Brailey Hydrologic

3527 North Point Drive
Anchorage, AK 99502
phone: 907-248-0058
dbrailey@alaska.net

January 21, 2019

Water Policy Consulting, LLC
P.O. Box 15332
Fritz Creek, AK 99603

Attn: Hal Shepherd, Principal

Subject: 2016-18 streamflow data processing results,
Hot Springs Creek, Alaska

Dear Hal:

This letter provides results of 2016-2018 streamflow data processing for the Hot Springs Creek gage operated by the Native Village of Teller Traditional Council. Field notes were provided for eight discharge measurements conducted between August 11, 2016 and September 12, 2018. Transducer data was provided from July 25, 2017 through September 12, 2018, consisting of water pressure and temperature readings recorded at 15-minute intervals. Survey data was provided for an August 15, 2017 level loop and four level loops surveyed in 2018. Photographs were provided for the July 2017, August 2018, and September 2018 site visits.

<u>Site Conditions</u>. Figures 1 and 2 show upstream and downstream views at the Hot Springs Creek gage site. A cobble riffle provides downstream section control (Figure 2). During discharge measurements, the maximum depth recorded was 1.2 feet, and the maximum velocity was 1.2 ft/s . Photographs indicate that the gage pool has a cobble bed mantled by silt. Based on your observations, the gage site is not backwatered by downstream lake levels during the open-water season.

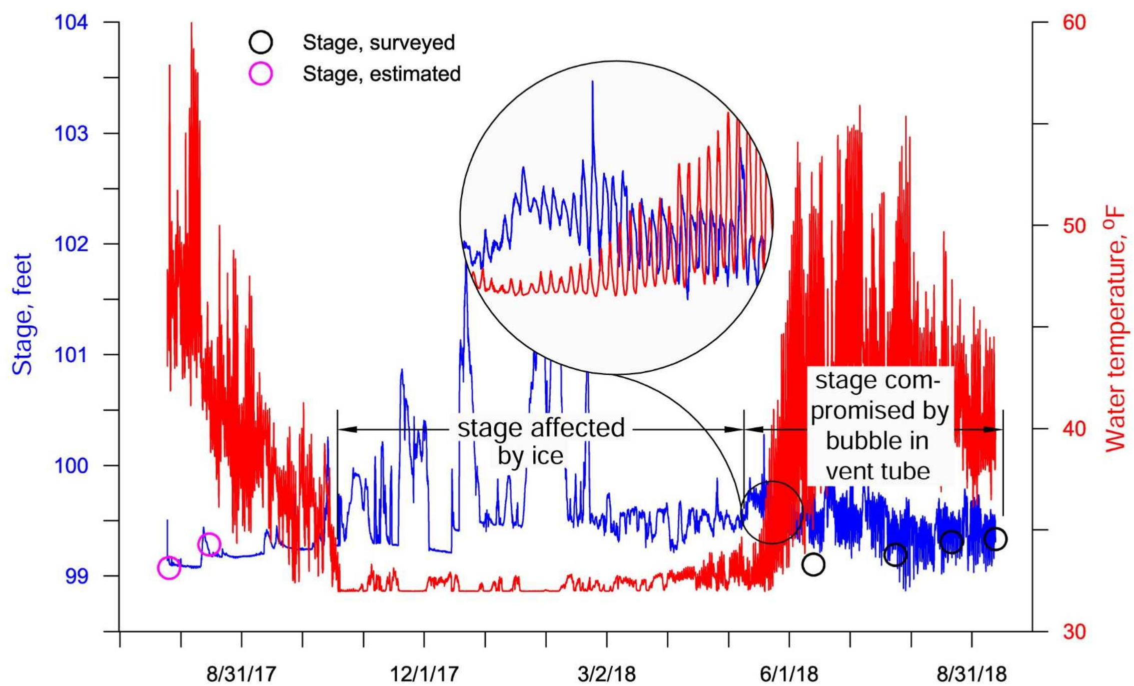
<u>Stage Measurements</u>. Water temperature and stage data were recorded using an In-Situ Level Troll 500 datalogger, and were downloaded periodically using an In-Situ Rugged Reader. An initial Level Troll 500 installed in 2016 was damaged, requiring replacement in July 2017. Although the 2017 staff gage was surveyed relative to three benchmarks, the benchmarks were destroyed during 2018 breakup. As a result, three new benchmarks were installed in June 2018.

The 2017 stage data suggest increasing flows from July through October 2017, when water temperatures indicate that stage was affected by ice (Figure 3). Although very slight diurnal flow fluctuations are indicated for July 2017, the stage data shows large daily fluctuations (over 0.5 feet) beginning in May 2018. The daily stage fluctuations correspond with daily water temperature fluctuations that continue throughout the 2018 open-water season. According to

Figure 1. Upstream View at Hot Springs Creek Gage Site

Figure 2. Downstream View at Hot Springs Creek Gage Site

Figure 3. Stream Temperature and Stage Data



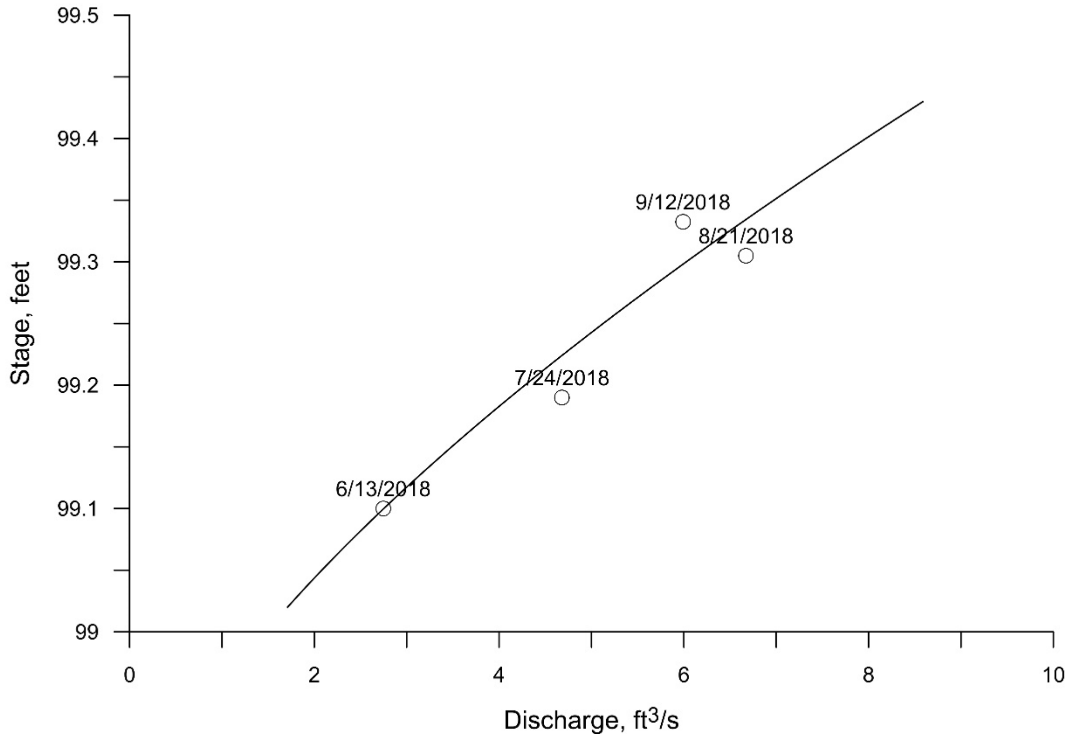
Andy Baker at In-Situ Technical Support, these fluctuations indicate that the transducer's vent tube was partially blocked, probably by a water droplet. Because the size of the water droplet and the orientation of the vent tube are not known, it is not possible to correct the stage data for the daily pressure fluctuations. As a result, the 2018 stage data cannot be used for streamflow computations.

In-Situ further indicated that the Level Troll 500 must be returned for factory repairs. Alternatively, a non-vented pressure transducer could be installed, but that would require an accompanying barometric pressure logger. In addition to avoiding dessicant and vent tube problems, most barometric pressure loggers also record air temperatures, which can be useful for interpreting winter stage records.

The loss of the 2017 staff gage and elevation benchmarks eliminates any direct means of calculating stream stage from the logger data. As a result, 2018 discharge measurements were used to develop a rating curve (Figure 4), and the rating curve was used to back-calculate stage during the 2017 discharge measurements. The estimated 2017 stage levels were used to correct the 2017 stage data as shown on Figure 3.

<u>Discharge Measurements</u>. Discharge measurements were performed using a Price AA meter in 2016 and 2017, and a Pygmy current meter in 2018. During 2016 and 2017, 0.5-foot station

Figure 4. Preliminary Rating Curve



intervals resulted in partial vertical sections that rarely exceeded 10% of the total discharge. During 2018, 1-foot station intervals caused more than 60% of the total discharge to occur in 4 adjacent vertical sections. Stage and discharge measurements are summarized on Table 1.

Table 1. Stage and Discharge Measurements

Date	Time, DST	Staff gage reading, ft	Surveyed water elev., ft	Computed stage, ft	Discharge, ft^3/s	Instrument
8/11/2016	16:45	0.99[1]			2.37	Price AA
9/14/2016	13:30	0.08[1]			3.93	Price AA
7/26/2017	12:30	0.44[1]		99.07[2]	2.38	Price AA
8/15/2017	14:00	0.57[1]		99.28[2]	5.71	Price AA
6/13/2018	13:00	0.57		99.10	2.75	Pygmy
7/24/2018	11:30	0.71	99.19	99.19	4.68	Pygmy
8/21/2018	12:35	0.76	99.31	99.31	6.67	Pygmy
9/12/2018	13:00	0.76	99.33	99.33	5.99	Pygmy

[1] 2016 and 2017 staff gages not surveyed relative to existing benchmarks

[2] Stage back-calculated from rating curve (Figure 4)

Streamflow Computations. The 2018 discharge measurements allow a preliminary rating curve that should be confirmed with additional measurements (Figure 4). Assuming that the rating remained stable between 2017 and 2018, 2017 streamflows were computed using the 2018 rating curve. Because the 2017 stage measurements are estimated, the streamflow data are qualified as "estimated" (Table 2).

During an October 13-14, 2017 runoff event, flows exceeded 13 cfs, more than twice the highest discharge measurement. Mean daily flows for these dates are qualified "uncertain" because they exceed the extended rating curve.

The 2017 streamflow data indicate that Hot Springs Creek flows varied from a low of 2.7 ft^3/s in late July to rainfall peaks over 13 ft^3/s in October. Although the peak magnitudes vary, a similar runoff pattern is evident in 2017 daily flows on the Niukluk River at Council (Figure 5). The Niukluk gage is located about 60 miles east of Hot Springs Creek, draining a 700 square-mile watershed on the south side of the Kigluaik Mountains. Of the six years of streamflow data between 2013 and 2019, 2017 appeared to be an average year for the Niukluk River gage.

Figure 5. 2017 Hydrographs for Hot Springs Creek and the Niukluk River near Council

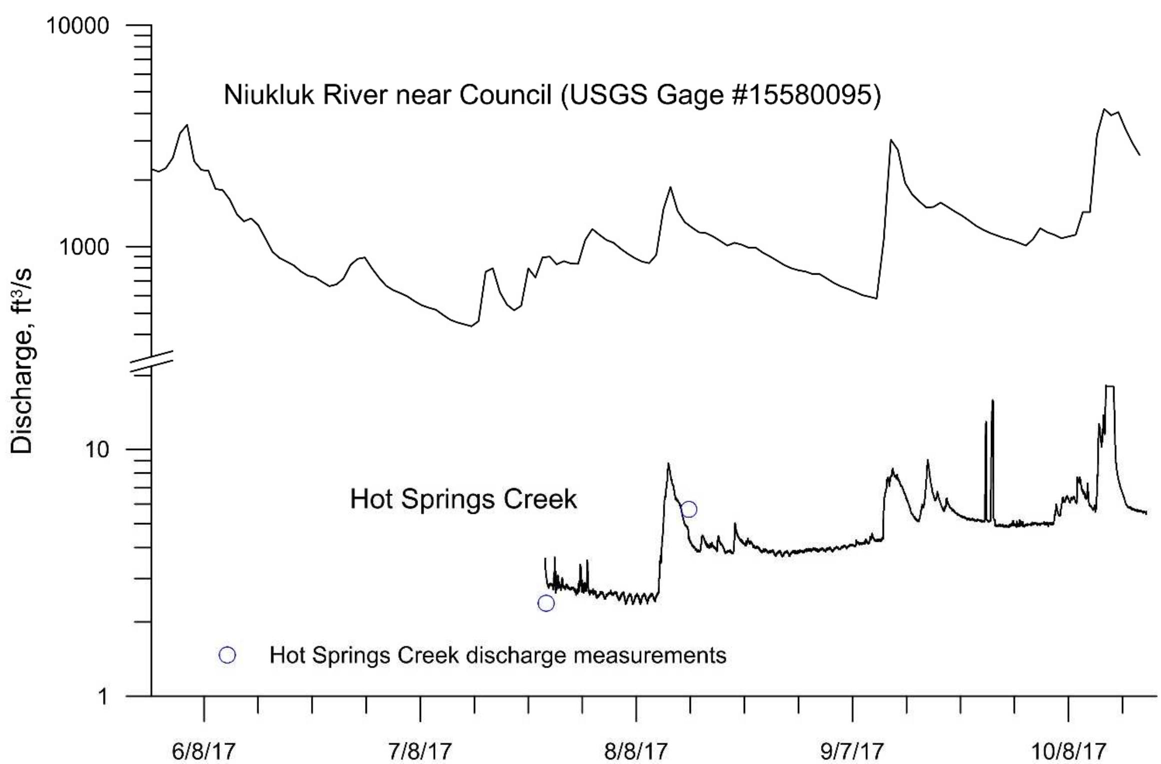


Table 2. Hot Springs Creek Mean Daily Discharge

Units: ft^3/s

Year: 2017

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	*	*	*	*	*	*	*	2.77 E	3.90 E	4.94 E	*	*
2	*	*	*	*	*	*	*	2.59 E	3.92 E	4.96 E	*	*
3	*	*	*	*	*	*	*	2.57 E	3.92 E	4.99 E	*	*
4	*	*	*	*	*	*	*	2.60 E	3.94 E	4.99 E	*	*
5	*	*	*	*	*	*	*	2.56 E	3.97 E	5.00 E	*	*
6	*	*	*	*	*	*	*	2.51 E	4.02 E	5.57 E	*	*
7	*	*	*	*	*	*	*	2.49 E	4.07 E	6.27 E	*	*
8	*	*	*	*	*	*	*	2.50 E	4.17 E	6.27 E	*	*
9	*	*	*	*	*	*	*	2.51 E	4.20 E	7.06 E	*	*
10	*	*	*	*	*	*	*	2.53 E	4.35 E	6.50 E	*	*
11	*	*	*	*	*	*	*	3.34 E	4.37 E	5.82 E	*	*
12	*	*	*	*	*	*	*	7.30 E	7.09 E	11.08 E	*	*
13	*	*	*	*	*	*	*	6.85 E	7.89 E	16.77 U	*	*
14	*	*	*	*	*	*	*	5.67 E	7.09 E	12.97 U	*	*
15	*	*	*	*	*	*	*	4.58 E	5.99 E	6.77 E	*	*
16	*	*	*	*	*	*	*	3.97 E	5.25 E	5.85 E	*	*
17	*	*	*	*	*	*	*	4.19 E	5.98 E	5.67 E	*	*
18	*	*	*	*	*	*	*	4.07 E	7.72 E	5.58 E	*	*
19	*	*	*	*	*	*	*	4.10 E	6.37 E	*	*	*
20	*	*	*	*	*	*	*	3.97 E	5.89 E	*	*	*
21	*	*	*	*	*	*	*	3.87 E	5.77 E	*	*	*
22	*	*	*	*	*	*	*	4.50 E	5.44 E	*	*	*
23	*	*	*	*	*	*	*	4.19 E	5.27 E	*	*	*
24	*	*	*	*	*	*	*	4.12 E	5.19 E	*	*	*
25	*	*	*	*	*	*	3.67 E	3.94 E	5.14 E	*	*	*
26	*	*	*	*	*	*	3.18 E	3.88 E	6.22 E	*	*	*
27	*	*	*	*	*	*	2.87 E	3.82 E	7.92 E	*	*	*
28	*	*	*	*	*	*	2.80 E	3.79 E	4.91 E	*	*	*
29	*		*	*	*	*	2.76 E	3.80 E	4.89 E	*	*	*
30	*		*	*	*	*	2.69 E	3.84 E	4.95 E	*	*	*
31	*		*		*		2.82 E	3.86 E		*		*
Average	*	*	*	*	*	*	2.97	3.78	5.33	7.06	*	*
Min	*	*	*	*	*	*	2.69	2.49	3.90	4.94	*	*
Max	*	*	*	*	*	*	3.67	7.30	7.92	16.77	*	*

Qualifiers:

E = estimated based on preliminary rating and back-calculated 2017 stage measurements

U = uncertain because flows over twice the highest discharge measurement

Thank you for the opportunity to provide these services. Please call should you have any questions.

Sincerely,

David E. Brailey
Brailey Hydrologic

.