DONLIN GOLD PROJECT

Analysis of Crooked Creek Stream Temperature

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Prepared by BGC Engineering Inc. for:
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TABLE OF REVISIONS

ISSUE	DATE	REV	REMARKS
DRAFT	September 28, 2021		Original issue for comment

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ACRONYMS AND ABBREVIATIONS

Acronyms and abbreviations used in this report:

CWA	Clean Water Act
EED	Environmental Evaluation Document
FEIS	Final Environmental Impact Statement
Project	Donlin Gold Project
SRS	Seepage Recovery System
TSF	Tailings Storage Facility

1. INTRODUCTION

The Final Environmental Impact Statement (FEIS) for the Donlin Gold Project (Project) includes a section on potential changes in stream temperature in Crooked Creek in the mine site area. Specifically, the FEIS includes the following statement[1]:

> *"Maximum recorded stream temperatures for Crooked Creek at Crevice Creek in June, July, and August are 45.8°F, 51.6°F, and 50.1°F, respectively. Under summer low flow conditions during mining operations, reductions in groundwater inputs to Crooked Creek could cause stream temperatures in reaches near the mine to be close to or above the State of Alaska's water quality temperature standard of 55.4°F for egg/fry incubation and spawning and 59.0°F for migration and rearing."*

The statement was taken directly from the May 2013 Environmental Evaluation Document (EED) prepared by ARCADIS (2013) for Donlin Gold. The statement was addressed in Section 11.2.3.3 in ADEC's Response to Comments (RTC) issued in May 2020 in upholding the Clean Water Act (CWA) Section 401 certification of the project's CWA Section 404 permit.

The EED statement was a qualitative and general assessment of the potential for exceedance of the applicable temperature water quality standards, considering baseline water temperatures (that are below the standards) and the EED's predicted loss of some colder groundwater inputs to Crooked Creek due to planned pit-dewatering. A detailed quantitative analysis was not performed for the EED or the FEIS to define the magnitude and frequency of potential temperature changes in Crooked Creek. As a result of the Section 401 certification appeal which is focused, in part, on this issue, BGC Engineering Inc. (BGC, May 18, 2021) was requested by Donlin Gold to complete a quantitative analysis to further define potential changes in Crooked Creek stream temperatures that may occur because of the proposed Project. Results of that analysis and the methodology used by BGC are provided herein.

[1] FEIS, page 3.13-101.

2. BACKGROUND

2.1. Study Area

The intent of the analysis is to estimate the potential change in stream temperature during operations as a result of reduced surface and subsurface (i.e., groundwater) inflows to Crooked Creek. The watersheds for two Crooked Creek tributaries – American Creek and Anaconda Creek – will be directly impacted by the Project (Figure 2-1). An open pit and contact water dams will intercept almost all the surface runoff and groundwater flows in American Creek, while a tailings storage facility (TSF) and seepage recovery system (SRS) will collect surface and groundwater flows from about 75% of the Anaconda Creek watershed.

Groundwater modelling also indicates that water will be removed from Crooked Creek by the pit dewatering system with the maximum occurring at around year 20 of operations, when maximum pit drawdown occurs (BGC, July 18, 2014; BGC, May 6, 2016). In the valley bottom of Crooked Creek, surface flows are conveyed in the Crooked Creek channel. Flows are also conveyed sub-surface in the alluvial sediments that mantle the valley bottom, a region that is referred to as the hyporheic zone. The hyporheic zone is the region of sediment and porous space beneath and alongside a stream bed, where there is mixing of shallow groundwater and surface water (Figure 2-2).

There are two important attributes of the hyporheic zone. First, water in the channel moves at a much faster rate compared to the hyporheic zone. Second, stream water enters the hyporheic zone temporarily, but eventually the stream water re-enters the surface channel or contributes to groundwater storage. The rate of hyporheic exchange is influenced by streambed structure, with shorter water flow paths created by streambed roughness. Longer flow paths are induced by geomorphic features, such as stream meander patterns, pool-riffle sequences, large woody debris dams, and other features.

The hyporheic zone and its interactions influence the volume of stream water that is moved downstream. Gaining reaches indicate that groundwater is discharged into the stream as water moves downstream, so that the volume of water in the main channel increases from upstream to downstream. Conversely, when surface water infiltrates into the groundwater zone (thereby resulting in a net loss of surface water), then that stream reach is considered to be "losing" water. A particular segment of a stream may be "gaining" or "losing" at different periods of the year, e.g., during the freshet or in July when stream temperatures are highest.

As shown in Figure 2-3, the pit dewatering system will draw down the surrounding water table. That drawdown includes the water table in the valley bottom of Crooked Creek, resulting in the removal of some water from the saturated alluvial sediments in the Crooked Creek valley bottom (i.e., the hyporheic zone).

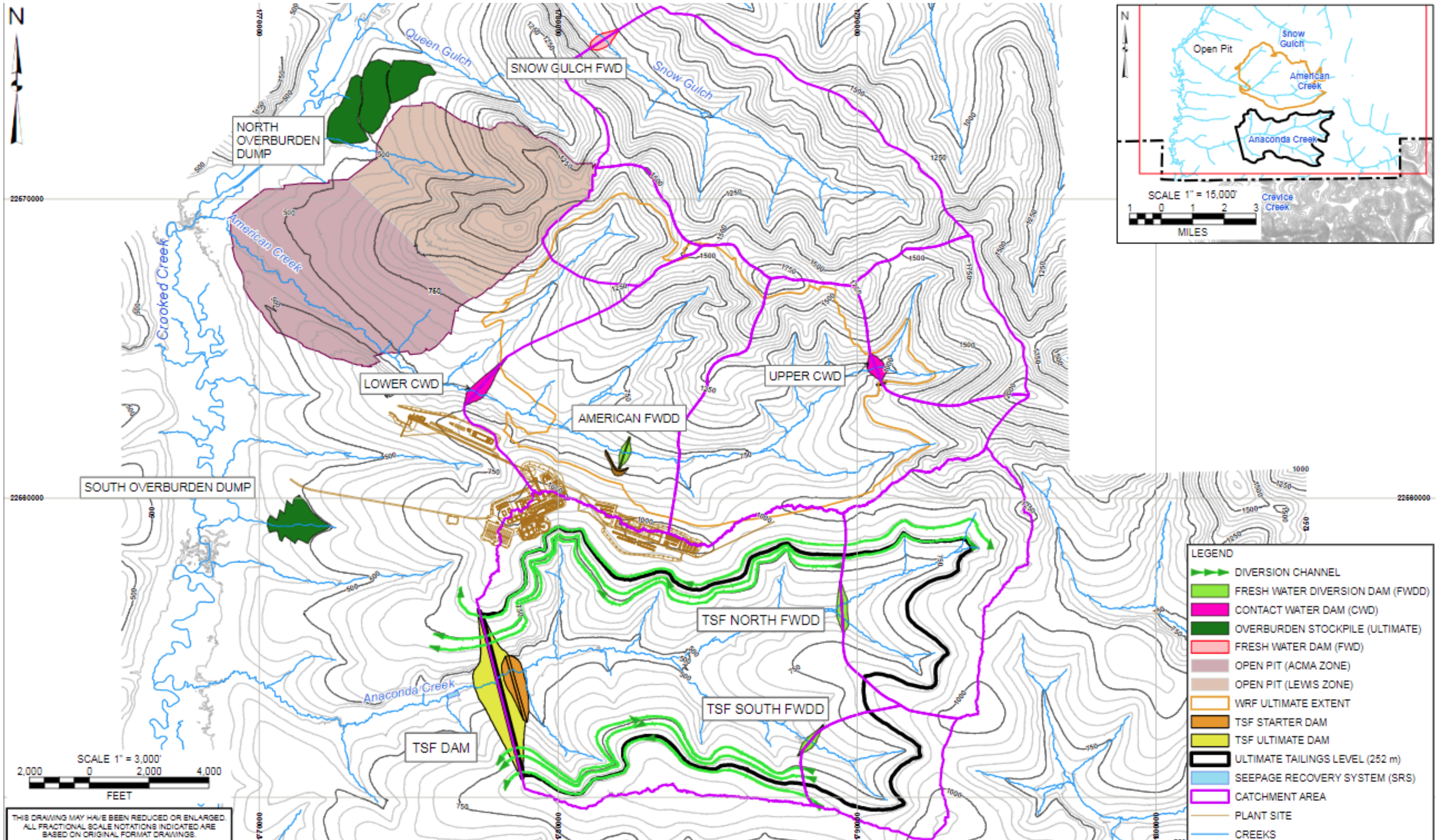

Figure 2-1. Proposed mine water management overview.

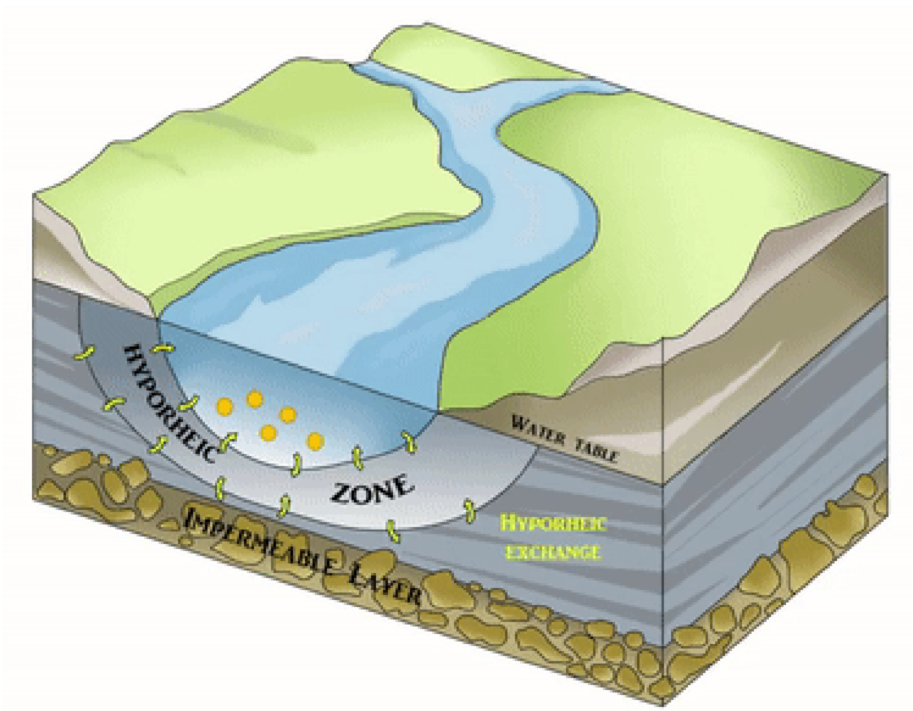

Figure 2-2. Schematic of hyporheic zone (https://commons.wikimedia.org/w/index.php?curid=91553685).

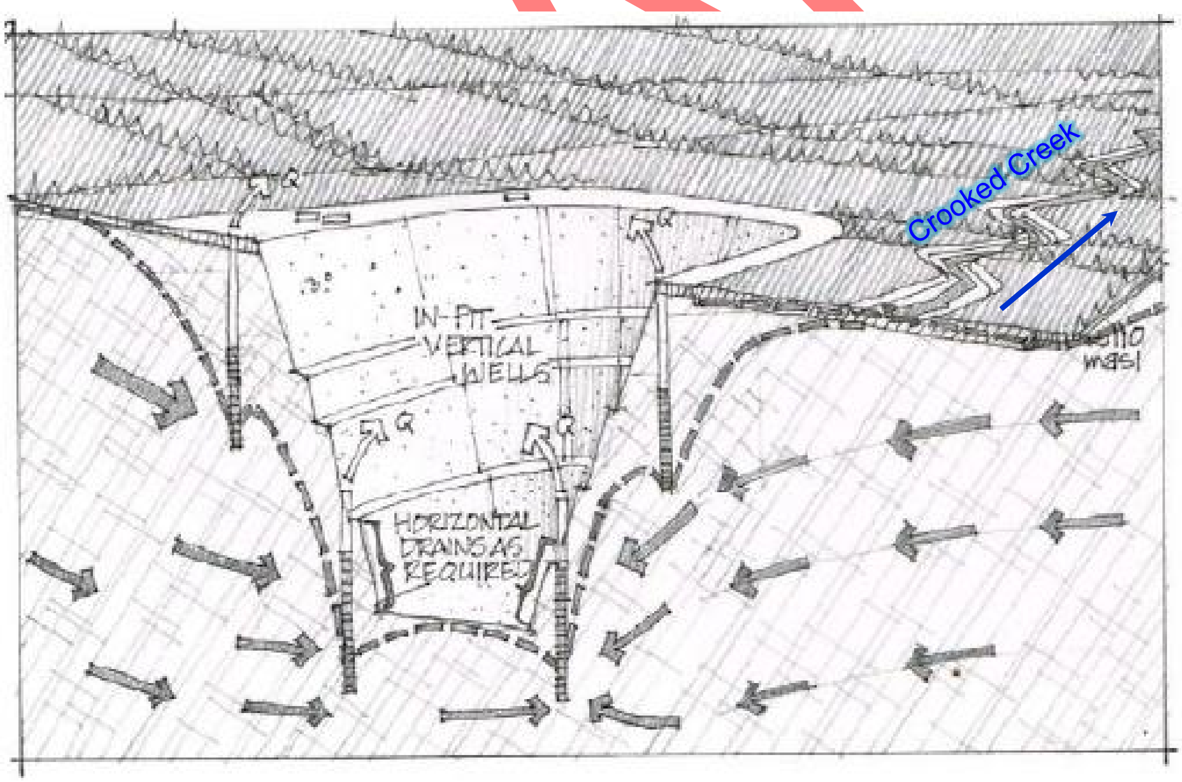

Figure 2-3. Schematic showing conceptual drawdown of water table around the proposed open pit in American Creek (BGC, July 18, 2014).

2.2. Available Data

As part of baseline studies for the Project, streamflow was continuously measured at several hydrometric stations, as illustrated on Figure 2-4. A full description of these stations and available data is provided in BGC (June 14, 2012). For the purposes of this analysis, the key stations are those located on Crooked Creek above Crevice Creek (CCAC), American Creek (AMER), and Anaconda Creek (ANDA). At these stations, a level logger measured water level (which was converted to streamflow discharge using rating curves) and water temperature every 30 minutes, during the open water season (typically early June to late September). These stations have overlapping flow monitoring data for 2005-2009 and 2011[2]. Figure 2-5 shows daily average stream temperature measured at CCAC for the period 2005-2011.

Figure 2-5 demonstrates that stream temperatures in 2005 were much warmer compared to other years. A similar trend is observed in the AMER and ANDA records (Figure 2-6 and Figure 2-7). This trend is consistent with air temperatures recorded at the Camp Station weather station, the location of which is shown on Figure 2-4. For the period 2006-2010, the average May-September air temperature recorded at Camp Station was 51.4°F compared to 58.3°F in 2005. These figures demonstrate that the maximum monthly stream temperatures noted in the EED and FEIS text (i.e., June, July, and August temperatures of 45.8°F, 51.6°F, and 50.1°F) are based on the 2005 CCAC records.

To estimate the magnitude of potential temperature increases, BGC first modeled the 2005 conditions with Project impacts, as this dataset represents the warmest period of Crooked Creek stream temperatures within the available record. The analysis also focused on July and August, as stream temperatures are highest in these months. However, all other years with concurrent records were also modelled by BGC.

The daily streamflow and stream temperature data used in the analysis are provided in Appendix A. The available data were collected at 30-minute intervals but averaged on a daily basis for the analysis.

2 Continuous flow monitoring was discontinued at all stations in 2011 because sufficient baseline data were collected to support the EIS and permitting processes.

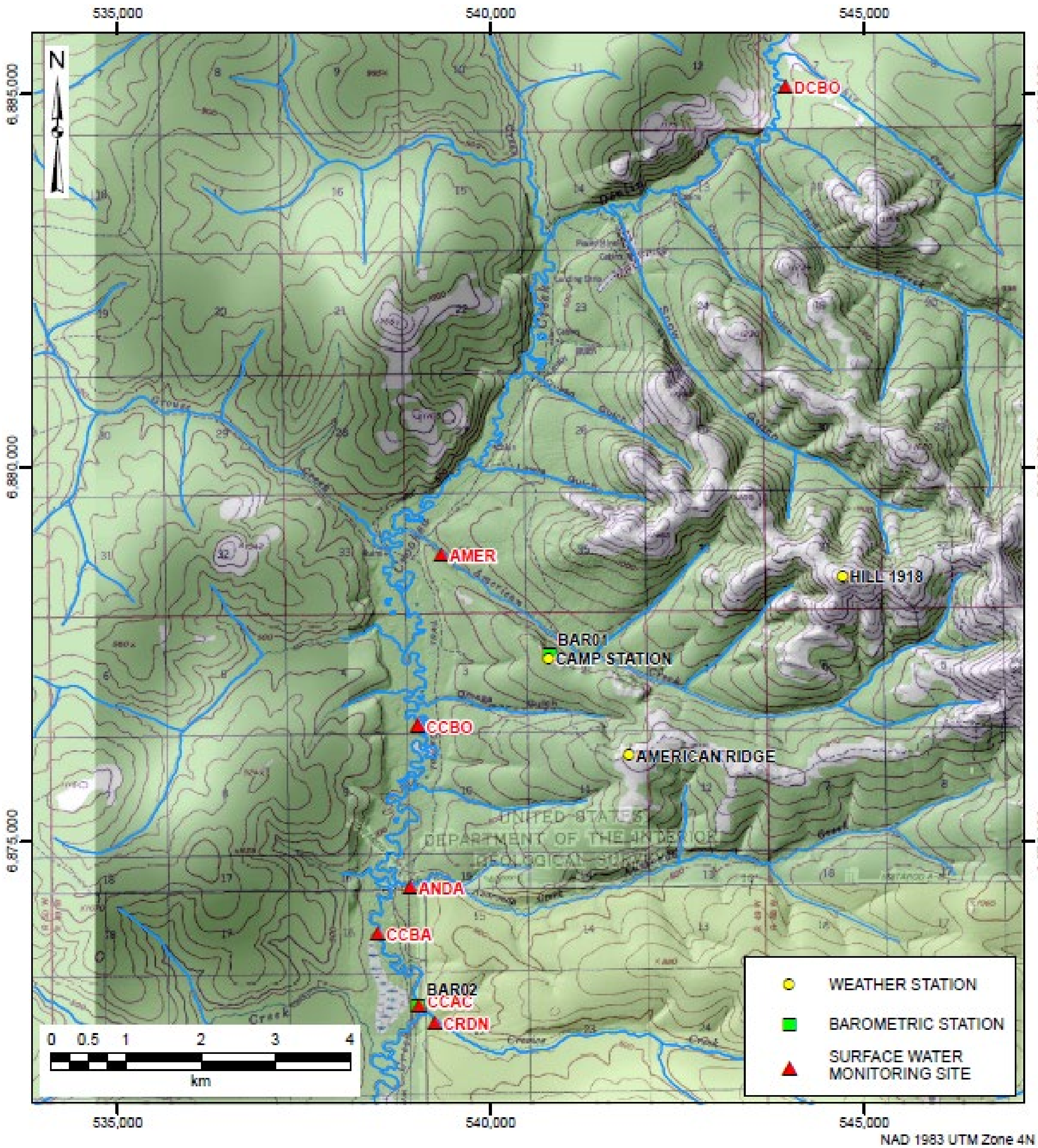

Figure 2-4. Donlin Gold climate and hydrometric stations.

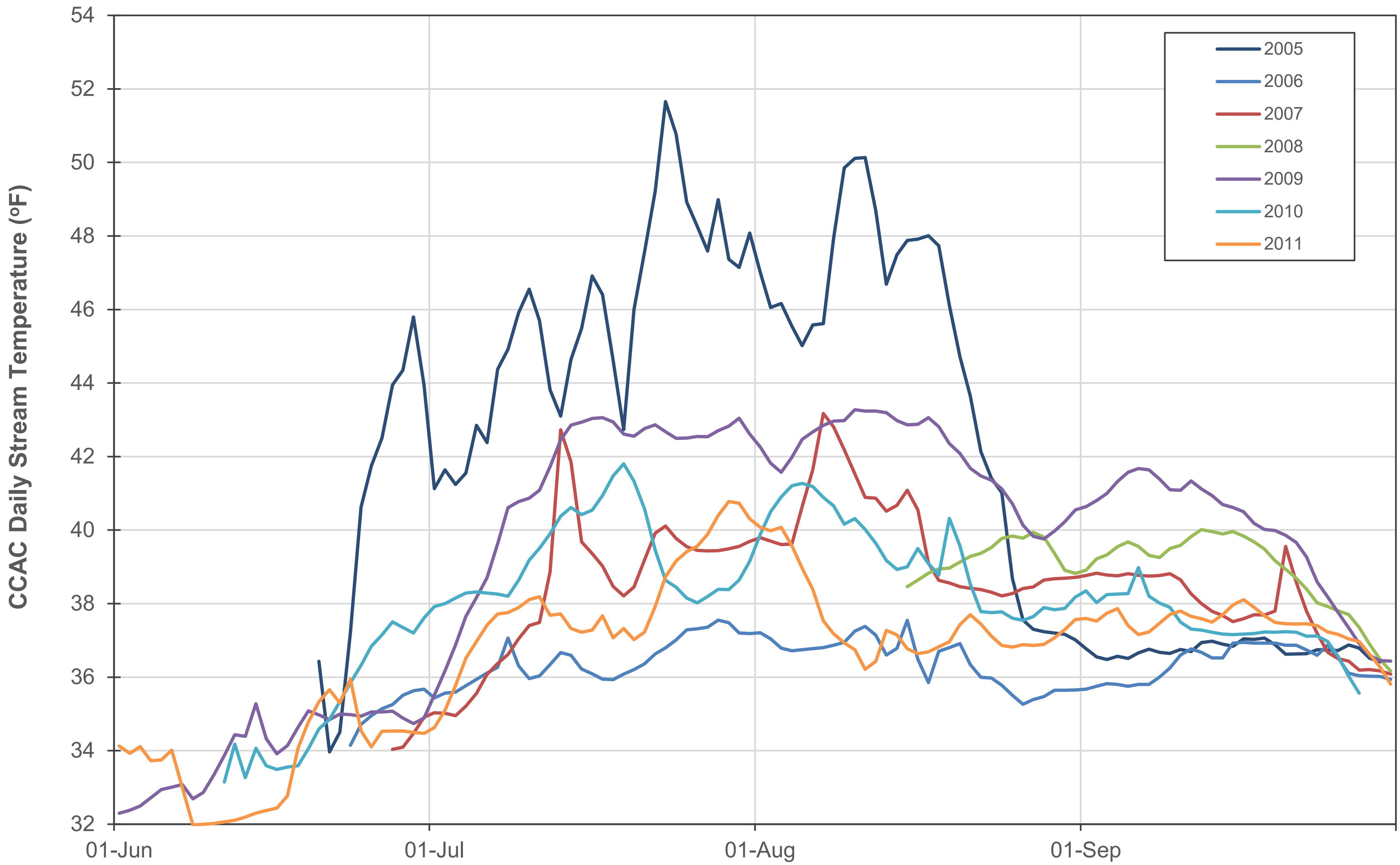

Figure 2-5. Crooked Creek daily stream temperature at CCAC for the period 2005-2011.

Figure 2-6. American Creek daily stream temperature at AMER for the period 2005-2011. No flows or stream temperature were measured in 2010 at this station.

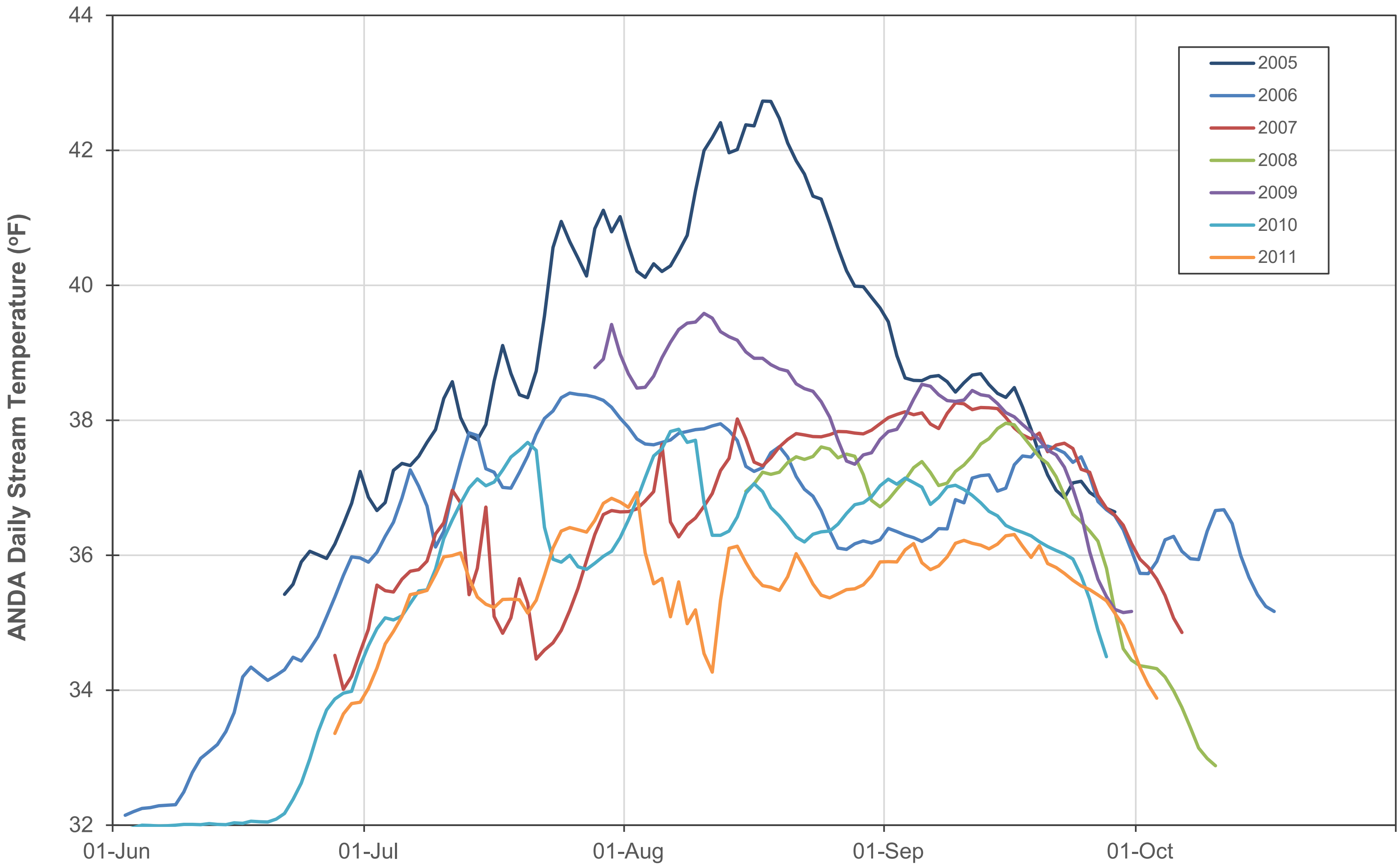

Figure 2-7. Anaconda Creek daily stream temperature at ANDA for the period 2005-2011.

3. ANALYSIS

3.1. Model Framework

Figure 3-1 shows the modelling framework adopted for the analysis. The green dots represent the three streamflow gages where both discharges and stream temperatures are known: CCAC, AMER, and ANDA. The orange dots represent the modelled nodes. Table 3-1 summarizes the drainage areas at each of the nodes for baseline and end of mine life Project conditions.

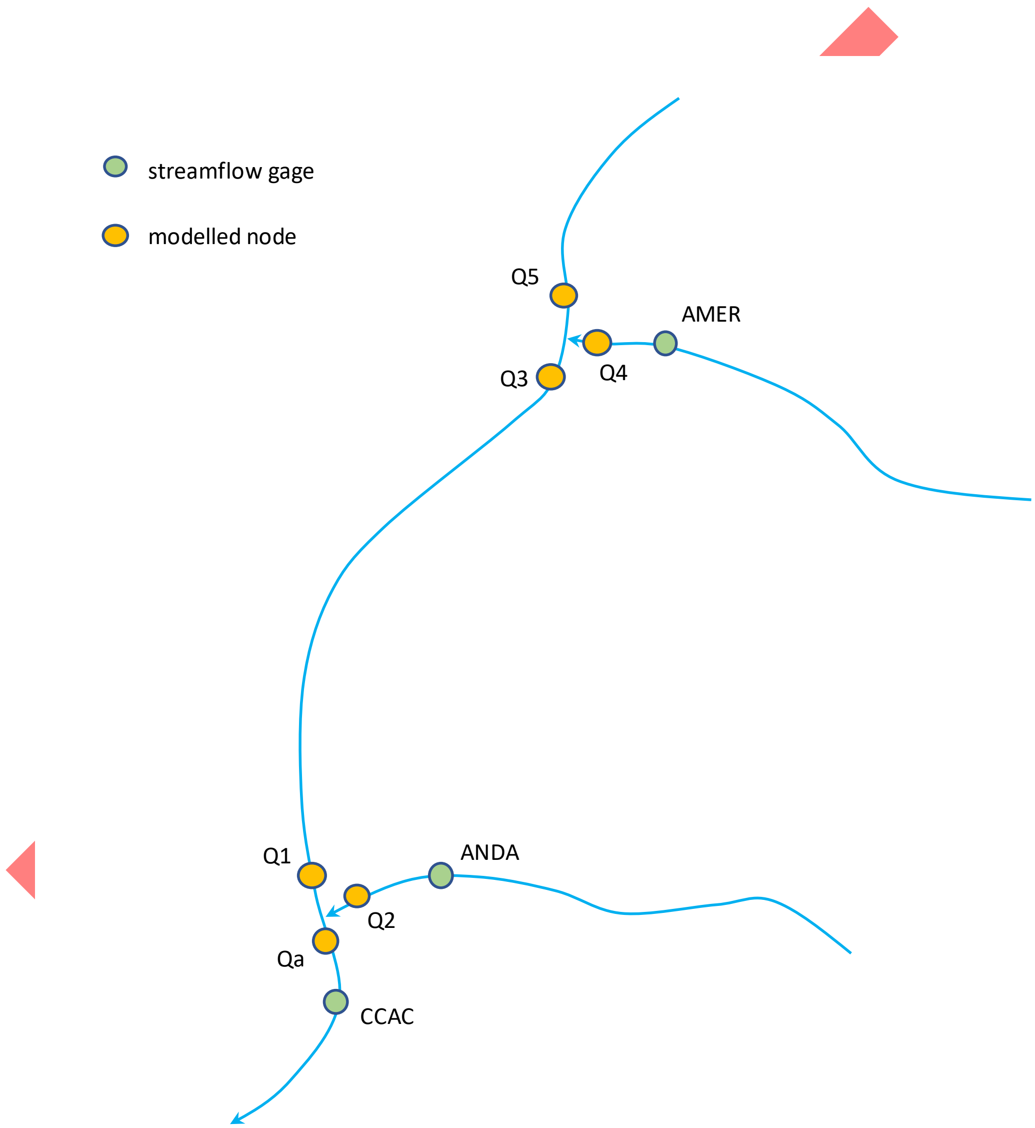

Figure 3-1. Modelling framework.

Table 3-1. Drainage areas at streamflow gages and modelled nodes.

Node	Name	Drainage Area (sq. mi.)	
		Baseline	Project Impacted
CCAC	Crooked Creek above Crevice Creek	111.9	97.8
Q_a	Crooked Creek at Anaconda Creek	108.0	94.0
Q_1	Crooked Creek above Anaconda Creek	100.3	92.3
Q_2	Anaconda Creek at Crooked Creek	7.7	1.7
ANDA	Anaconda Creek	7.6	-
Q_3	Crooked Creek at American Creek	77.5	69.5
Q_4	American Creek at Crooked Creek	8.0	0
AMER	American Creek	6.8	-
Q_5	Crooked Creek above American Creek	69.6	69.6

1. The drainage area of American Creek at the confluence with Crooked Creek is actually 6.9 sq.mi. However, the open pit will extend outside of the American Creek catchment. As a result, the reduction in drainage area at Crooked Creek is modelled as 8.0 sq. mi.

As a first step, daily streamflows at the streamflow gages (CCAC, AMER, ANDA) were adjusted by drainage area to the various model nodes to determine 2005 baseline conditions. For example, daily streamflows at AMER were adjusted to the confluence (Q_4) by multiplying the AMER discharge by the drainage area ratio (8.0/6.8). Next, it was assumed that the stream temperatures measured at the streamflow gages were similar at the nearby confluences (i.e., $T_{CCAC} = T_{Qa}$, $T_{ANDA} = T_{Q2}$, $T_{AMER} = T_{Q4}$). It was also assumed that the stream temperature at Q_1 was equal to that at Q_3.

Daily stream temperatures for 2005 baseline conditions were then calculated for the remaining modelling nodes (Q_5 and Q_1) using the following mixing equation (Bartholow, 2004):

$$T_j = \frac{[Q_1 \cdot T_1 + Q_2 \cdot T_2 + .. Q_n \cdot T_n]}{[Q_1 + Q_2 + \dots Q_n]}$$

where

T_j = temperature below the junction
Q_n = discharge of source n
T_n = temperature of source n

The Project impacts were then evaluated by considering that:

- 6.0 sq. mi. of Anaconda Creek would no longer report to Crooked Creek due to the construction of the TSF and SRS.
- The American Creek drainage (8.0 sq.mi.) would no longer report to Crooked Creek due to the excavation of the open pit and the collection of contact water in the Lower Contact Water Dam.
- The dewatering wells would remove an estimated 0.79 cfs from the hyporheic zone of Crooked Creek. This flow was derived from the integrated ground and surface water flow

models that were subject to expert review during the EIS process. (see BGC, October 12, 2016).

So, for example, if the streamflow and stream temperature on a given day in American Creek was 2 cfs and 40°F, then the flow and temperature in Crooked Creek was adjusted by removing a stream flow of 2 cfs with a temperature of 40°F.

It was assumed that the temperature of the water lost from the hyporheic zone of Crooked Creek due to the dewatering wells (0.79 cfs) would have a temperature of 35.6°F, which is the average groundwater temperature measured in the wells and vibrating wire piezometers installed near to and east of the Project. This temperature reflects data collected in a network of 40 groundwater monitoring locations over a variable period extending from June 2007 to March 2014. Groundwater temperatures fluctuate over a narrower range than surface water (typically less than 3°F at each well) because they are not exposed to transient warming influences from seasonal ambient air temperature and solar radiation. Crooked Creek water directly removed by the dewatering wells would be captured mainly from the hyporheic zone, which is expected to have a temperature similar to or slightly cooler than that of the creek (e.g., Malard, Tockner, Dole-Olivier, & Ward, 2002). In general, hyporheic temperatures are highly dynamic both spatially and temporally, due to the interaction between in-stream flow regime, groundwater table, in-stream water temperature, and hyporheic exchange (Marzadri, Tonina, & Bellin, 2013). By conservatively assigning the colder average annual groundwater temperature to the Crooked Creek water removed by the dewatering wells, the effects of these complex interactions are ignored.

Implicit in this analysis is that the recorded flows at all three gages represent a combination of surface runoff and groundwater inflows. Therefore, the losses of groundwater contributions to Crooked Creek from the American and Anaconda creek drainages are assumed to be captured by the removal of total streamflows for these creeks.

An example calculation is provided in Appendix B.

3.2. 2005 Data Analysis

3.2.1. Data

Figure 3-2 and Figure 3-3 show the average daily stream temperature and discharge measured at CCAC, AMER and ANDA for the months of July and August 2005. Of note is that stream temperatures at ANDA are notably cooler than those at AMER. This difference is interpreted as a greater percentage of inflow at ANDA being contributed by groundwater, which is consistent with the watershed topography – Anaconda Creek has a more subdued topography than American Creek, which is more conducive to slower runoff processes.

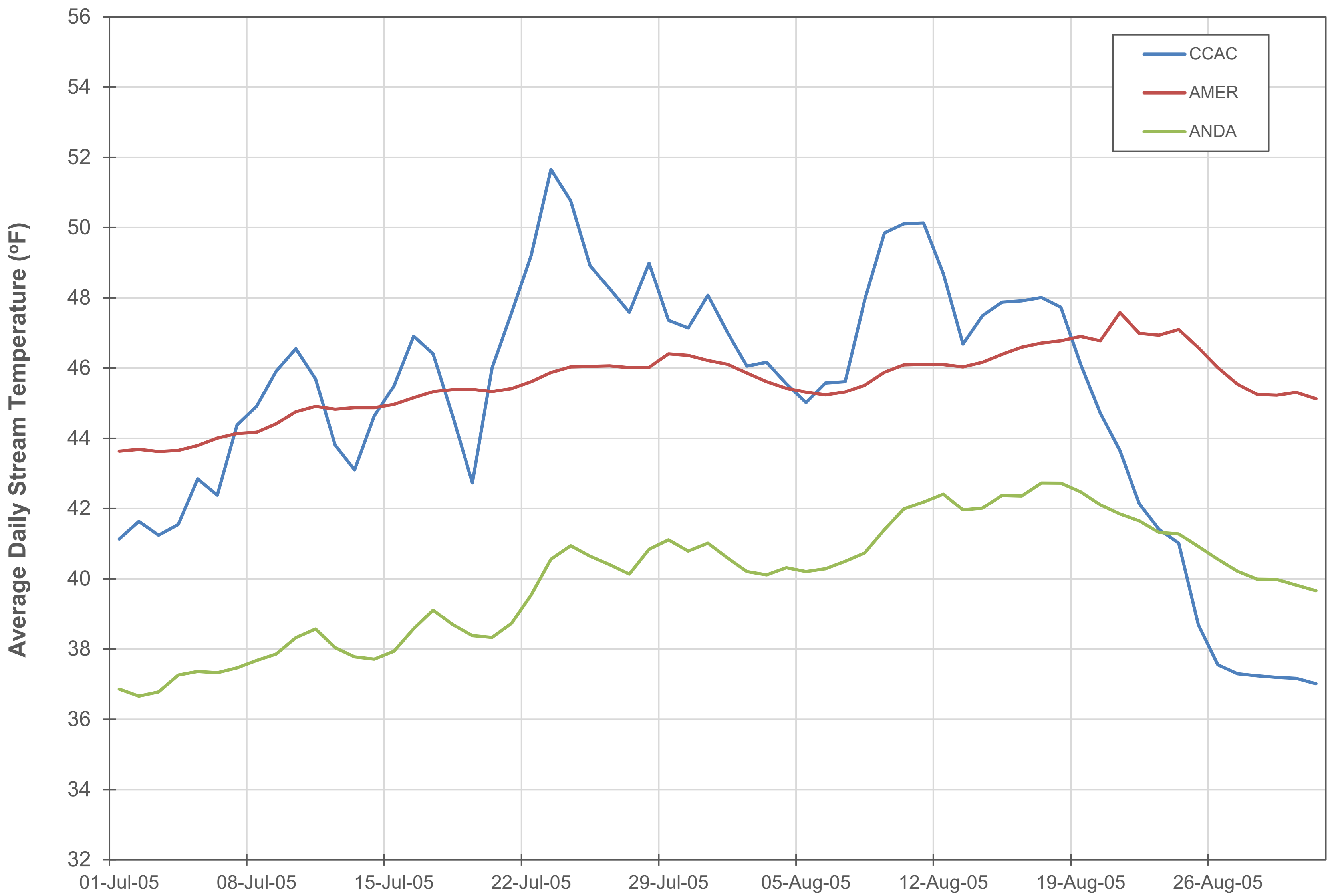

Figure 3-2. Average daily stream temperature at CCAC, AMER and ANDA for July and August 2005.

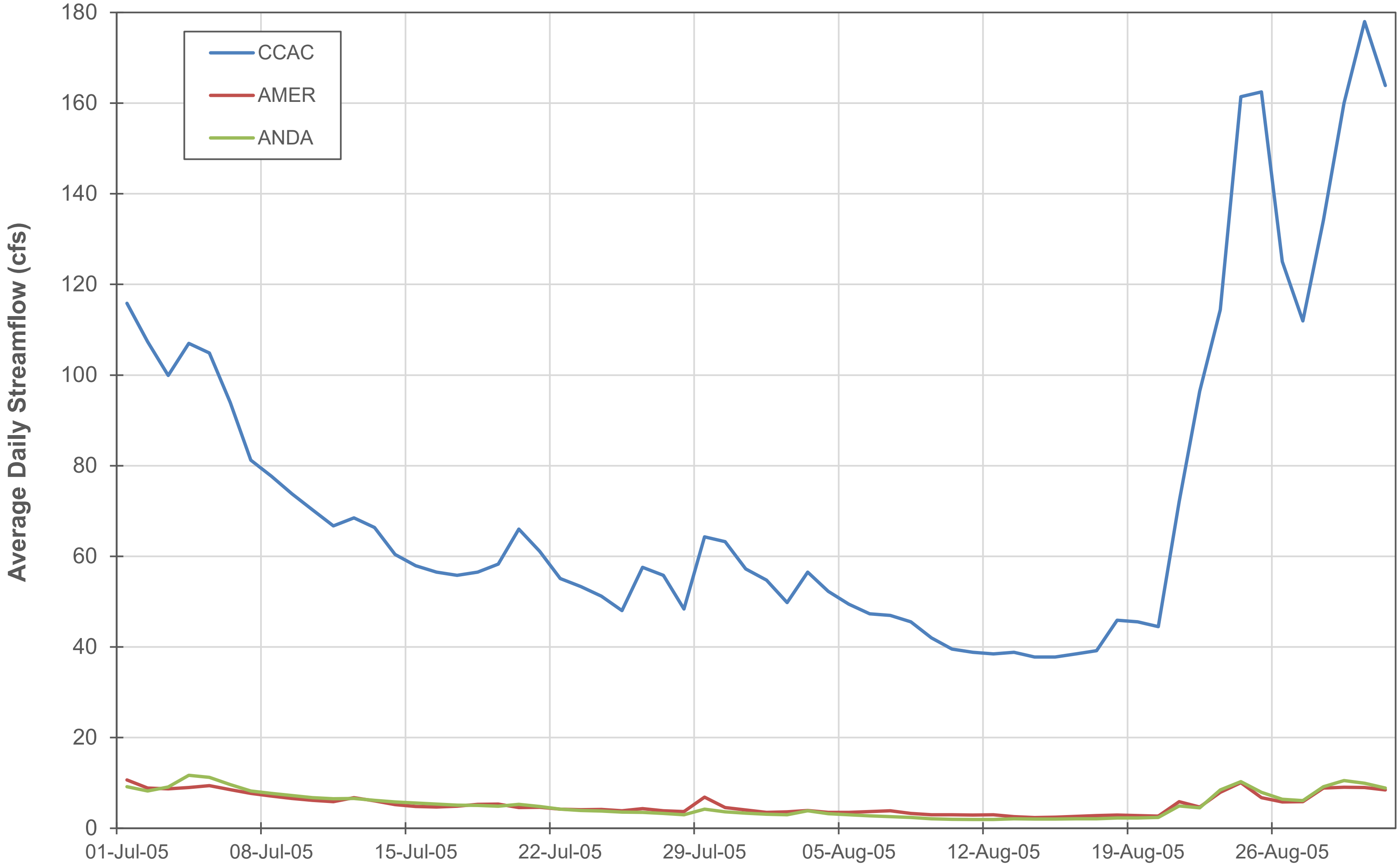

Figure 3-3. Average daily discharge at CCAC, AMER and ANDA for July and August 2005.

3.2.2. Results

The results of the analysis are presented in Figure 3-4 for node Q_3 (Crooked Creek at American). These results indicate that the maximum July 2005 stream temperature is predicted to increase from 52.6°F to 54.8°F, while the maximum August 2005 stream temperature is predicted to increase from 50.6°F to 52.7°F. Under baseline conditions, slightly warmer stream temperatures are calculated at Q_3 relative to CCAC as the modelling node is located upstream of Anaconda Creek, which has colder stream temperatures compared to American Creek and Crevice Creek.

The results of the analysis are presented in Figure 3-5 for node CCAC. These model results indicate that the maximum July 2005 stream temperature is predicted to increase from 51.7°F to 54.5°F, while the maximum August 2005 stream temperature is predicted to increase from 50.1°F to 52.5°F.

Using the warmest year in the available record of continuous monitoring (i.e., 2005), the predicted increases in Crooked Creek stream temperatures would remain below the State of Alaska's water quality temperature standards of 55.4°F for egg/fry incubation and spawning areas and 59.0°F for migration routes and rearing areas (Department of Environmental Conservation, March 5, 2020). In fact, for most of the time during 2005, the values would be well below the most restrictive standard (55.4°F).

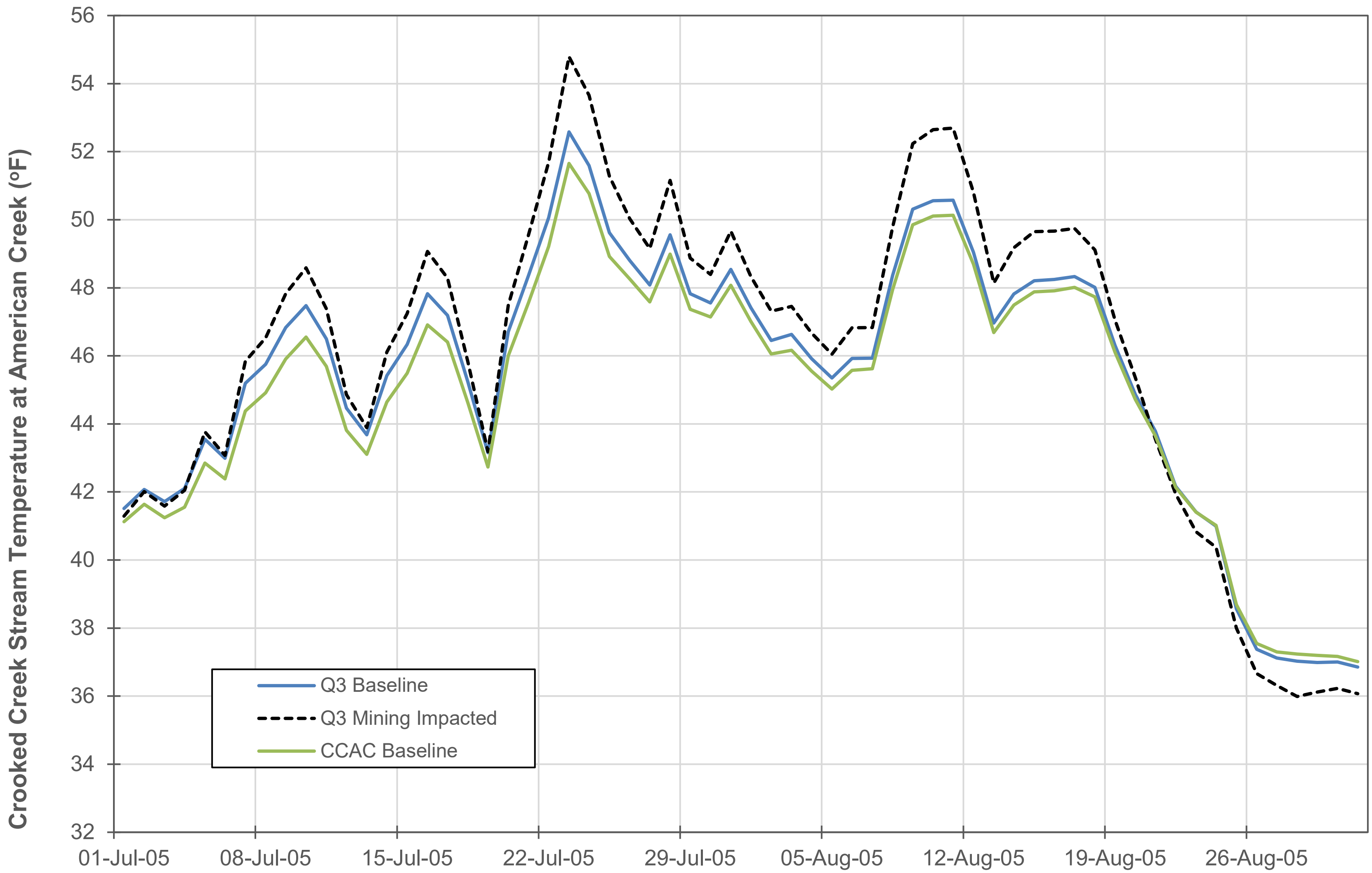

Figure 3-4. Modelled stream temperature at modelling node Q_3 (Crooked Creek at American) for baseline and mining conditions in July and August 2005.

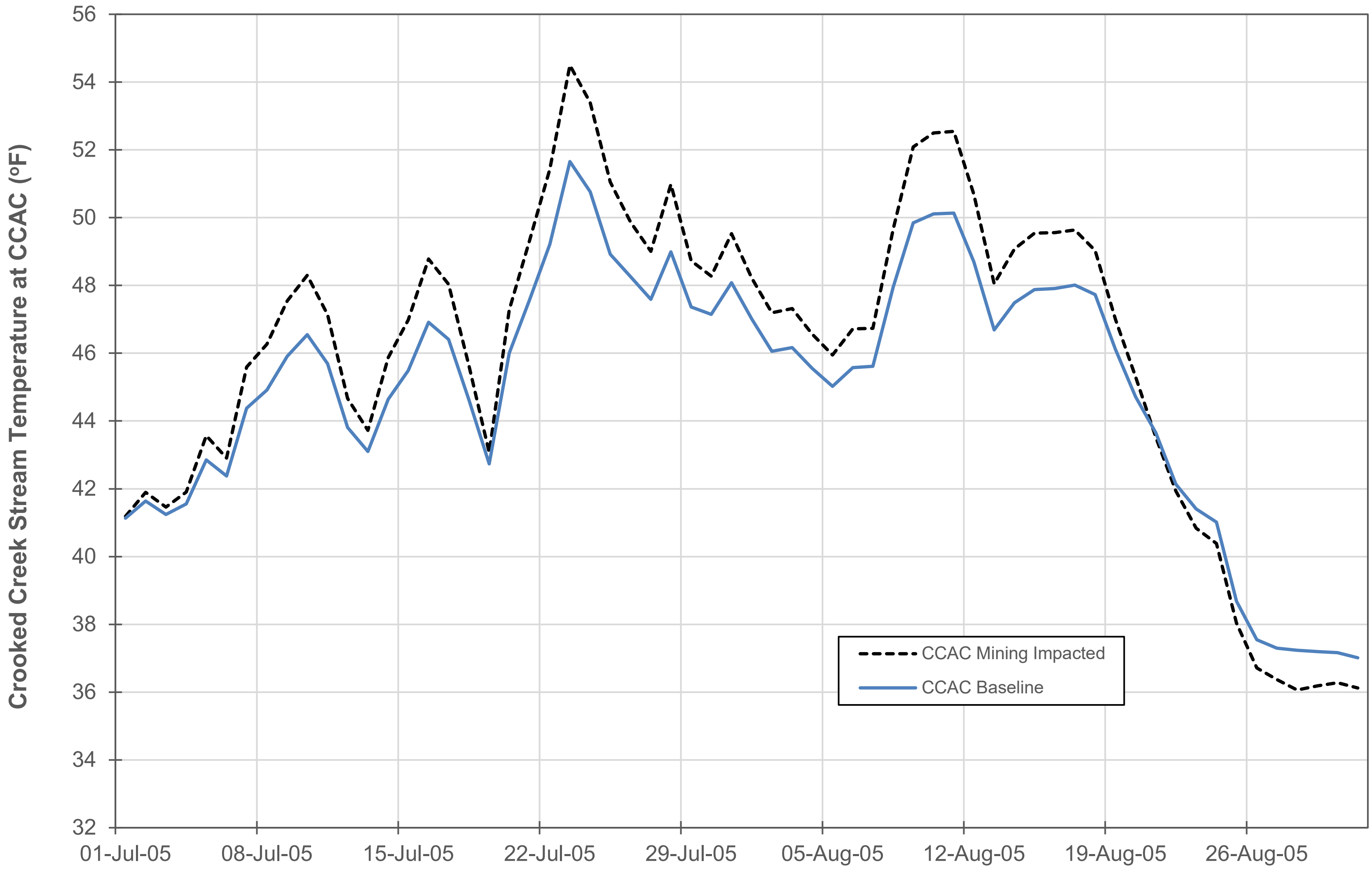

Figure 3-5. Modelled stream temperature at modelling node CCAC for baseline and mining conditions in July and August 2005.

3.2.3. Potential Temperature Effects of Treated Water

Under average precipitation conditions, the Project is expected to operate with a water surplus (BGC, December 7, 2016). Therefore, Donlin will generally treat and discharge contact water to Crooked Creek during late spring through early fall – this discharge is authorized under an Alaska Pollutant Discharge Elimination System (APDES) permit. The discharge to Crooked Creek would be between American Creek and Anaconda Creek. The contact water would be initially treated with a high-rate clarifier (HRC) and greensand filter, followed by reverse osmosis (RO) as required (Hatch, May 8, 2015). During operations, the average monthly treatment and discharge rate is predicted to be 2,370 gallons per minute (gpm, 5.3 cfs) in July and 2,644 gpm (5.9 cfs) in August (BGC, December 7, 2016).

This treated water is expected to have a water temperature that is well below 55.4°F, as a majority of the water to be treated will be sourced from the pit dewatering activities and subsurface flows collected in the TSF Seepage Recovery System (BGC, December 7, 2016). Nonetheless, a sensitivity analysis was conducted by accounting for the introduction of treated water with an assumed temperature of 55.4°F. The exercise was conducted using the 2005 data: introducing 5.3 cfs of treated 55.4°F water to Crooked Creek in July and 5.9 cfs in August. The results of the analysis are provided in Figure 3-6. Slightly warmer temperatures are modelled with the addition of treated water, but maximum stream temperatures remain below the State of Alaska's water quality temperature standards of 55.4°F for egg/fry incubation and spawning areas and 59.0°F for migration routes and rearing areas.

As a further sensitivity, BGC assumed that the treated water had a temperature of 40ºF, which is more consistent with the expected temperature of the discharge given the source waters and that the treatment plant should not cause significant warming. Results of this sensitivity run are provided in Figure 3-7 and show that the modelled increase in temperature is reduced with the addition of cooler treated water. This result suggests that ensuring the treated water is relatively cool could act as a potential mitigation strategy if warmer than predicted temperatures are observed.

3.3. Other Years

The calculations completed for 2005 were repeated for 2006, 2007, 2009, and 2011. The analysis could not be completed for 2008 due to limited data at CCAC (Figure 2-5) or 2010 due to a lack of data at AMER (Figure 2-6).

Plots showing modelled stream temperature at modelling nodes Q_3 (Crooked Creek at American) and CCAC for baseline and Project conditions are provided in Appendix C for years 2006, 2007, 2009, and 2011. Those plots show that predicted increases in Crooked Creek stream temperatures would remain below the State of Alaska's most restrictive water quality temperature standard of 55.4°F for egg/fry incubation and spawning areas. This result is expected given that for the period 2006-2011 the stream baseline temperatures were consistently below those observed in 2005 (see Figure 2-2).

The plots provided in Appendix C show that stream temperatures in Crooked Creek are predicted to decrease for some periods. These instances arise when the monitored stream temperatures in American Creek and Anaconda Creek are higher than those in Crooked Creek (e.g., 2006).

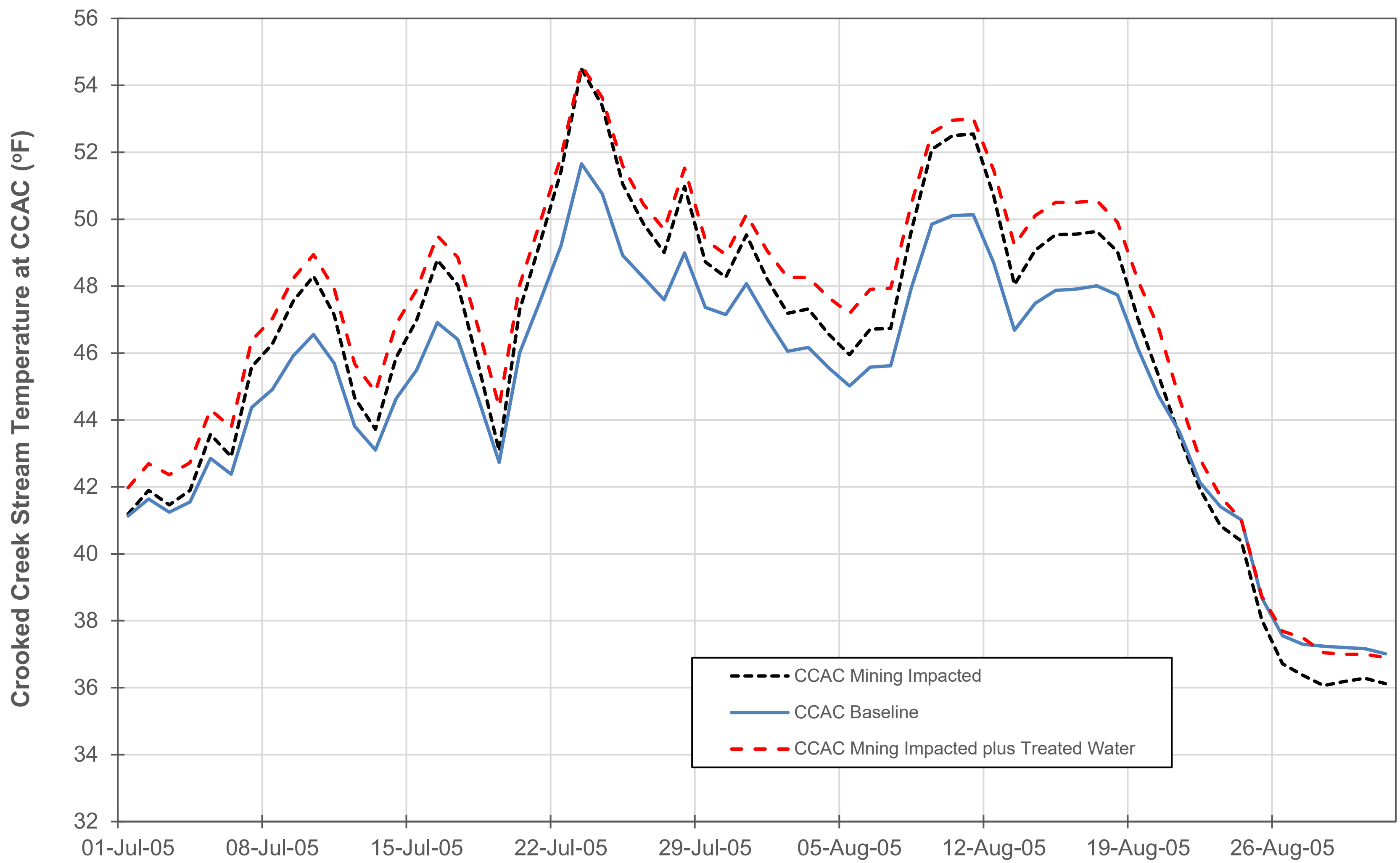

Figure 3-6. Modelled stream temperature at modelling node CCAC for baseline and mining conditions in July and August 2005. Two mining conditions are shown, one where the addition of treated water is neglected and the other where it is included at 55ºF.

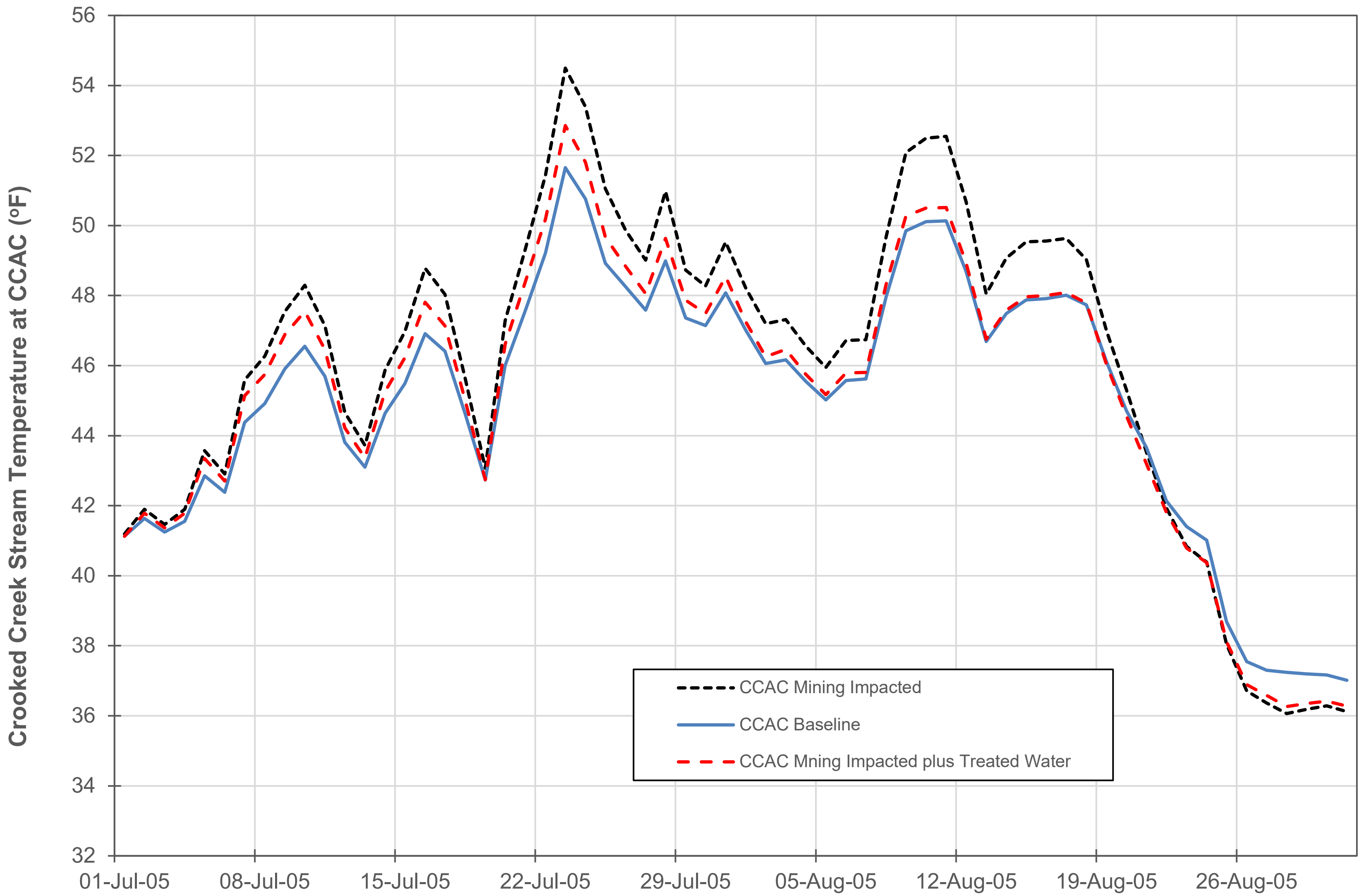

Figure 3-7. Modelled stream temperature at modelling node CCAC for baseline and mining conditions in July and August 2005. Two mining conditions are shown, one where the addition of treated water is neglected and the other where it is included at 40ºF.

4. LIMITATIONS

Modelling stream temperatures can be a complex undertaking. As noted by Benyahya, Caissie, St-Hilaire, Ouarda and Bobée (2007):

> "The thermal regime of rivers is affected by heat exchanges in which both meteorological factors and physical factors and physical characteristics are important. Meteorological factors affecting the temporal variability of energy exchanges include the annual cycle of incoming solar radiation as well as short-term conditions of wind speed, humidity and air temperature among others. The natural processes of heating and cooling highly depend on meteorological conditions as well as stream physical and hydrological characteristics. Stream characteristics affecting energy exchange include riparian vegetation (especially in small streams), stream aspect, channel geomorphology, valley topography, location of tributaries and groundwater inflows."

The analysis adopted by BGC did not account for all these factors. Other factors not considered in the analysis include:

- Losing and gaining reaches, where the volume of hyporheic flow varies along the creek.
- The potential removal of riparian vegetation along Crooked Creek due to the proposed Project. This factor is not considered significant because there are no plans for the riparian zone of Crooked Creek to be disturbed, except for one bridge crossing.

5. SUMMARY AND CONCLUSIONS

BGC was retained by Donlin Gold to assess potential changes in Crooked Creek stream temperatures that may occur because of the proposed Donlin Gold Project. The Project will intercept surface and groundwater flows from the American Creek and Anaconda Creek tributary drainages. There will also be a loss of flows in Crooked Creek due to pit dewatering. Concerns have been raised that the interception of these flows will cause increases in Crooked Creek stream temperature that could cause exceedances of Alaska water quality standards.

Seasonal discharge and stream temperature data are available for the period 2005-2011 in Crooked Creek, American Creek, and Anaconda Creek at stations CCAC, AMER, and ANDA. Using these data and dilution mixing equations, BGC evaluated the potential impact of the Project on stream temperatures in Crooked Creek at various locations.

For the period 2005-2011, the highest stream temperatures in Crooked Creek were observed in 2005. Model results for this year can be summarized as follows:

- At node Q_3 (Crooked Creek at American), the maximum July 2005 stream temperature would have increased from 52.6°F to 54.8°F, while the maximum August 2005 stream temperature would have increased from 50.6°F to 52.7°F.
- At node CCAC, the maximum July 2005 stream temperature would have increased from 51.7°F to 54.5°F, while the maximum August 2005 stream temperature would have increased from 50.1°F to 52.5°F.

These predicted increases indicate that Crooked Creek stream temperatures would remain below Alaska's lowest water quality temperature standard of 55.4°F for egg/fry incubation and spawning areas. A similar conclusion was reached for the other years with available stream flow and temperature data. The small, modelled increases in Crooked Creek stream temperature are consistent with the relatively small magnitude of both flows in American Creek and Anaconda Creek (that would be cutoff because of the Project) and Crooked Creek flows that would be potentially removed by the dewatering wells (Figure 3-3).

Finally, a sensitivity analysis in which the effect of treated water discharges from the project on Crooked Creek stream temperatures, in which the treated water was assumed to have a temperature of 40°F, shows that the modelled increase in Crooked Creek temperature is reduced with the addition of cooler treated water (Figure 3-7). This result indicates that ensuring the treated water is relatively cool could act as a potential mitigation strategy if warmer than predicted temperatures are observed in Crooked Creek during operations.

6. CLOSURE

We trust the above satisfies your requirements at this time. Should you have any questions or comments, please do not hesitate to contact us.

Yours sincerely,

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per:

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Principal Hydrologist

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Principal Hydrogeological Engineer

HW/TC/sf/

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APPENDIX A
DAILY STREAMFLOW AND STREAM TEMPERATURE DATA

Table A-1. Daily stream temperature and flow data at American Creek (AMER).

	Temperature (°F)							Discharge (cfs)						
	2005	2006	2007	2008	2009	2010	2011	2005	2006	2007	2008	2009	2010	2011
01-Jun										7.5		13.0		
02-Jun										7.0		12.1		
03-Jun									20.9	22.9		10.6		
04-Jun					36.6				19.2	14.2		10.2		
05-Jun					37.2				17.5			9.9		
06-Jun					37.4				16.3	11.2		9.2		
07-Jun					37.6				15.6	8.5		8.5		
08-Jun					37.8				14.4	9.7		7.6		
09-Jun					38.2				13.6	9.1		7.2		
10-Jun					38.8				13.0	9.1		6.8		
11-Jun					39.2				12.2			6.1		
12-Jun					39.8				12.1			7.0		
13-Jun					41.2				11.4			15.3		
14-Jun					41.4				10.7			11.5		
15-Jun					41.4				10.1			10.8		
16-Jun					41.2				12.0			10.4		
17-Jun					41.3				12.9	7.4		10.0		
18-Jun					41.5				10.9	6.7		9.4		
19-Jun		41.5			41.6				10.2			8.9		
20-Jun		41.8			41.8				11.0	5.3		9.1		
21-Jun	42.9	41.5			42.0			11.1	10.9			9.5		
22-Jun	41.0	42.1			42.0			12.0	10.4	5.2		9.7		
23-Jun	40.6	42.9			42.0			11.4	9.5			10.1		
24-Jun	40.7	42.6			41.9			10.4	8.9			9.3		
25-Jun	41.0	42.9			42.0			10.3	8.7			9.7		
26-Jun	41.5	43.2			41.8			9.2	8.7			9.0		
27-Jun	42.0	43.7	36.1		41.7			8.3	8.2	8.8		8.3		
28-Jun	42.5	43.7	35.2		41.6			8.2	8.2	6.7		8.1		
29-Jun	43.2	43.4	35.2		41.6			7.5	8.3	5.4		7.3		
30-Jun	43.4	42.6	35.1		41.5			10.2	12.4	5.0		6.7		
01-Jul	43.6	42.9	35.7		41.6		32.7	10.7	9.7	5.3		6.2		6.1
02-Jul	43.7	43.6	36.6		41.9		32.8	8.9	9.2	11.4		5.7		5.6
03-Jul	43.6	43.2	36.8		42.3		32.9	8.7	8.4	8.9		5.4		5.2
04-Jul	43.7	44.3	36.8		42.8		33.1	9.0	7.8	8.4		5.3		5.0
05-Jul	43.8	45.2	36.3		43.2		33.3	9.4	7.2	7.1		5.1		4.8
06-Jul	44.0	44.7	36.4		43.5		33.7	8.5	8.4	7.1		4.6		4.6
07-Jul	44.1	43.7	36.9		44.1		34.2	7.7	11.1	7.1		4.2		4.7
08-Jul	44.2	43.6	37.4		44.6		34.7	7.1	11.6	6.4		4.6		4.6
09-Jul	44.4	44.3	37.4		45.2		35.2	6.6	8.5	7.3		4.4		4.6
10-Jul	44.8	45.1	37.5		45.5		35.6	6.2	7.7	7.2		3.3		4.6
11-Jul	44.9	44.9	38.5		45.5		36.5	5.9	10.9	15.4		2.9		6.4
12-Jul	44.8	44.7	38.8		45.6		37.7	6.7	8.6	13.8		2.6		10.7
13-Jul	44.9	43.6	38.2		45.9		37.8	6.1	8.6	11.3		2.6		7.5
14-Jul	44.9	41.0	38.6		46.3		37.7	5.2	9.1	17.1		2.7		6.4
15-Jul	45.0	40.4	39.6		46.6		37.8	4.8	11.5	22.4		2.7		6.1
16-Jul	45.2	40.2	38.9		46.7		38.0	4.7	14.1	19.9		2.4		5.7
17-Jul	45.3	41.3	38.7		46.7		38.2	4.8	11.7	19.3		2.5		6.4
18-Jul	45.4	42.2	38.8		46.6		38.7	5.3	10.8	18.6		2.9		7.7
19-Jul	45.4	42.1	39.4		46.5		39.0	5.3	10.7	21.4		3.0		7.9
20-Jul	45.3	42.8	40.1		46.5		39.1	4.6	10.0	20.9		2.5		6.2
21-Jul	45.4	43.2	39.5		46.5		39.2	4.6	9.8	17.5		2.3		5.9
22-Jul	45.6	43.2	39.8		46.5		39.7	4.2	9.7	18.2		2.1		5.8
23-Jul	45.9	44.0	39.7		46.5		40.1	4.1	10.5	16.2		2.0		6.0
24-Jul	46.0	43.6	39.6		46.4		40.6	4.1	9.8	14.9		2.1		6.4
25-Jul	46.1	42.9	39.6		46.2		40.9	3.8	10.7	14.1		1.9		6.3
26-Jul	46.1	42.4	39.8		46.1		41.2	4.3	9.9	13.2		2.2		6.3
27-Jul	46.0	42.1	40.2		46.0		41.5	3.9	9.7	12.7		2.0		6.1
28-Jul	46.0	42.1	40.7		45.9		41.9	3.7	9.1	12.3		2.1		6.5
29-Jul	46.4	41.7	41.0		46.0		42.3	6.9	9.9	12.0		2.0		7.3
30-Jul	46.4	41.1	41.3		46.0		42.4	4.6	11.5	12.1		1.4		7.1
31-Jul	46.2	40.8	41.4		46.6		42.4	4.1	11.1	11.8		8.0		7.4
01-Aug	46.1	40.0	41.6		46.3		42.4	3.5	10.6	11.7		4.5		7.7
02-Aug	45.9	40.6	41.6		45.9		42.8	3.6	11.3	11.1		3.5		15.6
03-Aug	45.6	40.6	41.7		45.6		43.1	3.9	11.0	11.0		3.2		12.1
04-Aug	45.4	40.9	42.2		45.5		43.4	3.5	11.0	11.7		2.9		15.0
05-Aug	45.3	41.2	43.9		45.7		43.1	3.5	14.1	19.1		3.2		14.7
06-Aug	45.2	41.5	43.6		45.9		42.7	3.7	11.8	17.2		3.5		14.3
07-Aug	45.3	40.9	42.7		46.0		42.5	3.8	11.8	15.9		2.9		17.8
08-Aug	45.5	40.9	42.4		46.1		42.0	3.3	11.4	16.2		2.9		18.1
09-Aug	45.9	41.1	42.2		46.1		40.9	3.0	11.6	16.0		2.8		22.1
10-Aug	46.1	41.5	42.2		46.1		40.5	3.0	16.8	15.7		2.5		19.1
11-Aug	46.1	41.3	42.1		46.0		40.2	2.9	18.1	15.5		2.3		19.0

Table A-1. Daily stream temperature and flow data at American Creek (AMER).

	Temperature (°F)						
	2005	2006	2007	2008	2009	2010	2011
12-Aug	46.1	40.4	42.7		45.8		41.2
13-Aug	46.0	39.6	42.7		45.7		40.7
14-Aug	46.2	40.4	43.6		45.6		39.9
15-Aug	46.4	40.4	43.5	43.3	45.8		39.5
16-Aug	46.6	40.2	43.3	43.5	46.0		39.2
17-Aug	46.7	39.0	43.2	44.3	45.9		39.1
18-Aug	46.8	40.6	43.1	44.4	45.5		39.3
19-Aug	46.9	38.0	43.0	44.2	45.1		39.5
20-Aug	46.8	36.7	43.0	44.2	44.8		40.1
21-Aug	47.6	36.7	43.1	44.3	44.6		40.7
22-Aug	47.0	38.1	43.1	44.2	44.3		40.7
23-Aug	46.9	38.1	43.0	44.1	44.2		40.6
24-Aug	47.1	38.0	42.9	44.1	44.1		40.4
25-Aug	46.6	37.5	42.8	44.0	43.7		40.4
26-Aug	46.0	38.6	42.8	43.7	43.3		40.6
27-Aug	45.5	39.1	42.8	43.6	42.8		40.6
28-Aug	45.2	38.9	42.8	43.6	42.4		40.6
29-Aug	45.2	38.8	42.8	43.3	42.3		40.7
30-Aug	45.3	38.6	42.9	42.9	42.1		40.8
31-Aug	45.1	39.7	42.9	42.6	42.1		41.2
01-Sep	44.9	38.6	43.2	42.6	42.2		41.4
02-Sep	44.3	38.2	43.2	42.6	42.4		41.4
03-Sep	43.6	38.2	43.3	42.7	42.5		41.8
04-Sep	43.3	38.0	43.2	42.8	42.6		42.1
05-Sep	43.3	38.7	43.1	43.0	42.7		41.9
06-Sep	43.6	39.3	42.9	42.8	42.7		41.8
07-Sep	43.7	40.1	42.8	42.7	42.5		41.8
08-Sep	43.6	41.2	43.4	43.0	42.5		41.9
09-Sep	43.4	40.3	43.4	42.8	42.5		42.2
10-Sep	43.4	40.9	43.4	42.8	42.4		42.3
11-Sep	43.4	39.7	43.3	42.8	42.4		42.0
12-Sep	43.6	39.6	43.3	42.9	42.3		41.8
13-Sep	43.5	38.6	43.2	43.0	42.2		41.6
14-Sep	43.4	41.5	43.1	43.1	42.0		41.6
15-Sep	43.3	41.1	42.7	43.1	41.8		41.7
16-Sep	43.4	41.2	42.6	43.0	41.7		41.7
17-Sep	43.4	40.8	42.4	42.9	41.6		41.4
18-Sep	43.3	40.7	42.6	42.6	41.4		41.0
19-Sep	43.0	40.3	42.9	42.4	41.2		40.7
20-Sep	42.7	39.6	43.0	42.1	41.0		40.3
21-Sep	42.4	39.6	42.7	41.9	40.8		40.2
22-Sep	42.1	39.6	42.0	41.6	40.6		40.2
23-Sep	42.0	39.5	41.8	41.7	40.3		40.0
24-Sep	42.0	37.1	41.3	41.5	39.9		39.8
25-Sep	41.9	35.3	41.0	41.2	39.5		39.8
26-Sep	41.8	37.2	40.8	40.9	39.0		39.8
27-Sep	41.6	37.5	40.6	40.5	38.7		39.6
28-Sep	41.4	36.0	40.6	39.8	38.3		39.3
29-Sep		35.6	40.5	39.1	38.1		38.9
30-Sep		34.6	40.3	38.4	37.9		38.5
01-Oct		36.5	40.0	37.8	37.7		38.0
02-Oct		37.7	39.8	37.6	37.7		37.5
03-Oct		38.9	39.6	37.5	37.4		37.0
04-Oct		38.2	39.2	37.4	37.2		
05-Oct		36.4	38.8	37.2	37.4		
06-Oct		36.8	38.5	36.9	37.5		
07-Oct		36.5		36.4	37.3		
08-Oct		38.4			37.4		
09-Oct		39.6			37.6		
10-Oct		37.0			38.0		
11-Oct		36.7			38.2		
12-Oct		35.1			38.4		
13-Oct		34.5			38.4		
14-Oct		35.2			38.5		
15-Oct		35.1			38.4		
16-Oct		36.2			38.1		
17-Oct		36.1			37.7		
18-Oct					37.1		
19-Oct					36.5		
20-Oct					36.1		
21-Oct					36.1		

	Discharge (cfs)						
	2005	2006	2007	2008	2009	2010	2011
12-Aug	3.0	19.4	18.9		2.2		31.8
13-Aug	2.5	19.4	15.9		3.4		33.6
14-Aug	2.4	25.8	19.5		3.2		34.8
15-Aug	2.5	24.3	17.2		5.9		32.6
16-Aug	2.6	24.4	16.5	7.1	4.2		28.6
17-Aug	2.8	23.7	15.8	8.4	3.3		25.2
18-Aug	2.9	39.5	15.8	7.3	4.0		22.2
19-Aug	2.8	33.3	15.3	6.8	4.6		20.5
20-Aug	2.7	32.3	14.9	6.6	4.3		21.5
21-Aug	5.9	29.6	14.2	6.0	4.5		19.9
22-Aug	4.7	28.9	13.4	6.1	4.5		17.5
23-Aug	7.9	25.0	12.7	6.0	4.3		16.5
24-Aug	10.0	22.5	12.0	5.5	4.3		15.6
25-Aug	6.7	20.3	11.6	5.0	4.0		15.0
26-Aug	5.8	19.5	11.0	5.2	3.7		14.0
27-Aug	5.9	18.1	10.6	5.4	3.7		13.1
28-Aug	8.9	17.0	10.7	4.7	3.4		12.4
29-Aug	9.1	15.9	10.1	4.4	3.2		11.8
30-Aug	9.0	14.6	9.6	4.5	3.2		11.6
31-Aug	8.4	14.2	9.9	4.6	3.7		12.5
01-Sep	7.6	13.4	9.6	4.4	3.7		11.4
02-Sep	7.3	13.2	9.4	4.3	4.3		10.9
03-Sep	8.9	12.3	9.5	4.5	3.4		11.5
04-Sep	8.7	11.3	8.8	4.4	2.8		11.2
05-Sep	8.2	11.2	8.3	4.1	2.6		10.2
06-Sep	13.3	11.1	8.1	3.9	2.6		10.0
07-Sep	11.4	12.0	7.9	4.7	2.8		9.4
08-Sep	10.5	12.8	11.2	5.0	3.7		9.2
09-Sep	12.4	11.1	12.0	4.4	3.1		9.8
10-Sep	11.3	12.5	10.7	4.4	2.8		9.0
11-Sep	11.7	12.1	10.0	4.1	2.8		8.5
12-Sep	16.4	12.8	10.1	3.9	2.9		8.2
13-Sep	14.8	11.7	10.0	4.8	2.9		8.1
14-Sep	15.0	13.4	9.9	4.7	2.6		8.1
15-Sep	19.9	14.2	9.7	4.0	2.5		7.7
16-Sep	26.2	13.1	10.2	4.0	2.7		7.4
17-Sep	24.2	13.0	12.5	4.0	2.5		7.2
18-Sep	24.5	13.1	14.8	4.3	2.4		8.4
19-Sep	24.5	12.8	21.0	4.8	2.4		9.6
20-Sep	23.8	12.4	21.4	5.1	2.5		8.4
21-Sep	22.3	12.7	23.7	4.6	2.5		8.0
22-Sep	21.4	13.0	23.4	4.6	2.7		7.6
23-Sep	21.0	13.9	24.1	9.4	2.8		7.8
24-Sep	20.4	12.3	24.0	8.2	2.6		8.3
25-Sep	20.3	11.2	27.0	7.7	2.6		7.8
26-Sep	18.4	11.5	23.6	6.7	2.4		7.8
27-Sep	17.5	11.5	23.4	6.2	2.5		7.7
28-Sep	17.3	10.7	22.3	6.2	2.3		7.5
29-Sep		10.2	21.0	6.2	2.6		7.4
30-Sep		9.8	20.3	6.2	2.8		7.2
01-Oct		10.2	20.1	6.3	2.8		7.1
02-Oct		10.0	20.7	7.1	2.3		6.9
03-Oct		10.0	19.2	6.9	5.2		
04-Oct		10.4	18.6	6.6	3.8		
05-Oct		9.6	18.9	6.6	6.0		
06-Oct		10.5	19.0	6.3	6.1		
07-Oct		11.5		5.6	13.6		
08-Oct		19.3		6.9	10.6		
09-Oct		20.5		7.9	10.3		
10-Oct		24.4			9.6		
11-Oct		26.2			9.8		
12-Oct		25.4			10.8		
13-Oct		24.8			11.1		
14-Oct		23.6			11.2		
15-Oct		22.3			10.9		
16-Oct		21.1			10.6		
17-Oct		20.0			9.8		
18-Oct					11.6		
19-Oct					14.2		
20-Oct					13.4		
21-Oct							

Table A-2. Daily stream temperature and flow data at Anaconda Creek (ANDA).

	Temperature (°F)							Discharge (cfs)						
	2005	2006	2007	2008	2009	2010	2011	2005	2006	2007	2008	2009	2010	2011
01-Jun														
02-Jun		32.1				31.9							4.2	
03-Jun		32.2				32.0			14.4				3.8	
04-Jun		32.2				32.0			12.0				3.8	
05-Jun		32.3				32.0			10.7				3.3	
06-Jun		32.3				32.0			9.7				3.1	
07-Jun		32.3				32.0			9.1				3.1	
08-Jun		32.3				32.0			8.6				3.7	
09-Jun		32.5				32.0			8.3				4.0	
10-Jun		32.8				32.0			7.7				4.7	
11-Jun		33.0				32.0			7.2				9.0	
12-Jun		33.1				32.0			7.5				10.0	
13-Jun		33.2				32.0			7.3	5.2			6.3	
14-Jun		33.4				32.0			6.8				5.4	
15-Jun		33.7				32.0			6.4				8.0	
16-Jun		34.2				32.0			6.9				6.7	
17-Jun		34.3				32.1			9.2				10.5	
18-Jun		34.2				32.0			7.2				8.9	
19-Jun		34.1				32.0			7.4				6.6	
20-Jun		34.2				32.1			8.0				5.7	
21-Jun	35.4	34.3				32.2		12.0	8.5				5.2	
22-Jun	35.6	34.5				32.4		10.7	12.4				4.5	
23-Jun	35.9	34.4				32.6		10.0	7.2				4.2	
24-Jun	36.1	34.6				33.0		9.5	6.0				4.2	
25-Jun	36.0	34.8				33.4		9.7	5.5				4.9	
26-Jun	36.0	35.1				33.7		8.9	5.1				5.8	
27-Jun	36.2	35.4	34.5			33.9	33.4	8.2	4.9	10.4			4.9	7.3
28-Jun	36.5	35.7	34.0			34.0	33.6	7.7	4.8	6.7			5.6	6.3
29-Jun	36.8	36.0	34.2			34.0	33.8	7.2	4.8	4.8			4.6	5.7
30-Jun	37.2	36.0	34.6			34.4	33.8	8.1	7.5	3.7			4.3	5.6
01-Jul	36.9	35.9	34.9			34.7	34.0	9.1	6.3	3.3			4.2	5.6
02-Jul	36.7	36.0	35.6			34.9	34.3	8.2	5.3	10.1			4.1	5.1
03-Jul	36.8	36.3	35.5			35.1	34.7	9.1	5.0	8.6			4.1	4.9
04-Jul	37.3	36.5	35.5			35.0	34.9	11.7	4.4	6.7			4.8	4.6
05-Jul	37.4	36.8	35.6			35.1	35.1	11.2	4.0	5.5			5.5	4.4
06-Jul	37.3	37.3	35.8			35.3	35.4	9.6	5.0	5.0			5.0	4.1
07-Jul	37.5	37.0	35.8			35.5	35.4	8.2	8.0	4.6			4.9	3.9
08-Jul	37.7	36.7	35.9			35.5	35.5	7.7	11.1	3.9			4.4	3.9
09-Jul	37.9	36.1	36.3			35.8	35.7	7.2	6.5	4.6			4.3	3.8
10-Jul	38.3	36.4	36.5			36.2	36.0	6.8	5.3	4.0			3.9	3.8
11-Jul	38.6	36.9	37.0			36.5	36.0	6.5	5.5	11.2			3.6	4.3
12-Jul	38.0	37.4	36.8			36.8	36.0	6.6	5.0	14.4			3.9	8.1
13-Jul	37.8	37.8	35.4			37.0	35.7	6.2	4.9	8.3			3.5	7.2
14-Jul	37.7	37.8	35.8			37.1	35.4	5.8	5.7	14.0			3.5	5.6
15-Jul	37.9	37.3	36.7			37.0	35.3	5.6	7.1	23.2			3.4	5.2
16-Jul	38.6	37.2	35.1			37.1	35.2	5.3	10.4	13.8			3.5	4.5
17-Jul	39.1	37.0	34.8			37.3	35.3	5.1	8.3	11.6			3.4	4.6
18-Jul	38.7	37.0	35.1			37.5	35.3	5.0	6.8	10.9			3.7	6.2
19-Jul	38.4	37.2	35.7			37.6	35.3	4.8	6.3	13.7			4.3	8.4
20-Jul	38.3	37.5	35.3			37.7	35.1	5.3	5.7	16.4			10.4	6.3
21-Jul	38.7	37.8	34.5			37.6	35.3	4.8	5.4	12.1			25.7	5.4
22-Jul	39.5	38.0	34.6			36.4	35.7	4.2	5.3	12.5			10.2	5.0
23-Jul	40.6	38.1	34.7			35.9	36.1	3.9	6.0	11.3			7.8	4.9
24-Jul	40.9	38.3	34.9			35.9	36.4	3.8	5.8	10.1			8.2	5.1
25-Jul	40.6	38.4	35.2			36.0	36.4	3.6	6.5	9.2			9.7	4.9
26-Jul	40.4	38.4	35.5			35.8	36.4	3.5	6.2	8.3			7.9	5.1
27-Jul	40.1	38.4	35.9			35.8	36.3	3.3	5.7	7.8			7.3	5.2
28-Jul	40.8	38.3	36.3		38.8	35.9	36.5	3.0	5.4	7.2			7.4	4.9
29-Jul	41.1	38.3	36.6		38.9	36.0	36.8	4.2	5.8	6.8		0.9	7.5	5.2
30-Jul	40.8	38.2	36.7		39.4	36.1	36.8	3.6	7.2	6.7		1.3	7.6	5.3
31-Jul	41.0	38.0	36.6		39.0	36.3	36.8	3.4	7.7	6.6		1.1	6.9	5.4
01-Aug	40.6	37.9	36.6		38.7	36.5	36.7	3.1	7.5	6.8		5.3	6.4	5.4
02-Aug	40.2	37.7	36.7		38.5	36.8	36.9	3.0	7.9	6.3		4.6	6.4	13.1
03-Aug	40.1	37.6	36.8		38.5	37.1	36.0	3.8	7.3	6.3		3.5	6.6	10.0
04-Aug	40.3	37.6	36.9		38.7	37.5	35.6	3.2	6.8	6.9		3.3	7.6	12.0
05-Aug	40.2	37.7	37.6		38.9	37.6	35.7	3.0	8.2	19.1		2.8	7.4	14.1
06-Aug	40.3	37.7	36.5		39.2	37.8	35.1	2.8	7.3	16.2		3.0	8.9	10.5
07-Aug	40.5	37.8	36.3		39.3	37.9	35.6	2.6	6.8	12.2		2.9	9.5	21.1
08-Aug	40.7	37.8	36.5		39.4	37.7	35.0	2.4	6.8	11.3		2.8	9.7	15.7
09-Aug	41.4	37.9	36.6		39.5	37.7	35.2	2.1	7.0	10.4		2.9	17.5	30.5
10-Aug	42.0	37.9	36.7		39.6	36.8	34.5	2.0	11.8	9.8		2.7	11.7	18.8
11-Aug	42.2	37.9	36.9		39.5	36.3	34.3	1.9	15.3	9.4		2.6	10.5	15.5

Table A-2. Daily stream temperature and flow data at Anaconda Creek (ANDA).

	Temperature (°F)							Discharge (cfs)						
	2005	2006	2007	2008	2009	2010	2011	2005	2006	2007	2008	2009	2010	2011
12-Aug	42.4	37.9	37.3		39.3	36.3	35.3	1.9	18.2	12.8		2.5	11.1	67.3
13-Aug	42.0	37.8	37.4		39.2	36.4	36.1	2.1	15.4	11.0		2.4	11.5	71.1
14-Aug	42.0	37.7	38.0		39.2	36.6	36.1	2.0	28.7	14.9		3.0	12.1	56.9
15-Aug	42.4	37.3	37.7	36.9	39.0	36.9	35.9	2.0	23.2	12.6		2.9	13.6	41.7
16-Aug	42.4	37.2	37.4	37.1	38.9	37.1	35.7	2.1	21.4	11.3	6.1	4.4	18.6	33.1
17-Aug	42.7	37.3	37.3	37.2	38.9	36.9	35.5	2.1	20.4	10.2	6.3	4.2	37.4	26.6
18-Aug	42.7	37.5	37.4	37.2	38.8	36.7	35.5	2.3	64.8	10.1	6.1	3.4	26.7	22.6
19-Aug	42.5	37.6	37.6	37.2	38.8	36.6	35.5	2.3	45.5	9.8	5.7	3.3	22.7	18.9
20-Aug	42.1	37.5	37.7	37.4	38.7	36.4	35.7	2.4	38.3	9.3	5.4	3.2	21.5	20.6
21-Aug	41.8	37.2	37.8	37.5	38.5	36.3	36.0	4.9	33.2	8.8	5.0	3.0	20.1	22.9
22-Aug	41.6	37.0	37.8	37.4	38.5	36.2	35.8	4.5	34.7	8.3	5.1	3.0	17.8	17.7
23-Aug	41.3	36.9	37.8	37.5	38.4	36.3	35.6	8.4	29.0	7.9	4.9	3.0	19.2	15.6
24-Aug	41.3	36.7	37.8	37.6	38.3	36.3	35.4	10.3	24.4	7.3	4.8	3.1	18.4	13.9
25-Aug	40.9	36.4	37.8	37.6	38.0	36.4	35.4	7.9	21.2	7.2	4.7	3.1	16.9	13.1
26-Aug	40.6	36.1	37.8	37.4	37.7	36.5	35.4	6.4	19.5	6.7	4.8	3.1	15.3	12.0
27-Aug	40.2	36.1	37.8	37.5	37.4	36.6	35.5	6.1	17.4	6.4	5.0	2.8	14.5	11.0
28-Aug	40.0	36.2	37.8	37.5	37.3	36.8	35.5	9.2	16.6	6.4	4.9	2.7	15.0	10.2
29-Aug	40.0	36.2	37.8	37.2	37.5	36.8	35.6	10.5	15.2	6.3	4.8	2.8	14.6	9.5
30-Aug	39.8	36.2	37.9	36.8	37.5	36.9	35.7	10.0	14.0	6.0	4.7	2.6	14.6	9.4
31-Aug	39.7	36.2	37.9	36.7	37.7	37.0	35.9	8.9	13.5	6.2	4.6	2.5	17.3	10.3
01-Sep	39.5	36.4	38.0	36.8	37.8	37.1	35.9	7.6	12.5	6.3	4.3	2.5	17.0	9.6
02-Sep	39.0	36.4	38.1	37.0	37.9	37.1	35.9	7.6	11.9	5.8	4.2	2.4	16.4	9.2
03-Sep	38.6	36.3	38.1	37.1	38.1	37.1	36.1	9.2	11.2	5.9	4.4	3.1	23.4	11.6
04-Sep	38.6	36.3	38.1	37.3	38.3	37.1	36.2	9.2	10.7	5.5	4.5	3.0	25.1	12.8
05-Sep	38.6	36.2	38.1	37.4	38.5	37.0	35.9	8.8	10.2	5.1	4.7	2.9	31.8	10.4
06-Sep	38.6	36.3	37.9	37.2	38.5	36.8	35.8	11.8	10.1	5.2	4.5	2.9	26.4	9.6
07-Sep	38.7	36.4	37.9	37.0	38.4	36.9	35.8	10.8	11.5	5.2	4.9	3.1	27.0	8.9
08-Sep	38.6	36.4	38.1	37.1	38.3	37.0	36.0	9.6	14.6	7.6	5.1	3.2	26.8	8.8
09-Sep	38.4	36.8	38.3	37.2	38.3	37.0	36.2	10.9	11.9	9.2	4.7	3.6	28.4	9.7
10-Sep	38.6	36.8	38.2	37.3	38.3	37.0	36.2	10.5	13.0	8.3	4.4	3.7	24.5	9.1
11-Sep	38.7	37.1	38.2	37.5	38.4	36.9	36.2	10.5	11.2	7.7	4.4	3.5	21.4	8.7
12-Sep	38.7	37.2	38.2	37.6	38.4	36.8	36.1	14.4	10.9	7.3	4.5	3.7	20.6	8.5
13-Sep	38.5	37.2	38.2	37.7	38.4	36.7	36.1	13.1	10.1	7.0	5.3	3.6	19.2	8.1
14-Sep	38.4	37.0	38.2	37.9	38.2	36.6	36.2	12.7	11.7	6.9	5.5	3.8	18.2	7.9
15-Sep	38.3	37.0	38.0	38.0	38.1	36.4	36.3	16.2	13.6	7.0	5.3	3.9	16.7	7.7
16-Sep	38.5	37.3	37.9	37.9	38.0	36.4	36.3	22.2	12.5	7.8	5.2	3.6	15.9	7.5
17-Sep	38.2	37.5	37.8	37.8	37.9	36.3	36.1	18.7	11.5	10.9	5.3	3.5	15.0	7.4
18-Sep	37.9	37.5	37.7	37.6	37.8	36.3	36.0	17.5	11.2	15.2	5.2	3.7	14.7	8.0
19-Sep	37.5	37.6	37.8	37.5	37.7	36.2	36.1	16.5	10.9	28.9	5.5	3.6	13.8	10.7
20-Sep	37.2	37.6	37.5	37.4	37.6	36.1	35.9	15.3	10.6	23.8	6.2	3.6	12.9	8.7
21-Sep	37.0	37.6	37.6	37.2	37.5	36.1	35.8	14.8	10.6	27.1	6.3	3.5	12.6	8.2
22-Sep	36.9	37.5	37.7	36.9	37.3	36.0	35.7	15.7	10.9	23.4	6.2	3.6	12.2	7.9
23-Sep	37.1	37.4	37.6	36.6	37.0	35.9	35.6	17.2	12.0	22.6	9.3	3.6	11.4	7.9
24-Sep	37.1	37.5	37.3	36.5	36.6	35.7	35.5	16.1	10.5	22.4	9.8	3.6	11.4	8.6
25-Sep	36.9	37.2	37.2	36.4	36.0	35.3	35.5	15.5	10.1	27.3	9.0	3.5		8.3
26-Sep	36.8	36.8	36.9	36.2	35.6	34.9	35.4	14.3	10.2	23.0	8.2	3.7		8.4
27-Sep	36.7	36.7	36.7	35.8	35.4	34.5	35.3	13.7	10.1	21.8	7.9	3.6		8.2
28-Sep	36.6	36.6	36.6	35.2	35.2		35.1	13.5	9.7	21.4	8.6	3.5		8.0
29-Sep		36.4	36.4	34.6	35.2		35.0		9.5	19.5	7.7	3.2		7.8
30-Sep		36.1	36.2	34.4	35.2		34.7		9.3	18.4	7.6	3.3		7.5
01-Oct		35.7	35.9	34.4			34.3		9.3	17.5	7.6			7.4
02-Oct		35.7	35.8	34.3			34.1		8.9	17.9	7.8			7.4
03-Oct		35.9	35.6	34.3			33.9		8.9	16.1	7.7			5.1
04-Oct		36.2	35.4	34.2					9.1	15.2	7.4			
05-Oct		36.3	35.1	34.0					8.7	15.9	7.3			
06-Oct		36.1	34.9	33.7					9.6	15.6	7.2			
07-Oct		35.9		33.4					11.1		7.6			
08-Oct		35.9		33.1					27.1		12.7			
09-Oct		36.4		33.0					29.1		14.4			
10-Oct		36.7		32.9					34.8					
11-Oct		36.7							31.4					
12-Oct		36.5							29.2					
13-Oct		36.0							27.3					
14-Oct		35.7							25.7					
15-Oct		35.4							23.6					
16-Oct		35.2							21.2					
17-Oct		35.2							20.0					
18-Oct														
19-Oct														
20-Oct														
21-Oct														

Table A-3. Daily stream temperature and flow data at Crooked Creek (CCAC).

	Temperature (°F)							Discharge (cfs)						
	2005	2006	2007	2008	2009	2010	2011	2005	2006	2007	2008	2009	2010	2011
01-Jun					32.3		34.1				161	148		135
02-Jun					32.4		33.9				164	154		163
03-Jun					32.5		34.1				159	149		131
04-Jun					32.7		33.7				158	140		109
05-Jun					32.9		33.8				155	142		96
06-Jun					33.0		34.0				157	131		92
07-Jun					33.1		33.0				195	122		88
08-Jun					32.7		32.0				176	117		88
09-Jun					32.9		32.0				156	112		83
10-Jun					33.3		32.0				146	105		80
11-Jun					33.9	33.1	32.1				139	102	107	76
12-Jun					34.4	34.2	32.1				146	99	141	74
13-Jun					34.4	33.3	32.2				178	149	112	72
14-Jun					35.3	34.1	32.3				183	161	99	70
15-Jun					34.3	33.6	32.4				178	129	167	67
16-Jun					33.9	33.5	32.4				191	114	143	65
17-Jun					34.1	33.6	32.8				177	124	164	63
18-Jun					34.6	33.6	34.1				161	111	149	61
19-Jun					35.1	34.1	34.8				153	102	120	60
20-Jun	36.4				35.0	34.6	35.3				147	104	105	66
21-Jun	34.0				34.8	34.8	35.7	172			146	108	96	72
22-Jun	34.5				35.0	35.3	35.3	145	184		216	129	89	86
23-Jun	37.2	34.1			35.0	35.8	35.9	132	159		198	134	84	219
24-Jun	40.6	34.7			34.9	36.3	34.5	122	142		218	136	85	141
25-Jun	41.7	35.0			35.1	36.8	34.1	125	132		181	127	88	101
26-Jun	42.5	35.1			35.1	37.1	34.5	113	125		164	128	97	129
27-Jun	44.0	35.3	34.0		35.1	37.5	34.5	102	121	194	158	124	89	117
28-Jun	44.3	35.5	34.1		34.9	37.4	34.5	95	117	137	175	116	86	102
29-Jun	45.8	35.6	34.5		34.7	37.2	34.5	90	113	105	280	106	83	95
30-Jun	43.9	35.7	34.9		34.9	37.6	34.5	97	151	90	499	100	78	92
01-Jul	41.1	35.4	35.0		35.5	37.9	34.6	116	164	86	463	95	75	88
02-Jul	41.6	35.6	35.0		36.2	38.0	35.1	107	134	150	329	90	72	82
03-Jul	41.2	35.6	35.0		36.9	38.2	35.8	100	123	172	275	85	72	78
04-Jul	41.6	35.8	35.2		37.7	38.3	36.5	107	112	135	235	81	78	74
05-Jul	42.9	35.9	35.6		38.2	38.3	37.0	105	103	132	203	79	90	71
06-Jul	42.4	36.1	36.1		38.7	38.3	37.4	94	111	114	183	76	94	68
07-Jul	44.4	36.3	36.4		39.6	38.3	37.7	81	181	107	163	73	86	67
08-Jul	44.9	37.1	36.6		40.6	38.2	37.8	78	349	96	168	71	79	67
09-Jul	45.9	36.3	37.0		40.8	38.6	37.9	74	202	97	161	71	78	65
10-Jul	46.6	36.0	37.4		40.9	39.2	38.1	70	151	96	144	69	74	65
11-Jul	45.7	36.0	37.5		41.1	39.5	38.2	67	172	179	131	66	71	65
12-Jul	43.8	36.3	38.9		41.7	39.9	37.7	69	169	236	124	63	68	86
13-Jul	43.1	36.7	42.7		42.5	40.4	37.7	66	145	216	120	62	67	93
14-Jul	44.6	36.6	41.9		42.9	40.6	37.3	60	147	280	115	61	66	78
15-Jul	45.5	36.2	39.7		42.9	40.4	37.2	58	166	567	108	61	64	72
16-Jul	46.9	36.1	39.4		43.0	40.5	37.3	57	228	383	112	61	65	69
17-Jul	46.4	35.9	39.0		43.1	40.9	37.7	56	201	304	131	60	61	67
18-Jul	44.6	35.9	38.5		42.9	41.5	37.1	57	166	259	129	61	61	77
19-Jul	42.7	36.1	38.2		42.6	41.8	37.3	58	150	287	114	65	66	98
20-Jul	46.0	36.2	38.5		42.6	41.3	37.0	66	139	345	104	65	87	90
21-Jul	47.6	36.4	39.2		42.8	40.6	37.2	61	129	285	111	61	151	77
22-Jul	49.2	36.6	39.9		42.9	39.5	37.9	55	125	263	110	58	130	72
23-Jul	51.7	36.8	40.1		42.7	38.6	38.7	53	137	240	103	56	103	69
24-Jul	50.8	37.0	39.8		42.5	38.4	39.2	51	137	209	108	56	96	71
25-Jul	48.9	37.3	39.6		42.5	38.2	39.4	48	143	186	98	55	112	71
26-Jul	48.3	37.3	39.5		42.5	38.0	39.6	58	150	168	95	56	115	70
27-Jul	47.6	37.4	39.4		42.5	38.2	39.9	56	136	162	99	56	101	68
28-Jul	49.0	37.6	39.4		42.7	38.4	40.4	48	129	151	92	58	96	66
29-Jul	47.4	37.5	39.5		42.8	38.4	40.8	64	132	144	87	63	104	78
30-Jul	47.1	37.2	39.6		43.0	38.6	40.7	63	169	143	85	62	105	78
31-Jul	48.1	37.2	39.7		42.6	39.2	40.3	57	201	141	83	90	106	76
01-Aug	47.0	37.2	39.8		42.3	39.9	40.1	55	186	144	81	116	99	75
02-Aug	46.1	37.0	39.7		41.8	40.5	40.0	50	186	135	79	87	91	121
03-Aug	46.2	36.8	39.6		41.6	40.9	40.1	57	182	133	77	81	85	171
04-Aug	45.6	36.7	39.6		42.0	41.2	39.6	52	170	140	75	76	91	154
05-Aug	45.0	36.7	40.6		42.5	41.3	39.0	49	189	234	73	73	105	195
06-Aug	45.6	36.8	41.6		42.7	41.2	38.4	47	185	341	71	71	106	155
07-Aug	45.6	36.8	43.2		42.9	40.9	37.5	47	170	269	70	68	115	225
08-Aug	48.0	36.9	42.8		43.0	40.7	37.2	46	165	227	69	65	111	211
09-Aug	49.8	36.9	42.2		43.0	40.2	36.9	42	162	200	66	64	213	267
10-Aug	50.1	37.3	41.5		43.3	40.3	36.7	40	222	184	66	63	182	248
11-Aug	50.1	37.4	40.9		43.2	40.0	36.2	39	285	172	71	61	152	197

Table A-3. Daily stream temperature and flow data at Crooked Creek (CCAC).

	Temperature (°F)							Discharge (cfs)						
	2005	2006	2007	2008	2009	2010	2011	2005	2006	2007	2008	2009	2010	2011
12-Aug	48.7	37.1	40.9		43.2	39.6	36.4	38	340	212	75	59	138	307
13-Aug	46.7	36.6	40.5		43.2	39.2	37.3	39	298	209	73	61	132	617
14-Aug	47.5	36.8	40.7		43.0	38.9	37.1	38	389	239	80	66	131	566
15-Aug	47.9	37.5	41.1	38.5	42.9	39.0	36.8	38	396	232	79	73	143	429
16-Aug	47.9	36.5	40.5	38.6	42.9	39.5	36.6	38	382	213	74	85	220	338
17-Aug	48.0	35.9	39.1	38.8	43.1	39.1	36.7	39	352	191	72	73	444	280
18-Aug	47.7	36.7	38.6	38.9	42.8	38.8	36.8	46	670	187	75	66	541	241
19-Aug	46.1	36.8	38.6	39.0	42.4	40.3	37.0	46	881	181	72	64	361	211
20-Aug	44.7	36.9	38.5	39.1	42.1	39.6	37.4	44	644	171	69	62	295	214
21-Aug	43.7	36.3	38.4	39.3	41.7	38.5	37.7	72	541	161	67	61	263	262
22-Aug	42.1	36.0	38.4	39.4	41.5	37.8	37.4	96	516	153	65	61	236	224
23-Aug	41.4	36.0	38.3	39.5	41.4	37.8	37.1	114	479	145	65	61	243	189
24-Aug	41.0	35.8	38.2	39.8	41.1	37.8	36.9	161	407	137	63	62	257	169
25-Aug	38.7	35.5	38.3	39.8	40.7	37.6	36.8	162	358	135	61	61	222	164
26-Aug	37.6	35.3	38.4	39.8	40.1	37.5	36.9	125	329	132	60	59	196	165
27-Aug	37.3	35.4	38.5	39.9	39.8	37.6	36.9	112	296	126	60	58	189	149
28-Aug	37.2	35.5	38.6	39.8	39.8	37.9	36.9	134	275	131	61	57	204	136
29-Aug	37.2	35.6	38.7	39.4	40.0	37.8	37.1	160	253	134	59	55	183	129
30-Aug	37.2	35.6	38.7	38.9	40.2	37.9	37.3	178	236	124	58	54	176	125
31-Aug	37.0	35.6	38.7	38.8	40.6	38.2	37.6	164	220	124	58	54	208	130
01-Sep	36.8	35.7	38.8	38.9	40.6	38.3	37.6	139	201	129	58	56	223	128
02-Sep	36.6	35.8	38.8	39.2	40.8	38.0	37.5	128	189	126	56	58	197	123
03-Sep	36.5	35.8	38.8	39.3	41.0	38.2	37.7	139	175	125	56	62	275	128
04-Sep	36.6	35.8	38.8	39.5	41.3	38.3	37.9	150	165	122	57	62	325	143
05-Sep	36.5	35.7	38.8	39.7	41.6	38.3	37.4	137	156	113	58	59	443	131
06-Sep	36.7	35.8	38.8	39.6	41.7	39.0	37.2	169	150	115	56	58	364	120
07-Sep	36.8	35.8	38.8	39.3	41.6	38.2	37.2	175	156	113	58	57	369	112
08-Sep	36.7	36.0	38.8	39.3	41.4	38.0	37.5	153	200	147	59	58	367	108
09-Sep	36.6	36.3	38.8	39.5	41.1	37.9	37.7	165	171	179	58	59	362	113
10-Sep	36.8	36.6	38.6	39.6	41.1	37.5	37.8	170	186	177	57	58	315	111
11-Sep	36.7	36.8	38.3	39.8	41.3	37.3	37.7	156	171	163	57	57	276	106
12-Sep	36.9	36.7	38.0	40.0	41.1	37.3	37.6	214	161	152	56	57	246	103
13-Sep	37.0	36.5	37.8	40.0	40.9	37.2	37.5	218	149	145	61	57	224	102
14-Sep	36.9	36.5	37.7	39.9	40.7	37.2	37.7	217	159	141	73	56	205	99
15-Sep	36.8	36.9	37.5	40.0	40.6	37.2	38.0	237	189	137	68	56	189	99
16-Sep	37.0	36.9	37.6	39.8	40.5	37.2	38.1	378	176	146	65	56	176	95
17-Sep	37.0	36.9	37.7	39.7	40.2	37.2	37.9	378	161	171	64	56	164	92
18-Sep	37.1	36.9	37.7	39.5	40.0	37.2	37.7	348	156	207	62	56	153	91
19-Sep	36.9	36.9	37.8	39.2	40.0	37.2	37.5	316	152	387	63	55	145	93
20-Sep	36.6	36.9	39.6	38.9	39.9	37.2	37.5	285	147	416	65	54	138	91
21-Sep	36.6	36.9	38.6	38.7	39.7	37.2	37.4	265	147	442	68	53	132	91
22-Sep	36.6	36.7	37.8	38.4	39.3	37.1	37.5	261	147	395	67	52	127	88
23-Sep	36.7	36.6	37.2	38.0	38.6	37.1	37.4	329	170	359	79	53	122	84
24-Sep	36.7	36.9	36.7	37.9	38.2	37.0	37.2	301	155	338	112	56	117	89
25-Sep	36.7	36.5	36.5	37.8	37.8	36.6	37.2	294	146	387	99	55	111	91
26-Sep	36.9	36.1	36.4	37.7	37.3	36.0	37.0	276	144	358	90	54	88	92
27-Sep	36.8	36.0	36.2	37.4	36.9	35.6	37.0	259	145	341	82	53	82	87
28-Sep	36.5	36.0	36.2	36.9	36.6		36.6	244	141	337	77	53	91	84
29-Sep	36.4	36.0	36.2	36.5	36.5		36.3		138	316	76	52	89	82
30-Sep		35.9	36.1	36.2	36.4		35.8		135	304	74	53	83	80
01-Oct		35.8	36.0	36.0			35.2		135	295	73	53	81	
02-Oct		35.6	36.0	36.0			35.0		131	302	81	52	81	
03-Oct		35.7	35.9	35.8			34.9		130	284	85	63	81	
04-Oct		35.9	35.9	35.6					137	267	79	77	80	
05-Oct		36.0	35.7	35.3					136	270	75	77	81	
06-Oct		35.9	35.6	35.0					139	271	72	80	75	
07-Oct		35.7		34.7					158		69	124	79	
08-Oct		35.7		34.4					337		67	153	73	
09-Oct		35.9		34.1					450		65	156	69	
10-Oct		36.2							537		65	137	62	
11-Oct		35.9							526		60	119		
12-Oct		35.3							516		58	108		
13-Oct		34.9							458		58	103		
14-Oct		34.8							422		55	99		
15-Oct		34.6							380		55	95		
16-Oct		34.6							344		53	91		
17-Oct		34.6							322		53	83		
18-Oct														
19-Oct														
20-Oct														

APPENDIX B
EXAMPLE CALCULATION

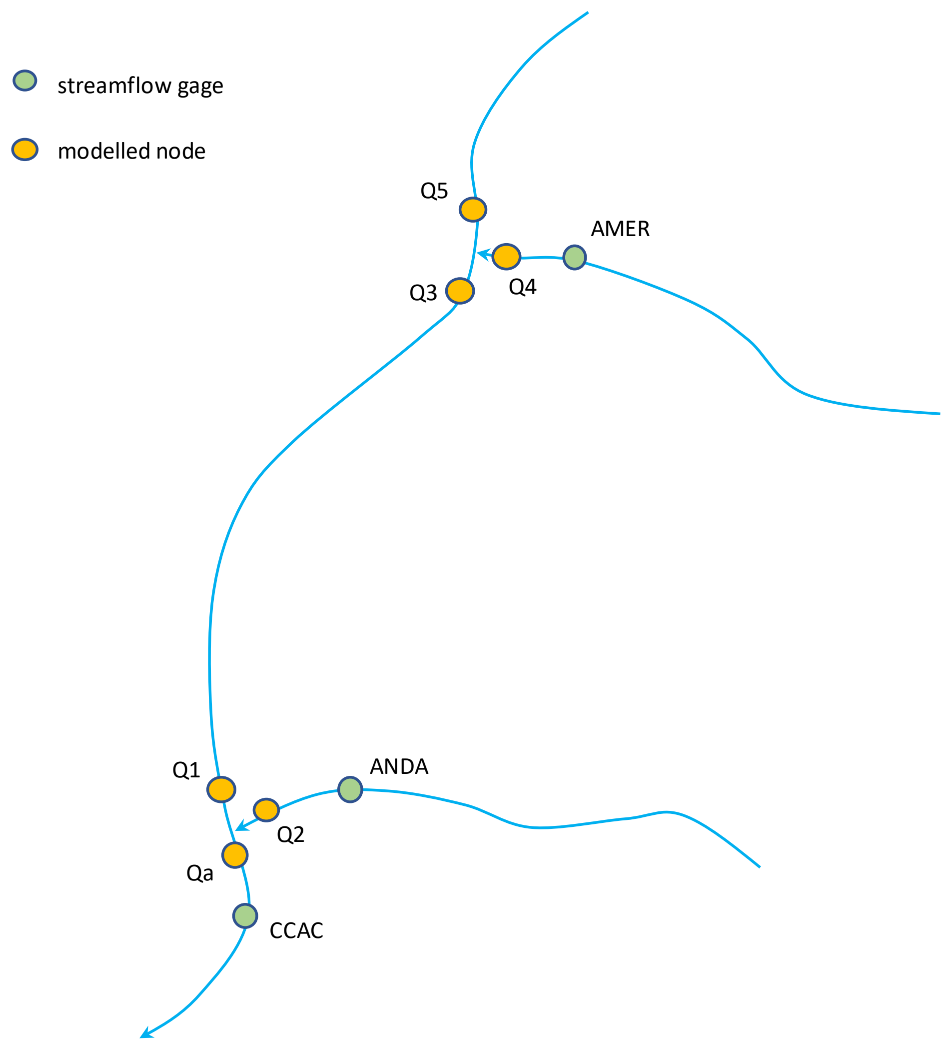
B.1. INTRODUCTION

The following example calculation is for July 1, 2005. On that day, the following daily average streamflows and stream temperatures were measured at the three hydrometric stations:

- CCAC = 115.8 cfs, 41.1 °F
- AMER = 10.7 cfs, 43.6°F
- ANDA = 9.1 cfs, 36.9°F

B.2. EXISTING CONDITIONS

First, daily average streamflow was estimated for existing (i.e., undisturbed) conditions at the modelling nodes shown in the schematic below.



Streamflow Discharge – Node Q_a

$$Q_a = Q_{CCAC} \cdot \frac{A_{CANA}}{A_{CCAC}}$$

where Q_{CCAC} = discharge at CCAC, A_{CC_ANA} = watershed area of Crooked Creek at Anaconda Creek, A_{CCAC} = watershed area at CCAC, and Q_a = discharge of Crooked Creek at Anaconda Creek.

$$Q_a = 115.8\, cfs \cdot \frac{108\, mi^2}{111.9\, mi^2}$$

$$Q_a = 111.8\, cfs$$

Streamflow Discharge – Node Q_2

$$Q_2 = Q_{ANDA} \cdot \frac{A_{ANDA\_mouth}}{A_{ANDA}}$$

where Q_{ANDA} = discharge at ANDA, A_{ANDA_mouth} = watershed area of Anaconda Creek at its mouth, and A_{ANDA} = watershed area at ANDA.

$$Q_2 = 9.1\, cfs \cdot \frac{7.7\, mi^2}{7.6\, mi^2}$$

$$Q_2 = 9.3\, cfs$$

Streamflow Discharge – Node Q_1

$$Q_1 = Q_a - Q_2$$

$$Q_1 = 111.8\, cfs - 9.3\, cfs$$

$$Q_1 = 102.6\, cfs$$

where node Q_1 is Crooked Creek before Anaconda Creek.

Streamflow Discharge – Node Q_3

$$Q_3 = Q_{CCAC} \cdot \frac{A_{CC\_AMER}}{A_{CCAC}}$$

where Q_3 = discharge of Crooked Creek at American Creek and A_{CC_AMER} = watershed area of Crooked Creek at American Creek.

$$Q_3 = 115.8\, cfs \cdot {}^{77.5\, mi^2}/_{111.9\, mi^2}$$

$$Q_3 = 80.3\ cfs$$

Streamflow Discharge – Node Q_4

$$Q_4 = Q_{AMER} \cdot \frac{A_{AMER\_mouth}}{A_{AMER}}$$

where Q_{AMER} = discharge at AMER, A_{AMER_mouth} = watershed area of American Creek at its mouth, and A_{AMER} = watershed area at AMER.

$$Q_4 = 10.7\ cfs \cdot {}^{8.0\ mi^2}/_{6.8\ mi^2}$$

$$Q_4 = 12.6\ cfs$$

Streamflow Discharge – Node Q_5

$$Q_5 = Q_3 - Q_4$$

$$Q_5 = 80.3\ cfs - 12.6\ cfs$$

$$Q_5 = 67.7\ cfs$$

where node Q_5 is Crooked Creek before American Creek.

Next undisturbed stream temperature was estimated at the various modelling nodes.

Streamflow Temperature – Node Q_a

$$T_a = T_{CCAC}$$

$$T_a = 41.1^oF$$

Streamflow Temperature – Node Q_2

$$T_2 = T_{ANDA}$$

$$T_2 = 36.9^oF$$

Streamflow Temperature – Node Q_1

Stream temperature at node Q_1 was estimated using the following mixing equation (Bartholow, 2004):

$$T_j = \frac{[Q_1 \cdot T_1 + Q_2 \cdot T_2 + .. Q_n \cdot T_n]}{[Q_1 + Q_2 + \ldots Q_n]}$$

$$T_1 = \frac{[T_a \cdot (Q_1 + Q_2) - (Q_2 \cdot T_2)]}{Q_1}$$

$$T_1 = \frac{[41.1(102.6 + 9.3) - (9.3 \cdot 36.9)]}{102.6}$$

$$T_1 = 41.5^o F$$

<u>Streamflow Temperature – Node Q_3</u>

$$T_3 = T_1$$

$$T_3 = 41.5^o F$$

<u>Streamflow Temperature – Node Q_4</u>

$$T_4 = T_{AMER}$$

$$T_4 = 43.6^o F$$

<u>Streamflow Temperature – Node Q_5</u>

$$T_5 = \frac{[T_3.(Q_4 + Q_5) - (Q_4 \cdot T_4)]}{Q_5}$$

$$T_5 = \frac{[41.5 \cdot (12.6 + 67.7) - (12.6 \cdot 43.6)]}{67.7}$$

$$T_5 = 41.1^o F$$

B.3. MINING CONDITIONS

Discharges and stream temperatures at the various modelling nodes were then calculated for mining (i.e., disturbed) conditions, with much of the surface and groundwater flow in American Creek and Anaconda Creek being intercepted by mine infrastructure before reaching Crooked Creek.

<u>Modelling Node Q_3</u>

The disturbed discharge at node Q_3 is equal to discharge at node Q_5, as the entire American Creek catchment will be intercepted by mining activities, minus the loss in Crooked Creek flows due to open pit dewatering wells (2.0 cfs).

$Q_{3d} = Q_5 - Q_{dewatering}$ $Q_{3d} = 67.7\ cfs - 2.0\ cfs$ $Q_{3d} = 65.7\ cfs$	$T_{3d} = \frac{[Q_5 \cdot T_5 - Q_{dewatering} \cdot T_{groundwater}]}{Q_5 - Q_{dewatering}}$ $T_{3d} = \frac{[67.7 \cdot 41.1 - 2 \cdot 35.6]}{67.7 - 2}$ $T_{3d} = 41.3^o F$

Modelling Node Q_1

$Q_{1d} = Q_1 - Q_4 - Q_{dewatering}$ $Q_{1d} = 102.6\ cfs - 12.6\ cfs - 2.0\ cfs$ $Q_{1d} = 88.0\ cfs$	$T_{1d} = T_{3d}$ $T_{1d} = 41.3^oF$

Modelling Node Q_2

$Q_{2d} = Q_2 \cdot \frac{A_{ANDA\_disturbed}}{A_{ANDA\_mouth}}$ $Q_{2d} = 9.3\ cfs \cdot \frac{1.7\ mi^2}{7.7\ mi^2}$ $Q_{2d} = 2.0\ cfs$	$T_{2d} = T_2$ $T_{2d} = 36.9^oF$

where $A_{ANDA\_distubed}$ = watershed area of Anaconda Creek that drains into Crooked Creek downstream of the TSF and SRS.

Modelling Node Q_a

Finally, at node Q_a:

$Q_{ad} = Q_{1d} + Q_{2d}$ $Q_{ad} = 88\ cfs + 2\ cfs$ $Q_{ad} = 90.0\ cfs$	$T_{ad} = \frac{[Q_{1d}.T_{1d} + Q_{2d} \cdot T_{2d}]}{Q_{1d} + Q_{2d}}$ $T_{ad} = \frac{[88 \cdot 41.3 + 2 \cdot 36.9]}{88 + 2}$ $T_{ad} = 41.2^oF = T_{CCAC\_disturbed}$

In this example, the undisturbed stream temperature at CCAC on July 1, 2005 was 41.1°F compared to a stream temperature of 41.2°F with the proposed project.

APPENDIX C
PLOTS OF PREDICTED CHANGES IN CROOKED CREEK STREAM TEMPERATURE

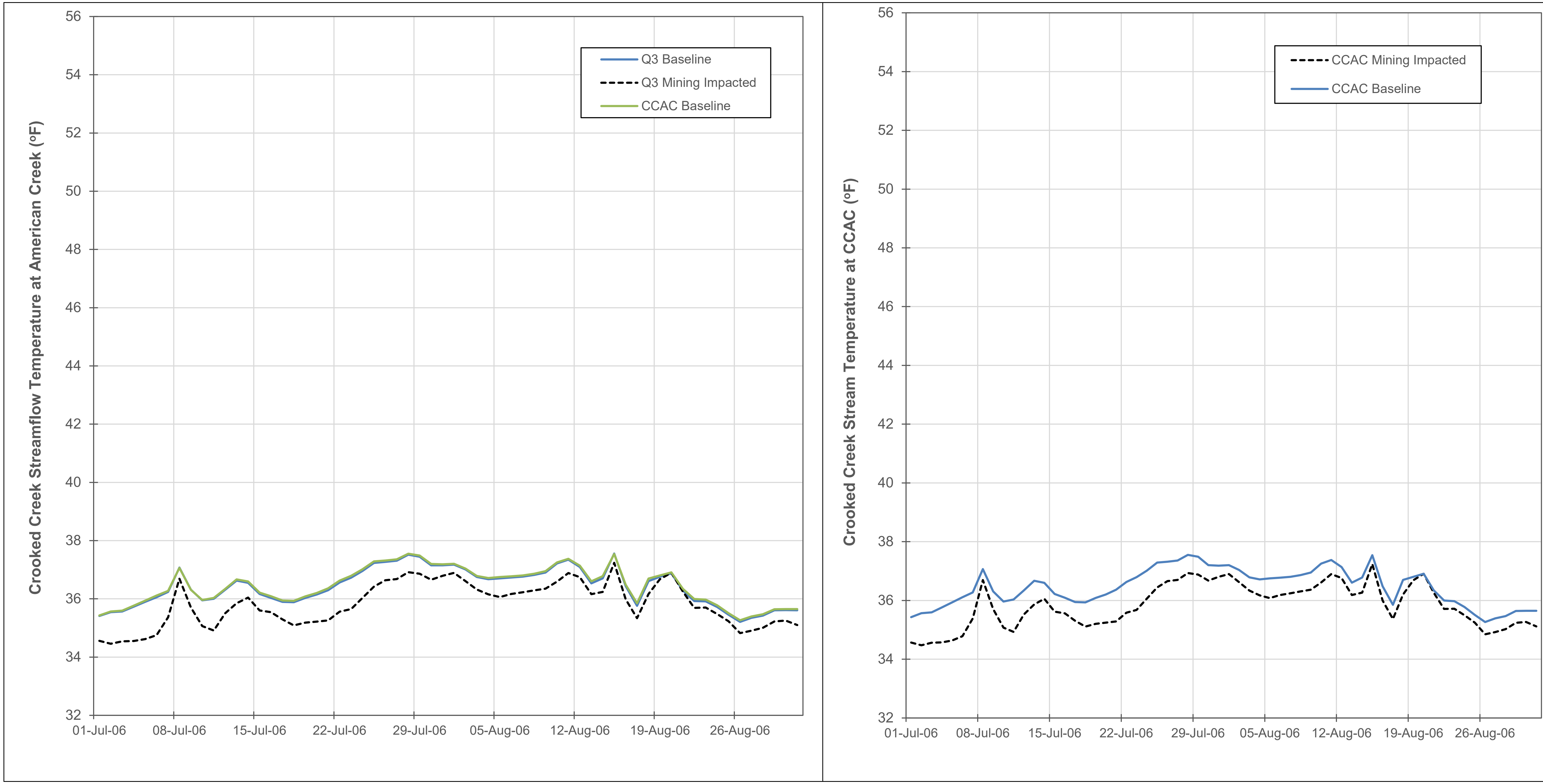


Figure C-1. Modelled stream temperature at modelling node Q_3 (Crooked Creek at American) and modelling node CCAC for baseline and mining conditions in July and August 2006.

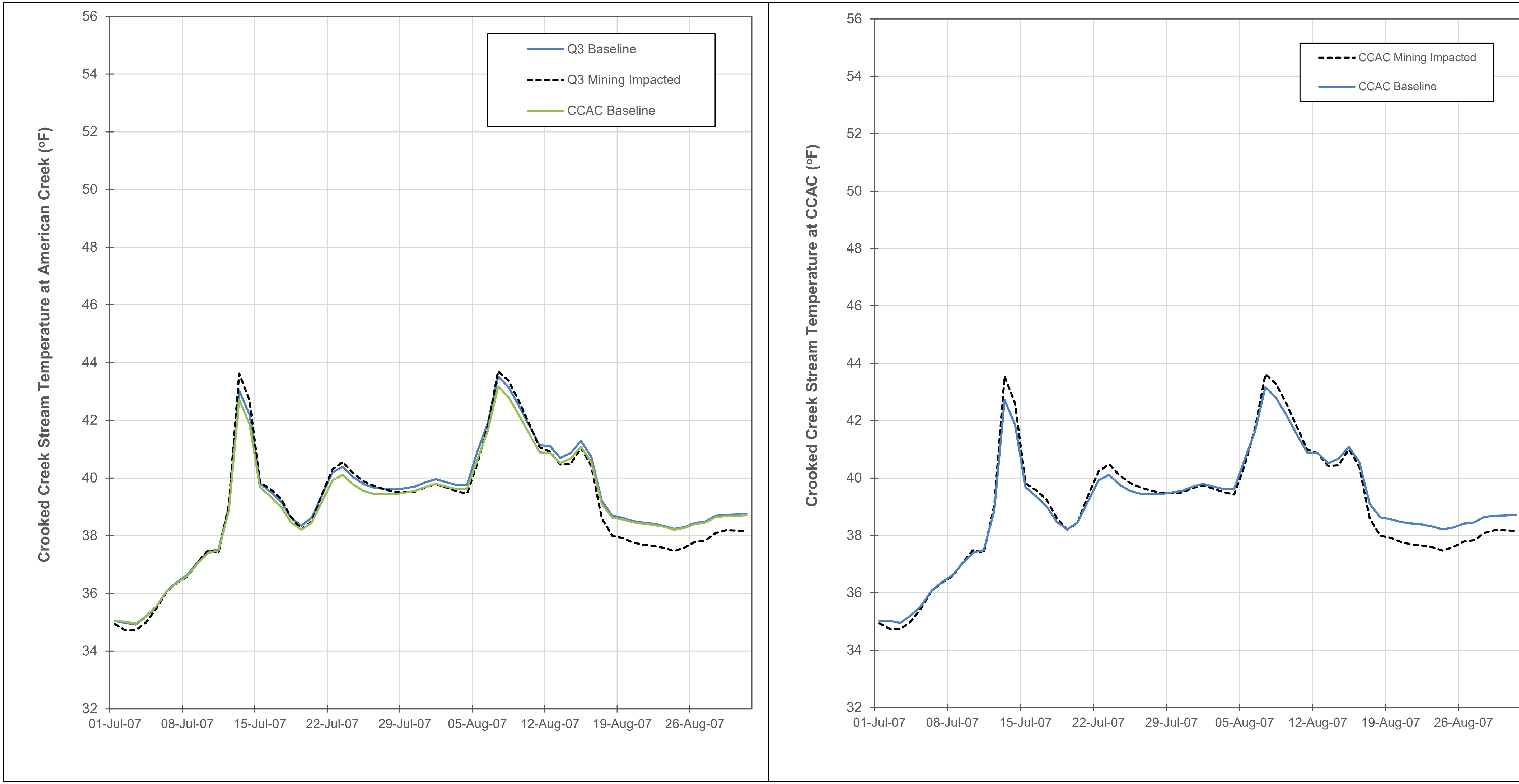


Figure C-2. Modelled stream temperature at modelling node Q_3 (Crooked Creek at American) and modelling node CCAC for baseline and mining conditions in July and August 2007.

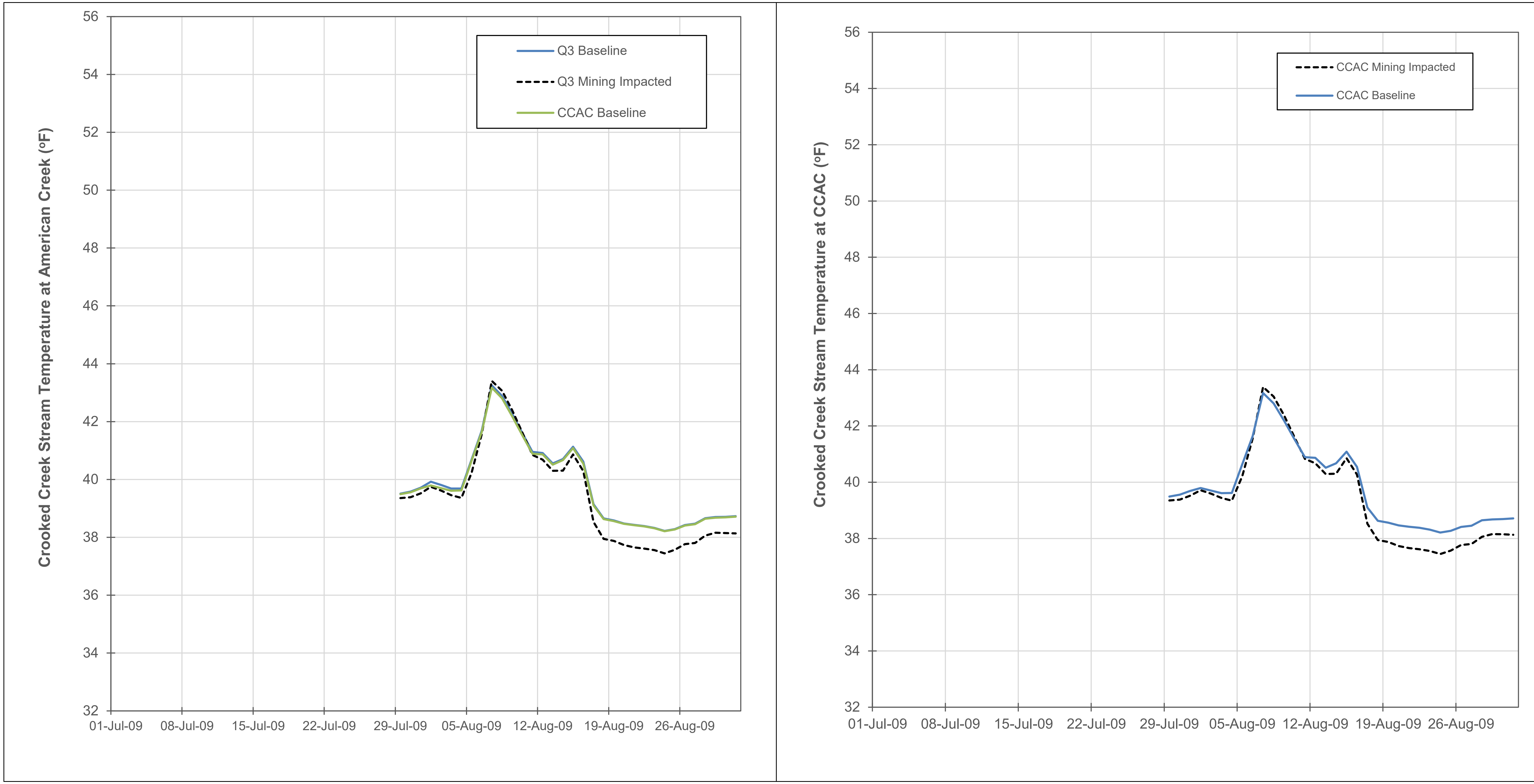


Figure C-3. Modelled stream temperature at modelling node Q_3 (Crooked Creek at American) and modelling node CCAC for baseline and mining conditions in August 2009.

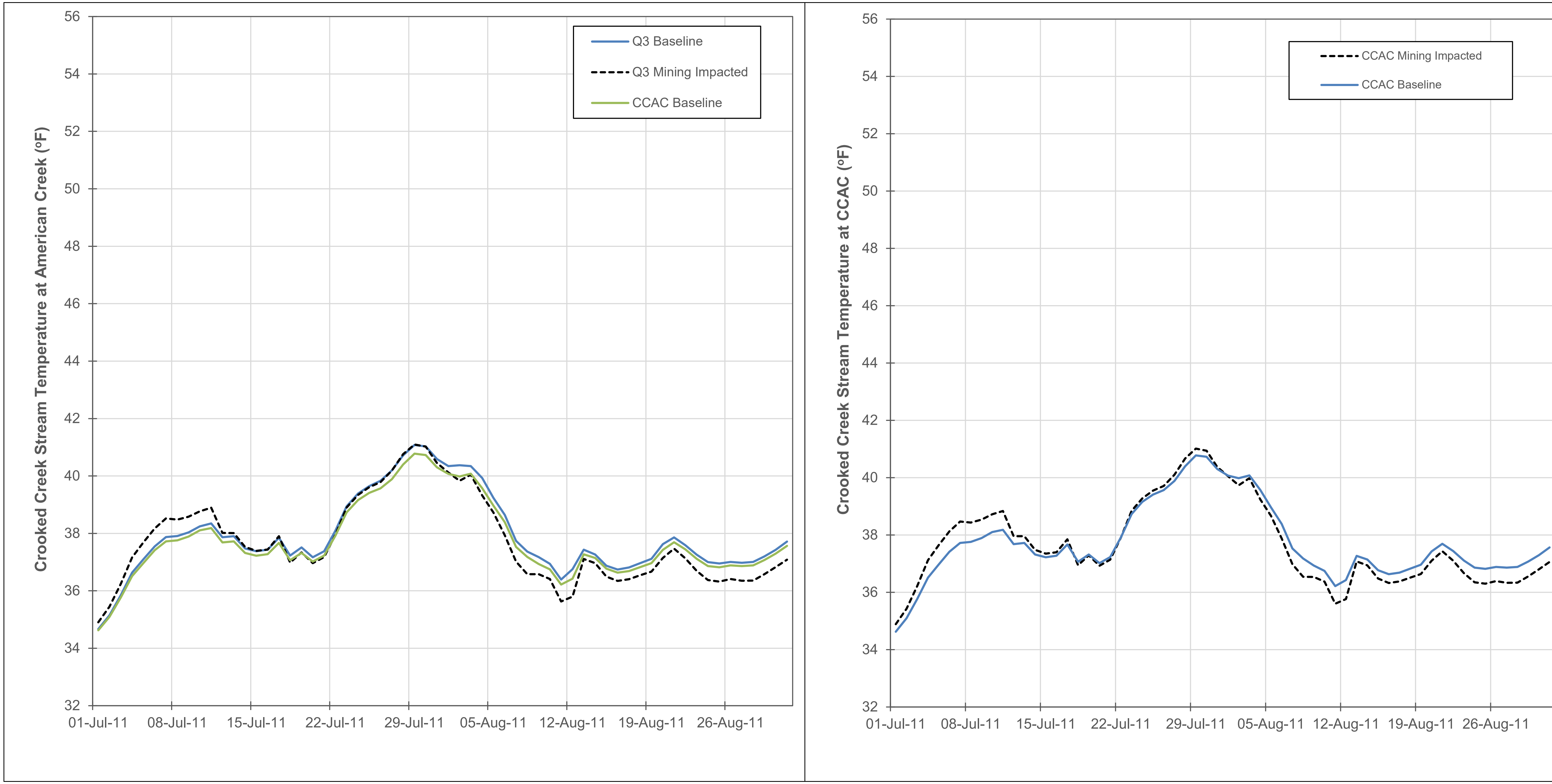


Figure C-4. Modelled stream temperature at modelling node Q_3 (Crooked Creek at American) and modelling node CCAC for baseline and mining conditions in July and August 2011.