Susitna-Watana Hydroelectric Project
(FERC No. 14241)

Baseline Water Quality Study (Study 5.5) and Water Quality Modeling Study (Study 5.6)

Water Quality and Lower River Modeling Technical Memorandum

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

Tetra Tech

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LIST OF ACRONYMS AND SCIENTIFIC LABELS

Abbreviation	Definition
ADEC	Alaska Department of Environmental Conservation
AEA	Alaska Energy Authority
EFDC	Environmental Fluid Dynamic Code
FA(s)	Focus Area(s)
FERC	Federal Energy Regulatory Commission
ILP	Integrated Licensing Process
NTU	Nephelometric turbidity unit
PRM	Project River Mile
Project	Susitna-Watana Hydroelectric Project
RWIS	Road Weather Information Systems
RSP	Revised Study Plan
TIR	thermal infrared
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey

1. INTRODUCTION

The Alaska Energy Authority (AEA) is preparing a License Application that will be submitted to the Federal Energy Regulatory Commission (FERC) for the Susitna-Watana Hydroelectric Project (Project) using the Integrated Licensing Process (ILP). The Project is located on the Susitna River, an approximately 320-mile-long river in Southcentral Alaska. The Project's dam site would be located at Project River Mile (PRM) 187.1.

AEA began monitoring water temperature in the Susitna River in 2012 (AEA 2013). The Baseline Water Quality Study (Study 5.5 of the Revised Study Plan [RSP]; AEA 2012) was initiated in 2013 to collect information to support an assessment of the effects of the proposed Project operations on water quality in the Susitna River basin. This Technical Memorandum evaluates QA/QC water quality data (including continuous water temperature monitoring) collected 2012 through 2014 for adequacy in representation of current riverine conditions. The need for continued monitoring of surface water temperature and for meteorological data beyond 2014 is evaluated at the spatial and temporal scale.

Predicting the potential impacts of the dam and its proposed operations on water quality will require the development of a water quality model. The Water Quality Modeling Study (Study 5.6 of the RSP; AEA 2012) will incorporate the extensive information collected from the Baseline Water Quality Study to develop a model(s) to evaluate the potential impacts of the proposed Project and operations on various physical parameters within the Susitna River watershed. The riverine model currently extends from the dam site downstream to PRM 29.9. Study 5.6, Part C of the Initial Study Report (ISR) explained that AEA would assess in 2014 whether to extend the water quality modeling downstream of PRM 29.9 (AEA 2014). This Technical Memorandum provides an assessment as to whether the riverine model should be extended below PRM 29.9.

2. STUDY OBJECTIVES

2.1 Baseline Water Quality Study

The goal of the Baseline Water Quality Study is to gather baseline data and assess the effects of the proposed Project and its operations on water quality in the Susitna River basin, which informs development of any appropriate conditions for inclusion in the Project license. The Project is expected to change some of the water quality characteristics of the drainage as well as the inundated area that will become the reservoir (RSP Section 5.5.1; AEA 2012).

The objectives of the Baseline Water Quality Study are as follows:

- Document historical water quality data and combine with data generated from this study. The combined dataset will be used in the Water Quality Modeling Study to predict Project impacts under various operations.

- Add current stream temperature and meteorological data to the existing data.

- Develop a monitoring program to adequately characterize surface water physical, chemical, and bacterial conditions in the Susitna River within and downstream of the proposed Project area.
- Measure baseline metals concentrations in sediment and fish tissue for comparison to state criteria.
- Perform Thermal Infrared Remote (TIR) sensing of the Susitna River from Susitna Station (Project River Mile [PRM] 29.9) to Deadman Creek (PRM 235.6), and use this data to map the groundwater discharge and possible extent of thermal refugia.

2.2 Water Quality Modeling Study

The collective goal of the Water Quality Modeling Study is to assess the impacts of the proposed Project operations on water quality in the Susitna River basin with particular reference to state water quality standards (RSP Section 5.6.1; AEA 2012). Further, the Water Quality Modeling Study will incorporate the extensive information collected from the Baseline Water Quality Study to develop a model(s) to evaluate the potential impacts of the proposed Project and operations on various physical parameters within the Susitna River watershed.

The objectives of the Water Quality Modeling Study are as follows:

- With input from licensing participants, implement an appropriate reservoir and river water temperature model for use with past and current monitoring data.
- Using the data developed in Sections 5.5 (Baseline Water Quality Study) model water quality conditions in the proposed Susitna-Watana Reservoir, including (but not necessarily limited to), temperature, DO, suspended sediment and turbidity, chlorophyll-a, nutrients, ice, and metals.
- Model water quality conditions in the Susitna River from the proposed site of the Susitna-Watana Dam downstream, including (but not necessarily limited to) temperature, suspended sediment and turbidity, and ice processes (in coordination with the Ice Processes Study).

3. STUDY AREA

As described in RSP Section 5.5.3, the study area for water quality monitoring includes the Susitna River from PRM 29.9 to PRM 235.2 (Oshetna River), and selected tributaries within the proposed transmission lines and access corridors. Water temperature monitoring began at PRM 19.9 and other water quality monitoring started at PRM 29.9.

4. THE WATER QUALITY STUDY PLAN COMPONENTS

As previously mentioned, AEA initiated the Baseline Water Quality Monitoring Study in 2013 and will apply results from this study as well as water temperature monitoring (begun in 2012) to complete the Water Quality Modeling Study. To meet study goals, AEA completed numerous study components in 2013 which are summarized in ISR Study 5.5 Section 4. The following sections describe study components completed in 2014.

4.1 Planned Baseline Water Quality Monitoring Study Components

AEA summarized its plans for completing the Baseline Water Quality Monitoring Study in ISR Study 5.5, Part C, Section 7.2. In 2014, AEA implemented the methods for the following study components as described in the Study Plan with the exception of the modifications described in ISR Study 5.5, Part C, Section 7.1.2, or as noted below.

4.1.1 Water Temperature Data Collection

Continuous temperature loggers were deployed at 38 sites (June 2014 to September 2014) set to 15 minute logging intervals with monthly data downloads. Temperature loggers were removed and downloaded September 2014 and not re-deployed (see Section 6.1).

4.1.2 Meteorological Data Collection

Data from the MET stations established between PRM 142.2 to PRM 235.2 (EMS-1, EMS-2, and EMS-3), as well from the three existing MET stations located between Willow Creek and the Talkeetna Airport was continually downloaded. These stations are scheduled for maintenance and winter preparation October 2014.

4.1.3 Baseline Water Quality Monitoring

All baseline water quality samples collected in 2013 as part of Study 5.5 have undergone QA/QC review per the QAPP (example provided in Figure 5.1-1). Baseline water quality monitoring samples were collected at five sites during winter 2014 and 17 sites from PRM 29.9 to PRM 235.2 each month from June 2014 through September 2014. In-situ field measurements were collected at each location using a Hydrolab® datasonde (MS5). A single grab sample was collected monthly at each location and analyzed for all total metals (except Ca and Mg) and dissolved Al, TP, TKN, and nitrate+nitrite-nitrogen.

4.1.4 Focus Area Water Quality

All water quality samples collected in 2013 in Focus Areas as part of Study 5.5 have undergone QA/QC review per the QAPP (see Section A.7.1; example provided in Figure 5.1-2). In-situ field measurements were collected with a Hydrolab® datasonde (MS5) at each point sample location, at the center of each transect within the main channel, and at locations along the transects in selected side channels where the flow differs from the main channel. Single grab samples were collected once in July and once in August at each point sample location, at the center of each transect, and at locations along the transects in selected side channels where the flow differs from the main channel. The grab samples were analyzed for all total metals (except Ca and Mg) and dissolved Al, TP, TKN, & nitrate+nitrite-nitrogen.

4.1.5 Sediment and Porewater Sampling

All sediment and porewater samples collected in 2013 as part of Study 5.5 have undergone QA/QC review per the QAPP (example provided in Figure 5.1-3). Sediment and porewater samples were collected once in August 2014 at the six sampling sites that were not visited in 2013 (Susitna Above Watana Dam, Susitna Below Watana Dam, Fog, Deadman, Watana, and Tsusena).

4.2 Lower River Modeling Study Components

AEA summarized a decision point for extending the Water Quality Modeling Study into the lower river in ISR Study 5.6, Part C, Section 7. The primary reason to consider extending the water quality modeling below PRM 29.9 was to assist in describing the relationship between river flows, water surface elevation, and Cook Inlet Beluga Whale (CIBW) foraging habitat in the Susitna River, consistent with Objective 3 of CIBW Modified Revised Study Plan (MRSP Section 9.17.1) (see ISR 9.17, Appendix E). This decision was made in coordination with the Fluvial Geomorphology Modeling (FGM) Study (Study 6.6), which has a coincident decision point as described in ISR Study 6.6, Section 7.1.1.1.2 and Tetra Tech 2014.

The approach used to determine the need for extending the EFDC model downstream of PRM 29.9 compares water quality parameters from pre-Project conditions with water quality parameters from post-Project conditions based on the maximum load-following scenario in the areas modeled upstream of PRM 29.9. If there is little difference between the water quality parameters between the two simulations, then change in water quality conditions from Project operations will be determined to be negligible and the model will not be extended. The water quality comparisons use three year modeling run periods ending with the wet year and dry year. These results will be provided to the CIBW Study (Study 9.17) as well as information on the natural variability of these parameters. The water quality parameters considered for CIBW habitat include water temperature, total suspended sediment, and dissolved oxygen during the period of interest.

5. MONITORING RESULTS AND MODEL DEVELOPMENT FOR STUDY COMPLETION

5.1 Results of Baseline Water Quality Monitoring Study

Planned baseline water quality monitoring study elements in 2014 focused on completing collection of data that could not be obtained in 2013 and in assuring an adequate data record was collected that characterized more than one monitoring year. Some of the data sets, such as continuous water temperature and meteorological data, captured inter-annual variations in surface water and climate conditions at select sites in the Susitna Basin. Constructing data sets that capture conditions over longer time periods in order to describe extreme conditions (e.g., climate or water temperature), benefits calibration of the reservoir and riverine models by accounting for the influence of temporal climate patterns directly correlated with water quality conditions (e.g., warm years versus cold years). The following sections describe the QA/QC reviewed baseline water quality data collection effort (including continuous temperature monitoring) from 2012 through 2014.

5.1.1 Water Temperature Data Collection

Water temperature characterization has been on-going throughout the Susitna Basin during three seasons as outlined in the RSP Section 5.5.4.1. The 2012 through 2014 data sets are complete and have been used to calibrate the reservoir and riverine models. Examples of 2013 and 2014 continuous temperature data can be found in Figure 6.1-1 through Figure 6.1-3. Multiple years of data collection demonstrates variation in river water temperatures that are covariant with climatological patterns. The June through September 2013 sampling season was characterized by warmer ambient air temperatures earlier in the year compared to the same period in 2014. Average daily mean temperature at the Watana Dam MET Station (ESM1) in 2013 was 14.81^{o}C in June and 5.36 ^{o}Celsius (^{o}C) in September (Table 5.2-1 from the ISR Study 5.5). In contrast, average daily mean temperature at the Watana Dam MET Station (ESM1) in 2014 was 8.7 ^{o}C in June and 6.2 ^{o}C in September. Surface water temperatures followed a similar pattern with warmer conditions during June 2013 than were recorded during June 2014 (Figure 6.1-1 through Figure 6.1-3). Temporal variations between years is evident with 2013 having higher temperatures on average, however profile variations throughout the water column within a given year are within 1^{o} C.

Temperature ranges shown in Figure 6.1-1 through Figure 6.1-3 are similar to those described from monitoring completed in 1985. Results from those studies were generated by Alaska Power Authority (predecessor to AEA) and the Alaska Department of Fish and Game and reported in URS (2011). The comparison of current conditions against historic riverine temperature ranges was used to verify that an adequate period of temperature data collection was completed (Table 6.1-1). In addition, this comparison was intended to verify overlapping range of conditions between the two time periods for the purpose of expanding the data record (as stated by the first objective for Study 5.5 (Section 2.1 in this Technical Memorandum). Temperature ranges were compared between historic (1970s and 1980s available data) and current (2013) conditions. Maximum temperatures at select sites on the Susitna River were similar and minimum temperature ranges from the historic data set expanded the data set for colder months. Once temperature data has been validated and verified from winter monitoring (2013/2014) and for ice-free conditions in 2014, additional range expansion for minimum temperatures is expected. The model calibration will benefit from combination of historic and current data making prediction of a broader range of conditions with greater accuracy possible.

Continuous temperature monitoring over the winters of 2012 (September 2012 – May 2013) and 2013 (September 2013 – May 2014) at PRM 87.8 and PRM 118.6 (Figures 6.1-4 and 6.1-5, respectively) indicate similar patterns. Temperatures in both years fell to or near zero within days of one another mid-October to early November.

5.1.2 Meteorological Data Collection

Climate conditions have an effect on surface water temperatures in the Susitna River basin. Response of river water temperature demonstrated this relationship and was captured with multi-year data collection. Similarly, MET station data have been collected continuously from 2012-2014 as outlined in RSP Section 5.5.4.2. The 2012 and 2013 data includes wind speeds, air temperature, relative humidity, dew point, atmospheric pressure, and solar radiation. Additional data collected during 2014 includes snow level reports and precipitation. Supplemental precipitation data was downloaded from the Talkeetna MET station at Parks Highway and was collected by Road Weather Information Systems (RWIS). Monthly precipitation data corresponding with sample collection in 2013 is shown in Figures 6-1.6 to Figure 6-1.9. MET station data from 2012-2013 can be found on the GINA website using the following link ftp://ftp.gina.alaska.edu/isr/5/5.5/. QA/QC'd MET station data for 2014 will be available at a later date.

MET Station data collection began following a heavy snowfall winter (2012/2013) and transitioned to a very warm summer during 2013. Isolated rain events resulted in flooding along points of the Susitna River during the latter part of 2013 water quality sampling. Meteorological conditions during 2014 were less severe than those during winter 2012/2013 and had a more moderate weather pattern during summer 2014 monitoring. Precipitation gage and snow depth sensors could not be installed at ESM-1 (Susitna River at Watana Dam Camp), but are currently being installed to measure 2014 conditions for use in improving calibration of the reservoir and riverine models.

5.1.3 Water Quality and Sediment Sampling

Baseline water quality data were collected during 2014 to supplement 2013 analytical results requiring re-analysis of select parameters (e.g., phosphorus and metals) for samples not meeting data validation/verification thresholds (ISR Study 5.5 Section 7.1.2). With the additional data collected in 2014, water quality sampling has been completed and will be used to generate modeling results for several seasons of the year. Water quality parameters collected in 2013, winter 2014 and summer 2014 are presented in Table 6.1-2, Tables 6.1-3 and 6.1-4, and Table 6.1-5, respectively. Data collected during 2014 are currently being evaluated for quality and usability prior to use for water quality model calibration and use for predicting post-Project conditions. The full data set will be available after the last data are received from the laboratory in November 2014; however, preliminary results thus far indicate that data from all parameters will be complete and useable in reference to data validation standards outlined in the Baseline Water Quality Study 5.5 ISR Part B- Attachment 1, Quality Assurance Project Plan for Water Quality and Mercury Assessment.

Sediment and porewater data from samples collected in 2014 (ISR Study 5.5 Section 7.1.2) will be available from the laboratory in November 2014 and will be validated and reviewed at that time.

5.2 Results of the Lower River Modeling Study

The EFDC hydrodynamic and water quality models simulated two, three-year periods, 1974-1976 and 1979-1981 under historic pre-Project conditions and post-Project conditions based on the maximum load following scenario. Model runs for the extreme conditions, wet year and dry year, include multiple years to account for the effect of interannual variation in climate. Each of the model run periods end in either the wet year (1981) or dry year (1976) with predicted results that demonstrate how climate record used for these time periods influence predicted water temperature for both pre- and post-Project conditions. The maximum load following scenario is based on operational flow data records from the years 1950-2010. Calibration of the temperature model is based on 2012-2014 records collected as part of Study 5.5. Temperature data collected from 2012-2014 will be used to synthesize data where existing gaps occur between the years 1950-2010. The model domain extended from the proposed dam site downstream to PRM 29.9. For pre-Project conditions the upstream river temperature boundary was based on a three-year synthesized temperature record which correlated recent observed temperatures with time of year and river flow. For post-Project conditions, the pre-Project river flow and temperature were used as upstream boundary conditions for the EFDC reservoir model. Flow and water temperature from the reservoir model provided upstream boundary conditions for the post-Project river model.

Temperature, turbidity, total suspended solids (TSS), and dissolved oxygen were the primary variables used for evaluating the downstream extent of potential impacts the proposed dam would have on the river. In this Technical Memorandum, temperature was used to demonstrate potential downstream impacts from Project operations. The temperature data represented one of the primary water quality parameters that could have an impact on the prey species captured by the Cook Inlet Beluga Whale (CIBW) and the foraging success of this whale population. Since the temperature data set is the most detailed with largest number of results, it has been used for model calibration. Figure 6.2-1 shows plots of model predictions of temperatures along the river for 1974 through 1976 period at the dam site, PRM 125, PRM 60, and PRM 29.9. Similar plots for the 1979 through 1981 period are shown in Figure 6.2-2. The top panels of the two figures show differences between the pre and post-Project river temperatures at the dam site under the worst case scenario, drawing water from the surface of the reservoir. Post-Project temperatures are higher in the summer and fall. The outflow elevation in the reservoir is based on movable vertical shutters which result in water being discharged from the warmer reservoir surface where solar radiation is absorbed during summer and early fall. This water withdrawal strategy is worst case scenario as the current dam design includes movable vertical shutters to allow water withdrawals at multiple reservoir water depths, allowing cooler water to be drawn at lower depths and that actual operations (i.e. appropriate reservoir water outflow depth) would occur to minimize Project effects on water temperatures below the dam.

Further down the river at PRM 125, the difference between pre- and post-Project (e.g., Maximum Load-following scenario with reservoir outflow from reservoir surface)temperature decreases with post-Project temperatures being 2 to 3 °C higher in late summer and fall. At PRM 60 the difference between pre- and post-Project (e.g., Maximum Load-following scenario with reservoir outflow from reservoir surface) temperatures decreases further with post- Project temperature being approximately 1 to 2 °C higher in the early fall but diminishing or declining to less than 1 °C higher toward the end of the three-year model run. Pre- and post-Project temperature falls to 0 °C during period of ice cover showing no difference between the two conditions. Model predicted pre-Project and post-Project (e.g., Maximum Load-following scenario with reservoir outflow from reservoir surface) temperatures at PRM 29.9, which include the effects of the Yentna River inflow immediately upstream, differs by less than 1 °C. Figures 6.2-3 and 6.2-4 show plots of differences between pre-Project and post-Project conditions at PRM 29.9, supporting the small difference and indicating a random mode of differences rather than consistent higher or lower differences between pre- and post-Project scenarios. It is noted that the difference between pre-Project and post-Project (e.g., Maximum Load-following scenario with reservoir outflow from reservoir surface) temperatures on a specific day are typically similar to or less than the diurnal temperature variation of a given day. These figures also show correlation plots and regression results indicating on average, post-Project (e.g., Maximum Load-following scenario with reservoir outflow from reservoir surface) temperatures at PRM 29.9 exceed pre-Project temperatures by approximately one percent.

Dissolved oxygen (DO) concentrations along the Susitna River, as seen in Figure 6.2-5, show that DO levels in the mainstem tend to be near saturation, particularly in the lower 90 miles of the river. DO saturation concentration is primarily a function of water temperature (Figure 6.2-

5) and saturation concentrations are not expected to change significantly in the lower river post-Project. The observed saturation conditions are expected to show no significant change between pre- and post-Project conditions at PRM 29.9.

Preliminary simulations of the silt and clay fraction of sediment transport through the reservoir have been made. The extreme depth of the reservoir and the current proposed surface outflow makes the reservoir a highly efficient settling basin. Using a single bulk settling velocity for this material, the results indicate that the reservoir passes less than 1 percent of the silt and clay. It has been estimated that the dam site load of silt and clay contributes approximately 12 percent of the total silt and clay load estimated at Susitna Station. Thus a conservative estimate is that the silt and clay load would be reduced by 1 percent below Susitna Station (PRM 29.9) when assuming a 90 percent trap efficiency. The lower silt and clay based TSS and corresponding turbidity change upstream of this site will be generated with model predictions and be further refined for determining implications to fisheries resources evaluated in other study components. Partitioning the silt and clay material into multiple size classes is one strategy that will increase the accuracy in the estimate of silt and clay discharged from the reservoir.

6. CONCLUSIONS

6.1 Proposed Modification for Water Temperature Data Collection

AEA has successfully completed the tasks listed within the Study Plan Section 5.5. An evaluation of continuous monitoring data for temperature indicates that adequate data collection for water quality modeling has been achieved. Meteorological monitoring locations will be maintained through June 2015 in order to capture an adequate set of winter data for use in the water quality model. Thermistors were removed from the river in September 2014 and not re-deployed as examination of temperature data records from winter 2012 (PRM 87.8 Susitna River at Parks Highway and PRM 118.6 Chulitna River) and winter 2013 show no difference in data results between these two periods (Figure 6.1-4 and Figure 6.1-5).

The intent for continuous temperature monitoring for two years has been completed with winter data sets from 2012/2013 and 2013/2014. Continuous monitoring of water temperature was discontinued during September 2014.

6.2 Lower River Modeling Study Components

Based on the model predictions shown in Figures 6.2-1 and 6.2-2, water temperature at PRM 29.9 shows little or no change in temperature patterns over the year. Since effects from Project operations on temperature are minimal at PRM 29.9, temperature is expected to be unchanged further downstream by Project operations.

As stated above, based upon the small difference between pre and post-Project temperatures at PRM 29.9 and similar small changes in DO based on observed saturation, AEA is not proposing to extend the water quality modeling downstream from PRM 29.9.

7. REFERENCES

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8. FIGURES

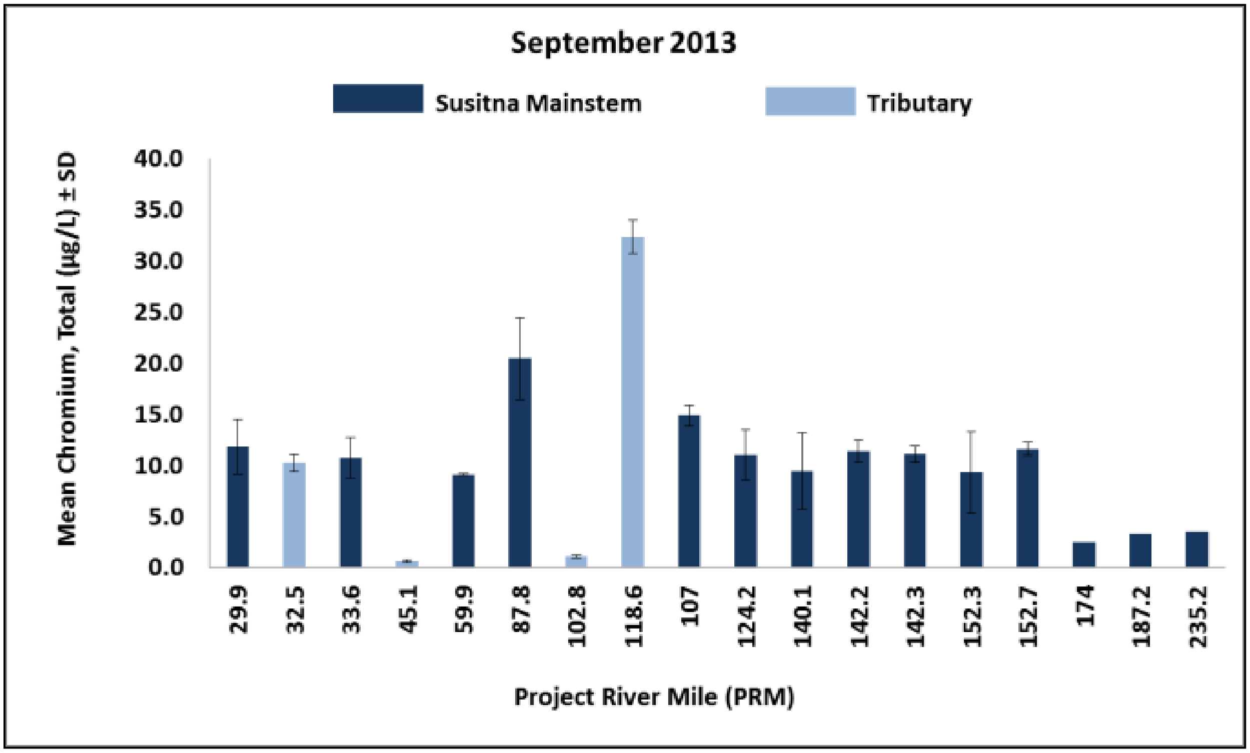

Figure 5.1-1. Example of QA/QC Baseline Water Quality Data Collected in 2013.

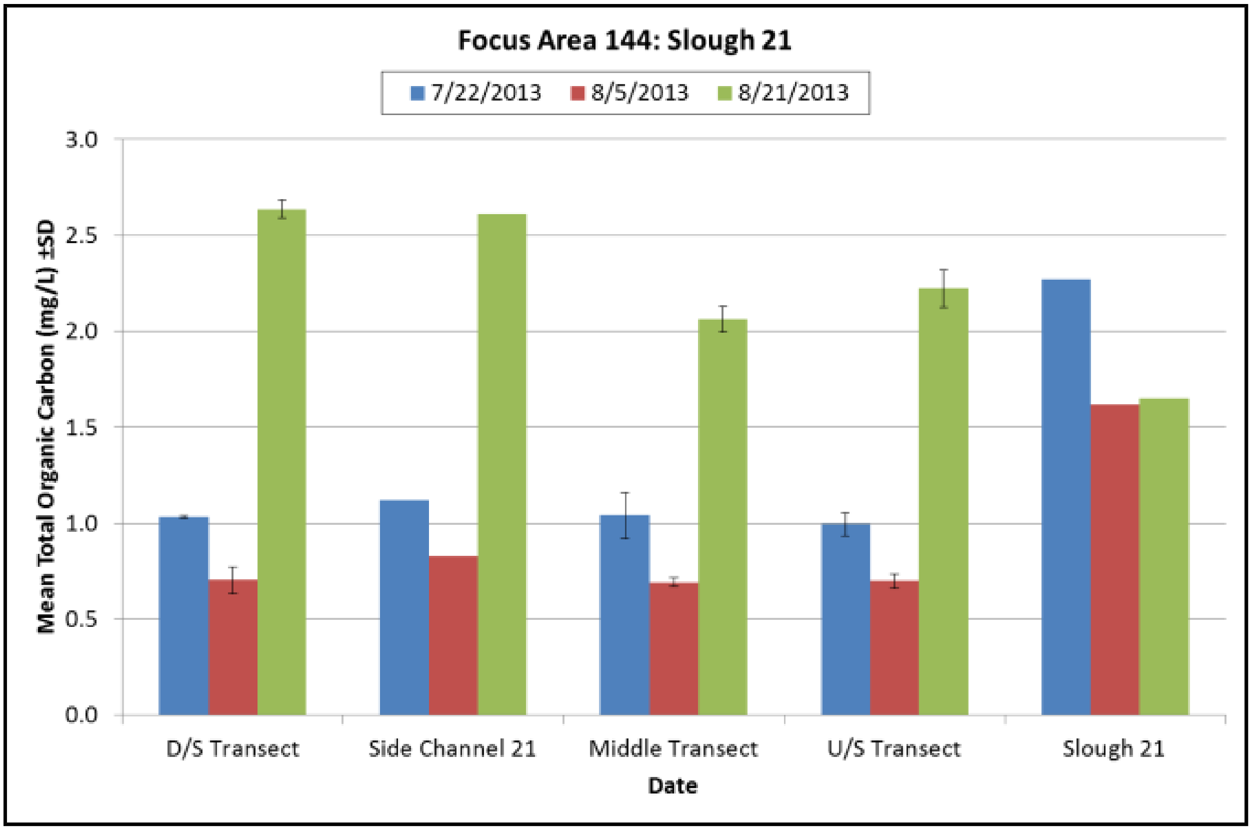

Figure 5.1-2. Example of QA/QC Focus Area Water Quality Data Collected in 2013.

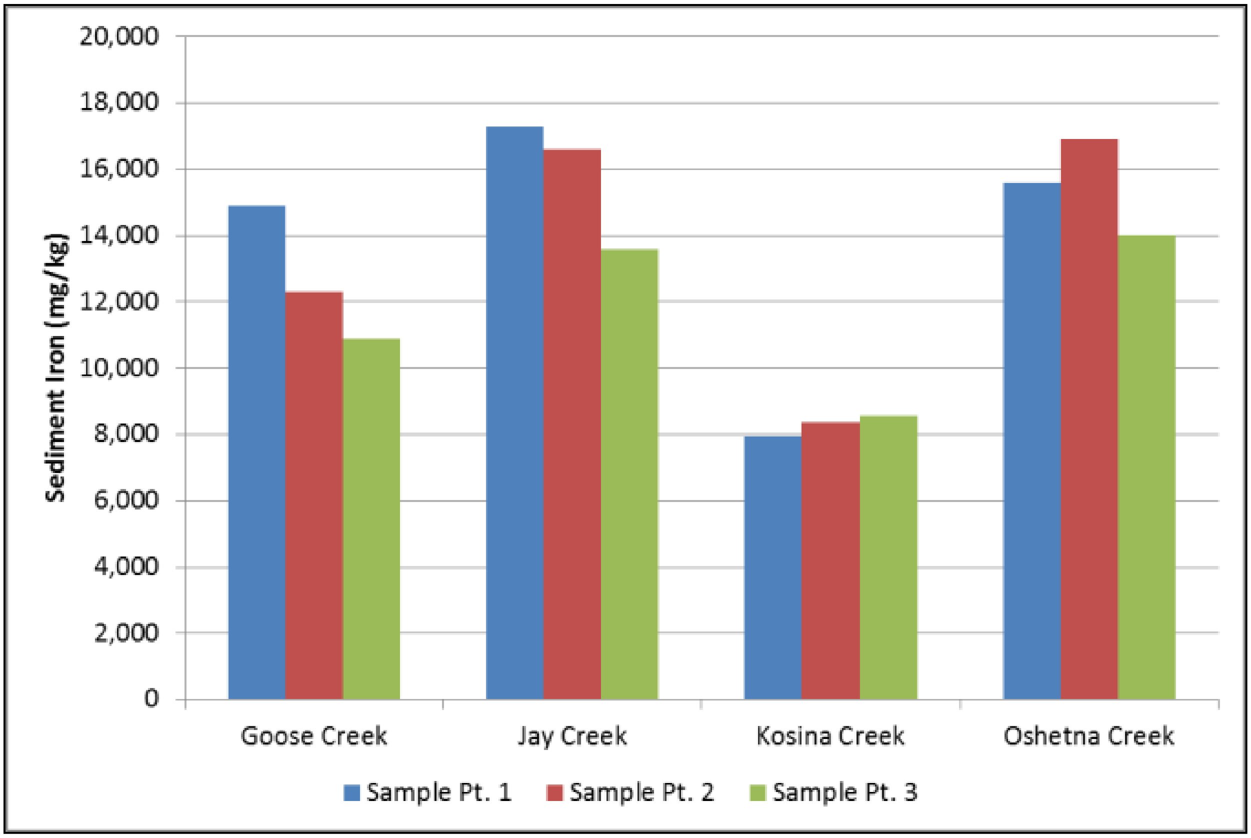

Figure 5.1-3. Example of QA/QC Sediment Data Collected in 2013.

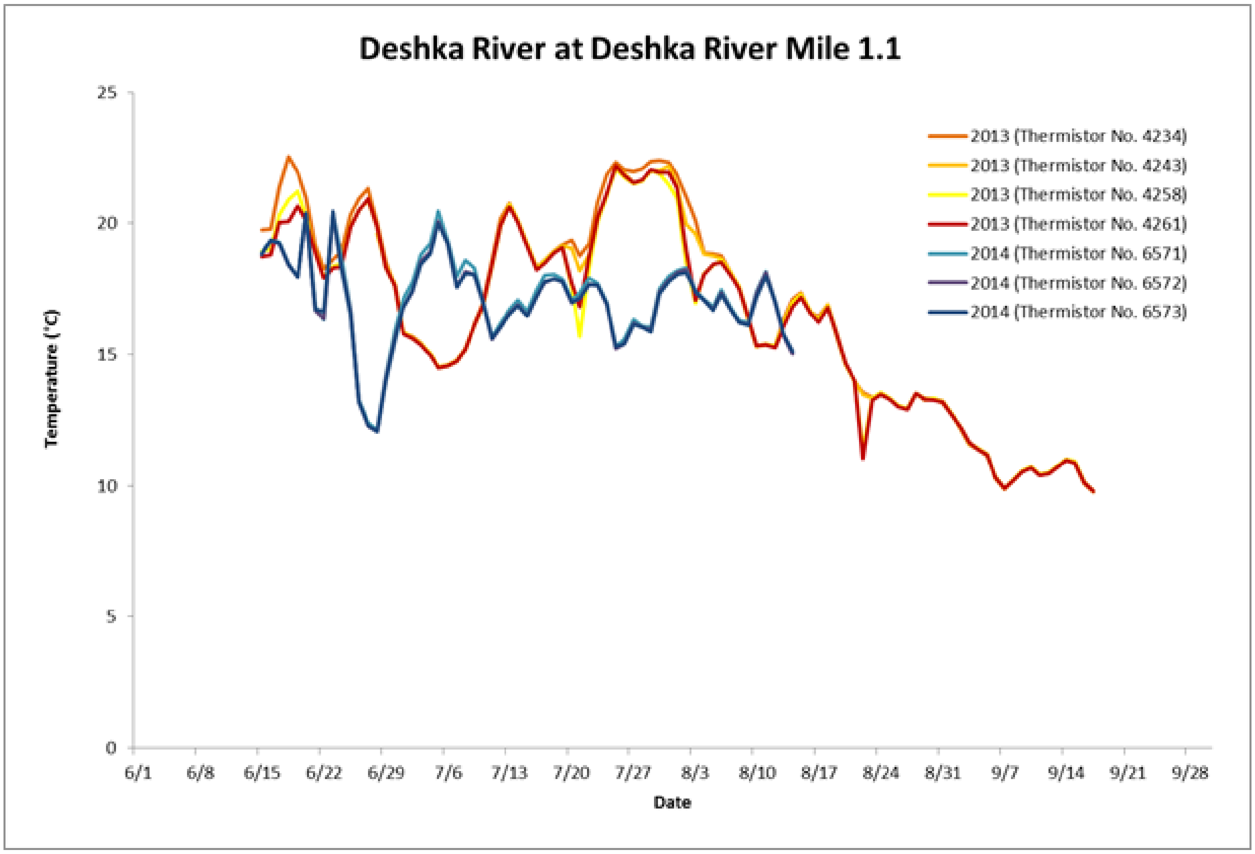

Figure 6.1-2. 2013 and 2014 Continuous Temperature Monitoring Data in the Deshka River at Deshka RM 1.1. The confluence of the Deshka River occurs at Susitna River PRM 45.1.

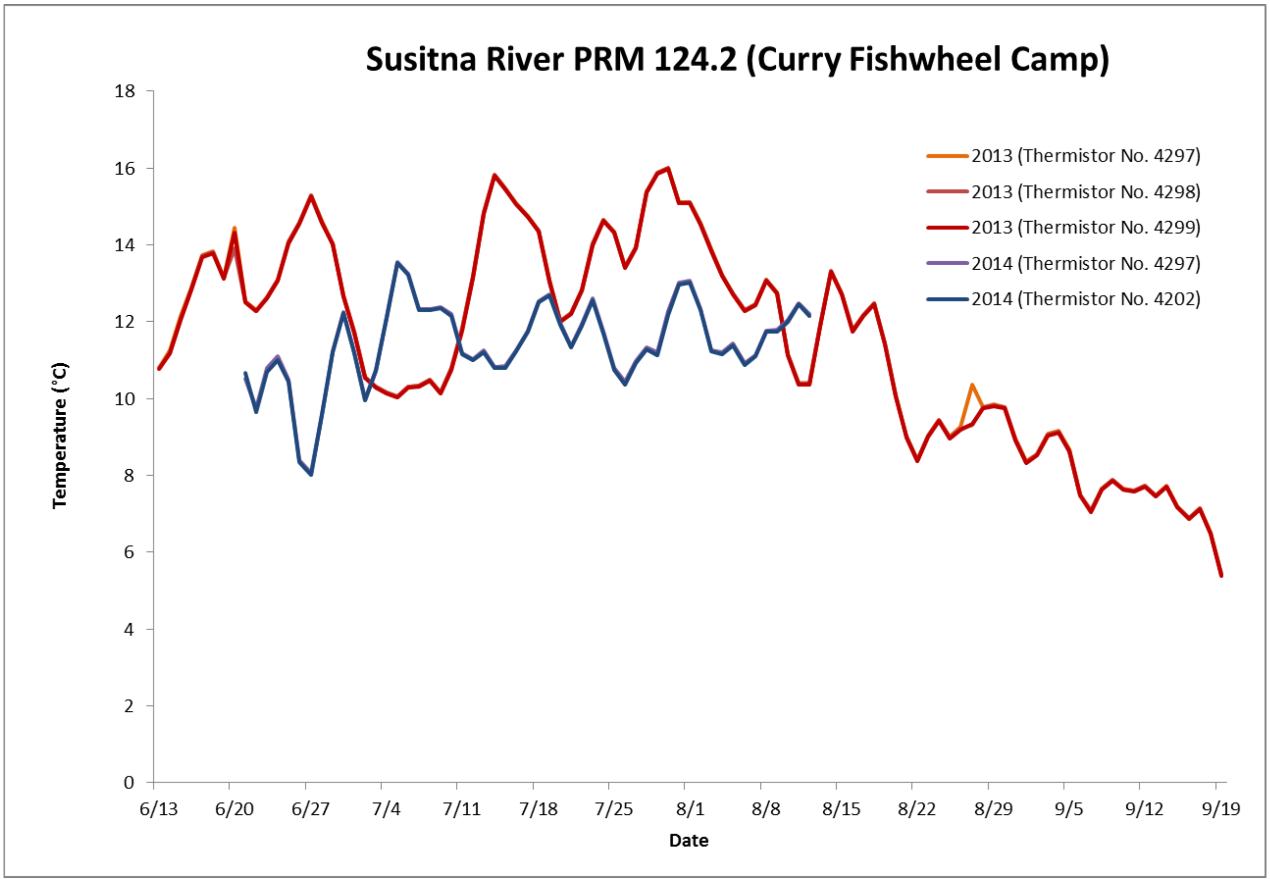

Figure 6.1-2. 2013 and 2014 Continuous Temperature Monitoring Data at Susitna River PRM 124.2, Curry Fishwheel Camp.

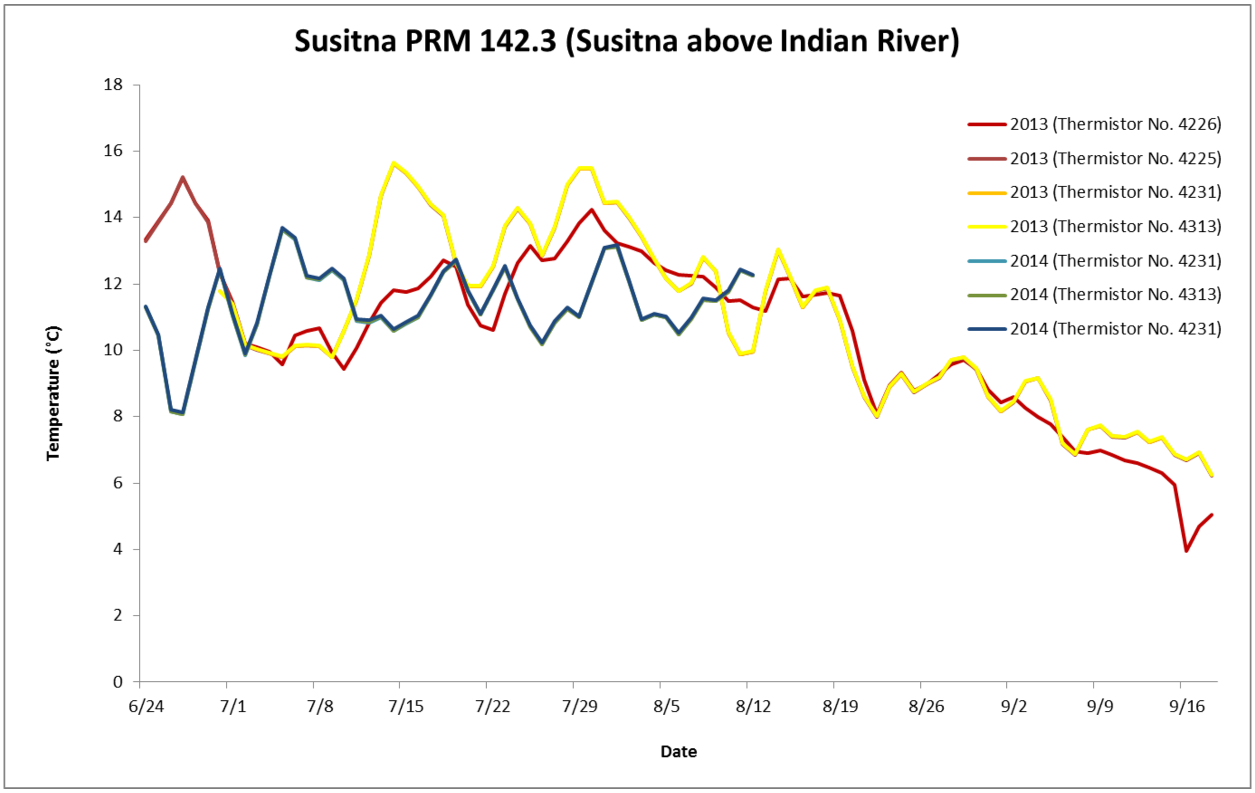

Figure 6.1-3. 2013 and 2014 Continuous Temperature Monitoring Data at Susitna River PRM 142.3, Susitna above Indian River.

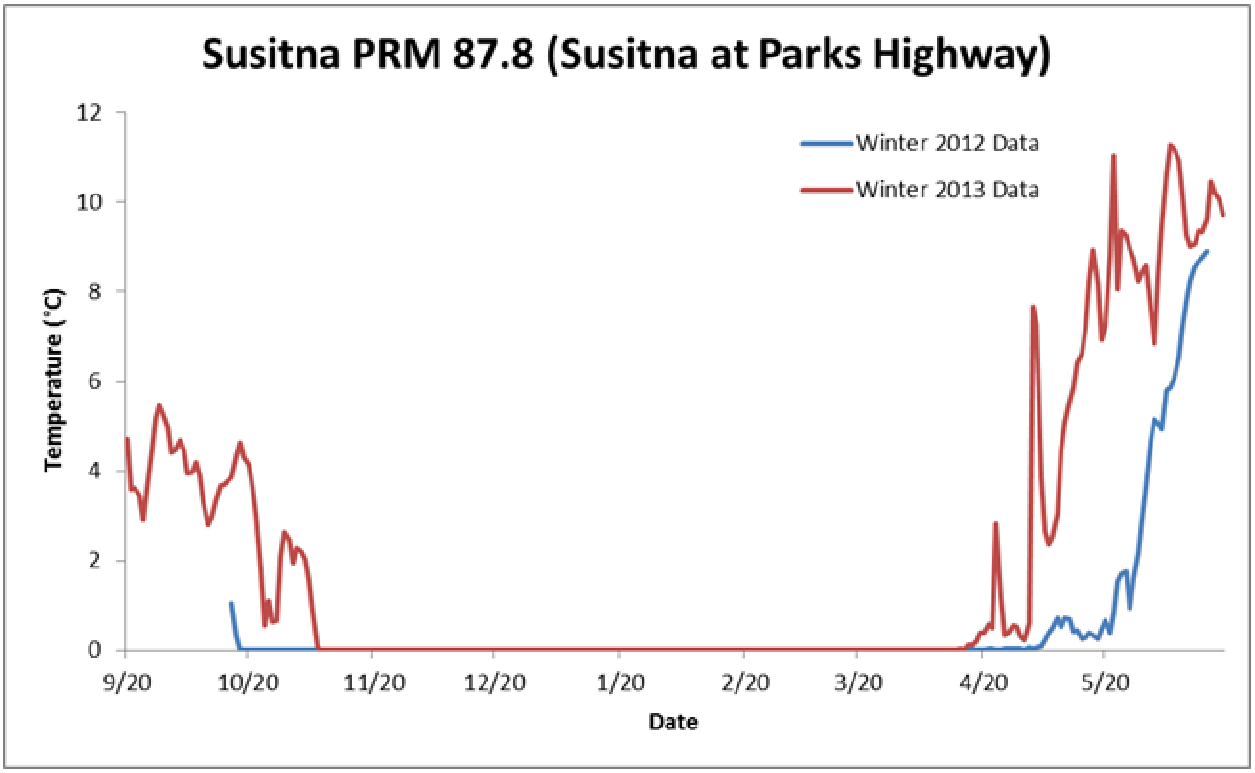

Figure 6.1-4. Winter 2012 and 2013 Continuous Temperature Monitoring Data at Susitna River PRM 87.8, Susitna at Parks Highway.

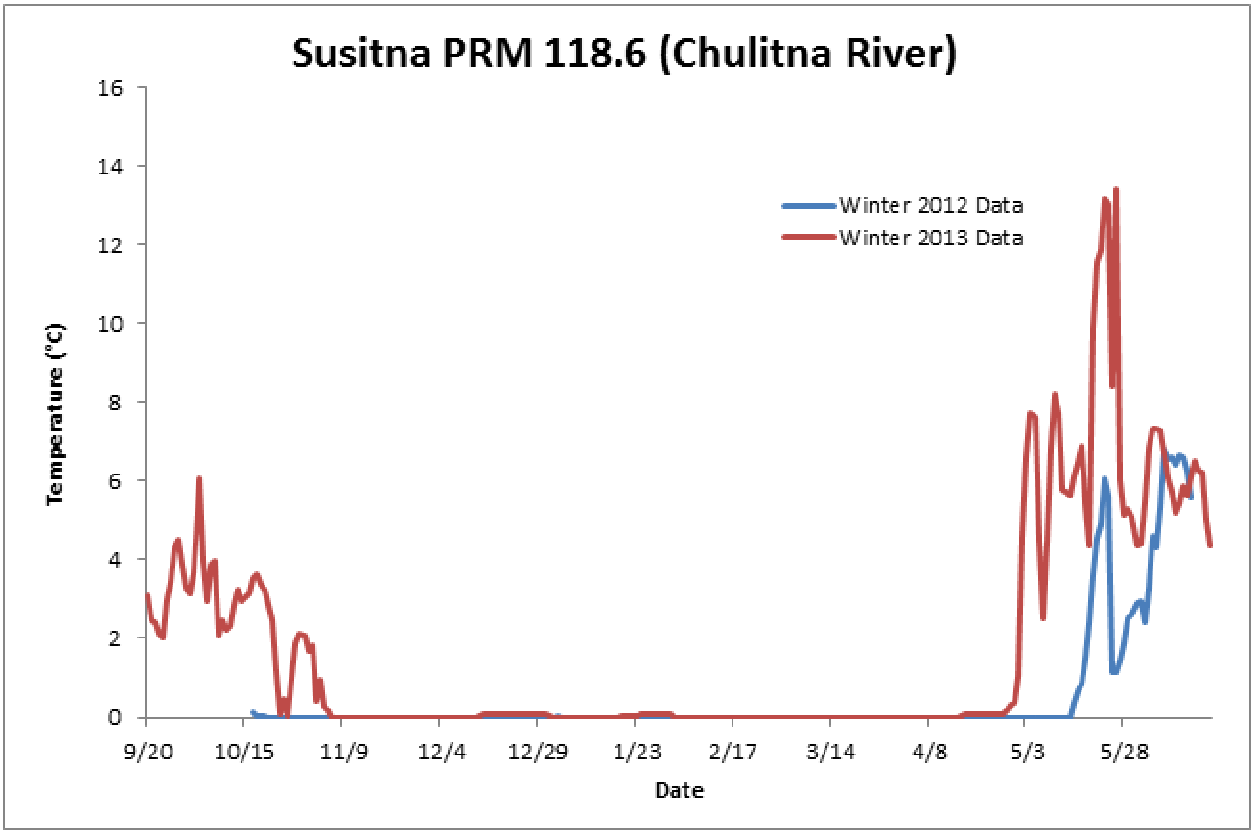

Figure 6.1-5. Winter 2012 and 2013 Continuous Temperature Monitoring Data at Susitna River PRM 118.6, Chulitna River.

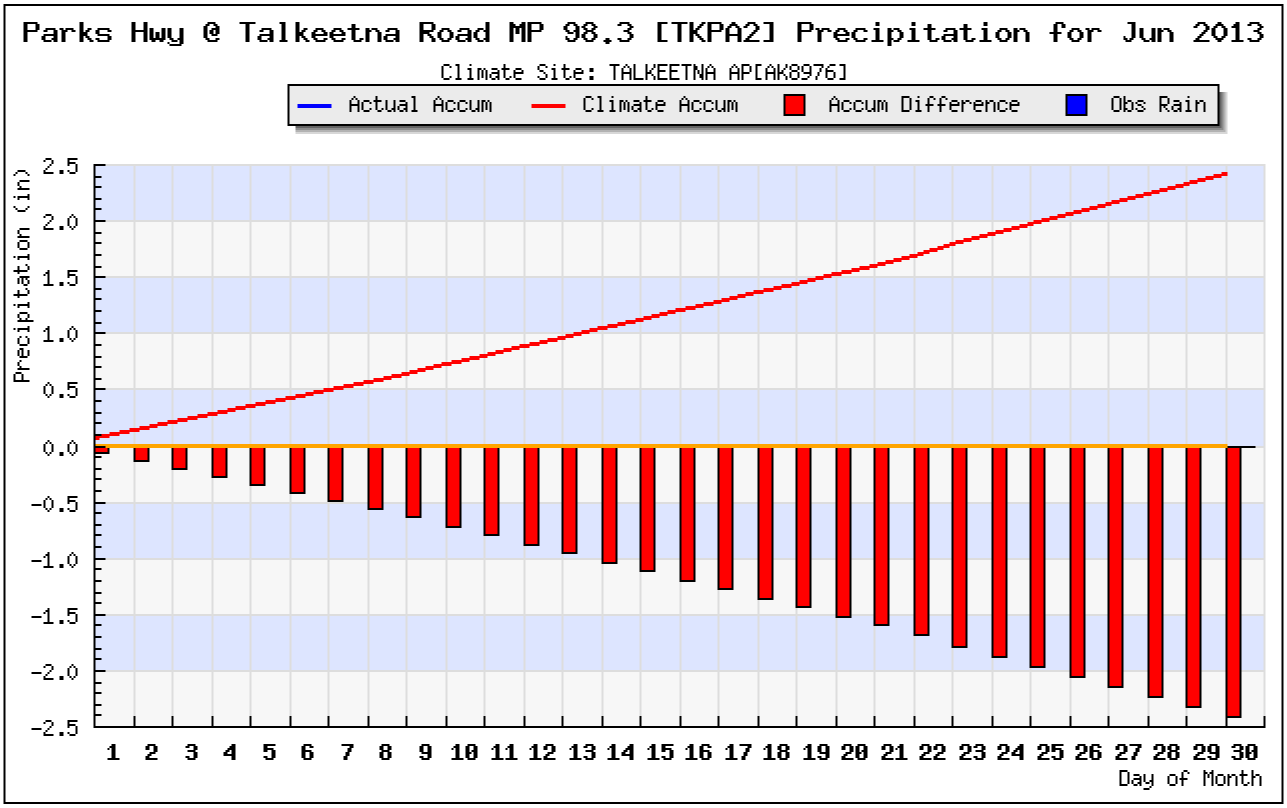

Figure 6-1.6. Precipitation Data Collected at the Talkeetna Road @ Parks Highway MET Station during June 2013, Downloaded from RWIS.

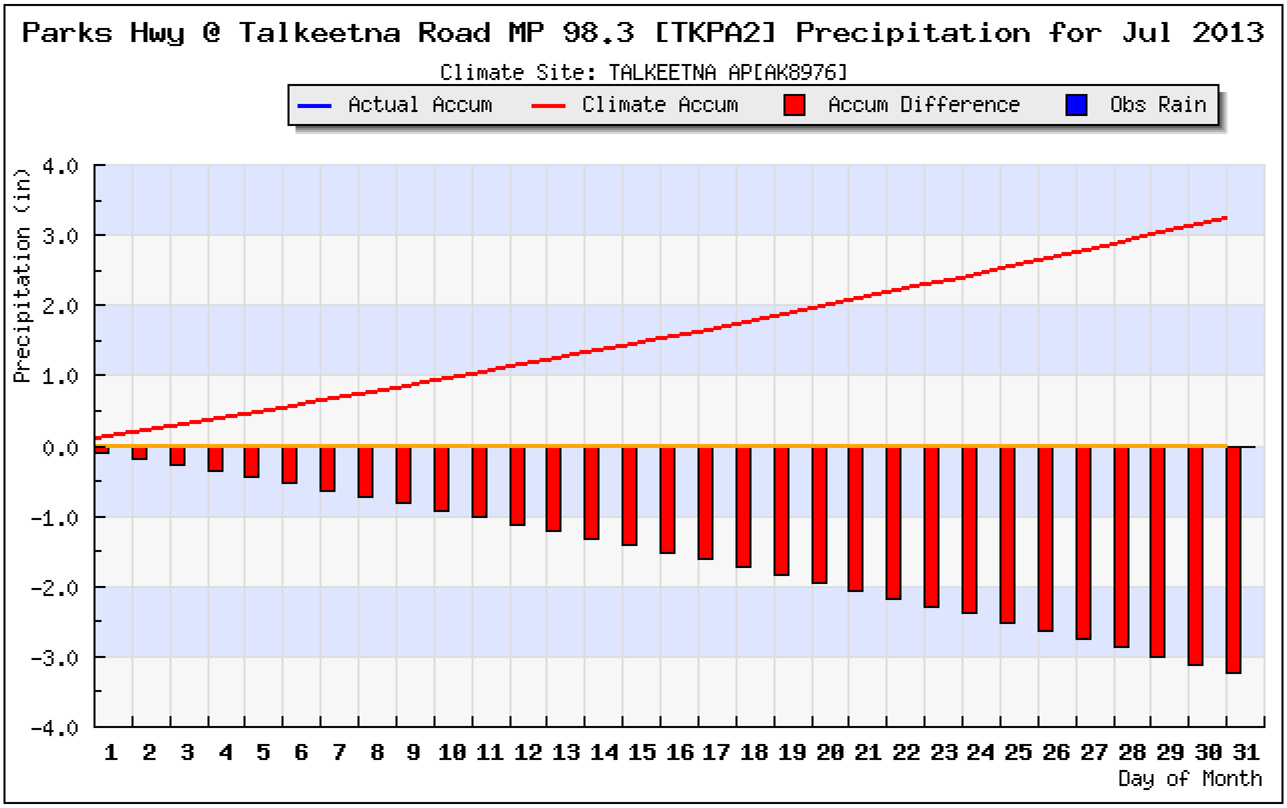

Figure 6-1.7. Precipitation Data Collected at the Talkeetna Road @ Parks Highway MET Station during July 2013, Downloaded from RWIS.

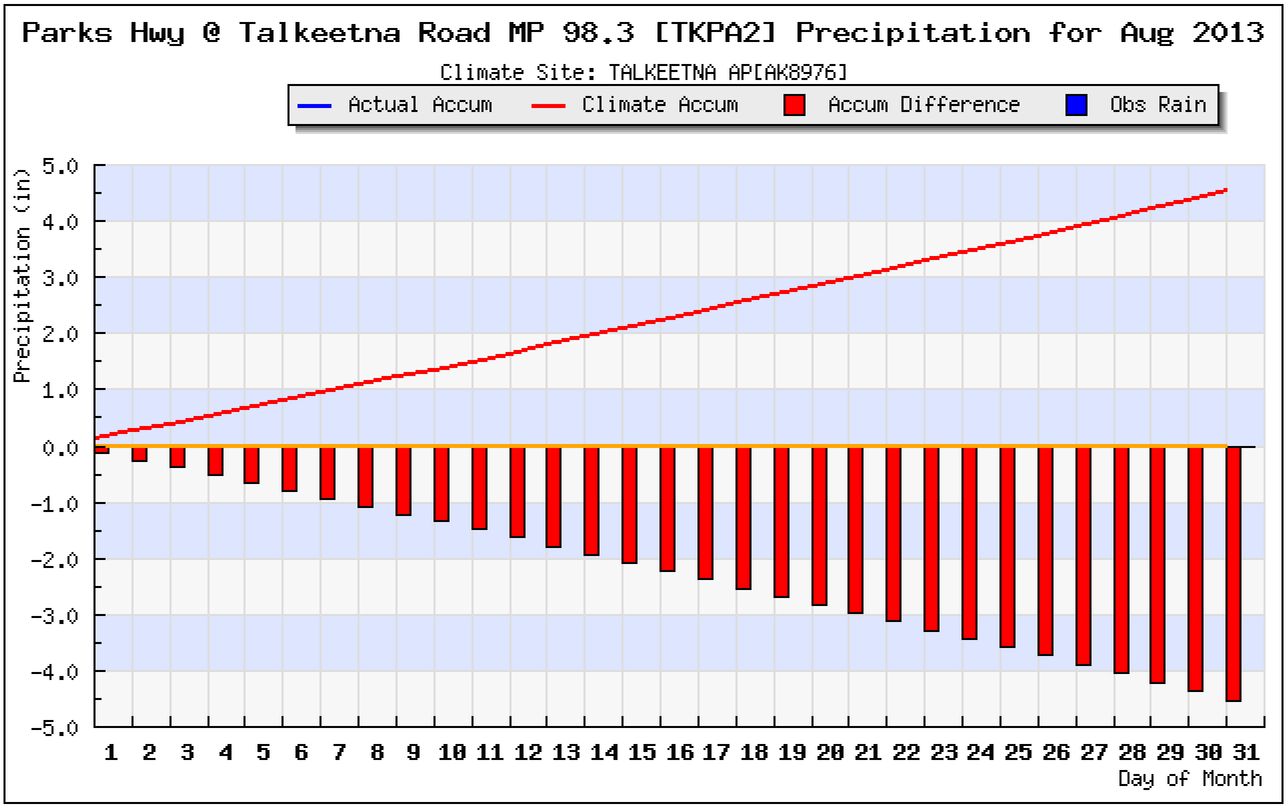

Figure 6-1.8. Precipitation Data Collected at the Talkeetna Road @ Parks Highway MET Station during August 2013, Downloaded from RWIS.

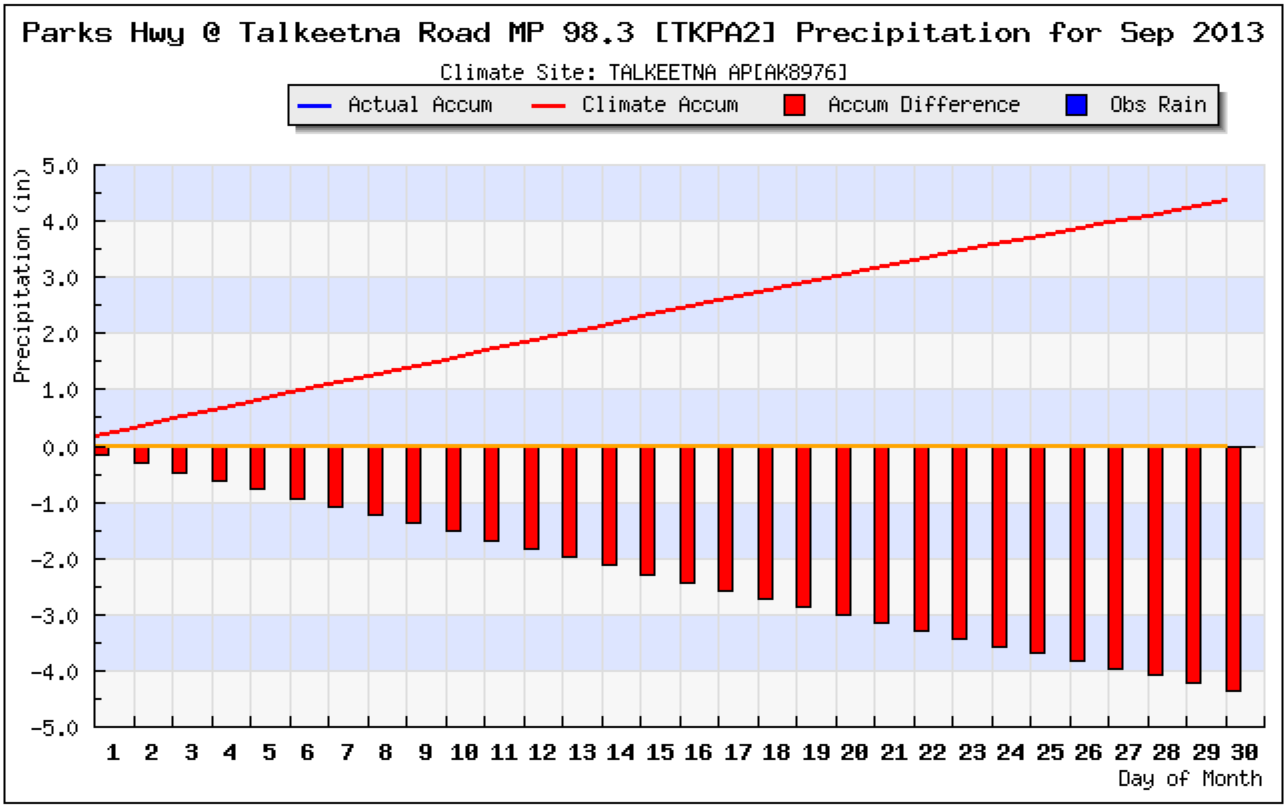

Figure 6-1.9. Precipitation Data Collected at the Talkeetna Road @ Parks Highway MET Station during September 2013, Downloaded from RWIS.

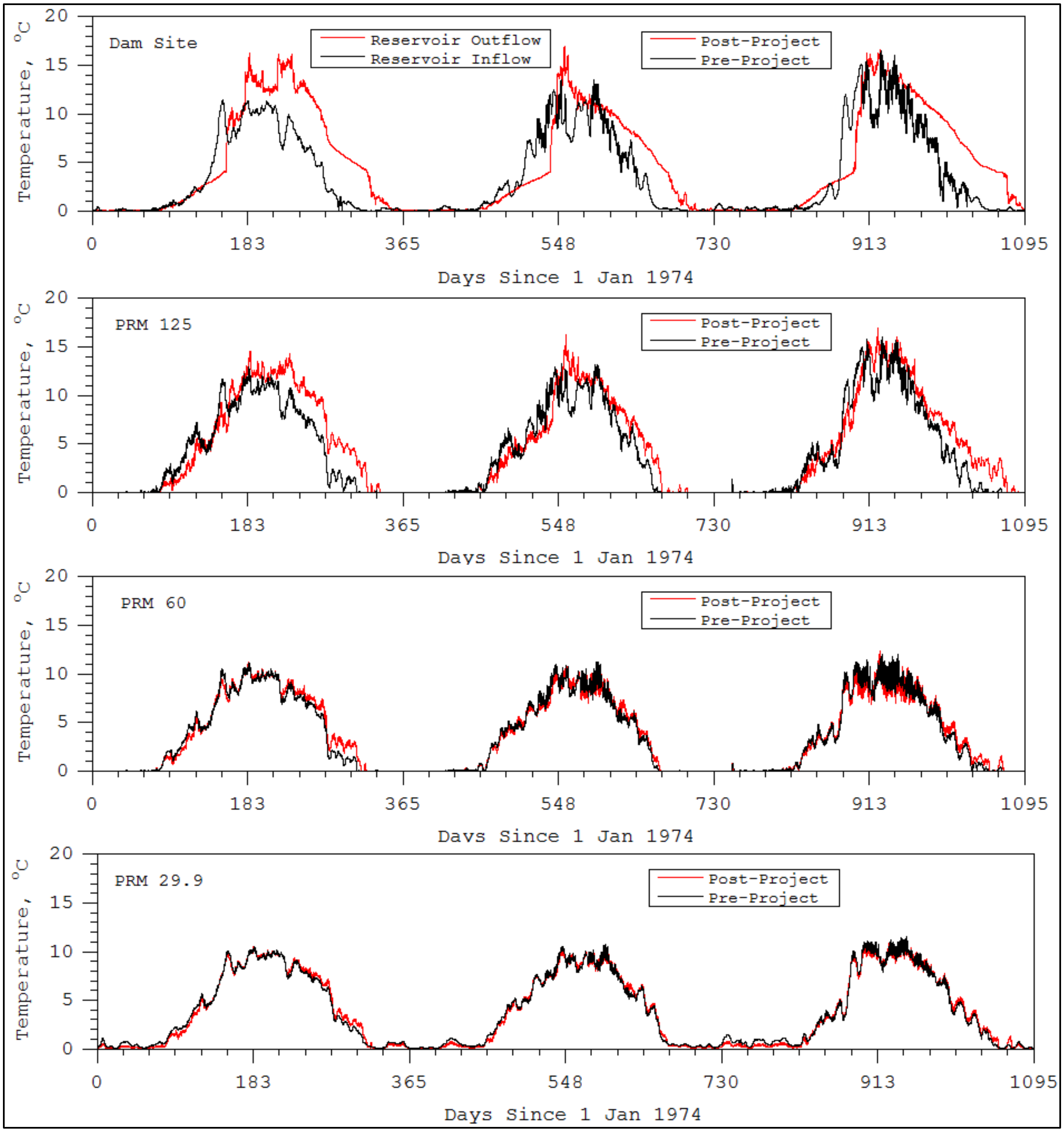

Figure 6.2-1. Comparison of Pre-Project (1974-1976) and Post-Project (Maximum Load Following Scenario) River Temperature along the Susitna River at the dam site, PRM 125, PRM 60 and PRM 29.9.

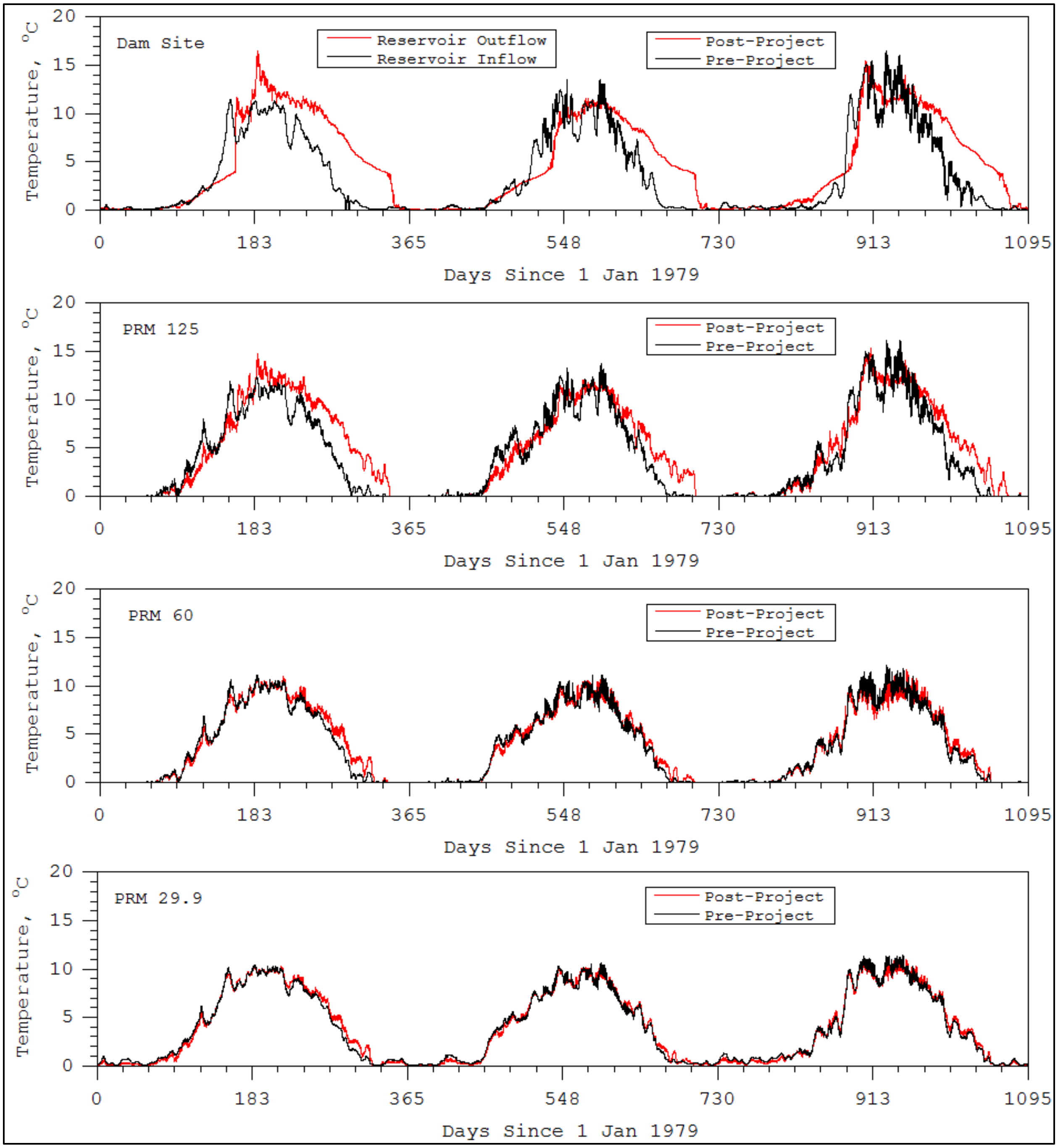

Figure 6.2-2. Comparison of Pre-Project (1979-1981) and Post-Project (Maximum Load Following Scenario) River Temperature along the Susitna River at the dam site, PRM 125, PRM 60 and PRM 29.9.

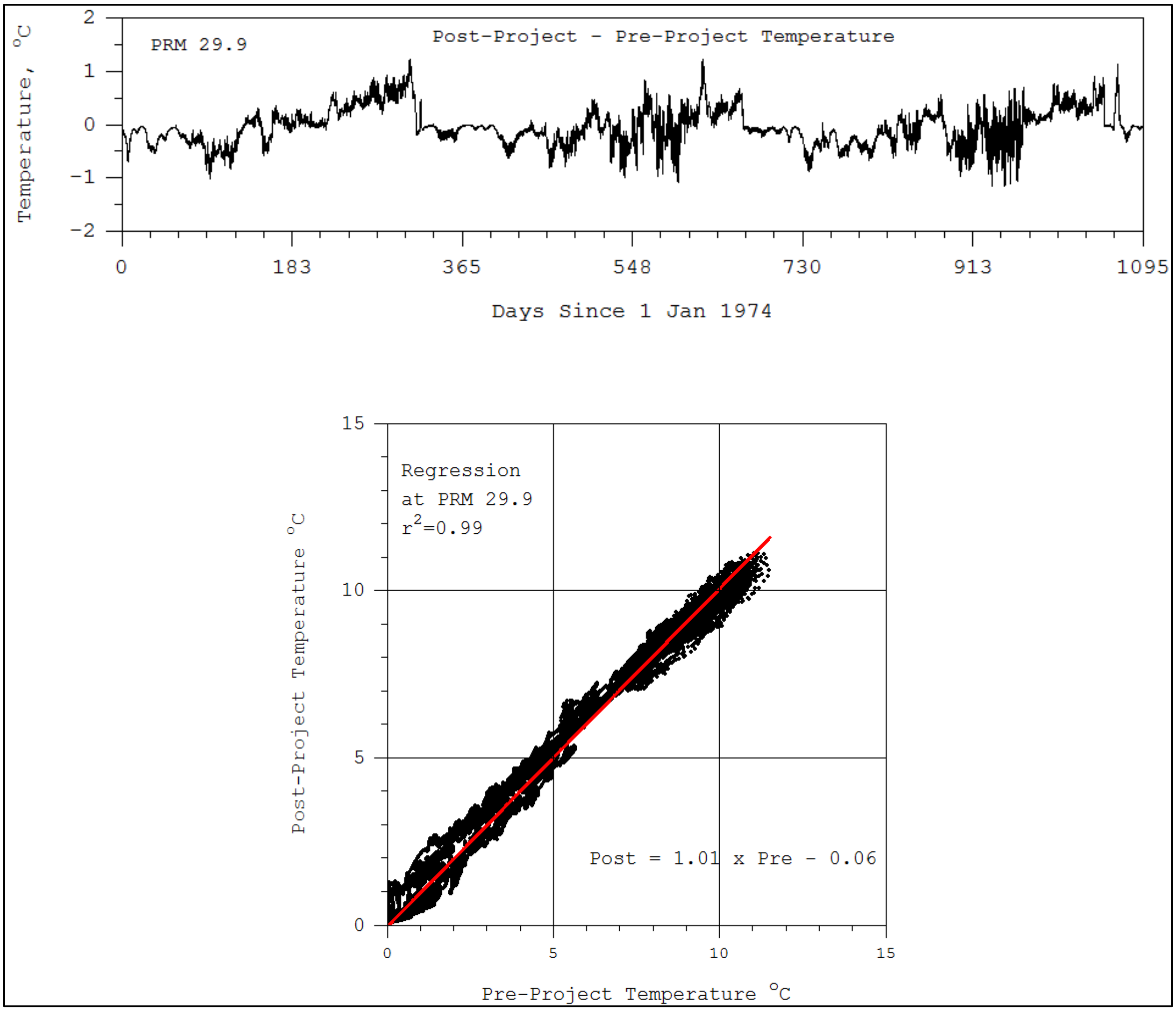

Figure 6.2-3. Daily Variation in Temperature at PRM 29.9 for Pre-Project (1974-1976) and Post-Project Maximum Load Following Conditions.

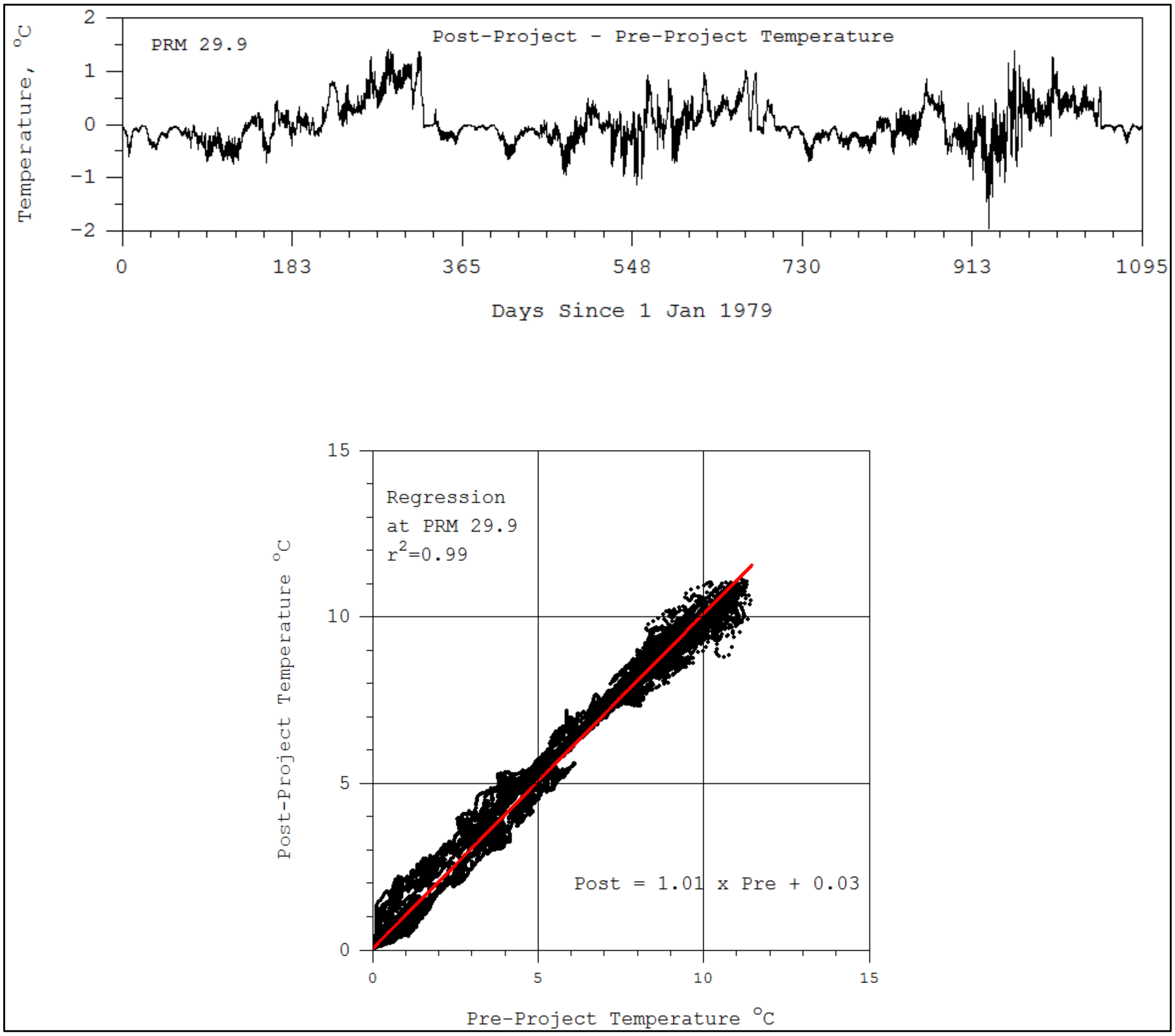

Figure 6.2-4. Daily Variation in Temperature at PRM 29.9 for Pre-Project (1979-1981) and Post-Project Maximum Load Following Conditions.

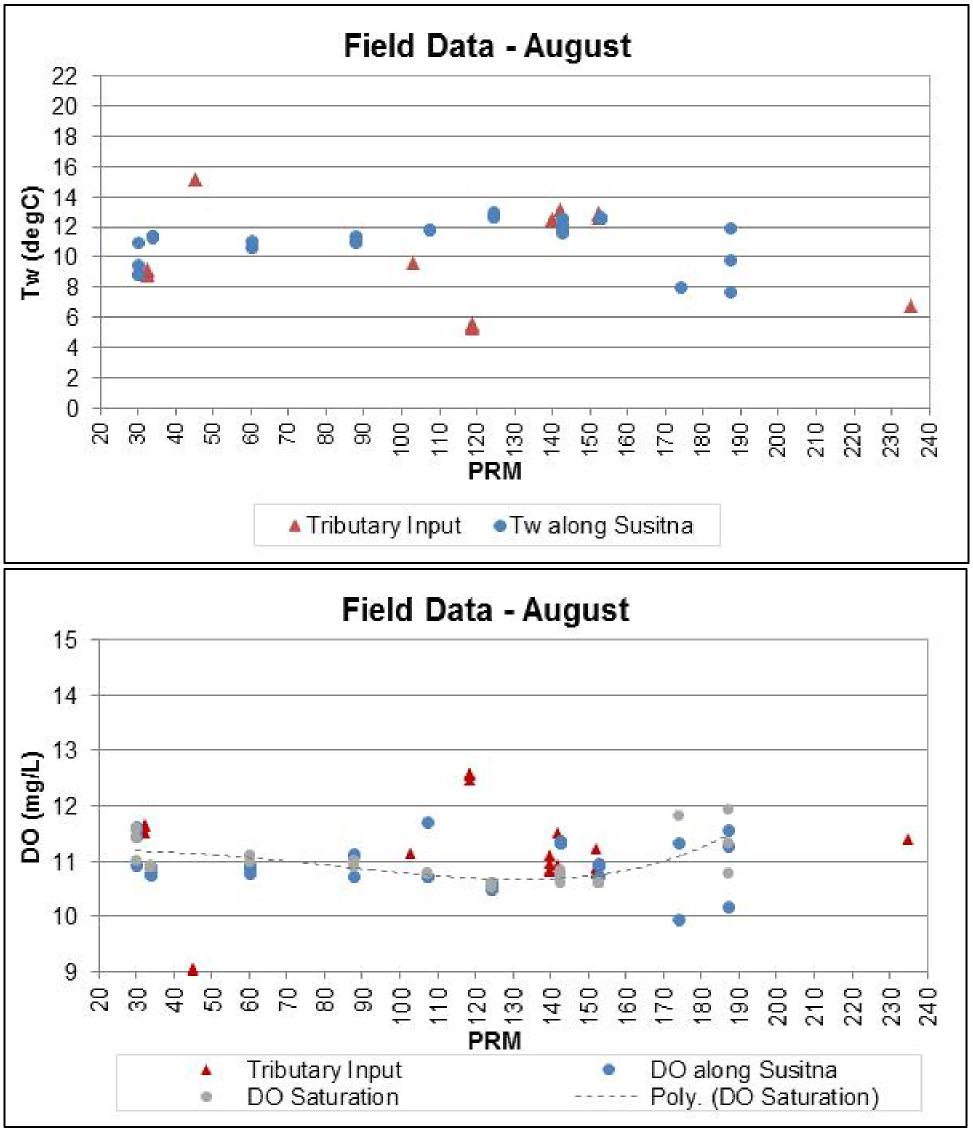

Figure 6.2-5. August 2013 Temperature (top) and Dissolved Oxygen (bottom) Observations.

9. TABLES

Table 6.1-1. Range of In situ Temperature and Dissolved Oxygen Results Collected from a Current Time Period (June 1 to September 30) and for a Historic (1970s and 1980s) and Current (2013) Time Period.

Location	RM	PRM	Source for Historic Data	Water Temperature (^{0}C)		Dissolved Oxygen (mg/L)	
				Historic	Current[1]	Historic	Current[1]
Susitna River	25.8	29.9	USGS 15294350 (July-September: 1975, 1986, 2003)	2.5 to 14.8	7.1 to 15.6	9.0 to 12.3	10.9 to 12.5
Talkeetna River	97.0	107	USGS 15292700 (July-September: Temp.1966, 1995, 2000; DO 1972-75, 1977-90, 1992-1995)	3.5 to 13.5	5.3 to 17.8	9.9 to 13.8	10.2 to 11.7
Curry Fishwheel Camp	120.7	124.2	APA and ADF&G (July-September: 1985)	2.7 to 15.3	5.2 to 16.7	10.1 o 13.9	10.0 to 12.5
Gold Greek	136.8	140.1	USGS 15292000 (July-Sept. & October-Dec.: Temp. 1949, 1957,1962, 1974-1977, 1979-1986) DO 1977, 1980-86)	0.3 to 14.1	5.9 to 16.3	8.5 to 13.3	10.5 to 12.5
Susitna River at Watana Dam Site	184.2	187.2	APA and ADF&G (July-September: 1985)	1.9 to 14.4	2.6 to 11.9**	N/A	10.5 to 12.5

[1] Reflects data collected August through September only
*one-time sample event only
** current water temperature based on field one-time grab sample from a Hydrolab (all other current temperature data based on continuously monitored sites using thermistors).
N/A = not available

Table 6.1-2. 2013 Water Quality Study Sampling Parameters and Schedule.

Parameter	Baseline Water Quality (collected monthly)	Focus Areas (collected every 2 weeks; 3 events)		Mercury Assessment (one-time survey)[2]		
		Surface Water	Ground Water	Sediment (Total)	Porewater (Dissolved)	Tissue (Total)
In Situ Water Quality Parameters						
Water Temperature	X	X	X		X	
Dissolved Oxygen (DO)	X	X	X			
pH	X	X	X		X	
Specific Conductance	X	X	X			
Turbidity	X	X	X			
Redox Potential	X	X	X			
Color	X		X			
Residues	X[1]					
Other Water Quality Parameters (grab samples for laboratory analysis)						
Hardness	X	X	X		X	
Alkalinity	X				X	
Nitrate/Nitrite	X	X	X			
Ammonia as N	X					
Total Kjeldahl Nitrogen	X	X	X			
Total Phosphorus	X	X	X			
Ortho-phosphate	X	X	X			
Chlorophyll-a	X	X	X			
Total Dissolved Solids	X					
Total Suspended Solids	X					
TOC	X[1]	X	X	X		
DOC	X	X			X	
Fecal Coliform	X[1]					
Petroleum Hydrocarbons	X[1]					
Radioactivity	X[1]					
Metals						
Aluminum	X[1]	X	X		X	
Arsenic	X			X	X	X
Barium	X					
Beryllium	X					
Cadmium	X			X	X	X
Calcium	X				X	
Chromium (Total)	X[1]					
Cobalt	X					

Parameter	Baseline Water Quality (collected monthly)	Focus Areas (collected every 2 weeks; 3 events)		Mercury Assessment (one-time survey)[2]		
		Surface Water	Ground Water	Sediment (Total)	Porewater (Dissolved)	Tissue (Total)
Copper	X			X	X	
Iron	X	X	X	X	X	
Lead	X			X	X	
Manganese	X					
Magnesium	X		X		X	
Mercury	X	X (total)	X (total)	X	X	X
Methyl mercury		X (dissolved)	X (dissolved)			X
Molybdenum	X					
Nickel	X			X	X	
Selenium	X[1]			X	X	X
Thallium	X					
Vanadium	X					
Zinc	X			X	X	
Sediment Size				X		

Notes:
1 One-time survey
2 Refer to ISR Section 5.7 for details
Metals in surface water were analyzed for dissolved and total.

Table 6.1-3. Winter 2014 Water Quality Study Sampling Parameters.

Winter Baseline Water Quality Monitoring			
Sampling Date	Susitna River PRM	Lab Parameters	Field Parameters
1/28/2014	29.9, 87.8	TP, SRP, Ammonia, NO_3+NO_2, TKN, MeHg, Alkalinity, Hardness, TDS, TSS, TOC, DOC, Turbidity, Chlorophyll Dissolved and Total Al, As, Fe, Ba, Be, Cd, Cr, Co, Cu, Pb, Mo, Ni, Se, Tl, V, Zn, Mn, Ca, Mg, Hg	Color, Temperature, DO, pH, Specific conductance, ORP, Turbidity
1/29/2014	185, 225		
1/30/2014	140		
3/10/2014	29.9, 87.8		
3/11/2014	185, 225		
3/12/2014	140		

Table 6.1-4. Winter 2014 Focus Area Groundwater Well Monitoring Locations.

Winter Focus Area Groundwater Well Monitoring			
Sampling Date	Focus Area	Lab Parameters	Field Parameters
2/6/2014	FA-104 (Whiskers Slough)	TP, SRP, Ammonia, NO_3+NO_2, TKN, Dissolved and Total Al, Fe	Temperature, pH, Specific conductance, ORP, DO
2/12/2014	FA-138 (Gold Creek)		
2/17/2014	FA-128 (Slough 8A)		
3/6/2014	FA-104 (Whiskers Slough)		
3/12/2014	FA-138 (Gold Creek)		
3/16/2014	FA-128 (Slough 8A)		
4/2/2014	FA-104 (Whiskers Slough)		
4/9/2014	FA-138 (Gold Creek)		
4/13/2014	FA-128 (Slough 8A)		

Table 6.1-5. 2014 Water Quality Study Sampling Parameters.

Parameter	Baseline Water Quality (collected monthly)	Focus Areas
Water Temperature	X	X
Dissolved Oxygen (DO)	X	X
pH	X	X
Specific Conductance	X	X
Turbidity	X	X
Redox Potential	X	X
Nitrate/Nitrite	X	X
Total Kjeldahl Nitrogen	X	X
Total Phosphorus	X	X
Ortho-phosphate	X	X
Aluminum (total and dissolved)	X	X
Arsenic (total)	X	X
Barium (total)	X	X
Iron (total)	X	X
Manganese (total)	X	X
Mercury (total)	X	X