833.07 |

[1] Based on time-lapse camera installed May 17.

Table 30. Estimated peak discharge events for the South Fork of Bedrock Creek (Alatna River tributary).

| Date | Peak Runoff ($m^3/s$) | Peak Runoff ($ft^3/s$) |
|---|---|---|
| Spring: May 30, 2012[1] | N/A | N/A |
| Summer: August 31, 2012 | 47e | 1660e |
| Spring: May 27, 2013 | N/A | N/A |
| Summer: June 5, 2013 | 10 | 350 |
| Spring: May 13, 2014 or May 17, 2014 | 60e | 2120e |
| Summer: July 14, 2014 | 11 | 388 |

[1] Based on time-lapse camera installed May 17.
e: Estimate based on rating curve extrapolation; very high uncertainty.

#### 4.10.3.1 South Fork Bedrock Creek summary – 2012

The station at South Fork Bedrock Creek was installed in late June 2012. However, a time-lapse camera was installed approximately 1 mile downstream of the station during a visit to the river on May 17, 2012, during spring breakup. Photographs taken during the visit show high stage (Figure 95). Water levels were high during the installation of the camera, but snow remained in the basin so it is assumed peak flow had not yet occurred. Based on the time-lapse camera, water levels were highest on May 18 to 19, and again May 30 (Figure 96 and Figure 97). Water levels on May 18 and 19 were possibly ice-affected (bottom ice). By May 25, much of the snow in the basin was gone (based on a time-lapse photo of the hillside). Peak flow likely occurred on May 30, based on camera images of high stage (and assuming ice-free river conditions). Typical stage during lower flows at the location of the camera is presented in Figure 98. The camera was relocated upstream in early July to the hydrometeorological station.

Rain events in western Alaska caused a dramatic rise in water levels and runoff in late August and early September (Figure 99 and Figure 100). Even though rainfall was not recorded for the entire season in 2012 (the continuous data record started in early July), 2012 overall was a very wet year due to these western Alaska storms. Figure 101 shows a typical low flow condition at the UAF gauge site before the significant rain events in late August, and Figure 102 shows the river at peak flow on August 31, 2012. The difference between the low and high stage in summer 2012 was nearly 1 m. The maximum stage recorded in the early September 2012 event is close to the maximum stages recorded during spring breakup in 2013 and 2014, which are typically ice-affected.

Figure 95. Aerial photograph of South Fork Bedrock Creek near the UAF station on May 17, 2012.

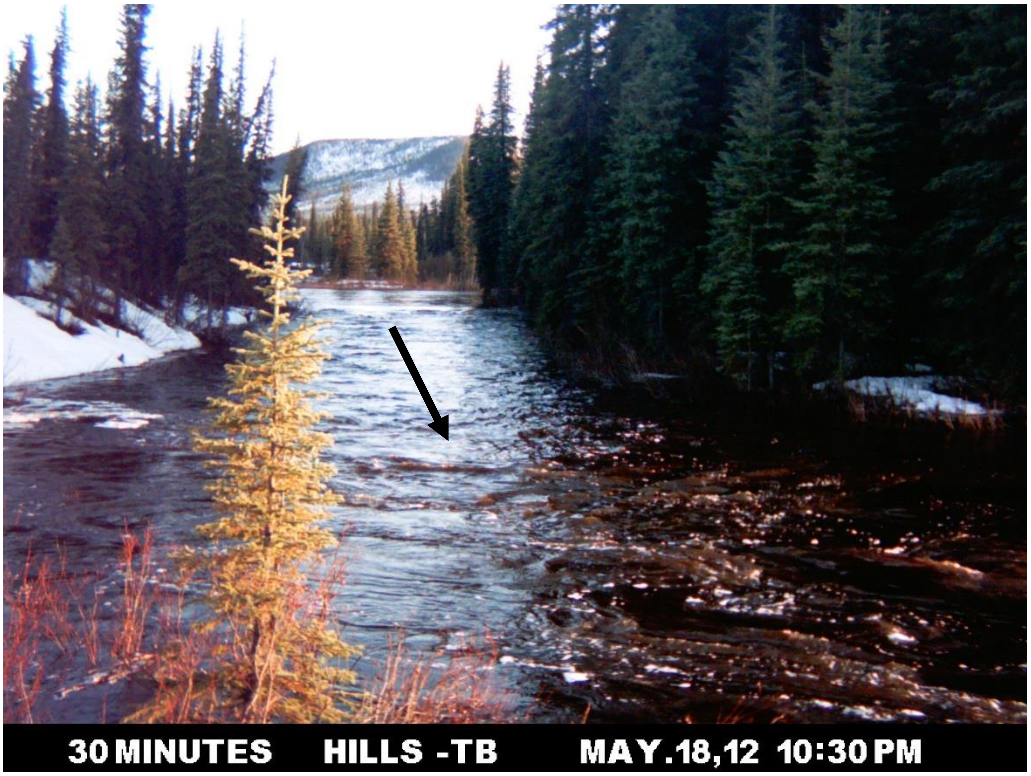



Figure 96. South Fork Bedrock Creek on May 18, 2012, during peak stage. Camera is facing upstream.


Figure 97. South Fork Bedrock Creek during high stage on May 30, 2012.

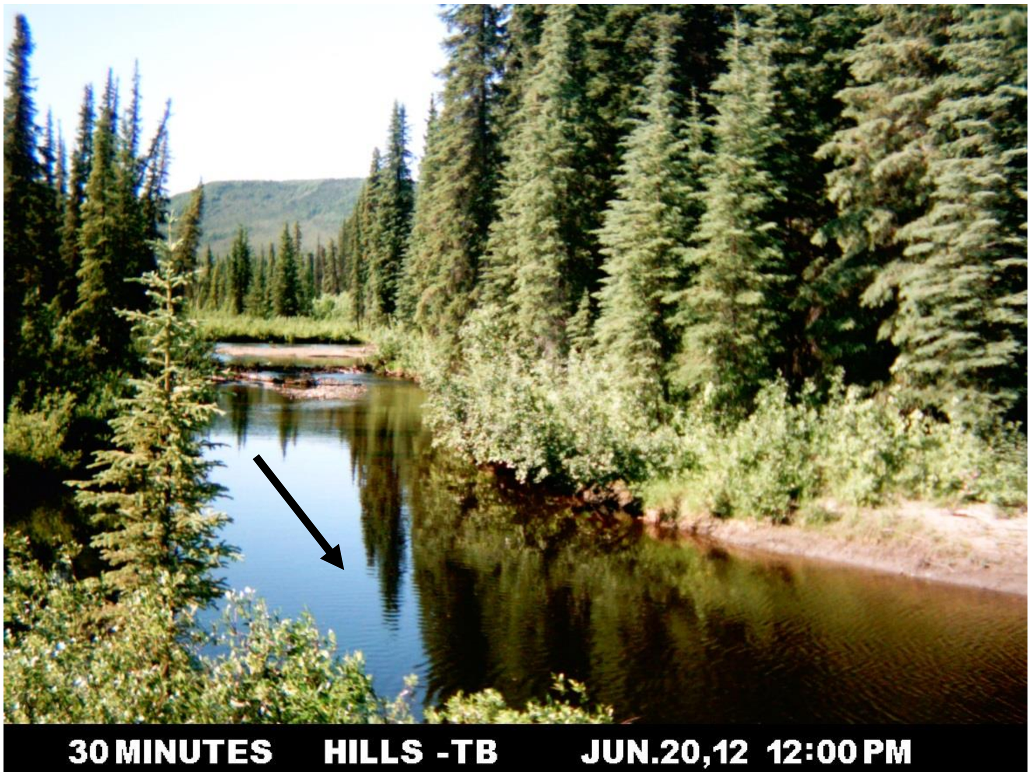



Figure 98. South Fork Bedrock Creek during typical lower flows (June 20, 2012).

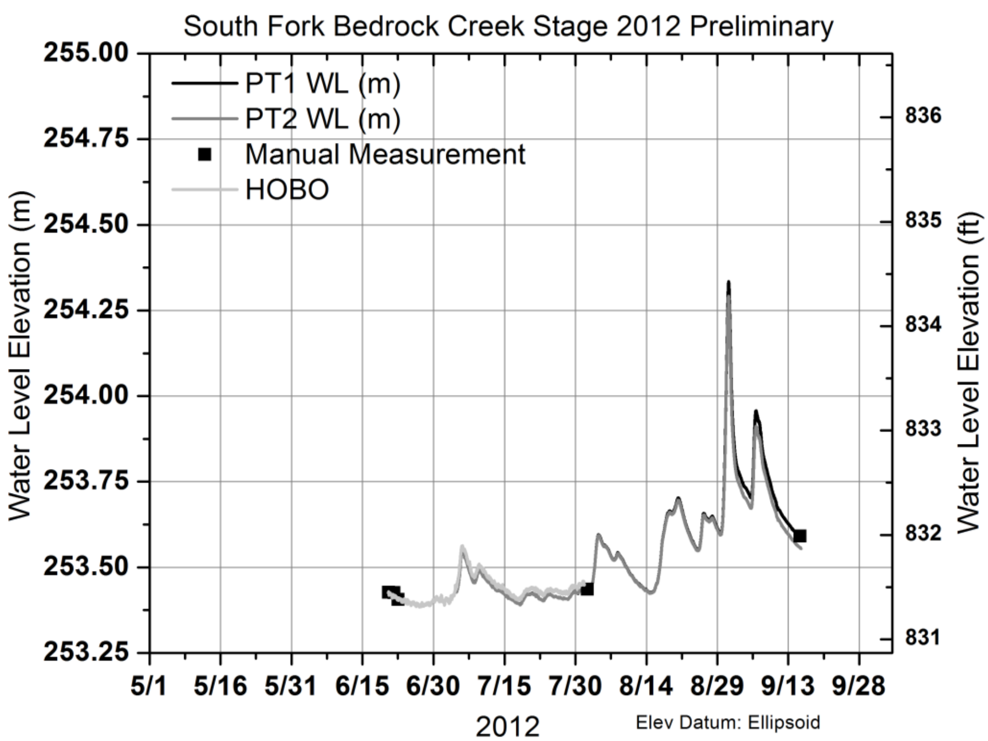



Figure 99. Water level observations at South Fork of Bedrock Creek in 2012. Station was installed after spring breakup.

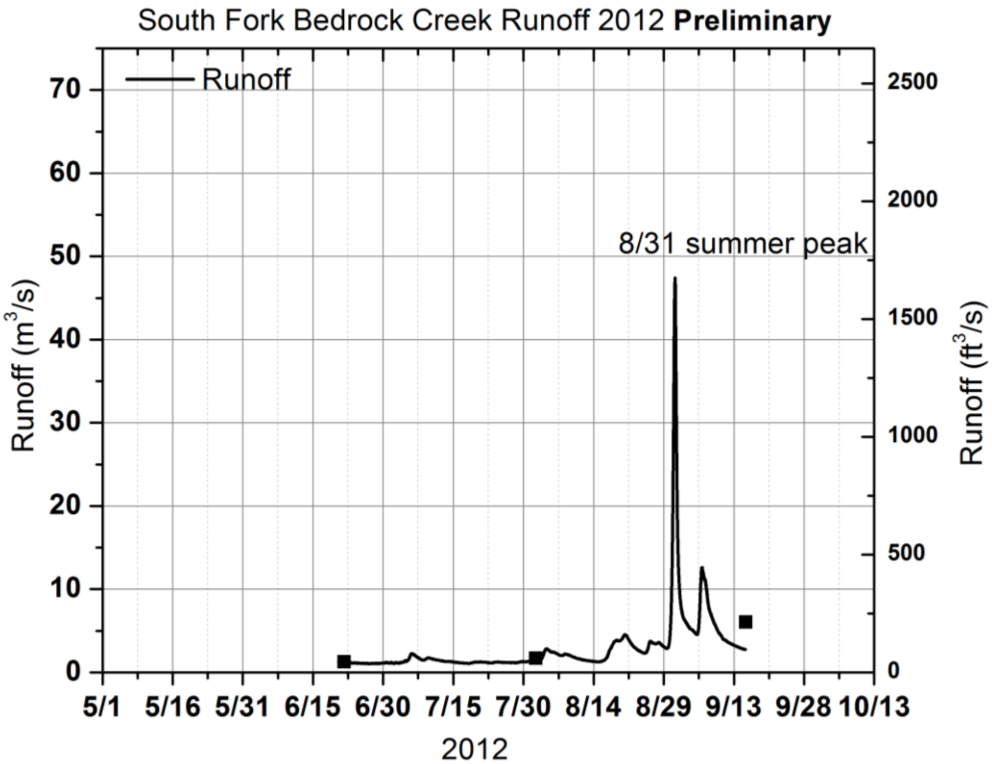



Figure 100. Preliminary estimated runoff for South Fork Bedrock Creek in 2012. Station was installed after spring breakup.


Figure 101. Typical low flow at new camera location (near station) on South Fork Bedrock Creek on August 14, 2012.


Figure 102. High stage at South Fork Bedrock Creek on August 31, 2012, during high flow. Camera was moved to new station location and faces upstream.

#### 4.10.3.2 South Fork Bedrock Creek summary – 2013

Water level observations for 2013 are shown in Figure 103, and estimated runoff is shown in Figure 104. Hydrographs for the spring breakup period only are shown in Figure 105 and Figure 106 to provide a clearer view of breakup. South Fork Bedrock Creek was snow- and ice-covered on May 18, 2013 (Figure 107). The river began flowing on May 23, with water flowing over the river ice (Figure 108). Anchor ice persisted until at least May 27, and the photographs in Figure 109 and Figure 110 show the extent of ice on May 25. The highest stage occurred on May 27 (Figure 111), and this was likely the peak flow as well, although ice-affected conditions persisted. After the peak on May 27, water levels declined rapidly to lower levels (Figure 111 through Figure 113). Diurnal fluctuations in stage were observed, but unfortunately, discharge measurements were made during the low stages. Water levels and runoff rose to their highest around midnight. There was a 0.8 m difference between the low and high stages during breakup. Flows were low the rest of summer due to little rainfall.

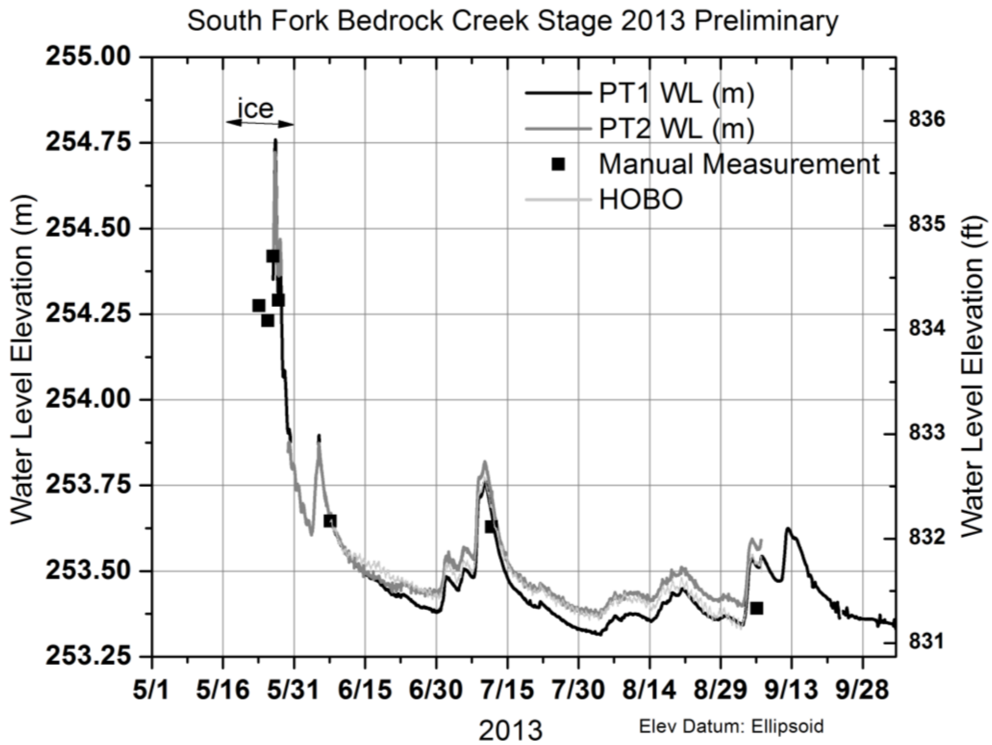



Figure 103. Water level observations for South Fork of Bedrock Creek in 2013.

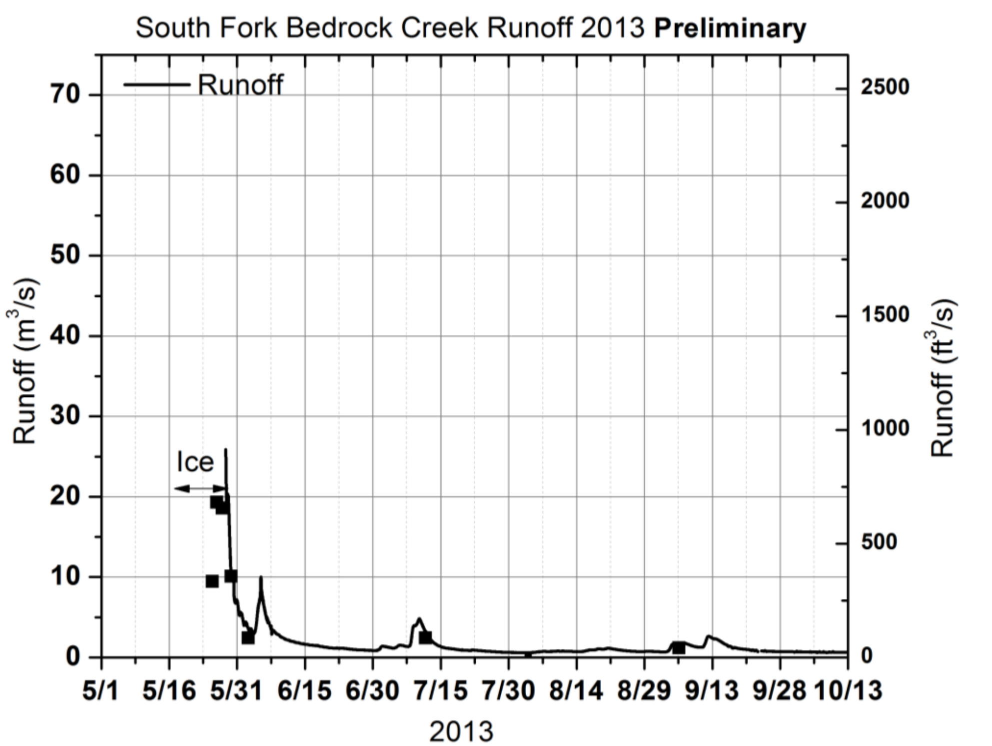



Figure 104. Preliminary estimated runoff for South Fork of Bedrock Creek in 2013. Peak flow was likely above 25 $m^3/s$ at times during spring breakup, but could not be estimated due to ice-affected conditions.

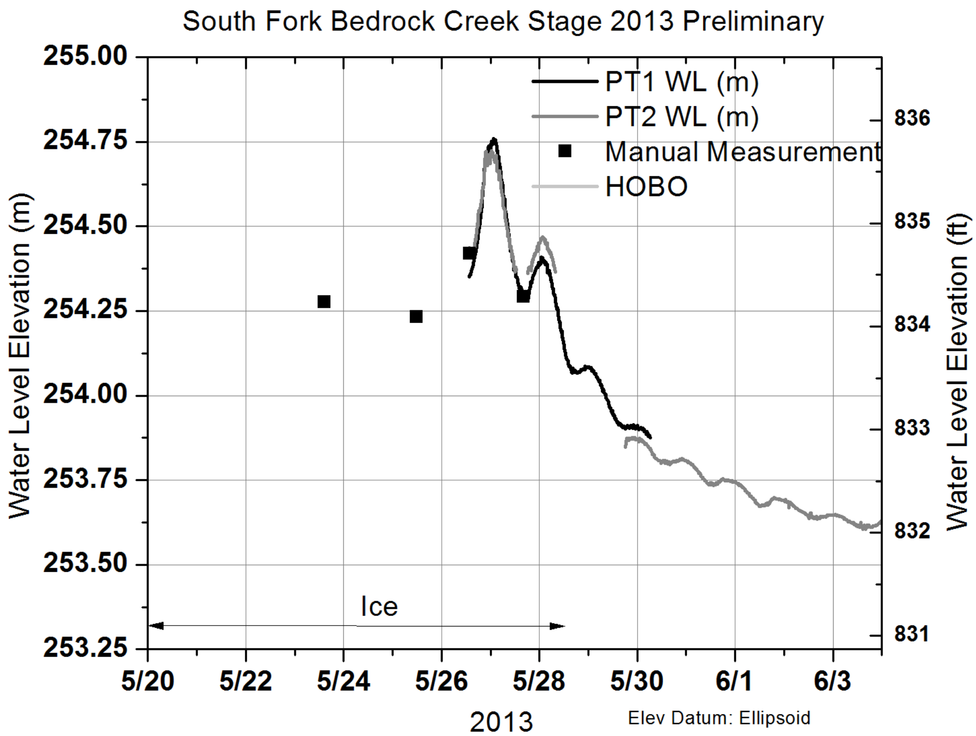



Figure 105. Water level observations during spring breakup at South Fork Bedrock Creek in 2013. Strong diurnal fluctuations were observed early in breakup.

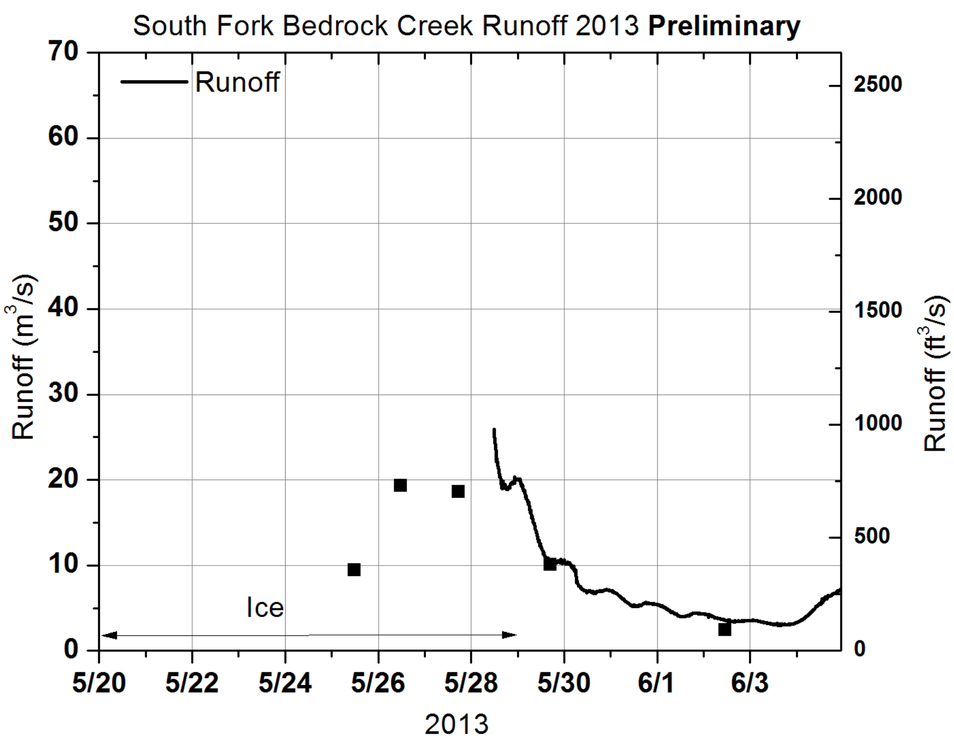



Figure 106. Preliminary estimated runoff during breakup for South Fork Bedrock Creek in 2013. Diurnal fluctuations in stage was observed by pressure transducers but conditions were ice-affected, so early runoff is unavailable. Manual measurements were made during periods of lower runoff.

Figure 107. South Fork Bedrock Creek covered by ice and snow on May 18, 2013.

Figure 108. Water flowing over ice beginning on May 23, 2013, South Fork Bedrock Creek.

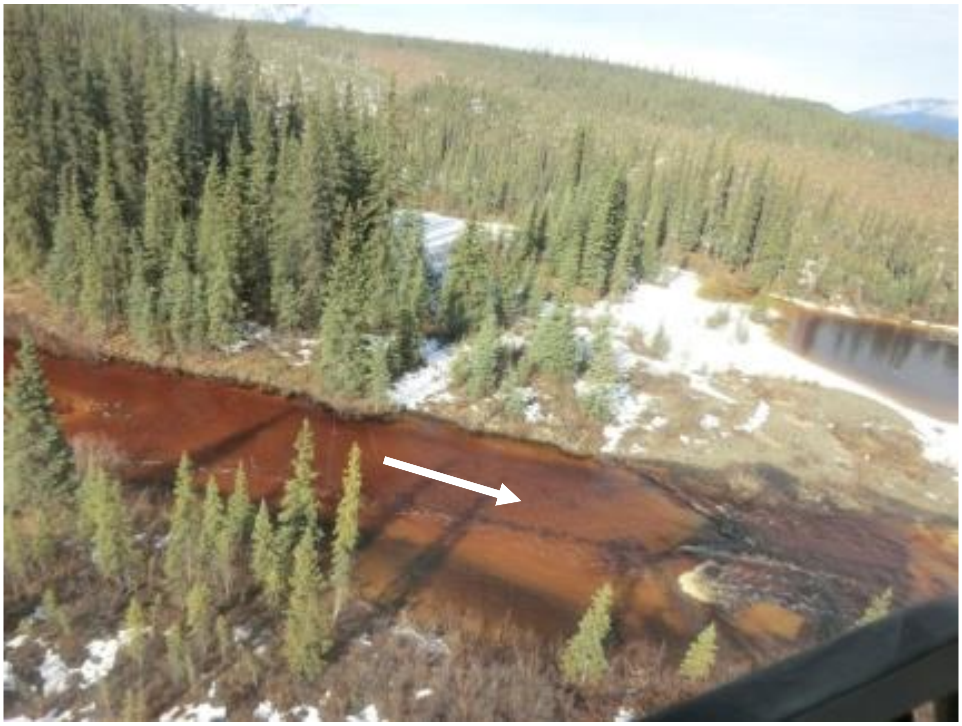


Figure 109. Anchor ice covers most of the stream on May 25, 2013, at South Fork Bedrock Creek.

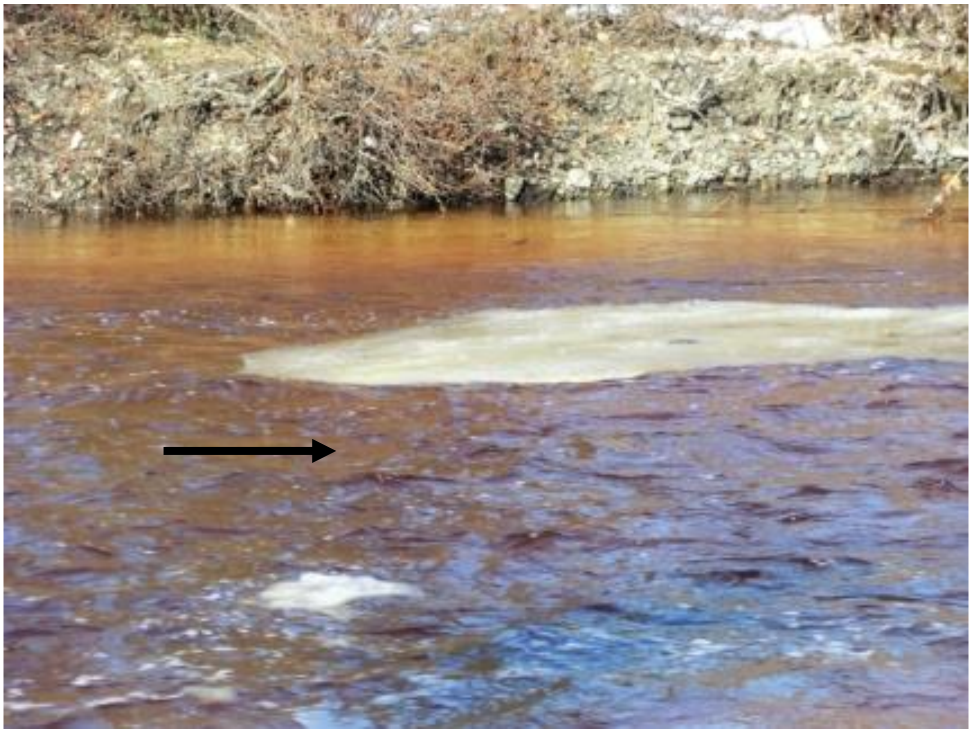


Figure 110. Ice floating in South Fork Bedrock Creek on May 25, 2013.

Figure 111. Shore ice and waves in South Fork Bedrock Creek on May 27, 2013.

Figure 112. Nearly ice-free flow condition on May 29, 2013, South Fork Bedrock Creek.

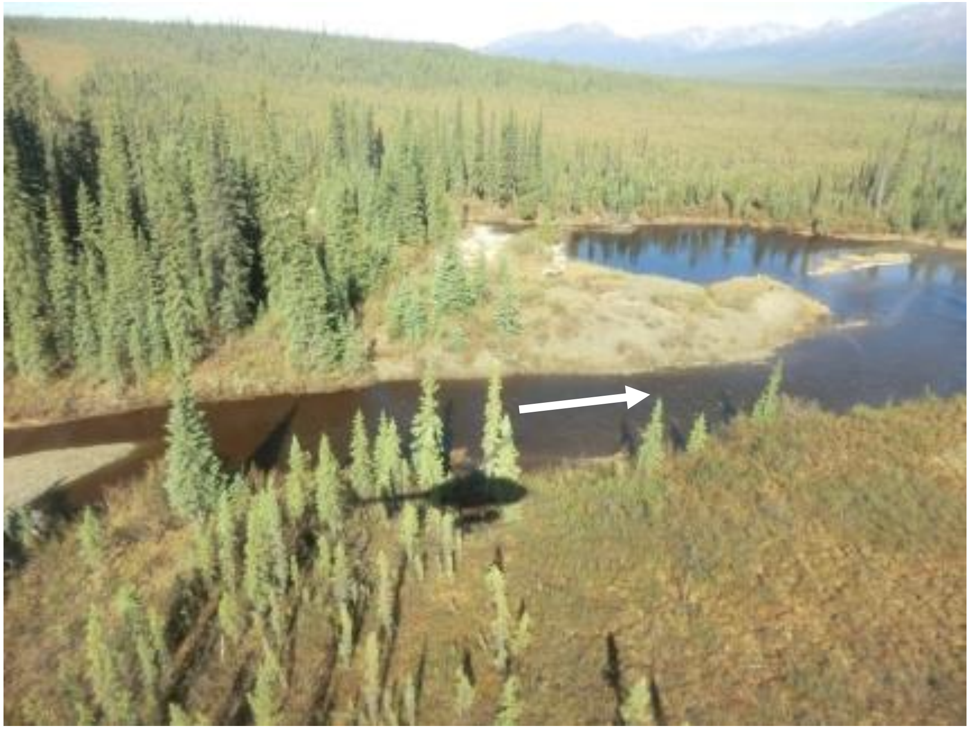


Figure 113. Water levels recede on June 2, 2013, South Fork Bedrock Creek.

#### 4.10.3.3 South Fork Bedrock Creek summary – 2014

Plots of stage and discharge for South Fork Bedrock Creek are shown in Figure 114 through Figure 117. South Fork Bedrock Creek began flowing sometime between April 28 and 30, 2014. Pictures from the station time-lapse camera taken before the afternoon of May 5 are of low resolution, making it difficult to ascertain quantity and size of ice within the channel. On May 6, large pieces of grounded ice are visible in the time-lapse photograph (Figure 118), which had not been visible in the channel the day before (during higher stages). The anchor ice was gone by May 10, but shore ice was present until at least May 11 (Figure 119). The highest water levels occurred on May 11 (Figure 119) and 13 (Figure 120), based on pressure transducer data and camera images. Stage remained high but with strong diurnal fluctuations until the evening of May 17 (Figure 121), when water levels rapidly declined and breakup was complete. Peak flow probably occurred on May 13 or 17, as stages were similar on both dates. Unfortunately, the peak flow was not manually measured, and the estimate of peak flow (~60 $m^3/s$) is highly uncertain due to the lack of rating measurements at high stage. There was approximately 0.8 m difference between the low and high stages during breakup. Although the summer was wet, the rain events did not produce any very large responses in runoff (compared with the 2012 events).

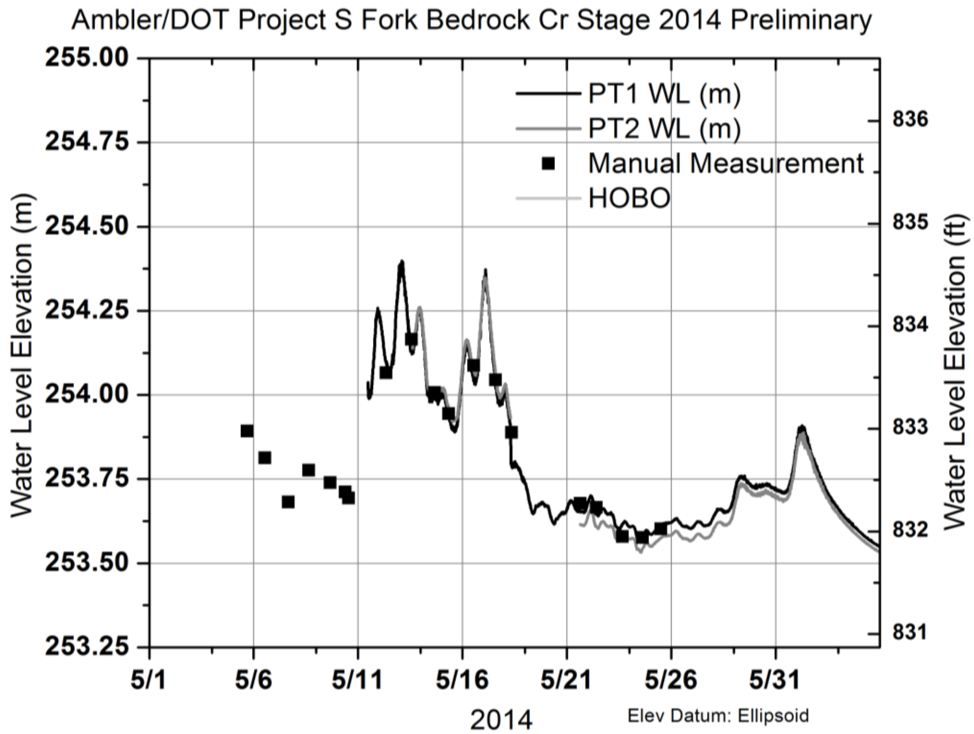



Figure 114. Water level observations for South Fork of Bedrock Creek in 2014. Diurnal fluctuations can be seen in the plots daily.

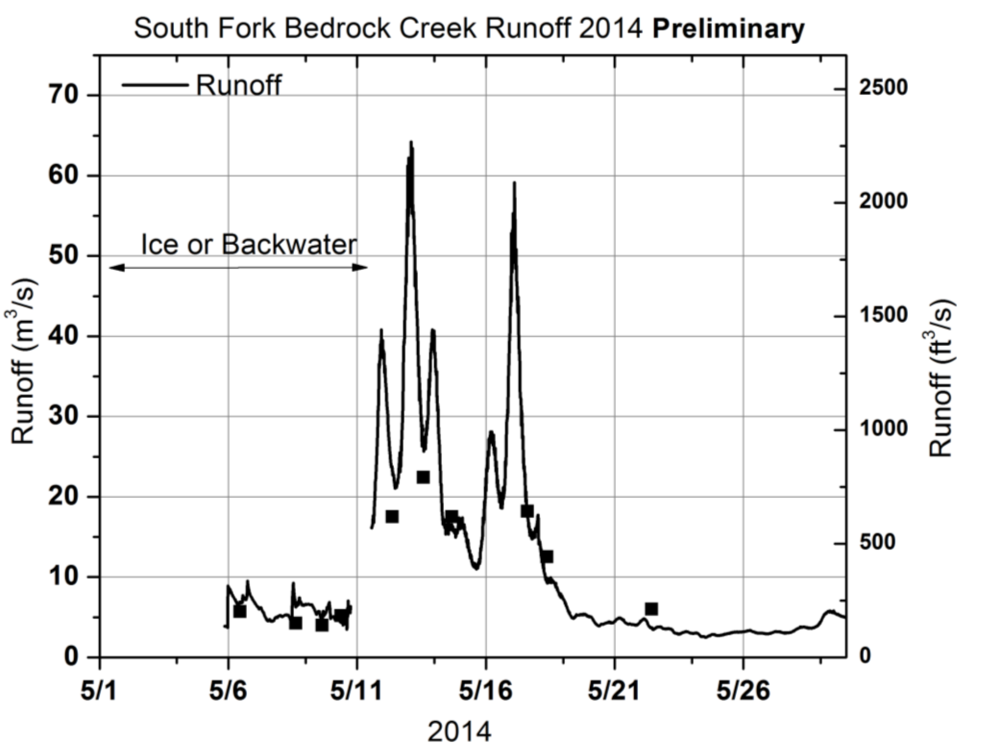



Figure 115. Preliminary runoff at South Fork Bedrock Creek during spring breakup 2014. Runoff is uncertain at the higher stages due to lack of rating measurements.

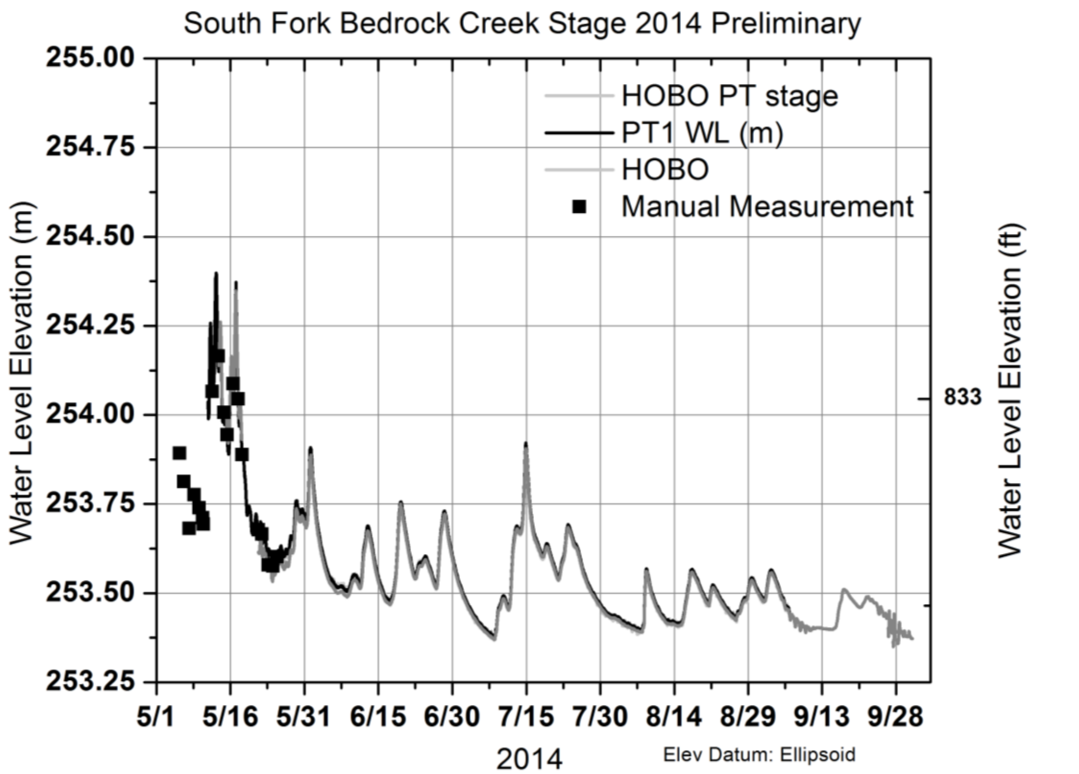



Figure 116. Water level observations for South Fork of Bedrock Creek in 2014.

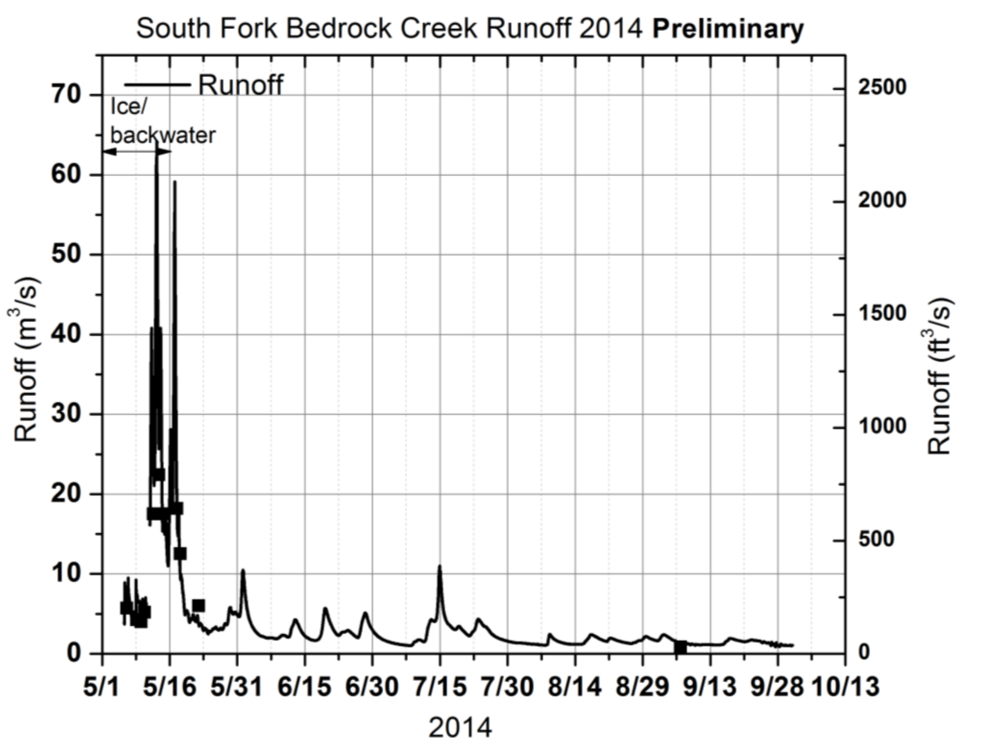



Figure 117. Preliminary runoff at South Fork Bedrock Creek during 2014. Runoff is very uncertain at the higher stages due to lack of rating measurements.


Figure 118. Grounded ice visible in South Fork Bedrock Creek on May 6, 2014.


Figure 119. Shore ice and small debris in front of the station in South Fork Bedrock Creek on May 11, 2014. Water levels are high.


Figure 120. South Fork Bedrock Creek at high stage and flow on May 13, 2014. Snow is still visible on the hillside. Water levels remain high, but ice is no longer present in the channel.


Figure 121. South Fork Bedrock Creek at high stage on May 17. Water levels had dropped between May 14 and 16, but increased again on May 17.

### 4.10.4 Kobuk River

The south-facing upper Kobuk River basin in the Central Brooks Range is bounded by the Alatna River to the east, the Noatak to the north, and the Reed River to the west. The Kobuk River eventually flows to the west for ~300 miles (~480 km), through the villages of Kobuk, Ambler, and Kiana, and discharges into Kotzebue Sound. The upper basin consists of an east channel (Kobuk River) and west channel, which includes Walker Lake. The basin area (at the proposed northern crossing, south of Walker Lake and the confluence with the east channel) is 1295 $km^2$ and drains south from the Brooks Range. The basin elevation ranges from 198 to 2053 m with a mean elevation of 743 m. Approximately 70% of this upper basin lies above 500 m elevation. The stream length above the proposed northern crossing is 76 km. Two observation sites were established by UAF on the Kobuk River in 2013. The two observation sites are below the confluence of the east and west channels. The southern site is located approximately 14 miles south of the northern site.

The Kobuk River is somewhat similar to the Koyukuk and Alatna in that much of the basin area lies in the mountain region; the majority of runoff (volume wise) occurs during the snowmelt period, although high rainfall events can cause runoff to increase greatly during summer months. One difference in the upper Kobuk basin is that Walker Lake, which is located in the western part of the basin, acts as a storage reservoir and may delay runoff. Additionally, the large Nutuvukti Lake drains into the Kobuk River above the UAF southern water level observation site.

During a flyover of the river in May 2012, photographs were taken at the northern proposed crossing (Figure 122; 67.0189°N, 154.3572°W) and the southern proposed crossing (Figure 123; 66.8880°N, 154.6373°W). The river ice was still intact, with areas of open water. Water level measurements were made on the upper Kobuk River from May through September 2013 and 2014 at two sites. One site was located near the proposed northern crossing; the other, near the southern crossing. The sites consisted only of a time-lapse camera, a temporary non-vented pressure transducer to measure river stage, and a sensor to measure barometric pressure. The nearest meteorological stations to the Kobuk River are the NPS Norutak Lake station, the UAF Reed River station, and the UAF Upper Reed station. Discharge measurements were not performed at either site on the Kobuk River because of lack of funding and logistical issues.

Water levels were manually surveyed a few times during the warm season to a temporary benchmark with an arbitrary datum to verify pressure transducer data. The cameras were installed prior to breakup in 2013, but the pressure transducers were not installed until late breakup of 2013. All sensors were removed in early September 2014. The following sections summarize data collected at each site.

Figure 122. Kobuk River near the proposed northern crossing on May 17, 2012. Much of the river was ice-covered.

Figure 123. Kobuk River near the southern proposed crossing on May 17, 2012. Open water is visible, but much of the river ice remains.

#### 4.10.4.1 Kobuk River north

Table 31 shows peak water levels on the Kobuk River near the northern crossing for 2013 and 2014. Figure 124 shows the water level observations for 2013. Flow over ice was observed on May 23 and 24, 2013, at the Kobuk North site (Figure 125), and flows remained low for several days. Numerous ice floes were visible on the Kobuk River near the northern crossing over a period of several days. Around May 27, flows increased, causing ice to break up physically, and an ice jam developed in front of the site around 3:30 P.M. (Figure 126). According to the time-lapse camera images, ice was no longer present the morning of May 28; however, an aerial photograph was taken of the ice extent on May 28, 2013 (Figure 127) that showed ice remained at the site. The front of the ice jam was approximately 100 m upstream of the time-lapse camera during the aerial flyover. Ice near the front consisted of several large pans and many heavy chunks, while ice below the jam consisted of stationary sheets. The ice jam had only moved a few hundred meters downstream on a site visit on May 29 (Figure 128). The ice jam appeared in the camera off and on throughout the morning of May 29 (Figure 129 and Figure 130). Stage remained high and near bankfull until later on May 29 when the ice released downstream.

Pressure transducers were installed on May 29. Stage then dropped approximately 1.5 m and continued to decline (Figure 131) until the rain event on June 3 and 4. The maximum stage observed during the short period of record occurred during the ice jam in 2013.

Table 31. Estimated peak spring breakup and summer water level events for the Kobuk River (North) site. The stage is reported in units above the arbitrary datum.

| Date | Peak Water Level Elevation (m) | Peak Water Level Elevation (ft) |
|---|---|---|
| Spring: May 29, 2013 (estimate) | 99.78+ | 327.36+ |
| Summer: June 4, 2013 | 98.67 | 323.72 |
| Spring: June 1, 2014 | 98.73 | 323.92 |
| Summer: July 14, 2014 | 98.82 | 324.21 |

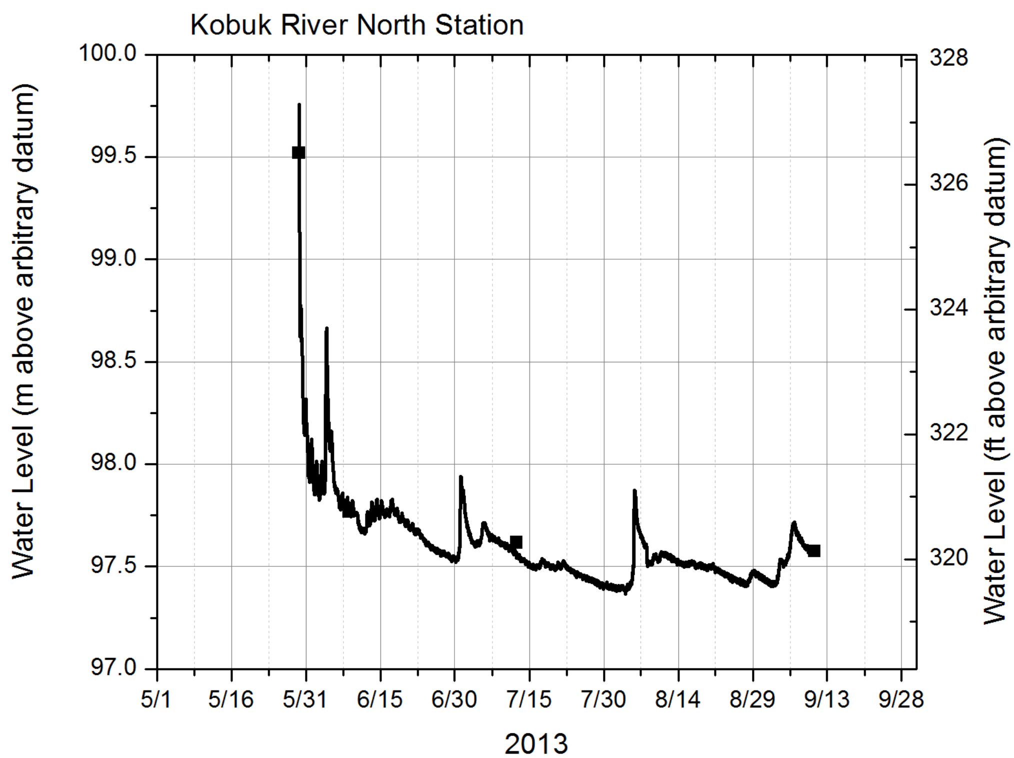



Figure 124. Water level observations at the Kobuk River near the proposed northern crossing for 2013.

Figure 125. Flow over ice (near the bank) on May 24, 2013, facing north. Active flow conditions in the middle of the channel. Arrow indicates flow direction.


Figure 126. Ice backing up at the station on May 27, 2013. No ice is visible over the cutbank.

Figure 127. Ice jam on the Kobuk River near the proposed northern crossing on May 28, 2013.

Figure 128. Ice jam on the Kobuk River near the proposed northern crossing on May 29, 2013.


Figure 129. Ice in the channel of the Kobuk River, near the proposed northern crossing. Ice chunks were visible in the time-lapse cameras for 2 days. Flow direction in time-lapse photograph is from right side of photograph to left.


Figure 130. After the ice clears out of the Kobuk River on May 29, ice chunks are visible above the cutbank. Flow direction is from right side of photograph to left.


Figure 131. By June 1, 2013, water levels dropped on the Kobuk River near the north crossing.

Figure 132 shows the water levels observations for 2014. This year, spring breakup began earlier, but was slower than 2013, and when UAF field staff arrived at the site on May 12, the river was already flowing (Figure 133) at low levels, with significant ice remaining in the channel. By May 14, much of the ice in the channel was gone. However, a freeze-back occurred in mid-May, with air temperatures remaining below freezing for several weeks. Water levels and runoff remained low (Figure 134) until the peak on June 1, 2014 (Figure 135). This spring peak correlates with that of the other rivers in the study (Koyukuk, Alatna). Water levels remained high through June and July due to high rainfall throughout the region. Water levels were much higher in 2014 than in 2013. On July 15, 2014, high stage was recorded (Figure 136), which exceeded the maximum stage during spring breakup for 2014 (but not breakup 2013). Water levels declined through August. The station was decommissioned in early September.

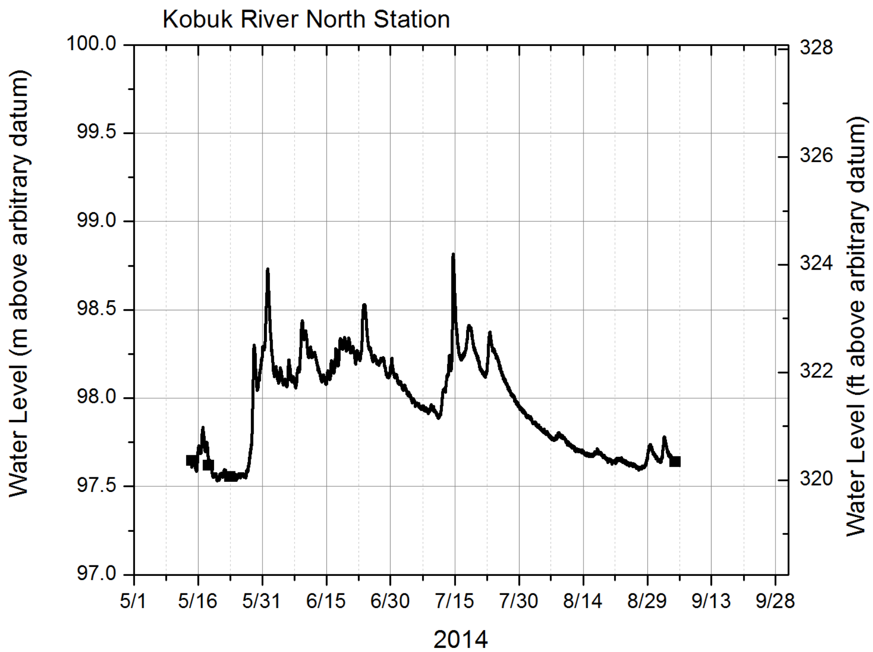



Figure 132. Water level observations at the Kobuk River near the proposed northern crossing for 2014.


Figure 133. Kobuk River near the proposed northern crossing, at least 10 days after the start of breakup in 2014. Flow direction in time-lapse photograph is from right to left.


Figure 134. Kobuk River near the proposed northern crossing on May 24, 2014. No ice remains in the channel, but flows are low due to a freeze-back in May.


Figure 135. Kobuk River near the proposed northern crossing during the spring peak on June 1, 2014.


Figure 136. Kobuk River near the proposed northern crossing on July 14, 2014, during the summer peak flow.

#### 4.10.4.2 Kobuk River south

Table 32 presents the peak water level elevations observed at the Kobuk River near the southern proposed crossing for the short period of record. In 2013, pressure transducers were not installed until spring breakup was underway. These observations are presented in Figure 137. Flow over ice was observed on May 23 and 24, 2013, at the southern Kobuk River site. The time-lapse cameras indicate that the river ice mostly melted in place until May 27, when flows began to increase and large ice pans began to physically break up and finally move downstream on May 28 (Figure 138). Peak stage likely occurred on May 30, based on time-lapse camera imagery (Figure 139 and Figure 140). This peak stage was due to a large amount of ice passing down the channel. It is unknown when peak flow occurred due to the presence of ice in the channel. Pressure transducer data appear to be influenced by the presence of ice, either due to an ice jam or due to movement of the pressure transducer during heavy ice conditions (Figure 137). Water levels began to decline on May 31 and continued to decline through June (Figure 141). The rest of 2013 was uneventful, with just a few small increases in river stage.

Table 32. Estimated peak spring breakup and summer water level events for the Kobuk River (South) site. The stage is reported in units above the arbitrary datum.

| Date | Peak Water Level Elevation (m) | Peak Water Level Elevation (ft) |
|---|---|---|
| Spring: May 30, 2013[1] | N/A | N/A |
| Summer: July 1, 2013[2] | 96.20[2] | 315.62[2] |
| Spring: June 1, 2014 | 97.22 | 318.96 |
| Summer: July 14, 2014 | 97.07 | 318.50 |

[1] Estimated date based on time-lapse camera imagery due to incomplete pressure transducer data.
[2] Stage was same elevation on both June 4, 2013, and July 1, 2013.

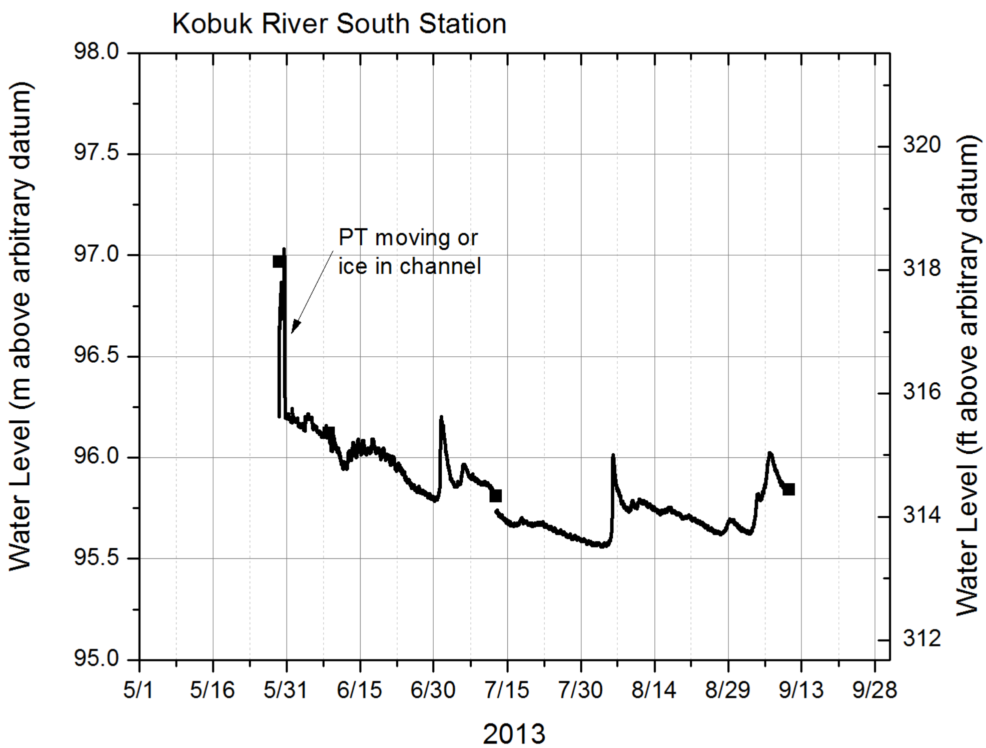



Figure 137. Water level observations at the Kobuk River near the proposed southern crossing for 2013. The high stage recorded by the pressure transducer (PT) was likely a result of ice floes/ice jam.


Figure 138. Kobuk River near the proposed southern crossing on May 27, 2013. Ice remained in the channel for several days.


Figure 139. By May 29, 2013, water levels rose and ice moved downstream at the Kobuk River site near the proposed southern crossing.


Figure 140. Ice floe or jam on May 30, 2013, at the Kobuk River site near the proposed southern crossing.


Figure 141. Kobuk River near the proposed southern crossing on May 31, 2013. Water levels declined, and ice chunks are visible along the banks.

Figure 142 is the stage for the Kobuk River near the proposed southern crossing for 2014. In 2014, on a site visit on May 12, the river was still frozen over with water pooling on top of ice (also observed in time-lapse imagery in Figure 143). High stage due to ice in the channel was observed early during breakup, but runoff was low. Water levels dropped at the site (according to time-lapse cameras), exposing areas of intact anchor ice and flowing water (Figure 144). By May 14, the river was completely open (with some areas of anchor and shore ice) at the southern site, but the Kobuk River remained mostly ice-covered between the northern and southern UAF sites. The river continued to flow at low water levels and flows due to a freeze-back in mid to late May (Figure 145). Finally, stage increased on June 1, after a warm period throughout the region that caused snow to melt in the entire basin (Figure 146). The rest of summer was wet, causing a series of peaks in the hydrograph, with the summer maximum occurring on July 15 (Figure 147). Stages in 2014 were much higher than in 2013.

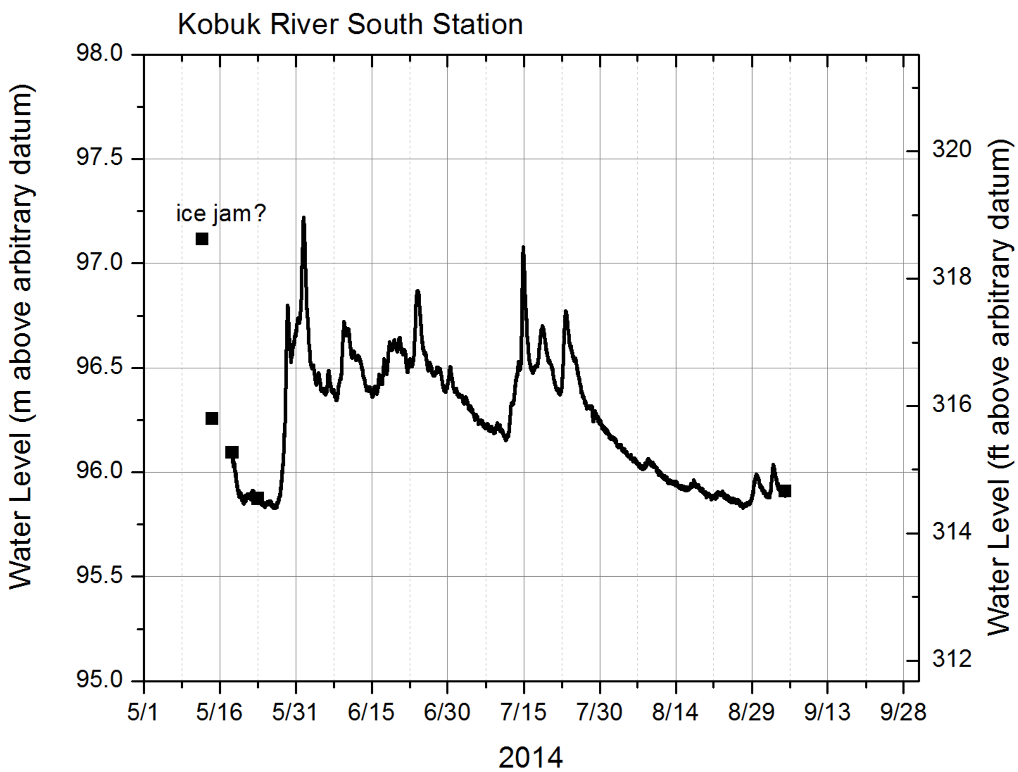



Figure 142. Water level observations at the Kobuk River near the proposed southern crossing for 2014. High stages were recorded early due to water flowing over anchor ice and ice floes/jams.

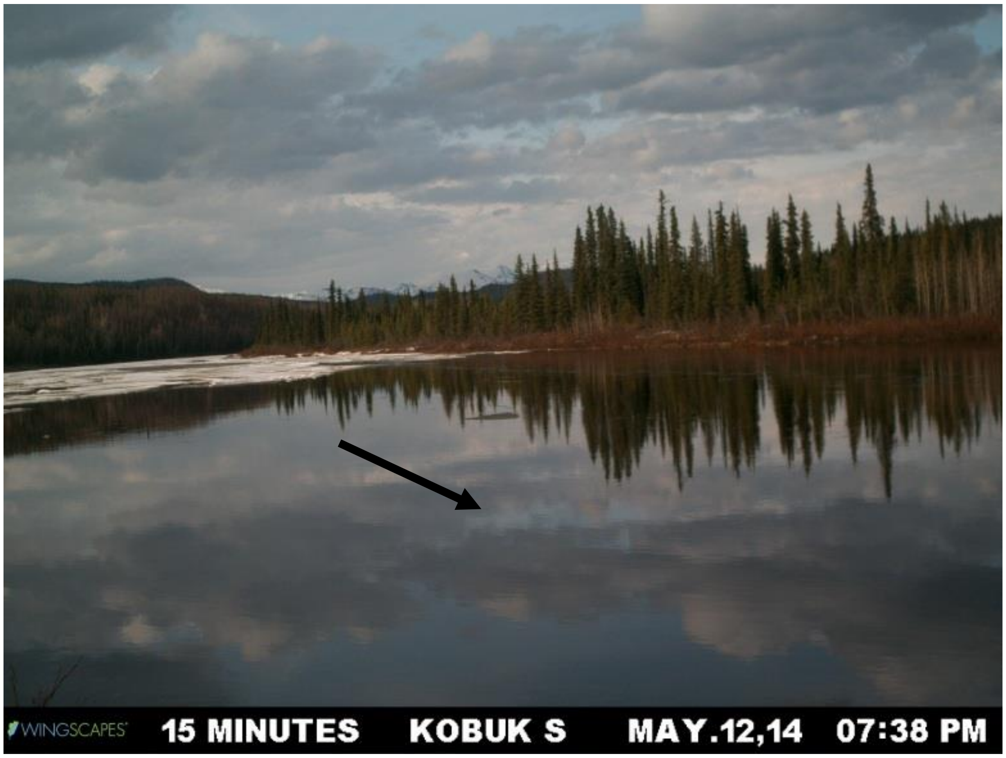



Figure 143. Kobuk River near the proposed southern crossing on May 12, 2014, with pooling of water above the ice at the site.


Figure 144. Kobuk River near the proposed southern crossing on May 13, 2014, after water levels dropped.

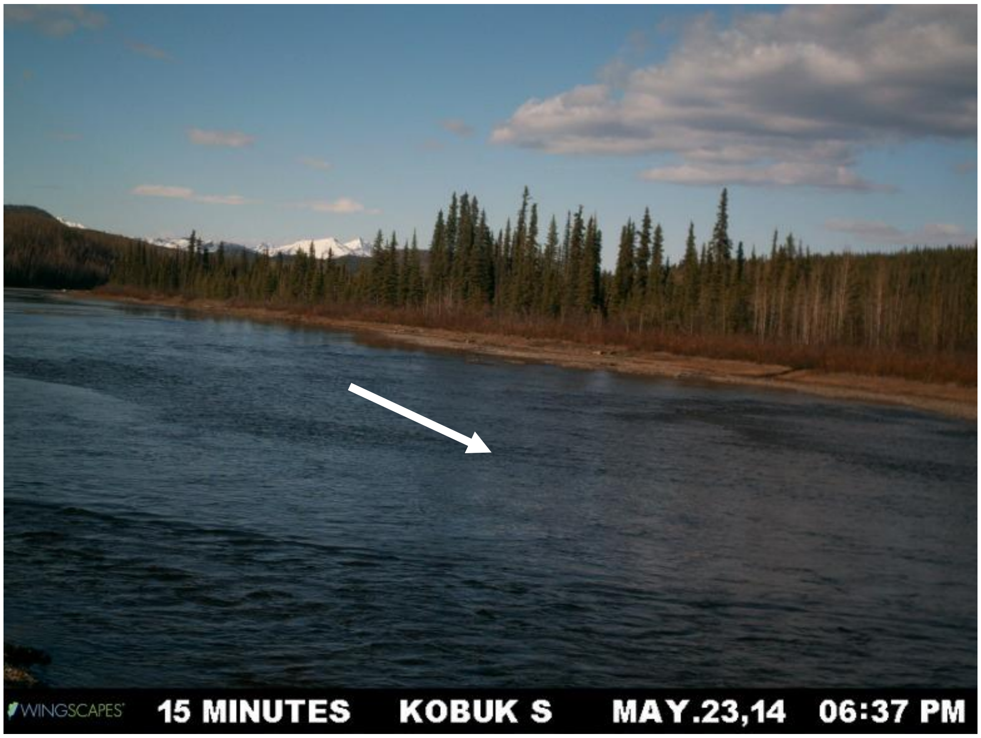



Figure 145. Kobuk River near the southern proposed crossing on May 23, 2014. River is ice-free, and water levels remain low.


Figure 146. After temperatures warmed throughout the region in late May, the snow finally melted, and spring peak occurred on June 1, 2014, at the Kobuk River south site.


Figure 147. Summer peak stage and flow occurred on July 15, 2014, at the Kobuk River site near the proposed southern crossing.

### 4.10.5 Reed River

The Reed River originates in the Brooks Range and drains to the south, eventually flowing into the Kobuk River approximately 8 miles south of the UAF gauge site. The watershed area is approximately 825 km$^2$ above the UAF gauge site. The gauge site is located roughly halfway between the proposed northern and southern crossings. The basin elevation ranges from 183 m to 2525 m, with an average basin elevation of 819 m. Above the UAF gauge site, approximately 77% of the basin lies in the mountainous region. The stream length is approximately 76 km. The Reed River basin is similar to the other medium-sized basins in the study area in that it has a high gradient, is south-facing, and drains from the Brooks Range. Two meteorological stations are located within the basin: one at the UAF gauge site (Reed River-DAS4) and the other located mid basin at higher elevation (Upper Reed-DAM7).

A hot spring exists in the Upper Reed basin (Waring et al., 1917; Pessel, 1975; Motyka et al., 1983). The hot spring is located approximately 23 miles upstream from the UAF Reed River (DAS4) station and within a mile of the UAF "Reed3" snow survey site. The Reed River hot spring was reported to have two openings. One was measured at 0.3 $ft^3/s$ on an August visit in 1979 by USGS (Childers and Kernodle, 1983), who reported a water temperature of 47.5°C.

The rating curve (and thus estimates of continuous discharge) is considered very poor at this site due to the low number of manual discharge measurements at varying stages. No measurements were made at the higher stages, so the rating curve is extrapolated at high stage (above ~100 $m^3/s$). Because of this problem, caution should be exercised when using the estimates of high flow. Table 33 shows the estimated peak water level elevation at the station during the study. The datum is arbitrary due to lack of any ADOT&PF surveyed benchmarks in the area. Table 34 lists the manual discharge measurements at the Reed River. Water slope was measured just downstream of the station, and Manning's *n* was calculated on three occasions. The estimated peak runoff is presented in Table 35.

Table 33. Estimated peak spring breakup and summer water level events for the Reed River 2012–2014. The stage is reported in units above the arbitrary datum.

| **Date** | **Peak Water Level Elevation (m)** | **Peak Water Level Elevation (ft)** |
|---|---|---|
| Summer: August 31, 2012 | 98.21 | 322.21 |
| Spring: May 27, 2013[1] | 98.5e[2] | 323.16e[2] |
| Summer: June 4, 2013 | 97.38 | 319.49 |
| Spring: June 1, 2014 | 97.53 | 319.98 |
| Summer: July 14, 2014 | 97.61 | 320.24 |

e: Estimated.
[1] Peak stage due to ice jam.
[2] Stage data mostly unavailable during early breakup period due to water level sensor movement during ice jams and ice floes. Peak stage is estimated to be 0.5 m below a temporary benchmark at the station (and slightly over bankfull) during an ice jam on May 27.

Table 34. Discharge measurements for the Reed River, 2012–2014. The stage is reported in units above the arbitrary datum.

| Date | No | Discharge ($m^3/s$) | Discharge ($ft^3/s$) | Stage (m) | Stage (ft) | Msmt Rating (%) | Width (m) | Area ($m^2$) | Velocity (m/s) | Max Velocity (m/s) | Max Depth (m) | Avg Depth (m) | Slope | n |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/30/2012 12:05 | 1 | 26 | 905 | 96.62 | 316.99 | Fair | 40.9 | 38.6 | 0.64 | 1.52 | 1.43 | 0.94 | | |
| 7/31/2012 13:40 | 2 | 84 | 2978 | 97.12 | 318.63 | Poor | 49.2 | 69.8 | 1.18 | 2.57 | 2.45 | 1.47 | | |
| 9/13/2012 15:45 | 3 | 57 | 1995 | 96.92 | 317.97 | Fair | 44.5 | 60.7 | 0.91 | 2.27 | 2.23 | 1.36 | 0.000155 | 0.0168 |
| 5/28/2013 12:20 | 4 | 104 | 3688 | 97.15 | 318.72 | fair | 37.9 | 74.8 | 1.43 | 3.12 | 3.17 | 2.00 | | |
| 5/30/2013 13:40 | 5 | 96 | 3388 | 97.16 | 318.78 | fair | 45.1 | 66.6 | 1.58 | 3.18 | 2.69 | 1.48 | | |
| 5/31/2013 11:15 | 6 | 89 | 3157 | 97.11 | 318.59 | fair | 51.8 | 69.6 | 1.33 | 2.67 | 2.60 | 1.35 | | |
| 6/1/2013 13:15 | 7 | 82 | 2889 | 97.03 | 318.35 | poor | 47.6 | 63.6 | 1.41 | 3.18 | 2.66 | 1.34 | | |
| 6/3/2013 13:20 | 8 | 72 | 2552 | 97.00 | 318.23 | poor | 45.6 | 59.6 | 1.25 | 4.07 | 2.55 | 1.31 | .000206 | 0.0137 |
| 7/12/2013 11:15 | 9 | 19 | 658 | 96.51 | 316.62 | fair | 30.0 | 26.4 | 0.75 | 2.05 | 1.73 | 0.89 | | |
| 9/8/2013 13:20 | 10 | 34 | 1209 | 96.66 | 317.13 | fair | 44.1 | 47.7 | 0.69 | 2.39 | 2.55 | 1.09 | | |
| 5/8/2014 10:40 | 11 | 11 | 390 | 96.42 | 316.34 | poor | 18.5 | 17.1 | 0.67 | 2.08 | 1.52 | 0.92 | | |
| 5/10/2014 11:10 | 12 | 10 | 337 | 96.39 | 316.25 | poor | 21.7 | 16.3 | 0.67 | 1.55 | 1.31 | 0.75 | | |
| 5/11/2014 11:30 | 13 | 14 | 503 | 96.44 | 316.39 | fair | 19.3 | 18.8 | 0.81 | 1.95 | 1.54 | 0.97 | | |
| 5/16/2014 10:55 | 14 | 27 | 954 | 96.58 | 316.86 | poor | 33.2 | 37.9 | 0.72 | 2.01 | 1.91 | 1.14 | | |
| 5/18/2014 10:30 | 15 | 29 | 1020 | 96.61 | 316.97 | fair | 36.2 | 40.3 | 0.73 | 2.25 | 1.90 | 1.11 | | |
| 5/21/2014 9:30 | 16 | 20 | 707 | 96.51 | 316.65 | fair | 35.8 | 35.5 | 0.62 | 1.6 | 1.72 | 0.99 | | |
| 5/23/2014 9:30 | 17 | 21 | 726 | 96.50 | 316.59 | poor | 36.1 | 34.1 | 0.66 | 1.76 | 1.70 | 0.94 | | |
| 9/4/2014 9:15 | 18 | 34 | 1208 | 96.51 | 316.64 | fair | 29.1 | 29.2 | 0.68 | 1.98 | 1.80 | 1.00 | 0.00011 | 0.0154 |

Table 35. Estimated peak runoff dates for the Reed River. Due to a lack of rating measurements at high stage and high uncertainty in the rating curve, peak runoff is very uncertain for these events. It is probable that the runoff from the late summer/early fall 2012 rain events were greater than 300 $m^3/s$.

| Date | Peak Runoff ($m^3/s$) | Peak Runoff ($ft^3/s$) |
|---|---|---|
| Summer: August 31, 2012 | 300G >e | 10600>e |
| Spring: May 28, 29, or 30, 2013[1] | n/a | n/a |
| Summer: June 4, 2013 | 144 | 5085 |
| Spring: June 1, 2014 | 200e | 7060 |
| Summer: July 14, 2014 | 220e | 7770 |

[1] Exact date of maximum spring flow unknown due to poor pressure transducer data, lack of measurements, and ice-affected conditions.
e: Estimate based on rating curve extrapolation; very high uncertainty.

#### 4.10.5.1 Reed River floodplain survey

A GPS survey of the floodplain was conducted at the Reed River UAF gauge site in fall 2013 (Figure 148). The survey was conducted using a Novatel Smart V1 RTK GPS setup with a horizontal accuracy of 0.2 m; the vertical accuracy is typically double the horizontal accuracy.

A cross section of the survey is presented in Figure 149. It shows the river channel and the water level elevation at the highest flow manually measured by UAF (104 $m^3/s$). The river reached bankfull on a few occasions (in fall 2012 and during an ice jam in 2013). Bankfull flow (that is not ice-affected) is at least three times the highest flow manually measured by UAF based on the river channel geometry shown in Figure 149. It is probable that the side channels on the east side of the river across from the gauge site are full of water during high stage.

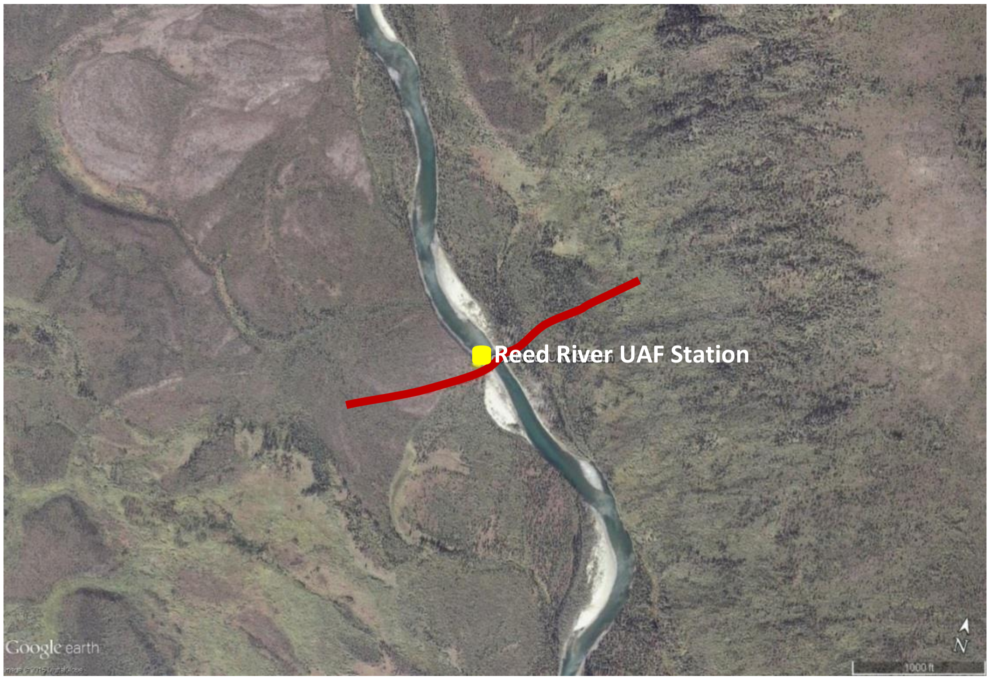



Figure 148. Location (red line) of Reed River GPS cross-section survey.

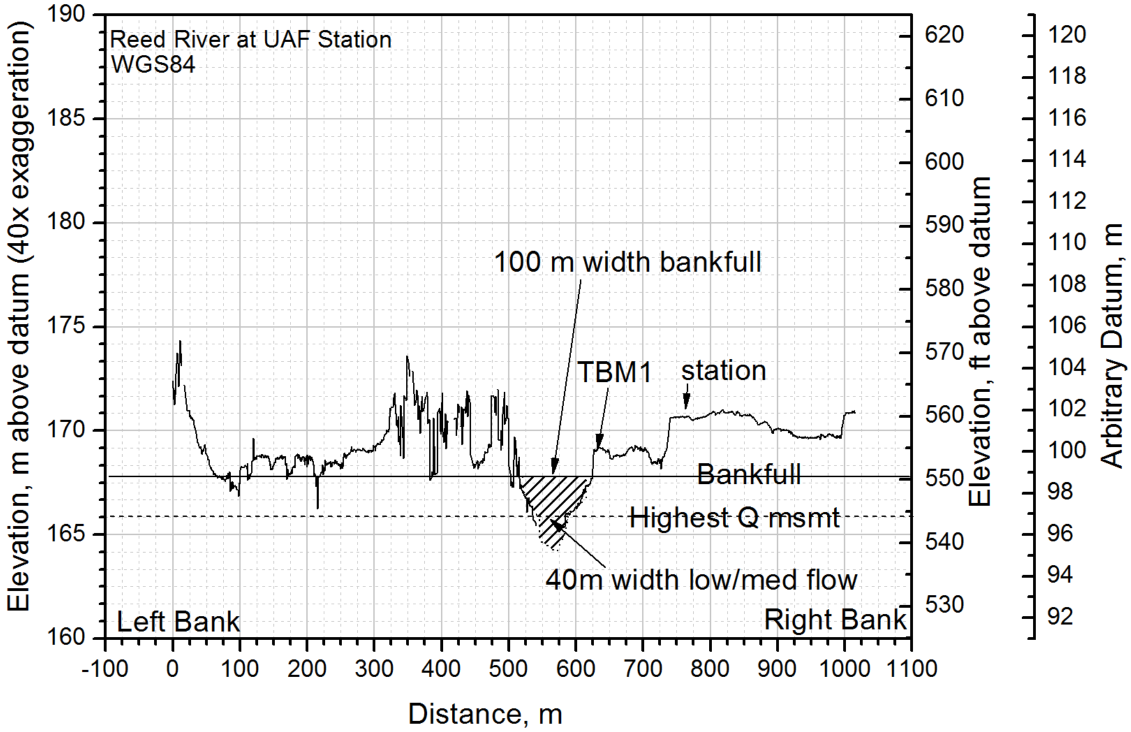



Figure 149. Cross section at Reed River station (40x vertical exaggeration). The solid black horizontal line shows bankfull flow conditions, which occurred in fall 2012 and during an ice jam in 2013. Unfortunately, no high flow measurements were made at this site.

#### 4.10.5.2 Reed River summary – 2012

During a site visit on May 17, 2012, snow cover was 100% in the basin; the river was flowing at low flow, but ice remained along the edges of the channel (Figure 150). Peak flow had not occurred. The hydrometeorological station was installed in mid-June 2012 after spring breakup. Water level observations are shown in Figure 151, and estimated runoff is presented in Figure 152.

A storm in western Alaska produced rainfall in late August and early September 2012; corresponding increases in fall stage and runoff are observed in Figure 151 and Figure 152. At the Reed River gauge site, over 350 mm of rain fell between mid-August and late September, and at the Upper Reed station (a higher-elevation station), over 550 mm of rainfall was recorded. Water levels increased at least 1.25 m above low stage and were likely at bankfull conditions at the station. Photographs were taken of the river in 2012 with a time-lapse camera located 1 mile downstream from the station. The river at low stage at the camera site is shown in Figure 153, and the river at high stage during two significant rain events is shown in Figure 154 and Figure 155. The estimated discharge shown on the hydrograph in Figure 152 should be used with caution, as there are no rating points at high stage and the rating curve is extrapolated.

Figure 150. Reed River on May 17, 2012. River is flowing with ice and snow present within the channel, indicating the breakup peak had not yet occurred. Arrow indicates direction of flow.

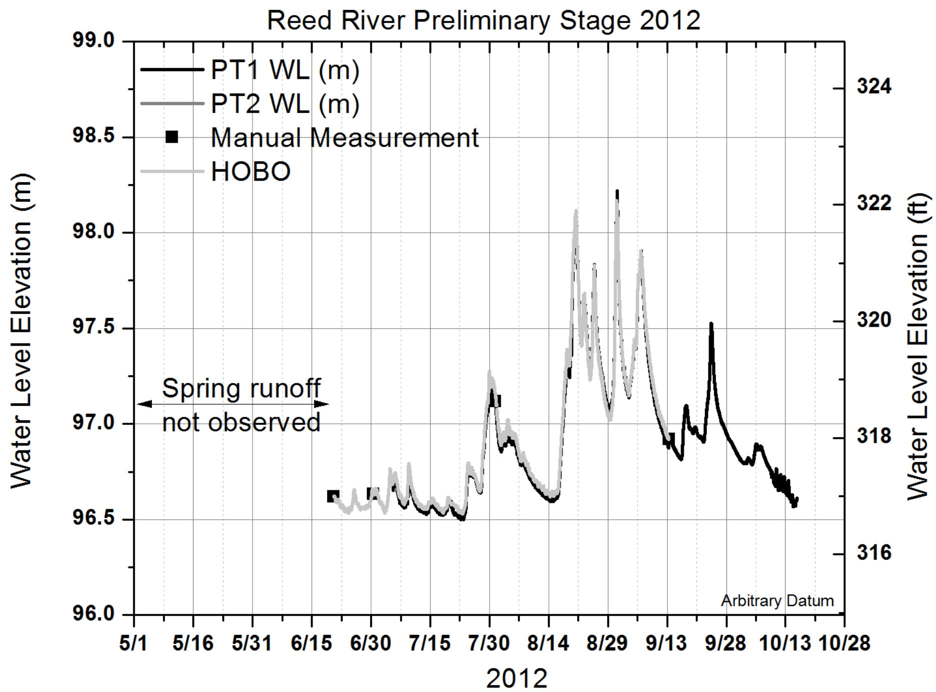



Figure 151. Water level observations at the Reed River in 2012. Stage increased over 1.5 m during several rainfall events in the fall. Station was installed after spring breakup.

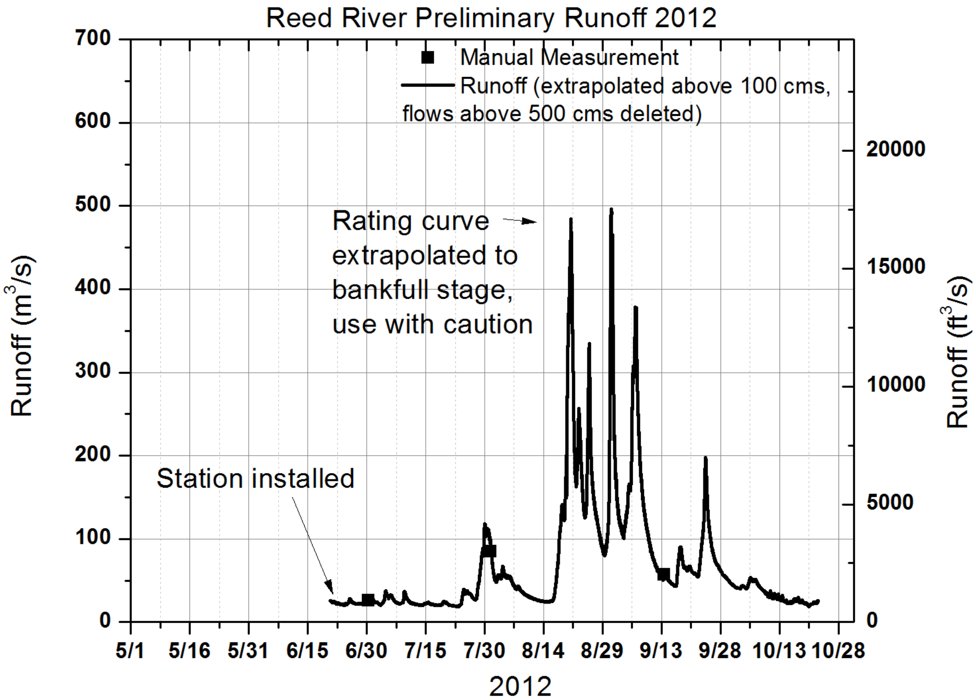



Figure 152. Estimated runoff for the Reed River 2012. The rating curve, extrapolated at high flows due to lack of rating points, has high uncertainty. Station was installed after spring breakup.


Figure 153. Reed River, downstream of station on August 15, 2012. Photograph shows low flow conditions.


Figure 154. Reed River on August 20, 2012, during a high rainfall event.


Figure 155. High stage recorded on the Reed River on August 31, 2012.

#### 4.10.5.3 Reed River summary – 2013

The stage and discharge for the Reed River in 2013 are shown in Figure 156 and Figure 157. Open areas of runoff were observed in the river upon UAF field staff's arrival at the station on May 18, 2013, and this condition continued through May 23 (Figure 158). Initial breakup flows began on May 24, with water flowing over ice (Figure 159). An ice jam occurred on May 27, 2013, with the front of the jam located approximately 100 m below the Reed River station, by the gravel bar on the right side of the river (Figure 160). During the ice jam, photographs show the river above bankfull at the station (Figure 161 and Figure 162). On May 27, the increasing flows washed the ice downstream, leaving a few large chunks stranded at the edge of the river and on gravel bars. Several hours later, another ice jam formed downstream of the station causing flooding once more. The flow consisted of ice pans (10 m × 5 m in size) and large chunks, and the ice was solid. Unfortunately, pressure transducer data were not usable due to ice damage and lack of surveyed stage measurements during this period. By May 28, water levels were variable, with diurnal fluctuations, and ice was stranded on gravel bars and in the channel (Figure 163). Ice floes continued to come down the river as stage fluctuated (Figure 164). On May 30 at 1:00 A.M., the pressure transducer data becomes usable again. By May 30, most of the channel was ice-free (although some stranded ice chunks remained, mostly above the water surface on gravel bars) (Figure 165). Stage increased again on June 4 in response to a rain event (Figure 129). River stage and flow remained relatively low the rest of summer (Figure 167), with a few small events causing slight increases in water levels. The river remained open into early November.

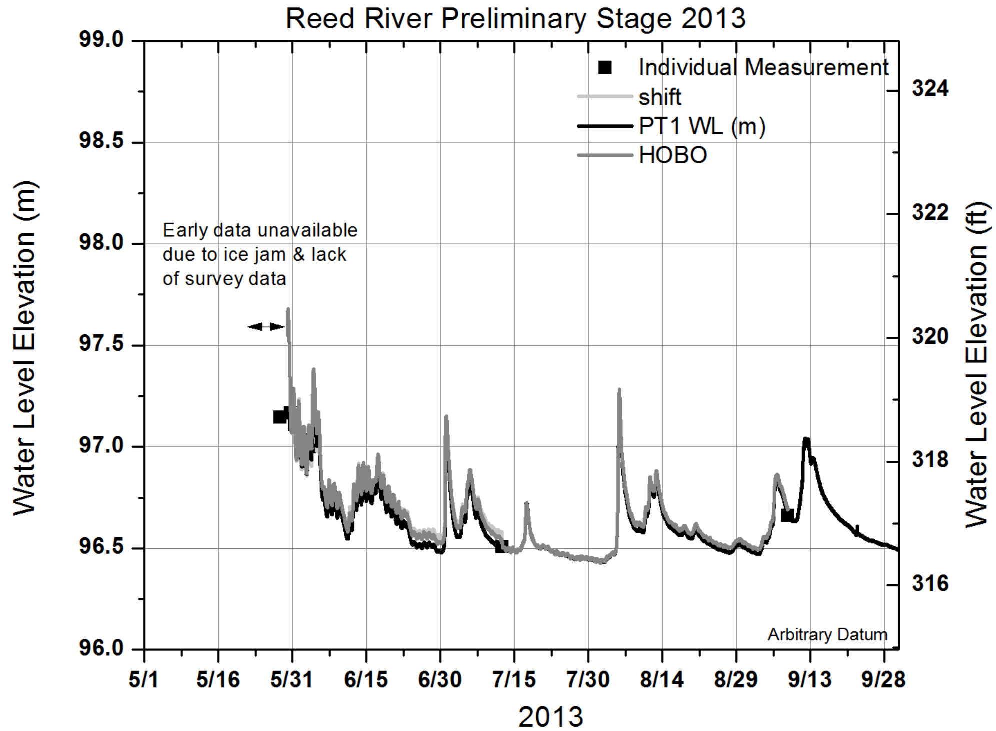



Figure 156. Water level observations at the Reed River station in 2013. Pressure transducer data are unavailable during early breakup due to an ice jam and lack of surveyed stage data, but stages during the ice jam were estimated to be above bankfull (above 98 m elevation).

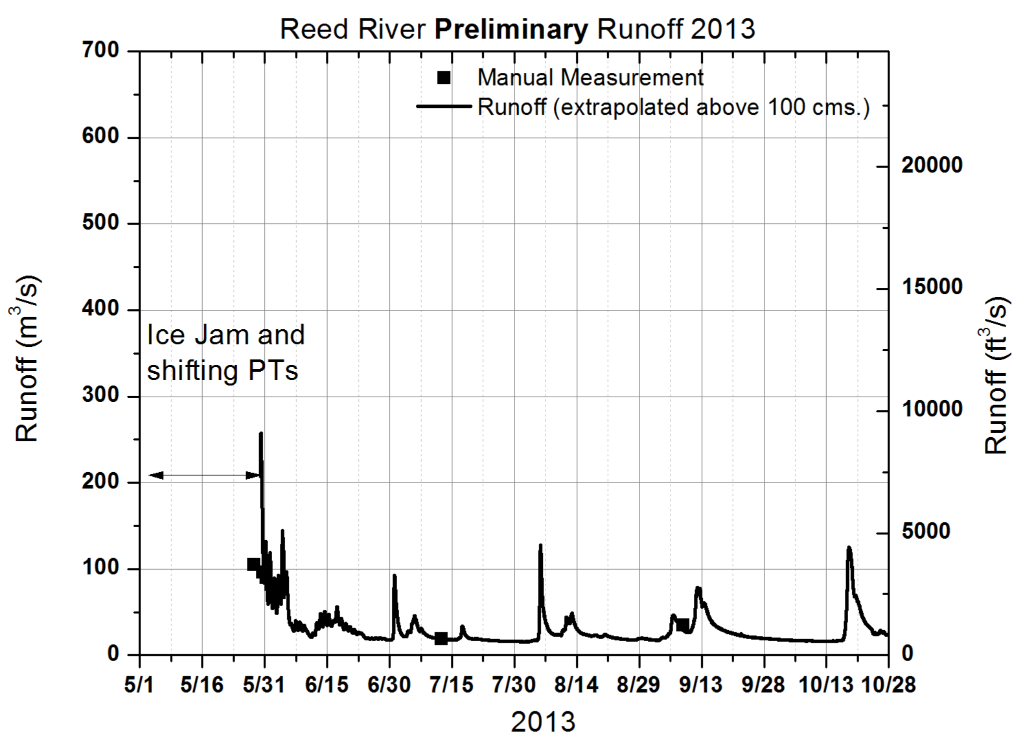



Figure 157. Estimated runoff on the Reed River, 2013. Runoff began on May 24; however, flow was not measured until May 28 due to ice floes and ice jams.


Figure 158. Reed River on May 22, 2013, showing areas of open flowing water.


Figure 159. Reed River initial flows on May 24, 2013.

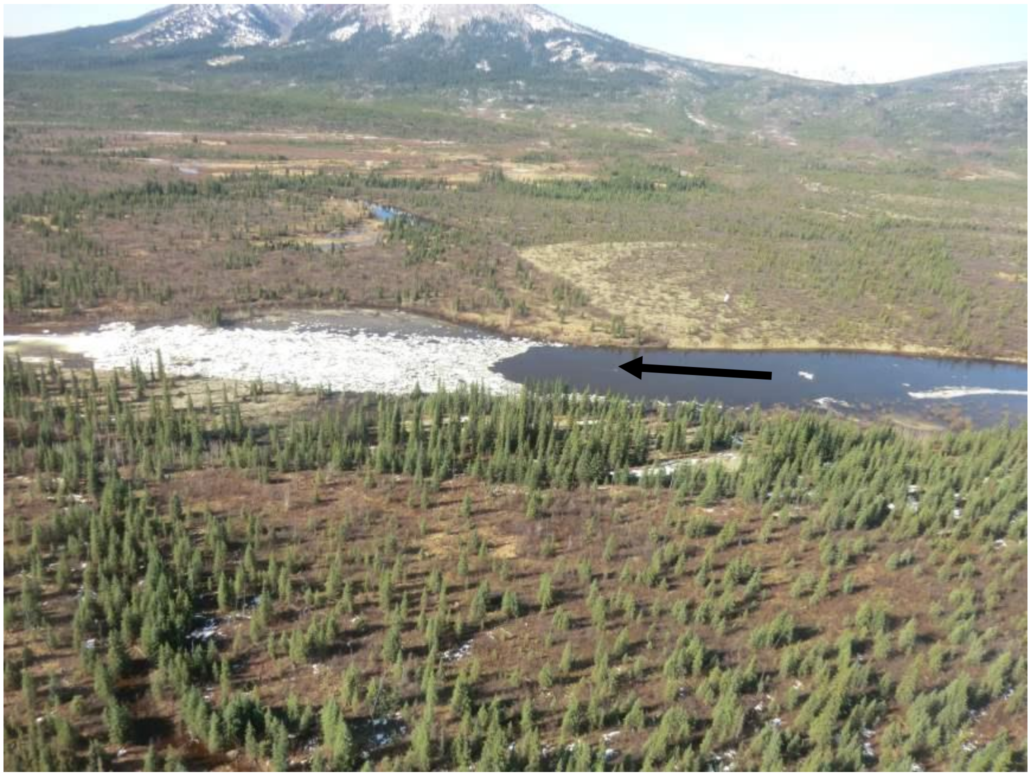


Figure 160. Reed River ice jam just below the station on May 27, 2013, at 9:30 A.M.

Figure 161. Ice jam at the Reed River on the morning of May 27, 2013. River conditions are bankfull above the ice jam.

Figure 162. Backwater in front of the station due to an ice jam on the Reed River on May 27, 2013. River conditions are bankfull.


Figure 163. One day after ice jam released. Photograph shows stranded ice and high stage.


Figure 164. Ice floe on May 29, 2013, and high stage in the Reed River.


Figure 165. By May 30, 2013, much of the ice was no longer present in the channel. Photograph on May 31 shows some stranded ice along the rivers edges.


Figure 166. High stage on the Reed River on June 4, 2013.


Figure 167. Lower stages on the Reed River in summer 2013. Photograph shows the streambed material (cobbles).

#### 4.10.5.4 Reed River summary – 2014

Continuous water level and discharge data are shown in Figure 168 and Figure 169 for the Reed River in 2014. The Reed River was flowing when UAF field staff arrived on May 6, 2014 (Figure 170). Based on earlier time-lapse photography at the station, the river was fully ice-covered on April 22, 2014, and began to flow by April 27 (the next available picture). By May 3, the channel in front of the station was fully open, with shore ice present along the entire length of the visible channel. Shore ice, which began to fragment on May 9, was mostly gone by May 13. Freezing temperatures occurred through the rest of May, delaying snowmelt and spring runoff. Water levels and flows remained low until May 28, when they rapidly rose in response to the snowpack finally melting in the entire basin. Peak flow occurred on the morning of June 1 (Figure 171), after UAF had left the field due to lack of funding/helicopter support. Stage and flow remained high for much of June and July, due to rainfall in the basin. The summer peak flow occurred on July 14 and slightly exceeds the spring peak flow. Water levels and runoff remained low during August and September.

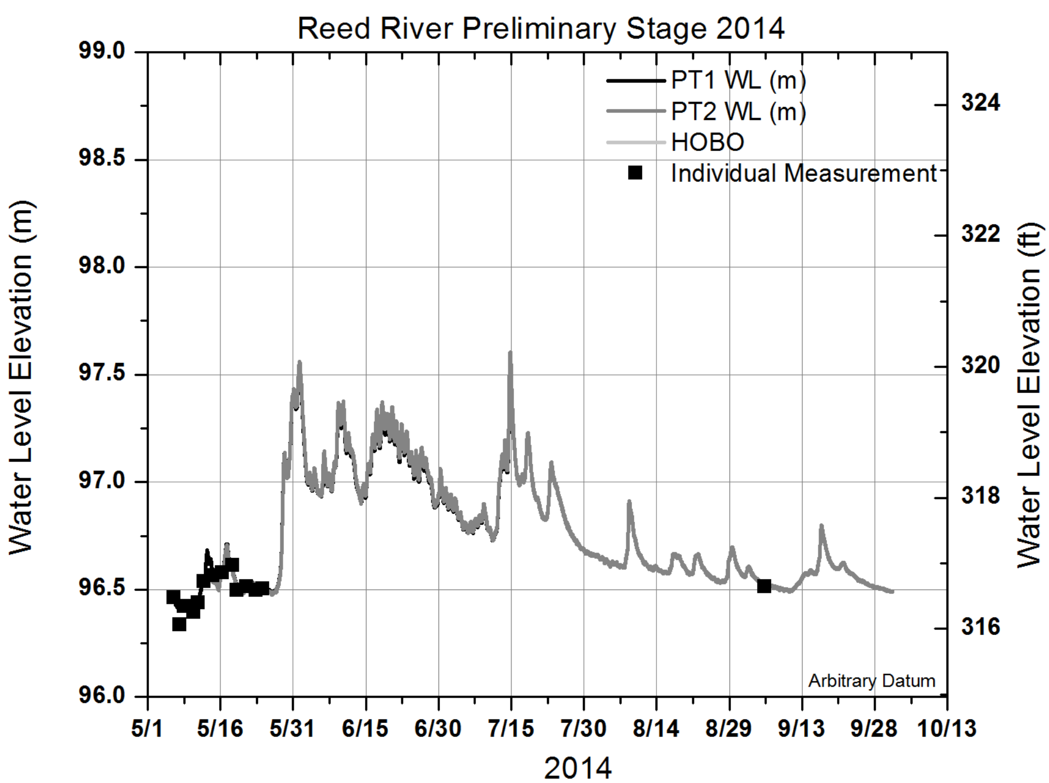



Figure 168. Water level observations at the Reed River station in 2014.

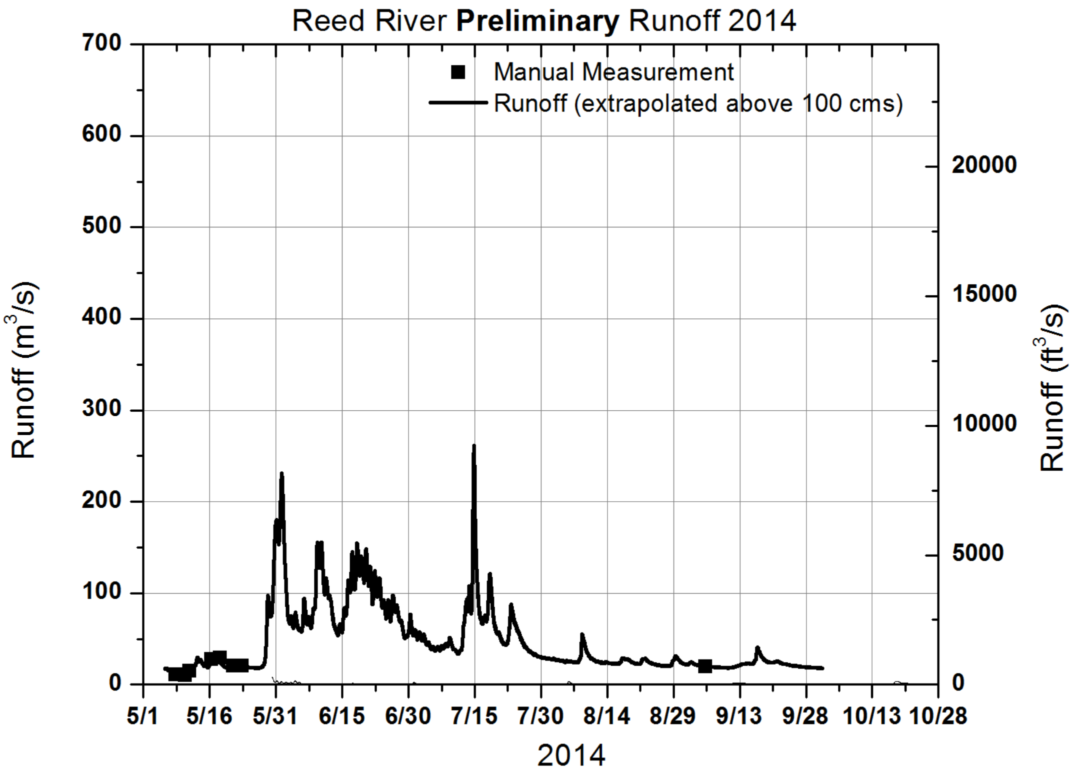



Figure 169. Runoff for the Reed River in 2014. Peak flow during breakup occurred on June 1 and in summer on July 14.


Figure 170. Reed River on May 6, 2014. Arrow indicates the flow direction.


Figure 171. Reed River on peak flow June 1, 2014.

### 4.10.6 Kogoluktuk River

In 2012, UAF field staff visited the Kogoluktuk River on May 17 and installed a time-lapse camera on a vegetated island within the channel. The river had begun to flow, but ice-covered reaches remained. The highest stage, according to the time-lapse camera, occurred on May 19 and/or 20, but the camera was taking photographs of a side channel, not pointing at the main channel and flow. It is unknown when the peak flow occurred due to lack of observations.

In 2013, cameras were placed on the right bank of the river facing upstream. Ice floes were visible in the camera from May 28 through May 31 (Figure 174), and stages were variable and likely fluctuated diurnally. Stage dropped on June 5, as flows decreased and gravel bars became exposed (Figure 175). Cameras were not placed at the Kogoluktuk in 2014.

Figure 172. Kogoluktuk River near the proposed crossing on May 17, 2012. Arrow indicates flow direction.


Figure 173. Kogoluktuk River on May 19, 2012, during early breakup. Arrow indicates flow direction. Camera was placed facing a side channel in 2012.


Figure 174. Kogoluktuk River near the proposed crossing on May 29, 2013. Camera was relocated this year to the main channel. Ice was stranded and floating in the channel from May 27 through 29 as stage varied. Arrow indicates flow direction.


Figure 175. By June 7, 2013, flows had decreased on the Kogoluktuk River near the proposed crossing.

## 4.10.7 Other observations

### 4.10.7.1 Kogoluktuk River

Lilly et al. (2012) report measurements on the Upper Kogoluktuk River from spring 2011. The highest flow manually measured was 160 $m^3/s$ (on May 28, 2011) during spring breakup, although this measurement was not the peak flow for breakup. The rating curve estimated peak for 2011 was near 300 $m^3/s$, but the rating curve is extrapolated.

### 4.10.7.2 Dahl Creek

Dahl Creek, a small (28.5 $km^2$) south-facing drainage in the Kobuk River basin, has been observed by the USGS since 1986. It drains from the Cosmos Hills into the Kobuk River near the village of Kobuk. Spring breakup flows typically occur in mid to late May. The annual peak flow may occur in either spring or summer. The maximum flow for the period of record (1986 to present) of 52 $m^3/s$ (1840 $ft^3/s$) occurred on August 17, 1994, during a historic flood event that affected the Kobuk and Koyukuk basins. The hydrograph for 1994 showing daily flow is presented in Figure 176.

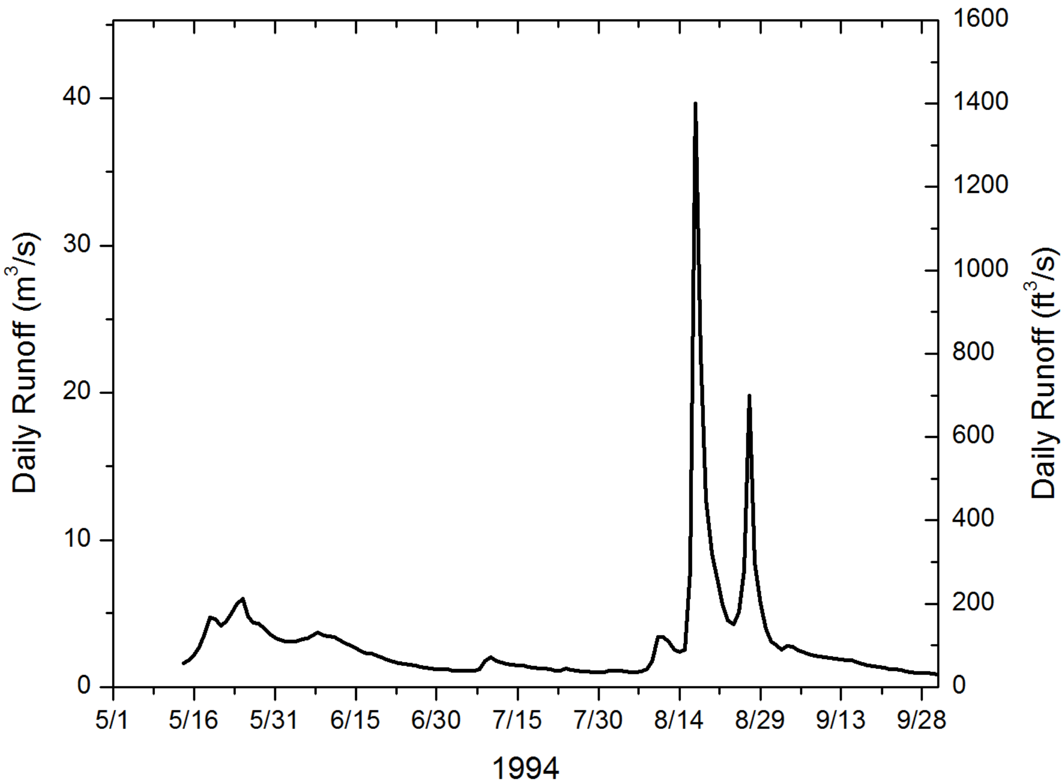



Figure 176. Hydrograph for Dahl Creek in 1994 (plot shows mean daily runoff). The maximum recorded flow at this site (52 $m^3/s$) was recorded on August 17.

Daily data were available from 1986–1994, and hourly data are available from 1995–present. Figure 177 through Figure 179 show hydrographs for Dahl Creek during the 2012–2014 study period. Although 2012 was very wet in the fall (Figure 177), the peak flow was nowhere near maximum recorded flow in 1994 (Figure 176). In 2013, the complete spring breakup record was unavailable, and the rest of summer was uneventful due to little rainfall (Figure 178). In 2014 (Figure 179), above-normal breakup flows followed by high runoff during the summer resulted in higher baseflow compared with 2013. Upon reviewing the USGS annual statistics for Dahl Creek, we found that the year 2014 had the fourth highest annual mean discharge in the 18-year record.

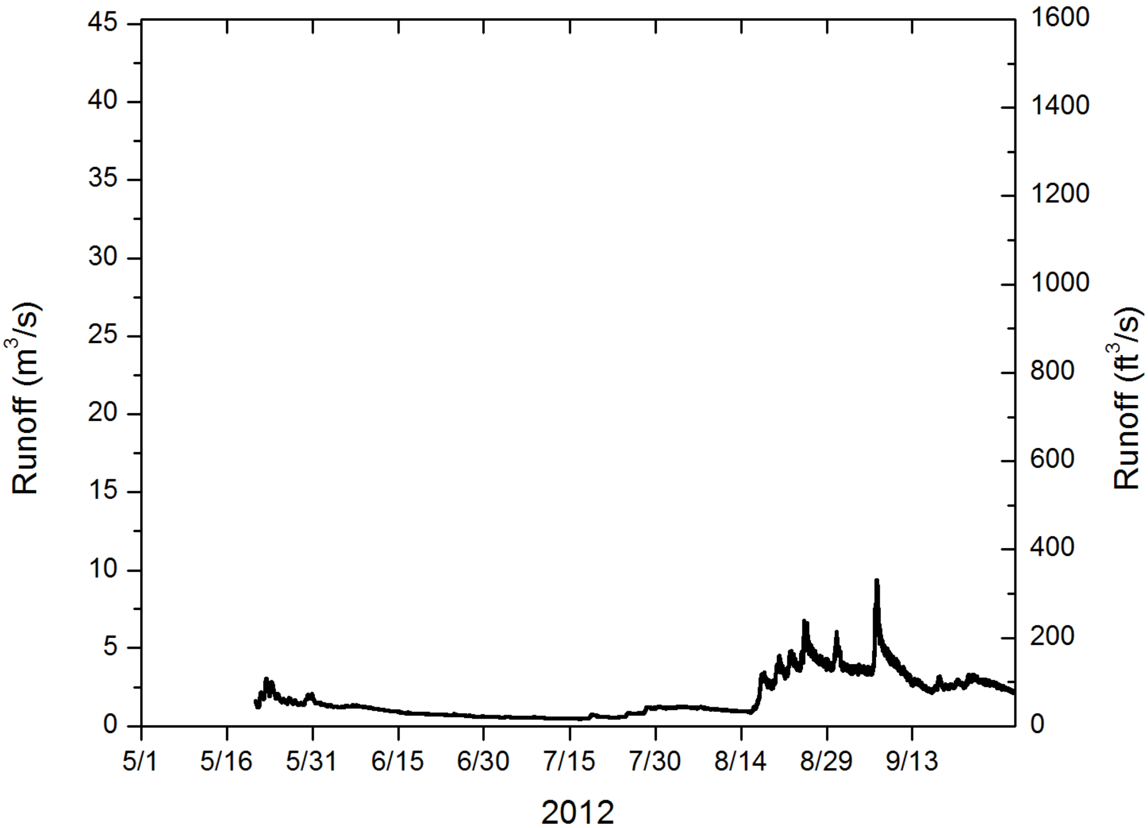



Figure 177. Hydrograph for Dahl Creek in 2012 (data courtesy of USGS, 2014).

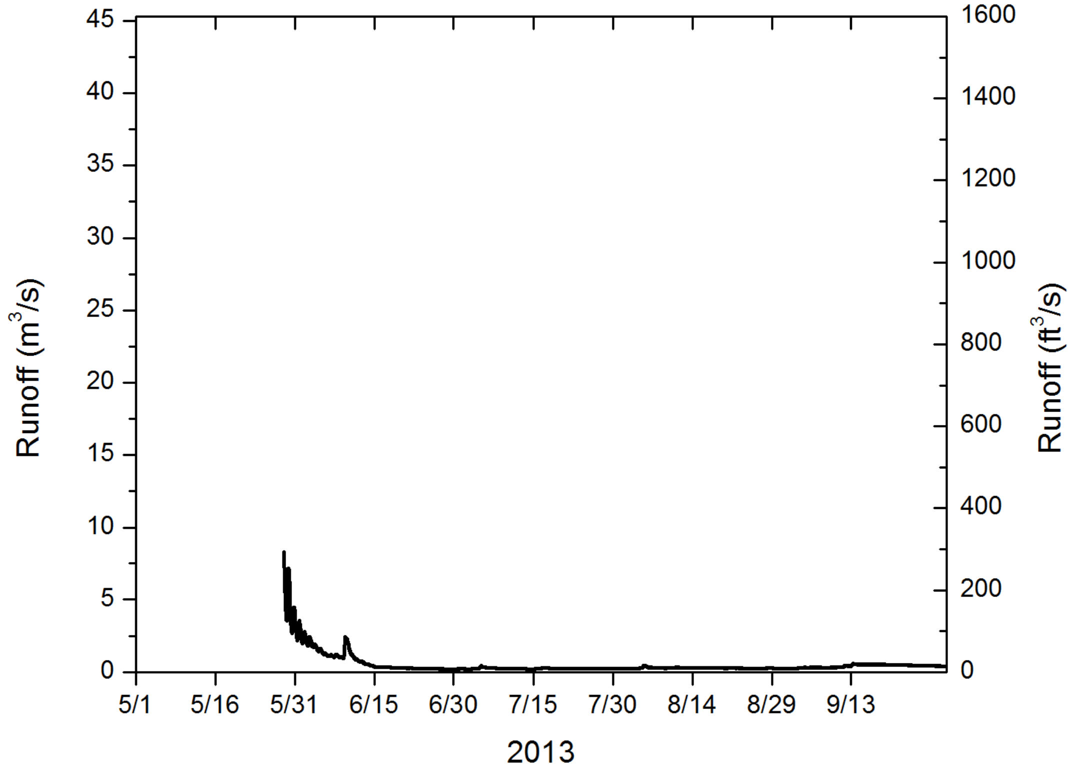



Figure 178. Hydrograph for Dahl Creek in 2013 (data courtesy of USGS, 2014). The complete record for spring breakup was unavailable.

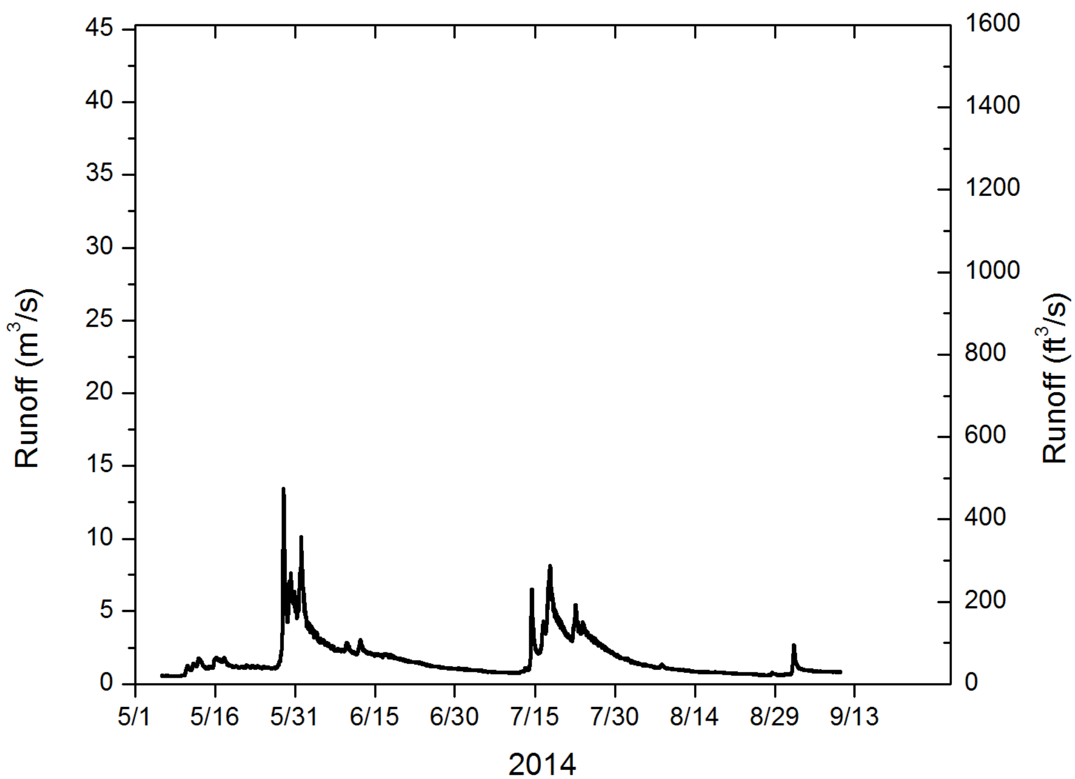



Figure 179. Hydrograph for Dahl Creek in 2014 (data courtesy of USGS, 2014).

#### 4.10.7.3 Slate Creek

Slate Creek is a small west-facing high-gradient basin (190 $km^2$) located near Coldfoot. It drains into the Middle Fork of the Koyukuk River, and streamflow has been observed continuously by the USGS since 1995. Annual peak flow data beginning in 1981 are available from the USGS. Spring breakup flows typically occur in mid to late May. Annual peak flow may occur in either spring or summer. The maximum flow for the period of record (1981 to present) occurred immediately after spring breakup 1998, when flows over 139 $m^3/s$ (4930 $ft^3/s$) were reported (as maximum daily discharge) on May 26. This peak was likely a result of a rain event combined with late snowmelt shortly after breakup, as the NRCS Coldfoot station recorded 23 mm of rain and warm air temperatures. The second highest flow of 133 $m^3/s$ (4700 $ft^3/s$) was recorded during a historic flood event on August 27, 1994, that affected the Kobuk and Koyukuk Rivers.

Data are presented for the 2012 to 2014 study period in Figure 180 through Figure 182. The hydrographs for Slate Creek are similar to other river observations in this study. A wet fall with higher August and September flows was observed in 2012 (Figure 180). The year 2013 was dry, with low baseflow throughout the summer (Figure 181). In 2014, runoff was high during spring breakup and continued to be high throughout the summer due to rainy conditions (Figure 182). Additionally, baseflow was higher in 2014 than in 2013. In the 16-year USGS record of annual mean discharge, the year 2014 had the highest annual mean discharge.

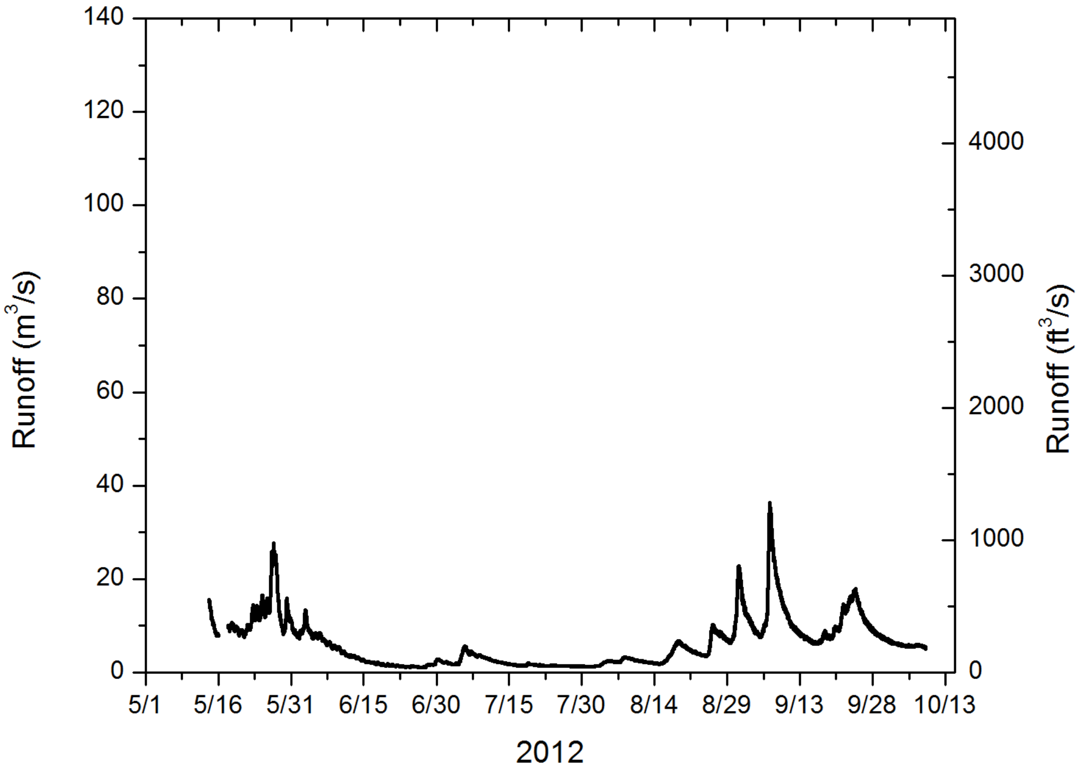



Figure 180. Slate Creek runoff in 2012 (data courtesy USGS, 2014).

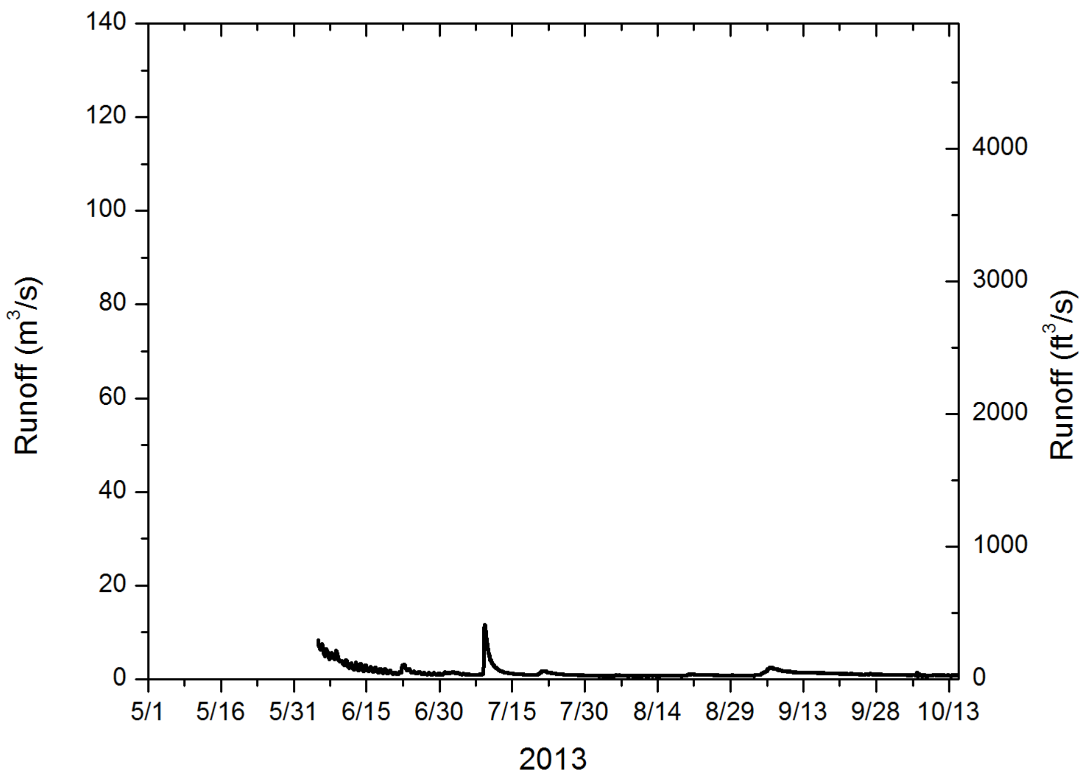



Figure 181. Slate Creek runoff in 2013 (data courtesy USGS, 2014). Data during spring breakup are unavailable for this year.

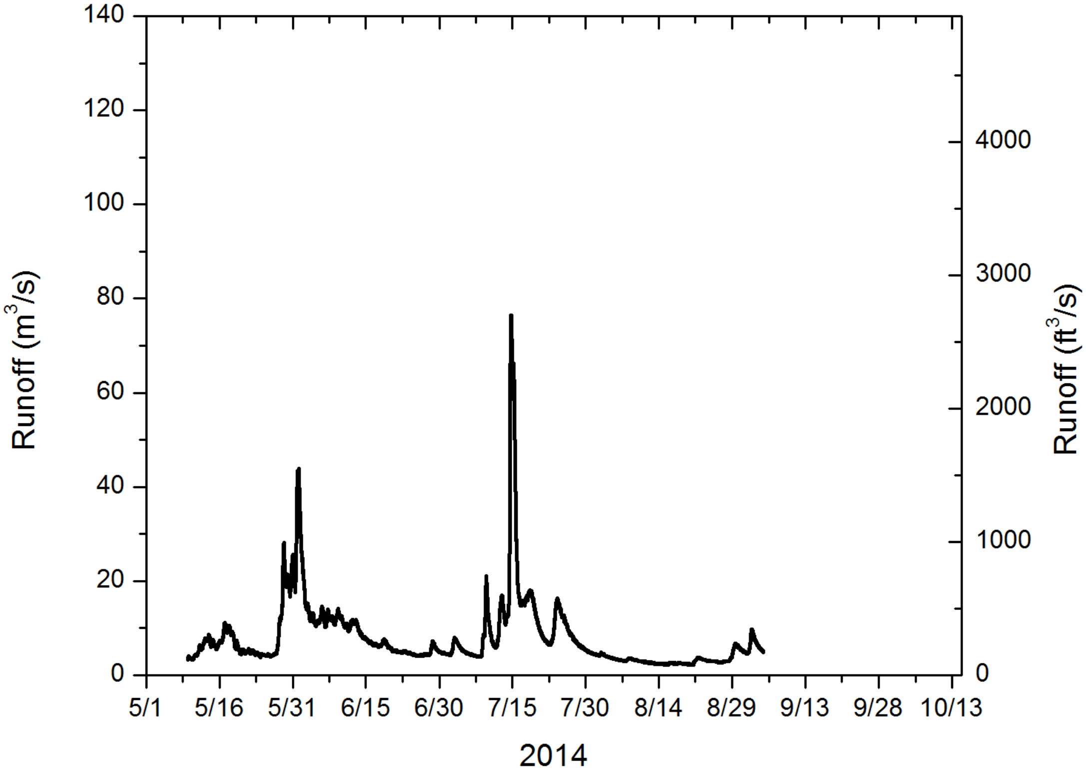


Figure 182. Slate Creek runoff in 2013 (data courtesy USGS, 2014).

## 4.11 Suspended Sediments Overview

To better describe the sediment characteristics of the rivers in the study area, we measured the suspended sediment concentration (SSC). Suspended sediment monitoring began in summer 2012 on the Reed, Alatna, and Koyukuk Rivers. In 2013 and 2014, spring breakup was monitored on all three rivers, with the sediment transport focus on suspended sediments. Because of logistical problems associated with the remoteness of these sites, it often takes several years to get good data on the sediment regime. Therefore, we need a longer time to establish a good and reliable relationship between the regimes of flow and sediment. These results are preliminary at best.

### 4.11.1 Bed sediment distribution

Calculation of the bed sediment distribution in a river and the subsequent determination of the $D_{50}$ allow for the use of multiple equations to determine hydraulic parameters. Examples would include the calculation of bankfull discharge, dimensionless bed shear stress, and Reynold’s number. The ability to estimate these parameters increases our understanding of a river and its sediment transport regime. Bed sediment distributions were calculated for the Reed, Alatna, and Koyukuk Rivers (Table 36 and Figure 183). The Alatna River had the smallest calculated $D_{50}$. In front of the station at the Alatna, the river is quite silty due to the presence of a backwater. The grid for $D_{50}$ at the Alatna River was done on a gravel bar approximately 100 m upstream of the station. The $D_{50}$ calculated at this grid was 19.1 mm, which is equivalent to coarse gravel. The Koyukuk River had the next largest $D_{50}$ at 32.3 mm, which just meets the classification of very coarse gravel. The grid for the Koyukuk River was done on the left bank, in the same reach as the discharge measurements. The Reed River $D_{50}$ was calculated at 47.5 mm, which is very coarse gravel. This grid for the Reed River was completed on the right bank, in the reach where discharge measurements were made.

Table 36. Bed sediment distribution by weight for the Reed, Alatna, and Koyukuk Rivers.

| | **% Finer by Weight** | | |
|---|---|---|---|
| **Diameter [mm]** | **Reed** | **Alatna** | **Koyukuk** |
| **218** | 91.6 | 100.0 | 100.0 |
| **154** | 82.7 | 100.0 | 100.0 |
| **109** | 74.3 | 100.0 | 98.2 |
| **77** | 65.4 | 97.7 | 92.0 |
| **54.5** | 54.9 | 92.9 | 73.6 |
| **38.5** | 43.7 | 87.2 | 63.7 |
| **27** | 34.9 | 68.8 | 50.7 |
| **19** | 26.1 | 49.7 | 37.5 |
| **13.5** | 18.3 | 31.4 | 23.4 |
| **9.5** | 12.9 | 18.2 | 13.5 |
| **7** | 7.7 | 9.5 | 5.8 |
| **5** | 2.4 | 3.1 | 1.4 |
| **3** | 0.0 | 0.0 | 0.0 |
| **1** | 0.0 | 0.0 | 0.0 |

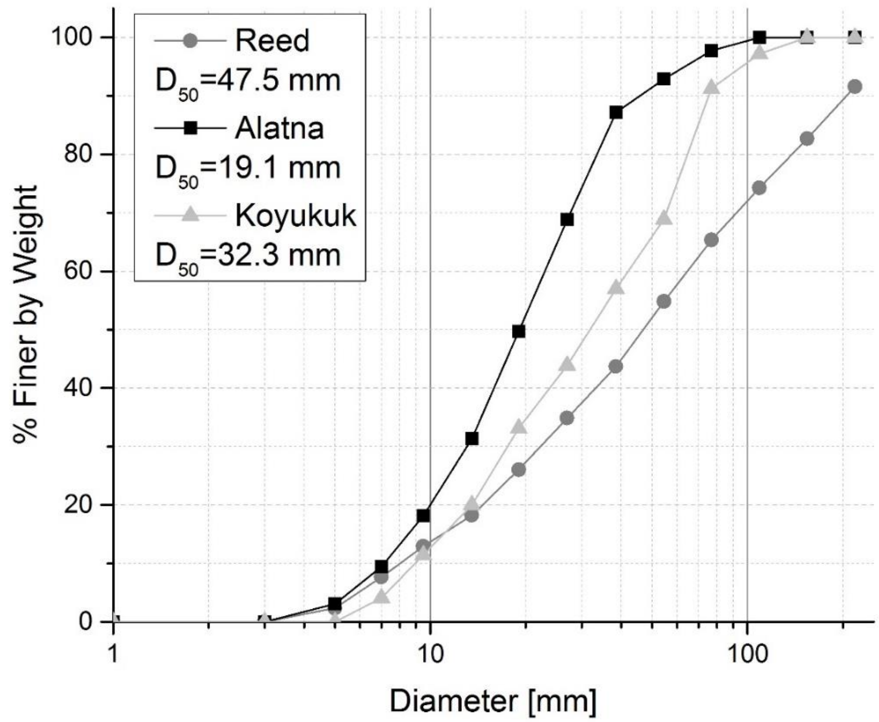



Figure 183. Bed sediment distribution for the Reed, Alatna, and Koyukuk Rivers.

### 4.11.2 Suspended sediment rating curves

Suspended sediment rating curves (Figure 184) were developed for each river using grab and depth-integrated samples. These curves are intended to relate SSC and discharge at times when the channels are not ice-affected, effectively for times after spring breakup. A lack of suspended sediment samples and discharge measurements at high flows, however, makes these rating curves preliminary; future work will be necessary to have samples at a wider range of flows.

The Reed River rating curve especially needs further work; no SSC samples were collected at flows above 109 $m^3/s$, but peak flows are thought to have peaked above 300 $m^3/s$ in 2012. The uncertainty in the discharge at high flows made it exceptionally challenging to create a rating curve that could accurately predict SSC at high flows. While a power curve had the best fit for these SSCs at lower discharges, it was deemed highly inaccurate at the higher flows that occurred during spring breakup in 2013 and 2014 and in the warm season of 2012. As a result, a linear fit was initially used instead. The SSC on the Alatna River was best fitted by a linear equation. This approximation of SSC as a function of discharge is obviously inaccurate at low discharges (Figure 184), as the rating curve predicts a “negative” SSC. The same problem occurred on the Koyukuk, where again a linear fit was the best fit.

In comparing the rivers, it appears that in this first estimate at discharges below 150 $m^3/s$, the Reed River has a higher SSC than the Alatna or Koyukuk, although it is more typical for the Alatna and Koyukuk Rivers to flow at much higher discharges than the Reed River, which is important to keep in mind.

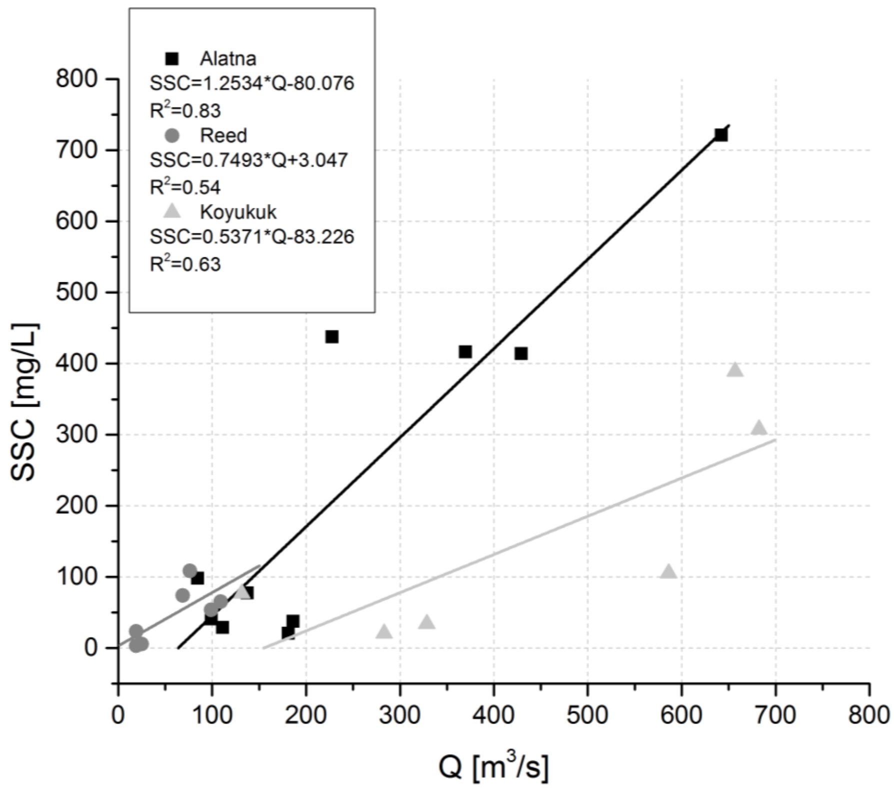



Figure 184. Rating curves for suspended sediment concentrations.

### 4.11.3 Suspended sediment concentration

Automatic Isco samplers were installed on each river in an effort to capture a picture of SSC throughout the flow season. These samplers, however, are very difficult to maintain and troubleshoot in the remote locations of this study. As a result, there are gaps in the datasets for a variety of reasons: samplers were knocked over during flooding, the pumps jammed, animals disrupted the systems on a number of occasions, and mechanical failures occurred. The data that we were to collect, however, allows for a tracking of SSC at various points throughout the flow season on each river.

On the Reed River (Figure 185), Isco instrument malfunctions made SSC data relatively ineffective in all 3 years of the study. Only short periods of data were collected before instrument failure, but the turbidimeters worked quite well on the Reed River, as discussed later.

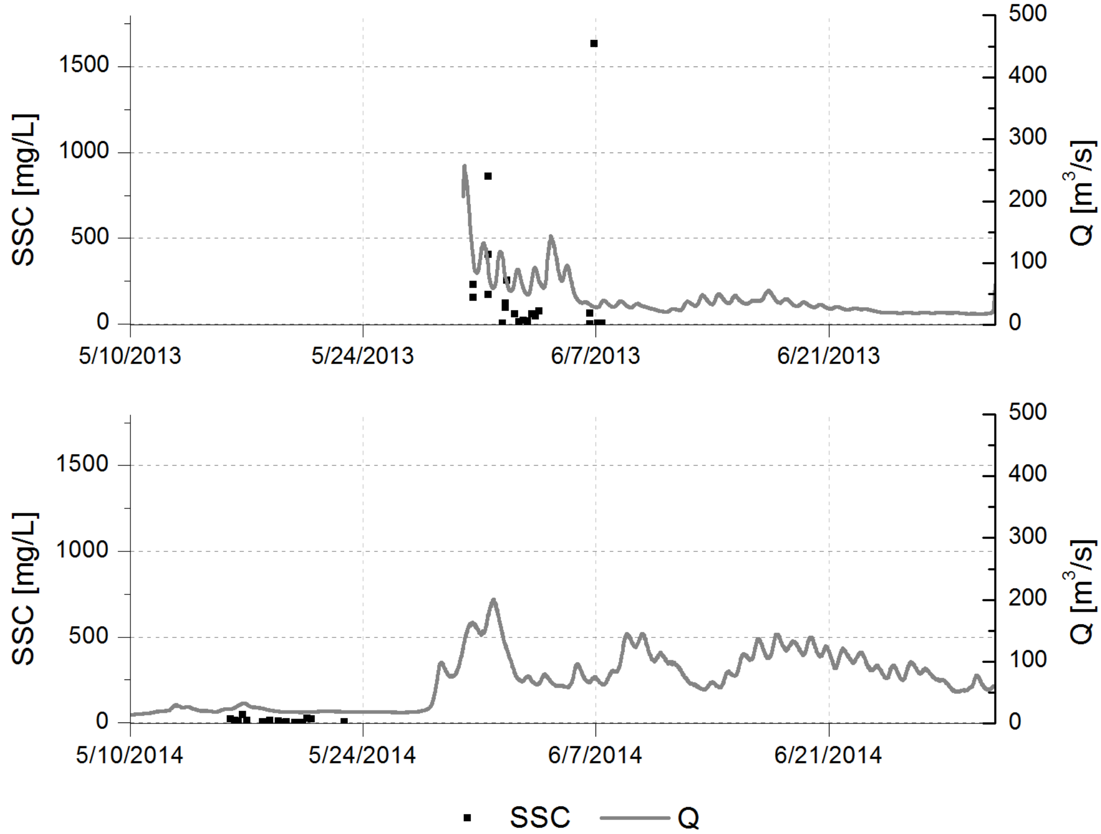



Figure 185. Suspended sediment concentration (from Isco samples) and discharge for the Reed River for the period 2013–2014. Instrument malfunctions in 2012 made this data unusable.

On the Alatna River (Figure 186), although nearly three seasons of SSC data were collected, only a few measurements exist for 2012 and 2014. In 2013, Iscos were installed shortly after breakup and collected data throughout the summer flow season. According to the Isco data, SSC peaked during a summer rain event on June 25, 2013. This SSC of 3823 mg/L is extremely high and was far above the values collected on the previous 2 days and the following day; therefore, it should be considered a preliminary result. Another rain event occurred on July 2, 2013, followed by another peak in SSC. Both these rain events show a lag between when discharge peaked and when SSC peak was measured. That the Iscos only collect a sample every 24 hours, however, is important to remember, as the actual peak in SSC may be missed during these rain events.

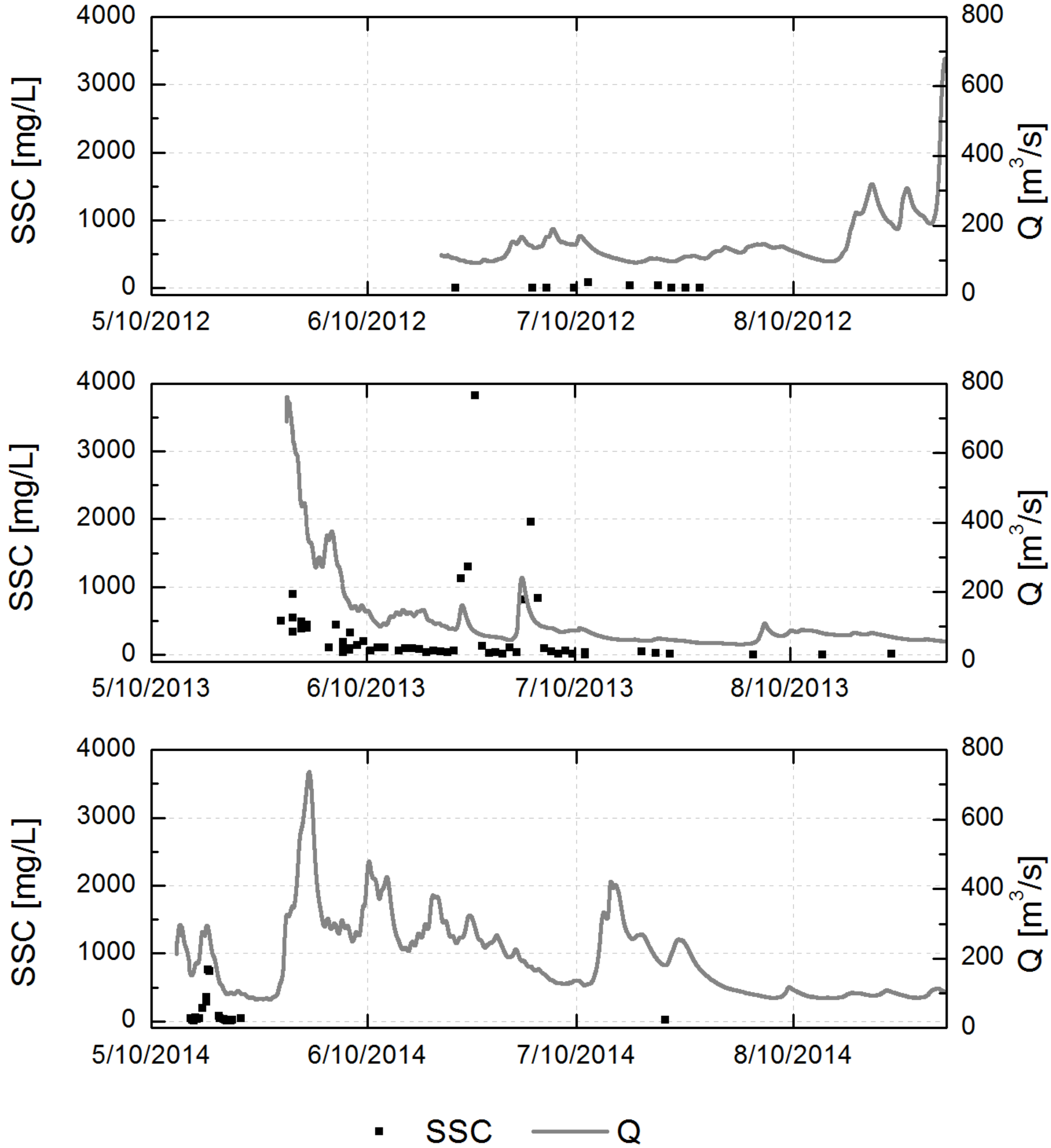



Figure 186. SSC (from Isco samples) and discharge for the Alatna River for the period 2012–2014.

At the Koyukuk River (Figure 187), the Iscos often malfunctioned in 2012 and 2014, as well as during the latter half of 2013. Data are only shown for 2013 (Figure 187). The malfunctions were due to high debris loads in the Koyukuk River, which regularly pulled tubing out of the Isco's pump housing, tipped instruments over, and led to batteries disconnecting.

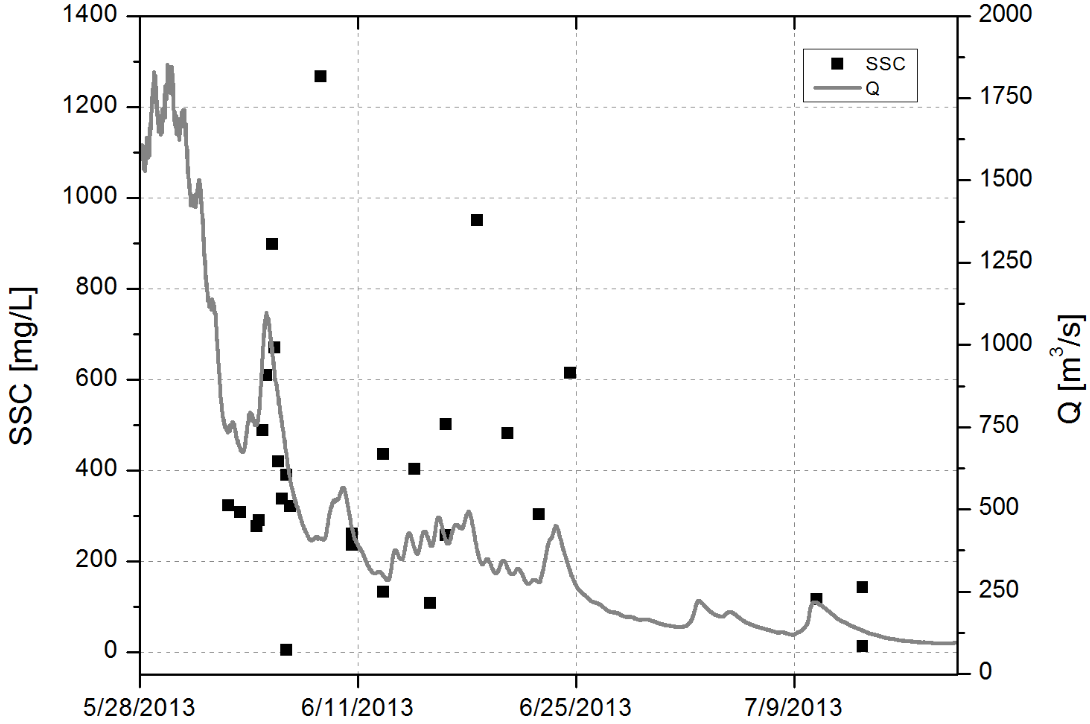



Figure 187. SSC (from Isco samples) and discharge for the Koyukuk River for 2013.

### 4.11.4 Suspended sediment discharge

While considering SSC at specific points in time conveys a large amount of information about the suspended sediment transport regime of a river, further insight into this regime is provided by considering the suspended sediment discharge ($q_S$), which allows for the comparison of sediment loads between rivers of varying discharges and within the same river over time as discharge fluctuates. Suspended sediment discharge can also be useful for considering the annual total suspended sediment loads of a river. Suspended sediment discharge curves were developed for the Reed (Figure 188), Alatna (Figure 189) and Koyukuk (Figure 190) Rivers using the suspended sediment rating curves (Figure 184) and the values of discharge at 15-minute intervals throughout the flow season when the channels were not ice-affected.

The Reed River (Figure 188) had several large flood events in August 2012 that dominated both the hydrograph and suspended sediment transport for the water year. In fact, the suspended sediment discharge from this event is so large that it dwarfs the suspended sediment discharge from breakup and other summer rain events in 2013 and 2014. Spring breakup in 2013 peaked at a suspended sediment transport rate of 50 kg/s, and in 2014, the peak during breakup was 31 kg/s, with a rainfall-related peak in the summer of 37 kg/s. In 2012, the peak was estimated to be 138 kg/s, but it is important to note that because no samples (or discharge measurements) were collected at high flows on the Reed River, the rating curve is preliminary, especially during high flow events.

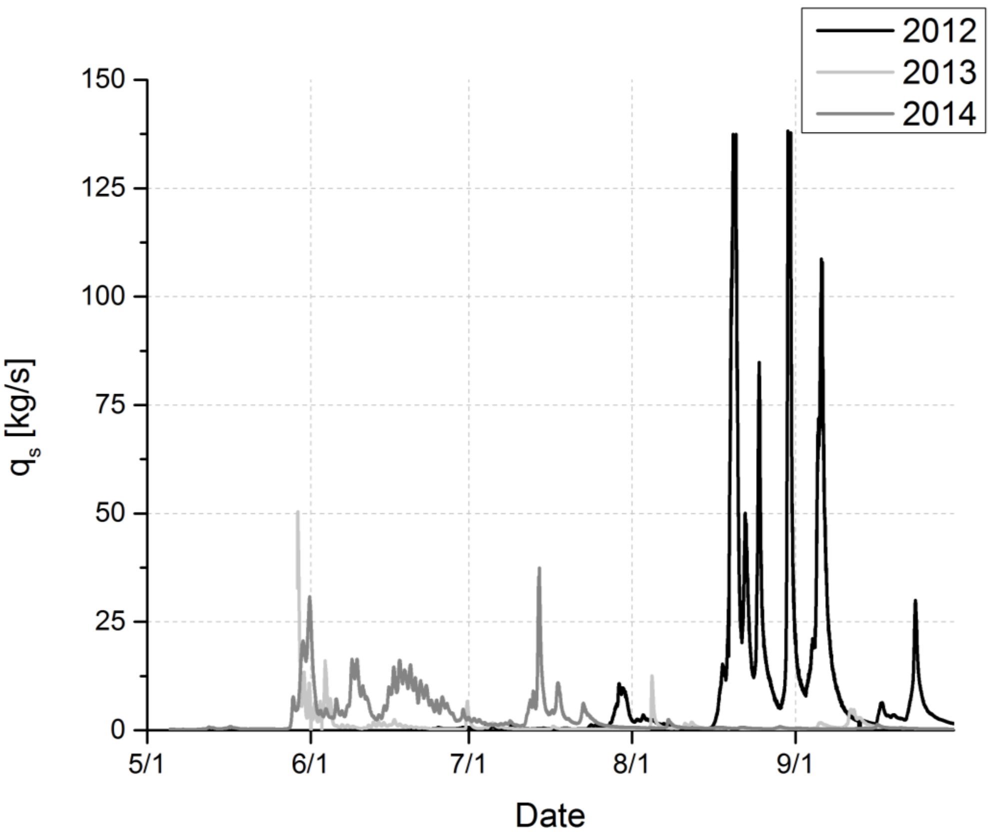



Figure 188. Reed River estimated suspended sediment discharge for the period 2012–2014 (no observations during 2012 breakup).

On the Alatna River (Figure 189), the largest recorded events for suspended sediment discharge between 2012 and 2014 were spring breakup events, although the 2012 summer rain and flood event was of a similar magnitude. Spring breakup in 2013 peaked at 664 kg/s, and in 2014, the peak was 620 kg/s. The 2012 spring rain event had a maximum transport rate of 526 kg/s.

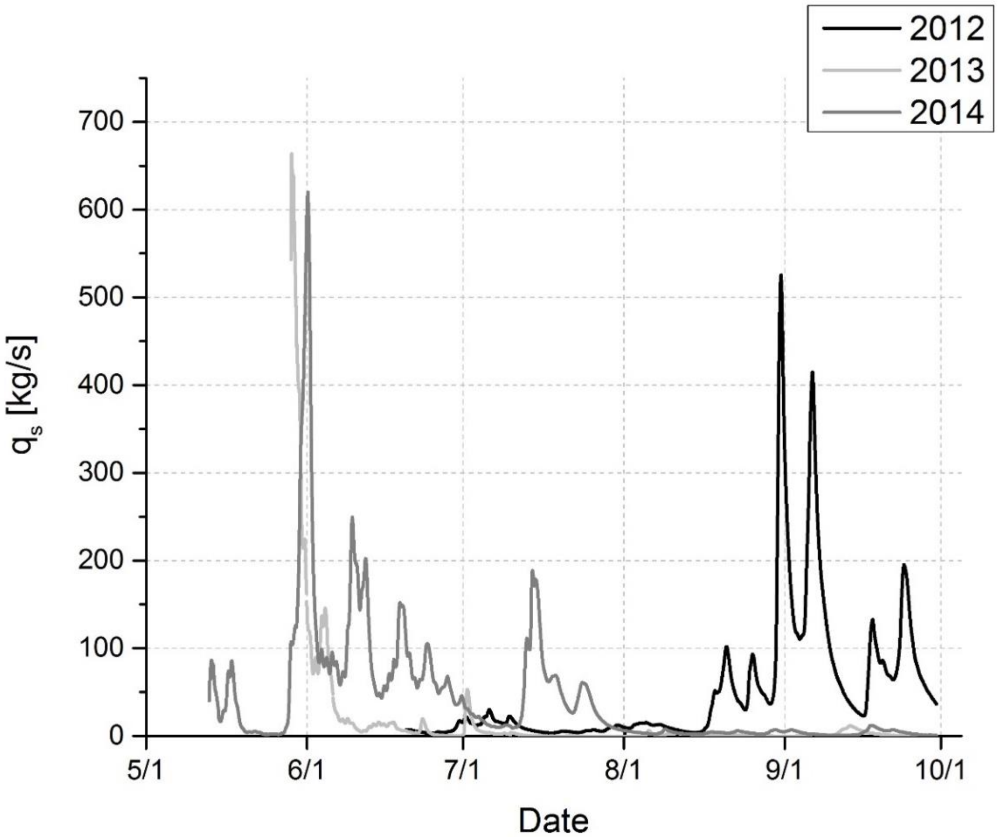



Figure 189. Alatna River estimated suspended sediment discharge for 2012–2014 (no observations during 2012 breakup).

Finally, on the Koyukuk River (Figure 190), which again is a larger basin with higher flows than either the Alatna or the Reed Rivers, it is evident that summer rain events can be the largest sediment transport events of the year. Spring breakup peaked at 1688 kg/s in 2013 and 2385 kg/s in 2014, but the overall largest suspended sediment transport rates occurred in summer 2014 during a rain event, with a peak of 3329 kg/s.

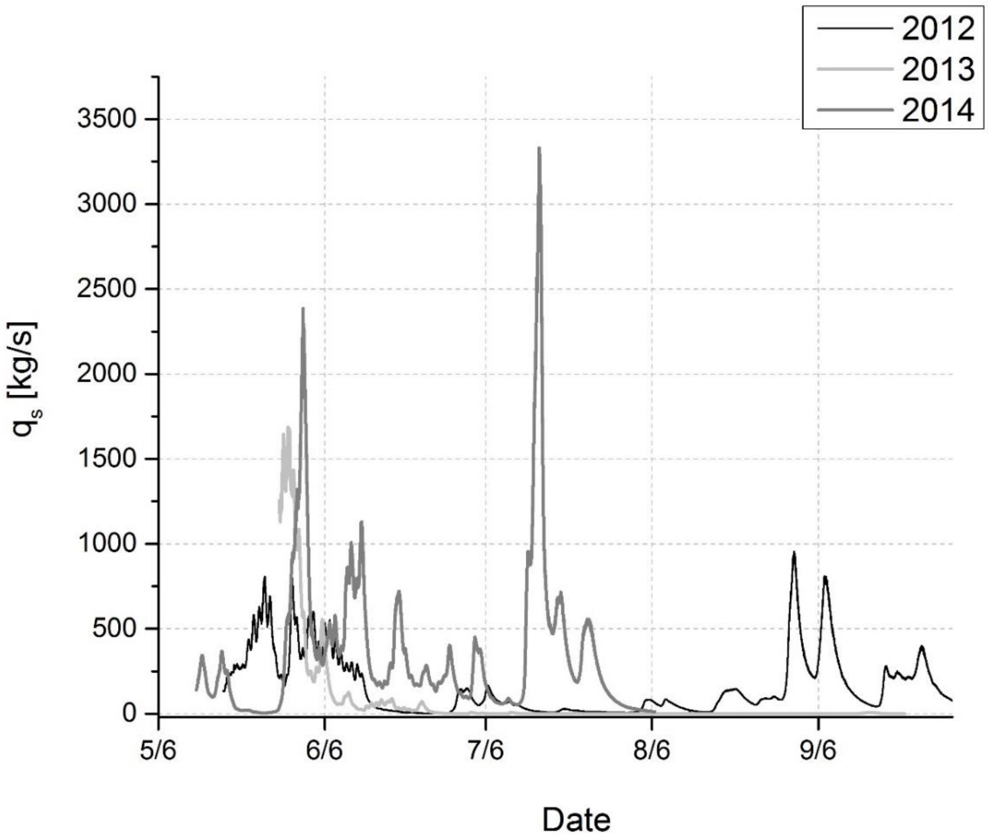



Figure 190. Koyukuk River estimated suspended sediment discharge for 2012–2014.

It is interesting to compare the total annual sediment yields of the three rivers. The Reed River (Table 37) had the smallest annual yields by a significant amount, followed by the Alatna River (Table 38). The Koyukuk River (.

Table 39) had sediment yields far above either of the other rivers, as would be expected based on both its much larger discharge and typically higher SSC. On all three rivers, the majority of sediment transport occurs during breakup (May and June), although July 2014 also had a large sediment yield, which was due to runoff that peaked in early July on these rivers in 2014 and to large and prolonged rain events that occurred throughout the study area in July 2014. September 2012 was also high in response to significant late summer rainfall.

Table 37. Suspended sediment yields for the Reed River for 2012–2014, in metric tonnes per month and monthly percentages. (Note that no observations were made during breakup in 2012, as monitoring started on 6/20/2012.)

| | 2012 | | 2013 | | 2014 | |
|---|---|---|---|---|---|---|
| May | | | 2445 | 20.1% | 3941 | 11.3% |
| June | 427 | 0.6% | 4015 | 33.1% | 19309 | 55.5% |
| July | 3385 | 4.8% | 1420 | 11.7% | 8708 | 25.0% |
| August | 37290 | 53.2% | 1885 | 15.5% | 1635 | 4.7% |
| September | 28929 | 41.3% | 2375 | 19.6% | 1170 | 3.4% |
| Annual | 70031[1] | | 12142 | | 34763 | |

[1] Entire month of May and over half of June is missing from annual total.

Table 38. Suspended sediment yields for the Alatna River for 2012–2014, in metric tonnes per month and monthly percentages. (Note that no observations were made during breakup in 2012, as monitoring started on 6/20/2012.)

| | 2012 | | 2013 | | 2014 | |
|---|---|---|---|---|---|---|
| May | | | 93989 | 51.9% | 80466 | 16.0% |
| June | 5192 | 1.2% | 69809 | 38.5% | 291919 | 58.0% |
| July | 27951 | 6.3% | 8333 | 4.6% | 110785 | 22.0% |
| August | 115041 | 25.8% | 3145 | 1.7% | 10936 | 2.2% |
| September | 298064 | 66.8% | 5815 | 3.2% | 9515 | 1.9% |
| Annual | 446248[1] | | 181090 | | 503619 | |

[1] Entire month of May and over half of June is missing from annual total.

Table 39. Suspended sediment yields for the Koyukuk River for 2012–2014, in metric tonnes per month and monthly percentages.

| | 2012 | | 2013 | | 2014 | |
|---|---|---|---|---|---|---|
| May | 468846 | 24.7% | 401168 | 57.6% | 311020 | 11.8% |
| June | 421915 | 22.2% | 291495 | 41.8% | 1209762 | 45.9% |
| July | 114124 | 6.0% | 2110 | 0.3% | 1105127 | 41.9% |
| August | 203502 | 10.7% | 0 | 0.0% | 11777 | 0.4% |
| September | 688904 | 36.3% | 1817 | 0.3% | | |
| Annual | 1897291 | | 696591 | | 2637686 | |

### 4.11.5 Turbidity

Turbidimeters were initially installed in July 2012, but mechanical problems with the new model were encountered during summer 2012 and spring 2013; the integrated wiper kept jamming over the optical window, making the sensors inoperable. A change in the timing and operation of the window resulted in much greater success later in 2013 and 2014. Turbidimeters worked quite well on the Reed River in 2013 and 2014. The graphs in Figure 191 show that turbidity appears to closely follow discharge. In Figure 192, hysteresis is evident in both 2013 and 2014 for the Reed River. In 2013, one large rain event was recorded on the Reed River, when discharge and turbidity began rising on August 4. Interestingly, some hysteresis can be seen in the turbidity rating curve for this event, with clockwise hysteresis evident, indicating that a large amount of sediment was readily available at the onset of the flood event. A similar curve can be seen in 2014 for a rain event that caused a rise in discharge beginning on July 14.

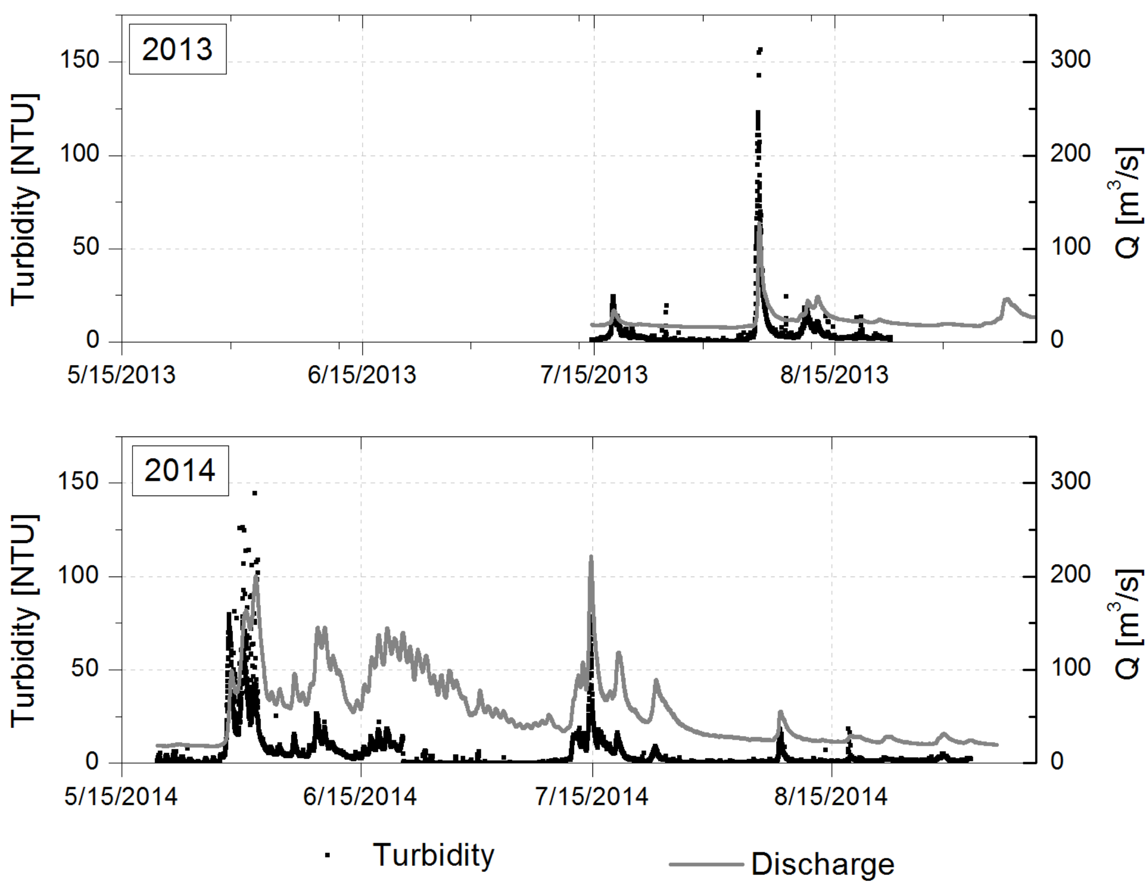



Figure 191. Reed River turbidity and discharge for 2013–2014.

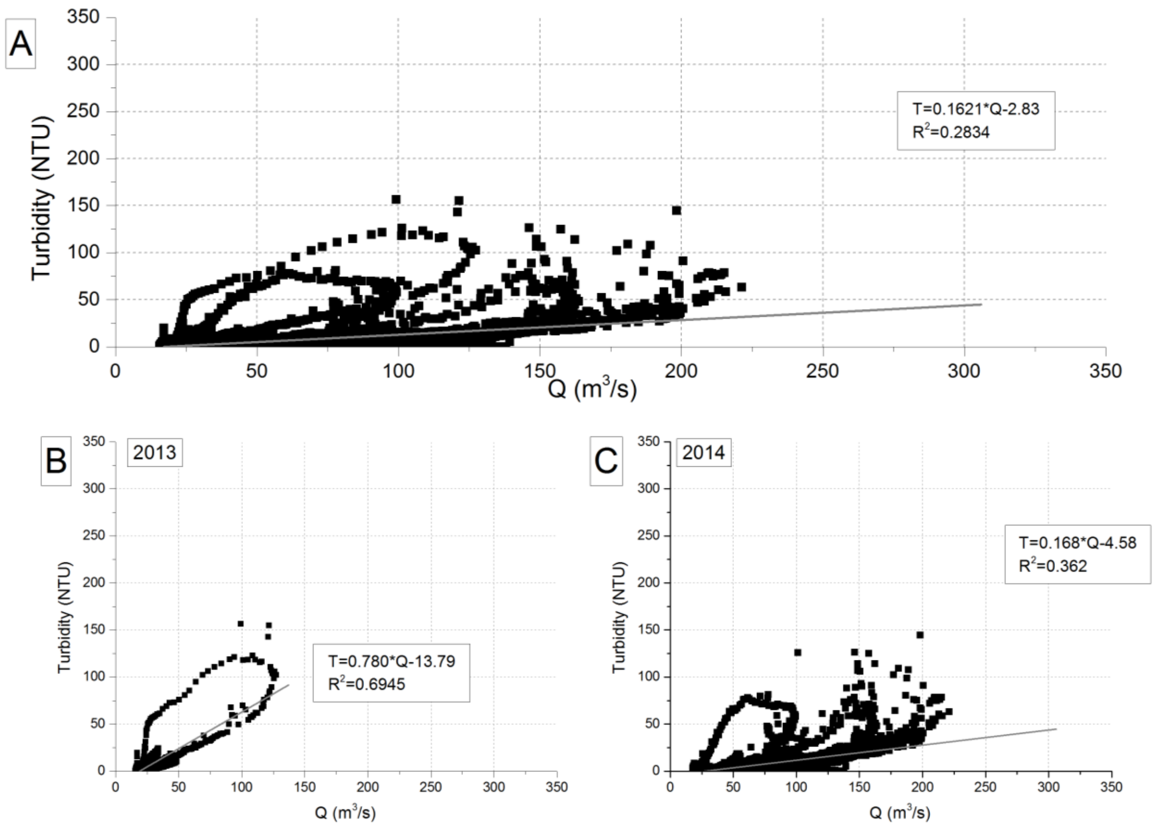



Figure 192. Reed River turbidity rating curves, comparing turbidity with discharge: (A) data from 2013–2014; (B) data from 2013 only; (C) data from 2014 only.

The Alatna River turbidimeter functioned quite poorly (Figure 193). The meteorological station at the Alatna River was installed in proximity to a large backwater, and due to limitations in how far from the station the turbidimeter could be installed, turbidity and discharge are not well related at this site. A few large peaks in turbidity were captured in 2014, but the instrument also malfunctioned for much of summer 2014.

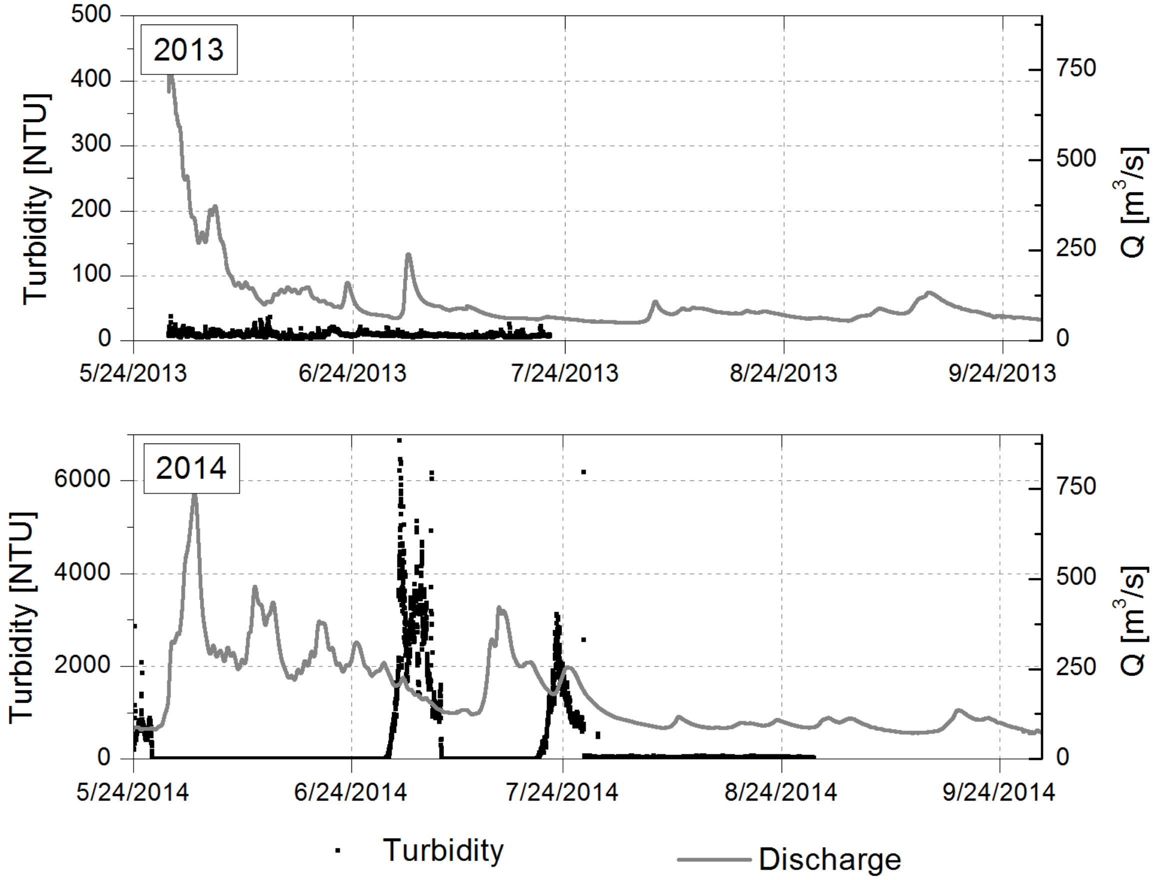



Figure 193. Alatna River turbidity and discharge for 2013 and 2014. Note the change in scale on the *y*-axis between the two plots. The results are not clear, likely due to equipment malfunctions and poor siting of the turbidimeters.

The Koyukuk River turbidimeter functioned quite poorly in 2012 and 2013. In 2014, however, for a 2½-month period, the readings were more reasonable (Figure 194). During this period, turbidity and discharge appear to be closely related, as demonstrated in the turbidity-discharge rating curve (Figure 195). The $R^2$ value of 0.67 is higher than the $R^2$ value of the SSC rating curve (Figure 184), in part because the turbidimeter has readings at a greater range of discharge than the samples used in the SSC rating curve, which furthers the legitimacy of using turbidimeters to monitor suspended sediment loads. Future work should correlate turbidity and SSC.

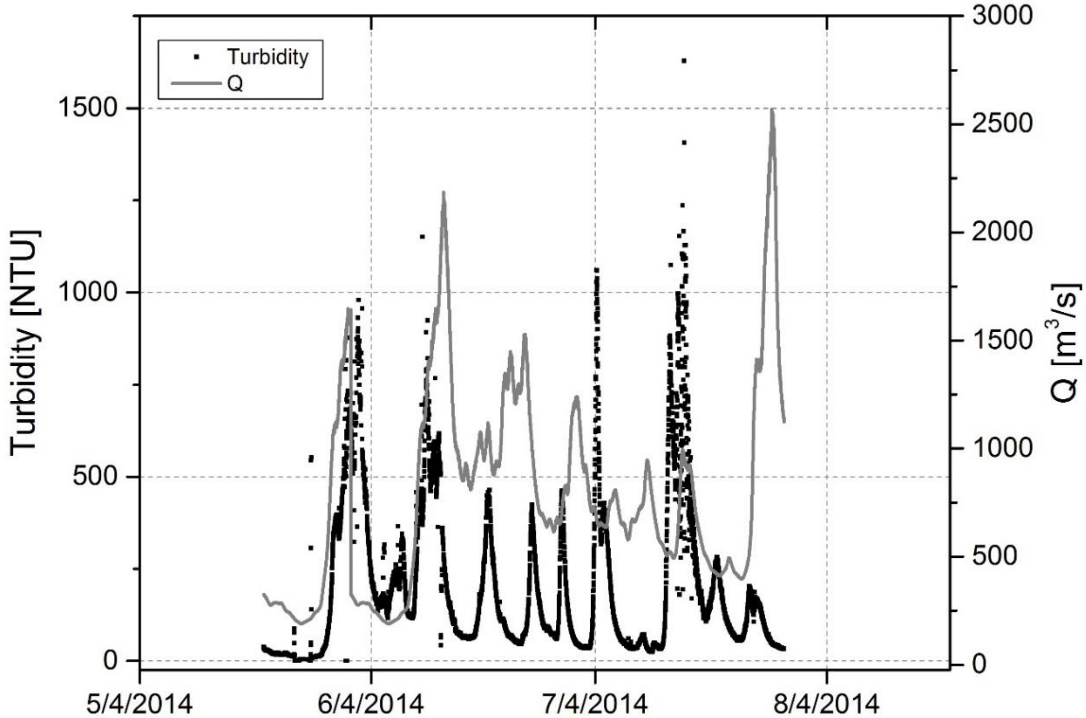



Figure 194. Koyukuk River turbidity and discharge for 2014.

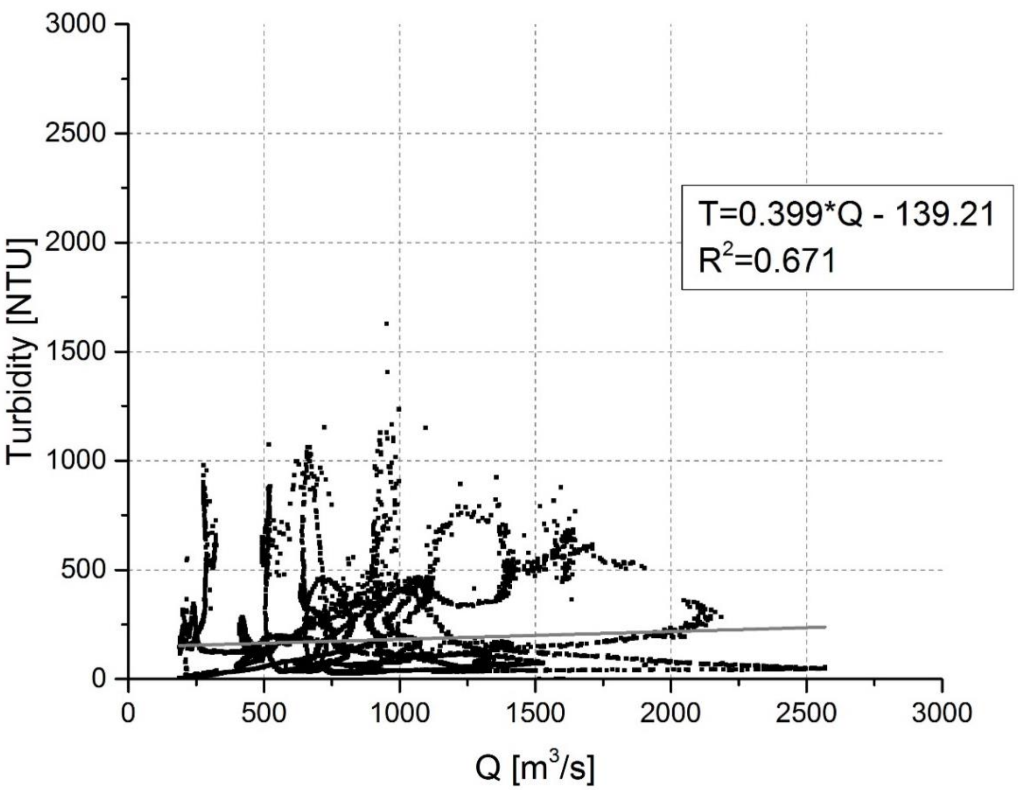



Figure 195. Koyukuk River rating curve for 2014, comparing turbidity with discharge.

### 4.11.6 Suspended sediment grain-size distribution

The volume-based $D_{50}$ of the suspended sediment grain-size distribution is presented in Table 40 for the three river gauging sites. On the Reed River, two samples were analyzed for spring 2013. Despite a decrease in SSC from 65 mg/L to 26 mg/L, the $D_{50}$ increased slightly from 44.91 µm to 47.40 µm. On the Alatna River, two samples were analyzed for spring 2013 and one for September 2013. In the spring, SSC decreased over a week from 340 mg/L to 128 mg/L, and the $D_{50}$ decreased from 34.29 µm to 21.10 µm. On the Koyukuk River, a sample was analyzed for June 2013 and for July 2013. The SSC decreased from 252 mg/L to 96 mg/L, while the $D_{50}$ rose from 23.96 µm to 29.65 µm.

Table 40. Grain sizes for the Reed, Alatna, and Koyukuk Rivers.

| River | Date | SSC (mg/L) | Volume Based D50 (µm) |
|---|---|---|---|
| **Reed** | 5/30/2013 14:30 | 65 | 44.91 |
| | 6/3/2013 14:00 | 26 | 47.40 |
| **Alatna** | 5/30/2013 8:40 | 340 | 34.29 |
| | 6/6/2013 14:30 | 128 | 21.10 |
| **Koyukuk** | 6/6/2013 10:20 | 252 | 23.96 |
| | 7/10/2013 10:30 | 96 | 29.64 |

# 5 HYDROLOGIC ANALYSES

## 5.1 Precipitation Frequency

In this report, we include data collected over 2½ years (summer 2012 to October 2014). Ideally, we would like to capture some major hydrologic events, not just events with a return period of 1 or 2 years. One way of determining if events are significant is to compare the estimated precipitation frequencies of Perica et al. (2012) with UAF's measured precipitation. In Table 41, the highest 1-hour and 24-hour precipitation events are shown for each year of observation (2012 through 2014) for the eight meteorological stations that were installed on the south side of the central Brooks Range (four stations in the mountains and four more just south of the Brooks Range [Figure 1]). Once the maximum measured 1-hour and 24-hour precipitation event was determined, that value was compared against the values in Perica et al. (2012) at various recurrence intervals to obtain an idea of the return period of the measured precipitation. For example, in Table 41 for the Bettles meteorological station (DAS1), a maximum hourly precipitation of 8.9 mm (0.35 in) was measured on July 8, 2014; from the Precipitation Frequency Atlas for Alaska (Perica et al., 2012), a precipitation frequency estimate of 2 years was obtained for this event.

For the period of record, two hourly events (Reed River-DAS4, August 10, 2013, and Wild-DAM5, July 8, 2014) were observed, where the return period ranged from 2 to 5 years. However, for longer durations such as 24 hours (Table 41), three events with return periods as long as 10 to 25 years, two events of 5 to 10 years, and six events of 2 to 5 years were observed.

Table 41. Comparison of hourly and 24-hour measured precipitation extremes and estimated precipitation extremes from Perica et al. (2012), to develop a return period estimate of annual maximums for 2012 through 2014.

**Bettles (DAS1) Hourly**

| | Date Time (AST) | Rainfall mm/hr | Rainfall in/hr | Return Period |
|---|---|---|---|---|
| 2012 | 9/16/2012 22:00 | 3.6 | 0.14 | < 1 yr |
| 2013 | 7/9/2013 3:00 | 5.5 | 0.22 | < 1 yr |
| 2014 | 7/8/2014 18:00 | 8.9 | 0.35 | 2 yr |

**Bettles (DAS1) 24 Hour**

| | Date Time (AST) | Rainfall mm/24 hr | Rainfall in/24 hr | Return Period |
|---|---|---|---|---|
| 2012 | 9/20/2012 9:00 | 13.5 | 0.53 | < 1 yr |
| 2013 | 7/9/2013 16:00 | 20.1 | 0.79 | < 1 yr |
| 2014 | 7/9/2014 11:00 | 29.3 | 1.15 | 2-5 yr |

**Alatna (DAS2) Hourly**

| | | | | |
|---|---|---|---|---|
| 2012 | 8/30/2012 11:00 | 3.7 | 0.15 | < 1 yr |
| 2013 | 9/10/2013 22:00 | 3.2 | 0.13 | < 1 yr |
| 2014 | 8/12/2014 20:00 | 5.6 | 0.22 | < 1 yr |

**Alatna (DAS2) 24 Hour**

| | | | | |
|---|---|---|---|---|
| 2012 | 8/30/2012 18:00 | 43.3 | 1.70 | 5-10 yr |
| 2013 | 10/18/2013 2:00 | 37.2 | 1.46 | 2-5 yr |
| 2014 | 9/2/2014 0:00 | 17.5 | 0.69 | < 1 yr |

**SF Bedrock Cr. (DAS3) Hourly**

| | | | | |
|---|---|---|---|---|
| 2012 | 9/16/2012 21:00 | 6.6 | 0.26 | < 1 yr |
| 2013 | 7/19/2013 19:00 | 9.4 | 0.37 | 1-2 yr |
| 2014 | 8/21/2014 3:00 | 4.1 | 0.16 | < 1 yr |

**SF Bedrock Cr. (DAS3) 24 Hour**

| | | | | |
|---|---|---|---|---|
| 2012 | 9/17/2012 16:00 | 35.2 | 1.39 | 2-5 yr |
| 2013 | 9/11/2013 18:00 | 18.1 | 0.71 | < 1 yr |
| 2014 | 8/7/2014 21:00 | 15.0 | 0.59 | < 1 yr |

**Reed River (DAS4) Hourly**

| | | | | |
|---|---|---|---|---|
| 2012 | 8/19/2012 23:00 | 8.0 | 0.31 | 1 yr |
| 2013 | 8/10/2013 16:00 | 11.1 | 0.44 | 2-5 yr |
| 2014 | 9/15/2014 22:00 | 9 | 0.35 | 1-2 yr |

**Reed River (DAS4) 24 Hour**

| | | | | |
|---|---|---|---|---|
| 2012 | 8/30/2012 17:00 | 56.1 | 2.21 | 10-25 yr |
| 2013 | 10/17/2013 19:00 | 52.8 | 2.08 | 10-25 yr |
| 2014 | 9/16/2014 20:00 | 29.1 | 1.15 | 1-2 yr |

**Wild (DAM5) Hourly**

| | | | | |
|---|---|---|---|---|
| 2012 | 7/8/2012 13:00 | 6.6 | 0.26 | < 1 yr |
| 2013 | 6/22/2013 2:00 | 6.9 | 0.27 | < 1 yr |
| 2014 | 7/8/2014 16:00 | 13.9 | 0.55 | 2-5 yr |

**Wild (DAM5) 24 Hour**

| | | | | |
|---|---|---|---|---|
| 2012 | 8/31/2012 0:00 | 35 | 1.38 | 2-5 yr |
| 2013 | 6/22/2013 4:00 | 15.2 | 0.60 | < 1 yr |
| 2014 | 7/12/2014 10:00 | 21.6 | 0.85 | < 1 yr |

**Upper Iniakuk (DAM6) Hourly**

| | | | | |
|---|---|---|---|---|
| 2012 | 7/8/2012 18:00 | 5.5 | 0.22 | < 1 yr |
| 2013 | 9/10/2013 23:00 | 5.3 | 0.21 | < 1 yr |
| 2014 | 7/14/2014 4:00 | 6.4 | 0.25 | < 1 yr |

**Upper Iniakuk (DAM6) 24 Hour**

| | | | | |
|---|---|---|---|---|
| 2012 | 9/17/2012 7:00 | 40.1 | 1.58 | 2-5 yr |
| 2013 | 8/4/2013 22:00 | 28.7 | 1.13 | 1-2 yr |
| 2014 | 7/14/2014 22:00 | 29.5 | 1.16 | 1-2 yr |

**Upper Reed (DAM7) Hourly**

| | | | | |
|---|---|---|---|---|
| 2012 | 8/30/2012 16:00 | 5.9 | 0.23 | < 1 yr |
| 2013 | 8/2/2013 16:00 | 5.9 | 0.23 | < 1 yr |
| 2014 | 8/12/2014 23:00 | 8.6 | 0.34 | 1 yr |

**Upper Reed (DAM7) 24 Hour**

| | | | | |
|---|---|---|---|---|
| 2012 | 8/30/2012 19:00 | 49.3 | 1.94 | 5-10 yr |
| 2013 | 8/5/2013 8:00 | 31.4 | 1.24 | 1-2 yr |
| 2014 | 5/28/2014 23:00 | 28.7 | 1.13 | 1-2 yr |

**Upper Kogoluktuk (DAM 8) Hourly**

| | | | | |
|---|---|---|---|---|
| 2012 | 8/24/2012 23:00 | 6.5 | 0.26 | < 1 yr |
| 2013 | 6/30/2013 4:00 | 4.9 | 0.19 | < 1 yr |
| 2014 | 7/12/2014 22:00 | 4.5 | 0.18 | < 1 yr |

**Upper Kogoluktuk (DAM 8) 24 Hour**

| | | | | |
|---|---|---|---|---|
| 2012 | 8/16/2012 14:00 | 63.1 | 2.48 | 10-25 yr |
| 2013 | 8/4/2013 20:00 | 29.8 | 1.17 | 1 yr |
| 2014 | 7/14/2014 8:00 | 43.6 | 1.72 | 2-5 yr |

## 5.2 Flood Frequency

A flood frequency analysis is conducted to examine the frequency of simulated events on rivers in or near a study area. Analyses are completed according to the Interagency Advisory Committee on Water Data, Hydrology Subcommittee, Bulletin 17B (Log Pearson III distribution) using Hydrologic Engineering Center (HEC) software. The analysis is performed using peak flow data, 15 minute or hourly, from USGS. The analysis was performed for Dahl Creek and Slate Creek for both the spring breakup and summer periods. The analysis was performed for Kobuk River at Ambler and Middle Fork Koyukuk River near Wiseman on the annual peak flow (mixed population). We recognize that the annual maximum flow event (for the mixed population analysis) may be generated by snowmelt, rainfall, or a combination of these processes, thus the peak event for any given year may not be independent and homogeneous. The standard frequency approach is used for the mixed population; only one annual maximum flow event is examined regardless of whether it is generated by rainfall, snowmelt, or glacier melt. The analysis could be improved if events generated by the different hydrologic processes could be examined individually, but this was not possible.

The generalized skew reported in the USGS tables by Curran et al. (2003) for Region 6 was used in the analysis (station skew is also presented on the probability plot). Table 42 and Table 43 present the number of events in each analysis and the period of record for each station. Table 44 reports the skewness coefficient for the analyses. The skewness was generally positive for simulations during summer and negative during the snowmelt period. Figure 196 through Figure 199 are the probability plots for each river in the analysis.

In addition to the flood frequency conducted on rivers with long-term records, the regression equations from Curran et al. (2003) for Region 6 (Table 45) and Region 7 (Table 46) were used to estimate the magnitude and frequency of peak flow for the Koyukuk River, Alatna River, South Fork Bedrock Creek, Kobuk River, and Reed River. Rivers in the Koyukuk basin are in Region 6, but rivers in the Kobuk basin are in Region 7. Estimates of flow were higher using the Region 7 equation, which only takes the basin area into account.

Table 42. Number of events in analysis.

| Basin | Number of Events Snow | Number of Events Summer | Number of Events Mixed Population |
|---|---|---|---|
| **Dahl Creek** | 23 | 29 | n/a |
| **Slate Creek** | 16 | 31 | n/a |
| **Kobuk River at Ambler** | n/a | n/a | 13 |
| **Middle Fork Koyukuk River** | n/a | n/a | 16 |

Table 43. Period of record in analysis.

| Basin | Period of Record Snow | Period of Record Summer | Period of Record Mixed Population |
|---|---|---|---|
| **Dahl Creek** | 1990–91, 1995–2015 | 1986–90, 1992–2015 | n/a |
| **Slate Creek** | 1987, 1990, 1995, 1997–98, 2000–02, 2004–06, 2008–11, 2014 | 1983–86, 1988–89, 1991–2015 | n/a |
| **Kobuk River at Ambler** | n/a | n/a | 1966–1978 |
| **Middle Fork Koyukuk River** | n/a | n/a | 1968, 1971–80, 1984–87, 1994 |

Table 44. Coefficient of skewness (weighted to Region 6).

| Basin | Coefficient of Skewness Snow | Coefficient of Skewness Rain | Coefficient of Skewness Mixed Population |
|---|---|---|---|
| **Dahl Creek** | -0.287 | -0.01 | |
| **Slate Creek** | -0.326 | 0.178 | |
| **Kobuk River at Ambler** | | | -0.255 |
| **Middle Fork Koyukuk River** | | | 0.349 |

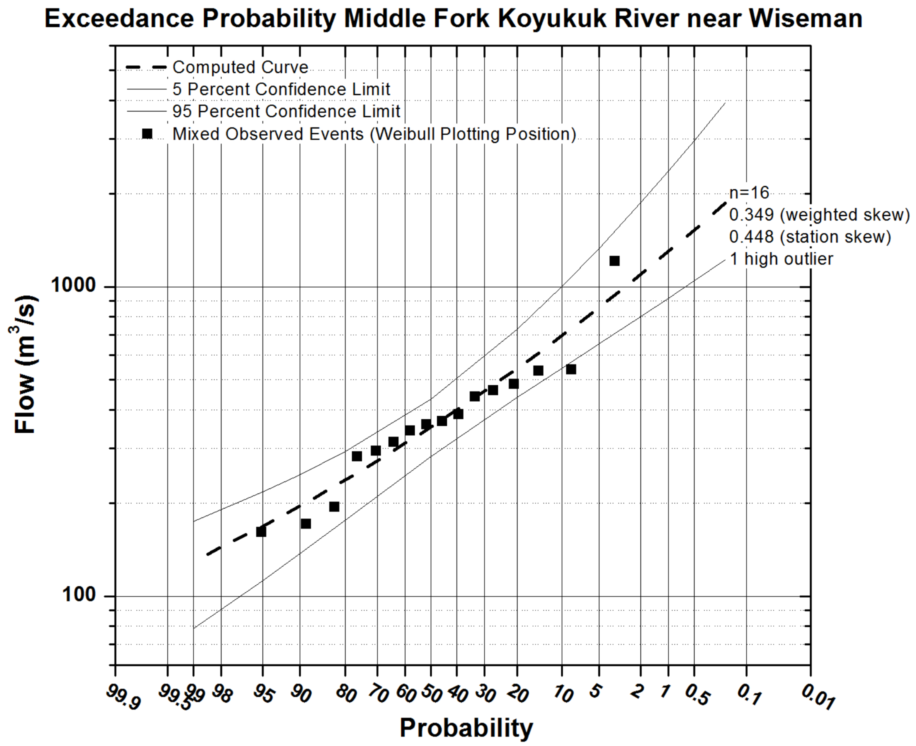



Figure 196. Flood frequency analysis for Middle Fork of the Koyukuk River near Wiseman. Analysis conducted on mixed population (the annual peak may be snowmelt- or rainfall-generated).

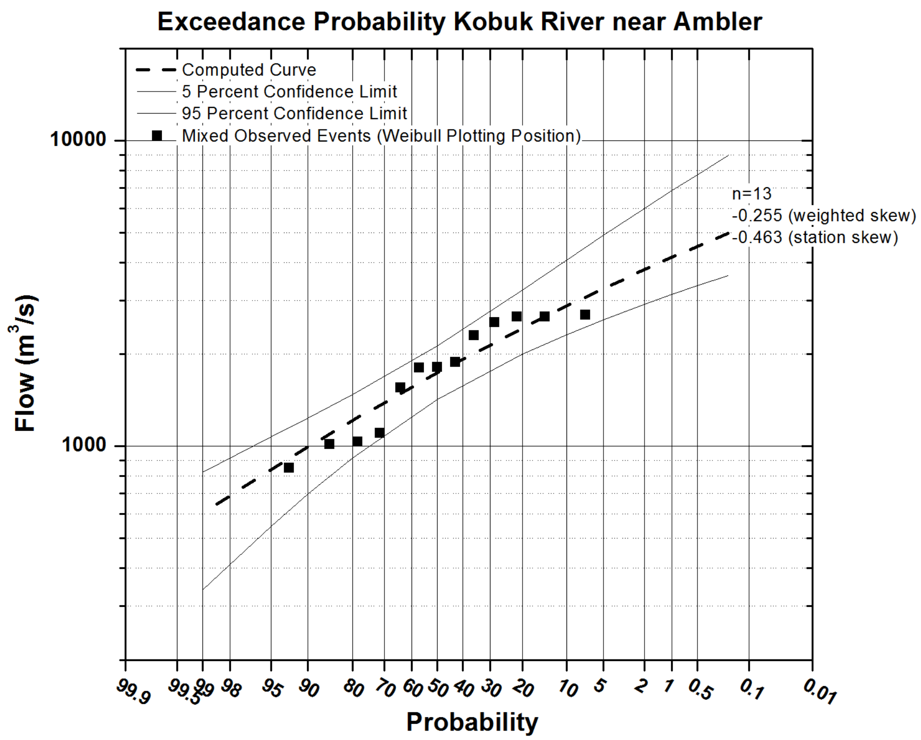



Figure 197. Flood frequency analysis for Kobuk River at Ambler. Analysis conducted on mixed population (the annual peak may be snowmelt- or rainfall-generated).

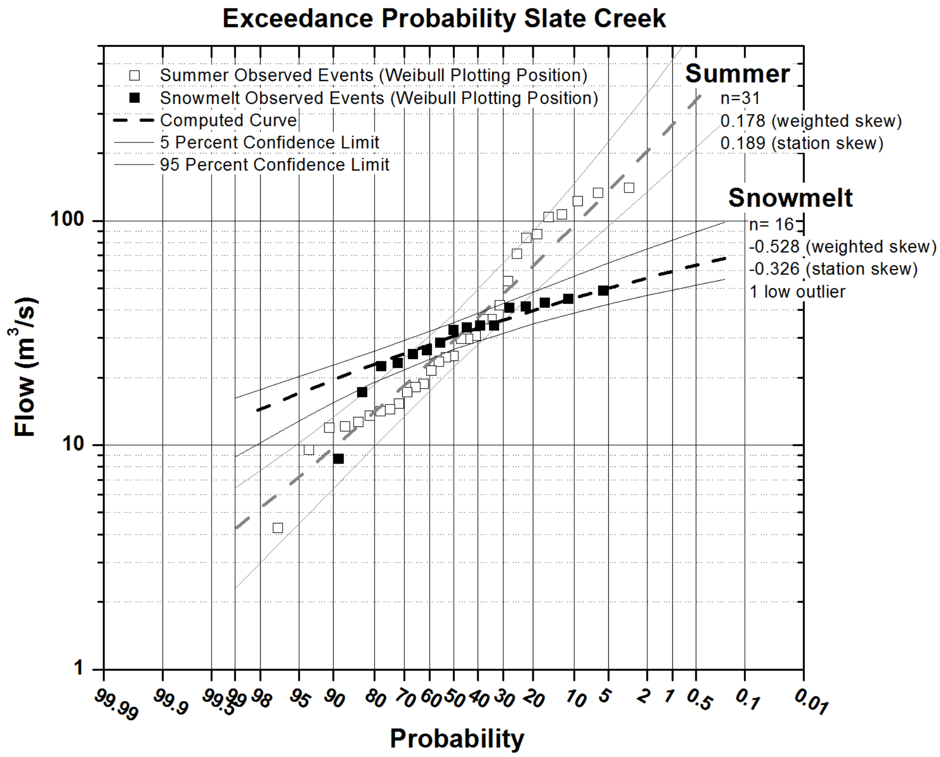



Figure 198. Flood frequency analysis for Slate Creek at Coldfoot. Analysis completed for the spring snowmelt peak and the summer peak separately. Limited streamflow data were available during the snowmelt period; therefore, only peak flow from 16 out of 31 years could be used. The skewness of the curves is quite different, and the slope of the summer curve indicates that the largest floods may be rainfall-generated.

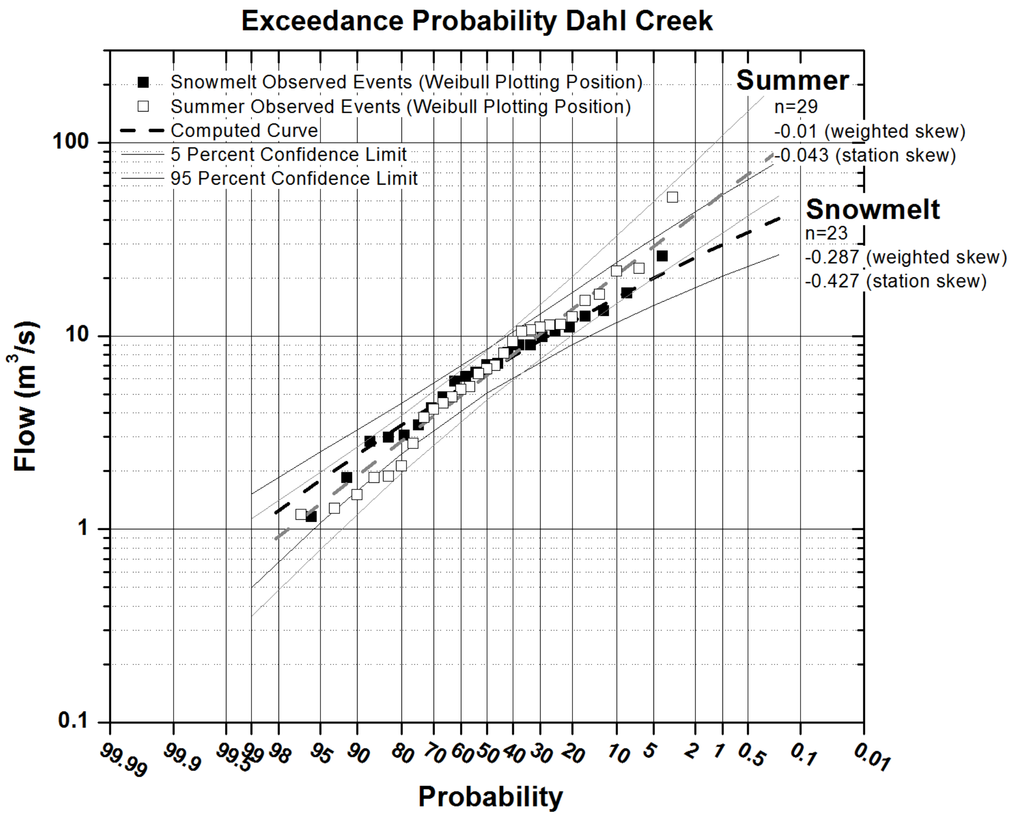



Figure 199. Flood frequency analysis for Dahl Creek near Kobuk. Analysis completed for the spring snowmelt peak and the summer peak separately. There was little difference between the probability curves for the snowmelt and summer periods, indicating that the annual peak and peaks of record could be either snowmelt- or rainfall-generated.

Table 45. Estimate of floods based on Curran et al. (2003) regression equations for estimating peak streamflow in Region 6. Q is reported in ($m^3/s$).

| Parameter | Koyukuk River | Alatna River | Kobuk River (North) | Reed River | South Fork Bedrock Creek |
|---|---|---|---|---|---|
| **Area ($km^2$)** | 18000 | 6300 | 1295 | 825 | 174 |
| **Storage (lakes and ponds) (%)** | 0.64 | 0.66 | 3.19 | 0.32 | 0.18 |
| **Forest (%)** | 11 | 15 | 26 | 14 | 34 |
| **Q2** | 1646 | 588 | 95 | 104 | 21 |
| **Q5** | 2056 | 780 | 140 | 150 | 33 |
| **Q10** | 2329 | 910 | 171 | 183 | 42 |
| **Q25** | 2678 | 1078 | 212 | 227 | 55 |
| **Q50** | 2934 | 1203 | 243 | 260 | 66 |
| **Q100** | 3192 | 1329 | 275 | 295 | 76 |
| **Q200** | 3446 | 1454 | 307 | 330 | 88 |

Table 46. Estimate of floods based on Curran et al. (2003) regression equations for estimating peak streamflow in Region 7. Q is reported in ($m^3/s$).

| Parameter | Koyukuk River | Alatna River | Kobuk River (North) | Reed River | South Fork Bedrock Creek |
|---|---|---|---|---|---|
| **Area ($km^2$)** | 18000 | 6300 | 1295 | 825 | 174 |
| **Q2** | 2117 | 830 | 203 | 136 | 34 |
| **Q5** | 2937 | 1179 | 298 | 202 | 52 |
| **Q10** | 3442 | 1397 | 359 | 244 | 64 |
| **Q25** | 4039 | 1657 | 433 | 295 | 79 |
| **Q50** | 4456 | 1840 | 485 | 332 | 89 |
| **Q100** | 4849 | 2014 | 536 | 367 | 100 |
| **Q200** | 5223 | 2180 | 584 | 402 | 110 |

## 5.3 Additional Studies of the Alatna and Malamute Fork Confluence

In general, flow configuration along a river reach is a complex phenomenon, the result of liquid and solid phases interacting with the bed geometry. In addition, the confluence of two streams modifies hydraulic and sedimentologic flow conditions. If the difference in a stream’s sediment load and water temperature (upstream of the confluence) is significant, the formation of a well-defined interface along the confluence area is possible. Downstream, lateral mixing processes are important, and eventually, the interface disappears. Preliminary results of the hydro-sedimentological conditions along the Alatna River and Malamute Fork confluence are presented in the following text. In particular, the spatiotemporal evolution of water temperature and SSC in the confluence zone is described. Additional details can be found in Lamb and Toniolo (2014).

### 5.3.1 Equipment and methodology

An ADCP, Rio Grande, was mounted on an inflatable boat during high waters. A GPS with RTK correction was also mounted on the boat. During low flow conditions, another ADCP (in this case, a StreamPro) was installed on a kayak. The position was established by the same GPS unit. Sediment samples were collected by an integrated sampler, DH76, or by grab samples taken approximately 50 cm below the water surface.

Transects upstream and downstream of the confluence were performed. In addition, integrated or grab samples were collected upstream of the confluence and in each side of the interface downstream of it. Plots of water temperature (at the sensor location) versus distance traveled were generated. Suspended sediment concentrations were calculated following ASTM standards. Finally, a limited number of granulometric distributions of suspended sediment were obtained.

### 5.3.2 Results

Flow conditions during high and low waters are shown in Figure 200. The change in water color and sediment load is noticeable also in this figure. An exposed gravel bar at the confluence is visible during low flows.

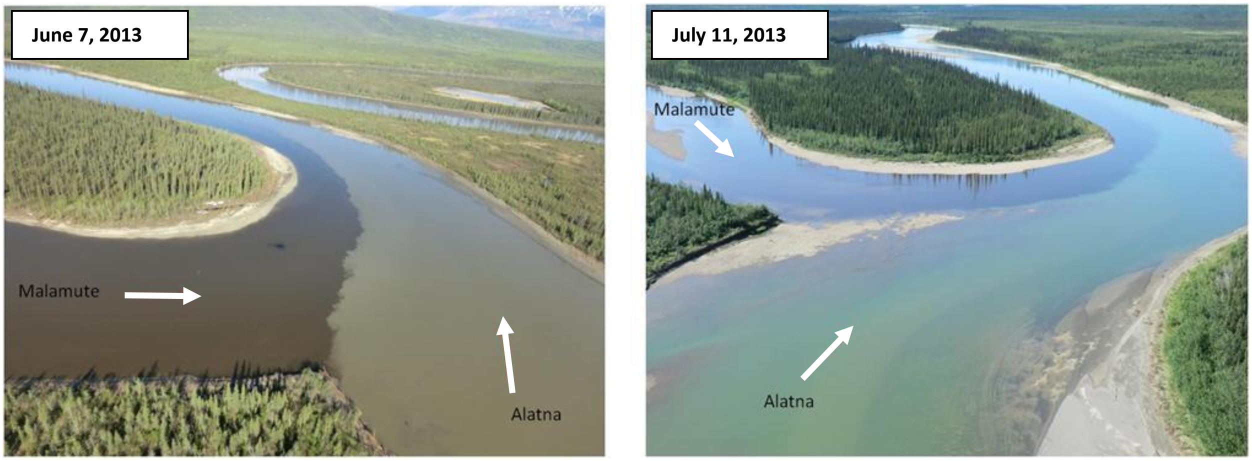



Figure 200. Flow configuration during high (left) and low (right) flows. The interface is visible in both cases.

The spatial variation of water temperature on June 7, 2013, is shown in Figure 201. Numbers in the figure indicate the suspended sediment concentration (mg/l) on each side of the interface. The graph on the upper right of Figure 201 points out a difference of approximately 2°C between the water flowing in Malamute Fork and the Alatna River. A sharp gradient in water temperature is visible in the plots located immediately downstream of the confluence. The temperature change is still evident in other plots, but the gradient is reduced. The sediment concentrations show a lateral mixing pattern in the downstream direction.

Figure 202 shows the water temperature along four transects measured on July 11, 2013. The vertical scale in each plot is the same (ranging from 12.5° to 14°C). The plots indicate that the water temperature was approximately constant, in contrast to the situation described in Figure 201.

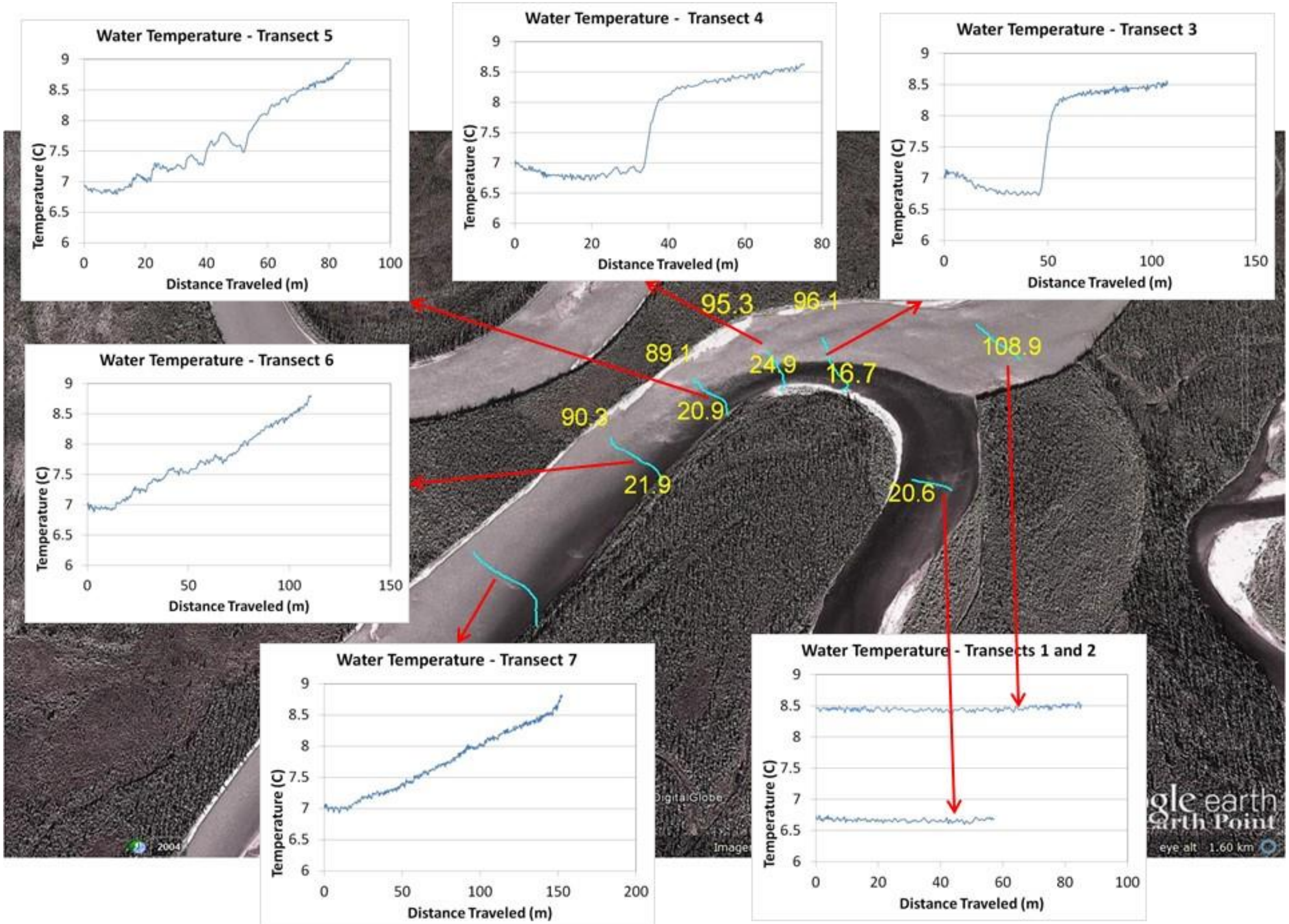



Figure 201. Water temperature profiles for June 7, 2013, along several ADCP transects. In each plot, the vertical temperature scale is the same (ranging from 6° to 9°C). Horizontal axis represents "distance traveled" in meters.

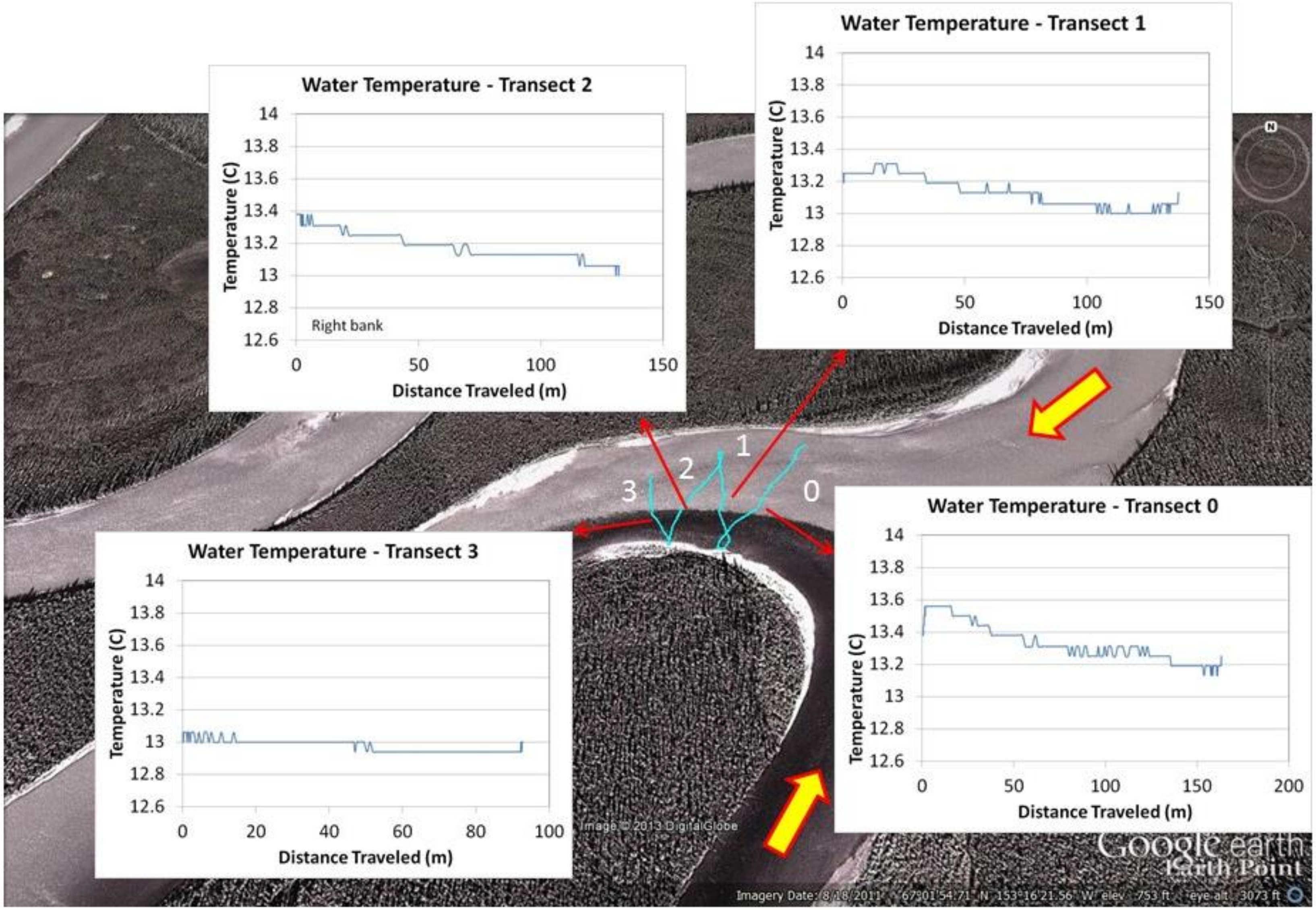
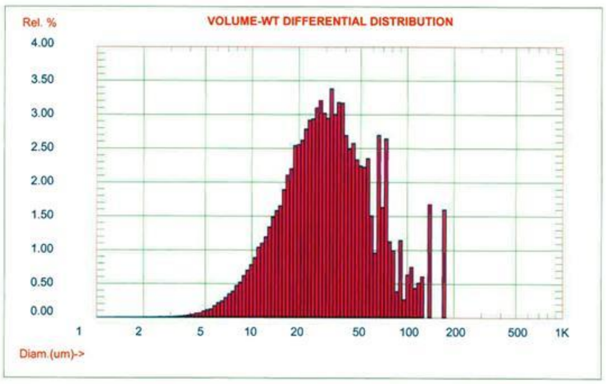



Figure 202. Water temperature profiles for July 11, 2013, along transects located downstream of the confluence zone. Plots indicate nearly constant temperature across the stream.

Finally, Figure 203 shows the sediment grain-size distributions from samples collected on Malamute Fork and the Alatna River, upstream of the confluence. The plots indicate that the Alatna River was transporting, in suspension, coarser sediment than the Malamute Fork.



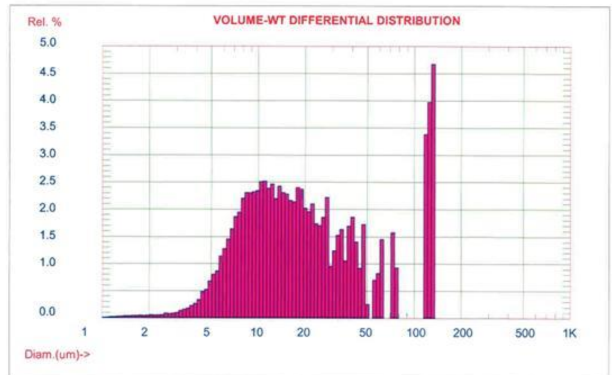




Figure 203. Grain-size distributions of suspended sediment. Alatna River (left) and Malamute Fork (right). Samples were collected on July 11, 2013 (note: *x*-axis is a log scale).

# 6 CONCLUSIONS

Because of the short duration of this study, it is very difficult to make strong conclusions about the hydrology and meteorology of the area along the proposed Ambler corridor. What is clear from the limited data collected is that the climate and hydrology along the proposed corridor are similar to that of the interior area of Alaska south of the Yukon River. In these two areas, the climate is continental, with warm summers and cold winters, and flooding can be generated by both rainfall and snowmelt, with ice jams a possibility during breakup. Permafrost extent increases as one progresses northward (headwaters of the south-draining watersheds), such that at the continental divide in the Brooks Range, permafrost is essentially continuous. We know from hydrologic studies in the interior of Alaska to south of the study area and the North Slope of Alaska (north of the Brooks Range) that the greater the coverage of permafrost, the higher the runoff ratio (the volume of runoff over the volume of precipitation). Areas with permafrost are known to have higher runoff ratios than temperate regions; this is mainly due to limited subsurface storage in the active layer overlying the permafrost.

The amount of annual precipitation received in the study area appears to be similar (slightly greater) to that measured in the Fairbanks area, with the split between solid and liquid precipitation about the same. Long-term data collected at Bettles, Wiseman, and Chandalar Shelf indicate that annual precipitation ranges around 14 in. (350+ mm). Precipitation data we collected, and that collected by others, indicate an increase in precipitation with elevation. Additional data may show that this increase with elevation is greater in the western reaches of the study area. Shortly after installing meteorological stations in 2012, we captured a significant amount of rainfall, especially in those stations to the west. In comparing the measured amounts with estimates by Perica et al. (2012) for a 1-hour duration, it appears that most of the return periods were 1 to 2 years. For a 24-hour duration, three 10- to 25-year potential events were captured (all in the western part of the study area). The amount of 24-hour precipitation measured at this time was between 2.0 and 2.5 in. (50 and 64 mm). Cumulative plots of warm season precipitation collected during the short period of this study demonstrate considerable spatial and temporal variation. Part of this variation is due to the topography.

The timing of snowfall events varied considerably between the winters of 2012–2013 and 2013–2014. In winter 2012–2013, snowfall was early at upper elevations in September, but much of that ablated shortly thereafter. Another storm occurred in early October, with snowfall at higher elevations. Then in mid-December and early January, snow fell area wide, with lower elevations finally receiving a significant amount on the ground. The timing of snowfall can be observed by examining soil temperature plots, where the insulative properties of snow come into play. In winter 2013–2014, area-wide snowfall prevailed in September, with upper elevations receiving higher amounts. However, in mid-November, there was additional significant snowfall, which helped suppress soil freezing. Snow cover is an important element of the hydrologic cycle and, therefore, deserves more attention than we have given it here, particularly in runoff generation.

Areas of aufeis were observed during April snow surveys at numerous locations in the study area, both along the lowland road corridor and in the mountainous regions. Some of these locations are documented in UAF field notes and by GPS; however, due to discontinued funding of the project, we did not have time to include these data in the report. Overflow ice or water was observed at several of our proposed snow survey sites (particularly at valley bottom sites in the mountainous region), so we would relocate the snow survey site to a nearby ice- and water-free area.

Flooding is a common occurrence in this area. Large historical floods like the one that occurred in August 1994 on the Koyukuk River have been documented (Meyer, 1995). Snowmelt-generated floods are also possible. Flooding due to ice jams was observed on many rivers while the UAF field team was flying by helicopter to gauging sites during breakup. On a couple of occasions, sites (selected at likely stream crossings for the proposed Ambler corridor) could not be stream gauged because of ice jams; measurements were delayed until the ice jam moved downstream. The estimates of continuous runoff in this study are considered preliminary, due to lack of rating measurements, particularly at high stage. We observed very high stage on the Reed River and South Fork Bedrock Creek during the 2012 summer rain event described earlier, but the reported flows are very uncertain due to the poor quality of the rating curves. Observations of continuous runoff on the Koyukuk River from 2010 to 2014 indicate that the highest flows occurred during 2014 (both during spring breakup and summer periods). Because only 2 to 3 years of runoff data were collected, we cannot perform flood frequency analyses. We performed flood frequency estimation on streams where data were collected by others. Additionally, we used regression equations to estimate flood frequency on the four rivers where we gauged streamflow.

In the first 2 years of this study, very little was known about the hydrologic behavior of catchments in this area. For example, it was unknown when snowmelt takes place and how rapidly breakup occurs on rivers. Since travel to the UAF sites is done via helicopter, we reserve this means of transportation with limited funding. Repeated conflicts in helicopter scheduling were encountered. It does not help that there is considerable natural year-to-year variation in when breakup occurs. Logistical problems played a significant role in our performance in this remote area. The premature termination of this project due to lack of funding severely limited what conclusions could be drawn.

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Kane, D.L., Youcha, E.K, Stuefer, S.L., Myerchin-Tape, G., Lamb, E., Homan, J.W., Gieck, R.E., Schnabel, W.E., and Toniolo, H. (2014). Hydrology and Meteorology of the Central Alaskan Arctic, Data Collection and Analysis. Final Report. University of Alaska Fairbanks, Water and Environmental Research Center, Report INE/WERC 14.05, Fairbanks, AK.

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# 8 APPENDICES

Appendix A – Wind Roses

Appendix B – Rainfall

Appendix C – Snow Survey Sites and Data

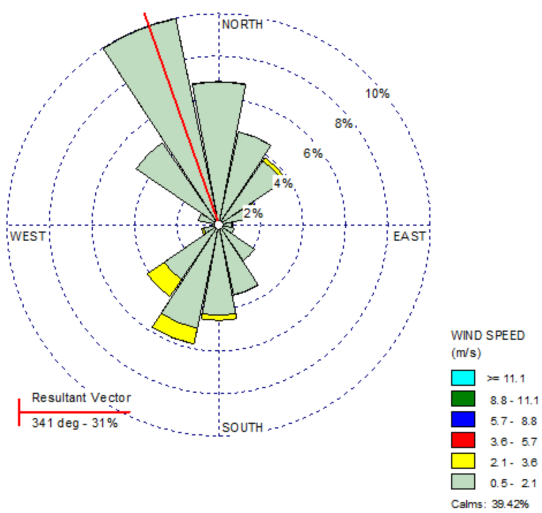
Appendix D – Soil Temperature and Soil Water Content Data

Appendix E – Rating Curves and Stream Discharge Measurement Summaries

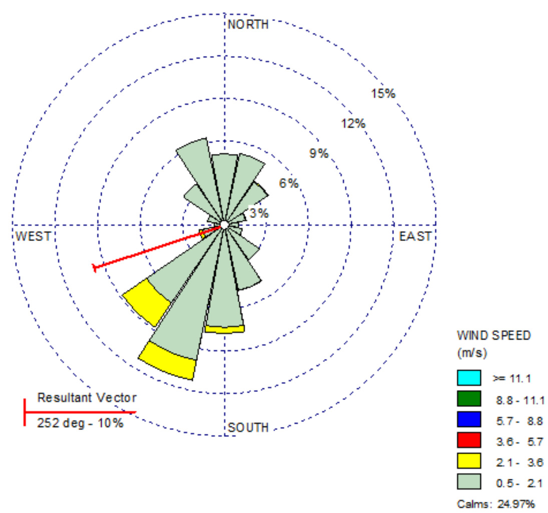
# Appendix A – Wind Roses

**DAS1 Bettles 1a) annual, b) summer, c) winter**

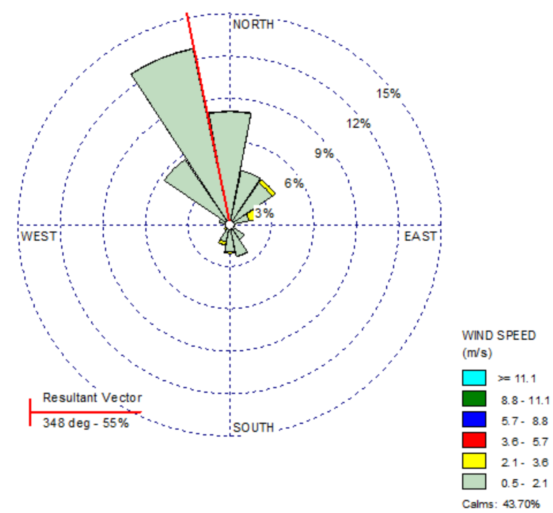
**1a**




**1b**

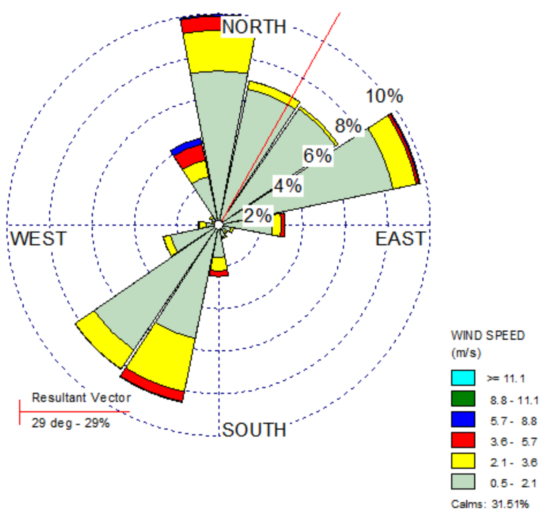



**1c**



**DAS2 Alatna River 2a) annual, b) summer, c) winter**

**2a**

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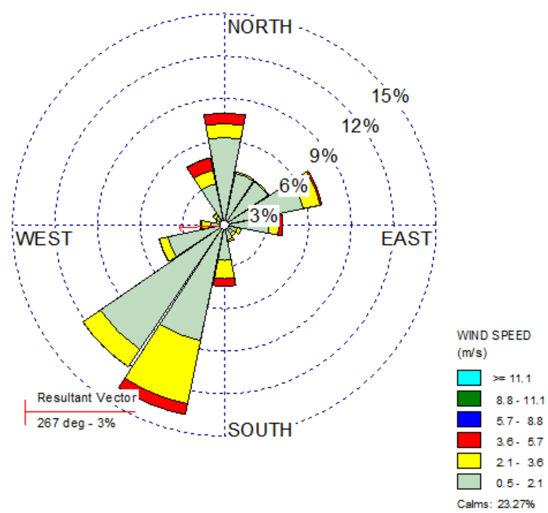


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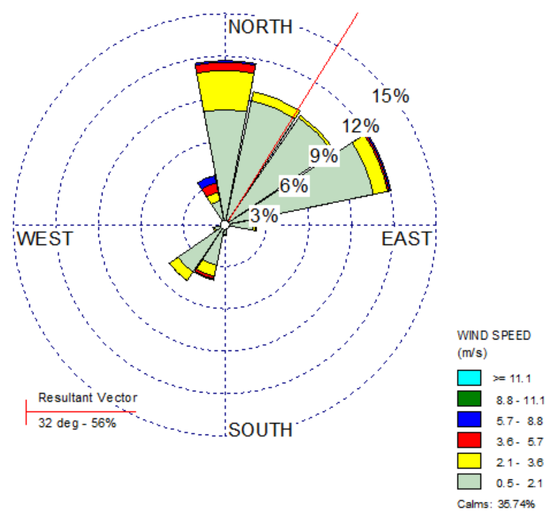
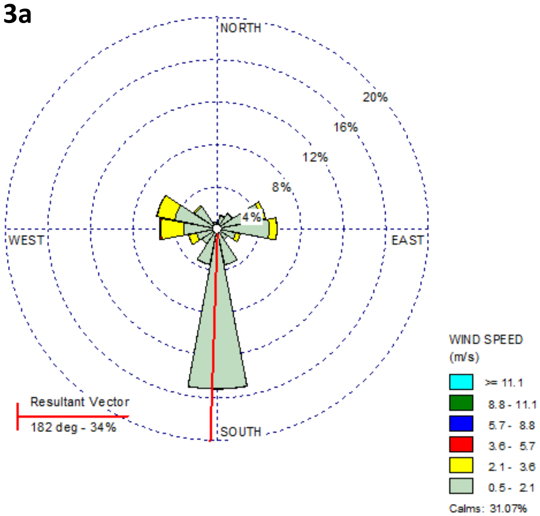


**DAS3 South Fork Bedrock Creek 3a) annual, b) summer, c) winter**

3a

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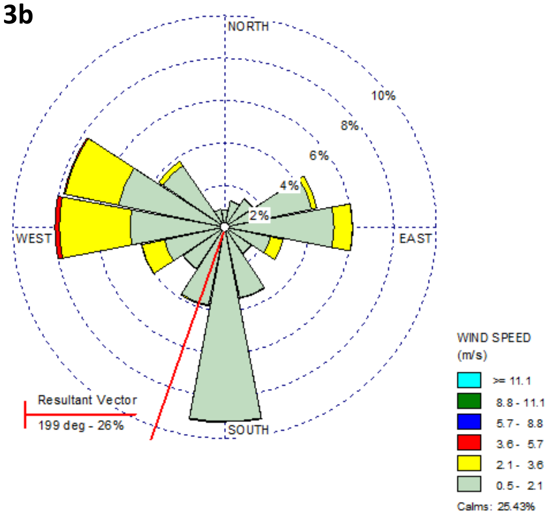


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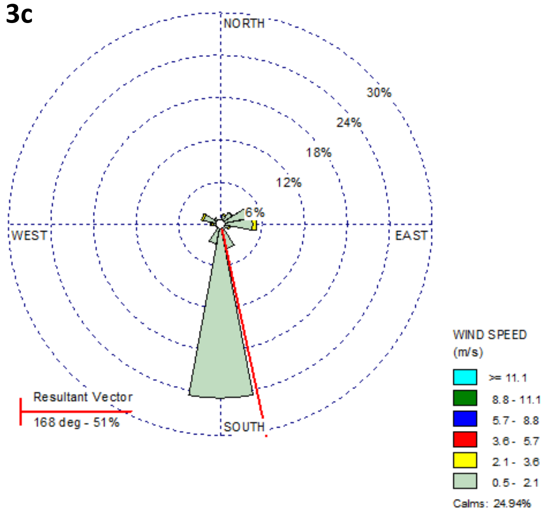
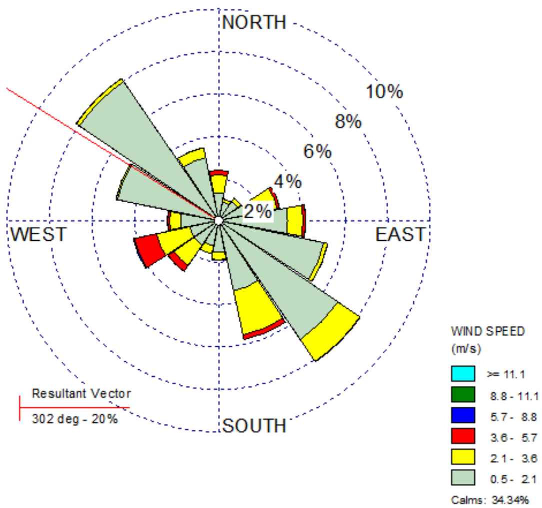


**DAS4 Reed River 4a) annual, b) summer, c) winter**

**4a**

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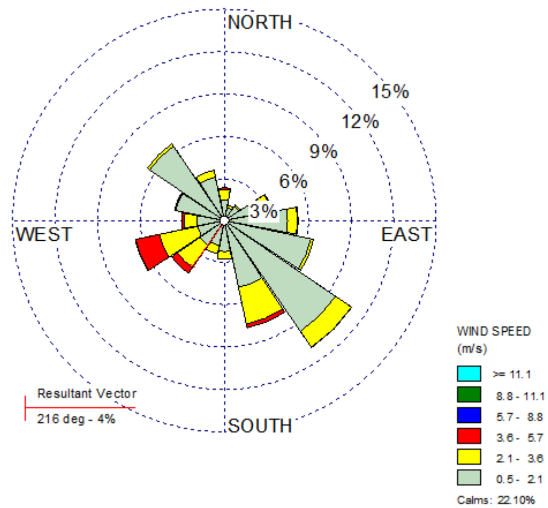


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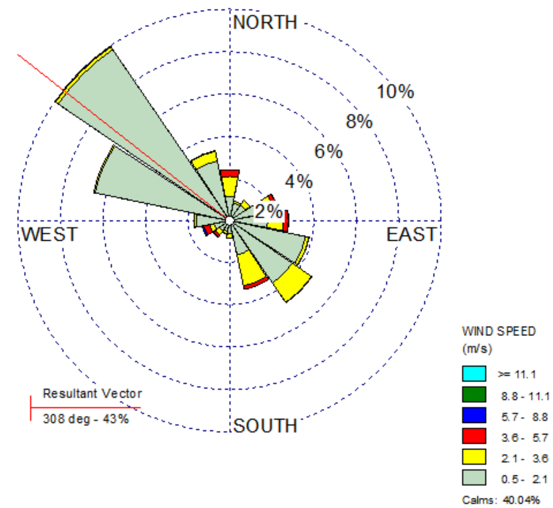
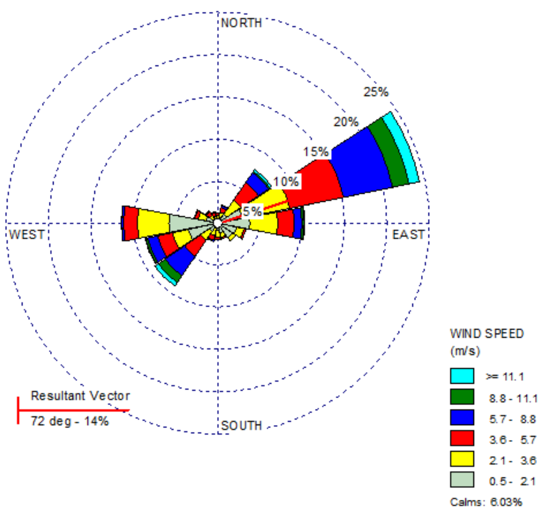


**DAM5 Wild 5a) annual, b) summer, c) winter**

**5a**

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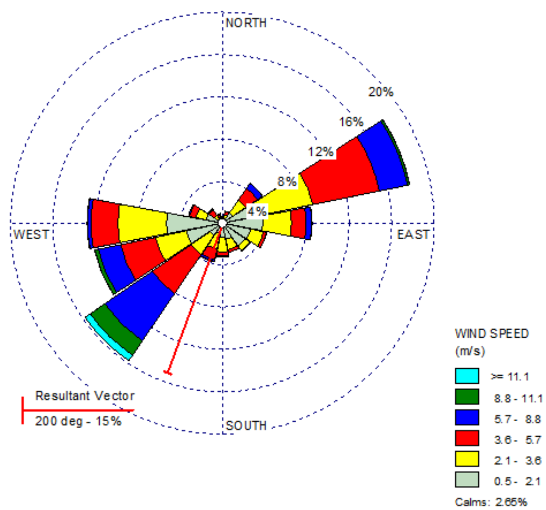
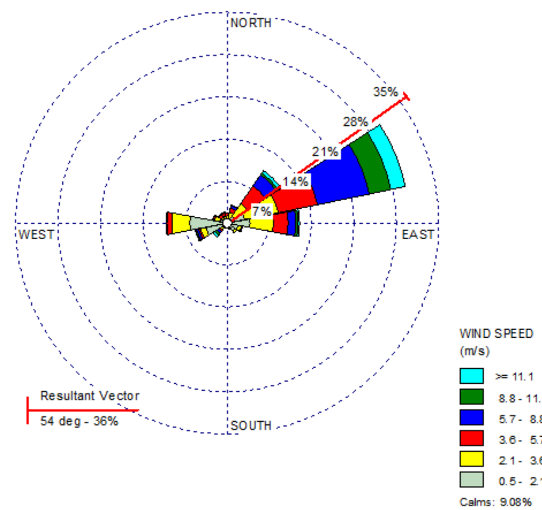
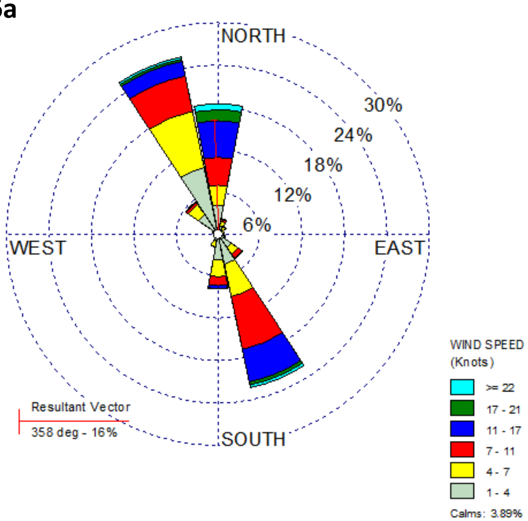



**5c**



**DAM6 Upper Iniakuk 6a) annual, b) summer, c) winter**

**6a**

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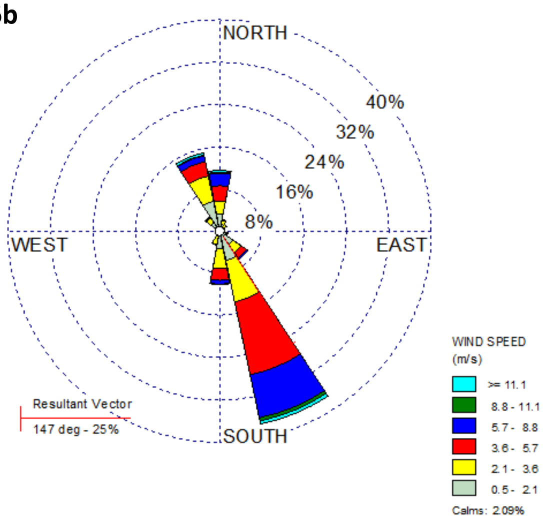
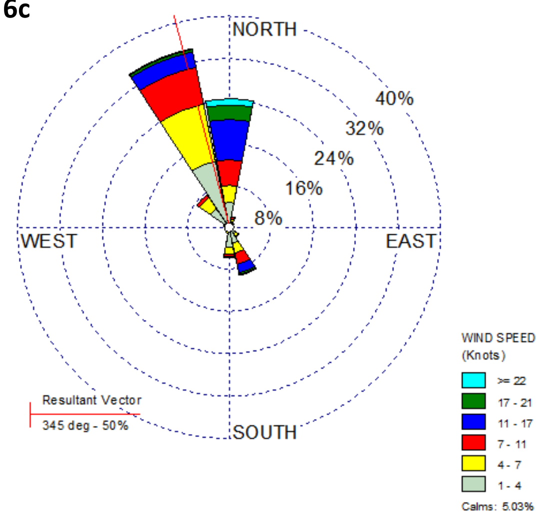
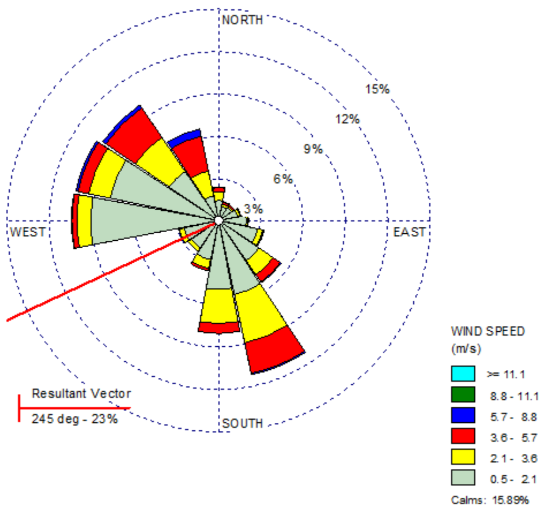



**6c**

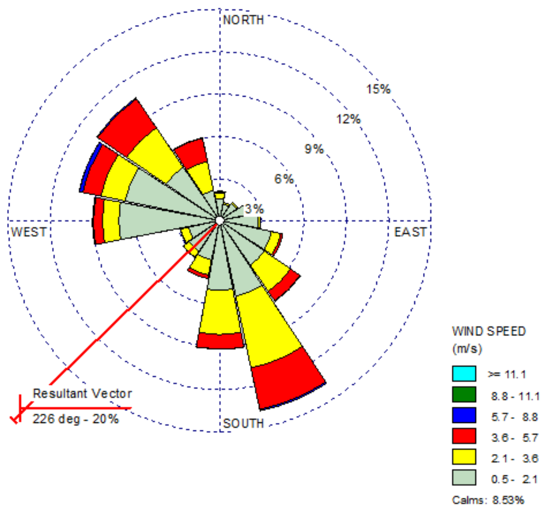


**DAM7 Upper Reed 7a) annual, b) summer, c) winter**

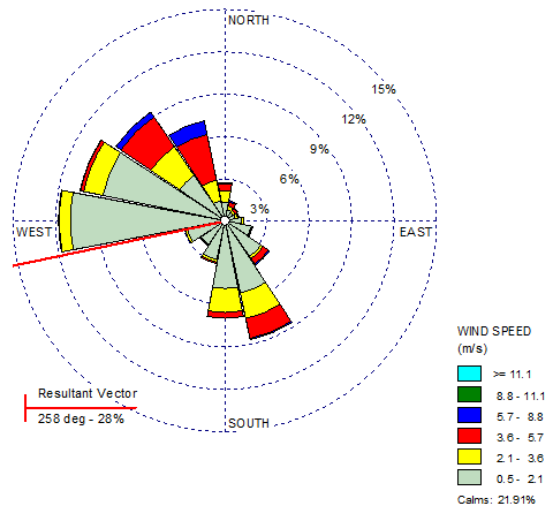
**7a**




**7b**

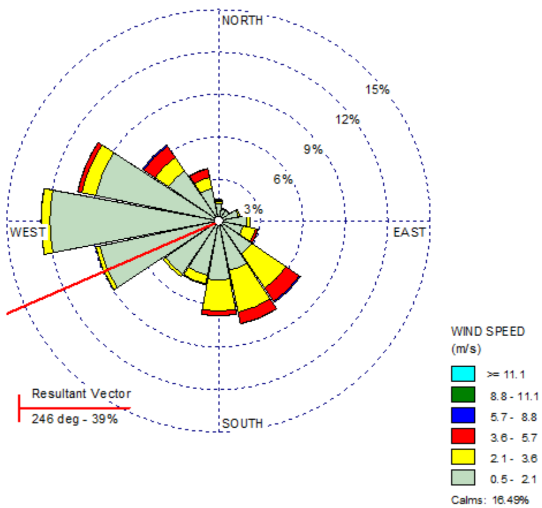



**7c**



**DAM8 Upper Kogoluktuk 8a) annual, b) summer, c) winter**

**8a**

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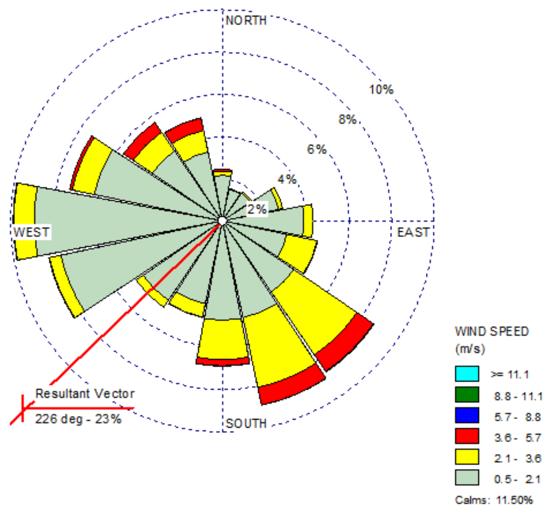


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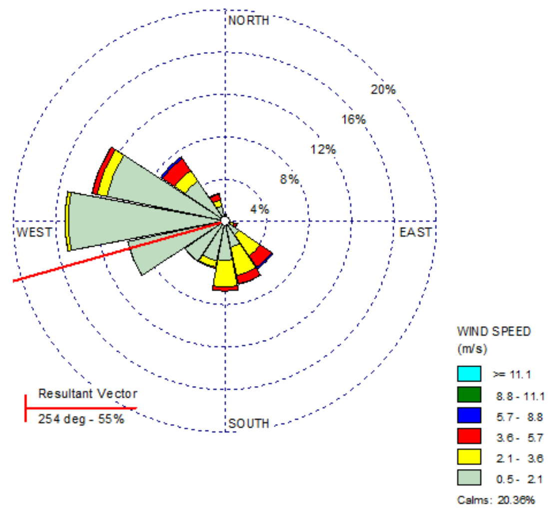
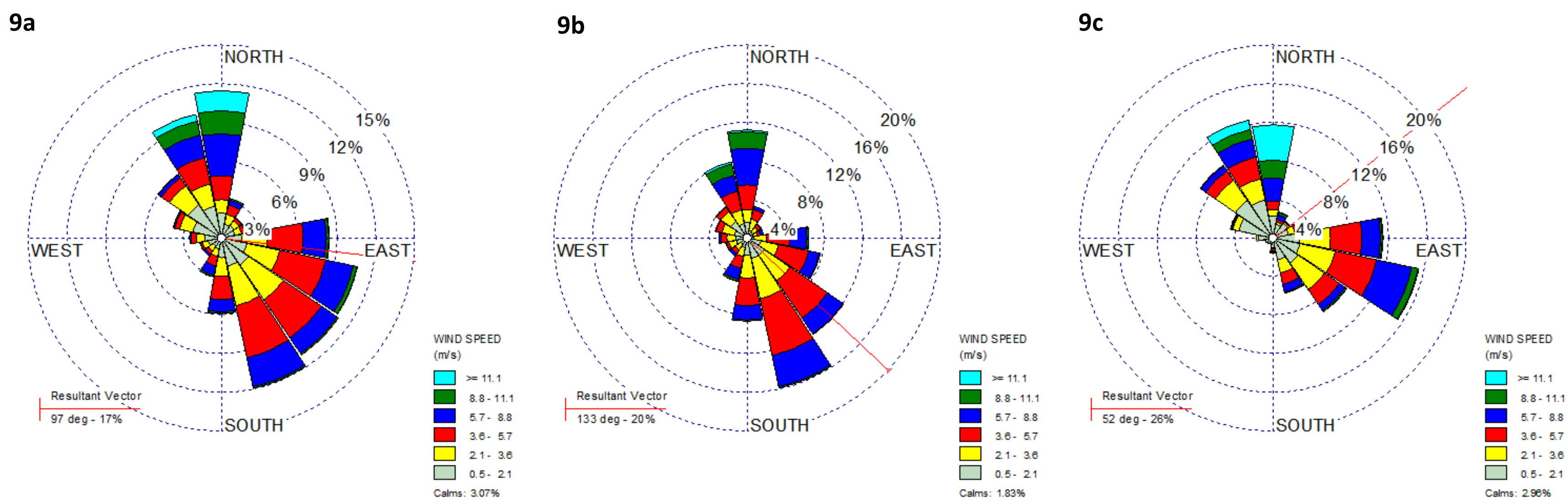
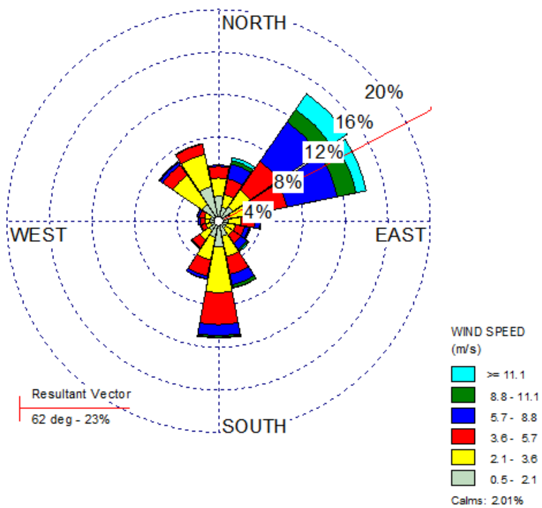


**NPS Pamichuk 9a) annual, b) summer, c) winter**

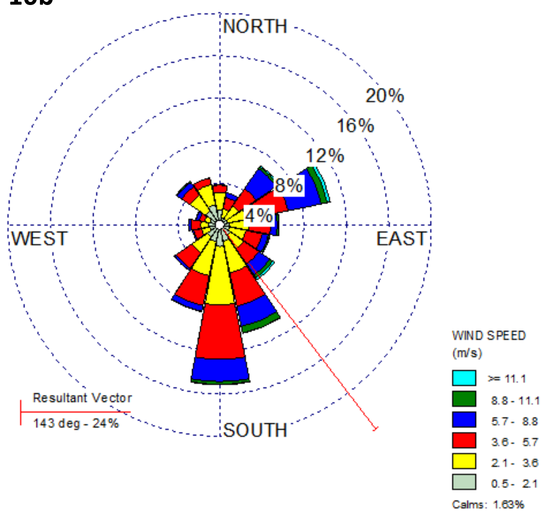


**NPS Chimney Lake 10a) annual, b) summer, c) winter**

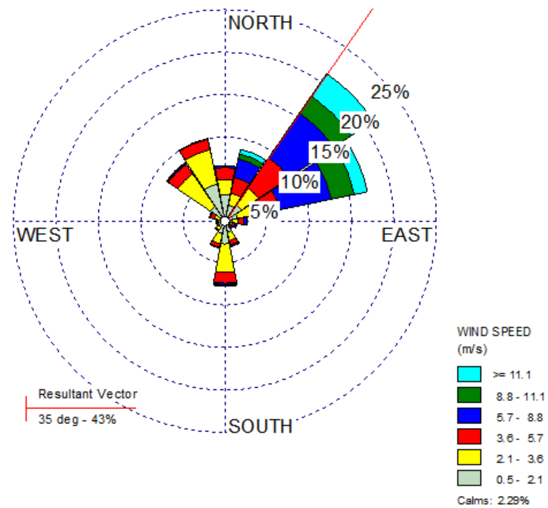
**10a**




**10b**

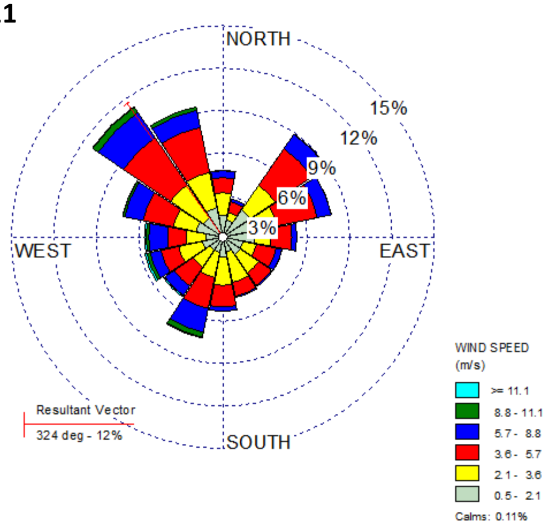



**10c**



**NPS Ram Creek 11) summer (data unavailable for most of winter)**

**11**



# Appendix B – Rainfall

Cumulative measured warm season precipitation at the eight Ambler meteorological stations, and the same data from the Kotzebue Airport, 2012 to 2014. Colors are the same for each year. For the eight Ambler stations, the data are partial for 2012. Upper Iniakuk was inoperable for much of 2012.

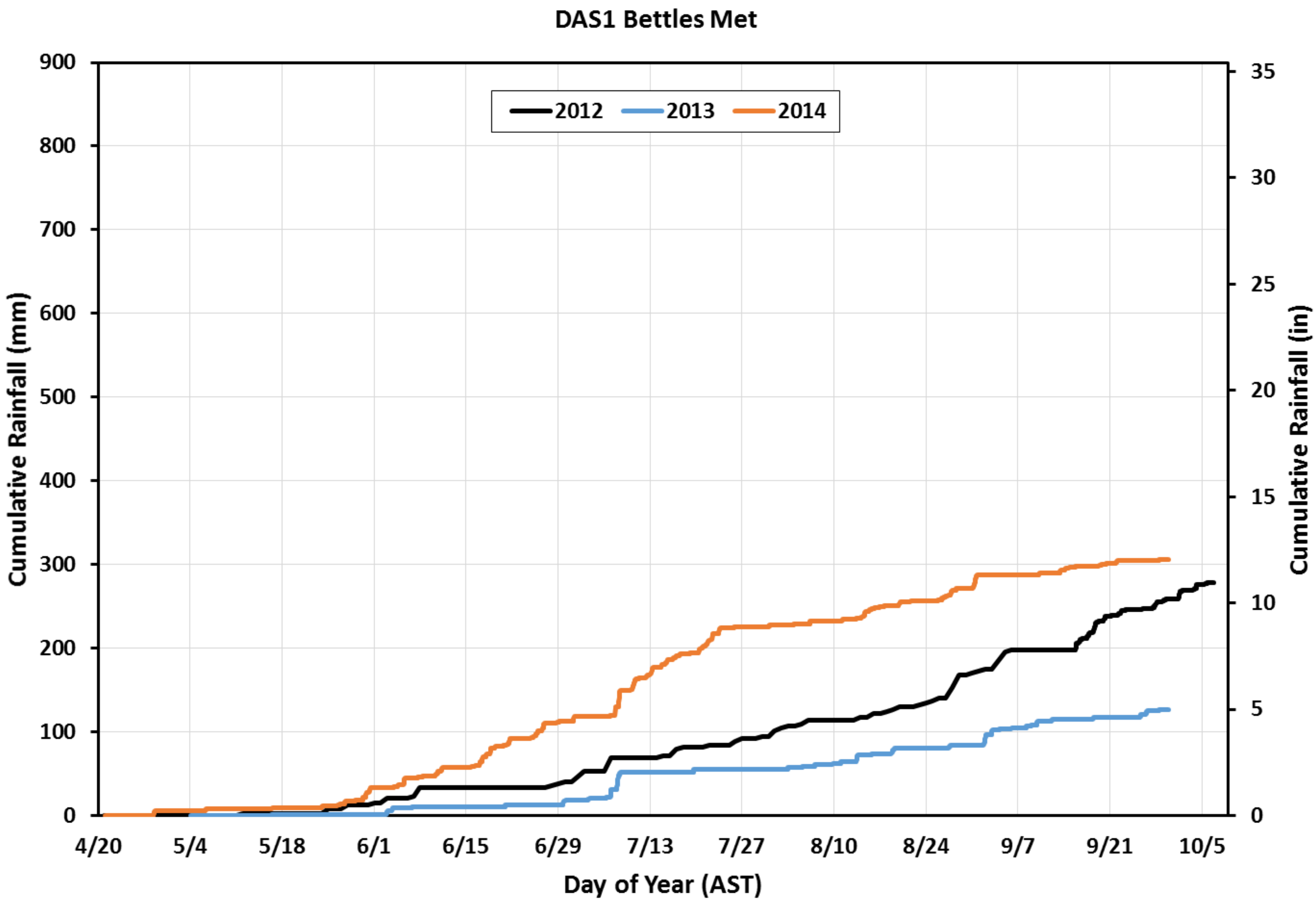



Figure B-1. Cumulative warm season precipitation for the 3-year Ambler study period at Bettles-DAS1.

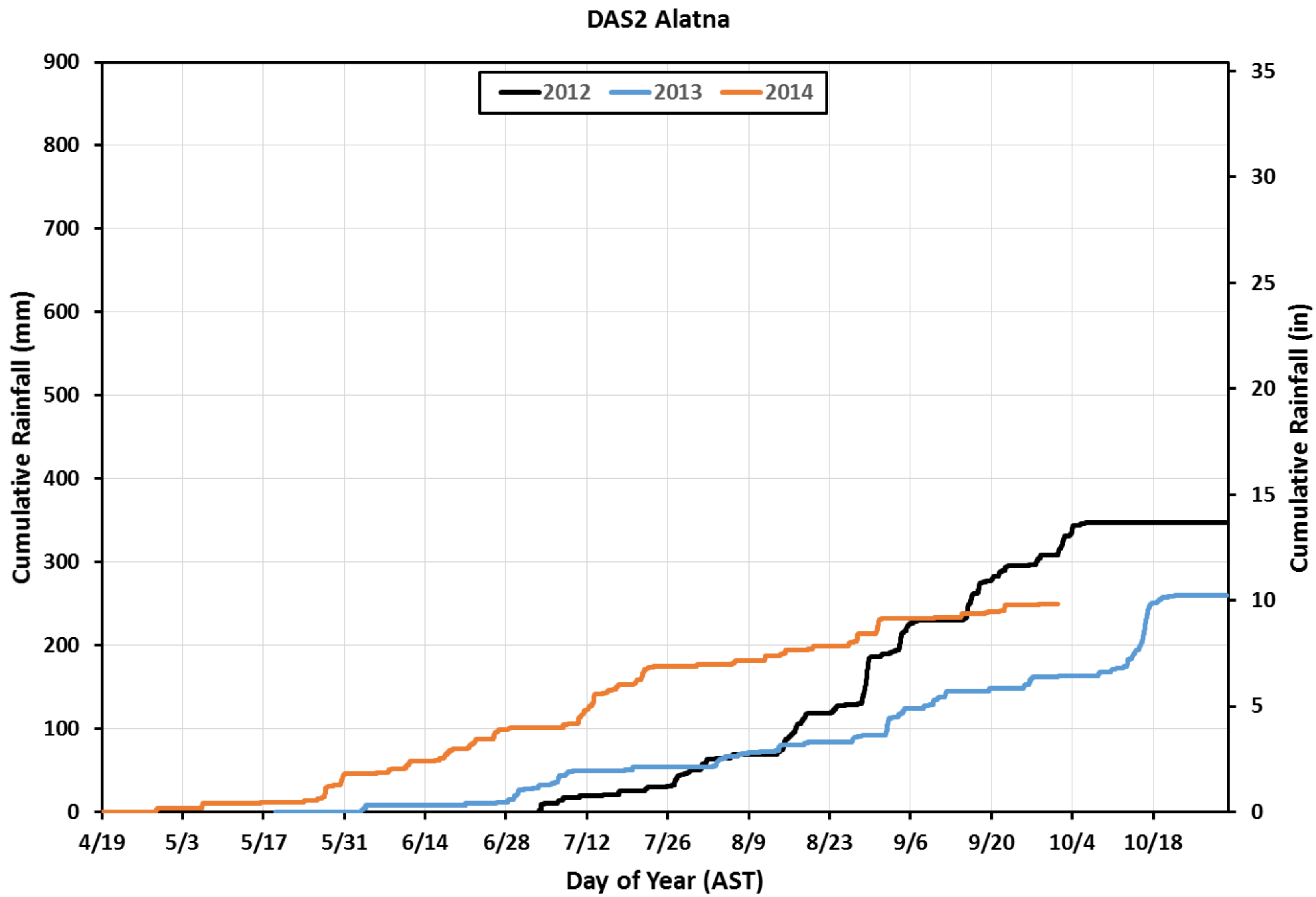



Figure B-2. Cumulative warm season precipitation for the 3-year Ambler study period at Alatna-DAS2. Data collection started in early July 2012.

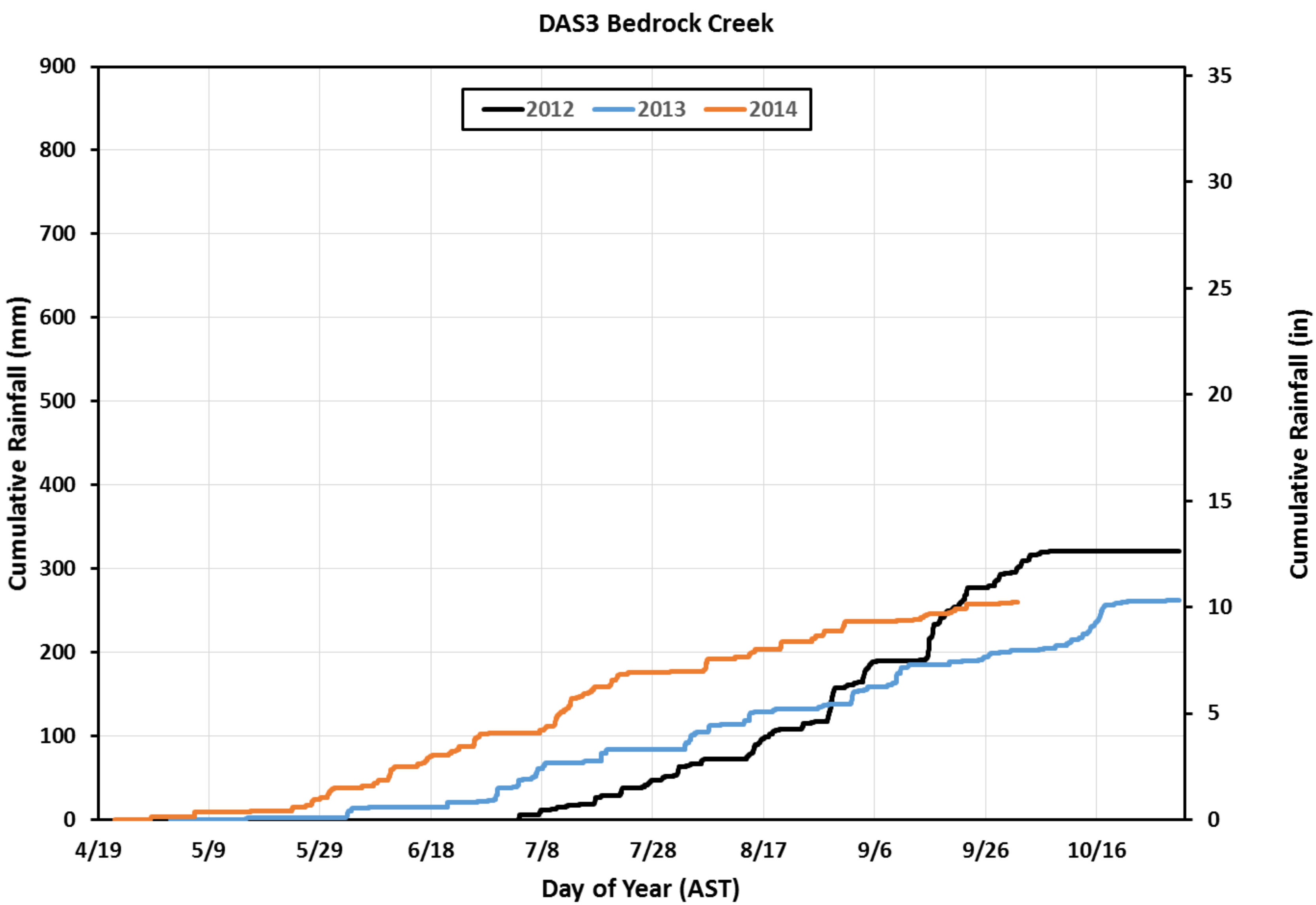



Figure B-3. Cumulative warm season precipitation for the 3-year Ambler study period at South Fork Bedrock Creek-DAS3. Data collection started in early July 2012.

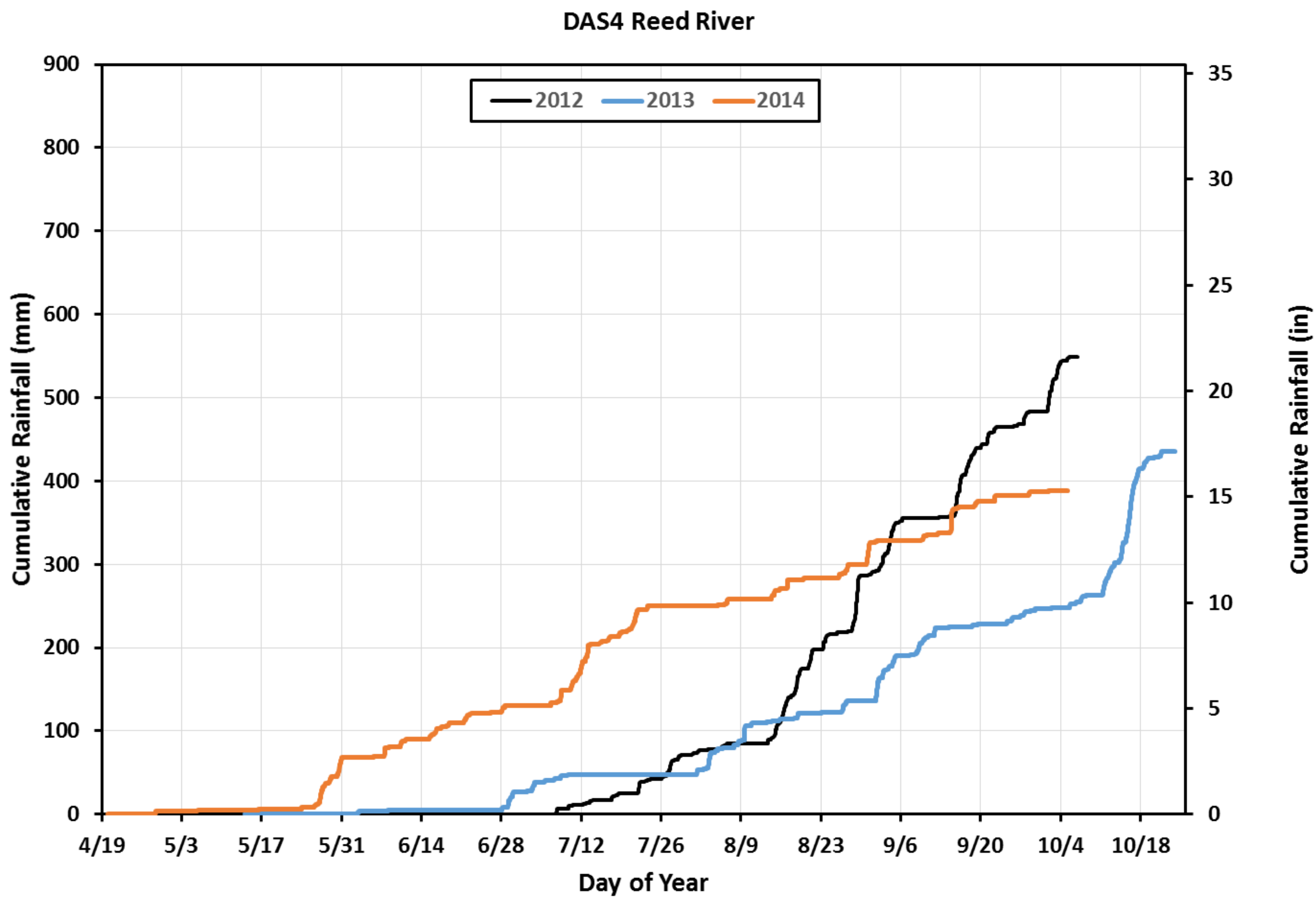



Figure B-4. Cumulative warm season precipitation for the 3-year Ambler study period at Reed River-DAS4. Data collection started in early July 2012.

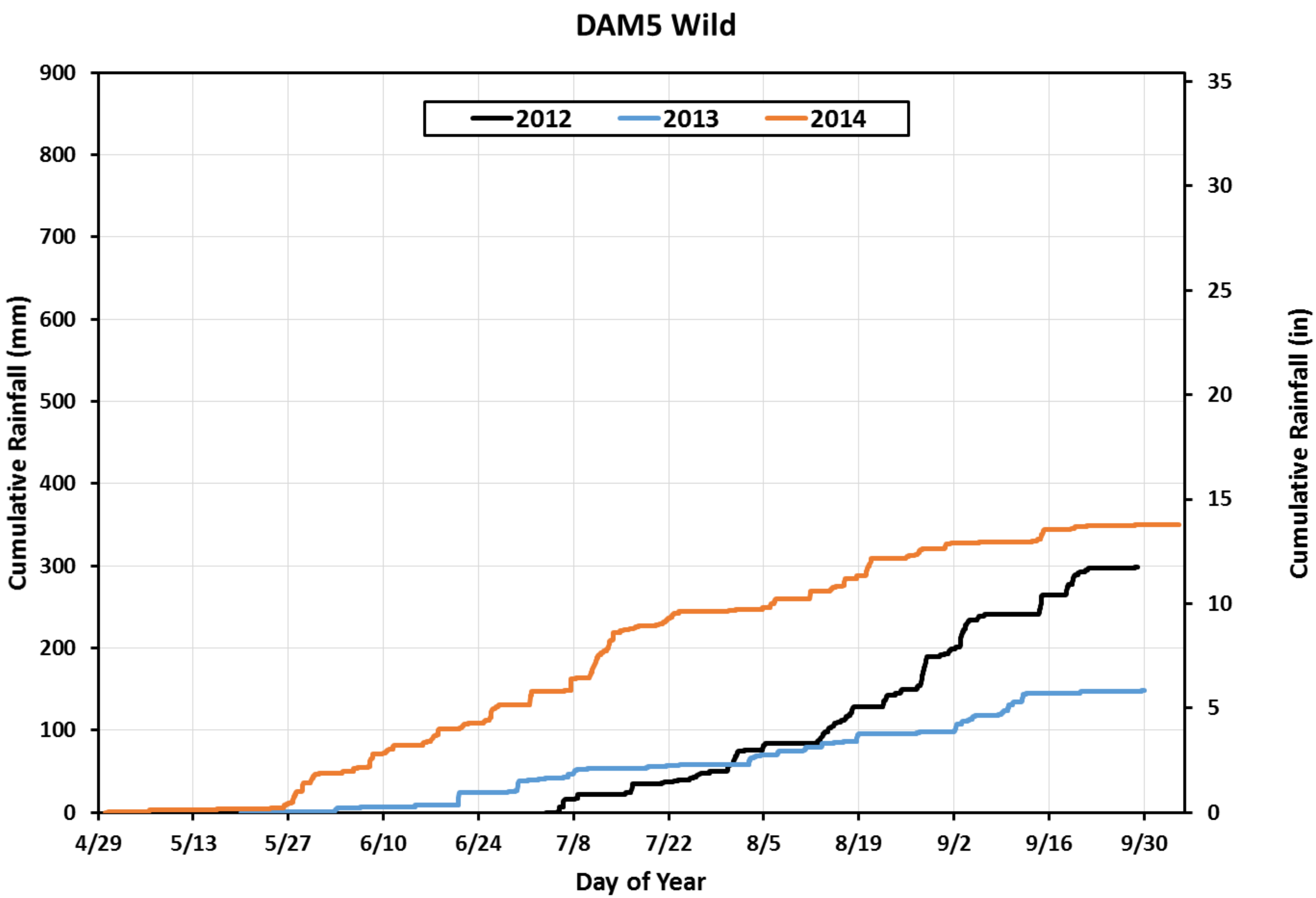



Figure B-5. Cumulative warm season precipitation for the 3-year Ambler study period at Wild-DAM5. Data collection started in early July 2012.

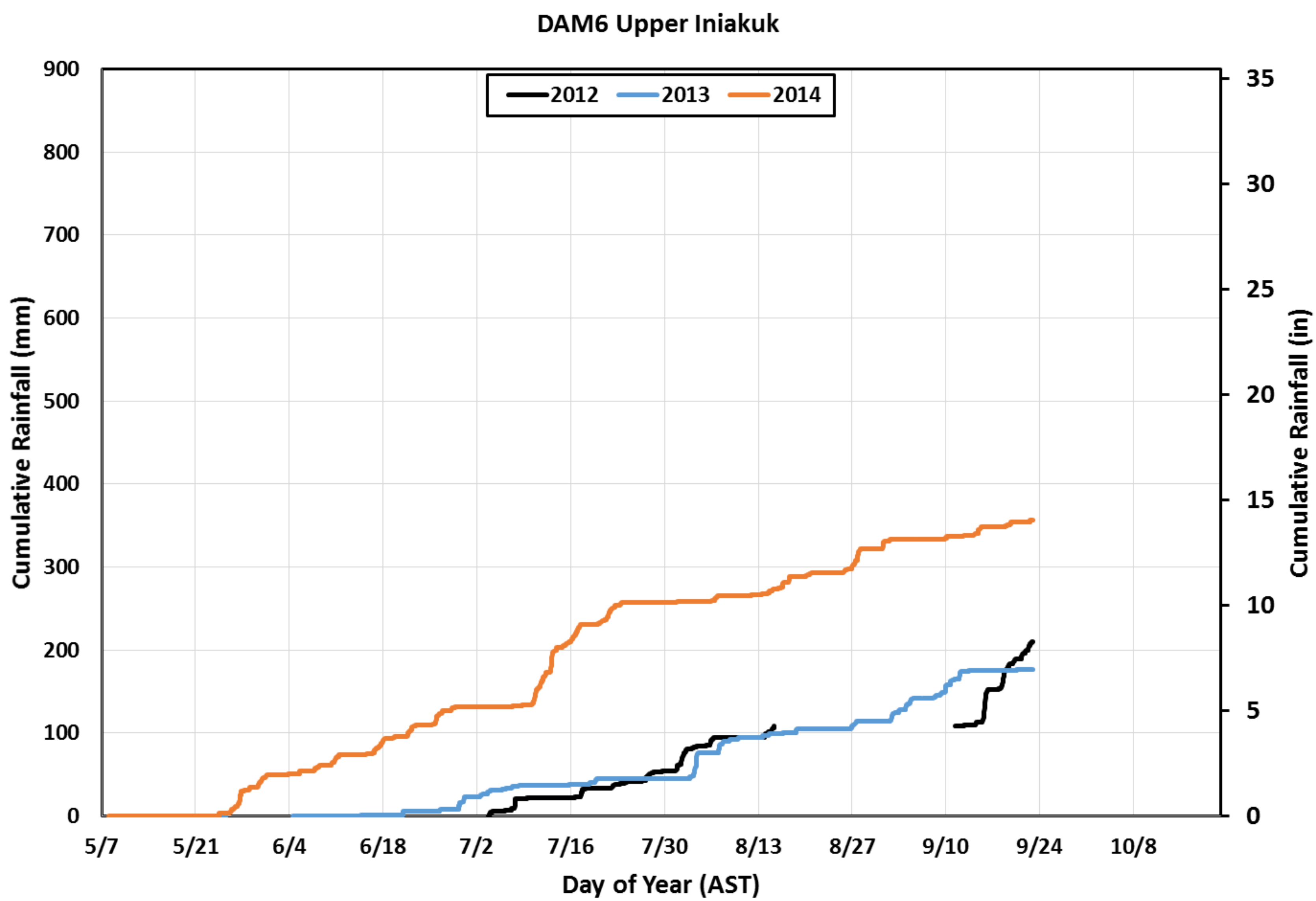



Figure B-6. Cumulative warm season precipitation for the 3-year Ambler study period at Upper Iniakuk-DAM6. Data collection started in early July 2012; also, missing data that year.

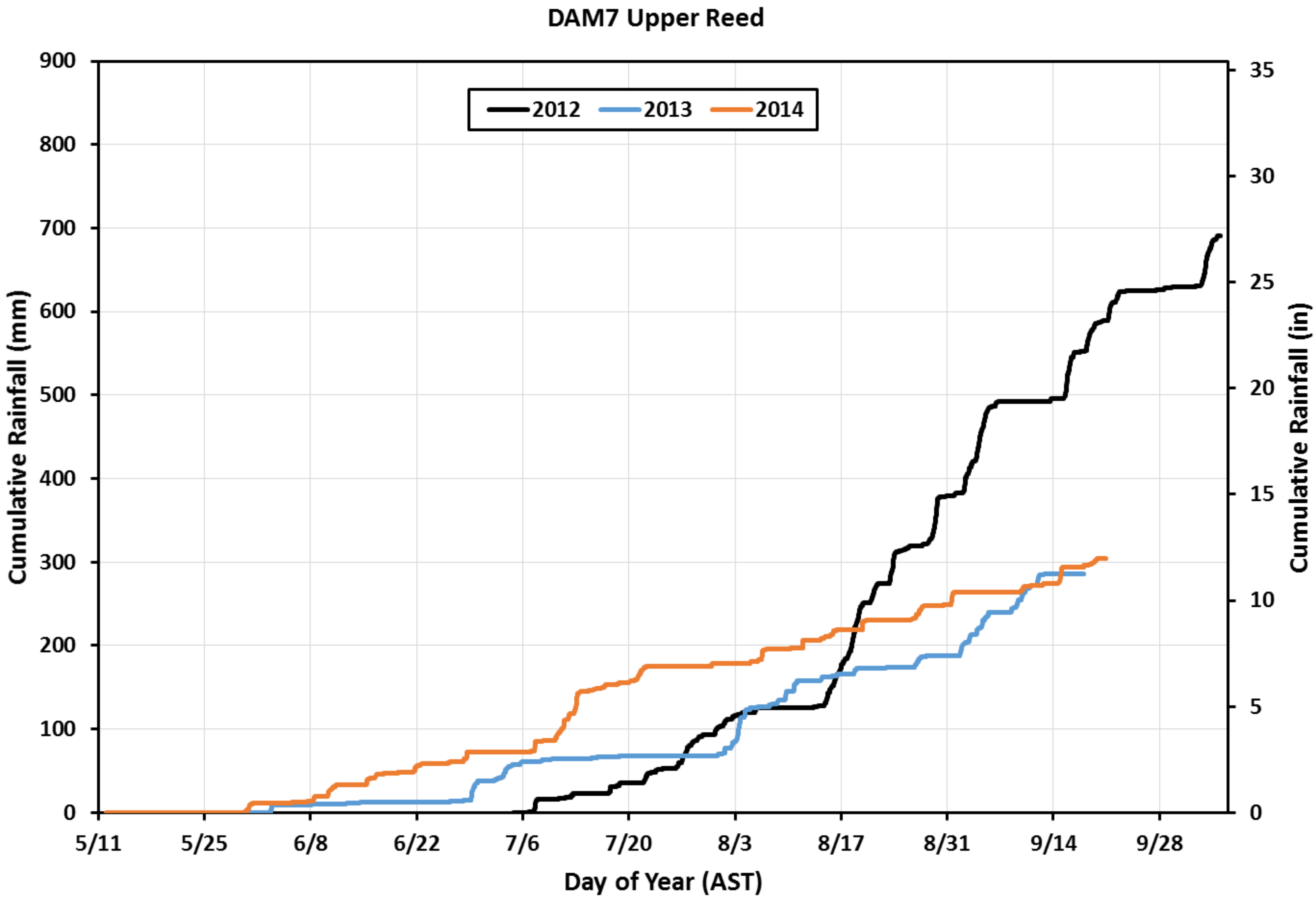



Figure B-7. Cumulative warm season precipitation for the 3-year Ambler study period at Upper Reed-DAM7. Data collection started in early July 2012.

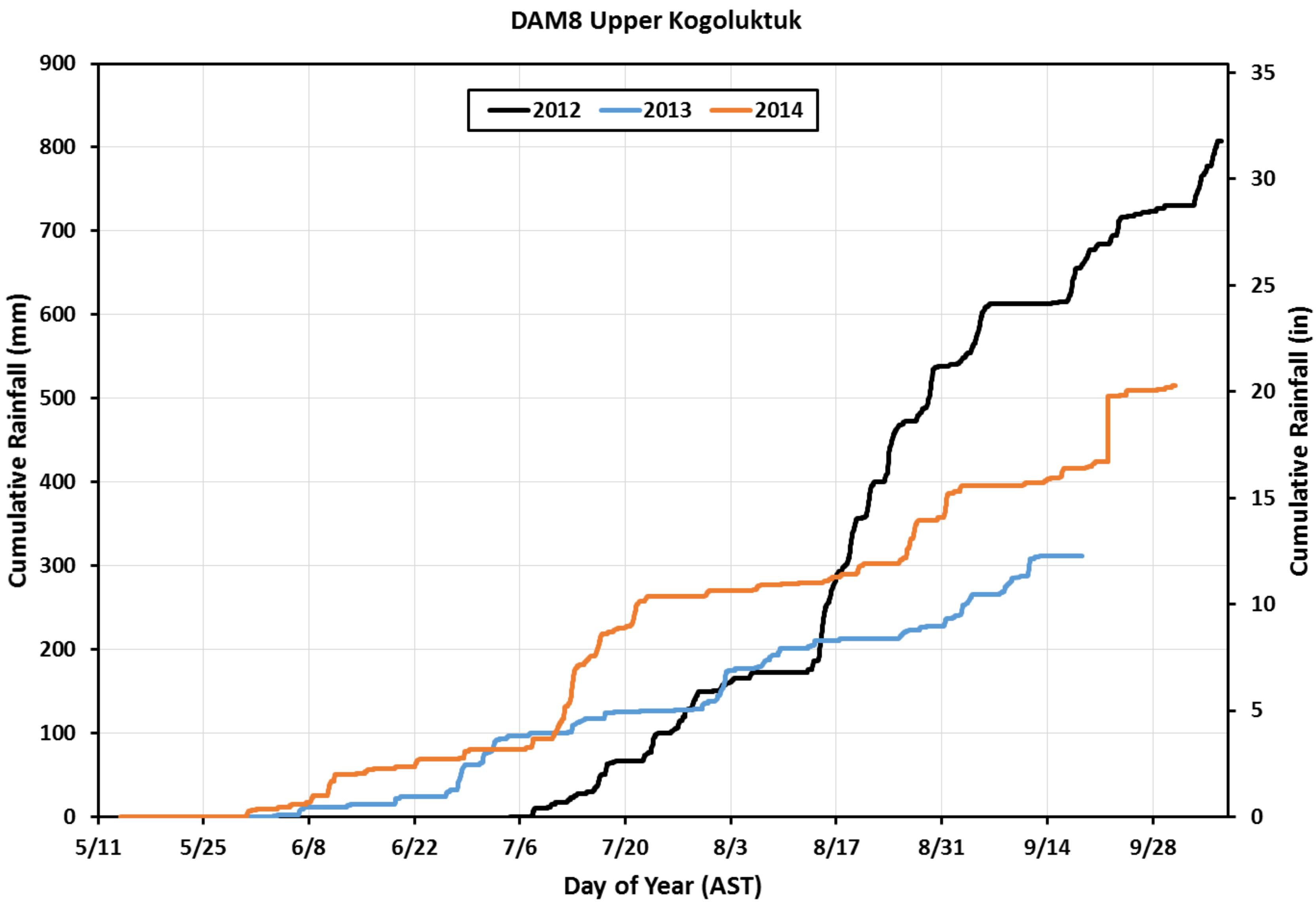



Figure B-8. Cumulative warm season precipitation for the 3-year Ambler study period at Upper Kogoluktuk-DAM8. Data collection started in early July 2012.

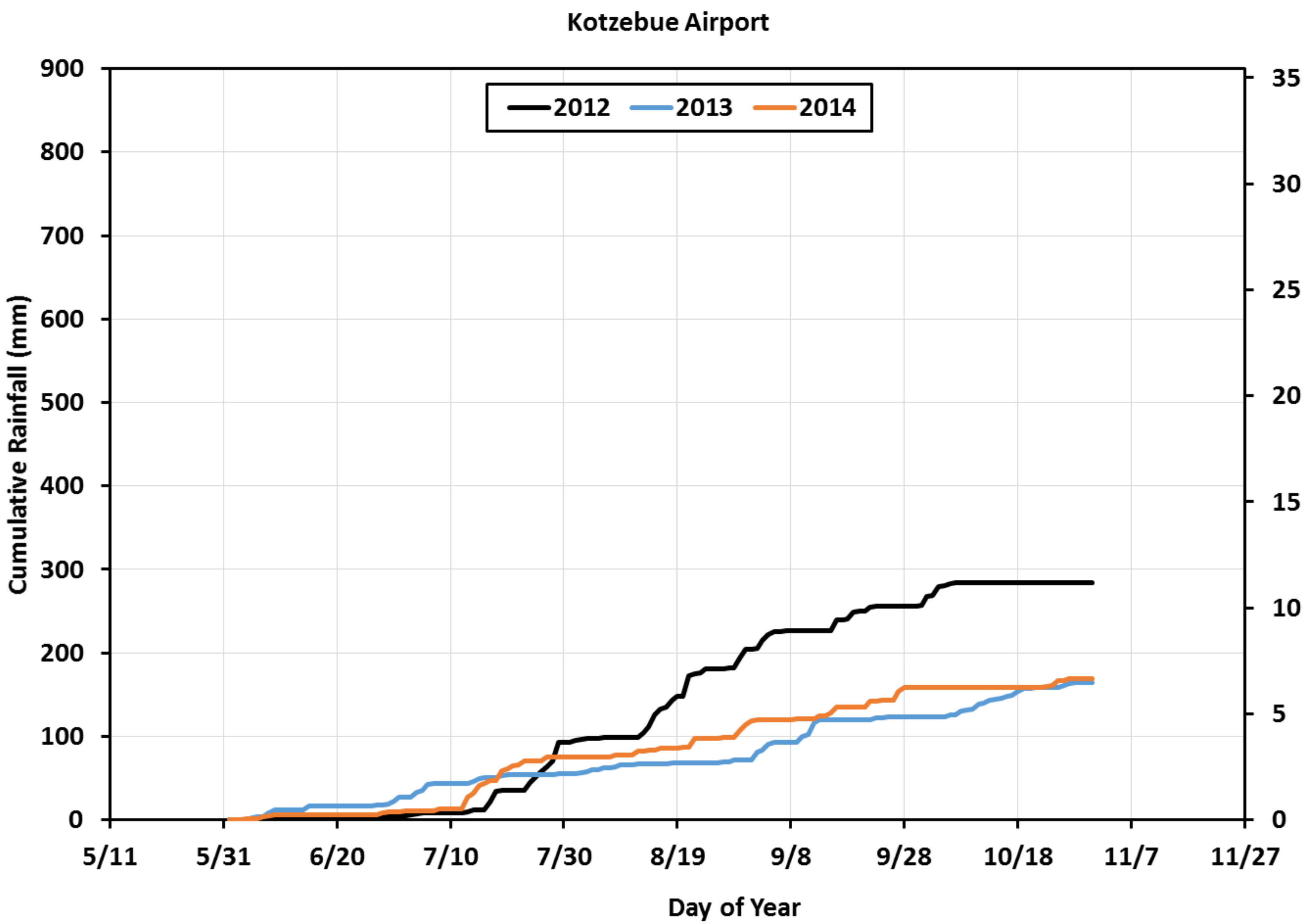



Figure B-9. Cumulative warm season precipitation at Kotzebue Airport, 2012 to 2014.

# Appendix C – Snow Survey Sites and Data

**Appendix C. Measured Snow Survey Data for the Ambler Study Area, April 1-10, 2014.**

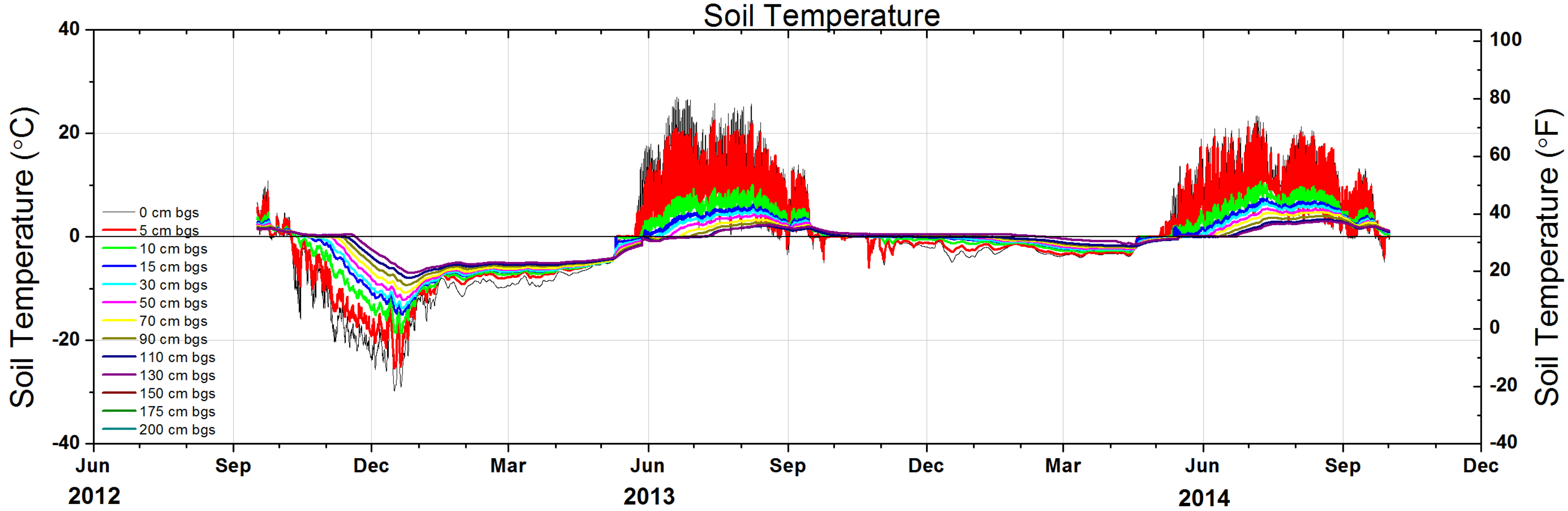
| N | Survey Date | ID | ELEV | LAT | LON | SWE | | Snow Depth | | Snow Density | | Basin |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | m | dd | dd | cm | in | cm | in | $kg/m^3$ | $slug/ft^3$ | |
| 1 | 04/05/14 | Alat1 | 335 | 67.5623 | -154.1389 | 8.1 | 3.2 | 45.9 | 18.1 | 177 | 0.343 | Alatna |
| 2 | 04/04/14 | Alat10 | 235 | 67.3426 | -153.5318 | 14.2 | 5.6 | 60.2 | 23.7 | 236 | 0.457 | Alatna |
| 3 | 04/05/14 | Alat2 | 792 | 67.3433 | -154.4033 | 34.7 | 13.7 | 131.7 | 51.8 | 264 | 0.512 | Alatna |
| 4 | 04/05/14 | Alat3 | 981 | 67.4330 | -153.9595 | 31.6 | 12.4 | 106.5 | 41.9 | 296 | 0.575 | Alatna |
| 5 | 04/04/14 | Alat4 | 1188 | 67.4846 | -153.4039 | 9.9 | 3.9 | 37.4 | 14.7 | 264 | 0.513 | Alatna |
| 6 | 04/05/14 | Alat5 Ram Cr Met | 1219 | 67.6245 | -154.3458 | 9.2 | 3.6 | 29.3 | 11.5 | 315 | 0.611 | Alatna |
| 7 | 04/05/14 | Alat6 | 634 | 67.7230 | -154.9814 | 8.5 | 3.4 | 40.6 | 16.0 | 210 | 0.407 | Alatna |
| 8 | 04/05/14 | Alat7 | 975 | 67.7575 | -154.0215 | 4.9 | 1.9 | 18.5 | 7.3 | 263 | 0.510 | Alatna |
| 9 | 04/05/14 | Alat8 | 579 | 67.7616 | -153.9825 | 6.4 | 2.5 | 28.4 | 11.2 | 226 | 0.438 | Alatna |
| 10 | 04/05/14 | Alat9 | 701 | 67.1743 | -153.3821 | 28.7 | 11.3 | 108.3 | 42.6 | 265 | 0.514 | Alatna |
| 11 | 04/05/14 | Alat-So1 | 332 | 66.9122 | -153.7448 | 24.4 | 9.6 | 95.0 | 37.4 | 257 | 0.499 | Alatna |
| 12 | 04/03/14 | DAM6 Upper Iniakuk | 838 | 67.3341 | -153.1354 | 16.2 | 6.4 | 58.2 | 22.9 | 277 | 0.538 | Alatna |
| 13 | 04/06/14 | DAS2 Alatna River | 229 | 67.0220 | -153.3020 | 17.5 | 6.9 | 79.5 | 31.3 | 220 | 0.427 | Alatna |
| 14 | 04/06/14 | S2 | 280 | 66.8330 | -154.2696 | 15.1 | 5.9 | 76.3 | 30.0 | 198 | 0.384 | Alatna |
| 15 | 04/04/14 | DAS3 SF Bedrock Creek | 198 | 67.0953 | -152.7240 | 14.9 | 5.9 | 81.4 | 32.1 | 183 | 0.356 | Alatna |
| Average | | | | | | 16.3 | 6.4 | 66.5 | 26.2 | 243 | 0.472 | |
| | | | | | | | | | | | | |
| 1 | 04/05/14 | DAM8 Upper Kogo | 567 | 67.3139 | -156.2712 | 29.2 | 11.5 | 108.4 | 42.7 | 270 | 0.523 | Kogoluktuk |
| 2 | 04/03/14 | Kogo Crossing | 87 | 67.0125 | -156.6914 | 16.0 | 6.3 | 69.9 | 27.5 | 229 | 0.445 | Kogoluktuk |
| 3 | 04/03/14 | Kogo2 | 899 | 67.2993 | -156.3531 | 42.5 | 16.7 | 121.1 | 47.7 | 351 | 0.681 | Kogoluktuk |
| 4 | 04/03/14 | Kogo3 | 282 | 67.3573 | -156.3370 | 27.7 | 10.9 | 100.8 | 39.7 | 275 | 0.533 | Koguluktuk |
| 5 | 04/03/14 | Kogo4 | 129 | 67.2840 | -156.2110 | 17.0 | 6.7 | 72.4 | 28.5 | 235 | 0.456 | Kogoluktuk |
| 6 | 04/03/14 | Kogo5 Trees | 134 | 67.1021 | -156.4432 | 13.8 | 5.4 | 70.5 | 27.7 | 196 | 0.381 | Kogoluktuk |
| 7 | 04/01/14 | Kogo5 Tundra | 134 | 67.1021 | -156.4432 | 3.1 | 1.2 | 10.4 | 4.1 | 294 | 0.570 | Kogoluktuk |
| Average | | | | | | 21.3 | 8.4 | 79.1 | 31.1 | 264 | 0.513 | |
| | | | | | | | | | | | | |
| 1 | 04/04/14 | DAM7 Upper Reed | 640 | 67.1853 | -154.9361 | 27.8 | 11.0 | 111.8 | 44.0 | 249 | 0.483 | Reed |
| 2 | 04/04/14 | DAS4 Reed River | 158 | 66.9973 | -154.8192 | 23.8 | 9.4 | 97.3 | 38.3 | 244 | 0.474 | Reed |
| 3 | 04/06/14 | Reed1 | 457 | 67.3659 | -155.0852 | 24.8 | 9.8 | 108.1 | 42.6 | 229 | 0.445 | Reed |
| 4 | 04/06/14 | Reed2 | 1097 | 67.4125 | -155.1232 | 58.7 | 23.1 | 163.6 | 64.4 | 359 | 0.696 | Reed |
| 5 | 04/06/14 | Reed3 | 183 | 67.2676 | -155.0656 | 19.8 | 7.8 | 111.1 | 43.7 | 178 | 0.345 | Reed |
| 6 | 04/06/14 | Reed4 | 168 | 67.1872 | -154.8484 | 14.6 | 5.8 | 103.5 | 40.7 | 141 | 0.274 | Reed |
| Average | | | | | | 28.2 | 11.12 | 115.9 | 45.6 | 233 | 0.453 | |
| | | | | | | | | | | | | |
| 1 | 04/02/14 | Chimney Lake | 1161 | 67.7142 | -150.5850 | 3.5 | 1.4 | 11.1 | 4.4 | 318 | 0.617 | Koyukuk |
| 2 | 04/02/14 | Coldfoot | 317 | 67.2532 | -150.1826 | 18.5 | 7.3 | 78.6 | 30.9 | 235 | 0.457 | Koyukuk |
| 3 | 04/04/14 | DAM5 Wild | 1143 | 67.4150 | -151.6800 | 10.0 | 3.9 | 34.0 | 13.4 | 293 | 0.568 | Koyukuk |
| 4 | 04/04/14 | DAS1 Bettles | 137 | 66.9140 | -151.5360 | 15.9 | 6.3 | 74.1 | 29.2 | 215 | 0.418 | Koyukuk |
| 5 | 04/04/14 | Jim River DOT | 335 | 67.0871 | -150.3660 | 15.4 | 6.1 | 75.7 | 29.8 | 203 | 0.395 | Koyukuk |

## Appendix C (continued)

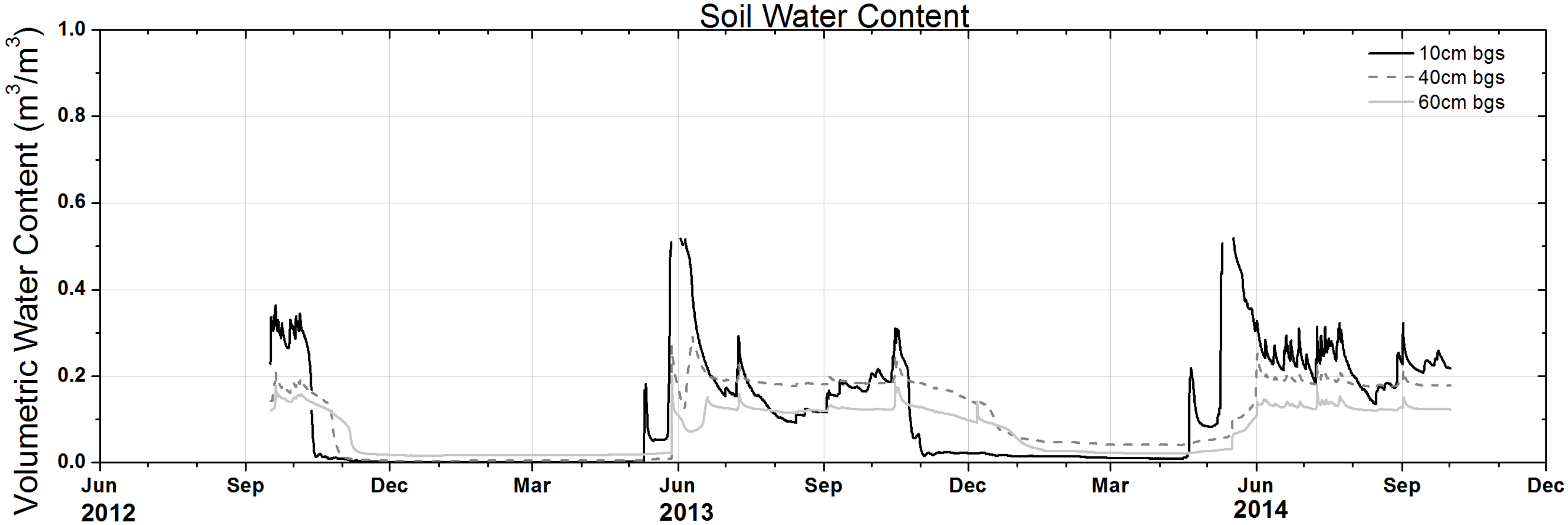
| N | Survey Date | ID | ELEV m | LAT dd | LON dd | SWE cm | SWE in | Snow Depth cm | Snow Depth in | Snow Density $kg/m^3$ | Snow Density $slug/ft^3$ | Basin |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 04/04/14 | John1 | 305 | 67.6114 | -152.4497 | 10.4 | 4.1 | 56.9 | 22.4 | 183 | 0.355 | Koyukuk |
| 7 | 04/04/14 | John2 Pamichuk Lake | 975 | 67.7644 | -152.1636 | 3.0 | 1.2 | 10.4 | 4.1 | 289 | 0.560 | Koyukuk |
| 8 | 04/04/14 | John3 | 1158 | 67.7159 | -153.0833 | 11.4 | 4.5 | 43.1 | 17.0 | 265 | 0.514 | Koyukuk |
| 9 | 04/02/14 | John4 | 1481 | 68.0006 | -152.7231 | 12.4 | 4.9 | 44.6 | 17.6 | 279 | 0.541 | Koyukuk |
| 10 | 04/04/14 | John5 | 1241 | 67.9907 | -152.7118 | 9.7 | 3.8 | 38.7 | 15.2 | 252 | 0.489 | Koyukuk |
| 11 | 04/02/14 | John6 | 250 | 67.5444 | -152.2218 | 13.5 | 5.3 | 60.4 | 23.8 | 224 | 0.435 | Koyukuk |
| 12 | 04/05/14 | John7 | 358 | 67.5357 | -151.8476 | 12.9 | 5.1 | 63.0 | 24.8 | 206 | 0.399 | Koyukuk |
| 13 | 04/03/14 | John8 | 366 | 67.3676 | -152.3676 | 14.1 | 5.5 | 65.2 | 25.7 | 216 | 0.419 | Koyukuk |
| 14 | 04/03/14 | John9 | 233 | 67.0913 | -151.8771 | 9.1 | 3.6 | 38.6 | 15.2 | 236 | 0.457 | Koyukuk |
| 15 | 04/02/14 | NFK1 | 253 | 67.1522 | -150.7640 | 9.0 | 3.5 | 39.5 | 15.6 | 228 | 0.441 | Koyukuk |
| 16 | 04/02/14 | NFK2 | 422 | 67.4806 | -150.7973 | 9.6 | 3.8 | 60.5 | 23.8 | 159 | 0.308 | Koyukuk |
| 17 | 04/01/14 | NFK3 | 1006 | 67.5662 | -150.6684 | 14.6 | 5.7 | 77.8 | 30.6 | 187 | 0.363 | Koyukuk |
| 18 | 04/02/14 | NFK4 | 1250 | 68.0730 | -150.7257 | 20.4 | 8.0 | 75.3 | 29.6 | 271 | 0.525 | Koyukuk |
| 19 | 04/02/14 | NFK5 | 1006 | 67.9724 | -150.8868 | 15.3 | 6.0 | 58.8 | 23.1 | 260 | 0.504 | Koyukuk |
| 20 | 04/02/14 | NFK6 | 762 | 67.3925 | -150.7003 | 14.8 | 5.8 | 64.5 | 25.4 | 230 | 0.445 | Koyukuk |
| 21 | 04/06/14 | NFK7 | 975 | 67.8351 | -151.4221 | 17.2 | 6.8 | 79.1 | 31.1 | 217 | 0.422 | Koyukuk |
| 22 | 04/06/14 | NFK8 | 457 | 67.6538 | -151.3669 | 10.8 | 4.3 | 56.7 | 22.3 | 191 | 0.371 | Koyukuk |
| 23 | 04/06/14 | NFK9 | 640 | 67.9736 | -150.8429 | 3.4 | 1.3 | 13.2 | 5.2 | 255 | 0.494 | Koyukuk |
| 24 | 04/10/14 | Sukakpak Mt. | 439 | 67.5991 | -149.7814 | 11.2 | 4.4 | 57.2 | 22.5 | 196 | 0.379 | Koyukuk |
| 25 | 04/10/14 | Upper Dietrich | 777 | 68.0342 | -149.6574 | 5.6 | 2.2 | 28.2 | 11.1 | 199 | 0.386 | Koyukuk |
| Average | | | | | | 11.7 | 4.6 | 52.2 | 20.6 | 232 | 0.450 | |
| | | | | | | | | | | | | |
| 1 | 04/01/14 | Maun1 | 91 | 67.0134 | -156.0618 | 9.5 | 3.8 | 42.5 | 16.7 | 224 | 0.436 | Mauneluk |
| 2 | 04/01/14 | Maun2 | 792 | 67.1597 | -156.0287 | 54.1 | 21.3 | 161.9 | 63.7 | 334 | 0.649 | Mauneluk |
| 3 | 04/03/14 | Beav1 | 330 | 66.9939 | -155.3787 | 29.1 | 11.5 | 104.8 | 41.3 | 278 | 0.539 | Beaver |
| 5 | 04/03/14 | Kob1 | 345 | 67.0552 | -153.7673 | 22.1 | 8.7 | 91.3 | 35.9 | 242 | 0.470 | Kobuk |
| Average | | | | | | 28.7 | 11.3 | 100.1 | 39.4 | 270 | 0.523 | |

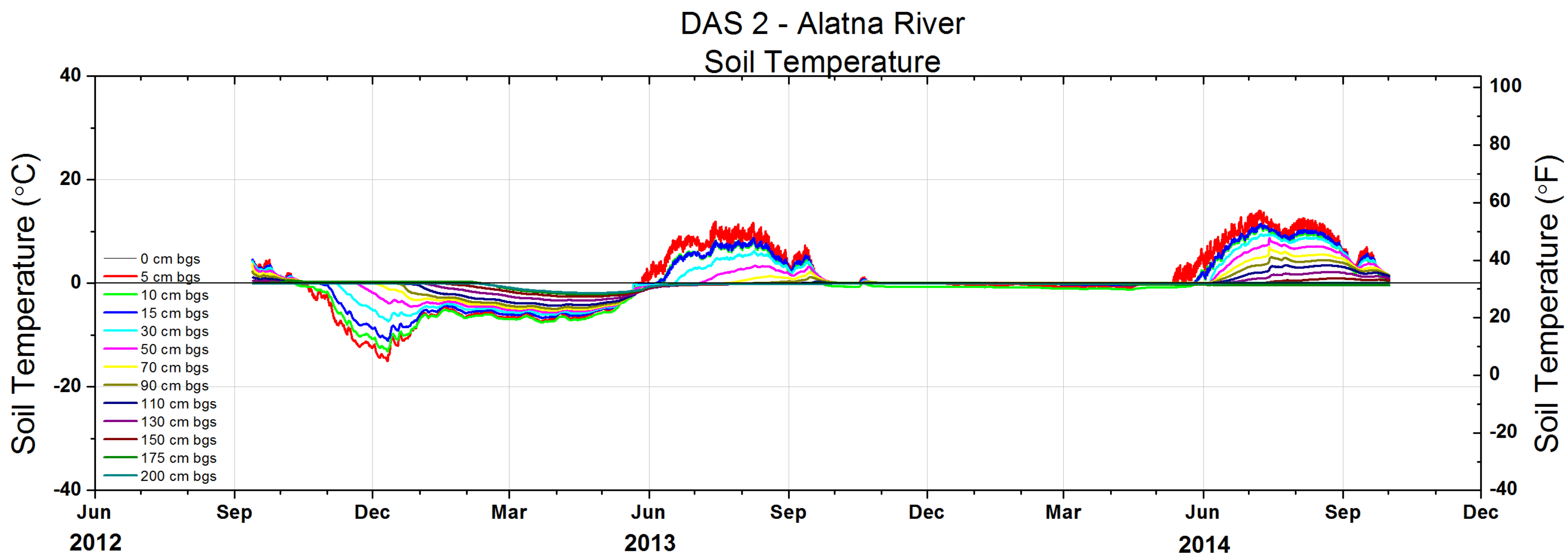
## Appendix D – Soil Temperature and Soil Water Content Data for the Eight Major Field Sites (2012 to 2014) in the Ambler Study. Also, Tables of Monthly Average Soil Temperature at 5 cm bgs and Soil Moisture at 10, 40, and 60 cm bgs

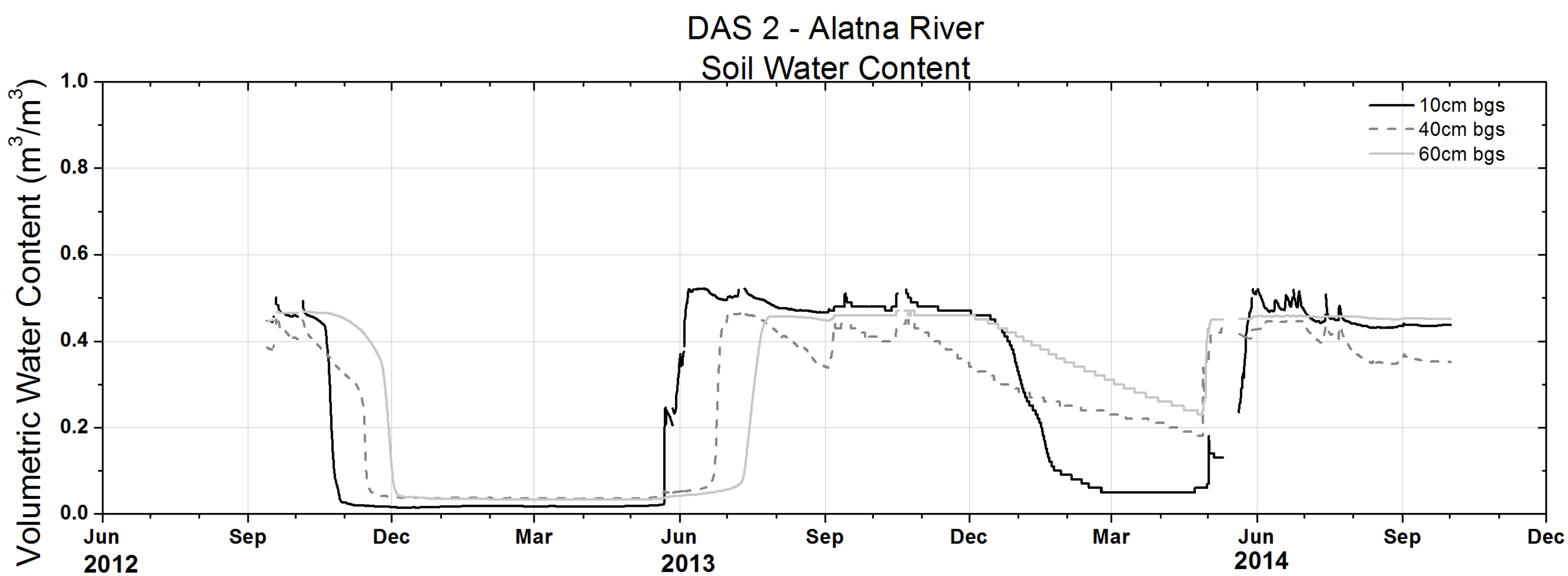
## DAS 1 - Bettles Met
## Soil Temperature

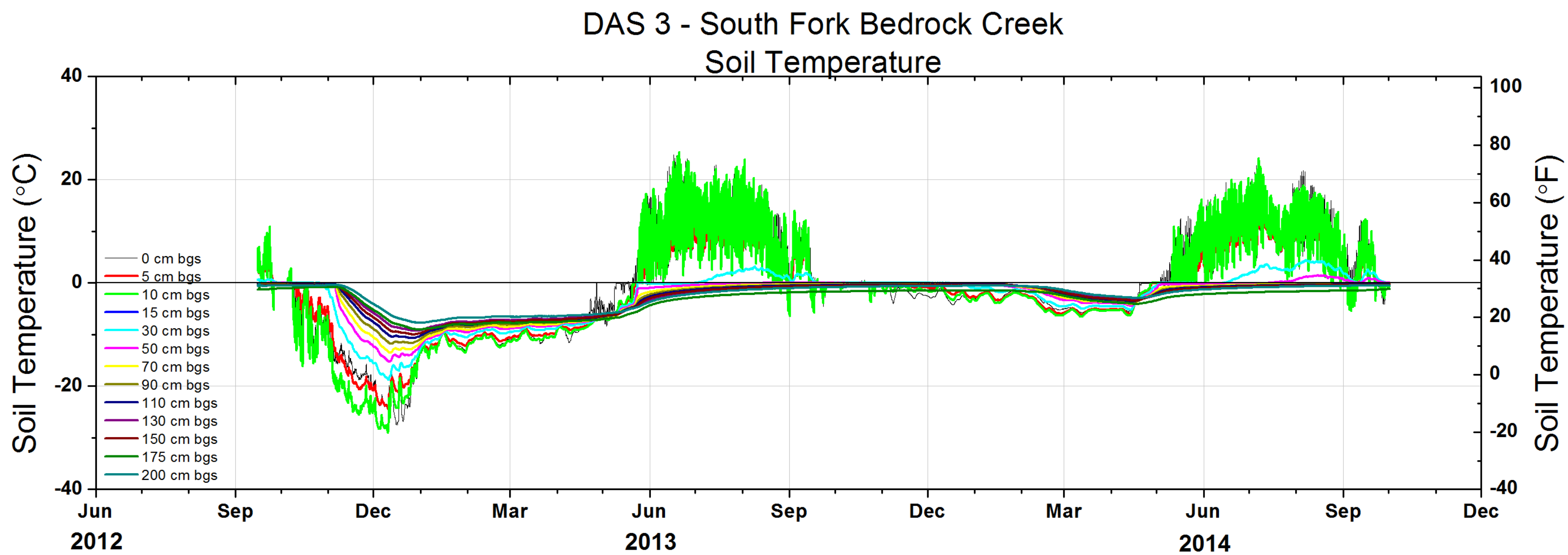


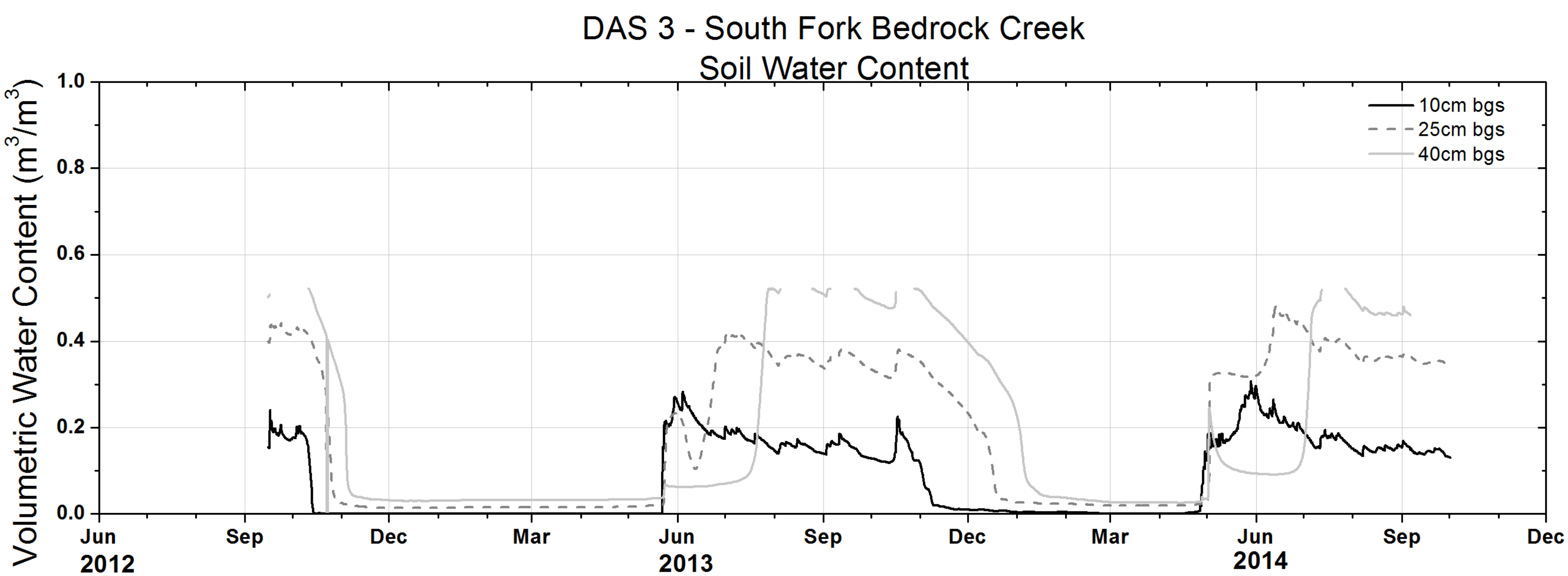

## DAS 1 - Bettles Met
## Soil Water Content

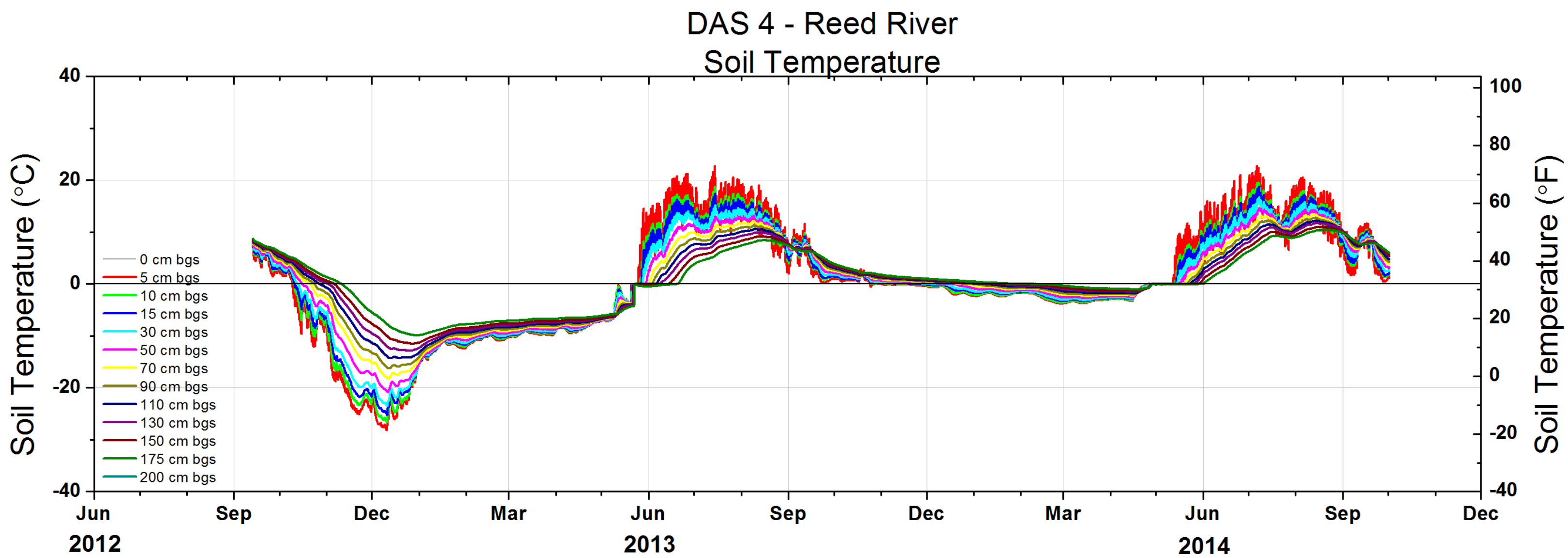



DAS 2 - Alatna River
Soil Temperature
Soil Temperature (°C)
Soil Temperature (°F)
40
20
0
-20
-40
100
80
60
40
20
0
-20
-40
0 cm bgs
5 cm bgs
10 cm bgs
15 cm bgs
30 cm bgs
50 cm bgs
70 cm bgs
90 cm bgs
110 cm bgs
130 cm bgs
150 cm bgs
175 cm bgs
200 cm bgs
Jun
Sep
Dec
Mar
Jun
Sep
Dec
Mar
Jun
Sep
Dec
2012
2013
2014

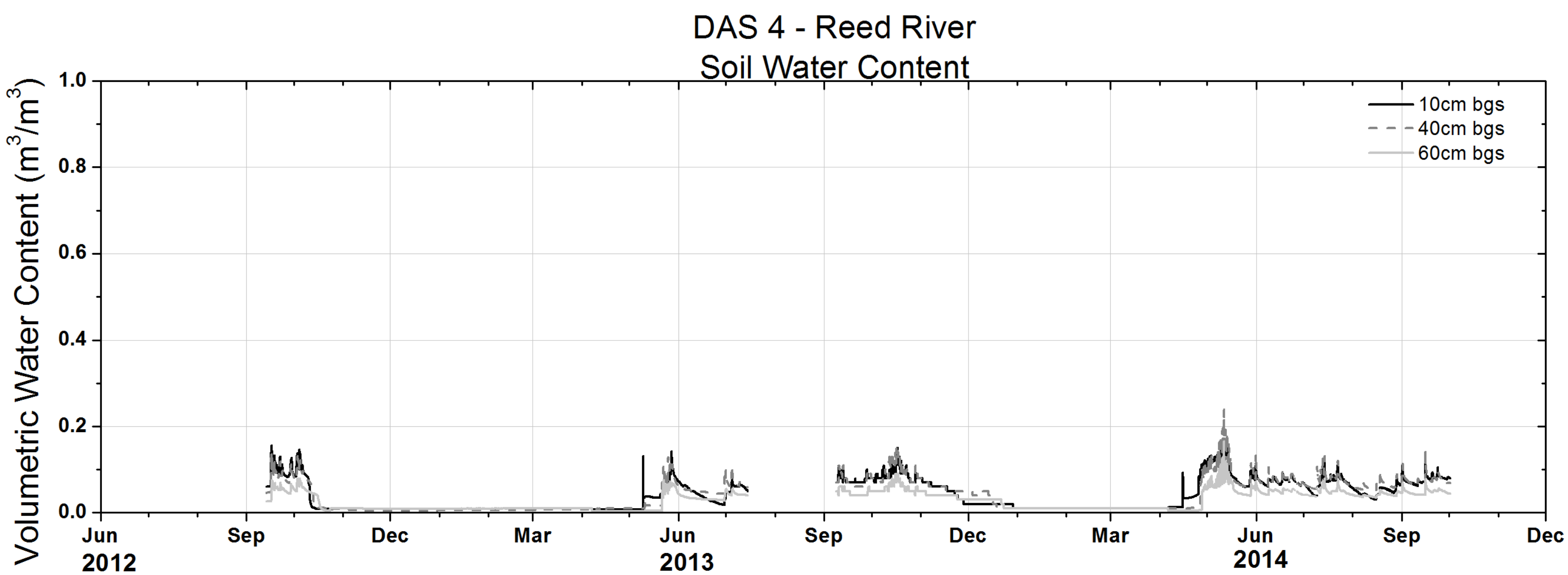

DAS 2 - Alatna River
Soil Water Content
Volumetric Water Content (m3/m3)
1.0
0.8
0.6
0.4
0.2
0.0
10cm bgs
40cm bgs
60cm bgs
Jun
Sep
Dec
Mar
Jun
Sep
Dec
Mar
Jun
Sep
Dec
2012
2013
2014


DAS 3 - South Fork Bedrock Creek
Soil Temperature
Soil Temperature (°C)
Soil Temperature (°F)
0 cm bgs
5 cm bgs
10 cm bgs
15 cm bgs
30 cm bgs
50 cm bgs
70 cm bgs
90 cm bgs
110 cm bgs
130 cm bgs
150 cm bgs
175 cm bgs
200 cm bgs
40
20
0
-20
-40
100
80
60
40
20
0
-20
-40
Jun
Sep
Dec
Mar
Jun
Sep
Dec
Mar
Jun
Sep
Dec
2012
2013
2014

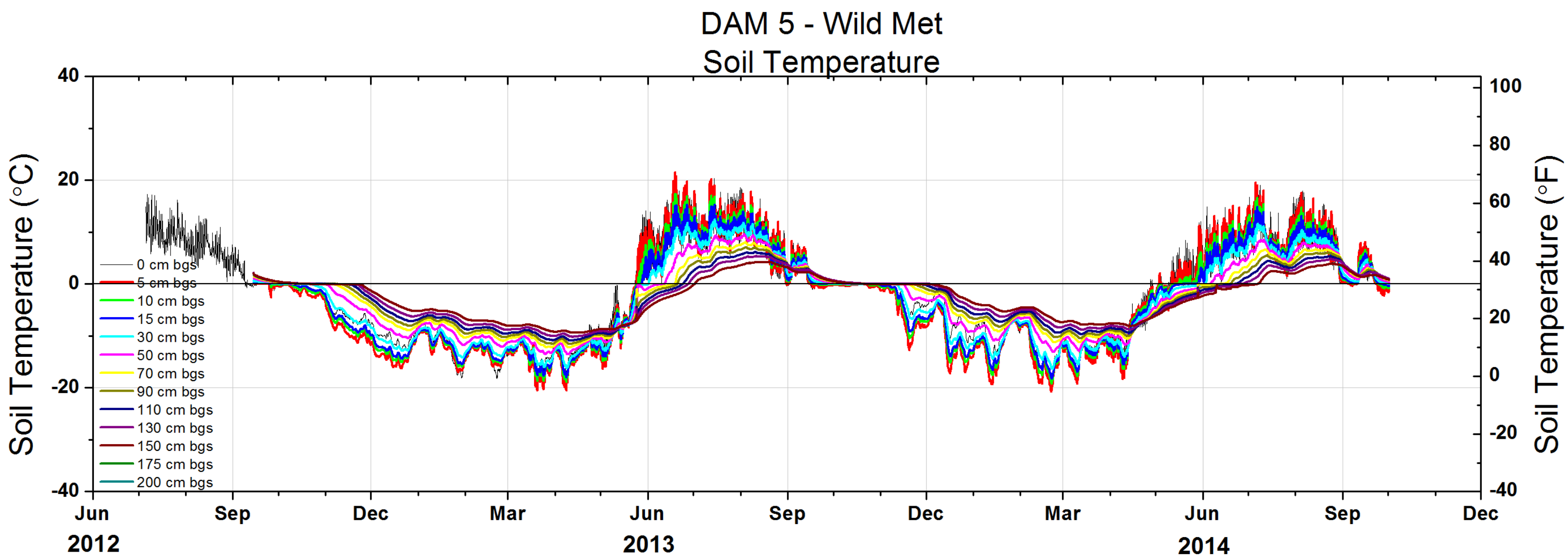

DAS 3 - South Fork Bedrock Creek
Soil Water Content
Volumetric Water Content (m³/m³)
10cm bgs
25cm bgs
40cm bgs
1.0
0.8
0.6
0.4
0.2
0.0
Jun
Sep
Dec
Mar
Jun
Sep
Dec
Mar
Jun
Sep
Dec
2012
2013
2014

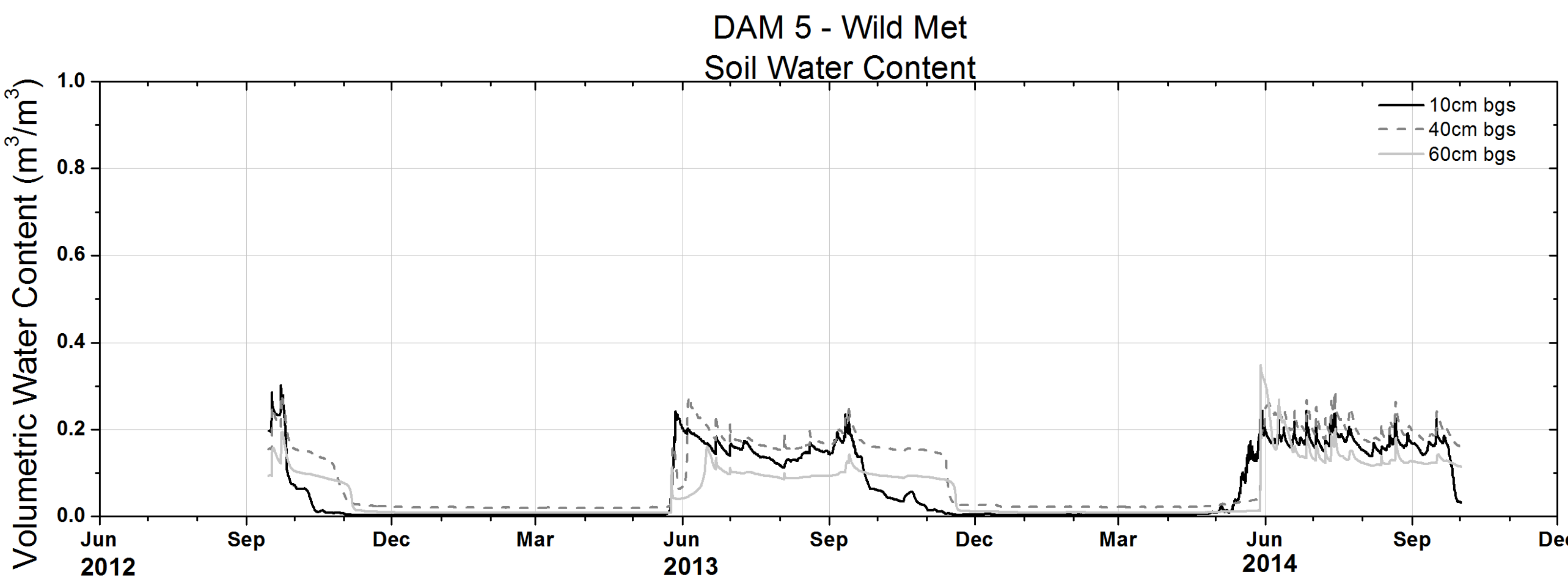


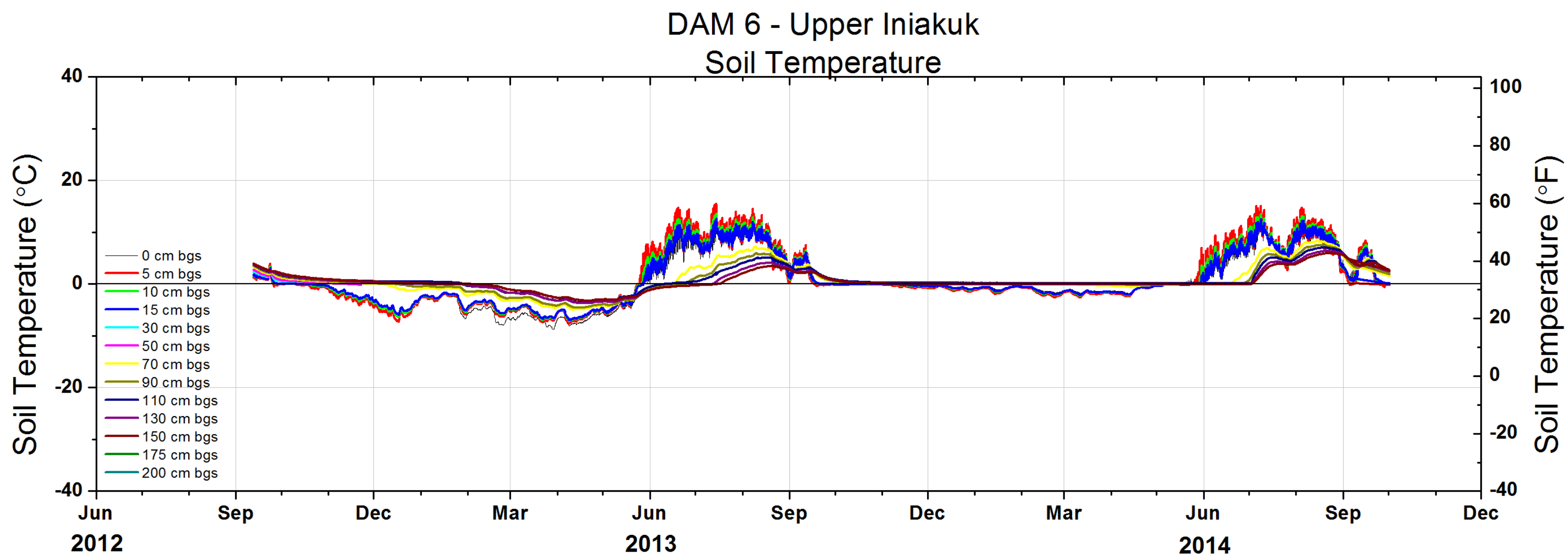
DAS 4 - Reed River
Soil Temperature
Soil Temperature (°C)
Soil Temperature (°F)
0 cm bgs
5 cm bgs
10 cm bgs
15 cm bgs
30 cm bgs
50 cm bgs
70 cm bgs
90 cm bgs
110 cm bgs
130 cm bgs
150 cm bgs
175 cm bgs
200 cm bgs
40
20
0
-20
-40
100
80
60
40
20
0
-20
-40
Jun
Sep
Dec
Mar
Jun
Sep
Dec
Mar
Jun
Sep
Dec
2012
2013
2014

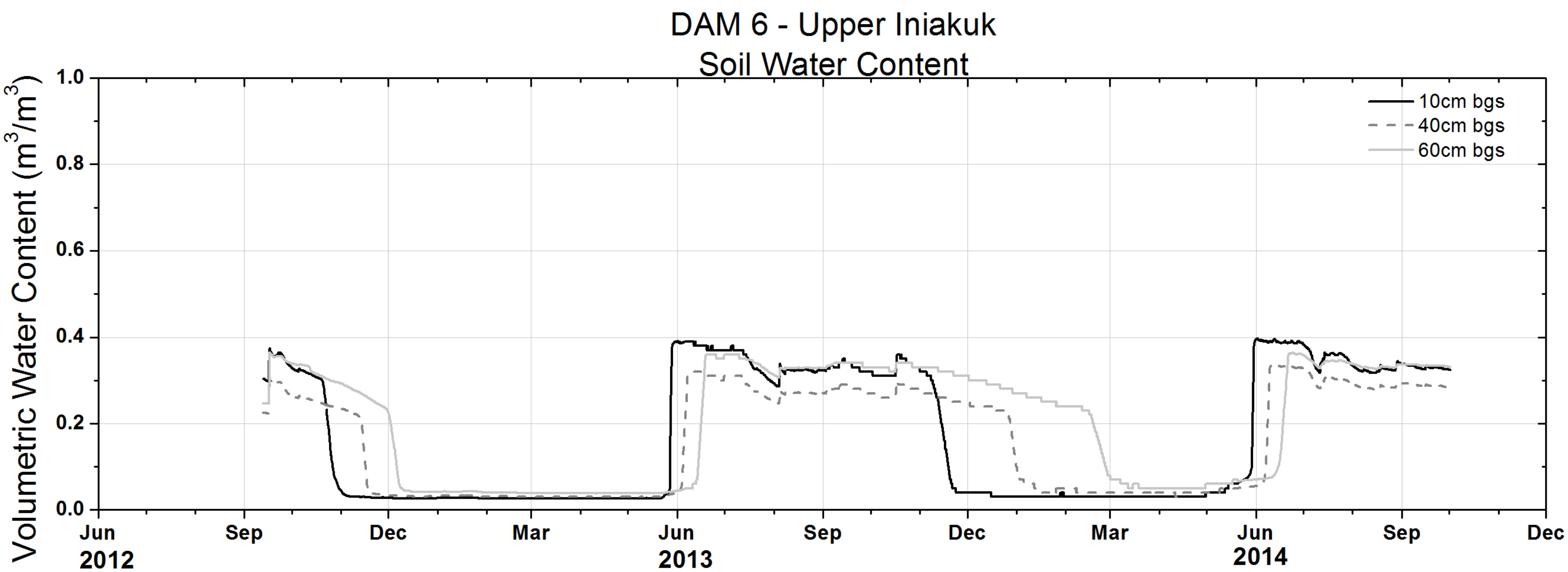



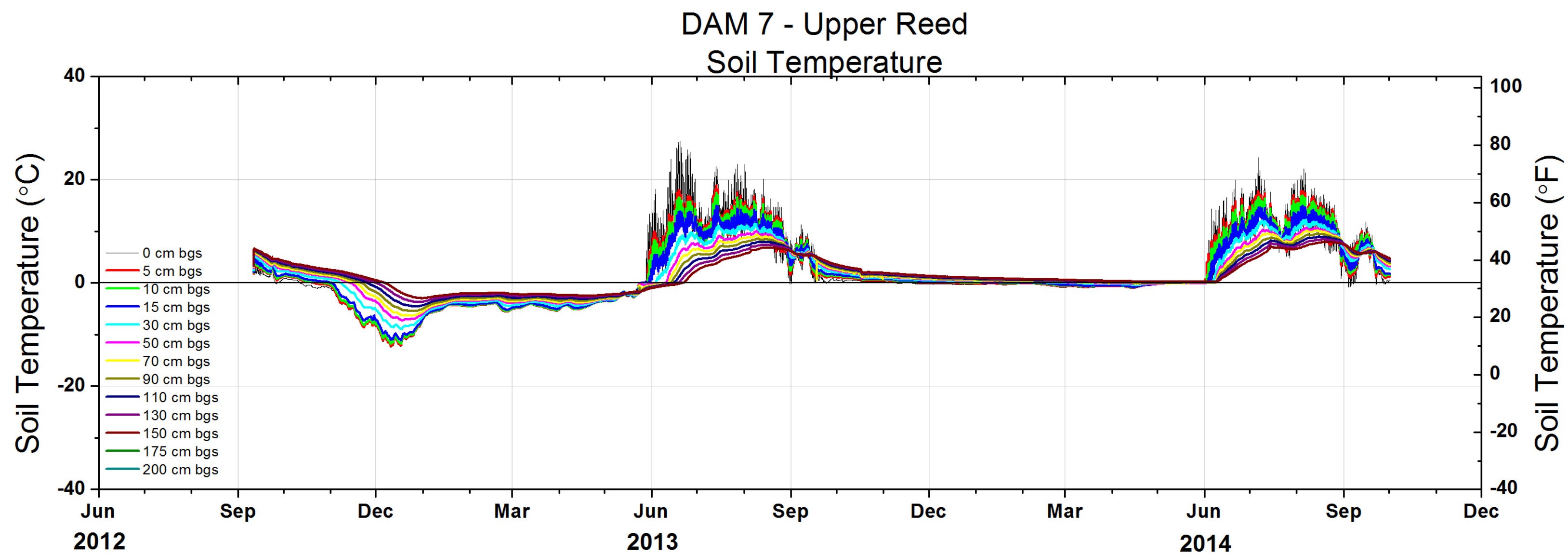
DAS 4 - Reed River
Soil Water Content
Volumetric Water Content (m3/m3)
10cm bgs
40cm bgs
60cm bgs
1.0
0.8
0.6
0.4
0.2
0.0
Jun
Sep
Dec
Mar
Jun
Sep
Dec
Mar
Jun
Sep
Dec
2012
2013
2014


DAM 5 - Wild Met
Soil Temperature
Soil Temperature (°C)
Soil Temperature (°F)
0 cm bgs
5 cm bgs
10 cm bgs
15 cm bgs
30 cm bgs
50 cm bgs
70 cm bgs
90 cm bgs
110 cm bgs
130 cm bgs
150 cm bgs
175 cm bgs
200 cm bgs
Jun
Sep
Dec
Mar
2012
2013
2014

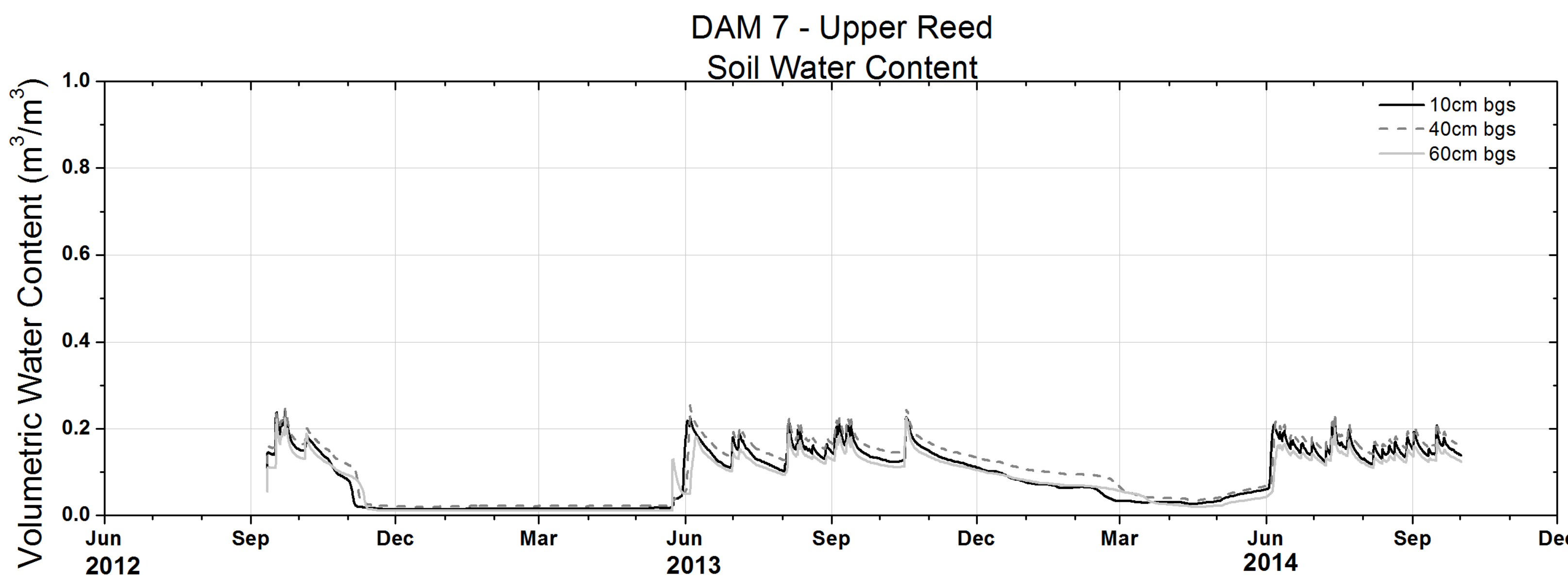

DAM 5 - Wild Met
Soil Water Content
Volumetric Water Content (m3/m3)
10cm bgs
40cm bgs
60cm bgs
Jun
Sep
Dec
Mar
2012
2013
2014


DAM 6 - Upper Iniakuk
Soil Temperature
Soil Temperature (°C)
Soil Temperature (°F)
40
20
0
-20
-40
100
80
60
40
20
0
-20
-40
0 cm bgs
5 cm bgs
10 cm bgs
15 cm bgs
30 cm bgs
50 cm bgs
70 cm bgs
90 cm bgs
110 cm bgs
130 cm bgs
150 cm bgs
175 cm bgs
200 cm bgs
Jun
Sep
Dec
Mar
Jun
Sep
Dec
Mar
Jun
Sep
Dec
2012
2013
2014

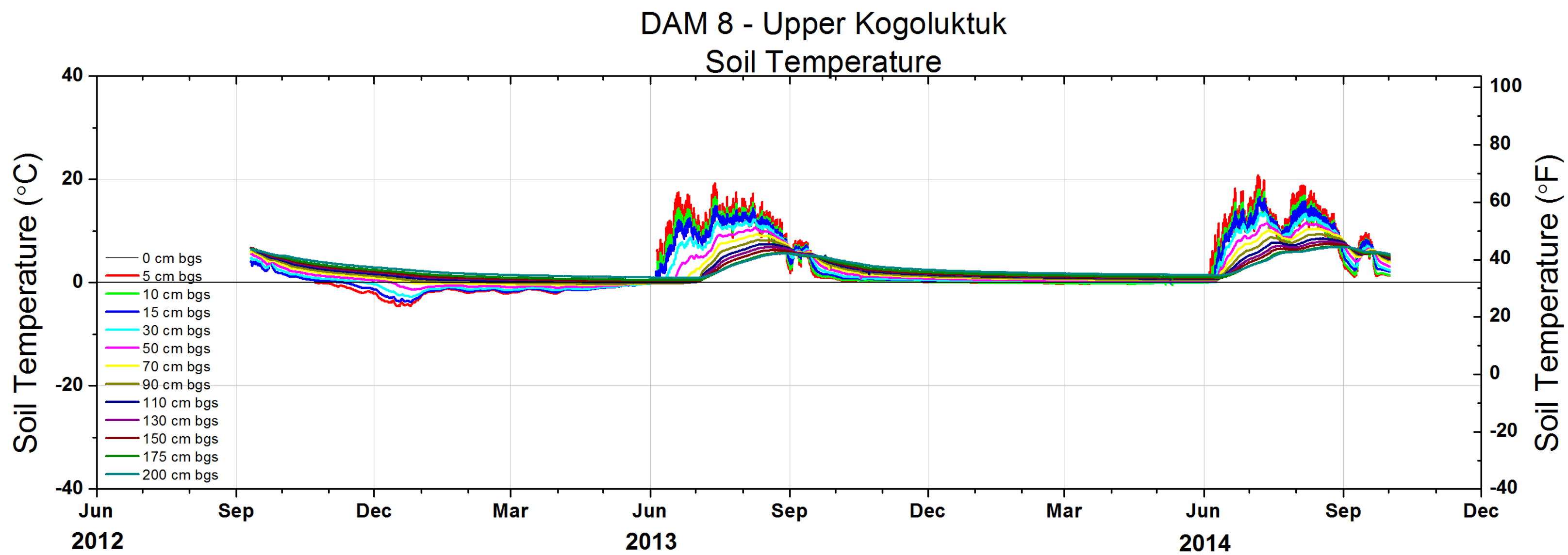

DAM 6 - Upper Iniakuk
Soil Water Content
Volumetric Water Content (m³/m³)
1.0
0.8
0.6
0.4
0.2
0.0
10cm bgs
40cm bgs
60cm bgs
Jun
Sep
Dec
Mar
Jun
Sep
Dec
Mar
Jun
Sep
Dec
2012
2013
2014



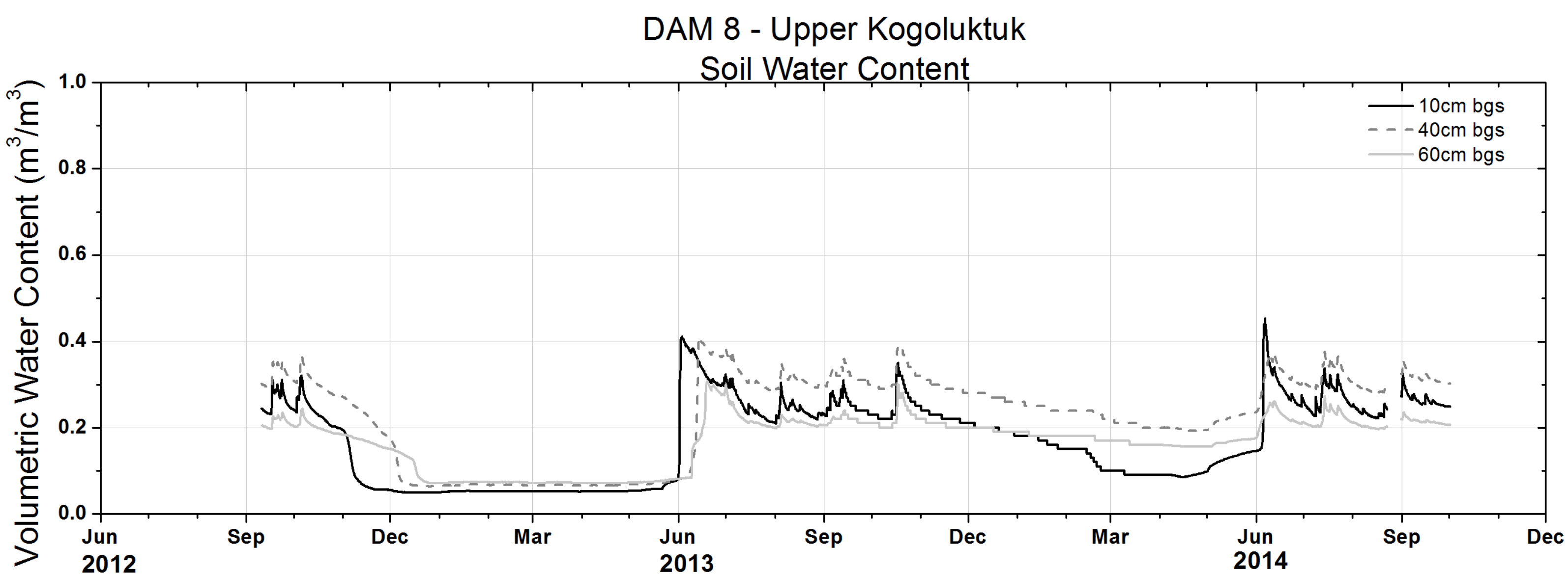
DAM 7 - Upper Reed
Soil Temperature
Soil Temperature (°C)
Soil Temperature (°F)
0 cm bgs
5 cm bgs
10 cm bgs
15 cm bgs
30 cm bgs
50 cm bgs
70 cm bgs
90 cm bgs
110 cm bgs
130 cm bgs
150 cm bgs
175 cm bgs
200 cm bgs
Jun 2012
Sep
Dec
Mar
Jun 2013
Sep
Dec
Mar
Jun 2014
Sep
Dec

DAM 7 - Upper Reed
Soil Water Content
Volumetric Water Content (m3/m3)
10cm bgs
40cm bgs
60cm bgs
Jun 2012
Sep
Dec
Mar
Jun 2013
Sep
Dec
Mar
Jun 2014
Sep
Dec



DAM 8 - Upper Kogoluktuk
Soil Temperature
Soil Temperature (°C)
Soil Temperature (°F)
40
20
0
-20
-40
100
80
60
40
20
0
-20
-40
0 cm bgs
5 cm bgs
10 cm bgs
15 cm bgs
30 cm bgs
50 cm bgs
70 cm bgs
90 cm bgs
110 cm bgs
130 cm bgs
150 cm bgs
175 cm bgs
200 cm bgs
Jun
Sep
Dec
Mar
Jun
Sep
Dec
Mar
Jun
Sep
Dec
2012
2013
2014

DAM 8 - Upper Kogoluktuk
Soil Water Content
Volumetric Water Content (m³/m³)
1.0
0.8
0.6
0.4
0.2
0.0
10cm bgs
40cm bgs
60cm bgs
Jun
Sep
Dec
Mar
Jun
Sep
Dec
Mar
Jun
Sep
Dec
2012
2013
2014

Table D-1. Average monthly soil temperature at 5 cm below ground surface (bgs) summary (in degrees C and F) for stations in the Ambler project.

| Soil Temperature at 5 cm bgs | DAS1 - Bettles Met | | DAS2 - Alatna River | | DAS3 - South Fork Bedrock Creek | | DAS4 - Reed River | |
|---|---|---|---|---|---|---|---|---|
| Period of Record | Oct/12-Sept/14 | | Oct/12-Sept/14 | | Sept/12-Sept/14 | | Oct/12-Sept/14 | |
| Month | (°C) | (°F) | (°C) | (°F) | (°C) | (°F) | (°C) | (°F) |
| **October** | | | | | | | | |
| Maximum | 1.79 | 35.22 | 1.56 | 34.80 | 0.00 | 31.99 | 3.43 | 38.18 |
| Average | -1.83 | 28.71 | -0.20 | 31.65 | -1.42 | 29.44 | -1.66 | 29.01 |
| Minimum | -8.21 | 17.21 | -1.63 | 29.06 | -4.06 | 24.68 | -6.31 | 20.65 |
| n | 2 | | 2 | | 2 | | 2 | |
| **November** | | | | | | | | |
| Maximum | -2.75 | 27.06 | -1.12 | 29.98 | -2.48 | 27.54 | -3.52 | 25.67 |
| Average | -7.68 | 18.17 | -4.65 | 23.63 | -8.59 | 16.53 | -10.21 | 13.62 |
| Minimum | -11.86 | 10.65 | -6.33 | 20.62 | -10.92 | 12.35 | -12.78 | 9.01 |
| n | 2 | | 2 | | 2 | | 2 | |
| **December** | | | | | | | | |
| Maximum | -5.71 | 21.72 | -3.39 | 25.89 | -6.62 | 20.08 | -7.69 | 18.17 |
| Average | -9.86 | 14.25 | -5.84 | 21.50 | -10.77 | 12.62 | -12.30 | 9.87 |
| Minimum | -14.20 | 6.44 | -7.71 | 18.13 | -13.68 | 7.38 | -15.24 | 4.57 |
| n | 2 | | 2 | | 2 | | 2 | |
| **January** | | | | | | | | |
| Maximum | -4.37 | 24.14 | -2.45 | 27.59 | -5.74 | 21.68 | -6.37 | 20.54 |
| Average | -5.49 | 22.11 | -3.05 | 26.52 | -6.98 | 19.44 | -7.29 | 18.88 |
| Minimum | -7.61 | 18.30 | -3.58 | 25.55 | -8.32 | 17.02 | -8.79 | 16.18 |
| n | 2 | | 2 | | 2 | | 2 | |
| **February** | | | | | | | | |
| Maximum | -4.34 | 24.18 | -2.93 | 26.73 | -5.88 | 21.42 | -5.79 | 21.59 |
| Average | -5.14 | 22.75 | -3.32 | 26.03 | -7.37 | 18.73 | -6.68 | 19.98 |
| Minimum | -6.03 | 21.14 | -3.72 | 25.30 | -8.74 | 16.26 | -7.93 | 17.72 |
| n | 2 | | 2 | | 2 | | 2 | |
| **March** | | | | | | | | |
| Maximum | -4.86 | 23.26 | -3.19 | 26.26 | -6.94 | 19.51 | -5.96 | 21.27 |
| Average | -5.34 | 22.39 | -3.67 | 25.40 | -7.64 | 18.24 | -6.51 | 20.28 |
| Minimum | -5.80 | 21.56 | -4.08 | 24.66 | -8.42 | 16.84 | -7.01 | 19.38 |
| n | 2 | | 2 | | 2 | | 2 | |
| **April** | | | | | | | | |
| Maximum | -2.50 | 27.51 | -2.60 | 27.33 | -3.43 | 25.83 | -3.49 | 25.71 |
| Average | -3.82 | 25.12 | -3.33 | 26.01 | -5.90 | 21.38 | -5.11 | 22.80 |
| Minimum | -5.11 | 22.80 | -3.86 | 25.05 | -7.58 | 18.35 | -6.38 | 20.51 |
| n | 2 | | 2 | | 2 | | 2 | |
| **May** | | | | | | | | |
| Maximum | 15.14 | 59.24 | 4.79 | 40.62 | 7.82 | 46.08 | 14.27 | 57.69 |
| Average | 1.34 | 34.41 | -0.43 | 31.23 | -0.77 | 30.61 | 1.27 | 34.29 |
| Minimum | -2.50 | 27.50 | -2.68 | 27.18 | -3.53 | 25.65 | -3.59 | 25.55 |
| n | 2 | | 2 | | 2 | | 2 | |
| **June** | | | | | | | | |
| Maximum | 21.10 | 69.98 | 11.08 | 51.94 | 13.30 | 55.93 | 21.08 | 69.94 |
| Average | 9.67 | 49.40 | 7.00 | 44.60 | 7.92 | 46.26 | 13.11 | 55.59 |
| Minimum | 0.83 | 33.50 | 1.29 | 34.33 | 1.05 | 33.89 | 4.55 | 40.19 |
| n | 2 | | 2 | | 2 | | 2 | |
| **July** | | | | | | | | |
| Maximum | 22.17 | 71.90 | 12.96 | 55.32 | 14.64 | 58.35 | 22.70 | 72.85 |
| Average | 11.03 | 51.85 | 10.02 | 50.03 | 9.78 | 49.61 | 14.76 | 58.56 |
| Minimum | 2.55 | 36.59 | 7.30 | 45.13 | 4.38 | 39.88 | 8.05 | 46.48 |
| n | 2 | | 2 | | 2 | | 2 | |
| **August** | | | | | | | | |
| Maximum | 20.99 | 69.77 | 12.14 | 53.84 | 13.61 | 56.50 | 19.85 | 67.73 |
| Average | 9.25 | 48.64 | 8.87 | 47.97 | 7.91 | 46.24 | 13.07 | 55.52 |
| Minimum | -0.60 | 30.91 | 4.15 | 39.47 | 1.07 | 33.93 | 3.75 | 38.76 |
| n | 2 | | 2 | | 2 | | 2 | |
| **September** | | | | | | | | |
| Maximum | 12.54 | 54.56 | 7.14 | 44.86 | 8.51 | 47.31 | 10.54 | 50.97 |
| Average | 2.91 | 37.24 | 3.30 | 37.95 | 1.90 | 35.41 | 4.79 | 40.62 |
| Minimum | -4.19 | 24.45 | 0.34 | 32.61 | -0.26 | 31.53 | 0.25 | 32.46 |
| n | 2 | | 2 | | 2 | | 2 | |

n = number of monthly records used to calculate statistic

| Soil Temperature at 5 cm bgs | DAM5 - Wild Met | | DAM6 - Upper Iniakuk | | DAM7 - Upper Reed River | | DAM8 - Upper Kogoluktuk | |
|---|---|---|---|---|---|---|---|---|
| Period of Record | Oct/12-Sept/14 | | Oct/12-Sept/14 | | Oct/12-Sept/14 | | Sept/12-Sept/14 | |
| Month | (°C) | (°F) | (°C) | (°F) | (°C) | (°F) | (°C) | (°F) |
| **October** | | | | | | | | |
| Maximum | -0.07 | 31.88 | -0.01 | 31.98 | 1.25 | 34.25 | 0.85 | 33.53 |
| Average | -0.86 | 30.45 | -0.22 | 31.61 | 0.54 | 32.97 | 0.36 | 32.65 |
| Minimum | -2.27 | 27.92 | -0.62 | 30.88 | -0.05 | 31.91 | 0.23 | 32.41 |
| n | 2 | | 2 | | 2 | | 1 | |
| **November** | | | | | | | | |
| Maximum | -2.00 | 28.39 | -0.48 | 31.13 | -0.03 | 31.96 | 0.04 | 32.08 |
| Average | -7.26 | 18.94 | -1.60 | 29.11 | -2.54 | 27.43 | -0.55 | 31.02 |
| Minimum | -12.26 | 9.94 | -2.66 | 27.21 | -4.26 | 24.33 | -1.05 | 30.11 |
| n | 2 | | 2 | | 2 | | 2 | |
| **December** | | | | | | | | |
| Maximum | -6.55 | 20.21 | -1.52 | 29.26 | -3.48 | 25.73 | -0.99 | 30.23 |
| Average | -12.30 | 9.86 | -3.12 | 26.38 | -5.15 | 22.73 | -1.84 | 28.69 |
| Minimum | -16.72 | 1.91 | -4.45 | 23.99 | -6.20 | 20.85 | -2.33 | 27.80 |
| n | 2 | | 2 | | 2 | | 2 | |
| **January** | | | | | | | | |
| Maximum | -7.96 | 17.68 | -1.18 | 29.88 | -2.17 | 28.09 | -0.62 | 30.88 |
| Average | -12.09 | 10.24 | -2.03 | 28.35 | -2.56 | 27.39 | -0.87 | 30.43 |
| Minimum | -18.17 | -0.71 | -3.93 | 24.94 | -3.60 | 25.51 | -1.34 | 29.58 |
| n | 2 | | 2 | | 2 | | 2 | |
| **February** | | | | | | | | |
| Maximum | -9.49 | 14.92 | -1.98 | 28.44 | -2.00 | 28.40 | -0.74 | 30.68 |
| Average | -13.93 | 6.92 | -3.15 | 26.34 | -2.44 | 27.62 | -0.97 | 30.26 |
| Minimum | -18.39 | -1.09 | -4.47 | 23.96 | -3.13 | 26.37 | -1.23 | 29.79 |
| n | 2 | | 2 | | 2 | | 2 | |
| **March** | | | | | | | | |
| Maximum | -9.79 | 14.39 | -2.80 | 26.96 | -2.32 | 27.82 | -0.73 | 30.68 |
| Average | -14.04 | 6.73 | -3.83 | 25.11 | -2.69 | 27.16 | -0.95 | 30.28 |
| Minimum | -19.80 | -3.63 | -5.03 | 22.95 | -3.10 | 26.42 | -1.23 | 29.78 |
| n | 2 | | 2 | | 2 | | 2 | |
| **April** | | | | | | | | |
| Maximum | -5.02 | 22.96 | -2.44 | 27.62 | -1.87 | 28.64 | -0.03 | 31.94 |
| Average | -11.20 | 11.84 | -3.69 | 25.35 | -2.52 | 27.46 | -0.18 | 31.68 |
| Minimum | -19.42 | -2.96 | -5.06 | 22.89 | -3.06 | 26.49 | -0.30 | 31.47 |
| n | 2 | | 2 | | 2 | | 1 | |
| **May** | | | | | | | | |
| Maximum | 11.14 | 52.04 | 7.39 | 45.30 | 3.51 | 38.31 | 0.06 | 32.10 |
| Average | -2.34 | 27.80 | -0.91 | 30.37 | -0.85 | 30.47 | 0.03 | 32.05 |
| Minimum | -10.74 | 12.68 | -3.20 | 26.25 | -1.92 | 28.55 | -0.50 | 31.09 |
| n | 2 | | 2 | | 2 | | 1 | |
| **June** | | | | | | | | |
| Maximum | 18.32 | 64.97 | 13.73 | 56.71 | 17.22 | 63.00 | 17.86 | 64.14 |
| Average | 8.71 | 47.68 | 7.32 | 45.18 | 9.04 | 48.27 | 9.26 | 48.68 |
| Minimum | 0.60 | 33.07 | 0.63 | 33.13 | 0.58 | 33.05 | 0.99 | 33.78 |
| n | 2 | | 2 | | 2 | | 2 | |
| **July** | | | | | | | | |
| Maximum | 19.87 | 67.77 | 15.32 | 59.58 | 18.34 | 65.00 | 20.05 | 68.09 |
| Average | 10.18 | 50.33 | 9.40 | 48.93 | 11.75 | 53.15 | 12.50 | 54.50 |
| Minimum | 3.56 | 38.40 | 4.25 | 39.66 | 6.86 | 44.35 | 6.68 | 44.02 |
| n | 2 | | 2 | | 2 | | 2 | |
| **August** | | | | | | | | |
| Maximum | 17.73 | 63.91 | 14.65 | 58.37 | 17.34 | 63.21 | 18.06 | 64.50 |
| Average | 8.63 | 47.54 | 8.66 | 47.59 | 10.91 | 51.64 | 11.37 | 52.47 |
| Minimum | -0.01 | 31.98 | 1.20 | 34.15 | 2.44 | 36.39 | 3.43 | 38.17 |
| n | 2 | | 2 | | 2 | | 2 | |
| **September** | | | | | | | | |
| Maximum | 8.22 | 46.79 | 7.99 | 46.39 | 9.54 | 49.17 | 8.88 | 47.98 |
| Average | 1.30 | 34.34 | 2.03 | 35.65 | 3.86 | 38.96 | 3.54 | 38.37 |
| Minimum | -1.57 | 29.18 | -0.53 | 31.04 | 0.98 | 33.76 | 0.94 | 33.69 |
| n | 2 | | 2 | | 2 | | 2 | |

n = number of monthly records used to calculate statistic

Table D-2. Unfrozen soil water content (volume fraction) summary (in $cm^3/cm^3$) at 10, 40, or 60 cm below ground surface (bgs), except where specified differently, for stations in the Ambler project.

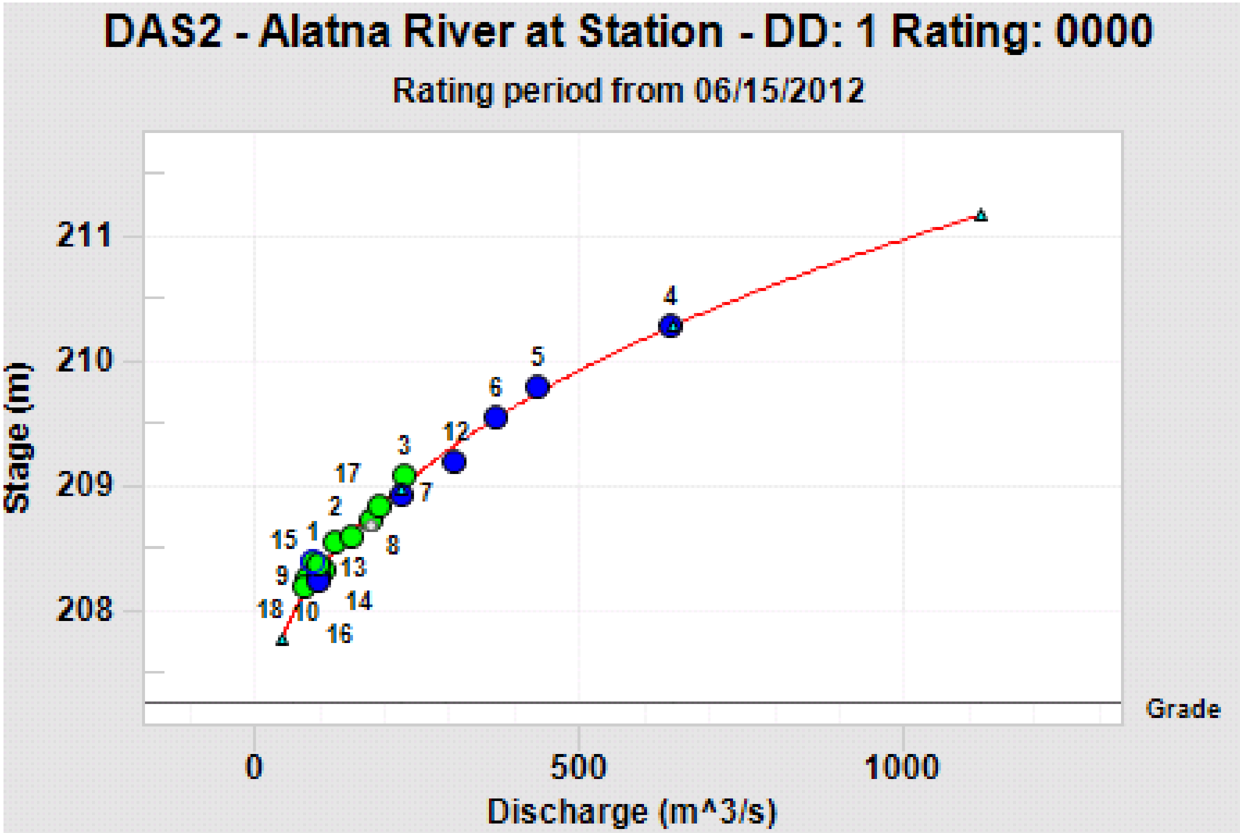
| **Volumetric Water Content** | **DAS1 - Bettles Met** | | | **DAS2 - Alatna River** | | | **DAS3 - South Fork Bedrock Creek** | | | **DAS4 - Reed River** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Oct/12 - Sept/14** | | | **Oct/12 - Sept/14** | | | **Sept/12 - Sept/14** | | | **Oct/12 - Sept/14** | | |
| Month | 10-cm Depth | 40-cm Depth | 60-cm Depth | 10-cm Depth | 25-cm Depth | 40-cm Depth | 10-cm Depth | 40-cm Depth | 60-cm Depth | 10-cm Depth | 40-cm Depth | 60-cm Depth |
| **October** | | | | | | | | | | | | |
| Maximum | 0.328 | 0.219 | 0.173 | 0.507 | 0.450 | 0.470 | 0.215 | 0.408 | 0.522 | 0.149 | 0.141 | 0.085 |
| Average | 0.153 | 0.164 | 0.132 | 0.406 | 0.399 | 0.463 | 0.106 | 0.321 | 0.418 | 0.064 | 0.067 | 0.044 |
| Minimum | 0.024 | 0.098 | 0.110 | 0.249 | 0.362 | 0.456 | 0.059 | 0.170 | 0.299 | 0.039 | 0.040 | 0.023 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 |
| **November** | | | | | | | | | | | | |
| Maximum | 0.024 | 0.099 | 0.113 | 0.254 | 0.372 | 0.456 | 0.059 | 0.189 | 0.408 | 0.044 | 0.045 | 0.028 |
| Average | 0.013 | 0.087 | 0.074 | 0.246 | 0.271 | 0.419 | 0.014 | 0.155 | 0.260 | 0.029 | 0.033 | 0.022 |
| Minimum | 0.009 | 0.076 | 0.058 | 0.243 | 0.195 | 0.286 | 0.005 | 0.125 | 0.215 | 0.013 | 0.030 | 0.017 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **December** | | | | | | | | | | | | |
| Maximum | 0.012 | 0.077 | 0.079 | 0.244 | 0.195 | 0.285 | 0.005 | 0.125 | 0.215 | 0.013 | 0.030 | 0.017 |
| Average | 0.009 | 0.055 | 0.052 | 0.224 | 0.176 | 0.239 | 0.004 | 0.065 | 0.180 | 0.012 | 0.018 | 0.014 |
| Minimum | 0.008 | 0.032 | 0.036 | 0.173 | 0.163 | 0.223 | 0.003 | 0.020 | 0.130 | 0.008 | 0.010 | 0.007 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **January** | | | | | | | | | | | | |
| Maximum | 0.009 | 0.032 | 0.037 | 0.174 | 0.164 | 0.223 | 0.003 | 0.021 | 0.131 | 0.008 | 0.010 | 0.007 |
| Average | 0.008 | 0.027 | 0.025 | 0.102 | 0.152 | 0.209 | 0.002 | 0.020 | 0.050 | 0.008 | 0.010 | 0.007 |
| Minimum | 0.007 | 0.026 | 0.021 | 0.054 | 0.144 | 0.192 | 0.002 | 0.019 | 0.034 | 0.008 | 0.010 | 0.007 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **February** | | | | | | | | | | | | |
| Maximum | 0.008 | 0.026 | 0.022 | 0.054 | 0.144 | 0.192 | 0.003 | 0.020 | 0.035 | 0.009 | 0.010 | 0.007 |
| Average | 0.007 | 0.025 | 0.021 | 0.042 | 0.139 | 0.182 | 0.001 | 0.019 | 0.032 | 0.008 | 0.010 | 0.007 |
| Minimum | 0.006 | 0.024 | 0.020 | 0.034 | 0.133 | 0.172 | 0.001 | 0.018 | 0.030 | 0.008 | 0.010 | 0.007 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **March** | | | | | | | | | | | | |
| Maximum | 0.006 | 0.024 | 0.020 | 0.034 | 0.133 | 0.172 | 0.001 | 0.018 | 0.030 | 0.009 | 0.010 | 0.007 |
| Average | 0.005 | 0.023 | 0.019 | 0.034 | 0.128 | 0.159 | 0.001 | 0.018 | 0.029 | 0.008 | 0.010 | 0.007 |
| Minimum | 0.005 | 0.023 | 0.019 | 0.034 | 0.123 | 0.147 | 0.001 | 0.018 | 0.029 | 0.008 | 0.010 | 0.007 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **April** | | | | | | | | | | | | |
| Maximum | 0.111 | 0.028 | 0.022 | 0.044 | 0.203 | 0.232 | 0.073 | 0.025 | 0.037 | 0.065 | 0.062 | 0.035 |
| Average | 0.027 | 0.024 | 0.020 | 0.035 | 0.121 | 0.143 | 0.007 | 0.019 | 0.030 | 0.021 | 0.016 | 0.008 |
| Minimum | 0.005 | 0.023 | 0.019 | 0.034 | 0.108 | 0.132 | 0.001 | 0.018 | 0.029 | 0.009 | 0.010 | 0.005 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **May** | | | | | | | | | | | | |
| Maximum | 0.515 | 0.231 | 0.155 | 0.438 | 0.241 | 0.250 | 0.290 | 0.281 | 0.157 | 0.158 | 0.184 | 0.121 |
| Average | 0.174 | 0.059 | 0.044 | 0.180 | 0.228 | 0.243 | 0.136 | 0.188 | 0.080 | 0.070 | 0.069 | 0.043 |
| Minimum | 0.043 | 0.029 | 0.022 | 0.044 | 0.193 | 0.227 | 0.066 | 0.025 | 0.034 | 0.033 | 0.034 | 0.022 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **June** | | | | | | | | | | | | |
| Maximum | 0.424 | 0.273 | 0.150 | 0.522 | 0.447 | 0.258 | 0.290 | 0.437 | 0.107 | 0.086 | 0.102 | 0.060 |
| Average | 0.266 | 0.201 | 0.119 | 0.489 | 0.289 | 0.253 | 0.217 | 0.321 | 0.081 | 0.056 | 0.063 | 0.041 |
| Minimum | 0.184 | 0.156 | 0.090 | 0.405 | 0.240 | 0.250 | 0.181 | 0.212 | 0.077 | 0.040 | 0.052 | 0.035 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **July** | | | | | | | | | | | | |
| Maximum | 0.308 | 0.229 | 0.169 | 0.516 | 0.452 | 0.458 | 0.199 | 0.427 | 0.522 | 0.098 | 0.117 | 0.068 |
| Average | 0.207 | 0.190 | 0.130 | 0.475 | 0.432 | 0.353 | 0.174 | 0.398 | 0.201 | 0.058 | 0.068 | 0.044 |
| Minimum | 0.148 | 0.181 | 0.121 | 0.460 | 0.400 | 0.256 | 3.000 | 3.000 | 3.000 | 0.030 | 0.050 | 0.034 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 |
| **August** | | | | | | | | | | | | |
| Maximum | 0.190 | 0.184 | 0.124 | 0.461 | 0.404 | 0.457 | 0.167 | 0.374 | 0.504 | 0.085 | 0.115 | 0.061 |
| Average | 0.144 | 0.179 | 0.120 | 0.453 | 0.370 | 0.453 | 0.152 | 0.360 | 0.470 | 0.053 | 0.066 | 0.042 |
| Minimum | 0.114 | 0.176 | 0.117 | 0.449 | 0.344 | 0.449 | 0.138 | 0.344 | 0.459 | 0.025 | 0.049 | 0.033 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 |
| **September** | | | | | | | | | | | | |
| Maximum | 0.264 | 0.208 | 0.141 | 0.476 | 0.405 | 0.457 | 0.178 | 0.375 | - | 0.132 | 0.136 | 0.074 |
| Average | 0.199 | 0.184 | 0.125 | 0.458 | 0.385 | 0.455 | 0.161 | 0.379 | 0.505 | 0.077 | 0.077 | 0.048 |
| Minimum | 0.162 | 0.179 | 0.121 | 0.450 | 0.345 | 0.449 | 0.130 | 0.337 | - | 0.062 | 0.061 | 0.041 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0/1 | 3 | 3 | 3 |

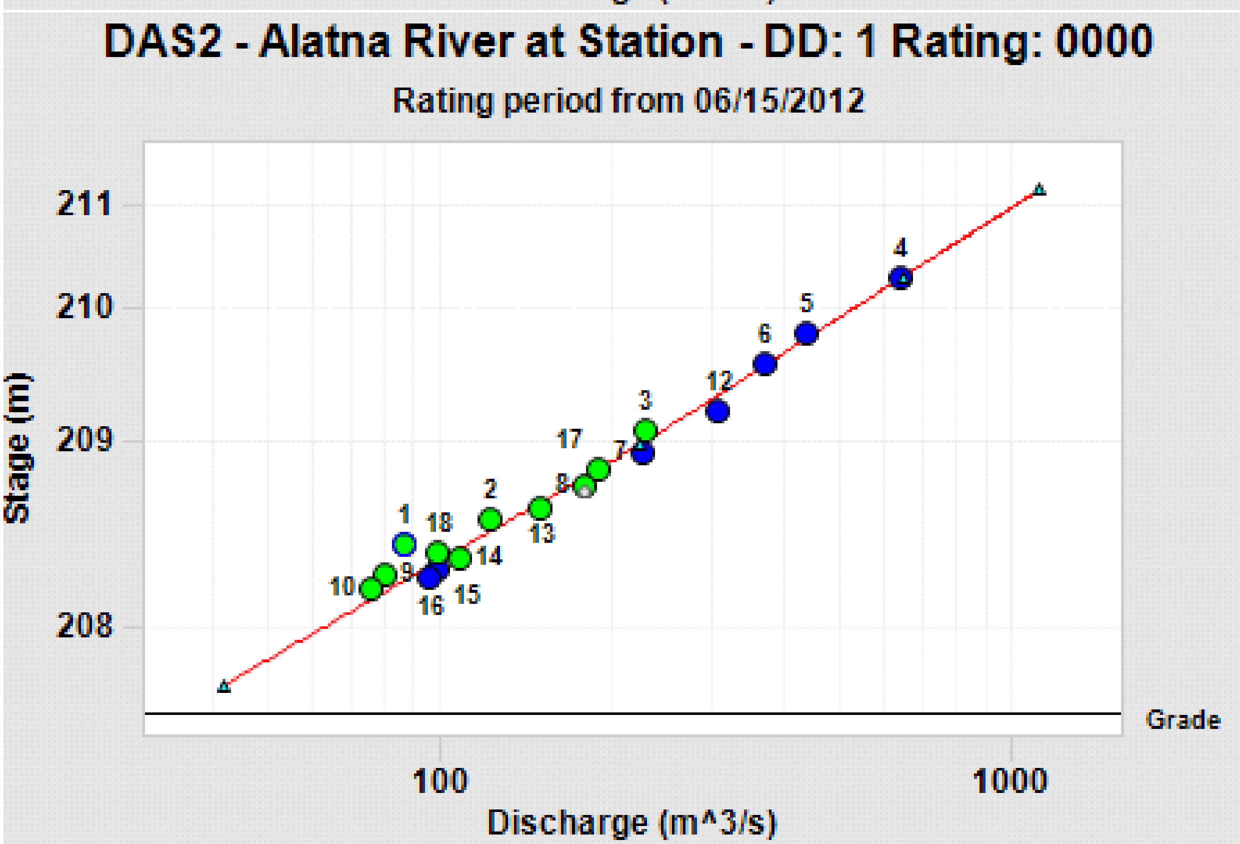
n = number of monthly records used to calculate statistic

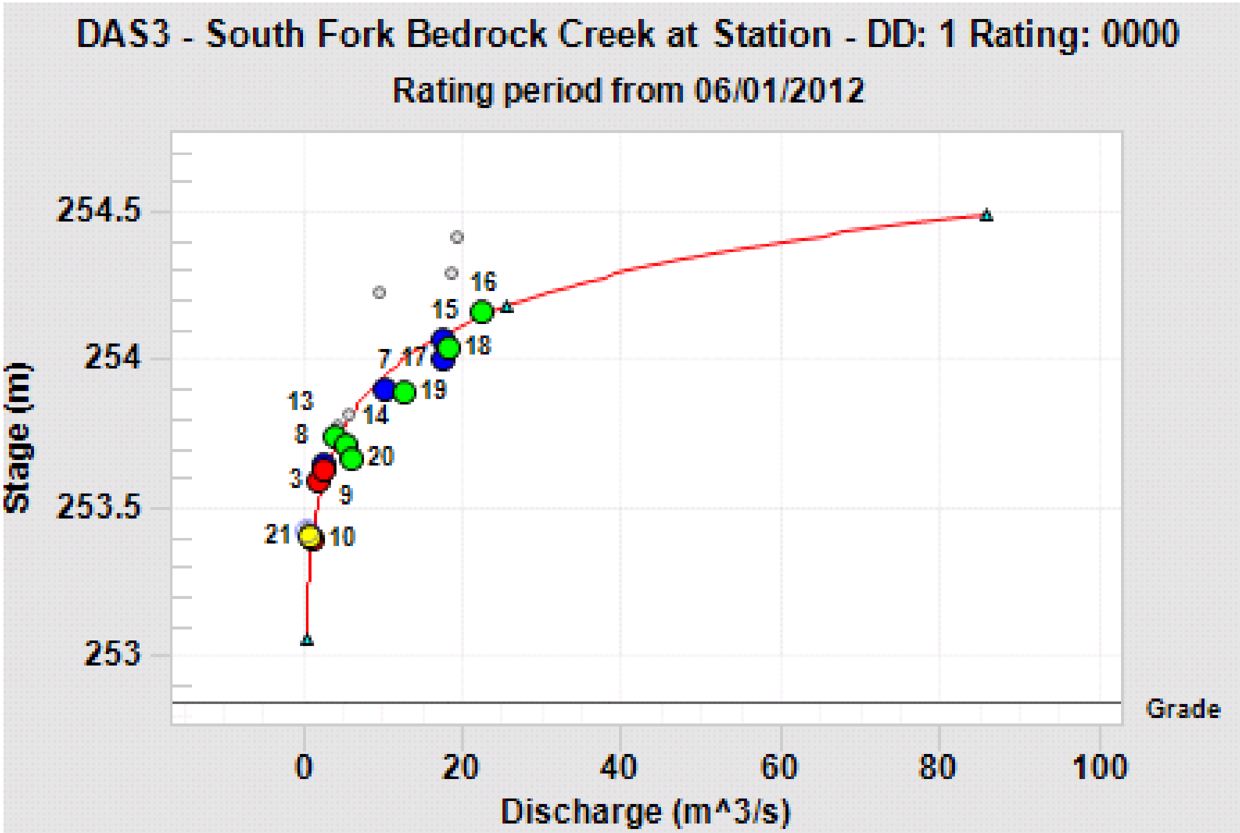
| Volumetric Water Content | DAM5 - Wild Met | | | DAM6 - Upper Iniakuk | | | DAM7 - Upper Reed River | | | DAM8 - Upper Kogoluktuk | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oct/12 - Sept/14 | | | Oct/12 - Sept/14 | | | Oct/12 - Sept/14 | | | Sept/12 - Sept/14 | | |
| Month | 10-cm Depth | 40-cm Depth | 60-cm Depth | 10-cm Depth | 40-cm Depth | 60-cm Depth | 10-cm Depth | 25-cm Depth | 40-cm Depth | 10-cm Depth | 40-cm Depth | 60-cm Depth |
| **October** | | | | | | | | | | | | |
| Maximum | 0.067 | 0.158 | 0.100 | 0.345 | 0.282 | 0.340 | 0.205 | 0.223 | 0.208 | 0.336 | 0.377 | 0.272 |
| Average | 0.035 | 0.142 | 0.092 | 0.289 | 0.262 | 0.324 | 0.141 | 0.162 | 0.131 | 0.244 | 0.312 | 0.213 |
| Minimum | 0.012 | 0.102 | 0.083 | 0.178 | 0.248 | 0.307 | 0.103 | 0.132 | 0.102 | 0.208 | 0.281 | 0.192 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **November** | | | | | | | | | | | | |
| Maximum | 0.012 | 0.103 | 0.084 | 0.188 | 0.253 | 0.312 | 0.116 | 0.144 | 0.115 | 0.222 | 0.296 | 0.202 |
| Average | 0.006 | 0.054 | 0.039 | 0.103 | 0.195 | 0.292 | 0.075 | 0.096 | 0.077 | 0.155 | 0.261 | 0.187 |
| Minimum | 0.004 | 0.025 | 0.011 | 0.034 | 0.142 | 0.268 | 0.063 | 0.078 | 0.059 | 0.133 | 0.227 | 0.175 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **December** | | | | | | | | | | | | |
| Maximum | 0.005 | 0.026 | 0.011 | 0.034 | 0.142 | 0.267 | 0.063 | 0.078 | 0.059 | 0.133 | 0.227 | 0.175 |
| Average | 0.004 | 0.023 | 0.010 | 0.031 | 0.128 | 0.178 | 0.055 | 0.070 | 0.052 | 0.124 | 0.177 | 0.152 |
| Minimum | 0.004 | 0.022 | 0.009 | 0.029 | 0.066 | 0.156 | 0.046 | 0.064 | 0.047 | 0.115 | 0.162 | 0.131 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **January** | | | | | | | | | | | | |
| Maximum | 0.005 | 0.005 | 0.005 | 0.035 | 0.067 | 0.157 | 0.047 | 0.065 | 0.047 | 0.117 | 0.164 | 0.133 |
| Average | 0.004 | 0.022 | 0.009 | 0.029 | 0.043 | 0.149 | 0.042 | 0.060 | 0.043 | 0.111 | 0.157 | 0.128 |
| Minimum | 0.004 | 0.021 | 0.009 | 0.029 | 0.036 | 0.140 | 0.039 | 0.058 | 0.040 | 0.100 | 0.153 | 0.126 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **February** | | | | | | | | | | | | |
| Maximum | 0.005 | 0.022 | 0.009 | 0.029 | 0.041 | 0.140 | 0.041 | 0.059 | 0.040 | 0.102 | 0.154 | 0.127 |
| Average | 0.004 | 0.021 | 0.009 | 0.028 | 0.037 | 0.118 | 0.035 | 0.055 | 0.038 | 0.092 | 0.151 | 0.125 |
| Minimum | 0.004 | 0.021 | 0.009 | 0.028 | 0.036 | 0.060 | 0.025 | 0.044 | 0.034 | 0.076 | 0.143 | 0.121 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **March** | | | | | | | | | | | | |
| Maximum | 0.004 | 0.022 | 0.009 | 0.029 | 0.036 | 0.060 | 0.025 | 0.044 | 0.034 | 0.077 | 0.144 | 0.122 |
| Average | 0.004 | 0.021 | 0.009 | 0.028 | 0.035 | 0.048 | 0.023 | 0.034 | 0.026 | 0.073 | 0.136 | 0.118 |
| Minimum | 0.004 | 0.021 | 0.009 | 0.028 | 0.035 | 0.044 | 0.023 | 0.031 | 0.019 | 0.071 | 0.133 | 0.116 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **April** | | | | | | | | | | | | |
| Maximum | 0.008 | 0.023 | 0.009 | 0.034 | 0.036 | 0.049 | 0.025 | 0.031 | 0.019 | 0.077 | 0.135 | 0.117 |
| Average | 0.005 | 0.021 | 0.009 | 0.028 | 0.034 | 0.044 | 0.023 | 0.030 | 0.017 | 0.071 | 0.131 | 0.115 |
| Minimum | 0.004 | 0.021 | 0.009 | 0.028 | 0.030 | 0.044 | 0.022 | 0.028 | 0.016 | 0.069 | 0.130 | 0.114 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **May** | | | | | | | | | | | | |
| Maximum | 0.243 | 0.204 | 0.231 | 0.393 | 0.048 | 0.058 | 0.112 | 0.061 | 0.087 | 0.118 | 0.159 | 0.129 |
| Average | 0.064 | 0.043 | 0.029 | 0.075 | 0.040 | 0.052 | 0.037 | 0.042 | 0.031 | 0.096 | 0.147 | 0.122 |
| Minimum | 0.006 | 0.023 | 0.009 | 0.033 | 0.035 | 0.049 | 0.025 | 0.031 | 0.017 | 0.077 | 0.132 | 0.115 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **June** | | | | | | | | | | | | |
| Maximum | 0.224 | 0.272 | 0.233 | 0.394 | 0.329 | 0.362 | 0.219 | 0.236 | 0.174 | 0.433 | 0.391 | 0.285 |
| Average | 0.175 | 0.212 | 0.137 | 0.385 | 0.268 | 0.198 | 0.156 | 0.168 | 0.124 | 0.308 | 0.294 | 0.212 |
| Minimum | 0.150 | 0.133 | 0.088 | 0.377 | 0.048 | 0.057 | 0.085 | 0.061 | 0.046 | 0.118 | 0.159 | 0.129 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **July** | | | | | | | | | | | | |
| Maximum | 0.206 | 0.243 | 0.157 | 0.382 | 0.319 | 0.359 | 0.206 | 0.220 | 0.177 | 0.329 | 0.379 | 0.287 |
| Average | 0.162 | 0.192 | 0.119 | 0.348 | 0.294 | 0.343 | 0.146 | 0.167 | 0.129 | 0.260 | 0.320 | 0.223 |
| Minimum | 0.133 | 0.165 | 0.106 | 0.305 | 0.266 | 0.321 | 0.114 | 0.138 | 0.106 | 0.219 | 0.286 | 0.201 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **August** | | | | | | | | | | | | |
| Maximum | 0.198 | 0.231 | 0.141 | 0.342 | 0.288 | 0.335 | 0.197 | 0.210 | 0.170 | 0.313 | 0.356 | 0.235 |
| Average | 0.151 | 0.178 | 0.108 | 0.322 | 0.277 | 0.329 | 0.147 | 0.167 | 0.130 | 0.241 | 0.302 | 0.208 |
| Minimum | 0.125 | 0.159 | 0.102 | 0.302 | 0.263 | 0.317 | 0.110 | 0.135 | 0.102 | 0.216 | 0.281 | 0.198 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **September** | | | | | | | | | | | | |
| Maximum | 0.234 | 0.247 | 0.143 | 0.345 | 0.292 | 0.339 | 0.210 | 0.222 | 0.180 | 0.316 | 0.357 | 0.237 |
| Average | 0.142 | 0.187 | 0.115 | 0.331 | 0.283 | 0.336 | 0.159 | 0.178 | 0.140 | 0.259 | 0.319 | 0.215 |
| Minimum | 0.048 | 0.160 | 0.105 | 0.322 | 0.277 | 0.330 | 0.134 | 0.155 | 0.121 | 0.236 | 0.296 | 0.203 |
| n | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |

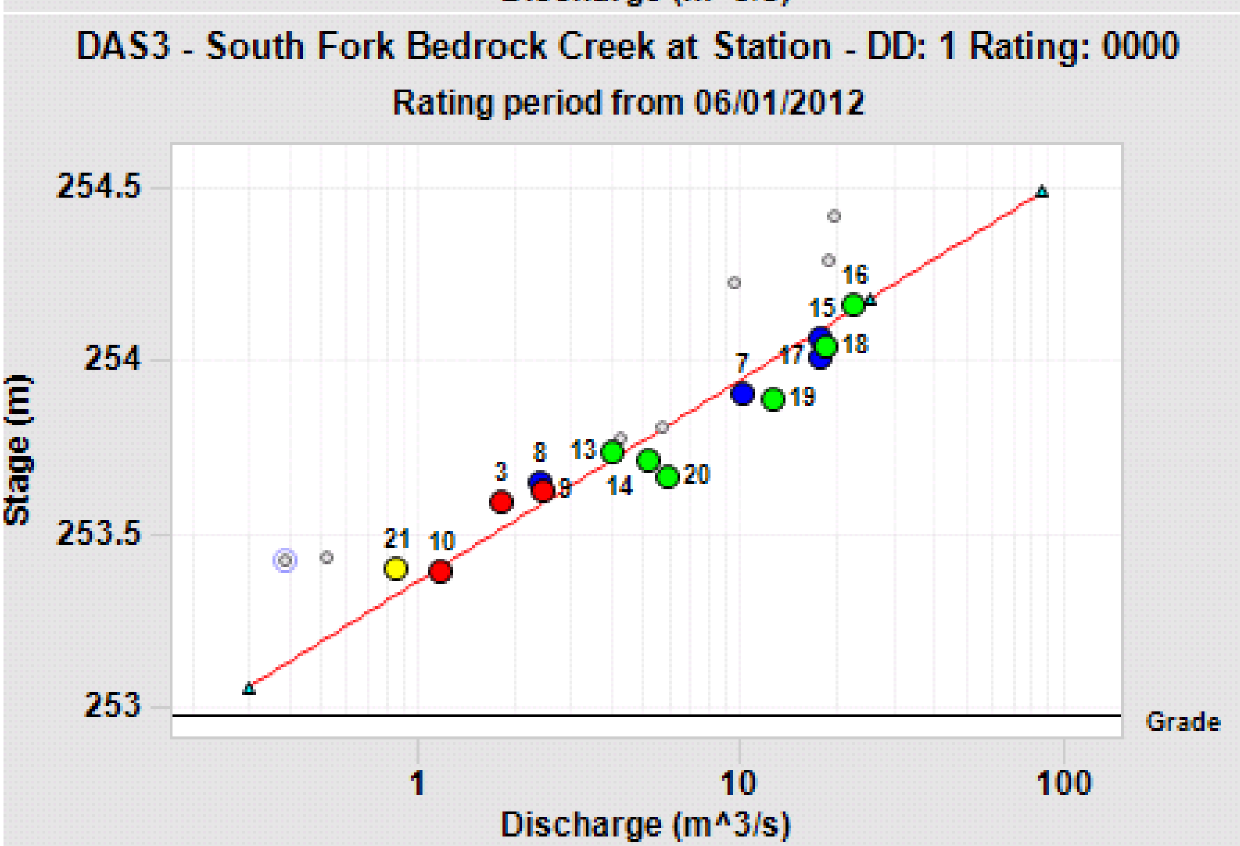
n = number of monthly records used to calculate statistic

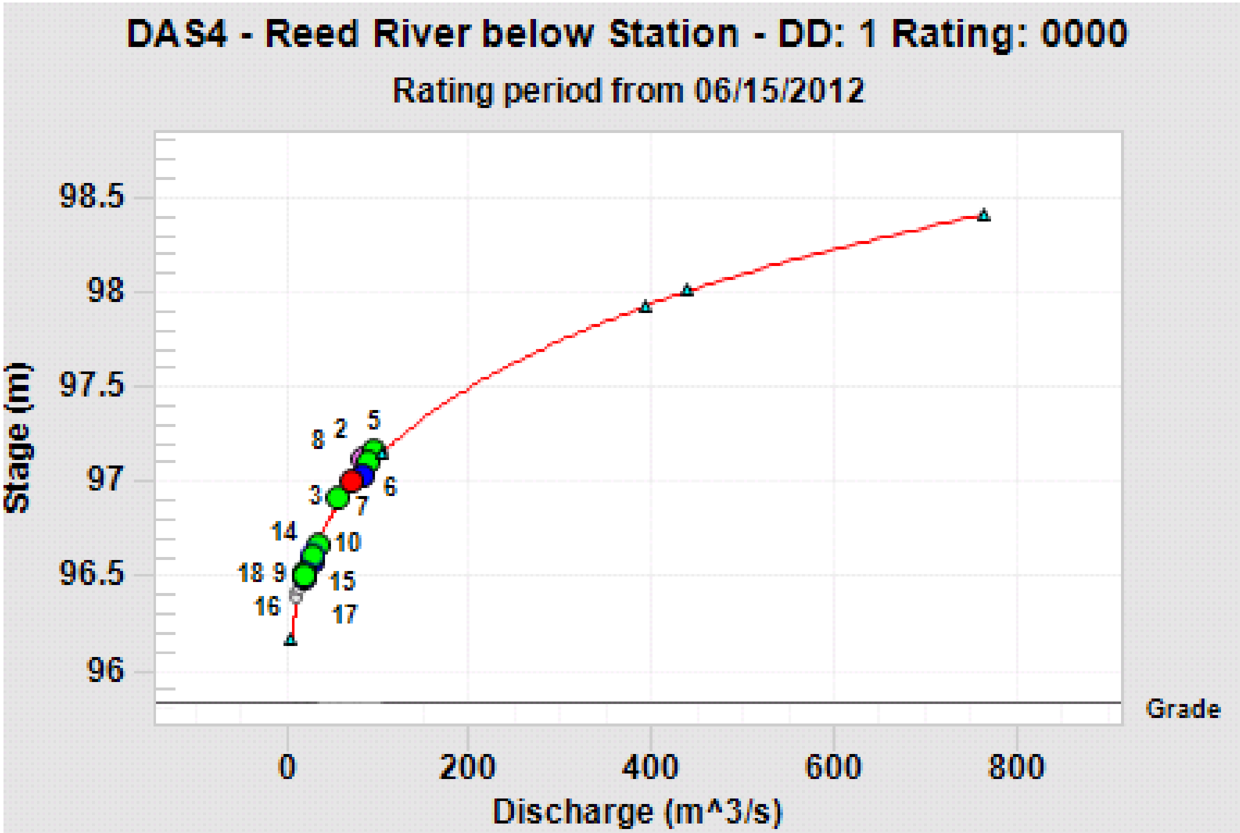
# Appendix E – Rating Curves and Stream Discharge Measurement Summaries

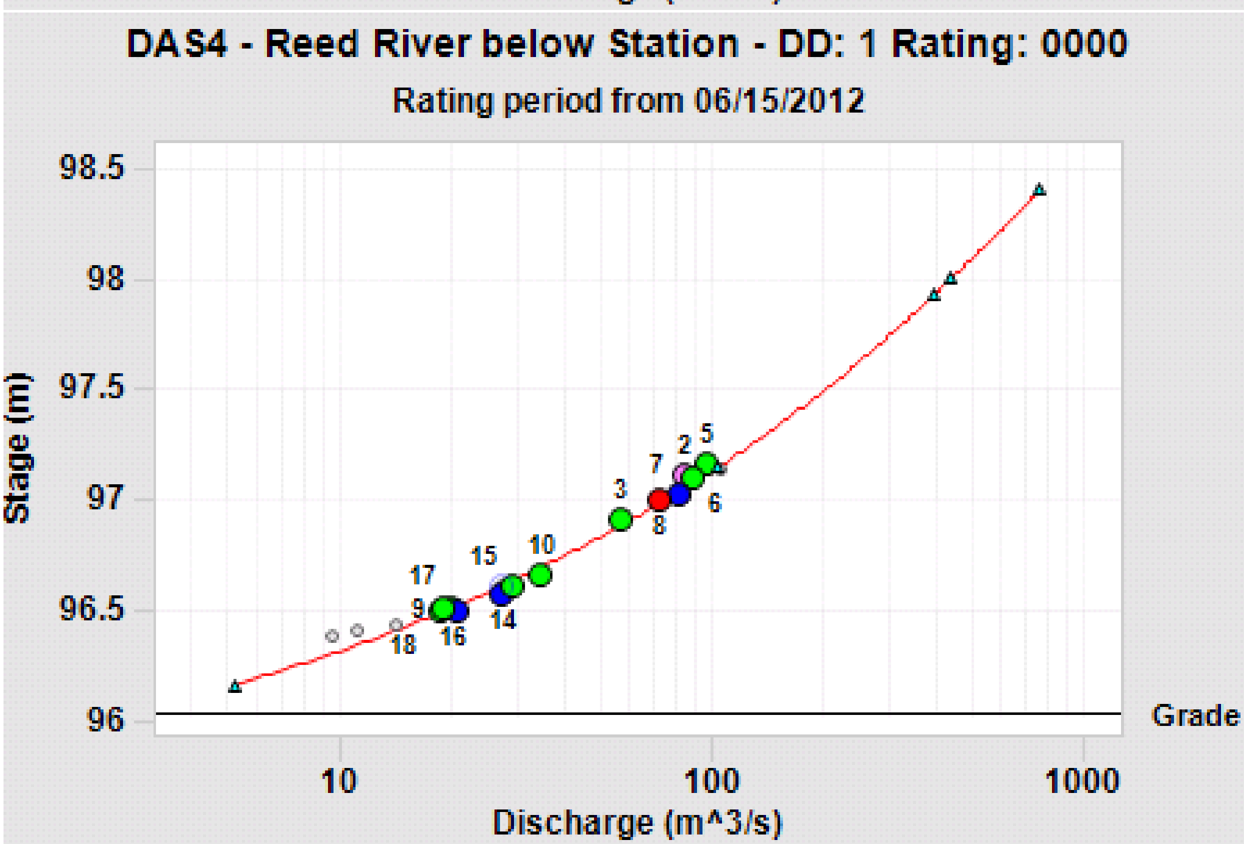

DAS2 - Alatna River at Station - DD: 1 Rating: 0000
Rating period from 06/15/2012
Stage (m)
211
210
209
208
Grade
0
500
1000
Discharge (m^3/s)


DAS2 - Alatna River at Station - DD: 1 Rating: 0000
Rating period from 06/15/2012
Stage (m)
211
210
209
208
Grade
100
1000
Discharge (m^3/s)


DAS3 - South Fork Bedrock Creek at Station - DD: 1 Rating: 0000
Rating period from 06/01/2012
Stage (m)
254.5
254
253.5
253
Discharge (m^3/s)
0
20
40
60
80
100
Grade
16
15
18
7
17
19
13
14
8
20
3
9
21
10


DAS3 - South Fork Bedrock Creek at Station - DD: 1 Rating: 0000
Rating period from 06/01/2012
Stage (m)
254.5
254
253.5
253
Discharge (m^3/s)
1
10
100
Grade
16
15
18
7
17
19
8
13
3
9
14
20
21
10


DAS4 - Reed River below Station - DD: 1 Rating: 0000
Rating period from 06/15/2012
Stage (m)
Discharge (m^3/s)
Grade
98.5
98
97.5
97
96.5
96
0
200
400
600
800
8
2
5
3
7
6
14
10
18
9
15
16
17


DAS4 - Reed River below Station - DD: 1 Rating: 0000
Rating period from 06/15/2012
Stage (m)
Discharge (m^3/s)
Grade
98.5
98
97.5
97
96.5
96
10
100
1000
7
2
5
3
8
6
15
10
17
9
14
18
16

Station Number: | Meas. No: 0
Station Name: koyukuk at old bettles usfws site 23 jun 2012 | Date: 06/23/2012

| | | |
|---|---|---|
| Party: ey rg | Width: 169.5 m | Processed by: ey |
| Boat/Motor: achilles 15hp | Area: 303.9 m² | Mean Velocity: 0.674 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 205 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.060 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: Bottom Track | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: G |
| MagVar Method: None (19.1°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth Sounder: Not Used | Top Est: Power (0.1667) | Control1: Unspecified | |
| | | Control2: Unspecified | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 1.30 m/s | Type/Freq.: StreamPro/2000 kHz | |
| WT 3-Beam Solution: NO | Max. Depth: 3.26 m | Serial #: 1180 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 1.80 m | Bin Size: 13 cm | Blank: 3 cm |
| WT Error Vel.: 0.30 m/s | % Meas.: 75.20 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 2.00 m/s* | ADCP Temp.: 17.5 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES
Performed Moving Bed Test: NO
Performed Compass Test: NO
Meas. Location: usfws statio

Project Name: koyukuk old betles 23jun2012_(
Software: 2.07

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 15.0 | 2.00 | 455 | 22.3 | 154 | 23.7 | 1.91 | 0.036 | 202 | 162.1 | 293.5 | 15:53 | 16:03 | 0.29 | 0.69 | 0 | 0 |
| 001 | L | 15.0 | 12.0 | 344 | 21.6 | 158 | 23.0 | 2.12 | 1.45 | 206 | 164.0 | 311.8 | 16:04 | 16:11 | 0.33 | 0.66 | 1 | 1 |
| 002 | R | 30.0 | 12.0 | 487 | 21.7 | 152 | 23.1 | 6.63 | 2.91 | 206 | 175.3 | 304.2 | 16:11 | 16:22 | 0.24 | 0.68 | 0 | 1 |
| 003 | L | 30.0 | 6.00 | 311 | 22.6 | 152 | 23.9 | 5.36 | 0.716 | 205 | 176.5 | 306.1 | 16:23 | 16:29 | 0.38 | 0.67 | 0 | 0 |
| **Mean** | | 22.5 | 8.00 | 399 | 22.1 | 154 | 23.4 | 4.01 | 1.28 | 205 | 169.5 | 303.9 | **Total** | 00:36 | 0.31 | 0.67 | 0 | 0 |
| **SDev** | | 8.66 | 4.90 | 85 | 0.493 | 2.94 | 0.447 | 2.36 | 1.23 | 1.88 | 7.5 | 7.6 | | | 0.06 | 0.01 | | |
| **SD/M** | | 0.38 | 0.61 | 0.21 | 0.02 | 0.02 | 0.02 | 0.59 | 0.96 | 0.01 | 0.04 | 0.03 | | | 0.19 | 0.02 | | |

**Remarks:** waas gps. Postprocessing: adjusted Mag Declination to 19.067.

* - value not consistent for all transects

Station Number: Meas. No: 0

Station Name: koyukuk at old bettles usfws site 23 jun 2012 Date: 06/23/2012

| | | |
|---|---|---|
| Party: ey rg | Width: 169.7 m | Processed by: ey |
| Boat/Motor: achilles 15hp | Area: 303.9 m² | Mean Velocity: 0.672 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 204 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.060 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: G |
| MagVar Method: None (19.1°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth Sounder: Not Used | Top Est: Power (0.1667) | Control1: Unspecified | |
| | | Control2: Unspecified | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 1.37 m/s | Type/Freq.: StreamPro/2000 kHz | |
| WT 3-Beam Solution: NO | Max. Depth: 3.26 m | Serial #: 1180 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 1.79 m | Bin Size: 13 cm | Blank: 3 cm |
| WT Error Vel.: 0.30 m/s | % Meas.: 75.18 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 2.00 m/s* | ADCP Temp.: 17.5 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES

Performed Moving Bed Test: NO

Performed Compass Test: NO

Meas. Location: usfws statio

Project Name: koyukuk old betles 23jun2012_(

Software: 2.07

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 15.0 | 2.00 | 455 | 22.4 | 155 | 23.7 | 1.77 | 0.041 | 203 | 162.7 | 293.3 | 15:53 | 16:03 | 0.30 | 0.69 | 0 | 0 |
| 001 | L | 15.0 | 12.0 | 344 | 21.4 | 157 | 22.8 | 2.28 | 1.90 | 206 | 164.1 | 312.3 | 16:04 | 16:11 | 0.33 | 0.66 | 1 | 0 |
| 002 | R | 30.0 | 12.0 | 487 | 21.9 | 153 | 23.3 | 6.58 | 2.83 | 208 | 174.6 | 302.5 | 16:11 | 16:22 | 0.25 | 0.69 | 0 | 1 |
| 003 | L | 30.0 | 6.00 | 311 | 22.1 | 148 | 23.2 | 5.36 | 0.759 | 199 | 177.2 | 307.5 | 16:23 | 16:29 | 0.38 | 0.65 | 0 | 0 |
| **Mean** | | 22.5 | 8.00 | 399 | 22.0 | 153 | 23.3 | 3.99 | 1.38 | 204 | 169.7 | 303.9 | **Total** | 00:36 | 0.31 | 0.67 | 0 | 0 |
| **SDev** | | 8.66 | 4.90 | 85 | 0.419 | 3.84 | 0.364 | 2.34 | 1.23 | 3.54 | 7.3 | 8.1 | | | 0.06 | 0.02 | | |
| **SD/M** | | 0.38 | 0.61 | 0.21 | 0.02 | 0.03 | 0.02 | 0.59 | 0.89 | 0.02 | 0.04 | 0.03 | | | 0.18 | 0.03 | | |

**Remarks:** waas gps. Postprocessing: adjusted Mag Declination to 19.067.

* - value not consistent for all transects

Station Number:

Station Name: koyukuk  near Bettles

Meas. No: 1

Date: 07/29/2012

Party: bs-ey

Boat/Motor: achilles 15hp

Gage Height: 0.000 m

Width: 152.3 m

Area: 298.4 m²

G.H.Change: 0.000 m

Processed by: ey

Mean Velocity: 0.742 m/s

Discharge: 221 m³/s

Area Method: Mean Flow

Nav. Method: Bottom Track

MagVar Method: None (19.0°)

Depth Sounder: Not Used

ADCP Depth: 0.140 m

Shore Ens.:10

Bottom Est: Power (0.1667)

Top Est: Power (0.1667)

Index Vel.: 0.00 m/s

Adj.Mean Vel: 0.00 m/s

Rated Area: 0.000 m²

Control1: Unspecified

Control2: Unspecified

Control3: Unspecified

Rating No.: 1

Qm Rating: F

Diff.: 0.000%

Screening Thresholds:

BT 3-Beam Solution: YES

WT 3-Beam Solution: NO

BT Error Vel.: 0.10 m/s

WT Error Vel.: 0.30 m/s

BT Up Vel.: 0.30 m/s

WT Up Vel.: 1.75 m/s

Use Weighted Mean Depth: YES

Max. Vel.: 1.39 m/s

Max. Depth: 3.40 m

Mean Depth: 1.96 m

% Meas.: 72.19

Water Temp.: None

ADCP Temp.: 14.6 °C

ADCP:

Type/Freq.: StreamPro/2000 kHz

Serial #: 597

Firmware: 31.12

Bin Size: 13 cm

Blank: 3 cm

BT Mode: 10

BT Pings: 2

WT Mode: 12

WT Pings: 6

Performed Diag. Test: YES

Performed Moving Bed Test: YES

Performed Compass Test: NO

Meas. Location:

Project Name: koyukukbettles29july2012_0.mr

Software: 2.07

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 14.0 | 9.00 | 554 | 31.1 | 163 | 26.4 | 3.17 | 0.791 | 225 | 150.4 | 298.3 | 18:41 | 18:54 | 0.26 | 0.75 | 0 | 1 |
| 001 | L | 14.0 | 12.0 | 369 | 31.0 | 161 | 27.2 | 3.44 | 1.79 | 224 | 150.7 | 284.7 | 18:54 | 19:02 | 0.33 | 0.79 | 0 | 0 |
| 003 | R | 20.0 | 14.0 | 367 | 29.3 | 156 | 23.2 | 5.37 | 3.57 | 218 | 152.3 | 299.5 | 19:06 | 19:14 | 0.30 | 0.73 | 0 | 0 |
| 004 | L | 20.0 | 9.00 | 280 | 29.4 | 158 | 24.7 | 4.69 | 0.994 | 218 | 155.6 | 311.1 | 19:14 | 19:21 | 0.46 | 0.70 | 0 | 0 |
| **Mean** | | 17.0 | 11.0 | 392 | 30.2 | 160 | 25.4 | 4.17 | 1.78 | 221 | 152.3 | 298.4 | **Total** | 00:39 | 0.34 | 0.74 | 0 | 0 |
| **SDev** | | 3.46 | 2.45 | 115 | 0.973 | 3.02 | 1.78 | 1.04 | 1.26 | 3.76 | 2.4 | 10.8 | | | 0.08 | 0.04 | | |
| **SD/M** | | 0.20 | 0.22 | 0.29 | 0.03 | 0.02 | 0.07 | 0.25 | 0.71 | 0.02 | 0.02 | 0.04 | | | 0.25 | 0.05 | | |

**Remarks:** WAAS gps. PostProcessing: Had to apply a 10 degree beam 3 misalignment due to improper transducer installation into highspeed trimaran. Adjusted declination to 19.0167. Measurement in front of Old bettles/USFWS gaugesite. Poor GPS GG/ data at end of transect 001.

Station Number:

Station Name: koyukuk  near Bettles

Meas. No: 1

Date: 07/29/2012

Party: bs-ey
Boat/Motor: achilles 15hp
Gage Height: 0.000 m

Width: 153.4 m
Area: 301.1 m²
G.H.Change: 0.000 m

Processed by: ey
Mean Velocity: 0.744 m/s
Discharge: 224 m³/s

Area Method: Mean Flow
Nav. Method: DGPS
MagVar Method: None (19.0°)
Depth Sounder: Not Used

ADCP Depth: 0.140 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: F
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: NO
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.30 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 1.75 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 6.60 m/s
Max. Depth: 3.40 m
Mean Depth: 1.96 m
% Meas.: 72.21
Water Temp.: None
ADCP Temp.: 14.6 °C

ADCP:
Type/Freq.: StreamPro/2000 kHz
Serial #: 597
Firmware: 31.12
Bin Size: 13 cm
Blank: 3 cm
BT Mode: 10
BT Pings: 2
WT Mode: 12
WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Test: NO
Meas. Location:

Project Name: koyukukbettles29july2012_0.mr
Software: 2.07

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 14.0 | 9.00 | 554 | 31.0 | 163 | 26.6 | 3.20 | 0.797 | 225 | 151.8 | 301.2 | 18:41 | 18:54 | 0.28 | 0.75 | 0 | 1 |
| 001 | L | 14.0 | 12.0 | 369 | 31.9 | 165 | 27.7 | 3.49 | 1.42 | 229 | 152.1 | 287.8 | 18:54 | 19:02 | 0.42 | 0.80 | 1 | 0 |
| 003 | R | 20.0 | 14.0 | 367 | 29.6 | 158 | 23.4 | 5.40 | 3.77 | 220 | 154.1 | 304.5 | 19:06 | 19:14 | 0.31 | 0.72 | 0 | 0 |
| 004 | L | 20.0 | 9.00 | 280 | 29.7 | 159 | 24.9 | 4.55 | 1.05 | 220 | 155.4 | 310.7 | 19:14 | 19:21 | 0.47 | 0.71 | 0 | 0 |
| **Mean** | | 17.0 | 11.0 | 392 | 30.6 | 161 | 25.6 | 4.16 | 1.76 | 224 | 153.4 | 301.1 | **Total** | 00:39 | 0.37 | 0.74 | 0 | 0 |
| **SDev** | | 3.46 | 2.45 | 115 | 1.12 | 3.11 | 1.88 | 1.01 | 1.36 | 4.51 | 1.7 | 9.6 | | | 0.09 | 0.04 | | |
| **SD/M** | | 0.20 | 0.22 | 0.29 | 0.04 | 0.02 | 0.07 | 0.24 | 0.78 | 0.02 | 0.01 | 0.03 | | | 0.24 | 0.05 | | |

**Remarks:** WAAS gps.  PostProcessing: Had to apply a 10 degree beam 3 misalignment due to improper transducer installation into highspeed trimaran.  Adjusted declination to 19.0167.  Measurement in front of Old bettles/USFWS gaugesite.  Poor GPS GGA data at end of transect 001.

Station Number:
Station Name: Koyukuk Near Bettles 9-11-12

Meas. No: 2
Date: 09/11/2012

Party: EY BS
Boat/Motor: achilles/15HP
Gage Height: 0.000 m

Width: 193.2 m
Area: 460.5 m²
G.H.Change: 0.000 m

Processed by: EY
Mean Velocity: 1.38 m/s
Discharge: 635 m³/s

Area Method: Mean Flow
Nav. Method: DGPS
MagVar Method: None (19.0°)
Depth Sounder: Not Used

ADCP Depth: 0.050 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: G
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: NO
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.30 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.50 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 2.53 m/s
Max. Depth: 4.26 m
Mean Depth: 2.42 m
% Meas.: 80.70
Water Temp.: None
ADCP Temp.: 4.0 °C

ADCP:
Type/Freq.: StreamPro/2000 kHz
Serial #: 1180 Firmware: 31.12
Bin Size: 15 cm Blank: 3 cm
BT Mode: 10 BT Pings: 2
WT Mode: 12 WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Test: NO
Meas. Location: Old Bettles

Project Name: KoyukukNrBettkes091112_0.mı
Software: 2.07

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 12.0 | 4.00 | 549 | 41.0 | 510 | 67.9 | 3.12 | -0.545 | 622 | 159.2 | 446.7 | 14:31 | 14:44 | 0.34 | 1.39 | 9 | 5 |
| 001 | L | 12.0 | 3.00 | 402 | 47.6 | 516 | 64.9 | 2.25 | 0.622 | 632 | 181.5 | 463.0 | 14:44 | 14:53 | 0.56 | 1.36 | 0 | 2 |
| 002 | R | 20.0 | 4.50 | 367 | 49.3 | 522 | 64.8 | 5.97 | 1.25 | 643 | 207.7 | 488.7 | 14:54 | 15:03 | 0.45 | 1.32 | 2 | 1 |
| 003 | L | 20.0 | 4.50 | 405 | 59.4 | 501 | 74.1 | 5.91 | 2.61 | 643 | 224.4 | 443.7 | 15:03 | 15:12 | 0.51 | 1.45 | 2 | 2 |
| **Mean** | | 16.0 | 4.00 | 430 | 49.3 | 512 | 67.9 | 4.31 | 0.985 | 635 | 193.2 | 460.5 | **Total** | 00:40 | 0.47 | 1.38 | 3 | 3 |
| **SDev** | | 4.62 | 0.71 | 81 | 7.58 | 8.78 | 4.38 | 1.91 | 1.31 | 10.3 | 28.7 | 20.6 | | | 0.10 | 0.06 | | |
| **SD/M** | | 0.29 | 0.18 | 0.19 | 0.15 | 0.02 | 0.06 | 0.44 | 1.33 | 0.02 | 0.15 | 0.04 | | | 0.20 | 0.04 | | |

**Remarks:** WAAS GPS. Loss of Bottom Track a few times during each transect and 2 times during loop moving bed test. Recommend u GPS GGA instead of BT results.

Station Number: USFWS station — Meas. No: 4

Station Name: Koyukuk 2-june 2013 — Date: 06/02/2013

| | | |
|---|---|---|
| Party: jk ht | Width: 165.9 m | Processed by: |
| Boat/Motor: achilles/honda 15hp | Area: 423.2 m² | Mean Velocity: 1.74 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 738 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.300 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: F |
| MagVar Method: Model (18.8°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: Unspecified | |
| | | Control2: Unspecified | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 4.86 m/s | Type/Freq.: Rio Grande / 1200 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 4.80 m | Serial #: 12557 | Firmware: 10.16 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 2.60 m | Bin Size: 10 cm | Blank: 25 cm |
| WT Error Vel.: 1.07 m/s | % Meas.: 63.63 | BT Mode: 7 | BT Pings: 1 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 1 |
| WT Up Vel.: 3.75 m/s | ADCP Temp.: 6.4 °C | WV : 227 | WO : 1, 4 |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES — Project Name: Koyukuk 2 june 2013_0.mmt

Performed Moving Bed Test: YES — Software: 2.12

Performed Compass Calibration: YES    Evaluation: YES

Meas. Location: USFWS station

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 36.0 | 12.0 | 400 | 196 | 448 | 72.7 | 11.9 | 9.02 | 737 | 189.7 | 424.3 | 14:39 | 14:46 | 0.66 | 1.74 | 0 | 2 |
| 001 | L | 36.0 | 16.0 | 298 | 186 | 452 | 74.3 | 14.0 | 6.07 | 733 | 184.2 | 401.0 | 14:47 | 14:52 | 0.74 | 1.83 | 0 | 2 |
| 002 | R | 16.0 | 6.00 | 381 | 156 | 472 | 72.7 | 9.23 | 2.67 | 713 | 141.3 | 425.8 | 14:55 | 15:02 | 0.49 | 1.67 | 0 | 2 |
| 003 | L | 16.0 | 5.00 | 345 | 170 | 505 | 80.5 | 9.62 | 2.16 | 767 | 148.3 | 441.7 | 15:02 | 15:08 | 0.77 | 1.74 | 0 | 3 |
| **Mean** | | 26.0 | 9.75 | 356 | 177 | 469 | 75.0 | 11.2 | 4.98 | 738 | 165.9 | 423.2 | **Total** | 00:29 | 0.67 | 1.74 | 0 | 2 |
| **SDev** | | 11.5 | 5.19 | 45 | 17.4 | 25.9 | 3.72 | 2.19 | 3.20 | 22.6 | 24.6 | 16.8 | | | 0.13 | 0.06 | | |
| **SD/M** | | 0.44 | 0.53 | 0.13 | 0.10 | 0.06 | 0.05 | 0.20 | 0.64 | 0.03 | 0.15 | 0.04 | | | 0.19 | 0.04 | | |

**Remarks:** nice river conditions, RTK GPS

Station Number: Meas. No: 5

Station Name: koyukuk 3 june 2013 bb Date: 06/03/2013

| | | |
|---|---|---|
| Party: jk ht | Width: 135.5 m | Processed by: EY/HT |
| Boat/Motor: achilles/15hp honda | Area: 388.7 m² | Mean Velocity: 1.73 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 670 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.300 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: U |
| MagVar Method: Model (18.8°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: Unspecified | |
| | | Control2: Unspecified | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 3.08 m/s | Type/Freq.: Rio Grande / 1200 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 4.41 m | Serial #: 12557 | Firmware: 10.16 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 2.87 m | Bin Size: 10 cm | Blank: 25 cm |
| WT Error Vel.: 1.07 m/s | % Meas.: 65.88 | BT Mode: 7 | BT Pings: 1 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 1 |
| WT Up Vel.: 3.00 m/s | ADCP Temp.: 6.5 °C | WV : 267 | WO : 8, 4 |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES Project Name: koyuku 3 june 2013 bb_0.mmt

Performed Moving Bed Test: NO Software: 2.12

Performed Compass Calibration: NO Evaluation: NO

Meas. Location: USFWS station

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 17.0 | 7.00 | 272 | 149 | 446 | 64.1 | 10.2 | 4.86 | 674 | 133.7 | 381.5 | 10:09 | 10:15 | 0.54 | 1.77 | 0 | 0 |
| 001 | L | 13.0 | 8.00 | 252 | 144 | 439 | 63.6 | 7.05 | 7.39 | 662 | 135.4 | 399.3 | 10:16 | 10:21 | 0.68 | 1.66 | 0 | 0 |
| 002 | R | 16.0 | 10.0 | 264 | 142 | 429 | 62.3 | 11.0 | 9.78 | 655 | 132.0 | 376.7 | 10:29 | 10:35 | 0.53 | 1.74 | 0 | 0 |
| 003 | L | 15.0 | 15.0 | 178 | 147 | 452 | 67.6 | 7.70 | 17.6 | 691 | 140.9 | 397.3 | 10:36 | 10:40 | 0.79 | 1.74 | 1 | 0 |
| **Mean** | | 15.3 | 10.0 | 241 | 145 | 442 | 64.4 | 8.97 | 9.92 | 670 | 135.5 | 388.7 | **Total** | 00:30 | 0.64 | 1.73 | 0 | 0 |
| **SDev** | | 1.71 | 3.56 | 43 | 2.76 | 9.66 | 2.23 | 1.90 | 5.53 | 16.1 | 3.9 | 11.3 | | | 0.13 | 0.05 | | |
| **SD/M** | | 0.11 | 0.36 | 0.18 | 0.02 | 0.02 | 0.03 | 0.21 | 0.56 | 0.02 | 0.03 | 0.03 | | | 0.20 | 0.03 | | |

**Remarks:**

Station Number: Meas. No: 6
Station Name: Koyukuk 4 june 2013 Date: 06/04/2013

| | | |
|---|---|---|
| Party: jk ht | Width: 187.4 m | Processed by: ey/ht |
| Boat/Motor: achilles / 15hp | Area: 468.1 m² | Mean Velocity: 1.63 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 754 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.300 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: F |
| MagVar Method: Model (18.8°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: Unspecified | |
| | | Control2: Unspecified | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 3.47 m/s | Type/Freq.: Rio Grande / 1200 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 4.18 m | Serial #: 12557 | Firmware: 10.16 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 2.57 m | Bin Size: 10 cm | Blank: 25 cm |
| WT Error Vel.: 1.07 m/s | % Meas.: 63.13 | BT Mode: 7 | BT Pings: 1 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 1 |
| WT Up Vel.: 3.00 m/s | ADCP Temp.: 6.2 °C | WV : 267 | WO : 5, 4 |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: NO Evaluation: NO
Meas. Location: USFWS station

Project Name: koyukuk 4 june 2013_0eky.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 16.0 | 6.00 | 301 | 163 | 501 | 68.7 | 3.46 | 4.03 | 740 | 139.1 | 402.4 | 10:06 | 10:11 | 0.73 | 1.84 | 0 | 0 |
| 001 | L | 15.0 | 13.0 | 277 | 168 | 509 | 72.6 | 6.29 | 7.98 | 764 | 154.8 | 443.9 | 10:11 | 10:16 | 0.66 | 1.72 | 2 | 0 |
| 002 | R | 26.0 | 9.00 | 462 | 215 | 451 | 74.8 | 11.5 | 3.84 | 756 | 224.2 | 508.5 | 10:19 | 10:27 | 0.76 | 1.49 | 2 | 0 |
| 003 | L | 26.0 | 8.00 | 384 | 219 | 443 | 79.7 | 6.41 | 6.27 | 755 | 231.7 | 517.4 | 10:35 | 10:41 | 0.80 | 1.46 | 0 | 0 |
| **Mean** | | 20.8 | 9.00 | 356 | 191 | 476 | 74.0 | 6.91 | 5.53 | 754 | 187.4 | 468.1 | **Total** | 00:35 | 0.74 | 1.63 | 1 | 0 |
| **SDev** | | 6.08 | 2.94 | 84 | 29.8 | 33.6 | 4.57 | 3.34 | 1.97 | 9.68 | 47.3 | 54.6 | | | 0.06 | 0.18 | | |
| **SD/M** | | 0.29 | 0.33 | 0.24 | 0.16 | 0.07 | 0.06 | 0.48 | 0.36 | 0.01 | 0.25 | 0.12 | | | 0.08 | 0.11 | | |

**Remarks:** rain and wind

Station Number: Meas. No: 7

Station Name: Koyukuk 5 june 2013 Date: 06/05/2013

| | | |
|---|---|---|
| Party: jk ht | Width: 203.8 m | Processed by: ht/ey |
| Boat/Motor: achilles/15hp | Area: 516.5 m² | Mean Velocity: 1.91 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 976 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.300 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: U |
| MagVar Method: Model (18.8°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: Unspecified | |
| | | Control2: Unspecified | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 3.80 m/s | Type/Freq.: Rio Grande / 1200 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 5.48 m | Serial #: 12557 | Firmware: 10.16 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 2.53 m | Bin Size: 10 cm | Blank: 25 cm |
| WT Error Vel.: 1.07 m/s | % Meas.: 65.40 | BT Mode: 7 | BT Pings: 1 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 1 |
| WT Up Vel.: 3.00 m/s | ADCP Temp.: 5.2 °C | WV : 267 | WO : 4, 4 |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES

Performed Moving Bed Test: YES

Performed Compass Calibration: NO Evaluation: NO

Meas. Location: above USFWS station

Project Name: koyukuk 5-june 2013_0eky.mmt

Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 29.0 | 9.00 | 433 | 234 | 650 | 88.6 | 11.8 | 3.87 | 988 | 215.4 | 571.0 | 11:00 | 11:07 | 0.67 | 1.73 | 0 | 0 |
| 001 | L | 32.0 | 10.0 | 266 | 220 | 645 | 90.6 | 16.5 | 5.29 | 977 | 182.0 | 459.0 | 11:08 | 11:12 | 0.83 | 2.13 | 0 | 0 |
| 002 | R | 36.0 | 12.0 | 480 | 241 | 623 | 88.9 | 15.1 | 7.13 | 976 | 227.6 | 570.9 | 11:17 | 11:25 | 0.56 | 1.71 | 0 | 0 |
| 003 | L | 36.0 | 9.00 | 264 | 219 | 635 | 85.5 | 19.2 | 3.85 | 962 | 190.0 | 465.0 | 11:26 | 11:30 | 1.00 | 2.07 | 0 | 0 |
| **Mean** | | 33.3 | 10.0 | 360 | 228 | 638 | 88.4 | 15.6 | 5.03 | 976 | 203.8 | 516.5 | **Total** | 00:30 | 0.77 | 1.91 | 0 | 0 |
| **SDev** | | 3.40 | 1.41 | 112 | 10.9 | 11.6 | 2.12 | 3.10 | 1.55 | 10.4 | 21.3 | 63.0 | | | 0.19 | 0.22 | | |
| **SD/M** | | 0.10 | 0.14 | 0.31 | 0.05 | 0.02 | 0.02 | 0.20 | 0.31 | 0.01 | 0.10 | 0.12 | | | 0.25 | 0.12 | | |

**Remarks:** standing waves in msmt reach, we moved upstream above USFWS station. WAAS GPS.

Station Number: Meas. No: 8

Station Name: Koyukuk 6 june 2013 Date: 06/06/2013

| | | |
|---|---|---|
| Party: jk ht | Width: 183.7 m | Processed by: EY/HT |
| Boat/Motor: achilles/15hp | Area: 431.5 m² | Mean Velocity: 1.53 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 648 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.300 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: F |
| MagVar Method: Model (18.8°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: Unspecified | |
| | | Control2: Unspecified | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 4.68 m/s | Type/Freq.: Rio Grande / 1200 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 4.21 m | Serial #: 12557 | Firmware: 10.16 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 2.47 m | Bin Size: 10 cm | Blank: 25 cm |
| WT Error Vel.: 1.07 m/s | % Meas.: 61.05 | BT Mode: 7 | BT Pings: 1 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 1 |
| WT Up Vel.: 3.00 m/s | ADCP Temp.: 5.6 °C | WV : 267 | WO : 6, 4 |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES Project Name: koyukuk 6 june 2013_0eky.mmt

Performed Moving Bed Test: YES Software: 2.12

Performed Compass Calibration: NO Evaluation: NO

Meas. Location:

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| *000* | *R* | *19.0* | *5.00* | *386* | *127* | *403* | *55.1* | *13.4* | *9.46* | *608* | *119.1* | *349.2* | *09:13* | *09:20* | *0.58* | *1.74* | *0* | *0* |
| 001 | L | 19.0 | 7.00 | 240 | 147 | 435 | 62.0 | 13.7 | 4.45 | 661 | 142.9 | 403.3 | 09:20 | 09:24 | 0.74 | 1.64 | 0 | 0 |
| 002 | R | 43.0 | 10.0 | 406 | 179 | 399 | 60.0 | 29.5 | 4.36 | 672 | 230.9 | 522.5 | 09:27 | 09:34 | 0.58 | 1.29 | 0 | 0 |
| 003 | L | 41.0 | 15.0 | 347 | 209 | 346 | 63.5 | 21.8 | 10.9 | 651 | 241.8 | 451.2 | 09:35 | 09:41 | 0.58 | 1.44 | 0 | 0 |
| **Mean** | | 30.5 | 9.25 | 344 | 165 | 396 | 60.2 | 19.6 | 7.30 | 648 | 183.7 | 431.5 | **Total** | 00:28 | 0.62 | 1.53 | 0 | 0 |
| **SDev** | | 13.3 | 4.35 | 74 | 36.2 | 36.8 | 3.64 | 7.65 | 3.39 | 28.2 | 61.8 | 73.6 | | | 0.08 | 0.20 | | |
| **SD/M** | | 0.44 | 0.47 | 0.22 | 0.22 | 0.09 | 0.06 | 0.39 | 0.46 | 0.04 | 0.34 | 0.17 | | | 0.13 | 0.13 | | |

**Remarks:** windy WAAS GPS

Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number:
Station Name: koyukuk R below John R 7/10/13

Meas. No: 9
Date: 07/10/2013

| | | |
|---|---|---|
| Party: EL, EM, NS | Width: 122.1 m | Processed by: EY |
| Boat/Motor: | Area: 256.8 m² | Mean Velocity: 0.839 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 215 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.100 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: Bottom Track | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: P |
| MagVar Method: None (18.7°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: Unspecified | |
| Discharge Method: None | | Control2: Unspecified | |
| % Correction: 0.00 | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 1.57 m/s | Type/Freq.: StreamPro / 2000 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 3.28 m | Serial #: 1349 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 2.10 m | Bin Size: 11 cm* | Blank: 3 cm |
| WT Error Vel.: 0.30 m/s | % Meas.: 77.81 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 1.50 m/s* | ADCP Temp.: 11.8 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: NO    Evaluation: NO
Meas. Location:

Project Name: koyukuk_2013-07-10_0.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 003 | R | 10.0 | 5.00 | 211 | 22.8 | 167 | 26.7 | 0.612 | 0.043 | 217 | 122.7 | 256.5 | 09:32 | 09:37 | 0.41 | 0.85 | 2 | 2 |
| 004 | L | 10.0 | 3.00 | 308 | 22.5 | 166 | 24.8 | 0.672 | 0.048 | 214 | 120.5 | 255.5 | 09:39 | 09:46 | 0.29 | 0.84 | 1 | 1 |
| 005 | R | 11.0 | 3.00 | 227 | 23.0 | 167 | 27.0 | 0.875 | 0.095 | 218 | 122.5 | 257.4 | 09:47 | 09:52 | 0.39 | 0.84 | 1 | 1 |
| 006 | L | 8.00 | 3.00 | 336 | 20.7 | 169 | 23.5 | 0.341 | 0.036 | 213 | 121.8 | 258.1 | 09:56 | 10:04 | 0.27 | 0.83 | 1 | 1 |
| 007 | R | 8.00 | 3.00 | 224 | 21.0 | 169 | 24.0 | 0.287 | 0.007 | 215 | 123.0 | 256.3 | 10:05 | 10:10 | 0.40 | 0.84 | 1 | 1 |
| **Mean** | | 9.40 | 3.40 | 261 | 22.0 | 168 | 25.2 | 0.557 | 0.046 | 215 | 122.1 | 256.8 | **Total** | 00:38 | 0.35 | 0.84 | 1 | 1 |
| **SDev** | | 1.34 | 0.89 | 57 | 1.06 | 1.31 | 1.57 | 0.243 | 0.032 | 1.86 | 1.0 | 1.0 | | | 0.06 | 0.01 | | |
| **SD/M** | | 0.14 | 0.26 | 0.22 | 0.05 | 0.01 | 0.06 | 0.44 | 0.69 | 0.01 | 0.01 | 0.00 | | | 0.18 | 0.01 | | |

**Remarks:** direcitonal bias in GPS data use bottom track data.

* - value not consistent for all transects

Station Number: | Meas. No: 10
Station Name: Koyukuk at Old Bettles | Date: 07/13/2013

Party: el | Width: 172.3 m | Processed by: EY
Boat/Motor: | Area: 252.7 m² | Mean Velocity: 0.533 m/s
Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 134 m³/s

Area Method: Mean Flow | ADCP Depth: 0.100 m | Index Vel.: 0.00 m/s | Rating No.: 1
Nav. Method: Bottom Track | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: P
MagVar Method: None (18.7°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000%
Depth: Composite | Top Est: Power (0.1667) | Control1: Unspecified
Discharge Method: None | Control2: Unspecified
% Correction: 0.00 | Control3: Unspecified

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.30 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 1.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 1.07 m/s
Max. Depth: 3.24 m
Mean Depth: 1.47 m
% Meas.: 69.66
Water Temp.: None
ADCP Temp.: 16.0 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1349 | Firmware: 31.12
Bin Size: 10 cm | Blank: 3 cm
BT Mode: 10 | BT Pings: 2
WT Mode: 12 | WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: USFWS station

Project Name: Koyukuk_2013-7-13_0.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 001 | R | 11.0 | 5.00 | 388 | 21.9 | 93.2 | 18.0 | 1.17 | 0.330 | 135 | 174.7 | 248.1 | 08:26 | 08:35 | 0.37 | 0.54 | 0 | 0 |
| 002 | L | 11.0 | 5.00 | 513 | 20.8 | 92.7 | 18.1 | 1.12 | 0.279 | 133 | 172.0 | 252.5 | 08:35 | 08:47 | 0.28 | 0.53 | 0 | 0 |
| 003 | R | 11.0 | 5.00 | 437 | 22.7 | 92.6 | 19.6 | 1.37 | 0.251 | 136 | 173.0 | 238.1 | 08:49 | 08:59 | 0.32 | 0.57 | 0 | 0 |
| 004 | L | 11.0 | 3.00 | 543 | 19.3 | 95.8 | 17.1 | 0.864 | 0.053 | 133 | 169.5 | 272.2 | 09:01 | 09:13 | 0.25 | 0.49 | 0 | 0 |
| **Mean** | | 11.0 | 4.50 | 470 | 21.2 | 93.6 | 18.2 | 1.13 | 0.228 | 134 | 172.3 | 252.7 | **Total** | 00:47 | 0.30 | 0.53 | 0 | 0 |
| **SDev** | | 0.00 | 1.00 | 71 | 1.46 | 1.52 | 1.04 | 0.206 | 0.121 | 1.63 | 2.2 | 14.3 | | | 0.05 | 0.03 | | |
| **SD/M** | | 0.00 | 0.22 | 0.15 | 0.07 | 0.02 | 0.06 | 0.18 | 0.53 | 0.01 | 0.01 | 0.06 | | | 0.16 | 0.07 | | |

**Remarks:** Directional bias in GPS data, use bottom track.

Station Number:
Station Name: Koyukuk at Old Bettles

Meas. No: 11
Date: 09/05/2013

| | | |
|---|---|---|
| Party: EL | Width: 112.9 m | Processed by: EY |
| Boat/Motor: | Area: 196.6 m² | Mean Velocity: 0.533 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 105 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.100 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: G |
| MagVar Method: None (18.7°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: Unspecified | |
| | | Control2: Unspecified | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 1.61 m/s | Type/Freq.: StreamPro / 2000 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 3.24 m | Serial #: 1349 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 1.74 m | Bin Size: 8 cm | Blank: 3 cm |
| WT Error Vel.: 0.30 m/s | % Meas.: 77.26 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 1.00 m/s | ADCP Temp.: 9.0 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES    Evaluation: YES
Meas. Location: USFWS station

Project Name: Koyukuk_2013_09_05_0.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 003 | L | 6.00 | 2.00 | 394 | 11.4 | 81.6 | 11.4 | 0.340 | 0.040 | 105 | 110.4 | 197.5 | 09:36 | 09:44 | 0.23 | 0.53 | 0 | 2 |
| 004 | R | 7.00 | 2.00 | 306 | 12.0 | 83.4 | 13.6 | 0.465 | 0.026 | 110 | 110.6 | 193.7 | 09:45 | 09:51 | 0.31 | 0.56 | 0 | 3 |
| 007 | L | 6.00 | 5.00 | 241 | 12.1 | 83.8 | 11.8 | 0.315 | -0.074 | 108 | 114.3 | 194.3 | 10:33 | 10:38 | 0.36 | 0.56 | 0 | 2 |
| *010* | *R* | *9.00* | *3.00* | *242* | *10.6* | *74.5* | *10.8* | *0.434* | *-0.093* | *96.2* | *116.3* | *201.1* | *10:55* | *11:00* | *0.42* | *0.48* | *0* | *2* |
| **Mean** | | 7.00 | 3.00 | 295 | 11.5 | 80.8 | 11.9 | 0.389 | -0.025 | 105 | 112.9 | 196.6 | **Total** | 01:24 | 0.33 | 0.53 | 0 | 2 |
| **SDev** | | 1.41 | 1.41 | 72 | 0.700 | 4.34 | 1.20 | 0.072 | 0.068 | 5.93 | 2.9 | 3.4 | | | 0.08 | 0.04 | | |
| **SD/M** | | 0.20 | 0.47 | 0.24 | 0.06 | 0.05 | 0.10 | 0.19 | 2.69 | 0.06 | 0.03 | 0.02 | | | 0.23 | 0.07 | | |

**Remarks:** WAAS GPS

Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number:
Station Name: Koyukuk River below John

Meas. No: 12
Date: 05/07/2014

| | | |
|---|---|---|
| Party: EL/JK | Width: 130.1 m | Processed by: EKY |
| Boat/Motor: achilles/15HP | Area: 335.4 m² | Mean Velocity: 1.30 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 434 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.200 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: Bottom Track | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: F |
| MagVar Method: None (18.0°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: Unspecified | |
| Discharge Method: Distributed | | Control2: Unspecified | |
| % Correction: 1.54 | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 2.66 m/s | Type/Freq.: Rio Grande / 1200 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 3.87 m | Serial #: 12557 | Firmware: 10.16 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 2.58 m | Bin Size: 25 cm | Blank: 25 cm |
| WT Error Vel.: 1.07 m/s | % Meas.: 57.81 | BT Mode: 5 | BT Pings: 1 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 1 |
| WT Up Vel.: 3.00 m/s | ADCP Temp.: 0.8 °C | WV : 254 | WO : 2, 4 |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: USFWS station

Project Name: koyukuk_2014_05_06_0eky.mn
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | MBT Corrected Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 18.0 | 17.0 | 774 | 96.6 | 248 | 60.3 | 11.8 | 18.9 | 435 | 125.5 | 315.9 | 17:11 | 17:16 | 0.67 | 1.38 | 6 | 0 |
| 001 | L | 18.0 | 10.0 | 628 | 101 | 255 | 64.1 | 9.77 | 4.40 | 434 | 134.8 | 354.9 | 17:16 | 17:20 | 0.68 | 1.22 | 8 | 0 |
| **Mean** | | 18.0 | 13.5 | 701 | 98.6 | 251 | 62.2 | 10.8 | 11.6 | 434 | 130.1 | 335.4 | **Total** | 00:08 | 0.68 | 1.30 | 7 | 0 |
| **SDev** | | 0.00 | 4.95 | 103 | 2.92 | 5.07 | 2.63 | 1.42 | 10.2 | 1.03 | 6.5 | 27.6 | | | 0.01 | 0.11 | | |
| **SD/M** | | 0.00 | 0.37 | 0.15 | 0.03 | 0.02 | 0.04 | 0.13 | 0.88 | 0.00 | 0.05 | 0.08 | | | 0.01 | 0.08 | | |

**Remarks:** No GPS. Only 2 transects 500seconds total duration. 3rd transect deleted due to bad bottom track data.

Station Number: Koyukuk
Station Name: Koyukuk River below John

Meas. No: 13
Date: 05/09/2014

Party: EL,JK
Boat/Motor: achilles/15HP
Gage Height: 0.000 m

Width: 120.0 m
Area: 215.2 m²
G.H.Change: 0.000 m

Processed by: EKY
Mean Velocity: 0.923 m/s
Discharge: 198 m³/s

Area Method: Mean Flow
Nav. Method: Bottom Track
MagVar Method: Model (18.4°)
Depth: Composite
Discharge Method: None
% Correction: 0.00

ADCP Depth: 0.160 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: P
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 1.07 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 1.84 m/s
Max. Depth: 3.54 m
Mean Depth: 1.79 m
% Meas.: 41.82
Water Temp.: None
ADCP Temp.: 1.3 °C

ADCP:
Type/Freq.: Rio Grande / 1200 kHz
Serial #: 12812 Firmware: 10.16
Bin Size: 25 cm Blank: 25 cm
BT Mode: 5 BT Pings: 1
WT Mode: 12 WT Pings: 1
WV : 175 WO : 3, 4*

Performed Diag. Test: YES
Performed Moving Bed Test: NO
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: Old Bettles

Project Name: koyukuk_2014_05_09_0eeky.m
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 30.0 | 15.0 | 927 | 50.7 | 79.7 | 31.8 | 19.1 | 9.90 | 191 | 113.0 | 200.5 | 09:21 | 09:27 | 0.27 | 0.95 | 3 | 0 |
| 001 | L | 24.0 | 19.0 | 686 | 50.9 | 91.3 | 32.3 | 14.1 | 11.4 | 200 | 116.4 | 221.0 | 09:29 | 09:34 | 0.35 | 0.91 | 4 | 0 |
| 002 | R | 35.0 | 14.0 | 858 | 54.9 | 76.0 | 33.2 | 28.9 | 8.88 | 202 | 117.1 | 195.9 | 09:36 | 09:42 | 0.28 | 1.03 | 3 | 0 |
| 003 | L | 23.0 | 28.0 | 790 | 46.0 | 83.5 | 30.0 | 16.8 | 18.3 | 195 | 120.2 | 223.8 | 09:53 | 09:58 | 0.37 | 0.87 | 4 | 0 |
| 004 | R | 38.0 | 26.0 | 787 | 47.5 | 74.0 | 30.1 | 28.0 | 18.4 | 198 | 128.9 | 210.9 | 09:58 | 10:03 | 0.34 | 0.94 | 2 | 0 |
| 005 | L | 31.0 | 19.0 | 734 | 48.0 | 91.5 | 30.2 | 22.7 | 8.15 | 201 | 124.6 | 239.3 | 10:04 | 10:09 | 0.40 | 0.84 | 3 | 0 |
| **Mean** | | 30.2 | 20.2 | 797 | 49.7 | 82.7 | 31.2 | 21.6 | 12.5 | 198 | 120.0 | 215.2 | **Total** | 00:47 | 0.34 | 0.92 | 3 | 0 |
| **SDev** | | 5.91 | 5.71 | 86 | 3.20 | 7.52 | 1.35 | 5.99 | 4.66 | 4.08 | 5.9 | 16.1 | | | 0.05 | 0.07 | | |
| **SD/M** | | 0.20 | 0.28 | 0.11 | 0.06 | 0.09 | 0.04 | 0.28 | 0.37 | 0.02 | 0.05 | 0.07 | | | 0.15 | 0.07 | | |

**Remarks:** GPS not outputting at 10hz, so use bottom track data not GPS data. No moving bed test. Used water mode 12 auto instead of custom. bins are too large.

* - value not consistent for all transects

Station Number: Koyukuk
Station Name: Koyukuk River below John R

Meas. No: 14
Date: 05/11/2014

Party: EL, JK
Boat/Motor: achilles, 15HP
Gage Height: 0.000 m

Width: 123.6 m
Area: 237.7 m²
G.H.Change: 0.000 m

Processed by: EKY
Mean Velocity: 1.19 m/s
Discharge: 283 m³/s

Area Method: Avg. Course
Nav. Method: DGPS
MagVar Method: Model (18.4°)
Depth: Composite

ADCP Depth: 0.160 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: G
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 1.07 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 2.25 m/s
Max. Depth: 3.04 m
Mean Depth: 1.92 m
% Meas.: 56.15
Water Temp.: None
ADCP Temp.: 4.3 °C

ADCP:
Type/Freq.: Rio Grande / 1200 kHz
Serial #: 12812 Firmware: 10.16
Bin Size: 10 cm Blank: 25 cm
BT Mode: 5 BT Pings: 1
WT Mode: 12 WT Pings: 1
WV : 214 WO : 6, 10

Performed Diag. Test: NO
Performed Moving Bed Test: NO
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: Old Bettles/USFWS station

Project Name: Koyukuk_2014_05_11c_0.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | L | 13.0 | 11.0 | 461 | 73.7 | 161 | 37.9 | 4.56 | 7.54 | 284 | 121.9 | 238.9 | 16:21 | 16:28 | 0.29 | 1.19 | 2 | 0 |
| 001 | R | 16.0 | 11.0 | 465 | 73.9 | 156 | 37.2 | 5.16 | 7.08 | 279 | 124.0 | 231.1 | 16:28 | 16:35 | 0.29 | 1.21 | 1 | 0 |
| 002 | L | 13.0 | 12.0 | 469 | 68.4 | 164 | 36.2 | 4.92 | 10.0 | 284 | 121.4 | 248.3 | 16:36 | 16:43 | 0.35 | 1.14 | 0 | 0 |
| 003 | R | 20.0 | 12.0 | 406 | 74.0 | 155 | 37.7 | 7.66 | 10.6 | 285 | 127.0 | 232.7 | 16:43 | 16:50 | 0.29 | 1.22 | 0 | 0 |
| **Mean** | | 15.5 | 11.5 | 450 | 72.5 | 159 | 37.2 | 5.58 | 8.82 | 283 | 123.6 | 237.7 | **Total** | 00:28 | 0.30 | 1.19 | 1 | 0 |
| **SDev** | | 3.32 | 0.58 | 30 | 2.72 | 4.16 | 0.762 | 1.41 | 1.78 | 2.42 | 2.5 | 7.8 | | | 0.03 | 0.04 | | |
| **SD/M** | | 0.21 | 0.05 | 0.07 | 0.04 | 0.03 | 0.02 | 0.25 | 0.20 | 0.01 | 0.02 | 0.03 | | | 0.10 | 0.03 | | |

**Remarks:** RTK GPS.

Station Number: Koyukuk
Station Name: Koyukuk River below John

Meas. No: 15
Date: 05/13/2014

Party: EL,JK
Boat/Motor: achilles/15HP
Gage Height: 0.000 m

Width: 128.7 m
Area: 335.9 m²
G.H.Change: 0.000 m

Processed by: EKY
Mean Velocity: 1.96 m/s
Discharge: 657 m³/s

Area Method: Mean Flow
Nav. Method: DGPS
MagVar Method: Model (18.4°)
Depth: Composite

ADCP Depth: 0.160 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: G
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 1.07 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 3.50 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 3.51 m/s
Max. Depth: 3.90 m
Mean Depth: 2.61 m
% Meas.: 66.59
Water Temp.: None
ADCP Temp.: 2.4 °C

ADCP:
Type/Freq.: Rio Grande / 1200 kHz
Serial #: 12812 Firmware: 10.16
Bin Size: 10 cm Blank: 25 cm
BT Mode: 5 BT Pings: 1
WT Mode: 12 WT Pings: 1
WV : 427 WO : 6, 10

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: nr USFWS station

Project Name: Koyukuk_2014_05_13_0.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 15.0 | 19.0 | 330 | 111 | 432 | 55.3 | 10.7 | 44.4 | 653 | 126.0 | 320.6 | 09:31 | 09:36 | 0.35 | 2.04 | 0 | 0 |
| 001 | L | 15.0 | 19.0 | 432 | 109 | 432 | 57.5 | 10.7 | 44.0 | 653 | 131.0 | 341.3 | 09:37 | 09:43 | 0.30 | 1.91 | 2 | 2 |
| 002 | R | 11.0 | 19.0 | 504 | 112 | 441 | 58.5 | 5.92 | 42.3 | 660 | 129.8 | 340.0 | 09:43 | 09:51 | 0.24 | 1.94 | 1 | 0 |
| 003 | L | 8.00 | 19.0 | 567 | 112 | 446 | 56.6 | 3.51 | 45.5 | 663 | 128.0 | 341.7 | 09:52 | 10:01 | 0.22 | 1.94 | 0 | 0 |
| **Mean** | | 12.3 | 19.0 | 458 | 111 | 438 | 57.0 | 7.72 | 44.1 | 657 | 128.7 | 335.9 | **Total** | 00:29 | 0.28 | 1.96 | 1 | 1 |
| **SDev** | | 3.40 | 0.00 | 102 | 1.47 | 6.98 | 1.34 | 3.60 | 1.32 | 5.15 | 2.2 | 10.2 | | | 0.06 | 0.05 | | |
| **SD/M** | | 0.28 | 0.00 | 0.22 | 0.01 | 0.02 | 0.02 | 0.47 | 0.03 | 0.01 | 0.02 | 0.03 | | | 0.21 | 0.03 | | |

**Remarks:** RTK GPS

Station Number: | Meas. No: 16
Station Name: koyukuk below John R | Date: 05/17/2014

Party: jk ht
Boat/Motor: achilles/15HP
Gage Height: 0.000 m

Width: 125.3 m
Area: 342.1 m²
G.H.Change: 0.000 m

Processed by: EKY
Mean Velocity: 1.64 m/s
Discharge: 560 m³/s

Area Method: Mean Flow
Nav. Method: DGPS
MagVar Method: Model (18.4°)
Depth: Composite

ADCP Depth: 0.160 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s | Rating No.: 1
Adj.Mean Vel: 0.00 m/s | Qm Rating: G
Rated Area: 0.000 m² | Diff.: 0.000%
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 1.07 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 3.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 4.41 m/s
Max. Depth: 4.23 m
Mean Depth: 2.73 m
% Meas.: 67.19
Water Temp.: None
ADCP Temp.: 6.8 °C

ADCP:
Type/Freq.: Rio Grande / 1200 kHz
Serial #: 12558 | Firmware: 10.16
Bin Size: 10 cm | Blank: 25 cm
BT Mode: 7 | BT Pings: 1
WT Mode: 12 | WT Pings: 1
WV : 187 | WO : 1, 4

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES    Evaluation: YES
Meas. Location: Old Bettles

Project Name: koyukuk_2014_05_16_0eky.mn
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | L | 12.0 | 5.00 | 590 | 113 | 380 | 63.1 | 4.09 | 2.40 | 562 | 118.5 | 331.1 | 16:02 | 16:10 | 0.29 | 1.70 | 0 | 1 |
| 001 | R | 15.0 | 10.0 | 588 | 114 | 373 | 63.1 | 9.10 | -1.24 | 558 | 131.1 | 345.4 | 16:11 | 16:18 | 0.29 | 1.62 | 0 | 2 |
| 002 | L | 12.0 | 5.00 | 1072 | 115 | 383 | 64.5 | 5.30 | 1.54 | 569 | 123.9 | 341.6 | 16:19 | 16:33 | 0.18 | 1.67 | 0 | 2 |
| 003 | R | 15.0 | 4.00 | 651 | 110 | 370 | 62.0 | 8.76 | 0.199 | 551 | 127.5 | 350.3 | 16:33 | 16:42 | 0.29 | 1.57 | 0 | 2 |
| **Mean** | | 13.5 | 6.00 | 725 | 113 | 376 | 63.2 | 6.81 | 0.723 | 560 | 125.3 | 342.1 | **Total** | 00:40 | 0.26 | 1.64 | 0 | 2 |
| **SDev** | | 1.73 | 2.71 | 233 | 2.10 | 5.94 | 1.02 | 2.50 | 1.59 | 7.54 | 5.4 | 8.1 | | | 0.06 | 0.05 | | |
| **SD/M** | | 0.13 | 0.45 | 0.32 | 0.02 | 0.02 | 0.02 | 0.37 | 2.20 | 0.01 | 0.04 | 0.02 | | | 0.22 | 0.03 | | |

**Remarks:** Directional bias. RTK GPS

Station Number:
Station Name: koyukuk River near John River

Meas. No: 17
Date: 05/19/2014

| | | |
|---|---|---|
| Party: | Width: 132.8 m | Processed by: EKY |
| Boat/Motor: achilles/15HP | Area: 344.7 m² | Mean Velocity: 1.64 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 565 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.160 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: G |
| MagVar Method: Model (18.4°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: Unspecified | |
| | | Control2: Unspecified | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 4.84 m/s | Type/Freq.: Rio Grande / 1200 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 3.97 m | Serial #: 12558 | Firmware: 10.16 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 2.60 m | Bin Size: 10 cm | Blank: 25 cm |
| WT Error Vel.: 1.07 m/s | % Meas.: 67.22 | BT Mode: 7 | BT Pings: 1 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 1 |
| WT Up Vel.: 4.00 m/s | ADCP Temp.: 3.9 °C | WV : 240 | WO : 1, 10 |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES    Evaluation: YES
Meas. Location: Old Bettles

Project Name: koyukuk_2014_05_19_0.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | L | 13.0 | 4.00 | 479 | 110 | 387 | 58.7 | 5.40 | 0.809 | 562 | 127.4 | 348.3 | 09:04 | 09:10 | 0.35 | 1.61 | 0 | 3 |
| 001 | R | 20.0 | 3.00 | 531 | 108 | 394 | 60.4 | 11.0 | 0.377 | 574 | 132.7 | 358.1 | 09:10 | 09:17 | 0.37 | 1.60 | 0 | 4 |
| 002 | L | 20.0 | 8.00 | 484 | 112 | 374 | 63.3 | 11.3 | 5.80 | 566 | 135.3 | 337.9 | 09:18 | 09:24 | 0.34 | 1.68 | 0 | 3 |
| 003 | R | 14.0 | 6.00 | 743 | 120 | 364 | 66.6 | 4.64 | 2.92 | 559 | 135.6 | 334.6 | 09:24 | 09:34 | 0.27 | 1.67 | 0 | 3 |
| **Mean** | | 16.8 | 5.25 | 559 | 112 | 380 | 62.2 | 8.09 | 2.48 | 565 | 132.8 | 344.7 | **Total** | 00:30 | 0.33 | 1.64 | 0 | 3 |
| **SDev** | | 3.77 | 2.22 | 125 | 5.49 | 13.4 | 3.45 | 3.56 | 2.48 | 6.53 | 3.8 | 10.6 | | | 0.04 | 0.04 | | |
| **SD/M** | | 0.23 | 0.42 | 0.22 | 0.05 | 0.04 | 0.06 | 0.44 | 1.00 | 0.01 | 0.03 | 0.03 | | | 0.14 | 0.02 | | |

**Remarks:** sunny cold windy, RTK GPS, moving bed test invalid.

Station Number:

Meas. No: 18

Station Name: koyukuk River near John

Date: 05/20/2014

Party: jk ht
Boat/Motor: achilles/15HP
Gage Height: 0.000 m

Width: 124.2 m
Area: 285.0 m²
G.H.Change: 0.000 m

Processed by: EKY
Mean Velocity: 1.12 m/s
Discharge: 318 m³/s

Area Method: Mean Flow
Nav. Method: DGPS
MagVar Method: Model (18.4°)
Depth: Composite

ADCP Depth: 0.200 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: U
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 1.07 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 3.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 2.13 m/s
Max. Depth: 3.57 m
Mean Depth: 2.29 m
% Meas.: 60.54
Water Temp.: None
ADCP Temp.: 6.7 °C

ADCP:
Type/Freq.: Rio Grande / 1200 kHz
Serial #: 12558 Firmware: 10.16
Bin Size: 10 cm Blank: 25 cm
BT Mode: 7 BT Pings: 1
WT Mode: 12 WT Pings: 1
WV : 187 WO : 6, 10

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: across from Old Bettles

Project Name: koyukuk_2014_05_20_0eky.mn
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | L | 15.0 | 4.00 | 202 | 83.9 | 200 | 39.3 | 6.01 | 0.586 | 329 | 124.6 | 286.1 | 13:59 | 14:03 | 0.48 | 1.15 | 0 | 0 |
| 001 | R | 14.0 | 4.00 | 223 | 79.7 | 188 | 39.6 | 4.12 | 0.286 | 311 | 123.7 | 281.9 | 14:03 | 14:08 | 0.50 | 1.10 | 0 | 0 |
| 002 | L | 16.0 | 5.00 | 219 | 80.6 | 194 | 39.4 | 5.96 | 1.29 | 321 | 124.5 | 287.7 | 14:08 | 14:13 | 0.49 | 1.12 | 0 | 0 |
| 003 | R | 14.0 | 3.00 | 305 | 79.1 | 189 | 37.5 | 4.48 | 0.219 | 310 | 124.1 | 284.3 | 14:13 | 14:20 | 0.40 | 1.09 | 2 | 0 |
| **Mean** | | 14.8 | 4.00 | 237 | 80.8 | 193 | 38.9 | 5.14 | 0.596 | 318 | 124.2 | 285.0 | **Total** | 00:21 | 0.47 | 1.12 | 1 | 0 |
| **SDev** | | 0.96 | 0.82 | 46 | 2.12 | 5.47 | 0.989 | 0.986 | 0.491 | 9.05 | 0.4 | 2.5 | | | 0.04 | 0.03 | | |
| **SD/M** | | 0.06 | 0.20 | 0.19 | 0.03 | 0.03 | 0.03 | 0.19 | 0.82 | 0.03 | 0.00 | 0.01 | | | 0.10 | 0.02 | | |

**Remarks:** RTK GPS.

Station Number: Meas. No: 19

Station Name: koyukuk River near John River Date: 05/22/2014

Party: jk ht
Boat/Motor: achilles 15HP
Gage Height: 0.000 m

Width: 115.3 m
Area: 253.7 m²
G.H.Change: 0.000 m

Processed by: EY
Mean Velocity: 1.08 m/s
Discharge: 274 m³/s

Area Method: Mean Flow
Nav. Method: DGPS
MagVar Method: Model (18.0°)
Depth: Composite

ADCP Depth: 0.200 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: G
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 1.07 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.75 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 2.28 m/s
Max. Depth: 3.34 m
Mean Depth: 2.20 m
% Meas.: 57.46
Water Temp.: None
ADCP Temp.: 7.5 °C

ADCP:
Type/Freq.: Rio Grande / 1200 kHz
Serial #: 12558 Firmware: 10.16
Bin Size: 10 cm Blank: 25 cm
BT Mode: 7 BT Pings: 1
WT Mode: 12 WT Pings: 1
WV : 175 WO : 4, 10

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: across from Old Bettles

Project Name: koyukuk_2014_05_22_0eky.mn
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | L | 2.00 | 5.00 | 255 | 79.0 | 163 | 36.0 | 0.378 | 1.01 | 279 | 114.7 | 259.3 | 13:33 | 13:38 | 0.56 | 1.08 | 1 | 0 |
| 002 | R | 10.0 | 8.00 | 254 | 73.4 | 157 | 34.4 | 4.40 | 2.71 | 272 | 115.1 | 255.6 | 13:40 | 13:44 | 0.42 | 1.06 | 0 | 0 |
| 003 | L | 10.0 | 8.00 | 201 | 72.4 | 157 | 33.1 | 4.36 | 4.70 | 272 | 110.5 | 246.9 | 13:45 | 13:48 | 0.56 | 1.10 | 0 | 0 |
| 004 | R | 12.0 | 8.00 | 293 | 77.3 | 151 | 35.8 | 3.04 | 3.51 | 271 | 120.6 | 252.8 | 13:48 | 13:54 | 0.47 | 1.07 | 0 | 0 |
| **Mean** | | 8.50 | 7.25 | 250 | 75.5 | 157 | 34.8 | 3.04 | 2.99 | 274 | 115.3 | 253.7 | **Total** | 00:20 | 0.50 | 1.08 | 1 | 0 |
| **SDev** | | 4.43 | 1.50 | 38 | 3.12 | 4.73 | 1.37 | 1.89 | 1.55 | 3.77 | 4.1 | 5.3 | | | 0.07 | 0.02 | | |
| **SD/M** | | 0.52 | 0.21 | 0.15 | 0.04 | 0.03 | 0.04 | 0.62 | 0.52 | 0.01 | 0.04 | 0.02 | | | 0.13 | 0.02 | | |

**Remarks:** Moving bed test bad. WAAS GPS .

Station Number:

Station Name: koyukuk below John R

Meas. No: 20

Date: 05/25/2014

Party: HT
Boat/Motor: achilles/15HP
Gage Height: 0.000 m

Width: 114.6 m
Area: 194.1 m²
G.H.Change: 0.000 m

Processed by: EKY
Mean Velocity: 0.992 m/s
Discharge: 193 m³/s

Area Method: Mean Flow
Nav. Method: DGPS
MagVar Method: Model (18.4°)
Depth: Composite

ADCP Depth: 0.200 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: G
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 1.07 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 2.18 m/s
Max. Depth: 2.79 m
Mean Depth: 1.69 m
% Meas.: 47.93
Water Temp.: None
ADCP Temp.: 6.8 °C

ADCP:
Type/Freq.: Rio Grande / 1200 kHz
Serial #: 12558 Firmware: 10.16
Bin Size: 10 cm Blank: 25 cm
BT Mode: 7 BT Pings: 1
WT Mode: 12 WT Pings: 1
WV : 175 WO : 4, 10

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: Old Bettles

Project Name: koyukuk_2014_05_25_0eky.mn
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 001 | R | 21.0 | 4.00 | 229 | 65.8 | 89.1 | 28.7 | 6.70 | 1.38 | 192 | 113.5 | 186.3 | 09:22 | 09:26 | 0.45 | 1.03 | 0 | 0 |
| 002 | L | 23.0 | 4.00 | 147 | 61.3 | 95.3 | 27.5 | 8.25 | 1.70 | 194 | 115.2 | 200.2 | 09:27 | 09:29 | 0.66 | 0.97 | 1 | 0 |
| 003 | R | 21.0 | 5.00 | 210 | 61.3 | 92.4 | 27.8 | 6.41 | 1.96 | 190 | 115.9 | 198.5 | 09:30 | 09:33 | 0.47 | 0.96 | 0 | 0 |
| 004 | L | 17.0 | 5.00 | 174 | 65.9 | 92.4 | 30.2 | 3.94 | 2.27 | 195 | 113.6 | 191.6 | 09:33 | 09:36 | 0.59 | 1.02 | 1 | 1 |
| **Mean** | | 20.5 | 4.50 | 190 | 63.6 | 92.3 | 28.5 | 6.33 | 1.83 | 193 | 114.6 | 194.1 | **Total** | 00:13 | 0.54 | 0.99 | 1 | 0 |
| **SDev** | | 2.52 | 0.58 | 37 | 2.62 | 2.52 | 1.24 | 1.78 | 0.380 | 2.29 | 1.2 | 6.4 | | | 0.10 | 0.04 | | |
| **SD/M** | | 0.12 | 0.13 | 0.19 | 0.04 | 0.03 | 0.04 | 0.28 | 0.21 | 0.01 | 0.01 | 0.03 | | | 0.18 | 0.04 | | |

**Remarks:** RTK GPS

Station Number: Koyukuk
Station Name: Koyukuk River near John River USFWS

Meas. No: 21
Date: 07/23/2014

Party: el,jk
Boat/Motor: achilles/15HP
Gage Height: 0.000 m

Width: 148.3 m
Area: 422.1 m²
G.H.Change: 0.000 m

Processed by: EKY
Mean Velocity: 1.66 m/s
Discharge: 697 m³/s

Area Method: Mean Flow
Nav. Method: Bottom Track
MagVar Method: Model (18.4°)
Depth: Composite
Discharge Method: Distributed
% Correction: 2.16

ADCP Depth: 0.160 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: G
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 1.07 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 3.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 3.31 m/s
Max. Depth: 4.87 m
Mean Depth: 2.85 m
% Meas.: 71.64
Water Temp.: None
ADCP Temp.: 7.8 °C

ADCP:
Type/Freq.: Rio Grande / 1200 kHz
Serial #: 12558 Firmware: 10.16
Bin Size: 10 cm Blank: 25 cm
BT Mode: 5 BT Pings: 1
WT Mode: 12 WT Pings: 1
WV : 427 WO : 6, 10

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: across from Old Bettles

Project Name: Koyukuk_2014_07_23_0.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | MBT Corrected Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | L | 11.0 | 11.0 | 241 | 119 | 504 | 66.8 | 4.54 | 10.4 | 705 | 138.3 | 395.0 | 10:21 | 10:25 | 0.91 | 1.78 | 8 | 0 |
| 001 | L | 7.00 | 11.0 | 282 | 120 | 501 | 63.5 | 4.64 | 7.46 | 696 | 142.8 | 428.2 | 10:33 | 10:38 | 0.65 | 1.63 | 7 | 0 |
| 003 | R | 11.0 | 6.00 | 326 | 122 | 515 | 62.0 | 1.52 | 3.19 | 704 | 162.2 | 469.7 | 10:38 | 10:43 | 0.64 | 1.50 | 6 | 0 |
| 004 | R | 9.00 | 9.00 | 263 | 130 | 478 | 67.1 | 1.02 | 8.27 | 685 | 149.9 | 395.7 | 10:46 | 10:51 | 0.68 | 1.73 | 10 | 0 |
| **Mean** | | 9.50 | 9.25 | 278 | 123 | 500 | 64.8 | 2.93 | 7.33 | 697 | 148.3 | 422.1 | **Total** | 00:29 | 0.72 | 1.66 | 8 | 0 |
| **SDev** | | 1.91 | 2.36 | 36 | 5.25 | 15.4 | 2.53 | 1.93 | 3.02 | 9.03 | 10.5 | 35.3 | | | 0.13 | 0.13 | | |
| **SD/M** | | 0.20 | 0.26 | 0.13 | 0.04 | 0.03 | 0.04 | 0.66 | 0.41 | 0.01 | 0.07 | 0.08 | | | 0.18 | 0.08 | | |

**Remarks:** RTK GPS. Moving bed correction. Slight directional bias, possibly due to side mount of adcp to boat. One ADCP test failed H
Operation.........................***FAIL***

Station Number: Koyukuk | Meas. No: 21
Station Name: Koyukuk River near John River USFWS | Date: 07/23/2014

Party: el,jk
Boat/Motor: achilles/15HP
Gage Height: 0.000 m

Width: 148.3 m
Area: 422.8 m²
G.H.Change: 0.000 m

Processed by: EKY
Mean Velocity: 1.65 m/s
Discharge: 696 m³/s

Area Method: Mean Flow
Nav. Method: DGPS
MagVar Method: Model (18.4°)
Depth: Composite

ADCP Depth: 0.160 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: G
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 1.07 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 3.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 3.32 m/s
Max. Depth: 4.87 m
Mean Depth: 2.85 m
% Meas.: 71.52
Water Temp.: None
ADCP Temp.: 7.8 °C

ADCP:
Type/Freq.: Rio Grande / 1200 kHz
Serial #: 12558 | Firmware: 10.16
Bin Size: 10 cm | Blank: 25 cm
BT Mode: 5 | BT Pings: 1
WT Mode: 12 | WT Pings: 1
WV : 427 | WO : 6, 10

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES    Evaluation: YES
Meas. Location: across from Old Bettles

Project Name: Koyukuk_2014_07_23_0.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | L | 11.0 | 11.0 | 241 | 119 | 500 | 66.5 | 4.57 | 10.7 | 701 | 137.7 | 392.2 | 10:21 | 10:25 | 0.95 | 1.79 | 0 | 0 |
| 001 | L | 7.00 | 11.0 | 282 | 119 | 494 | 63.0 | 4.85 | 7.57 | 689 | 139.9 | 420.2 | 10:33 | 10:38 | 0.66 | 1.64 | 0 | 0 |
| 003 | R | 11.0 | 6.00 | 326 | 123 | 517 | 62.3 | 1.49 | 3.09 | 707 | 163.7 | 476.4 | 10:38 | 10:43 | 0.64 | 1.48 | 1 | 0 |
| 004 | R | 9.00 | 9.00 | 263 | 131 | 480 | 67.3 | 1.00 | 8.03 | 687 | 152.0 | 402.5 | 10:46 | 10:51 | 0.68 | 1.71 | 2 | 0 |
| **Mean** | | 9.50 | 9.25 | 278 | 123 | 498 | 64.8 | 2.98 | 7.34 | 696 | 148.3 | 422.8 | **Total** | 00:29 | 0.73 | 1.65 | 1 | 0 |
| **SDev** | | 1.91 | 2.36 | 36 | 5.61 | 15.5 | 2.52 | 2.01 | 3.14 | 9.58 | 12.0 | 37.5 | | | 0.14 | 0.13 | | |
| **SD/M** | | 0.20 | 0.26 | 0.13 | 0.05 | 0.03 | 0.04 | 0.68 | 0.43 | 0.01 | 0.08 | 0.09 | | | 0.20 | 0.08 | | |

**Remarks:** RTK GPS. Moving bed correction. Slight directional bias, possibly due to side mount of adcp to boat. One ADCP test failed H
Operation.........................***FAIL***

Station Number: USFWS station
Station Name: Koyukuk R below JOhn

Meas. No: 22
Date: 09/06/2014

Party: EL,WS
Boat/Motor:
Gage Height: 0.000 m

Width: 125.5 m
Area: 283.9 m²
G.H.Change: 0.000 m

Processed by: EKY
Mean Velocity: 1.10 m/s
Discharge: 312 m³/s

Area Method: Mean Flow
Nav. Method: Bottom Track
MagVar Method: Model (18.4°)
Depth: Composite
Discharge Method: None
% Correction: 0.00

ADCP Depth: 0.060 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: U
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.30 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 2.00 m/s
Max. Depth: 3.44 m
Mean Depth: 2.26 m
% Meas.: 79.68
Water Temp.: None
ADCP Temp.: 4.1 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1180 Firmware: 31.12
Bin Size: 13 cm Blank: 3 cm
BT Mode: 10 BT Pings: 2
WT Mode: 12 WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: Old Bettles/USFWS station

Project Name: koyukuk_2014_09_06_0eky.mn
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 15.0 | 3.00 | 467 | 24.8 | 246 | 34.2 | 4.09 | -0.137 | 309 | 121.2 | 274.0 | 15:28 | 15:38 | 0.32 | 1.13 | 0 | 3 |
| 002 | L | 13.0 | 4.00 | 302 | 25.0 | 248 | 33.9 | 2.91 | 0.236 | 310 | 125.6 | 281.6 | 15:41 | 15:47 | 0.43 | 1.10 | 1 | 4 |
| 003 | R | 12.0 | 5.00 | 354 | 25.0 | 250 | 36.2 | 2.99 | 0.149 | 314 | 127.3 | 287.5 | 15:49 | 15:57 | 0.34 | 1.09 | 0 | 4 |
| 004 | L | 12.0 | 5.00 | 293 | 25.1 | 249 | 35.3 | 2.89 | 0.799 | 313 | 127.7 | 292.6 | 15:57 | 16:04 | 0.42 | 1.07 | 1 | 2 |
| **Mean** | | 13.0 | 4.25 | 354 | 25.0 | 248 | 34.9 | 3.22 | 0.262 | 312 | 125.5 | 283.9 | **Total** | 00:36 | 0.38 | 1.10 | 0 | 3 |
| **SDev** | | 1.41 | 0.96 | 80 | 0.161 | 1.53 | 1.02 | 0.582 | 0.392 | 2.37 | 3.0 | 8.0 | | | 0.06 | 0.02 | | |
| **SD/M** | | 0.11 | 0.23 | 0.23 | 0.01 | 0.01 | 0.03 | 0.18 | 1.50 | 0.01 | 0.02 | 0.03 | | | 0.15 | 0.02 | | |

**Remarks:** RTK GPS okay, BT good.

Station Number: USFWS station | Meas. No: 22

Station Name: Koyukuk R below JOhn | Date: 09/06/2014

| | | |
|---|---|---|
| Party: EL,WS | Width: 126.2 m | Processed by: EKY |
| Boat/Motor: | Area: 285.4 m² | Mean Velocity: 1.09 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 310 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.060 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: U |
| MagVar Method: Model (18.4°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth Sounder: Not Used | Top Est: Power (0.1667) | Control1: Unspecified | |
| Discharge Method: None | | Control2: Unspecified | |
| % Correction: 0.00 | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 2.04 m/s | Type/Freq.: StreamPro / 2000 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 3.44 m | Serial #: 1180 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 2.26 m | Bin Size: 13 cm | Blank: 3 cm |
| WT Error Vel.: 0.30 m/s | % Meas.: 79.66 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 2.00 m/s | ADCP Temp.: 4.1 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES | Project Name: Koyukuk_2014_09_06_0.mmt

Performed Moving Bed Test: YES | Software: 2.10

Performed Compass Calibration: YES    Evaluation: YES

Meas. Location: Old Bettles/USFWS station

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 15.0 | 3.00 | 467 | 25.6 | 251 | 35.0 | 4.18 | -0.152 | 315 | 123.3 | 276.1 | 15:28 | 15:38 | 0.30 | 1.14 | 0 | 3 |
| 002 | L | 13.0 | 4.00 | 302 | 24.3 | 246 | 33.2 | 3.30 | 0.285 | 307 | 126.6 | 286.8 | 15:41 | 15:47 | 0.41 | 1.07 | 0 | 4 |
| 003 | R | 12.0 | 5.00 | 354 | 25.8 | 257 | 37.2 | 3.07 | 0.151 | 323 | 126.1 | 288.0 | 15:49 | 15:57 | 0.33 | 1.12 | 0 | 4 |
| 004 | L | 12.0 | 5.00 | 293 | 23.6 | 235 | 33.4 | 2.69 | 0.807 | 295 | 128.5 | 290.5 | 15:57 | 16:04 | 0.41 | 1.02 | 0 | 2 |
| **Mean** | | 13.0 | 4.25 | 354 | 24.8 | 247 | 34.7 | 3.31 | 0.273 | 310 | 126.2 | 285.4 | **Total** | 00:36 | 0.37 | 1.09 | 0 | 3 |
| **SDev** | | 1.41 | 0.96 | 80 | 1.03 | 9.50 | 1.85 | 0.631 | 0.400 | 12.1 | 2.2 | 6.3 | | | 0.06 | 0.06 | | |
| **SD/M** | | 0.11 | 0.23 | 0.23 | 0.04 | 0.04 | 0.05 | 0.19 | 1.47 | 0.04 | 0.02 | 0.02 | | | 0.16 | 0.05 | | |

**Remarks:** RTK GPS okay, BT good.

Station Number: 1 | Meas. No: 1
Station Name: Alatna R 22Jun2012 | Date: 06/22/2012

Party: ey
Boat/Motor: kayak
Gage Height: 0.000 m

Width: 100.8 m
Area: 124.0 m²
G.H.Change: 0.000 m

Processed by: EY
Mean Velocity: 0.708 m/s
Discharge: 87.9 m³/s

Area Method: Mean Flow
Nav. Method: Bottom Track
MagVar Method: Model (18.5°)
Depth: Composite
Discharge Method: None
% Correction: 0.00

ADCP Depth: 0.140 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s | Rating No.: 1
Adj.Mean Vel: 0.00 m/s | Qm Rating: G
Rated Area: 0.000 m² | Diff.: 0.000%
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: NO
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.30 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 1.36 m/s
Max. Depth: 1.92 m
Mean Depth: 1.23 m
% Meas.: 64.38
Water Temp.: None
ADCP Temp.: 16.3 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1180 | Firmware: 31.12
Bin Size: 10 cm | Blank: 3 cm
BT Mode: 10 | BT Pings: 2
WT Mode: 12 | WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: NO
Performed Compass Calibration: YES    Evaluation: NO
Meas. Location: Station

Project Name: alatna r 22jun2012_1eky.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 2.00 | 15.0 | 329 | 15.6 | 56.5 | 12.6 | 0.243 | 1.36 | 86.3 | 95.5 | 121.5 | 16:28 | 16:36 | 0.22 | 0.71 | 5 | 1 |
| 001 | L | 2.00 | 20.0 | 241 | 15.6 | 56.9 | 12.7 | 0.098 | 2.05 | 87.4 | 99.5 | 122.6 | 16:37 | 16:42 | 0.28 | 0.71 | 6 | 0 |
| 002 | R | 3.50 | 20.0 | 279 | 16.1 | 56.4 | 12.9 | 0.490 | 1.85 | 87.8 | 103.3 | 122.5 | 16:49 | 16:56 | 0.25 | 0.72 | 11 | 1 |
| 003 | L | 4.00 | 13.0 | 240 | 16.9 | 56.5 | 15.0 | 0.367 | 1.22 | 90.0 | 104.9 | 129.3 | 16:58 | 17:04 | 0.29 | 0.70 | 10 | 1 |
| **Mean** | | 2.88 | 17.0 | 272 | 16.1 | 56.6 | 13.3 | 0.300 | 1.62 | 87.9 | 100.8 | 124.0 | **Total** | 00:35 | 0.26 | 0.71 | 8 | 1 |
| **SDev** | | 1.03 | 3.56 | 42 | 0.610 | 0.225 | 1.15 | 0.168 | 0.392 | 1.57 | 4.2 | 3.6 | | | 0.03 | 0.01 | | |
| **SD/M** | | 0.36 | 0.21 | 0.15 | 0.04 | 0.00 | 0.09 | 0.56 | 0.24 | 0.02 | 0.04 | 0.03 | | | 0.13 | 0.01 | | |

**Remarks:** waas gps. Transect 1 has bad GPS data, use BT for transect 1. Beam 3 misaligned. Adjusted magnetic declination.

Station Number: 1 | Meas. No: 2
Station Name: AlatnaR_31jul2012 | Date: 07/31/2012

| | | |
|---|---|---|
| Party: ey | Width: 112.1 m | Processed by: EY |
| Boat/Motor: kayak | Area: 153.9 m² | Mean Velocity: 0.804 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 124 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.140 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: G |
| MagVar Method: Model (18.3°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: Unspecified | |
| | | Control2: Unspecified | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 4.29 m/s | Type/Freq.: StreamPro / 2000 kHz | |
| WT 3-Beam Solution: NO | Max. Depth: 2.60 m | Serial #: 1180 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 1.37 m | Bin Size: 8 cm* | Blank: 3 cm |
| WT Error Vel.: 0.30 m/s | % Meas.: 70.74 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 1.60 m/s* | ADCP Temp.: 13.5 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES | Project Name: alatna31jul2012_1eky.mmt
Performed Moving Bed Test: NO | Software: 2.12
Performed Compass Calibration: YES Evaluation: NO
Meas. Location: Station

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 3.00 | 12.0 | 277 | 21.5 | 85.5 | 16.6 | 0.330 | 0.821 | 125 | 109.1 | 151.3 | 17:39 | 17:45 | 0.31 | 0.82 | 0 | 0 |
| 001 | L | 3.00 | 11.0 | 252 | 19.9 | 89.5 | 14.8 | 0.300 | 0.529 | 125 | 114.8 | 158.0 | 17:47 | 17:52 | 0.38 | 0.79 | 0 | 2 |
| 002 | R | 3.00 | 11.0 | 288 | 20.2 | 89.1 | 14.9 | 0.312 | 0.548 | 125 | 111.5 | 152.3 | 17:53 | 17:59 | 0.29 | 0.82 | 0 | 2 |
| 003 | L | 3.00 | 15.0 | 194 | 19.1 | 85.9 | 13.6 | 0.249 | 0.964 | 120 | 112.9 | 154.0 | 17:59 | 18:03 | 0.41 | 0.78 | 1 | 2 |
| **Mean** | | 3.00 | 12.3 | 252 | 20.2 | 87.5 | 15.0 | 0.298 | 0.716 | 124 | 112.1 | 153.9 | **Total** | 00:24 | 0.35 | 0.80 | 0 | 2 |
| **SDev** | | 0.00 | 1.89 | 42 | 0.979 | 2.08 | 1.27 | 0.035 | 0.213 | 2.62 | 2.4 | 2.9 | | | 0.06 | 0.02 | | |
| **SD/M** | | 0.00 | 0.15 | 0.17 | 0.05 | 0.02 | 0.08 | 0.12 | 0.30 | 0.02 | 0.02 | 0.02 | | | 0.16 | 0.03 | | |

**Remarks:** waas gps.

* - value not consistent for all transects

Station Number: 1 | Meas. No: 2
Station Name: AlatnaR_31jul2012 | Date: 07/31/2012

Party: ey
Boat/Motor: kayak
Gage Height: 0.000 m

Width: 112.5 m
Area: 154.0 m²
G.H.Change: 0.000 m

Processed by: EY
Mean Velocity: 0.783 m/s
Discharge: 121 m³/s

Area Method: Mean Flow
Nav. Method: Bottom Track
MagVar Method: Model (18.3°)
Depth: Composite
Discharge Method: None
% Correction: 0.00

ADCP Depth: 0.140 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: G
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: NO
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.30 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 1.60 m/s*
Use Weighted Mean Depth: YES

Max. Vel.: 1.62 m/s
Max. Depth: 2.60 m
Mean Depth: 1.37 m
% Meas.: 70.66
Water Temp.: None
ADCP Temp.: 13.5 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1180 | Firmware: 31.12
Bin Size: 8 cm* | Blank: 3 cm
BT Mode: 10 | BT Pings: 2
WT Mode: 12 | WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: NO
Performed Compass Calibration: YES Evaluation: NO
Meas. Location: Station

Project Name: alatna31jul2012_1eky.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 3.00 | 12.0 | 277 | 20.5 | 81.4 | 15.8 | 0.320 | 0.692 | 119 | 110.1 | 151.6 | 17:39 | 17:45 | 0.30 | 0.78 | 2 | 0 |
| 001 | L | 3.00 | 11.0 | 252 | 19.6 | 87.2 | 14.5 | 0.254 | 0.441 | 122 | 113.7 | 156.4 | 17:47 | 17:52 | 0.34 | 0.78 | 2 | 2 |
| 002 | R | 3.00 | 11.0 | 288 | 19.7 | 86.4 | 14.6 | 0.310 | 0.513 | 122 | 112.3 | 153.3 | 17:53 | 17:59 | 0.29 | 0.79 | 2 | 2 |
| 003 | L | 3.00 | 15.0 | 194 | 19.2 | 85.6 | 13.4 | 0.259 | 1.30 | 120 | 114.0 | 154.8 | 17:59 | 18:03 | 0.41 | 0.77 | 2 | 2 |
| **Mean** | | 3.00 | 12.3 | 252 | 19.8 | 85.1 | 14.6 | 0.286 | 0.736 | 121 | 112.5 | 154.0 | **Total** | 00:24 | 0.33 | 0.78 | 2 | 2 |
| **SDev** | | 0.00 | 1.89 | 42 | 0.561 | 2.56 | 0.976 | 0.034 | 0.388 | 1.53 | 1.8 | 2.0 | | | 0.06 | 0.01 | | |
| **SD/M** | | 0.00 | 0.15 | 0.17 | 0.03 | 0.03 | 0.07 | 0.12 | 0.53 | 0.01 | 0.02 | 0.01 | | | 0.17 | 0.01 | | |

**Remarks:** waas gps.

* - value not consistent for all transects

Station Number: 1
Station Name: AlatnaRatStn_12Sept2012

Meas. No: 3
Date: 09/12/2012

| | | |
|---|---|---|
| Party: EY | Width: 140.6 m | Processed by: EY |
| Boat/Motor: Kayak | Area: 260.0 m² | Mean Velocity: 0.883 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 228 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.110 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: G |
| MagVar Method: Model (18.3°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: Unspecified | |
| | | Control2: Unspecified | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 2.13 m/s | Type/Freq.: StreamPro / 2000 kHz | |
| WT 3-Beam Solution: NO | Max. Depth: 3.19 m | Serial #: 1180 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 1.86 m | Bin Size: 10 cm* | Blank: 3 cm |
| WT Error Vel.: 0.30 m/s | % Meas.: 77.16 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 2.40 m/s* | ADCP Temp.: 4.2 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES
Performed Moving Bed Test: NO
Performed Compass Calibration: YES Evaluation: NO
Meas. Location: Stn

Project Name: AlatnaR_Stn_12Sept2012_3.mı
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 3.00 | 2.00 | 488 | 31.4 | 169 | 28.3 | 0.544 | 0.098 | 230 | 155.8 | 247.3 | 14:55 | 15:05 | 0.28 | 0.93 | 8 | 0 |
| 001 | L | 2.00 | 1.00 | 349 | 26.5 | 178 | 22.0 | 0.256 | -0.004 | 227 | 135.4 | 269.4 | 15:07 | 15:15 | 0.32 | 0.84 | 0 | 0 |
| 002 | R | 2.00 | 1.00 | 570 | 29.0 | 178 | 23.5 | 0.286 | -0.016 | 231 | 132.6 | 237.0 | 15:15 | 15:28 | 0.28 | 0.97 | 0 | 1 |
| 003 | L | 2.00 | 1.00 | 292 | 25.7 | 178 | 20.8 | 0.258 | -0.031 | 225 | 138.6 | 286.4 | 15:29 | 15:35 | 0.39 | 0.79 | 0 | 0 |
| **Mean** | | 2.25 | 1.25 | 424 | 28.1 | 176 | 23.7 | 0.336 | 0.012 | 228 | 140.6 | 260.0 | **Total** | 00:40 | 0.31 | 0.88 | 2 | 0 |
| **SDev** | | 0.50 | 0.50 | 127 | 2.57 | 4.43 | 3.29 | 0.139 | 0.059 | 2.72 | 10.4 | 22.2 | | | 0.05 | 0.08 | | |
| **SD/M** | | 0.22 | 0.40 | 0.30 | 0.09 | 0.03 | 0.14 | 0.41 | 4.98 | 0.01 | 0.07 | 0.09 | | | 0.17 | 0.10 | | |

**Remarks:** WAAS GPS. Need to adjust the mag declination. Adjusted declination to 18.31

* - value not consistent for all transects

Station Number: Meas. No: 4

Station Name: alatna-30-may-2013 Date: 05/30/2013

| | | |
|---|---|---|
| Party: jk ht | Width: 155.4 m | Processed by: EY/HT |
| Boat/Motor: Achilles/15HP honda | Area: 447.6 m² | Mean Velocity: 1.45 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 642 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.200 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: G |
| MagVar Method: Model (18.0°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: 7-Light Debris | |
| | | Control2: 14-Shore Ice | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 2.79 m/s | Type/Freq.: StreamPro / 2000 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 4.62 m | Serial #: 12813 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 2.92 m | Bin Size: 8 cm | Blank: 3 cm |
| WT Error Vel.: 1.07 m/s | % Meas.: 65.52 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 2.00 m/s | ADCP Temp.: 2.1 °C | WV : 175 | WO : 6, 4 |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: Station

Project Name: alatna-30-may-2013_0.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 5.00 | 6.00 | 546 | 165 | 392 | 76.8 | 2.34 | 2.19 | 639 | 167.7 | 400.8 | 10:08 | 10:17 | 0.43 | 1.60 | 3 | 0 |
| 001 | L | 5.00 | 4.00 | 433 | 121 | 449 | 69.4 | 3.99 | 2.03 | 645 | 143.0 | 494.5 | 10:18 | 10:25 | 0.41 | 1.30 | 0 | 0 |
| **Mean** | | 5.00 | 5.00 | 489 | 143 | 421 | 73.1 | 3.16 | 2.11 | 642 | 155.4 | 447.6 | **Total** | 00:17 | 0.42 | 1.45 | 2 | 0 |
| **SDev** | | 0.00 | 1.41 | 80 | 31.5 | 40.2 | 5.20 | 1.17 | 0.111 | 4.48 | 17.5 | 66.3 | | | 0.01 | 0.21 | | |
| **SD/M** | | 0.00 | 0.28 | 0.16 | 0.22 | 0.10 | 0.07 | 0.37 | 0.05 | 0.01 | 0.11 | 0.15 | | | 0.03 | 0.14 | | |

**Remarks:** debris coming down. Shore and floating ice present.

Station Number: Meas. No: 5

Station Name: Alatna 31 may 2013 Date: 05/31/2013

| | | |
|---|---|---|
| Party: jk ht | Width: 158.4 m | Processed by: EY/HT |
| Boat/Motor: achilles/Honda15hp | Area: 364.0 m² | Mean Velocity: 1.20 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 436 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.200 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: F |
| MagVar Method: Model (18.0°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: 4-Clear | |
| | | Control2: Unspecified | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 2.43 m/s | Type/Freq.: Rio Grande / 1200 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 5.46 m | Serial #: 12813 | Firmware: 10.16 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 2.45 m | Bin Size: 10 cm | Blank: 25 cm |
| WT Error Vel.: 1.07 m/s | % Meas.: 62.77 | BT Mode: 7 | BT Pings: 1 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 1 |
| WT Up Vel.: 2.00 m/s | ADCP Temp.: 4.7 °C | WV : 175 | WO : 8, 4 |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES

Performed Moving Bed Test: YES

Performed Compass Calibration: YES Evaluation: YES

Meas. Location: Station

Project Name: alatna 31 may 2013_0eky.mmt

Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 002 | R | 8.00 | 84.0 | 300 | 105 | 238 | 44.0 | 4.99 | 26.4 | 418 | 199.0 | 316.4 | 15:02 | 15:07 | 0.59 | 1.32 | 0 | 0 |
| 003 | L | 8.00 | 12.0 | 232 | 81.0 | 305 | 44.7 | 6.06 | 5.68 | 442 | 118.9 | 366.9 | 15:08 | 15:12 | 0.66 | 1.21 | 0 | 0 |
| 006 | R | 11.0 | 16.0 | 360 | 122 | 254 | 51.5 | 9.49 | 2.35 | 439 | 190.4 | 388.4 | 15:24 | 15:30 | 0.60 | 1.13 | 10 | 0 |
| 007 | L | 10.0 | 11.0 | 246 | 86.8 | 297 | 45.5 | 7.35 | 6.53 | 443 | 125.2 | 384.4 | 15:32 | 15:37 | 0.53 | 1.15 | 0 | 0 |
| **Mean** | | 9.25 | 30.8 | 284 | 98.5 | 273 | 46.4 | 6.97 | 10.2 | 436 | 158.4 | 364.0 | **Total** | 00:34 | 0.59 | 1.20 | 3 | 0 |
| **SDev** | | 1.50 | 35.6 | 58 | 18.4 | 32.5 | 3.41 | 1.93 | 10.9 | 11.8 | 42.2 | 33.1 | | | 0.06 | 0.09 | | |
| **SD/M** | | 0.16 | 1.16 | 0.21 | 0.19 | 0.12 | 0.07 | 0.28 | 1.07 | 0.03 | 0.27 | 0.09 | | | 0.09 | 0.07 | | |

**Remarks:** RTK GPS. No ice.

Station Number:

Station Name: alatna 1june 2013

Meas. No: 6

Date: 06/01/2013

| | | |
|---|---|---|
| Party: jk ht | Width: 131.7 m | Processed by: HT/EY |
| Boat/Motor: achilles/honda15hp | Area: 325.8 m² | Mean Velocity: 1.13 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 370 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.200 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: G |
| MagVar Method: Model (18.0°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: 4-Clear | |
| | | Control2: Unspecified | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 2.45 m/s | Type/Freq.: Rio Grande / 1200 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 5.37 m | Serial #: 12813 | Firmware: 10.16 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 2.56 m | Bin Size: 10 cm | Blank: 25 cm |
| WT Error Vel.: 1.07 m/s | % Meas.: 63.35 | BT Mode: 7 | BT Pings: 1 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 1 |
| WT Up Vel.: 2.00 m/s | ADCP Temp.: 3.9 °C | WV : 175 | WO : 6, 4 |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES

Performed Moving Bed Test: YES

Performed Compass Calibration: NO    Evaluation: NO

Meas. Location: station

Project Name: alatna-1-june-2013_0eky.mmt

Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 12.0 | 5.00 | 516 | 104 | 212 | 42.9 | 7.44 | 1.01 | 367 | 164.0 | 323.9 | 09:54 | 10:03 | 0.50 | 1.13 | 0 | 0 |
| 001 | L | 11.0 | 8.00 | 358 | 70.4 | 258 | 37.0 | 6.04 | 2.74 | 374 | 108.4 | 328.8 | 10:03 | 10:09 | 0.38 | 1.14 | 0 | 0 |
| 002 | R | 11.0 | 8.00 | 439 | 97.6 | 219 | 44.6 | 7.87 | 2.02 | 372 | 146.7 | 326.3 | 10:12 | 10:19 | 0.43 | 1.14 | 0 | 0 |
| 003 | L | 10.0 | 8.00 | 248 | 70.5 | 248 | 39.0 | 7.20 | 1.75 | 366 | 107.4 | 324.2 | 10:20 | 10:24 | 0.52 | 1.13 | 0 | 0 |
| **Mean** | | 11.0 | 7.25 | 390 | 85.6 | 234 | 40.9 | 7.14 | 1.88 | 370 | 131.7 | 325.8 | **Total** | 00:29 | 0.46 | 1.13 | 0 | 0 |
| **SDev** | | 0.82 | 1.50 | 115 | 17.6 | 22.1 | 3.48 | 0.782 | 0.717 | 3.84 | 28.3 | 2.3 | | | 0.07 | 0.00 | | |
| **SD/M** | | 0.07 | 0.21 | 0.29 | 0.21 | 0.09 | 0.09 | 0.11 | 0.38 | 0.01 | 0.21 | 0.01 | | | 0.15 | 0.00 | | |

**Remarks:** RTK GPS.  channel clear

Station Number:
Station Name: Alatna 6 june 2013

Meas. No: 7
Date: 06/06/2013

| | | |
|---|---|---|
| Party: jk ht | Width: 129.6 m | Processed by: HT/EY |
| Boat/Motor: achilles/honda 15HP | Area: 286.2 m² | Mean Velocity: 0.811 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 228 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.200 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: G |
| MagVar Method: Model (18.1°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: 4-Clear | |
| | | Control2: Unspecified | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 2.06 m/s | Type/Freq.: Rio Grande / 1200 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 3.39 m | Serial #: 12813 | Firmware: 10.16 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 2.21 m | Bin Size: 10 cm | Blank: 25 cm |
| WT Error Vel.: 1.07 m/s | % Meas.: 60.04 | BT Mode: 7 | BT Pings: 1 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 1 |
| WT Up Vel.: 2.50 m/s | ADCP Temp.: 7.1 °C | WV : 240 | WO : 8, 4 |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES    Evaluation: YES
Meas. Location: Station

Project Name: Alatna 6 june 2013_0.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | L | 9.00 | 5.00 | 251 | 63.9 | 133 | 25.9 | 4.11 | 0.299 | 227 | 151.8 | 314.1 | 12:46 | 12:50 | 0.61 | 0.72 | 0 | 0 |
| 002 | R | 10.0 | 10.0 | 269 | 57.0 | 140 | 24.2 | 4.84 | -1.20 | 225 | 112.3 | 264.1 | 12:56 | 13:00 | 0.45 | 0.85 | 0 | 0 |
| 003 | L | 9.00 | 8.00 | 255 | 60.4 | 139 | 25.4 | 3.93 | -0.187 | 228 | 138.8 | 332.9 | 13:02 | 13:06 | 0.54 | 0.69 | 0 | 0 |
| 004 | R | 8.00 | 6.00 | 365 | 67.2 | 134 | 25.9 | 2.60 | -0.643 | 229 | 115.6 | 233.6 | 13:08 | 13:14 | 0.50 | 0.98 | 0 | 0 |
| **Mean** | | 9.00 | 7.25 | 285 | 62.1 | 137 | 25.4 | 3.87 | -0.433 | 228 | 129.6 | 286.2 | **Total** | 00:28 | 0.52 | 0.81 | 0 | 0 |
| **SDev** | | 0.82 | 2.22 | 54 | 4.41 | 3.65 | 0.773 | 0.933 | 0.640 | 1.71 | 18.9 | 45.5 | | | 0.07 | 0.13 | | |
| **SD/M** | | 0.09 | 0.31 | 0.19 | 0.07 | 0.03 | 0.03 | 0.24 | 1.48 | 0.01 | 0.15 | 0.16 | | | 0.13 | 0.17 | | |

**Remarks:** RTK GPS.

Station Number: Meas. No: 8
Station Name: Alatna 7 june 2013 Date: 06/07/2013

Party: jk ht
Boat/Motor: achilles/honda15hp
Gage Height: 0.000 m

Width: 129.1 m
Area: 243.6 m²
G.H.Change: 0.000 m

Processed by: HT/EY
Mean Velocity: 0.740 m/s
Discharge: 179 m³/s

Area Method: Mean Flow
Nav. Method: DGPS
MagVar Method: Model (18.1°)
Depth: Composite

ADCP Depth: 0.200 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: 4-Clear
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: G
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 1.07 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.50 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 1.99 m/s
Max. Depth: 2.92 m
Mean Depth: 1.90 m
% Meas.: 55.59
Water Temp.: None
ADCP Temp.: 8.0 °C

ADCP:
Type/Freq.: Rio Grande / 1200 kHz
Serial #: 12813 Firmware: 10.16
Bin Size: 10 cm Blank: 25 cm
BT Mode: 7 BT Pings: 1
WT Mode: 12 WT Pings: 1
WV : 240 WO : 8, 4

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: NO Evaluation: NO
Meas. Location: Station

Project Name: alatna 7 june 2013_0eky.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | L | 6.00 | 7.00 | 395 | 54.1 | 100 | 21.5 | 1.42 | 0.025 | 177 | 138.2 | 273.5 | 09:33 | 09:40 | 0.39 | 0.65 | 0 | 0 |
| 001 | R | 8.00 | 5.00 | 321 | 58.8 | 96.7 | 22.6 | 2.46 | -0.458 | 180 | 120.2 | 222.7 | 09:43 | 09:48 | 0.56 | 0.81 | 0 | 0 |
| 003 | L | 7.00 | 5.00 | 375 | 56.5 | 96.0 | 21.1 | 2.89 | 0.166 | 177 | 147.7 | 254.0 | 09:51 | 09:57 | 0.51 | 0.69 | 1 | 0 |
| 004 | R | 9.00 | 8.00 | 371 | 53.8 | 105 | 21.2 | 2.37 | -0.754 | 181 | 110.1 | 224.3 | 10:00 | 10:06 | 0.45 | 0.81 | 0 | 0 |
| **Mean** | | 7.50 | 6.25 | 365 | 55.8 | 99.4 | 21.6 | 2.28 | -0.255 | 179 | 129.1 | 243.6 | **Total** | 00:33 | 0.48 | 0.74 | 0 | 0 |
| **SDev** | | 1.29 | 1.50 | 31 | 2.33 | 4.05 | 0.684 | 0.621 | 0.427 | 2.28 | 17.0 | 24.6 | | | 0.07 | 0.08 | | |
| **SD/M** | | 0.17 | 0.24 | 0.09 | 0.04 | 0.04 | 0.03 | 0.27 | 1.67 | 0.01 | 0.13 | 0.10 | | | 0.15 | 0.11 | | |

**Remarks:** RTK GPS

Station Number: Meas. No: 9
Station Name: Alatna River at Culverts Date: 07/11/2013

Party: EL
Boat/Motor: kayak
Gage Height: 0.000 m

Width: 134.0 m
Area: 173.5 m²
G.H.Change: 0.000 m

Processed by: EY
Mean Velocity: 0.462 m/s
Discharge: 79.1 m³/s

Area Method: Mean Flow
Nav. Method: Bottom Track
MagVar Method: None (18.1°)
Depth: Composite
Discharge Method: Proportional
% Correction: 0.00

ADCP Depth: 0.100 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: G
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.32 m/s*
BT Up Vel.: 0.30 m/s
WT Up Vel.: 1.50 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 1.32 m/s
Max. Depth: 2.52 m
Mean Depth: 1.30 m
% Meas.: 74.29
Water Temp.: None
ADCP Temp.: 12.8 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1349 Firmware: 31.12
Bin Size: 7 cm* Blank: 3 cm
BT Mode: 10 BT Pings: 2
WT Mode: 12 WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: culverts

Project Name: alatna_culverts_2013-7-11_0ek
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | MBT Corrected Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 4.00 | 4.00 | 291 | 12.9 | 56.4 | 9.68 | 0.496 | 0.034 | 79.6 | 131.0 | 153.2 | 09:19 | 09:25 | 0.37 | 0.52 | 2 | 0 |
| 001 | L | 4.00 | 4.00 | 314 | 11.5 | 60.9 | 8.51 | 0.265 | -0.050 | 81.1 | 136.6 | 189.4 | 09:26 | 09:33 | 0.36 | 0.43 | 0 | 2 |
| 002 | R | 3.00 | 3.00 | 349 | 11.5 | 58.4 | 8.65 | 0.190 | -0.035 | 78.7 | 131.4 | 153.5 | 09:35 | 09:42 | 0.34 | 0.51 | 1 | 3 |
| 003 | L | 3.00 | 2.00 | 301 | 9.93 | 61.7 | 8.05 | 0.253 | -0.029 | 79.9 | 128.4 | 230.2 | 09:43 | 09:49 | 0.39 | 0.35 | 2 | 4 |
| 004 | R | 3.50 | 4.00 | 282 | 11.4 | 58.6 | 8.42 | 0.161 | -0.060 | 78.6 | 132.1 | 169.0 | 09:50 | 09:56 | 0.39 | 0.47 | 1 | 3 |
| 005 | L | 4.00 | 4.00 | 288 | 11.1 | 61.1 | 8.26 | 0.249 | -0.021 | 80.6 | 134.2 | 192.8 | 09:56 | 10:02 | 0.37 | 0.42 | 1 | 2 |
| 006 | R | 4.00 | 4.00 | 231 | 11.2 | 56.8 | 8.97 | 0.270 | -0.024 | 77.2 | 137.5 | 159.9 | 10:21 | 10:26 | 0.50 | 0.48 | 2 | 2 |
| 007 | L | 4.00 | 4.00 | 297 | 11.3 | 58.3 | 8.84 | 0.223 | 0.033 | 78.7 | 136.5 | 164.7 | 10:26 | 10:32 | 0.38 | 0.48 | 2 | 2 |
| 008 | R | 4.00 | 4.00 | 237 | 11.3 | 57.5 | 8.87 | 0.172 | 0.050 | 77.9 | 137.0 | 158.3 | 10:33 | 10:38 | 0.47 | 0.49 | 3 | 2 |
| 009 | L | 4.00 | 4.00 | 294 | 11.4 | 57.8 | 9.11 | 0.226 | 0.013 | 78.6 | 134.7 | 164.3 | 10:38 | 10:44 | 0.37 | 0.48 | 2 | 3 |
| **Mean** | | 3.75 | 3.70 | 288 | 11.4 | 58.8 | 8.74 | 0.251 | -0.009 | 79.1 | 134.0 | 173.5 | **Total** | 01:25 | 0.39 | 0.46 | 2 | 2 |
| **SDev** | | 0.42 | 0.67 | 34 | 0.713 | 1.85 | 0.467 | 0.094 | 0.038 | 1.20 | 3.1 | 24.2 | | | 0.05 | 0.05 | | |
| **SD/M** | | 0.11 | 0.18 | 0.12 | 0.06 | 0.03 | 0.05 | 0.38 | 4.32 | 0.02 | 0.02 | 0.14 | | | 0.13 | 0.11 | | |

**Remarks:** RTK GPS.
Transects 0-5 may have a bad compass calibration, there is a directional bias in the data. After completing new compass calibration, the results greatly improved for transects 6-9. BT Q = 80, RTK Q = 84. Loop moving bed test completed prior to tl recalibration of the compass, so results are not valid. Stationary moving bed test results are used.

* - value not consistent for all transects

Station Number: Meas. No: 10

Station Name: Alatna River Date: 09/06/2013

| | | |
|---|---|---|
| Party: el | Width: 129.9 m | Processed by: EY |
| Boat/Motor: kayak | Area: 186.5 m² | Mean Velocity: 0.408 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 75.7 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.100 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: Bottom Track | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: G |
| MagVar Method: None (18.1°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: Unspecified | |
| Discharge Method: None | | Control2: Unspecified | |
| % Correction: 0.00 | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 1.19 m/s | Type/Freq.: StreamPro / 2000 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 2.24 m | Serial #: 1349 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 1.43 m | Bin Size: 8 cm | Blank: 3 cm |
| WT Error Vel.: 0.30 m/s | % Meas.: 73.87 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 1.00 m/s | ADCP Temp.: 6.9 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES

Performed Moving Bed Test: YES

Performed Compass Calibration: YES Evaluation: YES

Meas. Location: station/culverts

Project Name: alatna_2013_09_06_0eky.mmt

Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 001 | R | 5.00 | 2.00 | 357 | 11.1 | 55.3 | 8.47 | 0.268 | -0.025 | 75.1 | 124.9 | 167.2 | 09:50 | 09:57 | 0.31 | 0.45 | 0 | 1 |
| 002 | L | 6.00 | 4.00 | 382 | 10.7 | 55.9 | 8.52 | 0.250 | 0.044 | 75.4 | 131.0 | 190.1 | 09:58 | 10:06 | 0.26 | 0.40 | 0 | 2 |
| 003 | R | 6.00 | 4.00 | 372 | 10.8 | 56.4 | 8.74 | 0.343 | 0.056 | 76.3 | 131.8 | 189.6 | 10:07 | 10:15 | 0.29 | 0.40 | 0 | 1 |
| 004 | L | 6.00 | 4.00 | 365 | 10.6 | 56.3 | 8.84 | 0.316 | 0.035 | 76.1 | 132.0 | 199.0 | 10:16 | 10:23 | 0.28 | 0.38 | 0 | 1 |
| **Mean** | | 5.75 | 3.50 | 369 | 10.8 | 56.0 | 8.65 | 0.294 | 0.028 | 75.7 | 129.9 | 186.5 | **Total** | 00:33 | 0.29 | 0.41 | 0 | 1 |
| **SDev** | | 0.50 | 1.00 | 11 | 0.215 | 0.493 | 0.177 | 0.043 | 0.036 | 0.567 | 3.4 | 13.5 | | | 0.02 | 0.03 | | |
| **SD/M** | | 0.09 | 0.29 | 0.03 | 0.02 | 0.01 | 0.02 | 0.15 | 1.31 | 0.01 | 0.03 | 0.07 | | | 0.07 | 0.07 | | |

**Remarks:** WAAS GPS Q=77 CMS, BT Q = 76 CMS

Station Number: Meas. No: 11

Station Name: Alatna River at Station Date: 05/15/2014

| | | |
|---|---|---|
| Party: jk ht | Width: 128.1 m | Processed by: EY |
| Boat/Motor: zodiac | Area: 235.6 m² | Mean Velocity: 0.760 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 177 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.200 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: G |
| MagVar Method: Model (17.7°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: Unspecified | |
| | | Control2: Unspecified | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 1.88 m/s | Type/Freq.: Rio Grande / 1200 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 3.31 m | Serial #: 12812 | Firmware: 10.16 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 1.87 m | Bin Size: 10 cm | Blank: 25 cm |
| WT Error Vel.: 1.07 m/s | % Meas.: 53.04 | BT Mode: 7 | BT Pings: 1 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 1 |
| WT Up Vel.: 1.50 m/s | ADCP Temp.: 4.3 °C | WV : 175 | WO : 8, 4 |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES Project Name: alatna_2014_05_15_b_0_prime

Performed Moving Bed Test: YES Software: 2.12

Performed Compass Calibration: YES Evaluation: YES

Meas. Location: station

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | L | 5.00 | 17.0 | 652 | 62.8 | 91.2 | 24.5 | 1.90 | 0.127 | 181 | 160.4 | 230.0 | 12:06 | 12:18 | 0.35 | 0.79 | 8 | 0 |
| 002 | R | 7.00 | 9.00 | 768 | 55.2 | 94.2 | 22.0 | 2.88 | -1.64 | 173 | 120.5 | 252.2 | 12:22 | 12:36 | 0.28 | 0.69 | 0 | 0 |
| 003 | L | 7.00 | 10.0 | 462 | 58.6 | 92.5 | 23.0 | 2.73 | -0.967 | 176 | 127.7 | 256.6 | 12:36 | 12:44 | 0.39 | 0.69 | 0 | 0 |
| 004 | R | 7.00 | 12.0 | 658 | 57.4 | 98.2 | 22.8 | 2.80 | -1.43 | 180 | 103.7 | 203.7 | 12:46 | 12:58 | 0.25 | 0.88 | 0 | 0 |
| **Mean** | | 6.50 | 12.0 | 635 | 58.5 | 94.0 | 23.1 | 2.58 | -0.977 | 177 | 128.1 | 235.6 | **Total** | 00:51 | 0.32 | 0.76 | 2 | 0 |
| **SDev** | | 1.00 | 3.56 | 127 | 3.19 | 3.04 | 1.02 | 0.456 | 0.788 | 3.63 | 23.8 | 24.3 | | | 0.06 | 0.09 | | |
| **SD/M** | | 0.15 | 0.30 | 0.20 | 0.05 | 0.03 | 0.04 | 0.18 | 0.81 | 0.02 | 0.19 | 0.10 | | | 0.20 | 0.12 | | |

**Remarks:** RTK GPS Q = 177 cms, BT Q= 182 cms

Station Number: Alatna

Station Name: Alatna River at station

Meas. No: 12

Date: 05/17/2014

Party: HT,JK
Boat/Motor: zodiac
Gage Height: 0.000 m

Width: 135.2 m
Area: 315.2 m²
G.H.Change: 0.000 m

Processed by: EY
Mean Velocity: 1.01 m/s
Discharge: 313 m³/s

Area Method: Mean Flow
Nav. Method: Bottom Track
MagVar Method: None (17.7°)
Depth: Composite
Discharge Method: Distributed
% Correction: 8.03

ADCP Depth: 0.200 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: G
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 1.07 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 3.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 2.57 m/s
Max. Depth: 3.33 m
Mean Depth: 2.33 m
% Meas.: 63.69
Water Temp.: None
ADCP Temp.: 4.2 °C

ADCP:
Type/Freq.: Rio Grande / 1200 kHz
Serial #: 12812    Firmware: 10.16
Bin Size: 10 cm    Blank: 25 cm
BT Mode: 5    BT Pings: 1
WT Mode: 12    WT Pings: 1
WV : 427    WO : 5, 10

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES    Evaluation: YES
Meas. Location: station

Project Name: alatna_2014_05_17_0eky.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | MBT Corrected Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | L | 6.00 | 8.00 | 389 | 74.3 | 210 | 33.7 | 1.98 | 2.28 | 322 | 139.2 | 353.3 | 09:23 | 09:29 | 0.41 | 0.91 | 9 | 0 |
| 001 | R | 7.00 | 7.00 | 483 | 83.0 | 193 | 33.2 | 3.29 | 1.45 | 314 | 132.2 | 266.3 | 09:29 | 09:36 | 0.41 | 1.18 | 10 | 0 |
| 002 | L | 7.00 | 7.00 | 396 | 69.9 | 204 | 32.2 | 3.28 | 1.04 | 310 | 137.7 | 355.8 | 09:37 | 09:42 | 0.42 | 0.87 | 7 | 0 |
| 003 | R | 7.00 | 6.00 | 522 | 78.4 | 191 | 32.2 | 3.74 | 0.906 | 307 | 131.8 | 285.4 | 09:43 | 09:51 | 0.34 | 1.08 | 11 | 0 |
| **Mean** | | 6.75 | 7.00 | 447 | 76.4 | 199 | 32.8 | 3.07 | 1.42 | 313 | 135.2 | 315.2 | **Total** | 00:27 | 0.39 | 1.01 | 9 | 0 |
| **SDev** | | 0.50 | 0.82 | 66 | 5.62 | 8.60 | 0.738 | 0.763 | 0.618 | 6.55 | 3.8 | 46.1 | | | 0.04 | 0.14 | | |
| **SD/M** | | 0.07 | 0.12 | 0.15 | 0.07 | 0.04 | 0.02 | 0.25 | 0.44 | 0.02 | 0.03 | 0.15 | | | 0.09 | 0.14 | | |

**Remarks:** RTK GPS

Station Number:
Station Name: Alatna River at Station

Meas. No: 13
Date: 05/19/2014

Party: HT
Boat/Motor: zodiac
Gage Height: 0.000 m

Width: 113.7 m
Area: 230.9 m²
G.H.Change: 0.000 m

Processed by: EY
Mean Velocity: 0.654 m/s
Discharge: 150 m³/s

Area Method: Mean Flow
Nav. Method: DGPS
MagVar Method: Model (17.7°)
Depth: Composite

ADCP Depth: 0.200 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: G
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 1.07 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.75 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 1.95 m/s
Max. Depth: 3.65 m
Mean Depth: 2.03 m
% Meas.: 54.17
Water Temp.: None
ADCP Temp.: 5.9 °C

ADCP:
Type/Freq.: Rio Grande / 1200 kHz
Serial #: 12812 Firmware: 10.16
Bin Size: 10 cm Blank: 25 cm
BT Mode: 7 BT Pings: 1
WT Mode: 12 WT Pings: 1
WV : 175 WO : 3, 10

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: station

Project Name: alatna_2014_05_19_0eky.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| *000* | *L* | *9.00* | *6.00* | *329* | *51.0* | *84.1* | *22.1* | *2.76* | *-0.471* | *160* | *128.0* | *263.2* | *15:04* | *15:09* | *0.44* | *0.61* | *0* | *0* |
| 002 | R | *8.00* | *7.00* | *304* | *48.7* | *74.0* | *19.8* | *2.11* | *-1.06* | *144* | *118.0* | *224.1* | *15:12* | *15:16* | *0.46* | *0.64* | *0* | *0* |
| *003* | *L* | *10.0* | *9.00* | *263* | *46.6* | *89.3* | *20.5* | *2.78* | *-1.06* | *158* | *112.6* | *243.6* | *15:17* | *15:21* | *0.44* | *0.65* | *0* | *0* |
| 004 | R | *10.0* | *6.00* | *315* | *46.7* | *75.6* | *19.6* | *2.77* | *-0.573* | *144* | *110.6* | *212.7* | *15:21* | *15:26* | *0.44* | *0.68* | *0* | *0* |
| 005 | L | *8.00* | *7.00* | *295* | *43.7* | *86.2* | *19.4* | *2.06* | *-1.22* | *150* | *106.8* | *230.6* | *15:27* | *15:32* | *0.46* | *0.65* | *0* | *0* |
| 006 | R | *10.0* | *8.00* | *313* | *45.9* | *79.8* | *19.2* | *3.48* | *-0.984* | *147* | *105.9* | *211.0* | *15:32* | *15:37* | *0.40* | *0.70* | *0* | *0* |
| **Mean** | | 9.17 | 7.17 | 303 | 47.1 | 81.5 | 20.1 | 2.66 | -0.894 | 150 | 113.7 | 230.9 | **Total** | 00:33 | 0.44 | 0.65 | 0 | 0 |
| **SDev** | | 0.98 | 1.17 | 23 | 2.51 | 6.07 | 1.08 | 0.523 | 0.300 | 6.94 | 8.3 | 19.9 | | | 0.02 | 0.03 | | |
| **SD/M** | | 0.11 | 0.16 | 0.08 | 0.05 | 0.07 | 0.05 | 0.20 | 0.34 | 0.05 | 0.07 | 0.09 | | | 0.05 | 0.05 | | |

**Remarks:** RTK GPS

Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: Alatna
Station Name: Alatna RIver at Station

Meas. No: 14
Date: 05/21/2014

Party: HT,JK
Boat/Motor: zodiac/15hp
Gage Height: 0.000 m

Width: 116.4 m
Area: 200.8 m²
G.H.Change: 0.000 m

Processed by: EY
Mean Velocity: 0.550 m/s
Discharge: 109 m³/s

Area Method: Mean Flow
Nav. Method: DGPS
MagVar Method: None (17.7°)
Depth: Composite

ADCP Depth: 0.200 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: G
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 1.07 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 1.69 m/s
Max. Depth: 2.59 m
Mean Depth: 1.72 m
% Meas.: 46.08
Water Temp.: None
ADCP Temp.: 6.6 °C

ADCP:
Type/Freq.: Rio Grande / 1200 kHz
Serial #: 12812 Firmware: 10.16
Bin Size: 10 cm Blank: 25 cm
BT Mode: 7 BT Pings: 1
WT Mode: 12 WT Pings: 1
WV : 175 WO : 4, 10

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: station

Project Name: alatna_2014_05_21_0eky.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| *000* | *L* | *8.00* | *6.00* | *329* | *41.9* | *53.9* | *17.4* | *1.31* | *0.118* | *115* | *130.0* | *234.3* | *11:25* | *11:30* | *0.44* | *0.49* | *0* | *0* |
| *001* | *R* | *8.00* | *7.00* | *245* | *39.4* | *45.7* | *16.1* | *1.65* | *-0.816* | *102* | *102.6* | *166.2* | *11:31* | *11:35* | *0.60* | *0.61* | *0* | *0* |
| 003 | L | 10.0 | 9.00 | 388 | 42.6 | 51.6 | 17.8 | 2.39 | -0.252 | 114 | 132.1 | 228.5 | 11:36 | 11:42 | 0.34 | 0.50 | 0 | 0 |
| *004* | *R* | *10.0* | *6.00* | *290* | *37.1* | *45.8* | *15.1* | *2.52* | *-0.538* | *100* | *100.6* | *169.5* | *11:44* | *11:48* | *0.50* | *0.59* | *0* | *0* |
| *005* | *L* | *8.00* | *6.00* | *307* | *40.8* | *55.6* | *17.2* | *1.93* | *0.178* | *116* | *125.1* | *232.4* | *11:49* | *11:54* | *0.43* | *0.50* | *0* | *0* |
| 006 | R | 11.0 | 10.0 | 300 | 40.2 | 48.0 | 16.2 | 2.59 | -1.22 | 106 | 108.0 | 173.8 | 11:55 | 12:00 | 0.45 | 0.61 | 0 | 0 |
| **Mean** | | 9.17 | 7.33 | 309 | 40.3 | 50.1 | 16.6 | 2.06 | -0.421 | 109 | 116.4 | 200.8 | **Total** | 00:35 | 0.46 | 0.55 | 0 | 0 |
| **SDev** | | 1.33 | 1.75 | 47 | 1.96 | 4.22 | 1.00 | 0.520 | 0.544 | 6.97 | 14.3 | 34.0 | | | 0.09 | 0.06 | | |
| **SD/M** | | 0.14 | 0.24 | 0.15 | 0.05 | 0.08 | 0.06 | 0.25 | 1.29 | 0.06 | 0.12 | 0.17 | | | 0.19 | 0.11 | | |

**Remarks:** RTK GPS

Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: Alatna | Meas. No: 15
Station Name: Alatna River at Station | Date: 05/23/2014

Party: EL,JK
Boat/Motor: kayak/paddle
Gage Height: 0.000 m

Width: 120.1 m
Area: 196.6 m²
G.H.Change: 0.000 m

Processed by: EY
Mean Velocity: 0.514 m/s
Discharge: 98.9 m³/s

Area Method: Mean Flow
Nav. Method: Bottom Track
MagVar Method: None (1.0°)
Depth: Composite
Discharge Method: None
% Correction: 0.00

ADCP Depth: 0.140 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s | Rating No.: 1
Adj.Mean Vel: 0.00 m/s | Qm Rating: U
Rated Area: 0.000 m² | Diff.: 0.000%
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.30 m/s*
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 1.33 m/s
Max. Depth: 2.77 m
Mean Depth: 1.65 m
% Meas.: 72.32
Water Temp.: None
ADCP Temp.: 9.1 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1180 | Firmware: 31.12
Bin Size: 10 cm* | Blank: 3 cm
BT Mode: 10 | BT Pings: 2
WT Mode: 12 | WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES    Evaluation: YES
Meas. Location: station

Project Name: alatna_2014_05_23_0eky.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | L | 6.00 | 7.00 | 246 | 15.0 | 77.1 | 9.00 | 0.646 | 0.057 | 102 | 136.1 | 224.0 | 14:19 | 14:24 | 0.48 | 0.46 | 0 | 2 |
| 002 | R | 8.00 | 6.00 | 168 | 15.8 | 72.1 | 10.4 | 1.31 | -0.379 | 99.3 | 106.6 | 181.0 | 14:29 | 14:33 | 0.58 | 0.55 | 0 | 0 |
| 003 | L | 8.00 | 5.00 | 194 | 14.7 | 70.9 | 10.3 | 1.35 | -0.063 | 97.2 | 127.8 | 236.2 | 14:33 | 14:38 | 0.50 | 0.41 | 0 | 0 |
| 005 | R | 8.00 | 4.00 | 215 | 15.7 | 70.7 | 11.0 | 1.56 | -0.186 | 98.8 | 92.6 | 159.6 | 14:44 | 14:49 | 0.49 | 0.62 | 0 | 0 |
| 006 | L | 8.00 | 7.00 | 238 | 18.0 | 66.9 | 11.6 | 1.19 | -0.144 | 97.5 | 137.2 | 182.2 | 14:49 | 14:54 | 0.49 | 0.54 | 0 | 0 |
| **Mean** | | 7.60 | 5.80 | 212 | 15.8 | 71.5 | 10.5 | 1.21 | -0.143 | 98.9 | 120.1 | 196.6 | **Total** | 00:35 | 0.51 | 0.51 | 0 | 1 |
| **SDev** | | 0.89 | 1.30 | 32 | 1.28 | 3.68 | 0.955 | 0.343 | 0.161 | 1.87 | 19.6 | 32.2 | | | 0.04 | 0.08 | | |
| **SD/M** | | 0.12 | 0.22 | 0.15 | 0.08 | 0.05 | 0.09 | 0.28 | 1.13 | 0.02 | 0.16 | 0.16 | | | 0.08 | 0.16 | | |

**Remarks:** Strong directional bias in GPS data. Cannot use loop test results due to potential direction bias.

* - value not consistent for all transects

Station Number:
Station Name: Alatna River at Station

Meas. No: 16
Date: 05/24/2014

Party: EL,JK
Boat/Motor: achilles/15hp
Gage Height: 0.000 m

Width: 105.9 m
Area: 175.1 m²
G.H.Change: 0.000 m

Processed by: EKY
Mean Velocity: 0.596 m/s
Discharge: 96.3 m³/s

Area Method: Mean Flow
Nav. Method: Bottom Track
MagVar Method: None (17.7°)
Depth: Composite
Discharge Method: Distributed
% Correction: 7.77

ADCP Depth: 0.140 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: F
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.30 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 1.50 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 1.19 m/s
Max. Depth: 3.23 m
Mean Depth: 1.63 m
% Meas.: 71.14
Water Temp.: None
ADCP Temp.: 6.4 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1180 Firmware: 31.12
Bin Size: 10 cm Blank: 3 cm
BT Mode: 10 BT Pings: 2
WT Mode: 12 WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: NO Evaluation: NO
Meas. Location: station

Project Name: alatna_2014_05_24_0eky.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | MBT Corrected Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | L | 8.00 | 4.00 | 227 | 15.4 | 72.2 | 10.9 | 0.939 | -0.090 | 99.4 | 126.9 | 231.2 | 09:35 | 09:41 | 0.46 | 0.43 | 0 | 0 |
| 001 | R | 7.00 | 5.00 | 253 | 16.7 | 64.9 | 11.3 | 1.16 | -0.148 | 93.9 | 79.6 | 112.6 | 09:42 | 09:48 | 0.50 | 0.83 | 0 | 1 |
| 002 | L | 8.00 | 7.00 | 177 | 14.0 | 71.5 | 10.2 | 0.563 | -0.725 | 95.6 | 113.1 | 212.4 | 09:50 | 09:54 | 0.53 | 0.45 | 0 | 0 |
| 003 | R | 8.00 | 7.00 | 216 | 18.4 | 65.4 | 12.1 | 1.10 | -0.676 | 96.3 | 103.8 | 144.2 | 09:54 | 09:59 | 0.50 | 0.67 | 0 | 0 |
| **Mean** | | 7.75 | 5.75 | 218 | 16.1 | 68.5 | 11.1 | 0.940 | -0.410 | 96.3 | 105.9 | 175.1 | **Total** | 00:23 | 0.50 | 0.60 | 0 | 0 |
| **SDev** | | 0.50 | 1.50 | 32 | 1.86 | 3.90 | 0.777 | 0.268 | 0.337 | 2.28 | 19.9 | 56.0 | | | 0.03 | 0.19 | | |
| **SD/M** | | 0.06 | 0.26 | 0.14 | 0.12 | 0.06 | 0.07 | 0.28 | 0.82 | 0.02 | 0.19 | 0.32 | | | 0.06 | 0.32 | | |

**Remarks:** EKY: Strong directional bias due to side mount, loop moving bed data invalid.

Station Number: | Meas. No: 17
Station Name: Alatna | Date: 07/22/2014

| | | |
|---|---|---|
| Party: el,jk | Width: 110.3 m | Processed by: EKY |
| Boat/Motor: achilles/15HP | Area: 251.5 m² | Mean Velocity: 0.757 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 190 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.120 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: Bottom Track | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: G |
| MagVar Method: None (17.7°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: Unspecified | |
| Discharge Method: Distributed | | Control2: Unspecified | |
| % Correction: 4.47 | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 1.56 m/s | Type/Freq.: StreamPro / 2000 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 3.99 m | Serial #: 1180 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 2.29 m | Bin Size: 13 cm* | Blank: 3 cm |
| WT Error Vel.: 0.30 m/s | % Meas.: 76.23 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 3.00 m/s | ADCP Temp.: 8.1 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES | Project Name: alatna_2014_07_22_0eky.mmt
Performed Moving Bed Test: YES | Software: 2.12
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: station

| Tr.# | | Edge Distance | | #Ens. | MBT Corrected Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | L | 6.00 | 12.0 | 153 | 22.9 | 148 | 20.8 | 1.74 | -1.22 | 192 | 122.1 | 257.1 | 14:50 | 14:54 | 0.57 | 0.75 | 22 | 1 |
| 001 | R | 6.00 | 7.00 | 159 | 18.9 | 143 | 21.3 | 0.982 | 1.42 | 185 | 106.1 | 252.4 | 14:55 | 14:58 | 0.46 | 0.73 | 14 | 2 |
| 004 | L | 6.00 | 10.0 | 146 | 20.6 | 147 | 20.4 | 1.79 | 1.48 | 192 | 105.4 | 254.7 | 15:08 | 15:11 | 0.49 | 0.75 | 13 | 0 |
| 005 | R | 10.0 | 10.0 | 213 | 21.7 | 142 | 23.1 | 4.15 | 0.946 | 192 | 107.6 | 241.9 | 15:11 | 15:16 | 0.41 | 0.80 | 23 | 0 |
| **Mean** | | 7.00 | 9.75 | 167 | 21.0 | 145 | 21.4 | 2.16 | 0.656 | 190 | 110.3 | 251.5 | **Total** | 00:25 | 0.48 | 0.76 | 18 | 1 |
| **SDev** | | 2.00 | 2.06 | 31 | 1.72 | 2.96 | 1.21 | 1.38 | 1.27 | 3.40 | 7.9 | 6.7 | | | 0.07 | 0.03 | | |
| **SD/M** | | 0.29 | 0.21 | 0.18 | 0.08 | 0.02 | 0.06 | 0.64 | 1.94 | 0.02 | 0.07 | 0.03 | | | 0.14 | 0.03 | | |

**Remarks:** Strong directional bias, loop moving bed test invalid.

* - value not consistent for all transects

Station Number: Meas. No: 18

Station Name: Alatna at UAF station Date: 09/04/2014

Party: EL,WS
Width: 129.5 m
Processed by: EKY
Boat/Motor: Kayak
Area: 186.6 m²
Mean Velocity: 0.534 m/s
Gage Height: 0.000 m
G.H.Change: 0.000 m
Discharge: 99.5 m³/s

Area Method: Mean Flow
Nav. Method: DGPS
MagVar Method: Model (17.7°)
Depth Sounder: Not Used
Discharge Method: Distributed
% Correction: 4.95

ADCP Depth: 0.120 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s Rating No.: 1
Adj.Mean Vel: 0.00 m/s Qm Rating: U
Rated Area: 0.000 m² Diff.: 0.000%
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.30 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 1.31 m/s
Max. Depth: 2.12 m
Mean Depth: 1.44 m
% Meas.: 72.86
Water Temp.: None
ADCP Temp.: 4.5 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1180 Firmware: 31.12
Bin Size: 13 cm Blank: 3 cm
BT Mode: 10 BT Pings: 2
WT Mode: 12 WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: Station

Project Name: alatna_2014_09_04b_0eky.mm
Software: 2.10

| Tr.# | | Edge Distance | | #Ens. | MBT Corrected Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | L | 3.00 | 18.0 | 222 | 15.3 | 71.1 | 11.6 | 0.283 | -0.171 | 98.1 | 128.4 | 175.5 | 10:36 | 10:41 | 0.38 | 0.56 | 0 | 0 |
| 001 | R | 5.00 | 18.0 | 256 | 15.2 | 73.5 | 12.2 | 0.478 | -0.401 | 101 | 132.1 | 187.9 | 10:41 | 10:47 | 0.34 | 0.54 | 0 | 0 |
| 002 | L | 5.00 | 12.0 | 266 | 14.7 | 72.1 | 11.3 | 0.356 | -0.628 | 97.8 | 127.7 | 196.6 | 10:47 | 10:53 | 0.32 | 0.50 | 0 | 0 |
| 003 | R | 5.00 | 12.0 | 273 | 15.9 | 73.2 | 12.3 | 0.383 | -0.710 | 101 | 129.6 | 186.5 | 10:53 | 11:00 | 0.34 | 0.54 | 0 | 1 |
| **Mean** | | 4.50 | 15.0 | 254 | 15.3 | 72.5 | 11.8 | 0.375 | -0.478 | 99.5 | 129.5 | 186.6 | **Total** | 00:23 | 0.34 | 0.53 | 0 | 0 |
| **SDev** | | 1.00 | 3.46 | 23 | 0.484 | 1.13 | 0.449 | 0.081 | 0.243 | 1.76 | 1.9 | 8.6 | | | 0.03 | 0.03 | | |
| **SD/M** | | 0.22 | 0.23 | 0.09 | 0.03 | 0.02 | 0.04 | 0.21 | 0.51 | 0.02 | 0.01 | 0.05 | | | 0.08 | 0.05 | | |

**Remarks:** RTK GPS good.

South Fork Bedrock Creek
6/21/2012
16:30 AST
Crew: Gieck-Lamb

| Station (ft) | Station (m) | Cell Width (m) | Depth (cm) | 0.6 or 0.8 Depth Velocity (ft/s) | 0.2 Depth Velocity (ft/s) | Average Velocity (m/s) | Cell Discharge ($m^3/s$) |
|---|---|---|---|---|---|---|---|
| 50.5 | 15.3924 | | RB | ----- | | | |
| 45.5 | 13.8684 | 1.1 | 20.0 | 0.45 | 0.710 | 0.177 | 0.040 |
| 43.0 | 13.1064 | 0.6 | 26.0 | 0.50 | 0.700 | 0.183 | 0.029 |
| 41.5 | 12.6492 | 0.5 | 24.0 | 0.67 | | 0.204 | 0.022 |
| 40.0 | 12.192 | 0.5 | 32.0 | 0.63 | | 0.192 | 0.028 |
| 38.5 | 11.7348 | 0.5 | 35.0 | 0.71 | | 0.216 | 0.035 |
| 37.0 | 11.2776 | 0.5 | 38.0 | 0.62 | | 0.189 | 0.033 |
| 35.5 | 10.8204 | 0.5 | 36.0 | 0.72 | | 0.219 | 0.036 |
| 34.0 | 10.3632 | 0.5 | 34.0 | 0.67 | | 0.204 | 0.032 |
| 32.5 | 9.906 | 0.5 | 36.0 | 0.65 | | 0.198 | 0.033 |
| 31.0 | 9.4488 | 0.5 | 32.0 | 0.56 | | 0.171 | 0.025 |
| 29.5 | 8.9916 | 0.5 | 32.0 | 0.61 | | 0.186 | 0.027 |
| 28.0 | 8.5344 | 0.5 | 30.0 | 0.51 | | 0.155 | 0.021 |
| 26.5 | 8.0772 | 0.6 | 28.0 | 0.29 | | 0.088 | 0.015 |
| 24.0 | 7.3152 | 1.0 | 18.0 | 0.27 | | 0.082 | 0.015 |
| 19.7 | 6.00456 | | LB | ----- | | | |
| | | | | ft/s | | m/s | |
| | | | | Cross-section Q | | | 0.39 $m^3$ |
| 30.8 | 9.4 | avg | 30.1 | 0.561 | | 0.176 | |
| | | max | 38.0 | 0.72 | | 0.22 | |

QA/QC RG

South Fork Bedrock Creek
8/1/2012
15:20 AST
Crew: Youcha-Lamb
flowtracker

| Station (m) | Station ft | Cell Width (m) | Depth (cm) | 0.6 Velocity (m/s) | Cell Discharge ($m^3/s$) |
|---|---|---|---|---|---|
| 35.0 | 10.668 | | RB | ----- | |
| 32.0 | 9.7536 | 0.8 | 21.0 | 0.076 | 0.012 |
| 30.0 | 9.144 | 0.6 | 27.0 | 0.109 | 0.018 |
| 28.0 | 8.5344 | 0.5 | 32.0 | 0.170 | 0.029 |
| 26.5 | 8.0772 | 0.5 | 31.0 | 0.260 | 0.037 |
| 25.0 | 7.62 | 0.5 | 36.0 | 0.272 | 0.045 |
| 23.5 | 7.1628 | 0.5 | 38.0 | 0.269 | 0.047 |
| 22.0 | 6.7056 | 0.5 | 37.0 | 0.246 | 0.042 |
| 20.5 | 6.2484 | 0.5 | 33.0 | 0.221 | 0.033 |
| 19.0 | 5.7912 | 0.5 | 32.0 | 0.261 | 0.038 |
| 17.5 | 5.334 | 0.5 | 40.0 | 0.186 | 0.034 |
| 16.0 | 4.8768 | 0.5 | 34.0 | 0.178 | 0.028 |
| 14.5 | 4.4196 | 0.5 | 30.0 | 0.165 | 0.023 |
| 13.0 | 3.9624 | 0.5 | 31.0 | 0.190 | 0.031 |
| 11.0 | 3.3528 | 0.6 | 30.0 | 0.237 | 0.043 |
| 9.0 | 2.7432 | 0.6 | 25.0 | 0.180 | 0.027 |
| 7.0 | 2.1336 | 0.9 | 22.0 | 0.122 | 0.025 |
| 3.0 | 0.9144 | 0.8 | 14.0 | 0.029 | 0.003 |
| 1.5 | 0.4572 | | LB | | |
| | 0 | | | ----- | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Cross-section Q | 0.52 | $m^3$ |
| 28.0 | 8.5 | avg | 30.92857 | 0.201 | | |
| | | max | 40 | 0.272 | | |

QA/QC RG

South Fork Bedrock Creek
9/15/2012
13:00 AST
Crew: Schnable-Gieck
flowtracker

| Station (m) | Station ft | Cell Width (m) | Depth (cm) | 0.6 Velocity (m/s) | Cell Discharge ($m^3/s$) |
|---|---|---|---|---|---|
| 45.5 | 13.8684 | | RB | ----- | |
| 42.5 | 12.954 | 0.8 | 27 | 0.125 | 0.03 |
| 40.0 | 12.192 | 0.8 | 26 | 0.177 | 0.04 |
| 37.5 | 11.43 | 0.8 | 33 | 0.209 | 0.05 |
| 35.0 | 10.668 | 0.8 | 37 | 0.275 | 0.08 |
| 32.5 | 9.906 | 0.8 | 43 | 0.376 | 0.12 |
| 30.0 | 9.144 | 0.8 | 42 | 0.350 | 0.11 |
| 27.5 | 8.382 | 0.8 | 44 | 0.394 | 0.13 |
| 25.0 | 7.62 | 0.8 | 56 | 0.376 | 0.16 |
| 22.5 | 6.858 | 0.8 | 63 | 0.396 | 0.19 |
| 20.0 | 6.096 | 0.8 | 63 | 0.436 | 0.21 |
| 17.5 | 5.334 | 0.8 | 62 | 0.425 | 0.20 |
| 15.0 | 4.572 | 0.8 | 59 | 0.376 | 0.17 |
| 12.5 | 3.81 | 0.8 | 59 | 0.361 | 0.16 |
| 10.0 | 3.048 | 0.8 | 50 | 0.302 | 0.12 |
| 7.5 | 2.286 | 0.8 | 37 | 0.251 | 0.07 |
| 5.0 | 1.524 | | LB | ----- | |
| | | | | Cross-section Q = | 1.84 $m^3$ |
| 40.5 | 12.3 | avg | 46.73333 | 0.322 | |
| | | max | 63 | 0.436 | |

QA/QC RG

South Fork Bedrock Creek
7/11/2013
15:15 AST
Crew: Lamb-Stephan
flowtracker

| Station (ft) | Station (m) | Cell Width (m) | Depth (cm) | 0.6 Velocity (m/s) | Cell Discharge ($m^3/s$) |
|---|---|---|---|---|---|
| 43 | 13.1 | | RB | ----- | |
| 38 | 11.6 | 1.22 | 20 | 0.125 | 0.03 |
| 35 | 10.7 | 0.91 | 26 | 0.177 | 0.04 |
| 32 | 9.8 | 0.91 | 38 | 0.209 | 0.07 |
| 29 | 8.8 | 0.91 | 50 | 0.275 | 0.13 |
| 26 | 7.9 | 0.91 | 58 | 0.376 | 0.20 |
| 23 | 7.0 | 0.91 | 74 | 0.350 | 0.24 |
| 20 | 6.1 | 0.91 | 84 | 0.394 | 0.30 |
| 17 | 5.2 | 0.91 | 84 | 0.376 | 0.29 |
| 14 | 4.3 | 0.91 | 76 | 0.396 | 0.28 |
| 11 | 3.4 | 0.91 | 70 | 0.436 | 0.28 |
| 8 | 2.4 | 0.91 | 68 | 0.425 | 0.26 |
| 5 | 1.5 | 0.91 | 58 | 0.376 | 0.20 |
| 2 | 0.6 | 0.76 | 44 | 0.361 | 0.12 |
| 0 | 0.0 | | LB | | |
| | | | | | |
| 15.4 | 4.7 | | | ----- | |
| | | | | Cross-section Q = | 2.44 $m^3$ |
| | 13.1 | avg | 0.58 | 0.329 | |
| | | max | 0.84 | 0.436 | |

QA/QC RG

South Fork Bedrock Creek
9/5/2013
15:15 AST
Crew: Lamb-Gieck
flowtracker

| Station (ft) | Station (m) | Cell Width (m) | Depth (cm) | 0.6 Velocity (m/s) | Cell Discharge ($m^3/s$) |
|---|---|---|---|---|---|
| 54.6 | 16.6 | | RB | ----- | |
| 50 | 15.2 | 1.01 | 20 | 0.125 | 0.03 |
| 48 | 14.6 | 0.61 | 32 | 0.177 | 0.03 |
| 46 | 14.0 | 0.61 | 34 | 0.209 | 0.04 |
| 44 | 13.4 | 0.61 | 42 | 0.275 | 0.07 |
| 42 | 12.8 | 0.61 | 42 | 0.376 | 0.10 |
| 40 | 12.2 | 0.61 | 42 | 0.350 | 0.09 |
| 38 | 11.6 | 0.61 | 46 | 0.394 | 0.11 |
| 36 | 11.0 | 0.61 | 48 | 0.376 | 0.11 |
| 34 | 10.4 | 0.61 | 50 | 0.396 | 0.12 |
| 32 | 9.8 | 0.61 | 44 | 0.436 | 0.12 |
| 30 | 9.1 | 0.61 | 42 | 0.425 | 0.11 |
| 28 | 8.5 | 0.61 | 36 | 0.376 | 0.08 |
| 26 | 7.9 | 0.61 | 30 | 0.361 | 0.07 |
| 24 | 7.3 | 0.61 | 22 | 0.302 | 0.04 |
| 22 | 6.7 | 1.31 | 19 | 0.251 | 0.06 |
| 15.4 | 4.7 | | LB | ----- | |

Cross-section Q = 1.18 $m^3$

| | | | | |
|---|---|---|---|---|
| width= | 11.9 | avg | 0.37 | 0.322 |
| | | max | 0.50 | 0.436 |

QA/QC RG

South Fork Bedrock Creek
9/6/2014
10:00 AST
Crew: Lamb-Schnabel
flowtracker

| Station (ft) | Station (m) | Cell Width (m) | Depth (cm) | 0.6 Velocity (m/s) | Cell Discharge ($m^3/s$) |
|---|---|---|---|---|---|
| | 13.8 | | RB | ----- | |
| | 13.5 | 0.40 | 7.5 | 0.000 | 0.00 |
| | 13.0 | 0.50 | 16 | 0.090 | 0.01 |
| | 12.5 | 0.50 | 15 | 0.000 | 0.00 |
| | 12.0 | 0.50 | 22 | 0.098 | 0.01 |
| | 11.5 | 0.50 | 22 | 0.122 | 0.01 |
| | 11.0 | 0.50 | 22 | 0.153 | 0.02 |
| | 10.5 | 0.50 | 23 | 0.154 | 0.02 |
| | 10.0 | 0.50 | 21 | 0.165 | 0.02 |
| | 9.5 | 0.50 | 30 | 0.165 | 0.02 |
| | 9.0 | 0.50 | 27 | 0.191 | 0.03 |
| | 8.5 | 0.50 | 27 | 0.229 | 0.03 |
| | 8.0 | 0.50 | 31 | 0.245 | 0.04 |
| | 7.5 | 0.50 | 39 | 0.266 | 0.05 |
| | 7.0 | 0.50 | 46 | 0.258 | 0.06 |
| | 6.5 | 0.50 | 50 | 0.265 | 0.07 |
| | 6.0 | 0.50 | 51 | 0.272 | 0.07 |
| | 5.5 | 0.50 | 51 | 0.273 | 0.07 |
| | 5.0 | 0.50 | 49 | 0.284 | 0.07 |
| | 4.5 | 0.50 | 47 | 0.294 | 0.07 |
| | 4.0 | 0.50 | 44 | 0.294 | 0.06 |
| | 3.5 | 0.50 | 45 | 0.268 | 0.06 |
| | 3.0 | 0.50 | 37 | 0.209 | 0.04 |
| | 2.5 | 0.50 | 30 | 0.152 | 0.02 |
| | 2.0 | 0.45 | 18 | 0.093 | 0.01 |
| | 1.6 | | LB | | |
| | | | | Cross-section Q = | 0.85 $m^3$ |
| Area | 4.4 | avg | 0.32 | 0.189 | |
| | | max | 0.51 | 0.294 | |

QA/QC RG

Station Number: Meas. No: 4

Station Name: S Fork Bedrock Creek Date: 05/25/2013

| | | |
|---|---|---|
| Party: HT | Width: 17.8 m | Processed by: HT/EY |
| Boat/Motor: | Area: 6.7 m² | Mean Velocity: 1.40 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 9.46 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.060 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: Bottom Track | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: P |
| MagVar Method: Model (18.3°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: 2-Ice Anchor | |
| Discharge Method: None | | Control2: Unspecified | |
| % Correction: 0.00 | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 2.45 m/s | Type/Freq.: StreamPro / 2000 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 0.732 m | Serial #: 1349 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 0.378 m | Bin Size: 5 cm | Blank: 3 cm |
| WT Error Vel.: 0.38 m/s | % Meas.: 33.48 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 0.50 m/s | ADCP Temp.: 0.6 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES

Performed Moving Bed Test: NO

Performed Compass Calibration: NO Evaluation: NO

Meas. Location: upstream of station 250 ft

Project Name: bedrock_sedond time_0_beky.r

Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | L | 1.00 | 8.00 | 144 | 2.26 | 2.80 | 1.91 | 0.311 | 2.08 | 9.37 | 17.8 | 6.6 | 11:51 | 11:54 | 0.10 | 1.42 | 1 | 20 |
| 001 | R | 1.00 | 8.00 | 129 | 2.16 | 3.33 | 1.64 | 0.311 | 2.11 | 9.55 | 17.3 | 6.6 | 11:55 | 11:58 | 0.14 | 1.45 | 2 | 17 |
| 003 | R | 1.00 | 8.00 | 191 | 2.22 | 3.50 | 1.77 | 0.318 | 1.86 | 9.66 | 18.0 | 6.8 | 12:02 | 12:06 | 0.14 | 1.41 | 1 | 19 |
| 004 | L | 1.00 | 8.00 | 140 | 2.21 | 3.03 | 1.90 | 0.309 | 1.80 | 9.25 | 18.2 | 6.9 | 12:06 | 12:09 | 0.14 | 1.33 | 0 | 19 |
| **Mean** | | 1.00 | 8.00 | 151 | 2.21 | 3.17 | 1.80 | 0.312 | 1.96 | 9.46 | 17.8 | 6.7 | **Total** | 00:17 | 0.13 | 1.40 | 1 | 19 |
| **SDev** | | 0.00 | 0.00 | 27 | 0.043 | 0.310 | 0.127 | 0.004 | 0.157 | 0.184 | 0.4 | 0.2 | | | 0.02 | 0.05 | | |
| **SD/M** | | 0.00 | 0.00 | 0.18 | 0.02 | 0.10 | 0.07 | 0.01 | 0.08 | 0.02 | 0.02 | 0.02 | | | 0.14 | 0.04 | | |

**Remarks:** New unit, compass not working properly. Bottom track only. No moving bed test. Anchor ice and floating ice present. Only 33 of Q is measured, rest is estimated. Very poor measurement, estimated 20%+ error.

Station Number:
Station Name: S Fork Bedrock Creek

Meas. No: 5
Date: 05/26/2013

| | | |
|---|---|---|
| Party: KI, JR, HT | Width: 18.5 m | Processed by: HT/EY |
| Boat/Motor: | Area: 9.0 m² | Mean Velocity: 2.14 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 19.0 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.060 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: Bottom Track | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: P |
| MagVar Method: Model (18.3°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: 2-Ice Anchor | |
| Discharge Method: None | | Control2: Unspecified | |
| % Correction: 0.00 | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 3.94 m/s | Type/Freq.: StreamPro / 2000 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 0.873 m | Serial #: 1349 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 0.484 m | Bin Size: 5 cm | Blank: 50 cm |
| WT Error Vel.: 0.38 m/s | % Meas.: 34.40 | BT Mode: 0 | BT Pings: 1 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 3.00 m/s | ADCP Temp.: 0.5 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES
Performed Moving Bed Test: NO
Performed Compass Calibration: NO    Evaluation: NO
Meas. Location: above station

Project Name: bedrock-26-may-2013_0-b-eky.
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 002 | L | 1.00 | 8.00 | 158 | 3.54 | 6.57 | 3.77 | 1.73 | 4.28 | 19.9 | 19.3 | 9.8 | 11:30 | 11:33 | 0.22 | 2.04 | 42 | 22 |
| *003* | *R* | *1.00* | *8.00* | *144* | *2.87* | *5.52* | *2.50* | *1.61* | *4.23* | *16.7* | *15.5* | *7.0* | *11:34* | *11:36* | *0.16* | *2.38* | *31* | *25* |
| 004 | L | 1.00 | 8.00 | 72 | 3.51 | 6.18 | 3.27 | 1.75 | 4.23 | 18.9 | 17.3 | 8.1 | 11:37 | 11:38 | 0.22 | 2.33 | 36 | 20 |
| *005* | *R* | *1.00* | *8.00* | *132* | *4.96* | *7.73* | *4.45* | *1.70* | *3.28* | *22.1* | *19.7* | *9.6* | *11:38* | *11:41* | *0.19* | *2.30* | *39* | *24* |
| *006* | *L* | *1.00* | *8.00* | *102* | *4.74* | *7.73* | *4.46* | *1.54* | *3.10* | *21.6* | *19.9* | *9.6* | *11:41* | *11:43* | *0.20* | *2.26* | *45* | *27* |
| *007* | *R* | *1.00* | *8.00* | *155* | *2.84* | *6.07* | *2.80* | *1.78* | *3.38* | *16.9* | *20.6* | *10.6* | *11:45* | *11:48* | *0.16* | *1.59* | *17* | *25* |
| *010* | *L* | *1.00* | *8.00* | *82* | *3.20* | *6.06* | *2.85* | *1.59* | *3.47* | *17.2* | *17.2* | *8.2* | *11:53* | *11:55* | *0.22* | *2.10* | *24* | *25* |
| **Mean** | | 1.00 | 8.00 | 120 | 3.67 | 6.55 | 3.44 | 1.67 | 3.71 | 19.0 | 18.5 | 9.0 | **Total** | 00:24 | 0.20 | 2.14 | 34 | 24 |
| **SDev** | | 0.00 | 0.00 | 35 | 0.858 | 0.862 | 0.799 | 0.090 | 0.516 | 2.24 | 1.8 | 1.2 | | | 0.03 | 0.27 | | |
| **SD/M** | | 0.00 | 0.00 | 0.29 | 0.23 | 0.13 | 0.23 | 0.05 | 0.14 | 0.12 | 0.10 | 0.14 | | | 0.14 | 0.13 | | |

**Remarks:** no compass no moving bed test -- fast floating ice in the channel, anchor ice present.
New unit, compass not working properly.  Bottom track only.  No moving bed test.  Anchor ice and floating ice present. Only 34
of Q is measured, rest is estimated.  Very poor measurement, estimated 20%+ error.

Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: Meas. No: 6

Station Name: S Fork Bedrock Creek Date: 05/27/2013

| | | |
|---|---|---|
| Party: ki jk ht | Width: 16.8 m | Processed by: EKY/HT |
| Boat/Motor: | Area: 9.3 m² | Mean Velocity: 1.98 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 18.6 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.060 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: Bottom Track | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: P |
| MagVar Method: Model (18.3°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: 2-Ice Anchor | |
| Discharge Method: None | | Control2: Unspecified | |
| % Correction: 0.00 | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 3.51 m/s | Type/Freq.: StreamPro / 2000 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 1.01 m | Serial #: 1349 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 0.546 m | Bin Size: 5 cm | Blank: 3 cm |
| WT Error Vel.: 0.38 m/s | % Meas.: 36.59 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 3.50 m/s | ADCP Temp.: 0.5 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES

Performed Moving Bed Test: NO

Performed Compass Calibration: NO Evaluation: NO

Meas. Location:

Project Name: sfbedrock-27-may-2013_0b-eky

Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 001 | R | 0.50 | 8.00 | 107 | 3.14 | 7.77 | 3.45 | 0.339 | 5.44 | 20.1 | 16.9 | 9.7 | 17:24 | 17:26 | 0.17 | 2.07 | 14 | 23 |
| 002 | L | 0.50 | 8.00 | 171 | 2.13 | 4.88 | 2.48 | 0.329 | 5.61 | 15.4 | 15.2 | 8.4 | 17:26 | 17:30 | 0.17 | 1.84 | 15 | 22 |
| 003 | R | 0.50 | 8.00 | 139 | 5.96 | 14.8 | 6.55 | 0.314 | 5.29 | 32.9 | 24.0 | 15.1 | 17:30 | 17:33 | 0.20 | 2.18 | 17 | 21 |
| 004 | L | 0.50 | 8.00 | 126 | 1.68 | 4.31 | 2.46 | 0.335 | 5.12 | 13.9 | 13.6 | 7.4 | 17:33 | 17:36 | 0.17 | 1.89 | 29 | 22 |
| 005 | R | 1.50 | 8.50 | 147 | 2.04 | 5.63 | 1.49 | 0.973 | 5.66 | 15.8 | 14.8 | 7.3 | 17:38 | 17:41 | 0.20 | 2.18 | 16 | 22 |
| 006 | L | 1.50 | 8.00 | 118 | 3.44 | 7.65 | 4.16 | 1.05 | 5.09 | 21.4 | 18.9 | 10.6 | 17:42 | 17:44 | 0.21 | 2.02 | 15 | 21 |
| 007 | R | 1.50 | 8.00 | 152 | 2.46 | 6.54 | 2.22 | 0.932 | 5.22 | 17.4 | 16.9 | 9.0 | 17:44 | 17:47 | 0.22 | 1.92 | 21 | 22 |
| 008 | L | 1.50 | 8.00 | 98 | 1.35 | 2.93 | 1.45 | 0.954 | 5.30 | 12.0 | 14.2 | 6.9 | 17:48 | 17:49 | 0.24 | 1.75 | 33 | 22 |
| **Mean** | | 1.00 | 8.06 | 132 | 2.78 | 6.81 | 3.03 | 0.653 | 5.34 | 18.6 | 16.8 | 9.3 | **Total** | 00:25 | 0.20 | 1.98 | 20 | 22 |
| **SDev** | | 0.53 | 0.18 | 25 | 1.46 | 3.62 | 1.69 | 0.348 | 0.212 | 6.54 | 3.4 | 2.7 | | | 0.03 | 0.16 | | |
| **SD/M** | | 0.53 | 0.02 | 0.19 | 0.53 | 0.53 | 0.56 | 0.53 | 0.04 | 0.35 | 0.20 | 0.29 | | | 0.14 | 0.08 | | |

**Remarks:** New unit, compass not working properly. Bottom track only. Standing waves in measurement area. No moving bed test. Anc ice and floating ice present. Only 36% of Q is measured, rest is estimated. Very poor measurement, estimated 35%+ error.

Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number:
Station Name: S Fork Bedrock Cr

Meas. No: 7
Date: 05/29/2013

Party: ki ht
Boat/Motor:
Gage Height: 0.000 m

Width: 15.5 m
Area: 10.5 m²
G.H.Change: 0.000 m

Processed by: EY/HT
Mean Velocity: 0.962 m/s
Discharge: 10.1 m³/s

Area Method: Mean Flow
Nav. Method: Bottom Track
MagVar Method: Model (0.0°)
Depth: Composite
Discharge Method: Proportional
% Correction: 0.47

ADCP Depth: 0.060 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: 2-Ice Anchor
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: U
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.38 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 3.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 2.03 m/s
Max. Depth: 1.15 m
Mean Depth: 0.681 m
% Meas.: 50.11
Water Temp.: None
ADCP Temp.: 2.3 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1349 Firmware: 31.12
Bin Size: 5 cm Blank: 3 cm
BT Mode: 10 BT Pings: 2
WT Mode: 12 WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: NO Evaluation: NO
Meas. Location: upstream from station

Project Name: bedrock-29-may-2013-cc_0_ht.r
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | MBT Corrected Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | L | 1.00 | 6.00 | 127 | 1.47 | 4.95 | 1.67 | 0.301 | 1.63 | 10.0 | 15.8 | 10.5 | 17:02 | 17:05 | 0.12 | 0.95 | 6 | 14 |
| 001 | R | 1.00 | 6.00 | 81 | 1.48 | 5.31 | 1.47 | 0.279 | 1.89 | 10.4 | 15.7 | 10.7 | 17:05 | 17:07 | 0.15 | 0.97 | 4 | 13 |
| *002* | *L* | *1.00* | *5.50* | *133* | *1.58* | *5.31* | *1.86* | *0.292* | *1.63* | *10.7* | *15.4* | *10.7* | *17:07* | *17:10* | *0.13* | *1.00* | *6* | *15* |
| 003 | R | *1.00* | *5.50* | *84* | *1.48* | *5.10* | *1.59* | *0.315* | *1.58* | *10.1* | *15.1* | *10.3* | *17:10* | *17:12* | *0.14* | *0.97* | *2* | *12* |
| *004* | *L* | *1.00* | *5.50* | *144* | *1.39* | *4.73* | *1.59* | *0.293* | *1.50* | *9.51* | *15.3* | *10.4* | *17:12* | *17:15* | *0.12* | *0.91* | *3* | *14* |
| **Mean** | | 1.00 | 5.70 | 113 | 1.48 | 5.08 | 1.63 | 0.296 | 1.65 | 10.1 | 15.5 | 10.5 | **Total** | 00:12 | 0.13 | 0.96 | 4 | 14 |
| **SDev** | | 0.00 | 0.27 | 29 | 0.067 | 0.247 | 0.143 | 0.013 | 0.145 | 0.444 | 0.3 | 0.2 | | | 0.01 | 0.03 | | |
| **SD/M** | | 0.00 | 0.05 | 0.26 | 0.04 | 0.05 | 0.09 | 0.04 | 0.09 | 0.04 | 0.02 | 0.02 | | | 0.09 | 0.03 | | |

**Remarks:** anchor ice present. New unit, compass not working properly. Bottom track only. Stationary moving bed test attempted, but tethered boat didn't remain very station. Only 50% of Q is measured, rest is estimated. Poor measurement, estimated 8%+ er

Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number:
Station Name: S Fork Bedrock Creek

Meas. No: 8
Date: 06/02/2013

Party: ki ht
Boat/Motor:
Gage Height: 0.000 m

Width: 11.7 m
Area: 5.9 m²
G.H.Change: 0.000 m

Processed by: HT/EY
Mean Velocity: 0.407 m/s
Discharge: 2.41 m³/s

Area Method: Mean Flow
Nav. Method: Bottom Track
MagVar Method: Model (18.3°)
Depth: Composite
Discharge Method: None
% Correction: 0.00

ADCP Depth: 0.060 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: P
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.43 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 1.50 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 1.37 m/s
Max. Depth: 1.02 m
Mean Depth: 0.509 m
% Meas.: 48.82
Water Temp.: None
ADCP Temp.: 5.8 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1349 Firmware: 31.12
Bin Size: 4 cm Blank: 3 cm
BT Mode: 10 BT Pings: 2
WT Mode: 12 WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: NO Evaluation: NO
Meas. Location: upstream station

Project Name: bedrock 2 june 2013_0-eky.mm
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| *000* | *L* | 0.50 | 3.00 | 200 | 0.514 | 1.06 | 0.411 | 0.026 | 0.150 | 2.16 | 11.4 | 5.9 | 10:54 | 10:58 | 0.06 | 0.36 | 5 | 11 |
| *001* | *R* | 0.50 | 3.00 | 206 | 0.614 | 1.33 | 0.457 | 0.026 | 0.197 | 2.62 | 11.2 | 5.9 | 10:58 | 11:02 | 0.06 | 0.44 | 1 | 10 |
| 002 | L | 0.50 | 3.50 | 247 | 0.551 | 1.18 | 0.413 | 0.033 | 0.244 | 2.42 | 11.8 | 6.0 | 11:03 | 11:07 | 0.06 | 0.41 | 1 | 10 |
| 003 | R | 0.50 | 3.50 | 199 | 0.560 | 1.22 | 0.457 | 0.027 | 0.258 | 2.53 | 11.1 | 5.7 | 11:08 | 11:12 | 0.06 | 0.44 | 1 | 10 |
| 004 | L | 1.00 | 3.00 | 197 | 0.574 | 1.15 | 0.429 | 0.060 | 0.133 | 2.34 | 12.0 | 6.1 | 11:12 | 11:16 | 0.06 | 0.39 | 1 | 10 |
| 005 | R | 1.00 | 3.00 | 177 | 0.588 | 1.20 | 0.452 | 0.055 | 0.156 | 2.45 | 11.7 | 5.8 | 11:17 | 11:20 | 0.06 | 0.42 | 2 | 11 |
| 006 | L | 1.00 | 3.00 | 244 | 0.596 | 1.10 | 0.463 | 0.053 | 0.126 | 2.34 | 12.8 | 6.3 | 11:20 | 11:25 | 0.05 | 0.37 | 4 | 11 |
| 007 | R | 0.50 | 3.00 | 171 | 0.606 | 1.20 | 0.474 | 0.024 | 0.157 | 2.46 | 11.6 | 5.9 | 11:26 | 11:29 | 0.05 | 0.42 | 2 | 11 |
| **Mean** | | 0.69 | 3.13 | 205 | 0.575 | 1.18 | 0.445 | 0.038 | 0.178 | 2.41 | 11.7 | 5.9 | **Total** | 00:35 | 0.06 | 0.41 | 2 | 10 |
| **SDev** | | 0.26 | 0.23 | 28 | 0.033 | 0.081 | 0.024 | 0.015 | 0.050 | 0.138 | 0.5 | 0.2 | | | 0.00 | 0.03 | | |
| **SD/M** | | 0.38 | 0.07 | 0.13 | 0.06 | 0.07 | 0.05 | 0.40 | 0.28 | 0.06 | 0.04 | 0.03 | | | 0.09 | 0.07 | | |

**Remarks:** no ice low flow. Bottom track only due to compass not working properly on new unit. Measurement quality poor. Only 48% of measured.

Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: Meas. No: 11

Station Name: South Fork Bedrock Ck Date: 05/06/2014

Party: EL
Boat/Motor:
Gage Height: 0.000 m

Width: 13.0 m
Area: 6.0 m²
G.H.Change: 0.000 m

Processed by: EY
Mean Velocity: 0.960 m/s
Discharge: 5.70 m³/s

Area Method: Mean Flow
Nav. Method: Bottom Track
MagVar Method: None (18.0°)
Depth: Composite
Discharge Method: None
% Correction: 0.00

ADCP Depth: 0.070 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: P
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.49 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.00 m/s*
Use Weighted Mean Depth: YES

Max. Vel.: 2.14 m/s
Max. Depth: 0.627 m
Mean Depth: 0.459 m
% Meas.: 52.18
Water Temp.: None
ADCP Temp.: 0.6 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1349 Firmware: 31.12
Bin Size: 3 cm Blank: 3 cm
BT Mode: 10 BT Pings: 2
WT Mode: 12 WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: upstream of station

Project Name: southforkbedrock_2014_05_06_
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| *000* | *R* | *2.00* | *1.00* | *377* | *1.17* | *2.05* | *0.554* | *0.399* | *0.075* | *4.25* | *13.0* | *6.0* | *10:30* | *10:37* | *0.15* | *0.70* | *1* | *1* |
| *001* | *L* | *2.00* | *1.00* | *372* | *2.04* | *4.03* | *0.936* | *0.367* | *0.054* | *7.43* | *12.5* | *5.8* | *10:40* | *10:47* | *0.15* | *1.28* | *1* | *0* |
| *002* | *R* | *2.00* | *1.00* | *369* | *1.25* | *2.25* | *0.495* | *0.344* | *0.046* | *4.39* | *13.1* | *6.0* | *10:49* | *10:56* | *0.15* | *0.73* | *0* | *0* |
| *003* | *L* | *2.00* | *1.00* | *239* | *1.91* | *3.56* | *0.845* | *0.371* | *0.042* | *6.73* | *13.3* | *6.0* | *10:57* | *11:02* | *0.15* | *1.12* | *0* | *1* |
| **Mean** | | 2.00 | 1.00 | 339 | 1.59 | 2.97 | 0.708 | 0.370 | 0.054 | 5.70 | 13.0 | 6.0 | **Total** | 00:32 | 0.15 | 0.96 | 1 | 0 |
| **SDev** | | 0.00 | 0.00 | 67 | 0.445 | 0.971 | 0.216 | 0.023 | 0.015 | 1.62 | 0.3 | 0.1 | | | 0.00 | 0.29 | | |
| **SD/M** | | 0.00 | 0.00 | 0.20 | 0.28 | 0.33 | 0.31 | 0.06 | 0.27 | 0.28 | 0.03 | 0.02 | | | 0.02 | 0.30 | | |

**Remarks:** No ice in channel. Strong directional bias observed. Error message: Failed to converge while calculating magnetic field perturbations. Streampro S/N 1349 (compass repaired 2013, but still has problems. getting another Streampro shipped up ASAP).

* - value not consistent for all transects
Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: | Meas. No: 11
Station Name: South Fork Bedrock Ck | Date: 05/06/2014

| | | |
|---|---|---|
| Party: EL | Width: 13.0 m | Processed by: EY |
| Boat/Motor: | Area: 6.0 m² | Mean Velocity: 0.960 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 5.70 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.070 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: Bottom Track | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: P |
| MagVar Method: None (18.0°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: 14-Shore Ice | |
| Discharge Method: None | | Control2: Unspecified | |
| % Correction: 0.00 | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 2.14 m/s | Type/Freq.: StreamPro / 2000 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 0.627 m | Serial #: 1349 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 0.459 m | Bin Size: 4 cm | Blank: 3 cm |
| WT Error Vel.: 0.49 m/s | % Meas.: 52.18 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 2.00 m/s* | ADCP Temp.: 0.6 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES    Evaluation: YES
Meas. Location: upstream of station

Project Name: southforkbedrock_2014_05_06_
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| *000* | *R* | *2.00* | *1.00* | *377* | *1.17* | *2.05* | *0.554* | *0.399* | *0.075* | *4.25* | *13.0* | *6.0* | *10:30* | *10:37* | *0.15* | *0.70* | *1* | *1* |
| *001* | *L* | *2.00* | *1.00* | *372* | *2.04* | *4.03* | *0.936* | *0.367* | *0.054* | *7.43* | *12.5* | *5.8* | *10:40* | *10:47* | *0.15* | *1.28* | *1* | *0* |
| *002* | *R* | *2.00* | *1.00* | *369* | *1.25* | *2.25* | *0.495* | *0.344* | *0.046* | *4.39* | *13.1* | *6.0* | *10:49* | *10:56* | *0.15* | *0.73* | *0* | *0* |
| *003* | *L* | *2.00* | *1.00* | *239* | *1.91* | *3.56* | *0.845* | *0.371* | *0.042* | *6.73* | *13.3* | *6.0* | *10:57* | *11:02* | *0.15* | *1.12* | *0* | *1* |
| **Mean** | | 2.00 | 1.00 | 339 | 1.59 | 2.97 | 0.708 | 0.370 | 0.054 | 5.70 | 13.0 | 6.0 | **Total** | 00:32 | 0.15 | 0.96 | 1 | 0 |
| **SDev** | | 0.00 | 0.00 | 67 | 0.445 | 0.971 | 0.216 | 0.023 | 0.015 | 1.62 | 0.3 | 0.1 | | | 0.00 | 0.29 | | |
| **SD/M** | | 0.00 | 0.00 | 0.20 | 0.28 | 0.33 | 0.31 | 0.06 | 0.27 | 0.28 | 0.03 | 0.02 | | | 0.02 | 0.30 | | |

**Remarks:** No bottom ice, but ice/snow at edgel. Strong directional bias observed. No good compass calibration. Error message: Failed converge while calculating magnetic field perturbations. Streampro S/N 1349 (compass repaired 2013, but still has problems. getting another Streampro shipped up ASAP).

* - value not consistent for all transects
Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: DAS3 | Meas. No: 12
Station Name: S Fork Bedrock Cr | Date: 05/08/2014

Party: EL
Boat/Motor:
Gage Height: 0.000 m

Width: 12.4 m
Area: 7.0 m²
G.H.Change: 0.000 m

Processed by: EY
Mean Velocity: 0.613 m/s
Discharge: 4.27 m³/s

Area Method: Mean Flow
Nav. Method: Bottom Track
MagVar Method: None (18.0°)
Depth: Composite
Discharge Method: Proportional
% Correction: 0.65

ADCP Depth: 0.070 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: 14-Shore Ice
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: P
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.49 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 1.87 m/s
Max. Depth: 1.05 m
Mean Depth: 0.563 m
% Meas.: 60.34
Water Temp.: None
ADCP Temp.: 0.4 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1180 | Firmware: 31.12
Bin Size: 4 cm | Blank: 3 cm
BT Mode: 10 | BT Pings: 2
WT Mode: 12 | WT Pings: 6

Performed Diag. Test: NO
Performed Moving Bed Test: YES
Performed Compass Calibration: NO    Evaluation: NO
Meas. Location: upstream of station

Project Name: southforkbedrock_2014_05_08_
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | MBT Corrected Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 002 | R | 1.00 | 1.00 | 130 | 0.995 | 2.56 | 0.568 | 0.055 | 0.017 | 4.19 | 12.1 | 6.8 | 14:56 | 14:58 | 0.10 | 0.62 | 1 | 0 |
| 003 | L | 1.00 | 1.00 | 146 | 1.02 | 2.59 | 0.599 | 0.045 | -0.007 | 4.24 | 12.3 | 6.9 | 14:58 | 15:01 | 0.09 | 0.61 | 1 | 1 |
| 004 | R | 1.00 | 1.00 | 155 | 1.03 | 2.62 | 0.627 | 0.053 | 0.023 | 4.35 | 12.2 | 6.9 | 15:01 | 15:05 | 0.08 | 0.63 | 1 | 1 |
| 005 | L | 1.00 | 1.00 | 138 | 1.02 | 2.54 | 0.634 | 0.075 | 0.017 | 4.28 | 12.9 | 7.3 | 15:05 | 15:08 | 0.09 | 0.59 | 0 | 1 |
| **Mean** | | 1.00 | 1.00 | 142 | 1.02 | 2.57 | 0.607 | 0.057 | 0.013 | 4.27 | 12.4 | 7.0 | **Total** | 00:12 | 0.09 | 0.61 | 1 | 1 |
| **SDev** | | 0.00 | 0.00 | 11 | 0.014 | 0.036 | 0.030 | 0.013 | 0.013 | 0.066 | 0.4 | 0.2 | | | 0.01 | 0.02 | | |
| **SD/M** | | 0.00 | 0.00 | 0.08 | 0.01 | 0.01 | 0.05 | 0.22 | 1.06 | 0.02 | 0.03 | 0.03 | | | 0.08 | 0.03 | | |

**Remarks:** No compass calibration and no ADCP test. No GPS.

Station Number: DAS3 | Meas. No: 13
Station Name: S Fork Bedrock CR | Date: 05/09/2014

Party: EL,JK | Width: 13.5 m | Processed by: EY
Boat/Motor: | Area: 7.1 m² | Mean Velocity: 0.567 m/s
Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 4.01 m³/s

Area Method: Mean Flow | ADCP Depth: 0.070 m | Index Vel.: 0.00 m/s | Rating No.: 1
Nav. Method: Bottom Track | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: G
MagVar Method: None (18.0°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000%
Depth: Composite | Top Est: Power (0.1667) | Control1: 14-Shore Ice
Discharge Method: Proportional | Control2: Unspecified
% Correction: 0.09 | Control3: Unspecified

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.49 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 1.74 m/s
Max. Depth: 1.07 m
Mean Depth: 0.524 m
% Meas.: 59.04
Water Temp.: None
ADCP Temp.: 1.1 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1180 | Firmware: 31.12
Bin Size: 4 cm | Blank: 3 cm
BT Mode: 10 | BT Pings: 2
WT Mode: 12 | WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: NO Evaluation: NO
Meas. Location: upstream station

Project Name: southforkbedrock_2014_05_09_
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | MBT Corrected Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 1.00 | 1.00 | 120 | 0.977 | 2.37 | 0.547 | 0.041 | 0.013 | 3.95 | 13.8 | 7.2 | 15:13 | 15:15 | 0.11 | 0.55 | 1 | 1 |
| 001 | L | 1.00 | 1.00 | 152 | 1.00 | 2.38 | 0.560 | 0.042 | 0.011 | 4.00 | 13.3 | 7.0 | 15:15 | 15:19 | 0.08 | 0.57 | 0 | 1 |
| 002 | R | 1.00 | 1.00 | 143 | 0.979 | 2.34 | 0.612 | 0.036 | 0.012 | 3.98 | 13.2 | 7.0 | 15:19 | 15:22 | 0.09 | 0.57 | 2 | 1 |
| 003 | L | 1.00 | 1.00 | 175 | 1.06 | 2.37 | 0.628 | 0.048 | -0.004 | 4.09 | 13.7 | 7.1 | 15:22 | 15:26 | 0.08 | 0.57 | 0 | 1 |
| **Mean** | | 1.00 | 1.00 | 147 | 1.00 | 2.37 | 0.587 | 0.042 | 0.008 | 4.01 | 13.5 | 7.1 | **Total** | 00:12 | 0.09 | 0.57 | 1 | 1 |
| **SDev** | | 0.00 | 0.00 | 23 | 0.037 | 0.020 | 0.039 | 0.005 | 0.008 | 0.062 | 0.3 | 0.1 | | | 0.01 | 0.01 | | |
| **SD/M** | | 0.00 | 0.00 | 0.15 | 0.04 | 0.01 | 0.07 | 0.12 | 1.01 | 0.02 | 0.02 | 0.02 | | | 0.14 | 0.02 | | |

**Remarks:** NO GPS. No compass calibration. Shore ice present.

Station Number: DAS3 Meas. No: 14
Station Name: S Fork Bedrock CR Date: 05/10/2014

| | | |
|---|---|---|
| Party: EL,JK,HT | Width: 12.6 m | Processed by: EY |
| Boat/Motor: | Area: 7.4 m² | Mean Velocity: 0.703 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 5.18 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.070 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: Bottom Track | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: G |
| MagVar Method: None (18.0°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: 14-Shore Ice | |
| Discharge Method: Proportional | | Control2: Unspecified | |
| % Correction: 0.76 | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 1.77 m/s | Type/Freq.: StreamPro / 2000 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 1.02 m | Serial #: 1180 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 0.585 m | Bin Size: 4 cm | Blank: 3 cm |
| WT Error Vel.: 0.49 m/s | % Meas.: 60.02 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 2.00 m/s | ADCP Temp.: 0.5 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES Project Name: southforkbedrock_2014_05_10_
Performed Moving Bed Test: YES Software: 2.12
Performed Compass Calibration: NO Evaluation: NO
Meas. Location: upstream of station

| Tr.# | | Edge Distance | | #Ens. | MBT Corrected Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 1.00 | 1.00 | 148 | 1.23 | 3.14 | 0.713 | 0.069 | 0.032 | 5.18 | 12.2 | 7.1 | 08:36 | 08:39 | 0.09 | 0.73 | 1 | 1 |
| 001 | L | 1.00 | 1.00 | 215 | 1.25 | 3.08 | 0.700 | 0.071 | 0.040 | 5.14 | 12.9 | 7.5 | 08:39 | 08:43 | 0.08 | 0.68 | 1 | 1 |
| *002* | *R* | *1.00* | *1.00* | *198* | *1.37* | *3.46* | *0.799* | *0.103* | *0.037* | *5.77* | *13.4* | *7.9* | *08:44* | *08:47* | *0.08* | *0.73* | *2* | *1* |
| 003 | L | *1.00* | *1.00* | *188* | *1.22* | *3.03* | *0.695* | *0.085* | *0.036* | *5.06* | *12.6* | *7.3* | *08:48* | *08:51* | *0.08* | *0.69* | *1* | *1* |
| *004* | *R* | *1.00* | *1.00* | *209* | *1.18* | *2.94* | *0.679* | *0.066* | *0.038* | *4.90* | *12.1* | *7.0* | *08:51* | *08:56* | *0.08* | *0.70* | *1* | *1* |
| 005 | L | *1.00* | *1.00* | *178* | *1.19* | *3.01* | *0.716* | *0.086* | *0.038* | *5.04* | *12.4* | *7.3* | *08:56* | *08:59* | *0.08* | *0.69* | *3* | *1* |
| **Mean** | | 1.00 | 1.00 | 189 | 1.24 | 3.11 | 0.717 | 0.080 | 0.037 | 5.18 | 12.6 | 7.4 | **Total** | 00:23 | 0.08 | 0.70 | 1 | 1 |
| **SDev** | | 0.00 | 0.00 | 24 | 0.071 | 0.184 | 0.042 | 0.014 | 0.003 | 0.305 | 0.5 | 0.3 | | | 0.01 | 0.02 | | |
| **SD/M** | | 0.00 | 0.00 | 0.13 | 0.06 | 0.06 | 0.06 | 0.18 | 0.07 | 0.06 | 0.04 | 0.04 | | | 0.07 | 0.03 | | |

**Remarks:** No GPS. Shore ice still present.

Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: DAS3 Meas. No: 15
Station Name: SouthForkBedrock Date: 05/12/2014

| | | |
|---|---|---|
| Party: EL,HT,JK | Width: 18.3 m | Processed by: EY |
| Boat/Motor: | Area: 14.1 m² | Mean Velocity: 1.24 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 17.5 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.070 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: Bottom Track | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: F |
| MagVar Method: None (18.0°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: 14-Shore Ice | |
| Discharge Method: Proportional | | Control2: Unspecified | |
| % Correction: 0.34 | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 2.59 m/s | Type/Freq.: StreamPro / 2000 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 1.20 m | Serial #: 1180 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 0.770 m | Bin Size: 5 cm* | Blank: 3 cm |
| WT Error Vel.: 0.43 m/s* | % Meas.: 64.30 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 3.00 m/s | ADCP Temp.: 0.5 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES Project Name: southforkbedrock_2014_05_12_
Performed Moving Bed Test: YES Software: 2.12
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: upstream station

| Tr.# | | Edge Distance | | #Ens. | MBT Corrected Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 2.00 | 1.50 | 193 | 3.32 | 11.5 | 2.24 | 0.676 | 0.189 | 17.9 | 19.1 | 14.6 | 08:43 | 08:47 | 0.11 | 1.23 | 5 | 2 |
| 001 | L | 2.00 | 1.50 | 200 | 3.19 | 10.9 | 2.05 | 0.710 | 0.243 | 17.1 | 17.9 | 14.0 | 08:47 | 08:51 | 0.10 | 1.22 | 6 | 2 |
| *002* | *R* | *2.00* | *1.50* | *196* | *3.09* | *10.5* | *1.89* | *0.684* | *0.219* | *16.4* | *17.5* | *13.3* | *08:51* | *08:55* | *0.12* | *1.23* | *9* | *1* |
| 003 | L | *2.00* | *1.50* | *195* | *3.46* | *11.8* | *2.11* | *0.667* | *0.243* | *18.3* | *19.0* | *14.8* | *08:55* | *08:59* | *0.10* | *1.24* | *7* | *2* |
| 004 | R | *1.50* | *1.50* | *160* | *3.31* | *11.2* | *2.09* | *0.482* | *0.242* | *17.4* | *18.1* | *14.0* | *09:00* | *09:03* | *0.14* | *1.24* | *6* | *2* |
| 005 | L | *1.50* | *1.50* | *145* | *3.50* | *11.5* | *2.16* | *0.497* | *0.174* | *17.8* | *18.2* | *13.9* | *09:03* | *09:06* | *0.12* | *1.28* | *6* | *2* |
| **Mean** | | 1.83 | 1.50 | 181 | 3.31 | 11.2 | 2.09 | 0.619 | 0.218 | 17.5 | 18.3 | 14.1 | **Total** | 00:23 | 0.12 | 1.24 | 6 | 2 |
| **SDev** | | 0.26 | 0.00 | 23 | 0.156 | 0.457 | 0.120 | 0.102 | 0.030 | 0.670 | 0.6 | 0.5 | | | 0.01 | 0.02 | | |
| **SD/M** | | 0.14 | 0.00 | 0.13 | 0.05 | 0.04 | 0.06 | 0.16 | 0.14 | 0.04 | 0.03 | 0.04 | | | 0.11 | 0.02 | | |

**Remarks:** No GPS. Shore ice still present. Moving bed, flow is adjusted.

* - value not consistent for all transects
Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: DAS3 | Meas. No: 16
Station Name: S Fork Bedrock CR | Date: 05/13/2014

| | | |
|---|---|---|
| Party: EL,HT,JK | Width: 16.6 m | Processed by: EY |
| Boat/Motor: | Area: 15.3 m² | Mean Velocity: 1.47 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 22.4 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.090 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: Bottom Track | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: G |
| MagVar Method: None (18.0°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: Unspecified | |
| Discharge Method: Proportional | | Control2: Unspecified | |
| % Correction: 0.42 | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 2.86 m/s | Type/Freq.: StreamPro / 2000 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 1.34 m | Serial #: 1180 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 0.919 m | Bin Size: 5 cm | Blank: 3 cm |
| WT Error Vel.: 0.38 m/s | % Meas.: 67.35 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 3.00 m/s | ADCP Temp.: 1.2 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES | Project Name: SouthForkBedrock_2014_05_1
Performed Moving Bed Test: YES | Software: 2.12
Performed Compass Calibration: NO Evaluation: NO
Meas. Location: upstream of station

| Tr.# | | Edge Distance | | #Ens. | MBT Corrected Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| *001* | *R* | *0.50* | *1.00* | *153* | *4.07* | *14.2* | *2.52* | *0.240* | *0.102* | *21.1* | *15.9* | *14.5* | *13:43* | *13:46* | *0.14* | *1.46* | *3* | *2* |
| 002 | L | 0.50 | 1.00 | 146 | 4.44 | 15.5 | 2.75 | 0.234 | 0.085 | 23.0 | 16.9 | 15.6 | 13:46 | 13:49 | 0.12 | 1.48 | 1 | 3 |
| *003* | *R* | *0.50* | *1.00* | *170* | *4.56* | *16.1* | *2.90* | *0.219* | *0.083* | *23.8* | *17.6* | *16.1* | *13:49* | *13:52* | *0.13* | *1.48* | *5* | *3* |
| 005 | L | 0.50 | 1.00 | 206 | 4.19 | 14.8 | 2.62 | 0.248 | 0.084 | 22.0 | 16.4 | 15.1 | 13:54 | 13:58 | 0.10 | 1.46 | 6 | 2 |
| 006 | R | 0.50 | 1.00 | 179 | 4.31 | 15.3 | 2.78 | 0.251 | 0.087 | 22.7 | 17.0 | 15.6 | 13:58 | 14:02 | 0.11 | 1.45 | 4 | 3 |
| 007 | L | 0.50 | 1.00 | 155 | 4.15 | 14.8 | 2.70 | 0.254 | 0.098 | 22.0 | 15.9 | 14.8 | 14:02 | 14:05 | 0.11 | 1.49 | 5 | 2 |
| **Mean** | | 0.50 | 1.00 | 168 | 4.29 | 15.1 | 2.71 | 0.241 | 0.090 | 22.4 | 16.6 | 15.3 | **Total** | 00:22 | 0.12 | 1.47 | 4 | 3 |
| **SDev** | | 0.00 | 0.00 | 22 | 0.187 | 0.650 | 0.131 | 0.013 | 0.008 | 0.944 | 0.7 | 0.6 | | | 0.01 | 0.02 | | |
| **SD/M** | | 0.00 | 0.00 | 0.13 | 0.04 | 0.04 | 0.05 | 0.05 | 0.09 | 0.04 | 0.04 | 0.04 | | | 0.11 | 0.01 | | |

**Remarks:** Adjusted probe after tansect 00. Moving bed.

Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: DAS3 Meas. No: 17
Station Name: SouthForkBedrock Date: 05/14/2014

Party: EL,JK
Boat/Motor:
Gage Height: 0.000 m

Width: 17.7 m
Area: 13.9 m²
G.H.Change: 0.000 m

Processed by: EY
Mean Velocity: 1.26 m/s
Discharge: 17.5 m³/s

Area Method: Mean Flow
Nav. Method: Bottom Track
MagVar Method: None (18.0°)
Depth: Composite
Discharge Method: Proportional
% Correction: 0.32

ADCP Depth: 0.090 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: P
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.43 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.50 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 2.49 m/s
Max. Depth: 1.20 m
Mean Depth: 0.783 m
% Meas.: 63.27
Water Temp.: None
ADCP Temp.: 1.7 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1180 Firmware: 31.12
Bin Size: 5 cm Blank: 3 cm
BT Mode: 10 BT Pings: 2
WT Mode: 12 WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: NO Evaluation: NO
Meas. Location: upstream station

Project Name: SouthForkBedrock_2014_05_1
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | MBT Corrected Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | L | 1.00 | 1.00 | 175 | 3.72 | 10.7 | 2.02 | 0.404 | 0.052 | 16.9 | 17.1 | 13.5 | 16:01 | 16:05 | 0.11 | 1.25 | 2 | 1 |
| 001 | R | 1.00 | 1.00 | 154 | 4.03 | 11.6 | 2.23 | 0.389 | 0.040 | 18.3 | 18.4 | 14.3 | 16:05 | 16:08 | 0.12 | 1.27 | 1 | 2 |
| *002* | *L* | *1.00* | *1.00* | *204* | *3.52* | *9.90* | *1.91* | *0.401* | *0.039* | *15.8* | *17.3* | *13.3* | *16:08* | *16:12* | *0.10* | *1.19* | *3* | *1* |
| *003* | *R* | *1.00* | *1.00* | *149* | *4.00* | *11.9* | *2.18* | *0.361* | *0.056* | *18.5* | *18.3* | *14.5* | *16:12* | *16:15* | *0.13* | *1.28* | *3* | *1* |
| 004 | L | *1.00* | *1.00* | *180* | *3.77* | *10.4* | *2.05* | *0.388* | *0.075* | *16.7* | *17.1* | *13.3* | *16:15* | *16:19* | *0.11* | *1.25* | *1* | *1* |
| 005 | R | *1.00* | *1.00* | *133* | *3.71* | *10.7* | *1.99* | *0.358* | *0.065* | *16.8* | *17.1* | *13.3* | *16:19* | *16:22* | *0.13* | *1.26* | *0* | *1* |
| 006 | L | *1.00* | *1.00* | *149* | *3.70* | *10.7* | *2.01* | *0.425* | *0.059* | *16.9* | *17.7* | *14.0* | *16:23* | *16:25* | *0.12* | *1.21* | *1* | *1* |
| *007* | *R* | *1.00* | *1.00* | *127* | *4.43* | *12.5* | *2.51* | *0.355* | *0.048* | *19.9* | *18.9* | *14.9* | *16:26* | *16:28* | *0.15* | *1.33* | *4* | *1* |
| **Mean** | | 1.00 | 1.00 | 158 | 3.86 | 11.0 | 2.11 | 0.385 | 0.054 | 17.5 | 17.7 | 13.9 | **Total** | 00:27 | 0.12 | 1.26 | 2 | 1 |
| **SDev** | | 0.00 | 0.00 | 26 | 0.285 | 0.873 | 0.192 | 0.025 | 0.012 | 1.32 | 0.7 | 0.6 | | | 0.02 | 0.04 | | |
| **SD/M** | | 0.00 | 0.00 | 0.16 | 0.07 | 0.08 | 0.09 | 0.07 | 0.23 | 0.08 | 0.04 | 0.05 | | | 0.14 | 0.03 | | |

**Remarks:** NO GPS, small moving bed, Q adjusted.

Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: DAS3 Meas. No: 18
Station Name: SouthForkBedrock Date: 05/17/2014

| | | |
|---|---|---|
| Party: EL,HT,JK | Width: 16.9 m | Processed by: EY |
| Boat/Motor: | Area: 13.8 m² | Mean Velocity: 1.32 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 18.2 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.090 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: Bottom Track | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: G |
| MagVar Method: None (118.0°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: Unspecified | |
| Discharge Method: Proportional | | Control2: Unspecified | |
| % Correction: 0.36 | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 2.60 m/s | Type/Freq.: StreamPro / 2000 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 1.22 m | Serial #: 1180 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 0.814 m | Bin Size: 5 cm | Blank: 3 cm |
| WT Error Vel.: 0.38 m/s | % Meas.: 63.75 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 2.50 m/s | ADCP Temp.: 2.0 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES Project Name: southforkbedrock_2014_05_17_
Performed Moving Bed Test: YES Software: 2.12
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: upstream of station

| Tr.# | | Edge Distance | | #Ens. | MBT Corrected Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| *000* | *R* | *1.00* | *1.00* | *142* | *4.02* | *12.5* | *2.40* | *0.418* | *0.061* | *19.4* | *17.0* | *13.9* | *14:30* | *14:33* | *0.14* | *1.39* | *2* | *2* |
| 001 | L | *1.00* | *1.00* | *145* | *3.77* | *11.6* | *2.32* | *0.456* | *0.066* | *18.2* | *17.3* | *14.1* | *14:33* | *14:36* | *0.12* | *1.29* | *0* | *3* |
| 003 | R | *1.00* | *1.00* | *122* | *3.65* | *11.3* | *2.22* | *0.443* | *0.089* | *17.7* | *16.4* | *13.4* | *14:38* | *14:40* | *0.15* | *1.32* | *3* | *2* |
| 004 | L | *1.00* | *1.00* | *115* | *3.64* | *11.1* | *2.32* | *0.443* | *0.057* | *17.5* | *17.0* | *13.7* | *14:40* | *14:43* | *0.14* | *1.28* | *4* | *3* |
| **Mean** | | 1.00 | 1.00 | 131 | 3.77 | 11.6 | 2.31 | 0.440 | 0.068 | 18.2 | 16.9 | 13.8 | **Total** | 00:12 | 0.14 | 1.32 | 2 | 2 |
| **SDev** | | 0.00 | 0.00 | 15 | 0.175 | 0.627 | 0.070 | 0.016 | 0.014 | 0.838 | 0.4 | 0.3 | | | 0.01 | 0.05 | | |
| **SD/M** | | 0.00 | 0.00 | 0.11 | 0.05 | 0.05 | 0.03 | 0.04 | 0.21 | 0.05 | 0.02 | 0.02 | | | 0.08 | 0.04 | | |

**Remarks:** Small moving bed, data adjusted. No GPS.

Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: DAS3 | Meas. No: 19
Station Name: SouthForkBedrock | Date: 05/18/2014

Party: EL/HT/JK
Boat/Motor:
Gage Height: 0.000 m

Width: 17.0 m
Area: 11.6 m²
G.H.Change: 0.000 m

Processed by: EY
Mean Velocity: 1.08 m/s
Discharge: 12.5 m³/s

Area Method: Mean Flow
Nav. Method: Bottom Track
MagVar Method: None (18.0°)
Depth: Composite
Discharge Method: Proportional
% Correction: 0.27

ADCP Depth: 0.080 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s | Rating No.: 1
Adj.Mean Vel: 0.00 m/s | Qm Rating: G
Rated Area: 0.000 m² | Diff.: 0.000%
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.43 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.50 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 2.43 m/s
Max. Depth: 1.06 m
Mean Depth: 0.683 m
% Meas.: 60.60
Water Temp.: None
ADCP Temp.: 0.9 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1180 | Firmware: 31.12
Bin Size: 4 cm | Blank: 3 cm
BT Mode: 10 | BT Pings: 2
WT Mode: 12 | WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: NO    Evaluation: NO
Meas. Location: upstream of station

Project Name: southforkbedrock_2014_05_18_
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | MBT Corrected Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 1.00 | 1.00 | 165 | 2.93 | 7.89 | 1.75 | 0.266 | 0.087 | 12.9 | 17.9 | 11.8 | 08:37 | 08:40 | 0.12 | 1.09 | 5 | 1 |
| 001 | L | 1.00 | 1.00 | 162 | 2.84 | 7.44 | 1.57 | 0.283 | 0.077 | 12.2 | 16.1 | 11.1 | 08:40 | 08:43 | 0.11 | 1.10 | 4 | 1 |
| *002* | *R* | *0.50* | *1.00* | *157* | *3.24* | *8.34* | *1.83* | *0.139* | *0.077* | *13.6* | *17.4* | *12.1* | *08:44* | *08:47* | *0.12* | *1.12* | *5* | *1* |
| 003 | L | *1.00* | *1.00* | *136* | *2.88* | *7.30* | *1.67* | *0.270* | *0.090* | *12.2* | *17.1* | *11.7* | *08:47* | *08:49* | *0.13* | *1.04* | *6* | *2* |
| 004 | R | *1.00* | *1.00* | *132* | *2.81* | *7.29* | *1.62* | *0.289* | *0.078* | *12.1* | *16.7* | *11.3* | *08:49* | *08:52* | *0.13* | *1.07* | *7* | *1* |
| 005 | L | *1.00* | *1.00* | *112* | *2.84* | *7.31* | *1.63* | *0.281* | *0.078* | *12.1* | *16.9* | *11.6* | *08:52* | *08:54* | *0.15* | *1.05* | *4* | *1* |
| **Mean** | | 0.92 | 1.00 | 144 | 2.92 | 7.59 | 1.68 | 0.255 | 0.081 | 12.5 | 17.0 | 11.6 | **Total** | 00:17 | 0.13 | 1.08 | 5 | 1 |
| **SDev** | | 0.20 | 0.00 | 21 | 0.159 | 0.430 | 0.095 | 0.057 | 0.006 | 0.616 | 0.6 | 0.4 | | | 0.01 | 0.03 | | |
| **SD/M** | | 0.22 | 0.00 | 0.14 | 0.05 | 0.06 | 0.06 | 0.23 | 0.07 | 0.05 | 0.04 | 0.03 | | | 0.11 | 0.03 | | |

**Remarks:** No GPS. Compass calibration saved from 5/17 (although not used in measurement because no GPS). Slight moving bed.

Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: DAS3
Station Name: SouthForkBedrock

Meas. No: 20
Date: 05/22/2014

Party: EL,HT,JK
Boat/Motor:
Gage Height: 0.000 m

Width: 17.1 m
Area: 8.6 m²
G.H.Change: 0.000 m

Processed by: EY
Mean Velocity: 0.698 m/s
Discharge: 6.02 m³/s

Area Method: Mean Flow
Nav. Method: Bottom Track
MagVar Method: None (18.0°)
Depth: Composite
Discharge Method: Proportional
% Correction: 0.46

ADCP Depth: 0.070 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: G
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.49 m/s*
BT Up Vel.: 0.30 m/s
WT Up Vel.: 1.75 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 1.70 m/s
Max. Depth: 1.05 m
Mean Depth: 0.505 m
% Meas.: 55.57
Water Temp.: None
ADCP Temp.: 2.7 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1180
Firmware: 31.12
Bin Size: 3 cm*
Blank: 3 cm
BT Mode: 10
BT Pings: 2
WT Mode: 12
WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES    Evaluation: YES
Meas. Location: upstream station

Project Name: SouthForkBedrock_2014_05_2
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | MBT Corrected Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 0.50 | 5.00 | 128 | 1.57 | 3.18 | 0.876 | 0.047 | 0.273 | 5.95 | 17.3 | 8.7 | 10:27 | 10:30 | 0.11 | 0.68 | 0 | 0 |
| 001 | L | 0.50 | 5.00 | 194 | 1.41 | 3.31 | 0.788 | 0.048 | 0.383 | 5.94 | 16.8 | 8.5 | 10:30 | 10:34 | 0.08 | 0.69 | 2 | 1 |
| 002 | R | 0.50 | 5.00 | 189 | 1.46 | 3.46 | 0.809 | 0.053 | 0.316 | 6.10 | 17.0 | 8.6 | 10:34 | 10:38 | 0.09 | 0.71 | 1 | 1 |
| 003 | L | 0.50 | 5.00 | 152 | 1.46 | 3.43 | 0.861 | 0.058 | 0.278 | 6.09 | 17.1 | 8.6 | 10:38 | 10:41 | 0.08 | 0.70 | 0 | 0 |
| **Mean** | | 0.50 | 5.00 | 165 | 1.48 | 3.34 | 0.834 | 0.052 | 0.313 | 6.02 | 17.1 | 8.6 | **Total** | 00:13 | 0.09 | 0.70 | 1 | 1 |
| **SDev** | | 0.00 | 0.00 | 31 | 0.070 | 0.131 | 0.042 | 0.005 | 0.051 | 0.091 | 0.2 | 0.1 | | | 0.01 | 0.01 | | |
| **SD/M** | | 0.00 | 0.00 | 0.19 | 0.05 | 0.04 | 0.05 | 0.10 | 0.16 | 0.02 | 0.01 | 0.01 | | | 0.14 | 0.02 | | |

**Remarks:** No GPS.

* - value not consistent for all transects

Station Number: DAS4 | Meas. No: 1
Station Name: reed r below gage | Date: 06/30/2012

Party: erica lamb bob busey perrine
Boat/Motor: kayak
Gage Height: 0.000 m

Width: 40.9 m
Area: 38.6 m²
G.H.Change: 0.000 m

Processed by: EY
Mean Velocity: 0.665 m/s
Discharge: 25.6 m³/s

Area Method: Mean Flow
Nav. Method: Bottom Track
MagVar Method: Model (17.6°)
Depth: Composite
Discharge Method: None
% Correction: 0.00

ADCP Depth: 0.070 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s | Rating No.: 1
Adj.Mean Vel: 0.00 m/s | Qm Rating: G
Rated Area: 0.000 m² | Diff.: 0.000%
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: NO
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.32 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 1.52 m/s
Max. Depth: 1.43 m
Mean Depth: 0.944 m
% Meas.: 67.89
Water Temp.: 5.0 °C
ADCP Temp.: 11.1 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1180 | Firmware: 31.12
Bin Size: 7 cm | Blank: 3 cm
BT Mode: 10 | BT Pings: 2
WT Mode: 12 | WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES    Evaluation: NO
Meas. Location: below station/riffle

Project Name: 2012_06_30_reed_0eky.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 3.60 | 3.60 | 94 | 4.09 | 17.5 | 3.74 | 0.328 | 0.246 | 25.9 | 41.1 | 38.1 | 12:04 | 12:06 | 0.32 | 0.68 | 0 | 3 |
| 001 | L | 3.60 | 3.60 | 81 | 4.13 | 17.7 | 3.51 | 0.352 | 0.219 | 25.9 | 43.3 | 39.8 | 12:06 | 12:08 | 0.39 | 0.65 | 0 | 2 |
| 002 | R | 3.40 | 2.00 | 108 | 4.09 | 17.7 | 3.71 | 0.332 | 0.138 | 25.9 | 38.8 | 37.5 | 12:08 | 12:11 | 0.28 | 0.69 | 1 | 3 |
| 003 | L | 3.40 | 2.00 | 89 | 3.92 | 16.8 | 3.52 | 0.477 | 0.129 | 24.8 | 40.3 | 38.8 | 12:11 | 12:13 | 0.34 | 0.64 | 0 | 3 |
| **Mean** | | 3.50 | 2.80 | 93 | 4.06 | 17.4 | 3.62 | 0.372 | 0.183 | 25.6 | 40.9 | 38.6 | **Total** | 00:09 | 0.33 | 0.67 | 0 | 3 |
| **SDev** | | 0.12 | 0.92 | 11 | 0.092 | 0.440 | 0.123 | 0.071 | 0.058 | 0.558 | 1.9 | 1.0 | | | 0.04 | 0.02 | | |
| **SD/M** | | 0.03 | 0.33 | 0.12 | 0.02 | 0.03 | 0.03 | 0.19 | 0.32 | 0.02 | 0.05 | 0.03 | | | 0.13 | 0.04 | | |

**Remarks:** Location: 2/3 down the straight reach below the station.

Station Number: DAS4 Meas. No: 2

Station Name: Reed River below station Date: 07/31/2012

| | | |
|---|---|---|
| Party: ey bs | Width: 49.2 m | Processed by: EY |
| Boat/Motor: kayak | Area: 69.8 m² | Mean Velocity: 1.21 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 84.3 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.120 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: P |
| MagVar Method: Model (17.6°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: Unspecified | |
| | | Control2: Unspecified | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 2.57 m/s | Type/Freq.: StreamPro / 2000 kHz | |
| WT 3-Beam Solution: NO | Max. Depth: 2.45 m | Serial #: 1180 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 1.47 m | Bin Size: 8 cm | Blank: 3 cm |
| WT Error Vel.: 0.30 m/s | % Meas.: 71.88 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 3.00 m/s | ADCP Temp.: 8.6 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES

Performed Moving Bed Test: NO

Performed Compass Calibration: NO Evaluation: NO

Meas. Location: below stn/riffle

Project Name: reed_31jul2012_1eky.mmt

Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 004 | R | 0.00 | 2.00 | 467 | 12.4 | 61.5 | 11.9 | 0.000 | 0.111 | 85.9 | 67.4 | 76.8 | 13:25 | 13:35 | 0.17 | 1.12 | 41 | 6 |
| 005 | L | 0.00 | 1.00 | 189 | 11.4 | 59.0 | 10.9 | 0.000 | 0.162 | 81.5 | 39.6 | 65.2 | 13:36 | 13:40 | 0.40 | 1.25 | 5 | 6 |
| *006* | *R* | *1.50* | *3.00* | *154* | *13.5* | *64.1* | *13.4* | *0.198* | *0.157* | *91.3* | *50.4* | *70.2* | *13:45* | *13:48* | *0.35* | *1.30* | *3* | *8* |
| *007* | *L* | *1.50* | *1.00* | *167* | *10.3* | *57.8* | *10.2* | *0.163* | *0.134* | *78.6* | *39.5* | *67.1* | *13:49* | *13:52* | *0.56* | *1.17* | *3* | *8* |
| **Mean** | | 0.75 | 1.75 | 244 | 11.9 | 60.6 | 11.6 | 0.090 | 0.141 | 84.3 | 49.2 | 69.8 | **Total** | 00:27 | 0.37 | 1.21 | 13 | 7 |
| **SDev** | | 0.87 | 0.96 | 149 | 1.36 | 2.81 | 1.37 | 0.105 | 0.023 | 5.55 | 13.1 | 5.1 | | | 0.16 | 0.08 | | |
| **SD/M** | | 1.15 | 0.55 | 0.61 | 0.11 | 0.05 | 0.12 | 1.17 | 0.17 | 0.07 | 0.27 | 0.07 | | | 0.44 | 0.07 | | |

**Remarks:** No compass calibration or moving bed test due to lack of time on site.

Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: 1 | Meas. No: 3
Station Name: Reed R ds stn 13sept2012 | Date: 09/13/2012

Party: ey bs
Boat/Motor: kayak
Gage Height: 0.000 m

Width: 44.5 m
Area: 60.6 m²
G.H.Change: 0.000 m

Processed by: EY
Mean Velocity: 0.937 m/s
Discharge: 56.5 m³/s

Area Method: Mean Flow
Nav. Method: Bottom Track
MagVar Method: Model (17.6°)
Depth: Composite
Discharge Method: None
% Correction: 0.00

ADCP Depth: 0.140 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s | Rating No.: 1
Adj.Mean Vel: 0.00 m/s | Qm Rating: G
Rated Area: 0.000 m² | Diff.: 0.000%
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: NO
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.32 m/s*
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.50 m/s*
Use Weighted Mean Depth: YES

Max. Vel.: 2.27 m/s
Max. Depth: 2.23 m
Mean Depth: 1.36 m
% Meas.: 70.54
Water Temp.: None
ADCP Temp.: 4.2 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1180 | Firmware: 31.12
Bin Size: 7 cm* | Blank: 3 cm
BT Mode: 10 | BT Pings: 2
WT Mode: 12 | WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES    Evaluation: NO
Meas. Location: ds station 100 yds

Project Name: reedr13sept2012_3eky.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 2.00 | 3.50 | 191 | 10.9 | 39.0 | 8.02 | 0.234 | 0.225 | 58.4 | 46.1 | 59.9 | 15:26 | 15:30 | 0.26 | 0.98 | 8 | 3 |
| 001 | L | 2.00 | 2.50 | 186 | 9.69 | 40.6 | 6.82 | 0.304 | 0.138 | 57.5 | 44.0 | 58.6 | 15:32 | 15:36 | 0.23 | 0.98 | 1 | 5 |
| *002* | *R* | *2.50* | *2.50* | *301* | *8.04* | *37.5* | *6.06* | *0.521* | *0.141* | *52.2* | *41.3* | *56.0* | *15:38* | *15:44* | *0.23* | *0.93* | *3* | *5* |
| 003 | L | *2.50* | *2.50* | *206* | *9.76* | *39.2* | *6.78* | *0.452* | *0.216* | *56.4* | *43.1* | *56.3* | *15:44* | *15:49* | *0.29* | *1.00* | *0* | *5* |
| 004 | R | *1.00* | *2.50* | *281* | *10.1* | *41.7* | *6.64* | *0.055* | *0.144* | *58.6* | *47.8* | *63.0* | *15:50* | *15:55* | *0.18* | *0.93* | *1* | *4* |
| 005 | L | *1.00* | *0.50* | *256* | *8.82* | *41.2* | *5.79* | *0.052* | *0.025* | *55.9* | *44.8* | *70.2* | *15:56* | *16:01* | *0.21* | *0.80* | *0* | *3* |
| **Mean** | | 1.83 | 2.33 | 236 | 9.54 | 39.9 | 6.68 | 0.270 | 0.148 | 56.5 | 44.5 | 60.6 | **Total** | 00:35 | 0.23 | 0.94 | 2 | 4 |
| **SDev** | | 0.68 | 0.98 | 49 | 0.997 | 1.60 | 0.777 | 0.196 | 0.072 | 2.37 | 2.3 | 5.3 | | | 0.04 | 0.07 | | |
| **SD/M** | | 0.37 | 0.42 | 0.21 | 0.10 | 0.04 | 0.12 | 0.73 | 0.49 | 0.04 | 0.05 | 0.09 | | | 0.17 | 0.08 | | |

**Remarks:** WAAS GPS. Adjusted mag declination to 17.63 deg in post processing.

* - value not consistent for all transects
Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: 
Station Name: Reed-28-may-2013

Meas. No: 4
Date: 05/28/2013

Party: jk ki ht
Boat/Motor: cataraft/15HP
Gage Height: 0.000 m

Width: 36.6 m
Area: 69.4 m²
G.H.Change: 0.000 m

Processed by: HT/EY
Mean Velocity: 1.48 m/s
Discharge: 103 m³/s

Area Method: Mean Flow
Nav. Method: DGPS
MagVar Method: Model (17.4°)
Depth: Composite

ADCP Depth: 0.180 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: 2-Ice Anchor
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: F
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 1.07 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 4.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 3.11 m/s
Max. Depth: 3.16 m
Mean Depth: 1.89 m
% Meas.: 62.88
Water Temp.: None
ADCP Temp.: 1.8 °C

ADCP:
Type/Freq.: Rio Grande / 1200 kHz
Serial #: 12813 Firmware: 10.16
Bin Size: 10 cm Blank: 25 cm
BT Mode: 7 BT Pings: 1
WT Mode: 12 WT Pings: 1
WV : 427 WO : 10, 4

Performed Diag. Test: YES
Performed Moving Bed Test: NO
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: downstream of station

Project Name: reed-28-may-2013_0eky.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 2.00 | 8.00 | 162 | 23.4 | 64.7 | 12.0 | 1.15 | 1.67 | 103 | 36.6 | 69.4 | 12:06 | 12:08 | 0.43 | 1.48 | 10 | 0 |
| **Mean** | | 2.00 | 8.00 | 162 | 23.4 | 64.7 | 12.0 | 1.15 | 1.67 | 103 | 36.6 | 69.4 | **Total** | 00:02 | 0.43 | 1.48 | 10 | 0 |
| **SDev** | | | | | | | | | | | | | | | | | | |
| **SD/M** | | | | | | | | | | | | | | | | | | |

**Remarks:** Part 1 of 2. Only one transect and then winriver crashed. Started a new file for rest of measurement. Field notes, RTK GPS, lc
ice moving downstream.

Station Number: Meas. No: 4

Station Name: Reed-28-may-2013_BB Date: 05/28/2013

Party: JK, HT
Boat/Motor: Cataraft/15HP
Gage Height: 0.000 m

Width: 38.3 m
Area: 76.6 m²
G.H.Change: 0.000 m

Processed by: HT, EKY
Mean Velocity: 1.38 m/s
Discharge: 105 m³/s

Area Method: Mean Flow
Nav. Method: DGPS
MagVar Method: Model (17.3°)
Depth: Composite

ADCP Depth: 0.180 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s Rating No.: 1
Adj.Mean Vel: 0.00 m/s Qm Rating: F
Rated Area: 0.000 m² Diff.: 0.000%
Control1: 2-Ice Anchor
Control2: Unspecified
Control3: Unspecified

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 1.07 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 4.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 3.12 m/s
Max. Depth: 3.17 m
Mean Depth: 2.00 m
% Meas.: 61.91
Water Temp.: None
ADCP Temp.: 1.2 °C

ADCP:
Type/Freq.: Rio Grande / 1200 kHz
Serial #: 12813 Firmware: 10.16
Bin Size: 10 cm Blank: 25 cm
BT Mode: 7 BT Pings: 1
WT Mode: 12 WT Pings: 1
WV : 427 WO : 10, 4

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: NO Evaluation: NO
Meas. Location: downstream of station

Project Name: reed-28-may-2013-bb_0_ht_eky
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | L | 8.00 | 6.00 | 116 | 22.7 | 66.8 | 11.0 | 4.14 | 2.47 | 107 | 38.7 | 76.5 | 12:25 | 12:27 | 0.55 | 1.40 | 1 | 0 |
| *001* | *R* | *5.00* | *8.00* | *147* | *21.6* | *62.6* | *11.0* | *1.24* | *3.11* | *99.6* | *33.9* | *69.1* | *12:32* | *12:35* | *0.44* | *1.44* | *20* | *0* |
| 002 | L | *7.00* | *10.0* | *93* | *21.8* | *65.6* | *10.0* | *2.77* | *8.05* | *108* | *42.4* | *84.3* | *12:36* | *12:38* | *0.57* | *1.28* | *2* | *0* |
| **Mean** | | 6.67 | 8.00 | 118 | 22.0 | 65.0 | 10.7 | 2.72 | 4.54 | 105 | 38.3 | 76.6 | **Total** | 00:12 | 0.52 | 1.38 | 8 | 0 |
| **SDev** | | 1.53 | 2.00 | 27 | 0.618 | 2.16 | 0.595 | 1.45 | 3.05 | 4.67 | 4.2 | 7.6 | | | 0.07 | 0.08 | | |
| **SD/M** | | 0.23 | 0.25 | 0.23 | 0.03 | 0.03 | 0.06 | 0.53 | 0.67 | 0.04 | 0.11 | 0.10 | | | 0.14 | 0.06 | | |

**Remarks:** Part 2 of measurement (see other file).

Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: | Meas. No: 5
Station Name: Reed-30-may-2013 | Date: 05/30/2013

Party: jk ht
Boat/Motor: cataraft 15hp
Gage Height: 0.000 m

Width: 45.1 m
Area: 66.6 m²
G.H.Change: 0.000 m

Processed by: HT/EKY
Mean Velocity: 1.45 m/s
Discharge: 95.9 m³/s

Area Method: Mean Flow
Nav. Method: DGPS
MagVar Method: Model (17.4°)
Depth: Composite

ADCP Depth: 0.180 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: G
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 1.07 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 4.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 3.18 m/s
Max. Depth: 2.69 m
Mean Depth: 1.48 m
% Meas.: 49.87
Water Temp.: None
ADCP Temp.: 2.4 °C

ADCP:
Type/Freq.: Rio Grande / 1200 kHz
Serial #: 12813 | Firmware: 10.16
Bin Size: 10 cm | Blank: 25 cm
BT Mode: 7 | BT Pings: 1
WT Mode: 12 | WT Pings: 1
WV : 427 | WO : 10, 4

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: downstream from stn

Project Name: reed-30-may-2013_0eky.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 4.00 | 12.0 | 99 | 23.7 | 54.0 | 11.0 | 1.69 | 4.62 | 95.0 | 39.8 | 60.7 | 13:33 | 13:35 | 0.53 | 1.57 | 3 | 0 |
| 002 | L | 5.00 | 15.0 | 102 | 22.9 | 48.9 | 10.5 | 2.32 | 11.1 | 95.8 | 42.0 | 60.8 | 13:37 | 13:38 | 0.71 | 1.58 | 1 | 0 |
| 003 | R | 10.0 | 12.0 | 112 | 28.8 | 42.5 | 11.1 | 7.76 | 8.28 | 98.5 | 51.6 | 67.9 | 13:39 | 13:41 | 0.56 | 1.45 | 1 | 0 |
| 004 | L | 8.00 | 7.00 | 192 | 25.6 | 45.9 | 10.5 | 6.88 | 5.59 | 94.4 | 47.1 | 76.9 | 13:43 | 13:46 | 0.43 | 1.23 | 1 | 0 |
| **Mean** | | 6.75 | 11.5 | 126 | 25.2 | 47.8 | 10.8 | 4.66 | 7.41 | 95.9 | 45.1 | 66.6 | **Total** | 00:12 | 0.56 | 1.45 | 1 | 0 |
| **SDev** | | 2.75 | 3.32 | 44 | 2.61 | 4.87 | 0.322 | 3.10 | 2.93 | 1.80 | 5.3 | 7.7 | | | 0.11 | 0.16 | | |
| **SD/M** | | 0.41 | 0.29 | 0.35 | 0.10 | 0.10 | 0.03 | 0.67 | 0.40 | 0.02 | 0.12 | 0.12 | | | 0.21 | 0.11 | | |

**Remarks:** RTK GPS

Station Number:
Station Name: Reed-31-may-2013-BB

Meas. No: 6
Date: 05/31/2013

Party: jk ht
Boat/Motor: cataraft
Gage Height: 0.000 m

Width: 51.8 m
Area: 69.6 m²
G.H.Change: 0.000 m

Processed by: EY/HT
Mean Velocity: 1.28 m/s
Discharge: 89.1 m³/s

Area Method: Mean Flow
Nav. Method: DGPS
MagVar Method: Model (17.4°)
Depth: Composite

ADCP Depth: 0.230 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: F
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 1.07 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 3.75 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 2.67 m/s
Max. Depth: 2.60 m
Mean Depth: 1.35 m
% Meas.: 42.79
Water Temp.: None
ADCP Temp.: 2.3 °C

ADCP:
Type/Freq.: Rio Grande / 1200 kHz
Serial #: 12813 | Firmware: 10.16
Bin Size: 10 cm | Blank: 25 cm
BT Mode: 7 | BT Pings: 1
WT Mode: 12 | WT Pings: 1
WV : 427 | WO : 10, 4

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: NO    Evaluation: NO
Meas. Location: below station

Project Name: reed 31 may 2013 bb_0eky.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 7.00 | 9.00 | 182 | 33.1 | 36.0 | 10.5 | 3.96 | 3.55 | 87.1 | 52.9 | 67.2 | 11:09 | 11:12 | 0.46 | 1.30 | 1 | 0 |
| 001 | L | 7.00 | 6.00 | 165 | 31.4 | 41.9 | 10.7 | 4.30 | 4.48 | 92.7 | 49.7 | 72.1 | 11:12 | 11:15 | 0.49 | 1.29 | 1 | 0 |
| *002* | *R* | *9.00* | *8.00* | *173* | *31.4* | *34.4* | *10.1* | *4.50* | *3.29* | *83.7* | *52.3* | *65.1* | *11:18* | *11:21* | *0.47* | *1.29* | *1* | *0* |
| 003 | L | *9.00* | *7.00* | *149* | *30.4* | *40.1* | *10.4* | *5.98* | *5.89* | *92.6* | *52.4* | *74.2* | *11:21* | *11:23* | *0.48* | *1.25* | *1* | *0* |
| **Mean** | | 8.00 | 7.50 | 167 | 31.6 | 38.1 | 10.4 | 4.68 | 4.30 | 89.1 | 51.8 | 69.6 | **Total** | 00:14 | 0.47 | 1.28 | 1 | 0 |
| **SDev** | | 1.15 | 1.29 | 14 | 1.13 | 3.46 | 0.245 | 0.892 | 1.17 | 4.40 | 1.5 | 4.2 | | | 0.01 | 0.02 | | |
| **SD/M** | | 0.14 | 0.17 | 0.08 | 0.04 | 0.09 | 0.02 | 0.19 | 0.27 | 0.05 | 0.03 | 0.06 | | | 0.03 | 0.02 | | |

**Remarks:** WAAS GPS.

Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number:
Station Name: Reed-1-june-2013

Meas. No: 7
Date: 06/01/2013

| | | |
|---|---|---|
| Party: jk ht | Width: 47.6 m | Processed by: EY/HT |
| Boat/Motor: cataraft / 15HP | Area: 63.6 m² | Mean Velocity: 1.29 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 81.8 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.180 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: F |
| MagVar Method: Model (17.4°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: Unspecified | |
| | | Control2: Unspecified | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 3.18 m/s | Type/Freq.: Rio Grande / 1200 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 2.66 m | Serial #: 12813 | Firmware: 10.16 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 1.34 m | Bin Size: 10 cm | Blank: 25 cm |
| WT Error Vel.: 1.07 m/s | % Meas.: 46.05 | BT Mode: 7 | BT Pings: 1 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 1 |
| WT Up Vel.: 3.00 m/s | ADCP Temp.: 4.2 °C | WV : 267 | WO : 10, 4 |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES    Evaluation: YES
Meas. Location: downstream station

Project Name: reed-1-june-2013_0eky.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| *000* | *R* | 7.00 | 15.0 | 88 | 23.2 | 45.4 | 10.3 | 3.03 | 6.84 | 88.7 | 44.4 | 63.9 | 13:01 | 13:03 | 0.61 | 1.39 | 2 | 0 |
| 001 | L | 7.00 | 15.0 | 91 | 21.0 | 41.4 | 9.45 | 3.85 | 6.01 | 81.6 | 44.0 | 61.1 | 13:03 | 13:05 | 0.69 | 1.34 | 1 | 0 |
| *002* | *R* | 6.00 | 13.0 | 153 | 29.9 | 39.6 | 12.3 | 3.66 | 3.43 | 88.9 | 51.6 | 65.3 | 13:05 | 13:08 | 0.55 | 1.36 | 1 | 0 |
| *003* | *L* | 6.00 | 13.0 | 144 | 23.1 | 30.6 | 8.83 | 2.63 | 8.28 | 73.4 | 46.6 | 62.3 | 13:08 | 13:10 | 0.47 | 1.18 | 1 | 0 |
| 004 | R | 8.00 | 11.0 | 122 | 29.7 | 33.7 | 11.2 | 4.19 | 3.48 | 82.3 | 55.5 | 67.4 | 13:12 | 13:14 | 0.51 | 1.22 | 1 | 0 |
| *005* | *L* | 7.00 | 4.00 | 228 | 27.5 | 31.8 | 10.3 | 3.57 | 1.55 | 74.8 | 46.2 | 61.7 | 13:15 | 13:18 | 0.35 | 1.21 | 0 | 0 |
| *006* | *R* | 5.00 | 15.0 | 107 | 24.3 | 46.5 | 11.1 | 2.69 | 4.70 | 89.3 | 45.9 | 64.3 | 13:23 | 13:24 | 0.63 | 1.39 | 2 | 0 |
| *007* | *L* | 6.00 | 6.00 | 268 | 26.0 | 32.3 | 10.1 | 2.87 | 4.14 | 75.4 | 46.4 | 62.9 | 13:25 | 13:29 | 0.56 | 1.20 | 0 | 0 |
| **Mean** | | 6.50 | 11.5 | 150 | 25.6 | 37.7 | 10.4 | 3.31 | 4.80 | 81.8 | 47.6 | 63.6 | **Total** | 00:28 | 0.54 | 1.29 | 1 | 0 |
| **SDev** | | 0.93 | 4.28 | 65 | 3.26 | 6.36 | 1.08 | 0.582 | 2.15 | 6.70 | 4.0 | 2.1 | | | 0.11 | 0.09 | | |
| **SD/M** | | 0.14 | 0.37 | 0.44 | 0.13 | 0.17 | 0.10 | 0.18 | 0.45 | 0.08 | 0.08 | 0.03 | | | 0.19 | 0.07 | | |

**Remarks:** RTK GPS

Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: Meas. No: 8

Station Name: Reed 3 june 2013 Date: 06/03/2013

| | | |
|---|---|---|
| Party: jk ht | Width: 45.6 m | Processed by: EY/HT |
| Boat/Motor: Cataraft 15HP | Area: 59.5 m² | Mean Velocity: 1.22 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 72.3 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.180 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: P |
| MagVar Method: Model (17.4°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: Unspecified | |
| | | Control2: Unspecified | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 4.07 m/s | Type/Freq.: Rio Grande / 1200 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 2.55 m | Serial #: 12813 | Firmware: 10.16 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 1.31 m | Bin Size: 10 cm | Blank: 25 cm |
| WT Error Vel.: 1.07 m/s | % Meas.: 51.11 | BT Mode: 7 | BT Pings: 1 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 1 |
| WT Up Vel.: 3.50 m/s | ADCP Temp.: 5.2 °C | WV : 382 | WO : 5, 4 |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES  Project Name: reed 3 june 2013_0eky.mmt

Performed Moving Bed Test: YES  Software: 2.12

Performed Compass Calibration: NO  Evaluation: NO

Meas. Location: downstream station

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| *000* | R | 5.00 | 14.0 | 122 | 19.0 | 45.3 | 7.72 | 2.10 | 4.36 | 78.5 | 38.8 | 55.5 | 13:03 | 13:05 | 0.53 | 1.42 | 1 | 3 |
| *001* | L | 5.00 | 13.0 | 130 | 19.0 | 38.6 | 6.93 | 1.56 | 2.02 | 68.1 | 46.0 | 62.9 | 13:05 | 13:08 | 0.56 | 1.08 | 1 | 2 |
| *002* | R | 5.00 | 11.0 | 184 | 26.2 | 40.2 | 8.09 | 2.58 | 1.70 | 78.8 | 50.8 | 64.1 | 13:08 | 13:11 | 0.43 | 1.23 | 1 | 2 |
| *003* | L | 5.00 | 5.00 | 201 | 19.0 | 27.6 | 6.02 | 2.03 | 3.17 | 57.9 | 39.4 | 53.2 | 13:12 | 13:15 | 0.46 | 1.09 | 0 | 2 |
| *004* | R | 5.00 | 13.0 | 122 | 23.1 | 51.9 | 8.64 | 2.43 | 1.62 | 87.8 | 43.2 | 60.5 | 13:19 | 13:21 | 0.64 | 1.45 | 1 | 2 |
| *005* | L | 5.00 | 6.00 | 143 | 22.8 | 34.3 | 7.36 | 2.32 | 1.22 | 68.0 | 42.6 | 57.7 | 13:22 | 13:24 | 0.50 | 1.18 | 1 | 2 |
| 006 | R | 5.00 | 6.00 | 167 | 26.4 | 33.0 | 7.54 | 1.94 | 1.17 | 70.1 | 52.9 | 65.3 | 13:25 | 13:27 | 0.38 | 1.07 | 1 | 2 |
| 007 | L | 5.00 | 5.00 | 188 | 26.5 | 32.8 | 8.00 | 2.14 | 2.77 | 72.2 | 46.0 | 57.8 | 13:28 | 13:31 | 0.37 | 1.25 | 1 | 2 |
| 008 | R | 5.00 | 5.00 | 166 | 28.6 | 34.7 | 8.12 | 2.02 | 0.805 | 74.2 | 52.6 | 64.5 | 13:35 | 13:38 | 0.41 | 1.15 | 1 | 1 |
| *009* | L | 5.00 | 4.00 | 254 | 25.5 | 30.8 | 7.51 | 1.82 | 1.38 | 67.1 | 43.7 | 53.7 | 13:38 | 13:43 | 0.34 | 1.25 | 0 | 1 |
| **Mean** | | 5.00 | 8.20 | 167 | 23.6 | 36.9 | 7.59 | 2.09 | 2.02 | 72.3 | 45.6 | 59.5 | **Total** | 00:39 | 0.46 | 1.22 | 1 | 2 |
| **SDev** | | 0.00 | 4.02 | 41 | 3.59 | 7.28 | 0.730 | 0.298 | 1.10 | 8.16 | 5.1 | 4.6 | | | 0.10 | 0.13 | | |
| **SD/M** | | 0.00 | 0.49 | 0.25 | 0.15 | 0.20 | 0.10 | 0.14 | 0.54 | 0.11 | 0.11 | 0.08 | | | 0.21 | 0.11 | | |

**Remarks:** no ice. RTK GPS.

Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: Meas. No: 9

Station Name: Reed at Station Date: 07/12/2013

| | | |
|---|---|---|
| Party: el | Width: 30.0 m | Processed by: EY |
| Boat/Motor: kayak | Area: 26.4 m² | Mean Velocity: 0.726 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 18.6 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.100 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: G |
| MagVar Method: Model (17.4°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: Unspecified | |
| | | Control2: Unspecified | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 2.05 m/s | Type/Freq.: StreamPro / 2000 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 1.73 m | Serial #: 1349 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 0.891 m | Bin Size: 5 cm* | Blank: 3 cm |
| WT Error Vel.: 0.38 m/s* | % Meas.: 69.22 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 2.00 m/s* | ADCP Temp.: 14.5 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES

Performed Moving Bed Test: YES

Performed Compass Calibration: YES Evaluation: YES

Meas. Location: downtream of station below riffle

Project Name: Reed_2013-7-12_0.mmt

Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 4.00 | 0.00 | 110 | 3.21 | 12.3 | 2.74 | 0.175 | 0.000 | 18.4 | 21.0 | 20.9 | 10:59 | 11:01 | 0.15 | 0.88 | 1 | 3 |
| 001 | L | 4.00 | 0.00 | 155 | 3.17 | 12.2 | 2.55 | 0.227 | 0.000 | 18.2 | 20.3 | 20.1 | 11:02 | 11:05 | 0.13 | 0.91 | 1 | 3 |
| 002 | R | 5.00 | 8.00 | 155 | 3.53 | 12.9 | 2.61 | 0.227 | 0.201 | 19.5 | 32.5 | 24.7 | 11:07 | 11:10 | 0.15 | 0.79 | 1 | 2 |
| *003* | *L* | 5.00 | 8.00 | 184 | 3.22 | 11.5 | 2.56 | 0.178 | 0.033 | 17.5 | 32.4 | 23.1 | 11:10 | 11:14 | 0.13 | 0.76 | 2 | 2 |
| *004* | *R* | 5.00 | 8.00 | 145 | 3.26 | 14.0 | 2.59 | 0.204 | 0.163 | 20.3 | 34.8 | 30.0 | 11:15 | 11:18 | 0.17 | 0.68 | 1 | 2 |
| 005 | L | 5.00 | 8.00 | 191 | 2.59 | 12.7 | 2.16 | 0.117 | 0.178 | 17.7 | 31.5 | 27.9 | 11:18 | 11:22 | 0.12 | 0.64 | 2 | 2 |
| 006 | R | 3.00 | 8.00 | 174 | 2.57 | 14.5 | 2.17 | 0.007 | 0.057 | 19.3 | 33.7 | 36.3 | 11:23 | 11:27 | 0.16 | 0.53 | 1 | 3 |
| 007 | L | 3.00 | 8.00 | 209 | 2.83 | 12.8 | 2.30 | -0.045 | 0.074 | 18.0 | 33.5 | 28.5 | 11:27 | 11:32 | 0.13 | 0.63 | 0 | 3 |
| **Mean** | | 4.25 | 6.00 | 165 | 3.05 | 12.9 | 2.46 | 0.136 | 0.088 | 18.6 | 30.0 | 26.4 | **Total** | 00:32 | 0.14 | 0.73 | 1 | 3 |
| **SDev** | | 0.89 | 3.70 | 31 | 0.345 | 0.959 | 0.219 | 0.103 | 0.081 | 0.961 | 5.8 | 5.4 | | | 0.02 | 0.13 | | |
| **SD/M** | | 0.21 | 0.62 | 0.19 | 0.11 | 0.07 | 0.09 | 0.76 | 0.92 | 0.05 | 0.20 | 0.20 | | | 0.12 | 0.18 | | |

**Remarks:** RTK GPS.

* - value not consistent for all transects

Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: DAS4 | Meas. No: 10
Station Name: Reed below station | Date: 09/08/2013

Party: el
Width: 44.1 m
Processed by: EY
Boat/Motor: Kayak
Area: 47.7 m²
Mean Velocity: 0.719 m/s
Gage Height: 0.000 m
G.H.Change: 0.000 m
Discharge: 34.2 m³/s

Area Method: Mean Flow
Nav. Method: DGPS
MagVar Method: Model (17.4°)
Depth: Composite

ADCP Depth: 0.100 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Rating No.: 1
Adj.Mean Vel: 0.00 m/s
Qm Rating: G
Rated Area: 0.000 m²
Diff.: 0.000%
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.30 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 2.39 m/s
Max. Depth: 2.55 m
Mean Depth: 1.09 m
% Meas.: 71.51
Water Temp.: None
ADCP Temp.: 6.3 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1349
Firmware: 31.12
Bin Size: 8 cm
Blank: 3 cm
BT Mode: 10
BT Pings: 2
WT Mode: 12
WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES    Evaluation: YES
Meas. Location: below station, below riffle

Project Name: Reed_2013_09_08_0.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 3.00 | 7.00 | 179 | 4.27 | 24.6 | 4.05 | -0.231 | 0.371 | 33.1 | 36.2 | 45.2 | 13:09 | 13:13 | 0.20 | 0.73 | 1 | 5 |
| 001 | L | 3.00 | 11.0 | 172 | 4.43 | 26.3 | 4.32 | -0.278 | 0.703 | 35.5 | 44.0 | 50.5 | 13:13 | 13:17 | 0.23 | 0.70 | 1 | 5 |
| 002 | R | 2.00 | 11.0 | 150 | 4.29 | 25.3 | 4.54 | 0.204 | 0.477 | 34.8 | 39.6 | 45.7 | 13:18 | 13:21 | 0.28 | 0.76 | 1 | 5 |
| 003 | L | 2.00 | 11.0 | 188 | 4.39 | 23.9 | 4.08 | 0.228 | 0.314 | 32.9 | 43.6 | 49.0 | 13:21 | 13:25 | 0.17 | 0.67 | 1 | 3 |
| 004 | R | 3.00 | 11.0 | 186 | 5.78 | 23.6 | 4.53 | 0.250 | 0.189 | 34.3 | 50.6 | 48.7 | 13:25 | 13:29 | 0.24 | 0.71 | 1 | 1 |
| 005 | L | 3.00 | 11.0 | 178 | 6.12 | 23.1 | 4.51 | 0.258 | 0.707 | 34.7 | 50.7 | 47.1 | 13:29 | 13:33 | 0.18 | 0.74 | 1 | 1 |
| **Mean** | | 2.67 | 10.3 | 175 | 4.88 | 24.5 | 4.34 | 0.072 | 0.460 | 34.2 | 44.1 | 47.7 | **Total** | 00:24 | 0.22 | 0.72 | 1 | 3 |
| **SDev** | | 0.52 | 1.63 | 14 | 0.839 | 1.19 | 0.226 | 0.254 | 0.211 | 1.02 | 5.8 | 2.0 | | | 0.04 | 0.03 | | |
| **SD/M** | | 0.19 | 0.16 | 0.08 | 0.17 | 0.05 | 0.05 | 3.53 | 0.46 | 0.03 | 0.13 | 0.04 | | | 0.18 | 0.04 | | |

**Remarks:** WAAS GPS

Station Number: Meas. No: 11
Station Name: Reed Date: 05/08/2014

| | | |
|---|---|---|
| Party: EL,JK | Width: 18.5 m | Processed by: EY |
| Boat/Motor: kayak | Area: 17.1 m² | Mean Velocity: 0.650 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 11.0 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.120 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: F |
| MagVar Method: Model (17.0°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: 14-Shore Ice | |
| | | Control2: Unspecified | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 2.08 m/s | Type/Freq.: StreamPro / 2000 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 1.52 m | Serial #: 1180 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 0.922 m | Bin Size: 5 cm* | Blank: 3 cm |
| WT Error Vel.: 0.32 m/s* | % Meas.: 62.88 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 2.00 m/s | ADCP Temp.: 1.4 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES Project Name: reed_2014_05_08_0eky.mmt
Performed Moving Bed Test: YES Software: 2.12
Performed Compass Calibration: YES Evaluation: YES
Meas. Location:

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 2.00 | 2.50 | 130 | 2.30 | 6.60 | 1.34 | 0.229 | 0.166 | 10.6 | 19.4 | 16.4 | 10:28 | 10:31 | 0.21 | 0.65 | 1 | 1 |
| *001* | *L* | *2.00* | *3.00* | *95* | *1.75* | *6.88* | *1.01* | *0.248* | *0.477* | *10.4* | *17.0* | *17.3* | *10:31* | *10:33* | *0.19* | *0.60* | *1* | *1* |
| 002 | R | 2.00 | 4.00 | 125 | 2.26 | 7.19 | 1.37 | 0.182 | 0.573 | 11.6 | 19.3 | 16.3 | 10:36 | 10:38 | 0.19 | 0.71 | 1 | 2 |
| *003* | *L* | *2.00* | *4.00* | *138* | *1.84* | *6.40* | *1.24* | *0.155* | *0.691* | *10.3* | *18.7* | *17.5* | *10:38* | *10:42* | *0.19* | *0.59* | *1* | *5* |
| 004 | L | 2.00 | 3.00 | 119 | 2.17 | 6.60 | 1.40 | 0.157 | 0.427 | 10.7 | 17.8 | 16.3 | 10:44 | 10:46 | 0.21 | 0.66 | 1 | 3 |
| *006* | *R* | *3.00* | *2.00* | *139* | *2.42* | *7.40* | *1.62* | *0.438* | *0.233* | *12.1* | *18.4* | *16.2* | *10:55* | *10:58* | *0.18* | *0.75* | *1* | *3* |
| 007 | L | 3.00 | 3.00 | 135 | 2.08 | 7.51 | 1.34 | 0.291 | 0.279 | 11.5 | 19.1 | 19.4 | 10:58 | 11:01 | 0.20 | 0.59 | 1 | 3 |
| **Mean** | | 2.29 | 3.07 | 125 | 2.12 | 6.94 | 1.33 | 0.243 | 0.407 | 11.0 | 18.5 | 17.1 | **Total** | 00:33 | 0.19 | 0.65 | 1 | 3 |
| **SDev** | | 0.49 | 0.73 | 15 | 0.244 | 0.431 | 0.183 | 0.100 | 0.191 | 0.686 | 0.9 | 1.2 | | | 0.01 | 0.06 | | |
| **SD/M** | | 0.21 | 0.24 | 0.12 | 0.12 | 0.06 | 0.14 | 0.41 | 0.47 | 0.06 | 0.05 | 0.07 | | | 0.07 | 0.09 | | |

**Remarks:** WAAS GPS.

* - value not consistent for all transects
Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: Reed
Station Name: Reed River

Meas. No: 12
Date: 05/10/2014

| | | |
|---|---|---|
| Party: EL | Width: 21.7 m | Processed by: EY |
| Boat/Motor: kayak | Area: 16.3 m² | Mean Velocity: 0.587 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 9.55 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.120 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: G |
| MagVar Method: None (17.0°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: 14-Shore Ice | |
| | | Control2: Unspecified | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 1.55 m/s | Type/Freq.: StreamPro / 2000 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 1.31 m | Serial #: 1180 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 0.754 m | Bin Size: 5 cm | Blank: 3 cm |
| WT Error Vel.: 0.38 m/s | % Meas.: 61.86 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 2.00 m/s | ADCP Temp.: 2.2 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES Evaluation: YES
Meas. Location:

Project Name: reed_2014_05_10_0eky.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 2.00 | 6.00 | 106 | 2.12 | 5.78 | 1.35 | 0.115 | 0.402 | 9.77 | 21.9 | 15.3 | 11:01 | 11:03 | 0.14 | 0.64 | 1 | 2 |
| 001 | L | 2.00 | 4.00 | 165 | 2.12 | 5.84 | 1.25 | 0.042 | 0.162 | 9.41 | 20.1 | 15.5 | 11:03 | 11:07 | 0.13 | 0.61 | 1 | 1 |
| 002 | R | 3.00 | 4.00 | 244 | 2.15 | 6.12 | 1.20 | 0.172 | 0.144 | 9.79 | 21.9 | 16.9 | 11:07 | 11:12 | 0.11 | 0.58 | 1 | 1 |
| 003 | L | 3.00 | 3.00 | 205 | 2.11 | 5.88 | 1.14 | 0.124 | -0.024 | 9.23 | 22.8 | 17.7 | 11:12 | 11:16 | 0.10 | 0.52 | 0 | 1 |
| **Mean** | | 2.50 | 4.25 | 180 | 2.12 | 5.91 | 1.24 | 0.113 | 0.171 | 9.55 | 21.7 | 16.3 | **Total** | 00:15 | 0.12 | 0.59 | 1 | 1 |
| **SDev** | | 0.58 | 1.26 | 59 | 0.018 | 0.149 | 0.090 | 0.054 | 0.175 | 0.277 | 1.1 | 1.2 | | | 0.02 | 0.05 | | |
| **SD/M** | | 0.23 | 0.30 | 0.33 | 0.01 | 0.03 | 0.07 | 0.47 | 1.03 | 0.03 | 0.05 | 0.07 | | | 0.15 | 0.09 | | |

**Remarks:** WAAS GPS

Station Number: Reed
Station Name:

Meas. No: 13
Date: 05/11/2014

Party: EL
Boat/Motor: kayak
Gage Height: 0.000 m

Width: 19.3 m
Area: 18.7 m²
G.H.Change: 0.000 m

Processed by: EY
Mean Velocity: 0.776 m/s
Discharge: 14.2 m³/s

Area Method: Mean Flow
Nav. Method: DGPS
MagVar Method: Model (17.0°)
Depth: Composite

ADCP Depth: 0.120 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: 14-Shore Ice
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: G
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.38 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 1.95 m/s
Max. Depth: 1.54 m
Mean Depth: 0.968 m
% Meas.: 65.24
Water Temp.: None
ADCP Temp.: 3.3 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1180
Firmware: 31.12
Bin Size: 5 cm
Blank: 3 cm
BT Mode: 10
BT Pings: 2
WT Mode: 12
WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: downstream of station

Project Name: reed_2014_05_11_0eky.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 2.00 | 0.50 | 116 | 3.15 | 9.28 | 2.08 | 0.226 | 0.021 | 14.8 | 17.5 | 16.0 | 10:34 | 10:37 | 0.13 | 0.92 | 1 | 2 |
| *001* | *L* | *2.00* | *0.50* | *148* | *2.64* | *8.62* | *1.64* | *0.288* | *0.045* | *13.2* | *16.2* | *15.6* | *10:37* | *10:40* | *0.15* | *0.85* | *1* | *1* |
| 002 | R | *2.00* | *0.50* | *114* | *2.80* | *9.14* | *1.95* | *0.193* | *0.019* | *14.1* | *16.3* | *16.2* | *11:24* | *11:27* | *0.18* | *0.87* | *1* | *2* |
| 003 | L | *2.00* | *3.00* | *138* | *2.80* | *9.37* | *1.96* | *0.209* | *0.162* | *14.5* | *21.3* | *20.1* | *11:27* | *11:30* | *0.15* | *0.72* | *1* | *1* |
| 004 | R | *1.00* | *3.00* | *141* | *2.85* | *9.64* | *2.01* | *0.070* | *0.149* | *14.7* | *22.0* | *21.6* | *11:31* | *11:34* | *0.14* | *0.68* | *1* | *2* |
| 005 | L | *1.00* | *4.00* | *167* | *2.64* | *9.71* | *1.81* | *0.057* | *-0.050* | *14.2* | *22.8* | *22.9* | *11:34* | *11:38* | *0.13* | *0.62* | *1* | *1* |
| **Mean** | | 1.67 | 1.92 | 137 | 2.81 | 9.29 | 1.91 | 0.174 | 0.058 | 14.2 | 19.3 | 18.7 | **Total** | 01:03 | 0.15 | 0.78 | 1 | 2 |
| **SDev** | | 0.52 | 1.59 | 20 | 0.187 | 0.394 | 0.157 | 0.091 | 0.082 | 0.565 | 3.0 | 3.2 | | | 0.02 | 0.12 | | |
| **SD/M** | | 0.31 | 0.83 | 0.15 | 0.07 | 0.04 | 0.08 | 0.53 | 1.43 | 0.04 | 0.15 | 0.17 | | | 0.12 | 0.15 | | |

**Remarks:** WAAS GPS

Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: Reed | Meas. No: 14
Station Name: Reed River | Date: 05/16/2014

Party: EL,HT,JK
Boat/Motor: kayak
Gage Height: 0.000 m

Width: 33.2 m
Area: 37.9 m²
G.H.Change: 0.000 m

Processed by: EY
Mean Velocity: 0.712 m/s
Discharge: 27.0 m³/s

Area Method: Mean Flow
Nav. Method: DGPS
MagVar Method: Model (17.0°)
Depth: Composite

ADCP Depth: 0.120 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s | Rating No.: 1
Adj.Mean Vel: 0.00 m/s | Qm Rating: F
Rated Area: 0.000 m² | Diff.: 0.000%
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.32 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 3.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 2.01 m/s
Max. Depth: 1.91 m
Mean Depth: 1.14 m
% Meas.: 72.07
Water Temp.: None
ADCP Temp.: 5.9 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1180 | Firmware: 31.12
Bin Size: 7 cm | Blank: 3 cm
BT Mode: 10 | BT Pings: 2
WT Mode: 12 | WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES    Evaluation: YES
Meas. Location: downstream of station

Project Name: Reed_2014_05_16_0.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 2.00 | 7.00 | 178 | 3.96 | 18.3 | 2.88 | 0.089 | 0.623 | 25.8 | 32.1 | 35.6 | 10:50 | 10:54 | 0.20 | 0.72 | 1 | 3 |
| *001* | *L* | *2.00* | *6.00* | *204* | *4.20* | *21.1* | *2.94* | *0.046* | *0.368* | *28.7* | *32.8* | *38.9* | *10:54* | *10:58* | *0.22* | *0.74* | *0* | *5* |
| 002 | R | 2.00 | 6.00 | 198 | 4.09 | 18.4 | 3.07 | 0.030 | 0.406 | 26.0 | 34.3 | 38.2 | 10:58 | 11:02 | 0.16 | 0.68 | 1 | 3 |
| 003 | L | 2.00 | 6.00 | 192 | 4.02 | 20.1 | 3.00 | 0.026 | 0.457 | 27.6 | 33.5 | 39.1 | 11:02 | 11:06 | 0.23 | 0.71 | 1 | 5 |
| **Mean** | | 2.00 | 6.25 | 193 | 4.07 | 19.5 | 2.97 | 0.048 | 0.464 | 27.0 | 33.2 | 37.9 | **Total** | 00:16 | 0.20 | 0.71 | 1 | 4 |
| **SDev** | | 0.00 | 0.50 | 11 | 0.102 | 1.37 | 0.082 | 0.029 | 0.112 | 1.35 | 1.0 | 1.6 | | | 0.03 | 0.02 | | |
| **SD/M** | | 0.00 | 0.08 | 0.06 | 0.03 | 0.07 | 0.03 | 0.60 | 0.24 | 0.05 | 0.03 | 0.04 | | | 0.15 | 0.03 | | |

**Remarks:** Moving bed test in separate file indicates moving bed. WAAS GPS used.

Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: DAS4
Station Name: Reed

Meas. No: 15
Date: 05/18/2014

Party: EL,JK
Boat/Motor: kayak
Gage Height: 0.000 m

Width: 37.0 m
Area: 42.5 m²
G.H.Change: 0.000 m

Processed by: EY
Mean Velocity: 0.681 m/s
Discharge: 28.9 m³/s

Area Method: Avg. Course
Nav. Method: DGPS
MagVar Method: None (17.0°)
Depth: Composite

ADCP Depth: 0.120 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: G
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.32 m/s
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 2.25 m/s
Max. Depth: 1.90 m
Mean Depth: 1.15 m
% Meas.: 70.98
Water Temp.: None
ADCP Temp.: 4.6 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1180 Firmware: 31.12
Bin Size: 7 cm Blank: 3 cm
BT Mode: 10 BT Pings: 2
WT Mode: 12 WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES Evaluation: YES
Meas. Location: downstream of station

Project Name: reed_2014_05_18_0eky.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 2.00 | 6.00 | 163 | 4.70 | 20.9 | 3.76 | -0.062 | 0.243 | 29.6 | 38.3 | 46.1 | 10:25 | 10:28 | 0.22 | 0.64 | 1 | 5 |
| 001 | L | 2.00 | 8.00 | 150 | 4.43 | 19.6 | 3.45 | -0.069 | 0.451 | 27.9 | 37.0 | 40.4 | 10:28 | 10:31 | 0.26 | 0.69 | 1 | 3 |
| 002 | R | 2.00 | 8.00 | 163 | 4.39 | 20.0 | 3.32 | 0.077 | 0.455 | 28.3 | 37.3 | 41.8 | 10:31 | 10:35 | 0.21 | 0.68 | 1 | 4 |
| 003 | L | 2.00 | 6.00 | 135 | 4.45 | 21.4 | 3.51 | 0.035 | 0.360 | 29.8 | 35.4 | 41.6 | 10:35 | 10:37 | 0.30 | 0.72 | 1 | 6 |
| **Mean** | | 2.00 | 7.00 | 152 | 4.49 | 20.5 | 3.51 | -0.005 | 0.377 | 28.9 | 37.0 | 42.5 | **Total** | 00:12 | 0.24 | 0.68 | 1 | 4 |
| **SDev** | | 0.00 | 1.15 | 13 | 0.138 | 0.829 | 0.183 | 0.072 | 0.100 | 0.944 | 1.2 | 2.5 | | | 0.04 | 0.03 | | |
| **SD/M** | | 0.00 | 0.16 | 0.09 | 0.03 | 0.04 | 0.05 | 15.21 | 0.26 | 0.03 | 0.03 | 0.06 | | | 0.18 | 0.05 | | |

**Remarks:** WAAS GPS

Station Number: Reed | Meas. No: 16
Station Name: Reed at Station | Date: 05/21/2014

Party: EL,HT,JK
Boat/Motor: kayak
Gage Height: 0.000 m

Width: 35.8 m
Area: 35.5 m²
G.H.Change: 0.000 m

Processed by: EY
Mean Velocity: 0.566 m/s
Discharge: 20.0 m³/s

Area Method: Mean Flow
Nav. Method: DGPS
MagVar Method: Model (17.0°)
Depth: Composite

ADCP Depth: 0.120 m
Shore Ens.:10
Bottom Est: Power (0.1667)
Top Est: Power (0.1667)

Index Vel.: 0.00 m/s
Adj.Mean Vel: 0.00 m/s
Rated Area: 0.000 m²
Control1: Unspecified
Control2: Unspecified
Control3: Unspecified

Rating No.: 1
Qm Rating: G
Diff.: 0.000%

Screening Thresholds:
BT 3-Beam Solution: YES
WT 3-Beam Solution: YES
BT Error Vel.: 0.10 m/s
WT Error Vel.: 0.35 m/s*
BT Up Vel.: 0.30 m/s
WT Up Vel.: 2.00 m/s
Use Weighted Mean Depth: YES

Max. Vel.: 1.60 m/s
Max. Depth: 1.72 m
Mean Depth: 0.992 m
% Meas.: 69.25
Water Temp.: None
ADCP Temp.: 7.6 °C

ADCP:
Type/Freq.: StreamPro / 2000 kHz
Serial #: 1180 | Firmware: 31.12
Bin Size: 6 cm* | Blank: 3 cm
BT Mode: 10 | BT Pings: 2
WT Mode: 12 | WT Pings: 6

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES  Evaluation: YES
Meas. Location: below station

Project Name: reed_2014_05_21_0eky.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| *000* | *R* | 1.00 | 5.00 | 159 | 3.98 | 15.3 | 2.42 | 0.053 | 0.182 | 21.9 | 34.0 | 33.5 | 09:17 | 09:20 | 0.26 | 0.65 | 1 | 1 |
| *001* | *L* | 1.00 | 5.00 | 144 | 3.73 | 12.8 | 2.20 | 0.034 | 0.118 | 18.9 | 34.2 | 33.5 | 09:20 | 09:23 | 0.20 | 0.56 | 1 | 2 |
| 002 | R | 2.00 | 5.00 | 185 | 3.57 | 13.7 | 2.11 | -0.056 | 0.178 | 19.5 | 38.2 | 37.5 | 09:24 | 09:27 | 0.21 | 0.52 | 1 | 2 |
| 003 | L | 2.00 | 5.00 | 146 | 3.59 | 13.8 | 2.31 | -0.039 | 0.122 | 19.8 | 37.3 | 38.3 | 09:27 | 09:30 | 0.22 | 0.52 | 1 | 2 |
| 004 | R | 2.00 | 5.00 | 180 | 3.89 | 14.4 | 2.34 | -0.031 | 0.076 | 20.7 | 35.6 | 35.5 | 09:31 | 09:34 | 0.18 | 0.58 | 1 | 2 |
| 005 | L | 2.00 | 6.00 | 135 | 3.72 | 13.3 | 2.30 | 0.028 | 0.159 | 19.5 | 35.5 | 34.8 | 09:34 | 09:37 | 0.20 | 0.56 | 1 | 2 |
| **Mean** | | 1.67 | 5.17 | 158 | 3.75 | 13.9 | 2.28 | -0.002 | 0.139 | 20.0 | 35.8 | 35.5 | **Total** | 00:20 | 0.21 | 0.57 | 1 | 2 |
| **SDev** | | 0.52 | 0.41 | 20 | 0.162 | 0.870 | 0.108 | 0.045 | 0.041 | 1.09 | 1.7 | 2.0 | | | 0.03 | 0.05 | | |
| **SD/M** | | 0.31 | 0.08 | 0.13 | 0.04 | 0.06 | 0.05 | 24.81 | 0.30 | 0.05 | 0.05 | 0.06 | | | 0.13 | 0.09 | | |

**Remarks:** WAAS GPS

* - value not consistent for all transects
Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: Reed
Station Name: Reed River

Meas. No: 17
Date: 05/23/2014

| | | |
|---|---|---|
| Party: EL,HT,JK | Width: 36.1 m | Processed by: EY |
| Boat/Motor: kayak | Area: 34.1 m² | Mean Velocity: 0.604 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 20.6 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.120 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: F |
| MagVar Method: Model (17.0°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth: Composite | Top Est: Power (0.1667) | Control1: Unspecified | |
| | | Control2: Unspecified | |
| | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 1.76 m/s | Type/Freq.: StreamPro / 2000 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 1.70 m | Serial #: 1180 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 0.944 m | Bin Size: 6 cm* | Blank: 3 cm |
| WT Error Vel.: 0.35 m/s* | % Meas.: 67.30 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 2.00 m/s | ADCP Temp.: 5.4 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES
Performed Moving Bed Test: YES
Performed Compass Calibration: YES    Evaluation: YES
Meas. Location: downstream from station

Project Name: reed_2014_05_23_0eky.mmt
Software: 2.12

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 2.00 | 4.00 | 168 | 3.96 | 14.7 | 2.54 | -0.114 | 0.130 | 21.2 | 35.0 | 34.8 | 09:19 | 09:23 | 0.19 | 0.61 | 1 | 2 |
| 001 | L | 2.00 | 7.00 | 154 | 3.52 | 12.1 | 2.15 | 0.095 | 0.351 | 18.2 | 33.7 | 31.3 | 09:24 | 09:27 | 0.21 | 0.58 | 1 | 2 |
| 002 | R | 2.00 | 7.00 | 204 | 4.40 | 16.2 | 2.81 | -0.026 | 0.338 | 23.7 | 38.5 | 36.7 | 09:28 | 09:32 | 0.24 | 0.65 | 0 | 2 |
| 003 | L | 2.00 | 8.00 | 152 | 3.38 | 13.1 | 2.23 | 0.017 | 0.453 | 19.2 | 31.7 | 28.6 | 09:32 | 09:35 | 0.23 | 0.67 | 1 | 2 |
| 004 | R | 2.00 | 8.00 | 248 | 4.12 | 14.0 | 2.42 | 0.196 | 0.325 | 21.0 | 39.6 | 36.8 | 09:37 | 09:42 | 0.15 | 0.57 | 0 | 1 |
| 005 | R | 2.00 | 6.00 | 118 | 3.90 | 12.8 | 2.40 | 0.104 | 0.211 | 19.4 | 37.1 | 34.6 | 09:44 | 09:46 | 0.23 | 0.56 | 1 | 1 |
| 006 | R | 2.00 | 6.00 | 106 | 4.18 | 14.0 | 2.58 | 0.125 | 0.264 | 21.2 | 37.0 | 35.8 | 09:47 | 09:49 | 0.26 | 0.59 | 1 | 1 |
| **Mean** | | 2.00 | 6.57 | 164 | 3.92 | 13.8 | 2.45 | 0.057 | 0.296 | 20.6 | 36.1 | 34.1 | **Total** | 00:30 | 0.21 | 0.60 | 1 | 2 |
| **SDev** | | 0.00 | 1.40 | 49 | 0.364 | 1.36 | 0.222 | 0.104 | 0.105 | 1.82 | 2.8 | 3.0 | | | 0.04 | 0.04 | | |
| **SD/M** | | 0.00 | 0.21 | 0.30 | 0.09 | 0.10 | 0.09 | 1.84 | 0.35 | 0.09 | 0.08 | 0.09 | | | 0.17 | 0.07 | | |

**Remarks:** WAAS GPS.

* - value not consistent for all transects
Discharge for transects in *italics* have a total Q more than 5% from the mean

Station Number: Meas. No: 18

Station Name: Reed River at UAF station Date: 09/05/2014

| | | |
|---|---|---|
| Party: EL | Width: 29.1 m | Processed by: EKY |
| Boat/Motor: kayak | Area: 29.3 m² | Mean Velocity: 0.674 m/s |
| Gage Height: 0.000 m | G.H.Change: 0.000 m | Discharge: 19.6 m³/s |

| | | | |
|---|---|---|---|
| Area Method: Mean Flow | ADCP Depth: 0.120 m | Index Vel.: 0.00 m/s | Rating No.: 1 |
| Nav. Method: DGPS | Shore Ens.:10 | Adj.Mean Vel: 0.00 m/s | Qm Rating: U |
| MagVar Method: Model (17.0°) | Bottom Est: Power (0.1667) | Rated Area: 0.000 m² | Diff.: 0.000% |
| Depth Sounder: Not Used | Top Est: Power (0.1667) | Control1: Unspecified | |
| Discharge Method: None | | Control2: Unspecified | |
| % Correction: 0.00 | | Control3: Unspecified | |

| Screening Thresholds: | | ADCP: | |
|---|---|---|---|
| BT 3-Beam Solution: YES | Max. Vel.: 1.98 m/s | Type/Freq.: StreamPro / 2000 kHz | |
| WT 3-Beam Solution: YES | Max. Depth: 1.80 m | Serial #: 1180 | Firmware: 31.12 |
| BT Error Vel.: 0.10 m/s | Mean Depth: 1.00 m | Bin Size: 6 cm | Blank: 3 cm |
| WT Error Vel.: 0.35 m/s | % Meas.: 71.88 | BT Mode: 10 | BT Pings: 2 |
| BT Up Vel.: 0.30 m/s | Water Temp.: None | WT Mode: 12 | WT Pings: 6 |
| WT Up Vel.: 2.00 m/s | ADCP Temp.: 3.0 °C | | |
| Use Weighted Mean Depth: YES | | | |

Performed Diag. Test: YES Project Name: Reed_2014_09_05_0.mmt

Performed Moving Bed Test: YES Software: 2.10

Performed Compass Calibration: YES Evaluation: YES

Meas. Location: below station

| Tr.# | | Edge Distance | | #Ens. | Discharge | | | | | | Width | Area | Time | | Mean Vel. | | % Bad | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | | Top | Middle | Bottom | Left | Right | Total | | | Start | End | Boat | Water | Ens. | Bins |
| 000 | R | 3.00 | 6.00 | 110 | 3.96 | 13.2 | 2.62 | 0.126 | 0.146 | 20.0 | 28.4 | 24.0 | 10:54 | 10:56 | 0.22 | 0.84 | 1 | 4 |
| 001 | L | 3.00 | 6.00 | 103 | 3.38 | 13.4 | 2.54 | 0.173 | -0.078 | 19.4 | 29.8 | 28.2 | 10:56 | 10:58 | 0.20 | 0.69 | 1 | 5 |
| *002* | *R* | *2.00* | *6.00* | *96* | *2.73* | *13.6* | *1.83* | *-0.070* | *-0.086* | *18.0* | *27.7* | *29.5* | *10:59* | *11:01* | *0.23* | *0.61* | *1* | *4* |
| 003 | L | 2.00 | 6.00 | 123 | 3.03 | 14.1 | 2.05 | -0.086 | 0.135 | 19.2 | 29.9 | 31.3 | 11:01 | 11:04 | 0.18 | 0.61 | 1 | 4 |
| *004* | *R* | *2.00* | *6.00* | *110* | *3.27* | *16.0* | *2.22* | *-0.089* | *0.092* | *21.5* | *29.7* | *32.6* | *11:04* | *11:07* | *0.19* | *0.66* | *1* | *4* |
| 005 | L | 2.00 | 6.00 | 163 | 3.09 | 14.0 | 2.06 | -0.068 | 0.032 | 19.1 | 29.3 | 30.1 | 11:07 | 11:10 | 0.15 | 0.64 | 1 | 3 |
| **Mean** | | 2.33 | 6.00 | 117 | 3.24 | 14.1 | 2.22 | -0.002 | 0.040 | 19.6 | 29.1 | 29.3 | **Total** | 00:16 | 0.20 | 0.67 | 1 | 4 |
| **SDev** | | 0.52 | 0.00 | 24 | 0.415 | 1.03 | 0.305 | 0.119 | 0.103 | 1.17 | 0.9 | 3.0 | | | 0.03 | 0.08 | | |
| **SD/M** | | 0.22 | 0.00 | 0.21 | 0.13 | 0.07 | 0.14 | 50.93 | 2.56 | 0.06 | 0.03 | 0.10 | | | 0.15 | 0.13 | | |

**Remarks:** RTK GPS

Discharge for transects in *italics* have a total Q more than 5% from the mean