Stream Flow Monitoring Report - Water Year 2019 – Salmon Creek

Annex Creek/Salmon Creek Hydroelectric Project

(FERC Project No. 2307)

Alaska Electric Light and Power Company

Juneau, Alaska

December 2, 2019

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TABLE OF CONTENTS

LIST OF APPENDICES

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1. INTRODUCTION AND PURPOSE

In October 2015, Alaska Electric Light & Power (AEL&P) requested an amendment to its license that would allow the operation of the stream gage to be performed by the licensee. By Order issued December 30, 2015, the Federal Energy Regulatory Commission (FERC) approved the amendment and stipulated that a new stream flow plan be developed after consultation with Alaska Department of Fish and Game (ADF&G), National Marine Fisheries Service (NMFS), and the United State Fish and Wildlife Service (USFWS). AEL&P prepared a plan in consultation with ADF&G, NMFS, and USFWS, as well as with the Alaska Department of Natural Resources (ADNR) Water Division and National Weather Service (NWS).

By Order issued August 9, 2016 the FERC approved the stream flow monitoring plan with a requirement to file an instream flow monitoring report biannually to the FERC, NMFS, USFWS and ADF&G with the requirement changing to an annual report after four successful biannual reports. The report is to review operation of the gage, identify when supplemental water was released and include information on the operation of the supplemental water valve. The report is to be submitted for agency review, with a 30-day review and comment period, prior to filing with the FERC. Documentation of agency consultation should be included in the report.

The first report was submitted to FERC on April 19, 2017, the second report on August 16, 2017, the third on February 20, 2018 and the fourth on August 28, 2018. With the submission to FERC of the fourth report, AELP requested that the due date for the annual report be changed to December 1, 2019 to allow the entire water year to be analyzed in the report. This request was approved by FERC Order on October 9, 2018.

This is the first annual report, it covers the period since the last semi-annual report which includes all of water year 2019.

1.1. Gage Operation

The stream gage started operation on April 27, 2016, taking level measurements on a 15 minute basis. This data is automatically distributed to www.aelp.com/About-Us/Salmon-Creek-Streamflow where it is available for public display. The page has multiple graph options for quick review of the data. Real-time flow data is supplied directly to the AELP Supervisory Control and Data Acquisition (SCADA) System where it is logged and monitored. Alarms are automatically generated for low flow conditions or for loss of communication with the sensor.

The communication path between the gage and the AEL&P SCADA system is through a cellular phone modem, which performed well during the period. This communication link is continuously monitored by the AELP SCADA system at the AELP dispatch center which is manned 24 hours per day. The operators

are trained to respond to all alarms, either by taking direct action or calling a technical specialist who can resolve the specific problem.

In April of 2019, AEL&P changed cell providers which resulted in multiple communication failures; each time requiring a person visit the site to reset the modem. This did not result in any data loss, since the data was still stored locally on the datalogger but it did result in a loss of real-time communication to the AELP SCADA system. Although in most cases, the stream flow was well above the 9CFS action level and the stream flow doesn't change rapidly, the AELP Operator opened the valve for any loss of communication event and left the valve opened until communication was restored. This ensure that AELP remained in compliance with the license requirements. Periodically since the change over, we have experienced additional failures but the same action was taken to open the valve in each case.

AEL&P worked with AT&T, the communications provider, to install a new product which should provide a more stable communications path for the site. Installation of the new cell router was completed on December 2, 2019.

Figures 1 through 5 below show the corrected discharge graphs for the period from July 1, 2018 to September 30, 2019. The corrections shown during the first quarter of 2019 are due to ice formation in the gaging reach, which impacts the operation of the gage, typically resulting in false high readings. In each of the last two winters ice formation dynamics have resulted in false low readings for brief periods, likely due to isolation of the gage from the flowing stream. A discharge measurement made on Jan. 9, 2019 (figure 3) verified that the anomalies were related to temporary gage transducer issues rather than actual sudden reductions in discharge. The dates of the manual discharge readings are identified in figures 1 through 5. A total of nine discharge measurements were conducted to validate discharges from July 2018 through September 2019. Calibration measurements included low-flow discharges of 11.5, 12, and 12.1 CFS.

Ed Neal with Alaska Hydroscience provided a new rating table for the stream on January 22, 2019. The datalogger was changed to use the new rating provided and a copy was distributed to NOAA. On June 25, 2019, Alaska Hydroscience provided a small shift correction of -0.06 based on the manual measurements taken to date. This shift was implemented in the datalogger. A copy of the rating curve is included in Appendix C.

A table of the Daily Mean Discharge for the months of October 2016 through September 2019 is included in Appendix B.

Figure 1 – Third Quarter 2018 Corrected Discharge

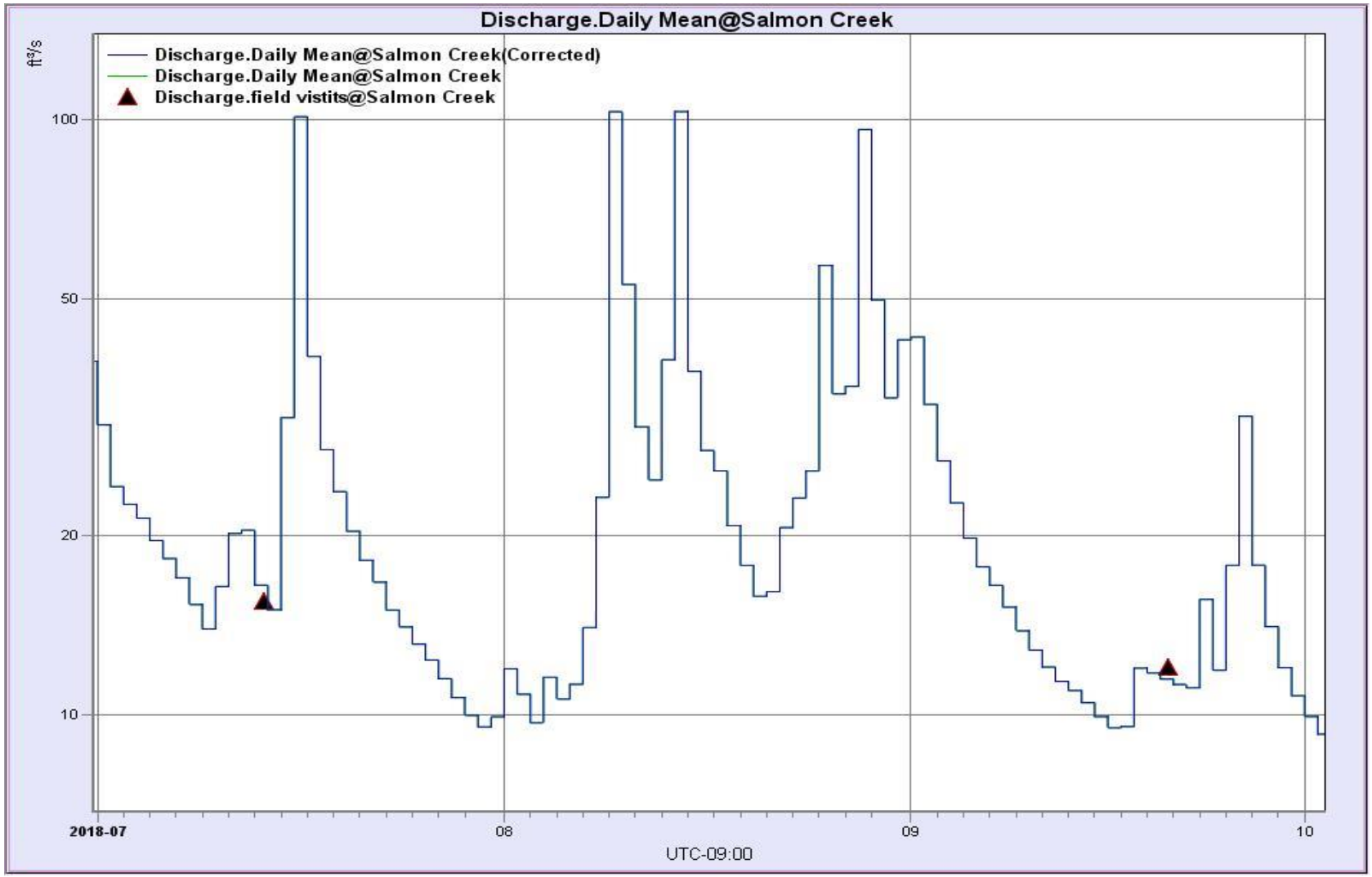


Figure 2 – Fourth Quarter 2018 Corrected Discharge

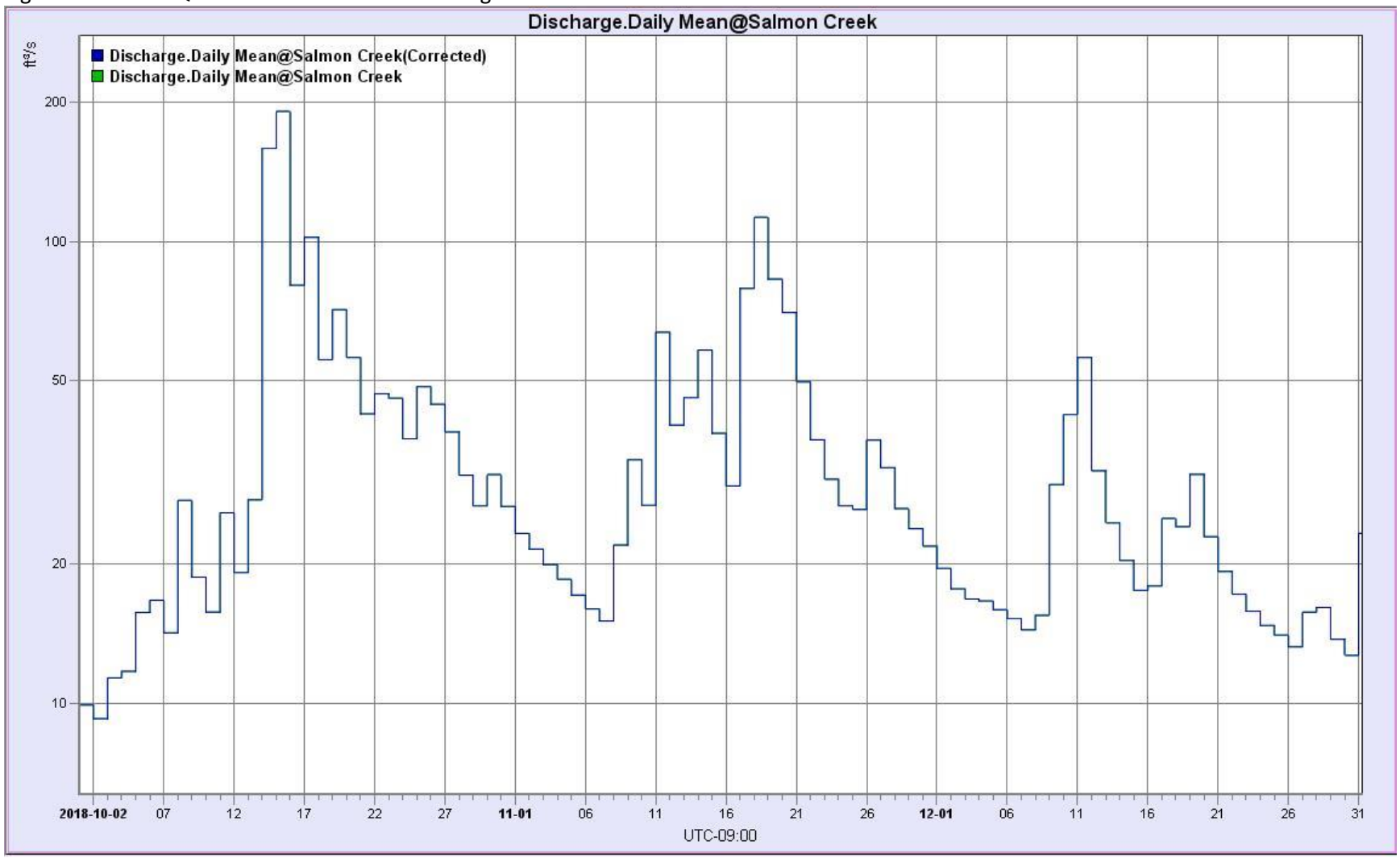


Figure 3 – First Quarter 2019 Corrected Discharge

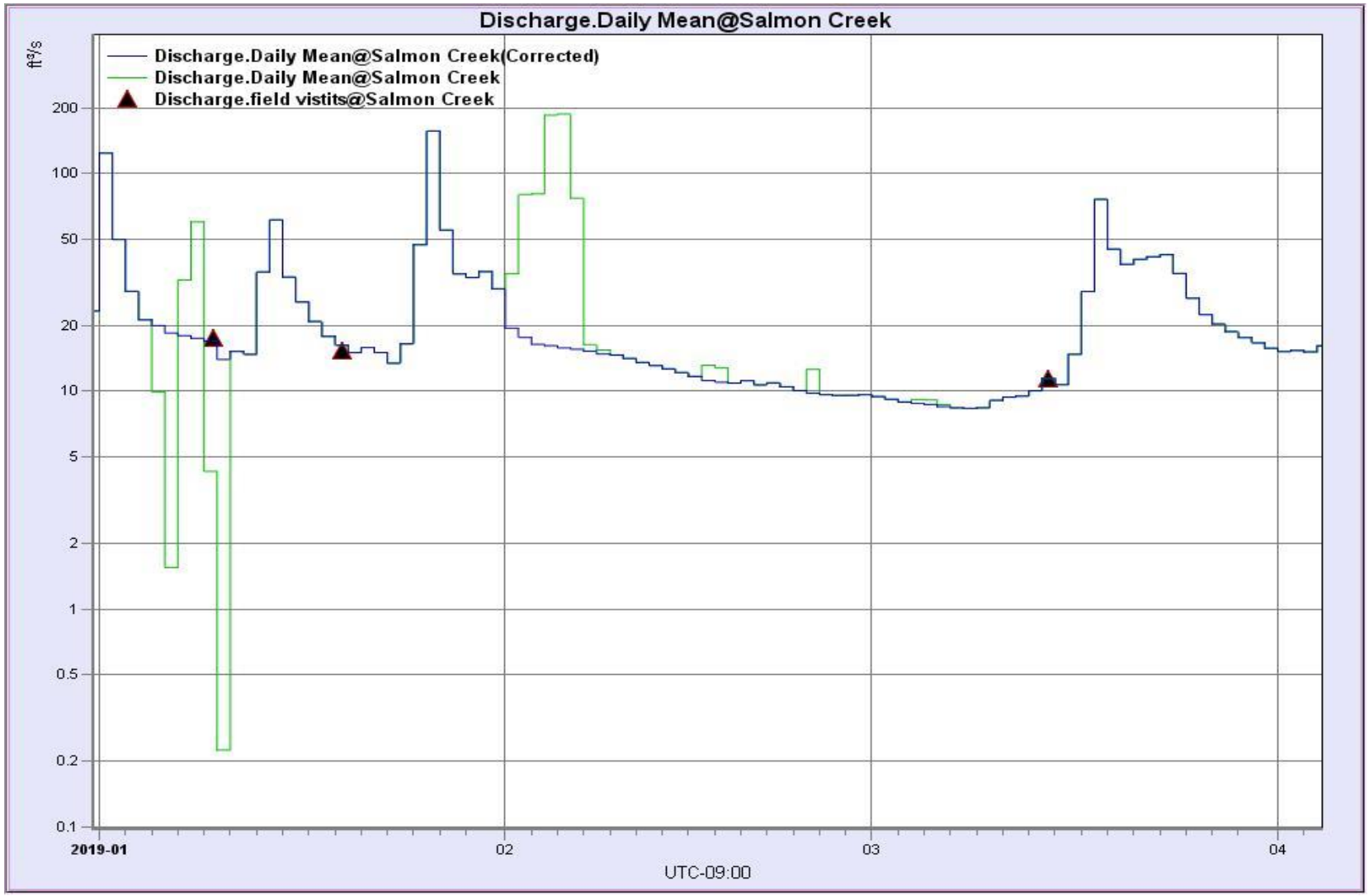


Figure 4 – Second Quarter 2019 Corrected Discharge

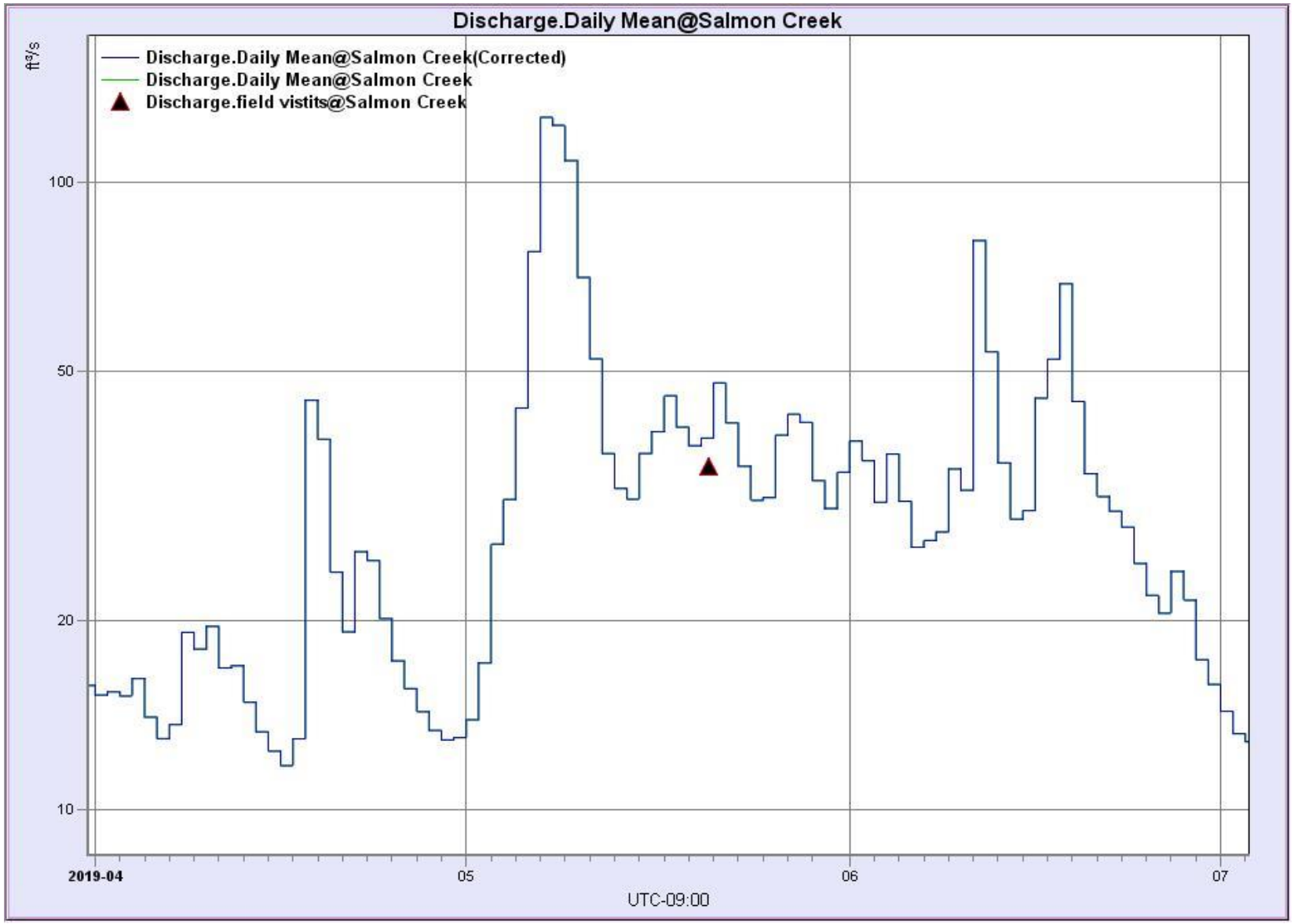
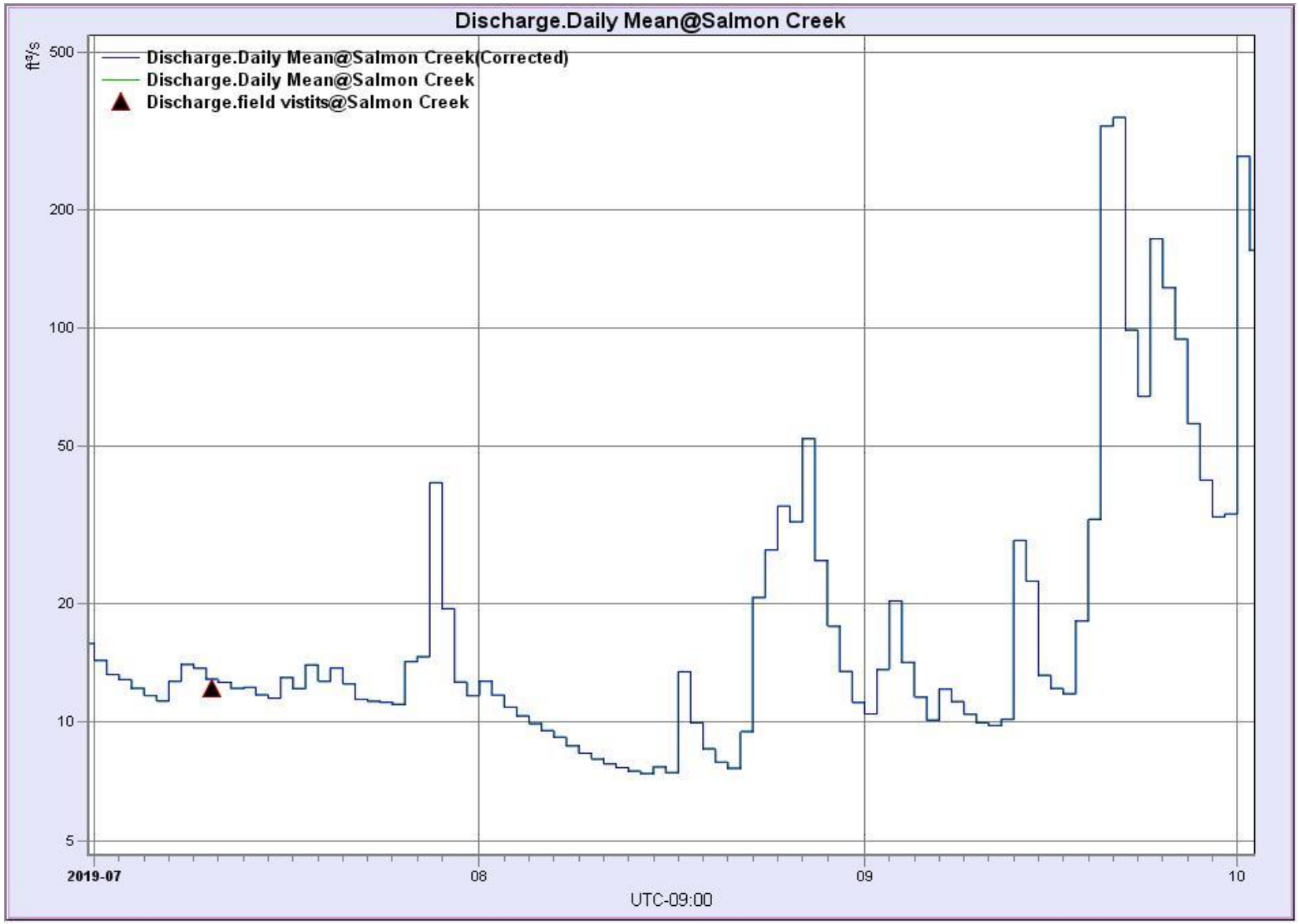


Figure 4 – Third Quarter 2019 Corrected Discharge



1.2. Supplemental Valve Operation

The supplemental water valve is a 6" valve tapped off the penstock at the base of the dam. The valve discharges water directly into the natural drainage. Operation of the valve is performed remotely by the AEL&P System Operator who also has real-time indication of the streamflow. When the flow drops to 9CFS, an alarm is generated, and the Operator opens the valve and logs the operation.

The valve is either open or closed, there are no intermediate positions. The Operator has feedback on the valve position, provided by limit switches which show the valve position as well as an analog signal which reflects valve position. In addition to valve position, there is a flowmeter on the outlet of the valve. The amount of flow through the valve when open varies with the reservoir elevation. At a higher elevation there is more flow and at a lower elevation the flow is less. The valve has been sized to ensure a minimum of 3CFS of flow at minimum reservoir elevation, so typically more CFS is discharged to the stream.

1.3. Supplemental Valve Release

Due to drought conditions throughout the region, the supplemental valve was opened for much of the water year. The table below shows operations of the supplemental valve for the period since the last semi-annual report. Station service at the valvehouse located at the base of the dam is provided by a small hydroelectric DC generator, this power is used for monitoring, valve operation and battery charging. The output of the turbine is discharged into the stream at the base of the dam. During the low flow periods, the stream flow in Salmon Creek was stable due to the consistent releases through the supplemental valve and the hydroelectric turbine output.

Date	Time	Action	Release Flow (CFS)
7/31/18	14:31	OPEN	3.9
8/2/18	8:43	CLOSED	3.9
8/4/18	01:33	OPEN(1)	4
8/4/18	20:17	CLOSED	
8/5/18	02:28	OPEN	4
8/7/18	07:37	CLOSED	
9/17/18	16:40	OPEN	
9/24/18	08:21	CLOSED	3.8
10/3/18	00:35	OPEN	3.9
10/5/18	05:39	CLOSED	
1/5/19	11:46	OPEN	4.2
1/11/19	08:57	CLOSED	
2/1/19	16:10	OPEN(2)	

3/16/19	12:23	CLOSED	3.6
4/11/19	03:18	OPEN(1)	3.3
4/11/19	8:05	CLOSED	3.3
4/25/19	01:01	OPEN(1)	3.6
4/25/19	02:19	CLOSED	3.2
5/11/19	00:40	OPEN(1)	3.4
5/11/19	04:55	CLOSED	
6/5/19	01:30	OPEN(1)	3.7
6/5/19	08:52	CLOSED	3.7
6/8/19	08:51	OPEN(1)	3.7
6/10/19	08:36	CLOSED	
7/7/19	07:40	OPEN	4
7/29/19	07:20	CLOSED	4
7/31/19	11:29	OPEN	4
8/17/19	08:03	CLOSED	
8/17/19	20:41	OPEN	3.9
8/22/19	22:22	CLOSED	
9/1/19	15:07	OPEN	3.8
9/2/19	17:28	CLOSED	3.9
9/6/19	19:43	OPEN	3.9
9/13/19	09:35	CLOSED	
9/13/19	20:45	OPEN(1)	
9/14/19	09:29	CLOSED	
9/16/19	22:28	OPEN(1)	
9/17/19	07:51	CLOSED	
9/18/19	11:52	OPEN	
9/18/19	16:18	CLOSED	

(1) Valve opened due to communication failure to stream gage, not a low flow condition.
(2) False readings from gauge due to icing.

1.4. Agency Consultation

A copy of the draft report with a request for consultation was sent on October 22, 2019 by Christy Yearous with AEL&P to ADF&G, USFWS and NMFS by e-mail.

A copy of the request for consultation and comments received are in Appendix A.

NMFS provided comments between reports with a few formatting suggestions, graphs of 15 minute data were added in Appendix D and the operation of the supplemental valve for low flow conditions is shown on the graphs. Note that the data in Appendix D is corrected data and valve operations are based on instantaneous readings which are uncorrected. Another suggestion was to use a consistent left axis on the plots in Figures 1 – 5. Due to the large seasonal differences in flows, using a consistent axis made the plots harder to read so a best fit was used to best display the data recorded.

ADF&G provided comments which showed that Figure 2 needed to be updated, a corrected Figure 2 has been included in this final draft. The comments also questioned the arrows showing supplemental valve operation on 8/17/19. The valve was closed at 8:03am and then reopened later that same day. During the day 0.92" of rain was recorded at the Juneau International Airport, so there was a short increase of streamflow during that period. The arrows in Figure D5 have been updated to reflect operation of the valve. The last comment was regarding communications failures to the site, more information on what AEL&P is doing to improve communications has been included in the body of the report.

APPENDIX A: AGENCY COMMENTS

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P2307 Salmon Creek Stream Gage Annual Report (Water Year 2019).txt

From: Christy Yearous
Sent: Tuesday, October 22, 2019 8:10 AM
To: 'Keith, Kevin D (DFG)'; 'steve_brockmann@fws.gov'; 'sean.eagan@noaa.gov'
Cc: 'Crane Johnson - NOAA Federal'
Subject: P2307 Salmon Creek Stream Gage Annual Report (Water Year 2019)
Attachments: 20191022_P2307_StreamFlow_Report_review.docx

Per the Salmon Creek Streamflow Monitoring Plan, AEL&P is required to submit annual reports for the
AEL&P operated Salmon Creek stream gage. Attached is the DRAFT of the first annual report covering
the period from July 1, 2018 through September 30, 2019. Please provide comments to me via e-mail by
November 22, 2019. I will incorporate any comments received and submit the report to FERC by
December 1, 2019.

Please let me know if you have any questions or concerns. Thank all of you for working with us on this
project.

Thank you,
Christy Yearous
AEL&P
463-6387

ADFGComments_RE P2307 Salmon Creek Stream Gage Annual Report (Water Year 2019).txt
From: Keith, Kevin D (DFG) <kevin.keith@alaska.gov>
Sent: Tuesday, November 12, 2019 10:29 AM
To: Christy Yearous
Cc: Crane Johnson - NOAA Federal; steve_brockmann@fws.gov; sean.eagan@noaa.gov
Subject: ** EXTERNAL ** RE: P2307 Salmon Creek Stream Gage Annual Report (Water Year 2019)

Dear Christy,

Thank you for the opportunity to review the Salmon Creek Stream Flow Monitoring Report for Water Year 2019. ADF&G appreciates all your efforts to protect the fish resources of Salmon Creek.

The report is clear and concise. Figures 1 to 4 are a very nice summary of both the gage results and the discharge measurements that were taken to calibrate and verify the accuracy of the streamgage. Appendix D is very helpful for understanding the operation and timing of the supplemental valve.

We have two corrections and one comment/question:

1) Figure 2 is labeled as the “Fourth Quarter 2018 Corrected Discharge” but the data is the data from the Third quarter (i.e. a repeat of Figure 1). Please replace this with the graph for the Fourth Quarter.

2) Figure D5 has a yellow arrow (indicating that the supplemental valve was opened) on August 20th, but the hydrograph and the Table in Section 1.3 both indicate that the valve was opened on August 17th, not the 20th. If that is indeed the case, please correct Figure D5.

3) The report discusses ongoing communication problems with the cellular phone modem, and thus a loss of real-time streamflow data. ADF&G is concerned that, in the absence of real-time data, flows may drop below 9 cfs in Salmon Creek. To address this problem, AELP has opened the supplemental valve when communication with the streamgage is lost; is this AELP’s long-term solution to the communication problem or are you planning to reduce the communication failures?

Again, we appreciate the close attention that has gone into the stream flow

monitoring in Salmon Creek.
Please let me know if you have any questions.

-Kevin

Kevin D. Keith
FERC Hydropower Coordinator
Instream Flow Program
Alaska Department of Fish & Game

907-267-2836

From: Christy Yearous <Christy.Yearous@aelp.com>
Sent: Tuesday, October 22, 2019 8:10 AM
To: Keith, Kevin D (DFG) <kevin.keith@alaska.gov>; steve_brockmann@fws.gov; sean.eagan@noaa.gov
Cc: Crane Johnson - NOAA Federal <benjamin.johnson@noaa.gov>
Subject: P2307 Salmon Creek Stream Gage Annual Report (Water Year 2019)

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Please let me know if you have any questions or concerns. Thank all of you for working with us on this
project.

Thank you,
Christy Yearous
AEL&P
463-6387

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APPENDIX B: DAILY DISCHARGE TABLE OCTOBER 2016-SEPTEMBER 2019

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Salmon Creek

Identifier: Discharge.Daily Mean@Salmon Creek
Location: Salmon Creek Juneau
Units: ft^3/s
Filter: None

Year: Oct. 2016 to Sept. 2017 **Aggr:** 39 **Min:** 8.2 **Max:** 560

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	25	11	19	12	13	12	34	34	64	63	21	150
2	22	12	67	12	12	12	21	37	62	92	19	96
3	20	24	98	12	11	12	16	39	57	110	18	59
4	19	33	38	11	11	11	13	32	46	70	17	120
5	17	59	25	11	12	11	17	27	45	52	16	76
6	16	31	20	11	13	11	17	25	59	47	15	56
7	15	27	19	9.9	12	11	14	25	68	40	14	75
8	14	51	17	9.5	11	10	13	34	78	36	13	80
9	13	64	15	9	10	10	19	69	67	54	12	140
10	13	76	14	8.6	11	10	16	42	48	46	12	120
11	12	120	13	8.3	19	9.8	16	46	39	49	12	72
12	12	95	14	8.8	31	9.6	18	55	37	46	14	57
13	12	65	16	16	53	9.4	22	50	36	69	16	46
14	11	63	15	43	74	9.2	20	49	33	82	33	39
15	11	43	14	45	77	9	18	43	35	54	30	34
16	12	33	13	130	43	8.7	18	44	51	57	69	31
17	17	27	15	55	27	8.6	17	48	77	46	130	32
18	37	23	17	29	21	8.4	16	49	49	37	110	27
19	32	20	19	34	17	8.3	13	81	45	33	73	23
20	31	18	20	22	15	8.3	12	81	53	29	73	21
21	23	16	24	17	14	8.2	13	300	43	27	110	20
22	26	16	15	15	13	8.2	18	150	42	37	150	27
23	25	16	12	14	12	8.3	22	94	37	39	75	31
24	19	15	11	15	11	8.2	25	73	42	30	51	68
25	16	14	10	23	11	8.2	32	59	40	27	68	50
26	15	14	12	22	12	8.2	30	58	37	35	95	74
27	14	14	13	27	13	8.6	41	52	41	76	70	150
28	13	13	15	33	13	12	62	47	36	48	55	130
29	12	27	11	25		16	38	61	34	35	43	60
30	12	30	13	18		13	29	64	50	29	42	41
31	11		12	15		42		62		24	100	
Aggr	18	36	21	23	21	11	22	62	48	49	51	67
Min	11	11	10	8.3	10	8.2	12	25	33	24	12	20
Max	37	120	98	130	77	42	62	300	78	110	150	150

Salmon Creek - Daily Mean Discharge

Identifier: Discharge.Daily Mean@Salmon Creek
Location: Salmon Creek Juneau
Units: ft^3/s
Filter: None

Year: Oct. 2017-Sept. 2018 **Aggr:** 28 **Min:** 7.8 **Max:** 210

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	33	42	12	10	14	8.6	8.7	37	31	31	12	43
2	28	35	10	25	14	8.2	8.6	50	31	24	11	33
3	39	32	11	48	13	8.2	8.5	28	29	23	9.7	27
4	35	29	27	41	13	8	8.3	56	33	21	12	23
5	41	26	20	45	12	7.8	8.3	100	35	20	11	20
6	75	24	24	35	11	8	8.4	71	31	18	11	18
7	47	22	25	28	11	7.8	8.7	54	31	17	14	16
8	60	20	52	18	10	7.9	9.9	53	29	15	23	15
9	60	19	120	16	9.4	7.9	18	63	26	14	100	14
10	40	17	72	15	9.1	8.1	22	64	33	16	53	13
11	31	16	200	13	9.7	12	21	79	38	20	30	12
12	26	15	95	18	10	16	16	110	32	20	25	11
13	23	14	130	20	10	25	15	75	29	16	39	11
14	24	13	210	57	10	22	15	56	31	15	100	10
15	42	12	83	63	9.9	16	14	37	27	32	38	9.9
16	49	11	70	50	9.8	15	13	31	28	100	28	9.5
17	40	11	52	35	9.6	14	12	30	44	40	26	9.5
18	32	11	38	26	9.5	12	16	36	40	28	21	12
19	27	11	31	22	9.3	14	28	39	35	24	18	12
20	35	10	28	20	9.2	16	20	41	33	20	16	11
21	33	10	24	17	9	13	14	77	31	18	16	11
22	27	10	21	16	8.9	11	15	85	25	17	21	11
23	37	10	19	15	8.9	11	49	49	21	15	23	16
24	37	9.9	18	16	8.7	9.8	41	43	20	14	26	12
25	28	9.5	17	17	8.7	9.9	27	42	18	13	57	18
26	57	9.2	16	16	8.4	10	36	66	19	12	35	32
27	560	9.2	15	16	8.4	10	36	69	20	11	36	18
28	110	9.1	14	15	8.3	9.9	24	51	18	11	96	14
29	61	12	14	15		9.5	19	42	30	10	50	12
30	52	18	12	15		9.1	17	37	39	9.5	34	11
31	54		11	15		8.8		34		9.9	43	
Aggr	59	17	48	25	10	11	19	55	30	21	33	16
Min	23	9.1	10	10	8.3	7.8	8.3	28	18	9.5	9.7	9.5
Max	560	42	210	63	14	25	49	110	44	100	100	43

Salmon Creek - Daily Mean Discharge

Identifier: Discharge.Daily Mean@Salmon Creek
Location: Salmon Creek Juneau
Units: ft^3/s
Filter: None

Year: Oct. 2018-Sept. 2019 **Aggr:** 32 **Min:** 7.4 **Max:** 600

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	9.9	23	20	120	19	9.5	15	14	39	14	13	10
2	9.3	22	18	50	18	9.2	15	17	36	13	12	14
3	11	20	17	29	16	8.9	15	26	31	13	11	20
4	12	19	17	21	16	8.8	16	31	37	12	10	14
5	16	17	16	20	16	8.7	14	44	31	12	9.9	12
6	17	16	15	18	16	8.5	13	78	26	11	9.5	10
7	14	15	14	18	15	8.4	14	130	27	13	9.2	12
8	28	22	16	18	15	8.3	19	120	28	14	8.7	11
9	19	34	30	17	15	8.4	18	110	35	14	8.3	10
10	16	27	42	14	14	9.1	20	71	32	13	8.1	10
11	26	64	56	15	14	9.4	17	52	81	13	7.8	9.8
12	19	40	32	15	13	9.5	17	37	54	12	7.7	10
13	28	46	25	35	13	10	15	33	36	12	7.5	29
14	160	58	20	61	12	11	13	31	29	12	7.4	23
15	190	38	18	33	12	11	12	37	30	11	7.7	13
16	81	30	18	26	11	15	12	40	45	13	7.4	12
17	100	79	25	21	11	29	13	46	52	12	13	12
18	56	110	24	18	11	76	45	41	69	14	10	18
19	71	83	31	16	11	45	39	38	45	13	8.6	33
20	56	70	23	15	11	38	24	39	34	14	7.9	330
21	42	50	19	16	11	40	19	48	32	12	7.6	340
22	47	37	17	15	10	41	26	41	30	11	9.5	99
23	46	31	16	13	10	42	25	35	28	11	21	67
24	37	27	15	16	9.8	35	20	31	25	11	27	170
25	49	26	14	47	9.6	27	17	31	22	11	35	130
26	44	37	13	160	9.6	22	16	40	21	14	32	94
27	39	32	16	55	9.6	20	14	43	24	15	52	57
28	31	26	16	35	9.6	19	13	41	22	40	26	41
29	27	24	14	33		18	13	33	17	19	17	33
30	31	22	13	35		17	13	30	16	13	13	34
31	27		23	30		16		35		12	11	
Aggr	44	38	21	33	13	21	18	47	34	14	14	56
Min	9.3	15	13	13	9.6	8.3	12	14	16	11	7.4	9.8
Max	190	110	56	160	19	76	45	130	81	40	52	340

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APPENDIX C: STREAM RATING CURVE

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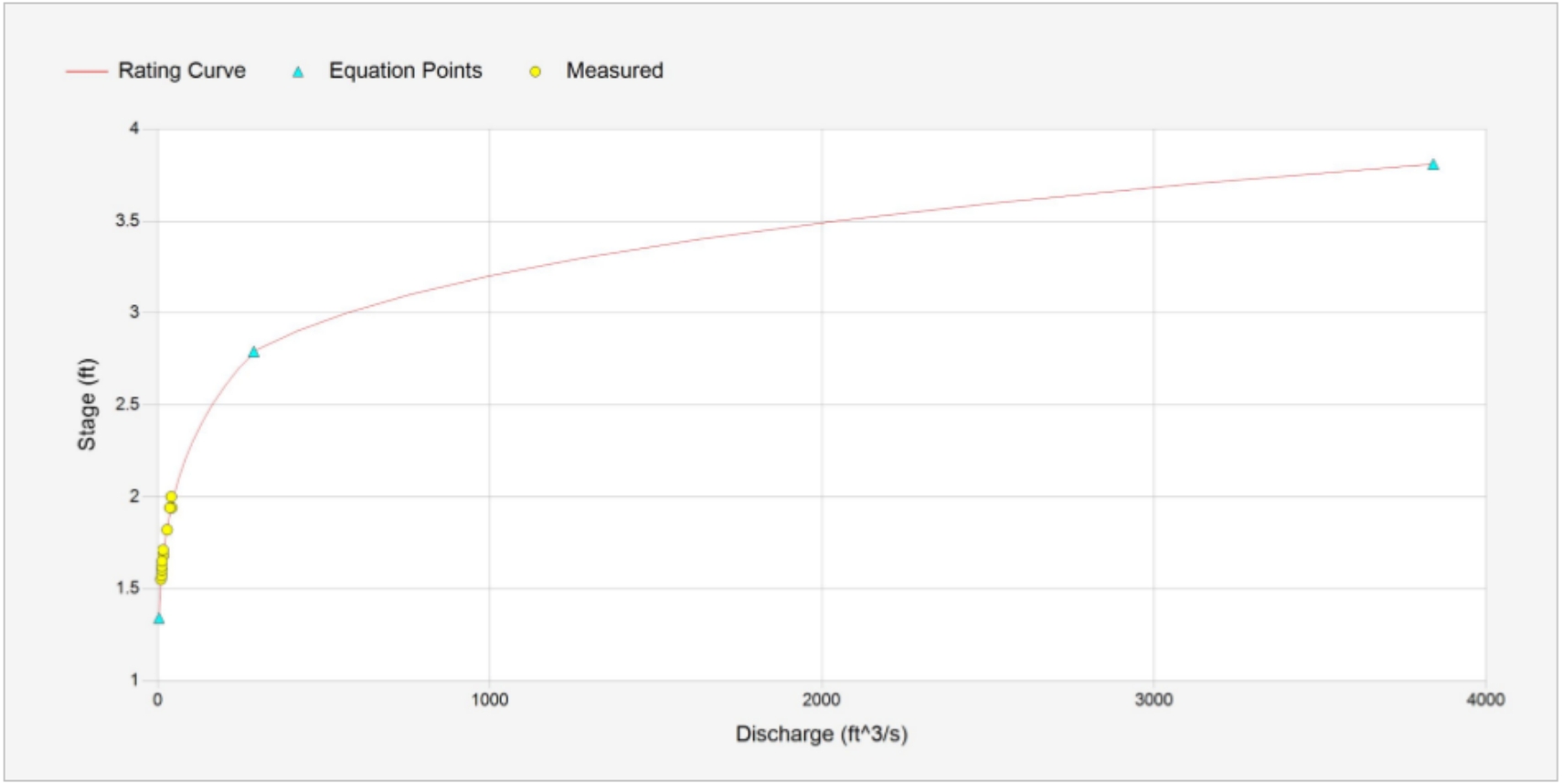
Rating Curve

Salmon Cr. Rating C001 - Begin date Feb. 05, 2018

Label: Salmon Creek
Description: Site ID-Salmon Creek

Curve on: October 15, 2019 Curve Start Date: February 5, 2018 Location: Salmon Creek Juneau



STATION NUMBER Salmon Creek Salmon Creek Juneau SOURCE AGENCY:
LATITUDE 49.28 LONGITUDE -123.11
Date Processed: 2018-07-27 10:44:09 UTC-09:00 By admin
Rating for Discharge (ft^3/s)
Created by admin on 2018-01-11 07:26:59 [UTC], Updated by admin on 2018-07-24 23:31:10 [UTC]
Remarks:

Offset1: 0.73 Offset2: 1.60
Breakpoint1: 2.79

EXPANDED CAQRating TABLE

Stage (m)	Discharge (ft^3/s)										DIFF IN Q PER
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	.1 UNITS
1.30					3.000*	3.189	3.386	3.592	3.807	4.031	2.108
1.40	4.265	4.509	4.763	5.027	5.302	5.587	5.884	6.192	6.512	6.843	2.922
1.50	7.187	7.544	7.913	8.295	8.691	9.100	9.524	9.961	10.41	10.88	4.173
1.60	11.36	11.86	12.37	12.90	13.45	14.01	14.59	15.19	15.80	16.44	5.730
1.70	17.09	17.76	18.45	19.16	19.89	20.63	21.40	22.19	23.00	23.84	7.600
1.80	24.69	25.57	26.47	27.39	28.34	29.31	30.30	31.32	32.36	33.43	9.830
1.90	34.52	35.64	36.79	37.96	39.16	40.39	41.65	42.93	44.24	45.58	12.440
2.00	46.96	48.36	49.79	51.25	52.75	54.28	55.83	57.42	59.05	60.71	15.440
2.10	62.40	64.12	65.88	67.68	69.51	71.38	73.28	75.22	77.20	79.22	18.870
2.20	81.27	83.36	85.50	87.67	89.88	92.13	94.43	96.76	99.14	101.6	22.730
2.30	104.0	106.5	109.1	111.7	114.3	117.0	119.7	122.5	125.3	128.2	27.100
2.40	131.1	134.1	137.1	140.2	143.3	146.5	149.7	153.0	156.3	159.7	32.000
2.50	163.1	166.6	170.1	173.7	177.4	181.1	184.8	188.6	192.5	196.5	37.300
2.60	200.4	204.5	208.6	212.8	217.0	221.3	225.7	230.1	234.6	239.1	43.300
2.70	243.7	248.4	253.1	257.9	262.8	267.7	272.7	277.8	282.9	288.2*	54.700
2.80	298.4	309.0	319.8	330.9	342.3	354.0	366.0	378.3	390.9	403.9	118.700
2.90	417.1	430.7	444.7	458.9	473.5	488.5	503.8	519.5	535.5	552.0	151.700
3.00	568.8	586.0	603.5	621.5	639.9	658.7	677.9	697.6	717.6	738.1	190.300
3.10	759.1	780.5	802.3	824.7	847.5	870.7	894.5	918.7	943.4	968.7	235.300
3.20	994.4	1021	1047	1075	1103	1131	1160	1190	1220	1250	287.600
3.30	1282	1313	1346	1379	1412	1447	1482	1517	1553	1590	346.000
3.40	1628	1666	1705	1744	1784	1825	1867	1909	1953	1996	413.000
3.50	2041	2086	2132	2179	2227	2275	2324	2374	2425	2477	488.000
3.60	2529	2583	2637	2692	2748	2805	2862	2921	2980	3041	573.000
3.70	3102	3165	3228	3292	3357	3423	3490	3558	3628	3698	667.000
3.80	3769										

"*" indicates a rating descriptor point

ID	Starting Date	Ending Date	Aging	Comments
C001	2018-02-05 12:00:00 [UTC-09:00]		0	

APPENDIX D: PLOTS OF 15 MINUTE DATA

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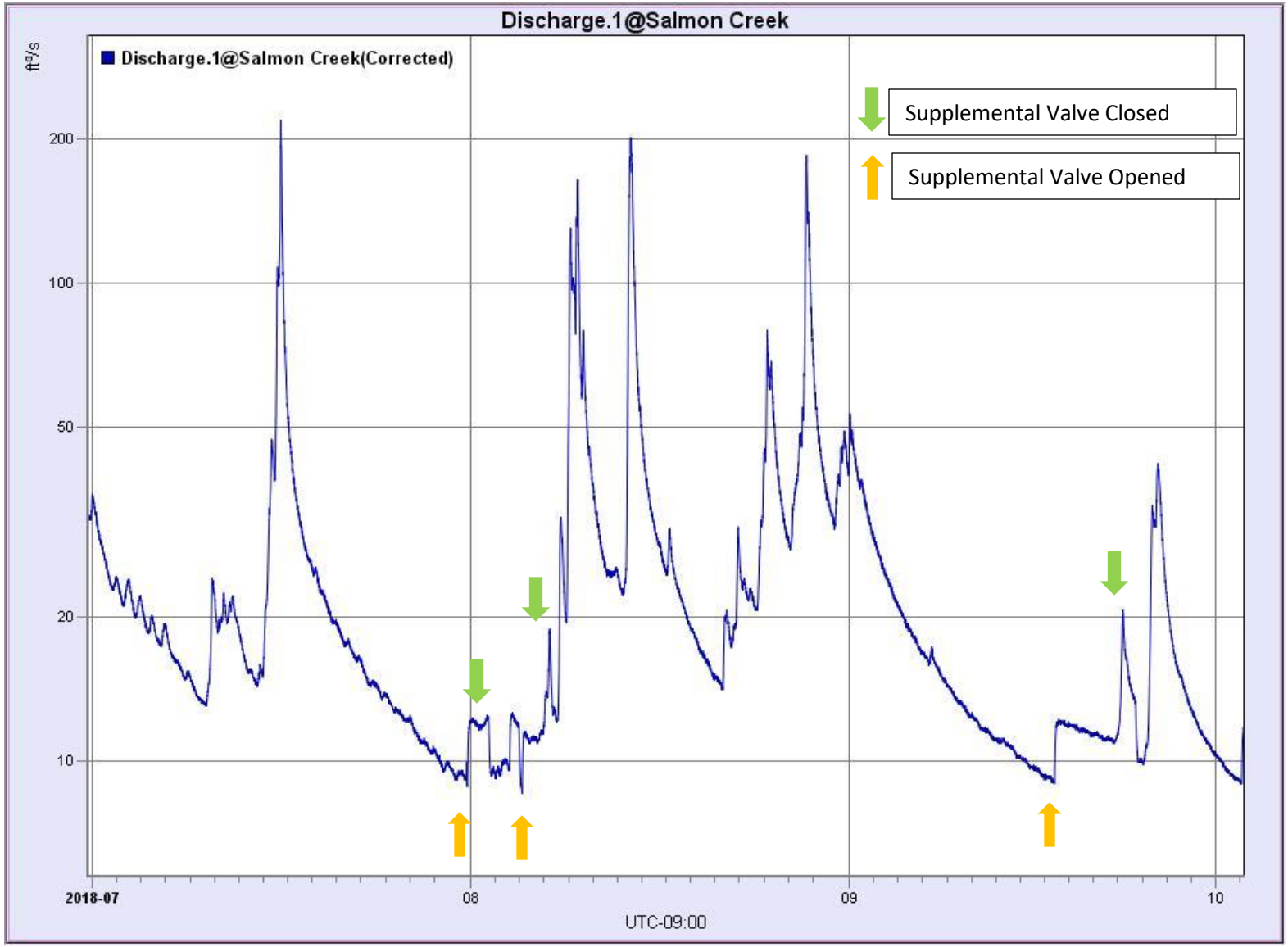

Figure D1 – Third Quarter 2018

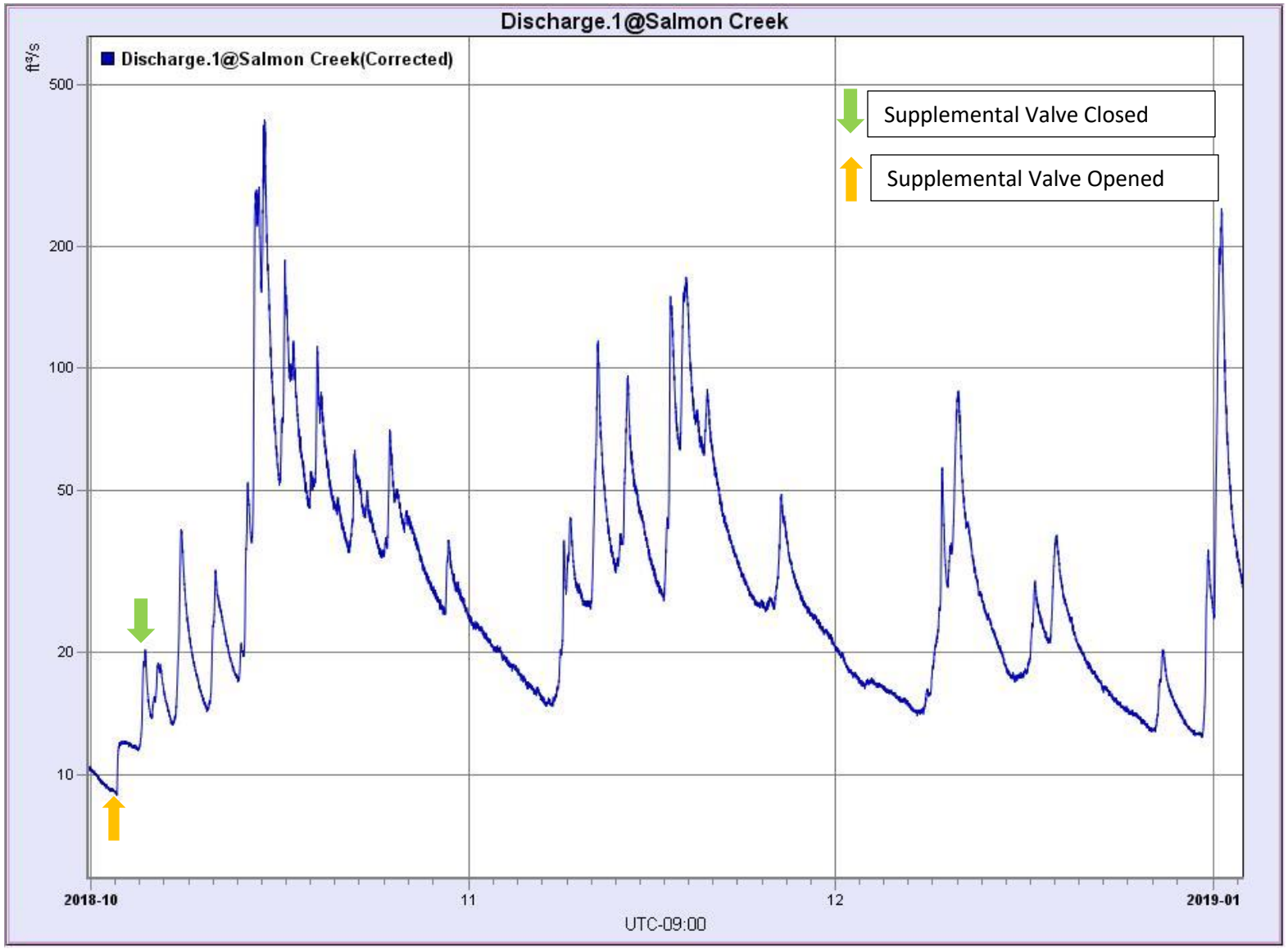

Figure D2 – Fourth Quarter 2018

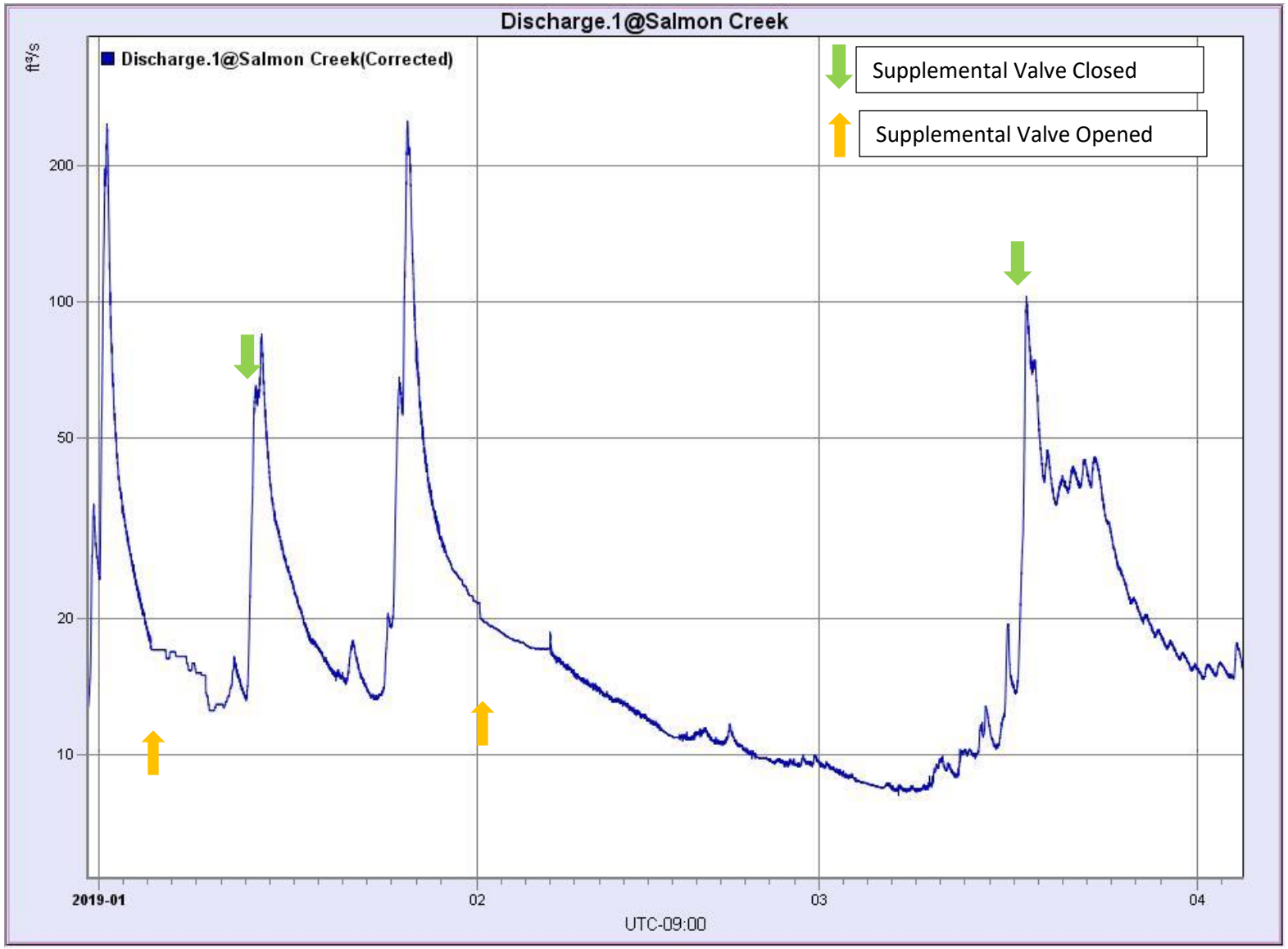

Figure D3 – First Quarter 2019

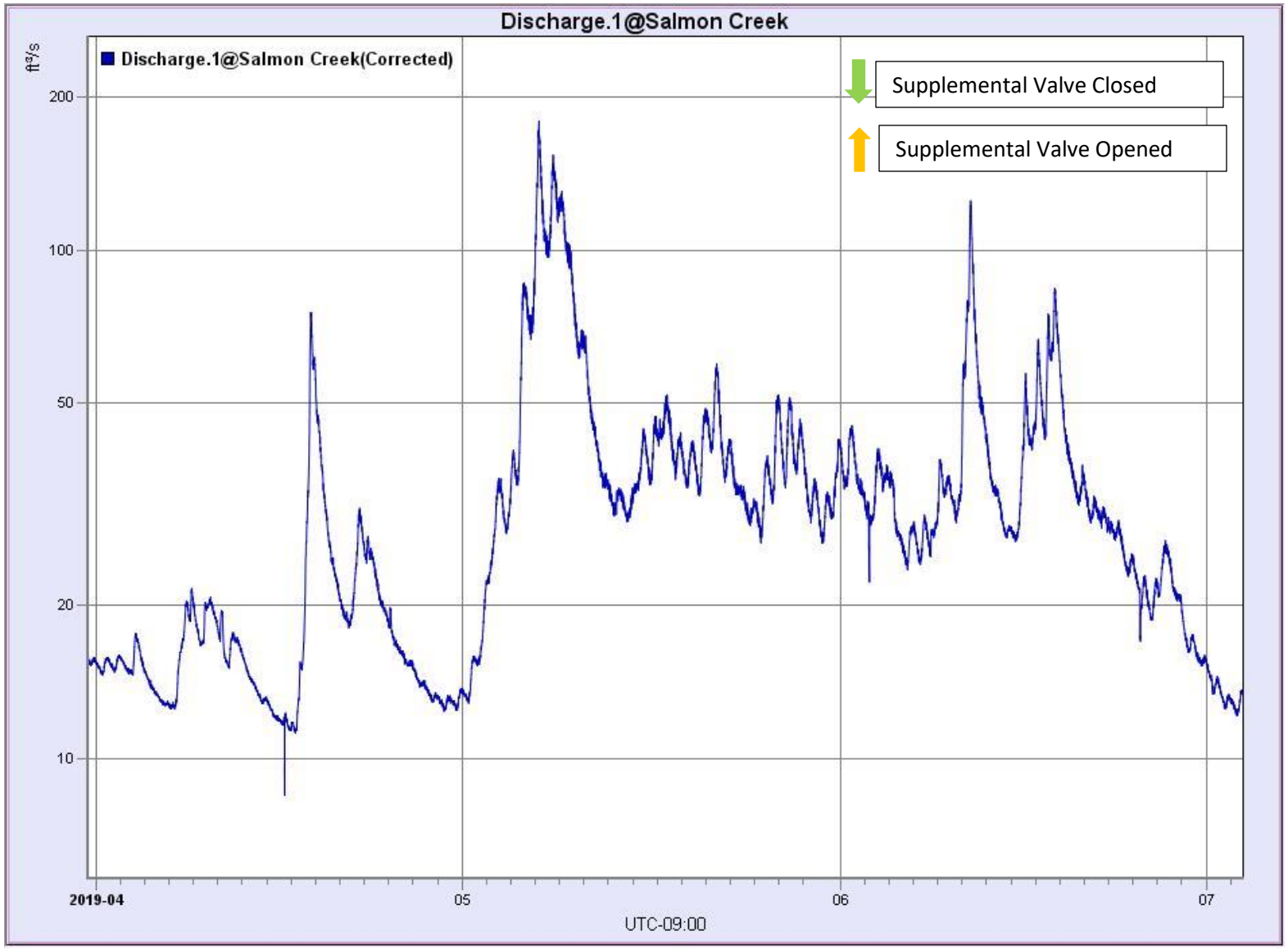

Figure D4 – Second Quarter 2019

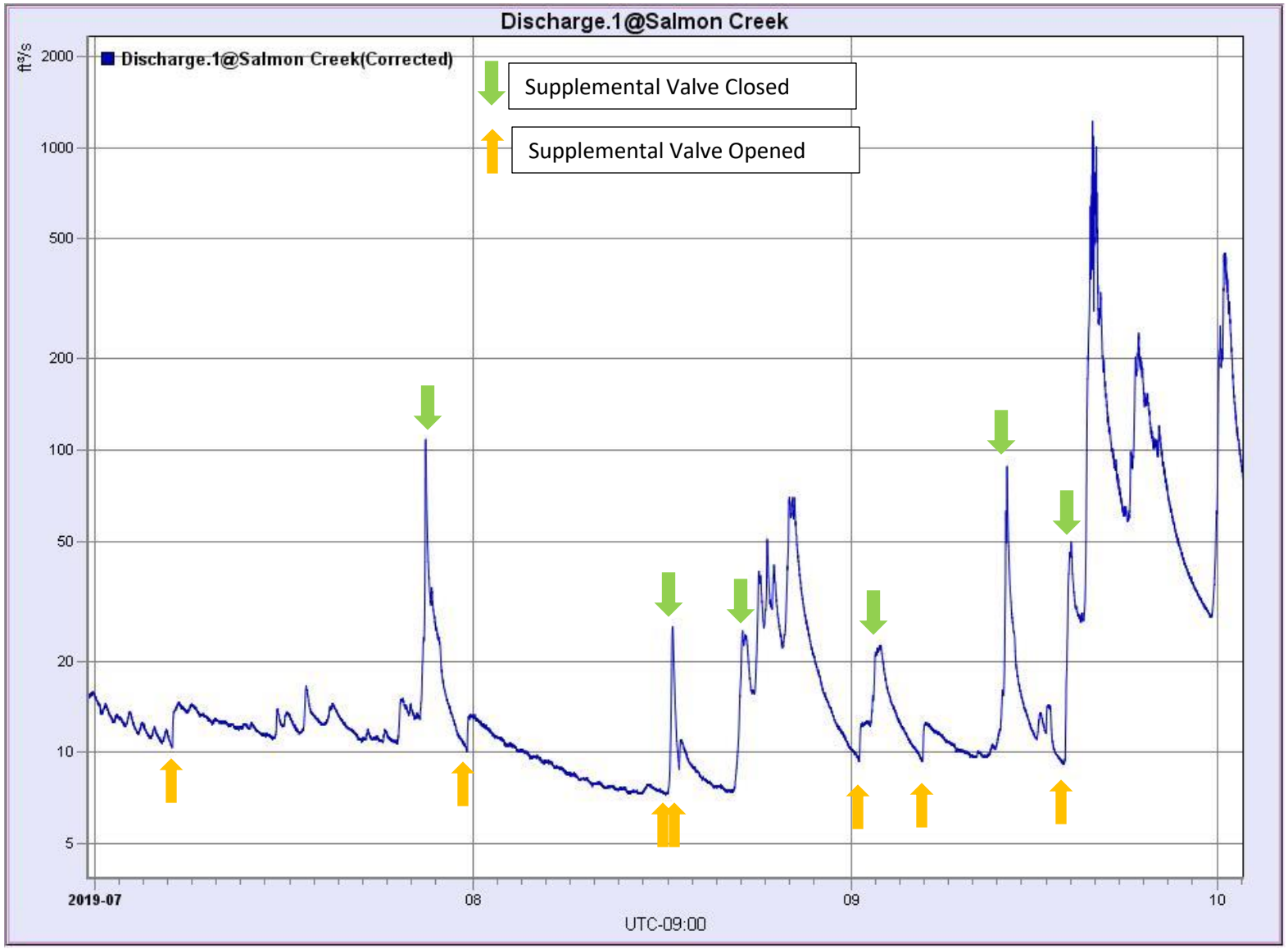

Figure D5 – Third Quarter 2019

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APPENDIX E: SALMON CREEK STATION DESCRIPTION AND ANALYSIS WATER YEAR 2019 (ALASKA HYDROSCIENCE)

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Salmon Creek Gaging Station near Juneau, Alaska

Station Description for the 2019 Water Year

LOCATION.—Lat 58°19'57", long 134°27'57" referenced to North American Datum of 1927, and Lat 58°19'56", long 134°28'04"referenced to World Geodetic System 1984. Gage is located on the left bank (when facing downstream), about 0.3 mi upstream from the mouth and 2.5 mi northwest of Juneau.

DRAINAGE AREA.—Drainage area 9.69 mi^2 as reported by the USGS, discharges are regulated.

ESTABLISHMENT AND HISTORY.—Gage established on April 27, 2016 at the same location and datum of U.S. Geological gaging station number 15051010.

GAGE.—A Campbell Scientific CS450 vented and temperature compensated transducer is coupled to a Campbell Scientific CR6 data logger and records stage data in 15 minute intervals. The transducer is housed in 1 inch galvanized pipe and set and referenced to vertical datum established by the U.S. Geological Survey (see reference marks). Additional equipment is housed in a gage house on left bank.

CONTROL.—Low flow control is a boulder/cobble riffle immediately below the orifice and staff gage. The channel is the control at medium and high stages. Shifting from the rating is possible at all stages as the gage reach can be alternately scoured and filled.

DISCHARGE MEASUREMENTS.—Measurements are made by wading in the vicinity of the gage. High flow measurements can be measured from a bridge approximately 0.25 mi downstream.

FLOODS.—U.S. Geological Survey recorded a maximum discharge of 2110 ft^3/s, Nov. 22, 2005 and gage height 4.20 ft. Minimum discharge recorded by the U.S. Geological Survey was 3.5 ft^3/s, March 17-20, 2006.

WINTER FLOW.—The stage-discharge relationship will be periodically affected by ice during cold periods during most winters.

REGULATION AND DIVERSIONS.—Flow is regulated by Salmon Creek Reservoir located 2 miles upstream. Diversion upstream for off-stream hydropower plant; outflow from the plant goes into Gastineau Channel and is not included in the discharge records. There is a supplemental water valve tapped off of the penstock at the base of the dam to supply additional water to Salmon Creek during periods of low flow. The valve discharges water directly into the natural channel. Operation of the valve is performed remotely by the AEL&P System Operator who also has real-time indication of the streamflow. When the flow drops to 9 ft^3/s, an alarm is generated and the Operator opens the valve and logs the operation.

ACCURACY.— Accuracy of the discharge records should be fair to good with the exception of ice affected record which will be fair to poor.

REFERENCE MARKS.—The gage is referenced to several vertical reference marks (RMs) established by the U.S. Geological Survey to accurately track vertical datum for the gage. The existing gage continues to reference these RMs to maintain accurate vertical datum.

RM 1 – Brass cap anchored in concrete 2 feet shoreward of the orifice on left bank, elevation 2.64 feet. This RM is the base RM from which to begin level surveys.

RM 4 – Lag bolt driven in 3 foot diameter spruce tree 20 feet from the left edge of water and 30 feet upstream of the orifice and outside staff gage, elevation 10.82 feet.

RP 1 – ¼ inch anchor bolt drilled in concrete block 1 foot upstream of orifice, elevation 2.44 feet.

RM 5 – ¼ inch lag bolt on upstream side of two foot diameter cottonwood 25 feet from left edge of water and 12 feet downstream of the orifice, elevation 8.574 feet.

RM 6 – ¼ inch lag bolt on upstream side of 1 foot diameter spruce tree, 15 feet from the left edge of water and 15 feet upstream of the orifice, elevation 7.774 feet.

2019 WATER YEAR STATION ANALYSIS

GAGE HEIGHT RECORD.—The gage height record is complete for the 2019 water year with no periods of missing record. The gage height record was periodically subject to backwater due to ice during which periods the discharges were estimated. In each of the last two winters for brief periods ice formation resulted in false low readings (see Jan. 2019, Figure 1.), as opposed to the typical backwater conditions created by ice. This was likely due to isolation of the gage transducer from the flowing stream. A discharge measurement made on Jan. 9, 2019 verified that these anomalies were related to temporary gage transducer issues rather than actual sudden reductions in discharge. Gage height record was subject to ice influence during the following dates:

Jan. 5-11, 2019; Jan. 29 – Feb. 6; Feb. 16-17; Feb. 23-24; and Mar. 4-6.

GAGE HEIGHT CORRECTIONS.—Gage height corrections to the recorder are used to adjust for differences between the recorded values and readings of the outside reference gage during site visits. Gage height corrections are typically prorated over time between site visits. Corrections ranged from -0.04 to +0.03 ft for the 2019 water year. A plot of corrected gage heights and measured field values of gage height is shown below in figures 1 and 2.

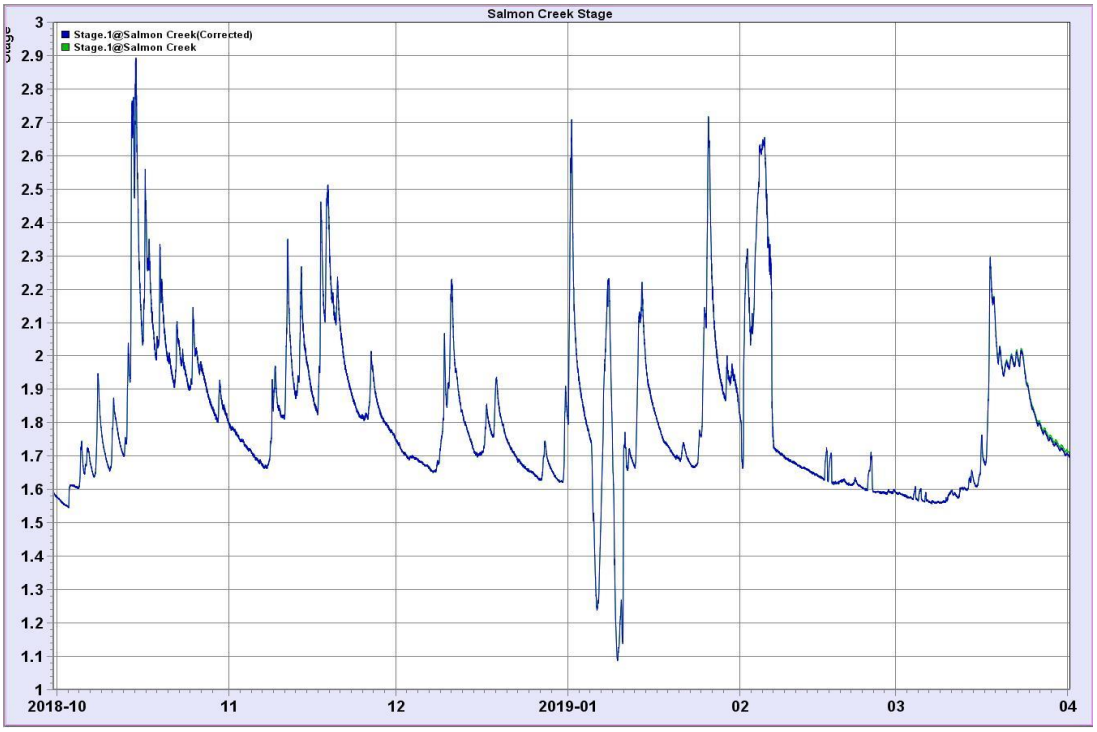


Figure 1. Stage data from Salmon Creek gaging station showing raw and corrected recorded values and field readings from the outside reference gage (Oct. 2018 to April 2019).

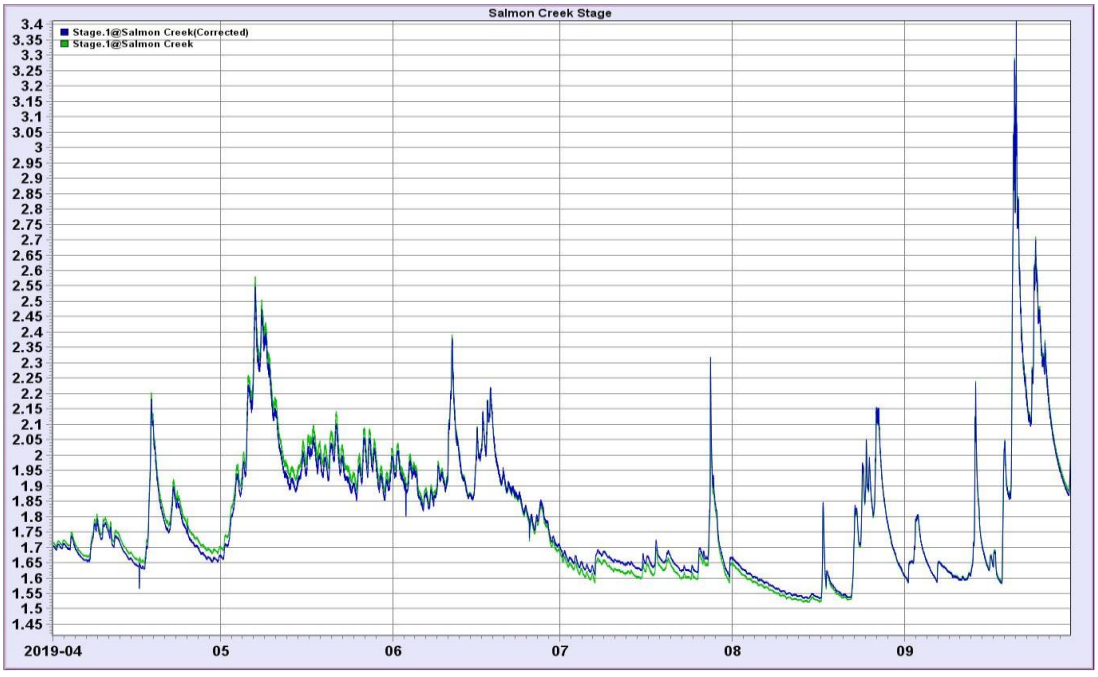


Figure 2. Stage data from Salmon Creek gaging station showing raw and corrected recorded values and field readings from the outside reference gage (April 2019 to October 2019).

DATUM CORRECTIONS.— A complete level survey conducted on May 22, 2016. No datum corrections were needed. A partial level survey was conducted on April 12, 2018 to determine a proper gage height following winter ice conditions. No datum corrections were needed based on this survey.

RATING.— The gage reach is under section control at low to midrange discharges and channel control at greater discharges. The gage reach is subject to scour and fill during peak flows and during salmon spawning season when salmon spawn throughout the gage reach. Rating 1 was developed by the USGS and continued in use with two stage variable shifts until Feb. 5, 2018. Discussion and description of rating 1 is covered in the 2017 water year station analysis report.

Rating 2 was put into use on Feb. 5, 2018 and was continued in use through the remainder of the 2019 water year. Rating 2 was developed to account for consistent scour conditions relative to rating 1 in lower to mid-range stages as defined by the more recent measurements in 2017 and 2018. The changes from rating 1 provide better definition of low to mid-range discharges without the need for application of stage variable shifts. Beginning in Jan. 2019 the channel conditions began to fill and a stage variable shift adjustment of -0.03 feet was applied to the rating at stages less than 2.00 feet as defined by measurements 21-24. This shift remained in place for the remainder of the 2019 water year.

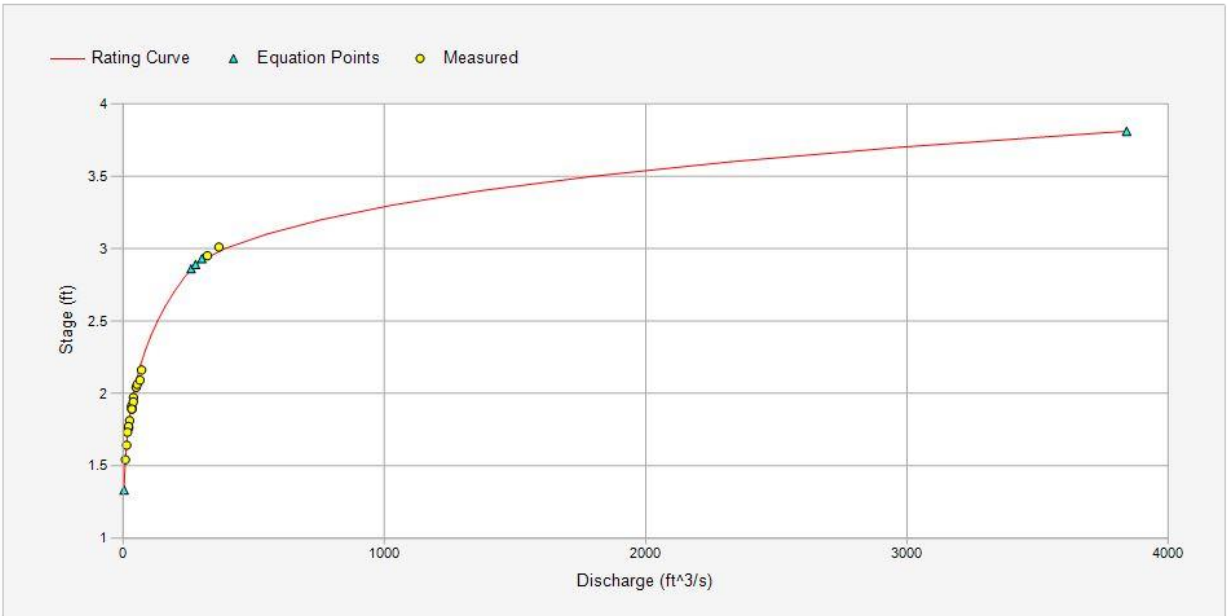
Six discharge measurements (numbers 19-24) ranging from 11.4-27.2 ft^3/s were conducted during the 2019 water year. Five of these measurements were used in rating analysis and one measurement was conducted under backwater conditions due to ice formation. Measurement number 18 was also used in the rating analysis and all measurements plotted within 6% of the rating when appropriate shifts were applied. Rating curve and rating equation points for both ratings are shown below:

Rating Curve

Salmon Creek Rating #1 2018 Water Year - Used to compute discharge with two stage variable shifts.

Label: Salmon Creek
Description: Site ID-Salmon Creek

Curve on: January 27, 2018 Curve Start Date: April 20, 2015 Location: Salmon Creek Juneau



Rating Curve

Salmon Creek Rating #1 2018 Water Year - Used to compute discharge with two stage variable shifts.

Label: Salmon Creek
Description: Site ID-Salmon Creek
Curve on: January 27, 2018 Curve Start Date: April 20, 2015 Location: Salmon Creek Juneau

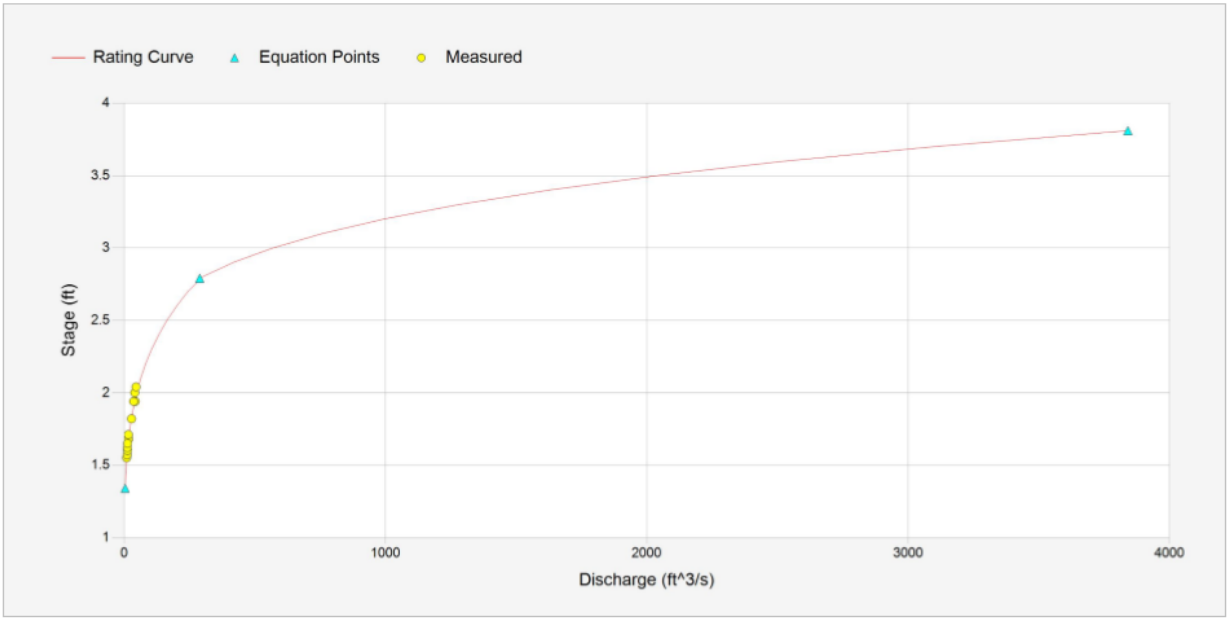
Stage (ft)	0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1.00	0.00	0.00	0.00	0.00	4.41	7.00	10.59	15.39	21.66	29.65
2.00	39.66	51.99	66.97	84.96	106.32	131.45	160.76	194.69	233.68	282.63
3.00	389.17	550.06	760.28	1,030.42	1,372.48	1,799.96	2,327.99	2,973.35	3,754.63	3,841.00

Figure 3. Salmon Creek Rating 1 used through Feb. 5, 2018 shown in graphic and tabular formats.

Rating Curve

Salmon Creek Rating #2 - Used to compute discharge for 2019 WY

Label: Salmon Creek
Description: Site ID-Salmon Creek
Curve on: October 1, 2019 Curve Start Date: February 5, 2018 Location: Salmon Creek Juneau



Rating Curve

Salmon Creek Rating #2 - Used to compute discharge for 2019 WY

Label: Salmon Creek
Description: Site ID-Salmon Creek
Curve on: October 1, 2019 Curve Start Date: February 5, 2018 Location: Salmon Creek Juneau

Stage (ft)	0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1.00	0.00	0.00	0.00	0.00	4.27	7.19	11.36	17.09	24.69	34.52
2.00	46.96	62.40	81.27	104.03	131.14	163.11	200.45	243.70	298.43	417.14
3.00	568.77	759.10	994.41	1,281.51	1,627.72	2,040.90	2,529.43	3,102.24	3,768.81	3,841.00

Figure 4. Salmon Creek Rating number 2 in effect from Feb. 5, 2018 through the 2019 water year, shown in graphic and tabular formats.

DISCHARGE RECORD.—Rating number 2 was used directly to compute discharge from the beginning of the 2019 water year through December 31, 2018. Rating number 2 was used with one stage variable shift (fig. 5) to adjust for slight fill conditions from January 1, 2019 through the remainder of the 2019 water year. The shift was defined by measurements 21-24 (shift 1) and corrects for slight fill in the control reach. The stage variable shift was in effect below stages of 2.27 feet, and in full effect at stages below 2.00 feet.

Stage record was affected by ice from Jan. 5-11 2019; Jan. 29 – Feb. 6; Feb. 16-17; Feb. 23-24; and Mar. 4-6. Discharges during periods of ice were estimated from discharge measurements, examination of the stage record, comparison with Juneau weather records and hydrographic comparison with the Mendenhall River near Juneau. Hydrographic comparison with the Mendenhall River is poor.

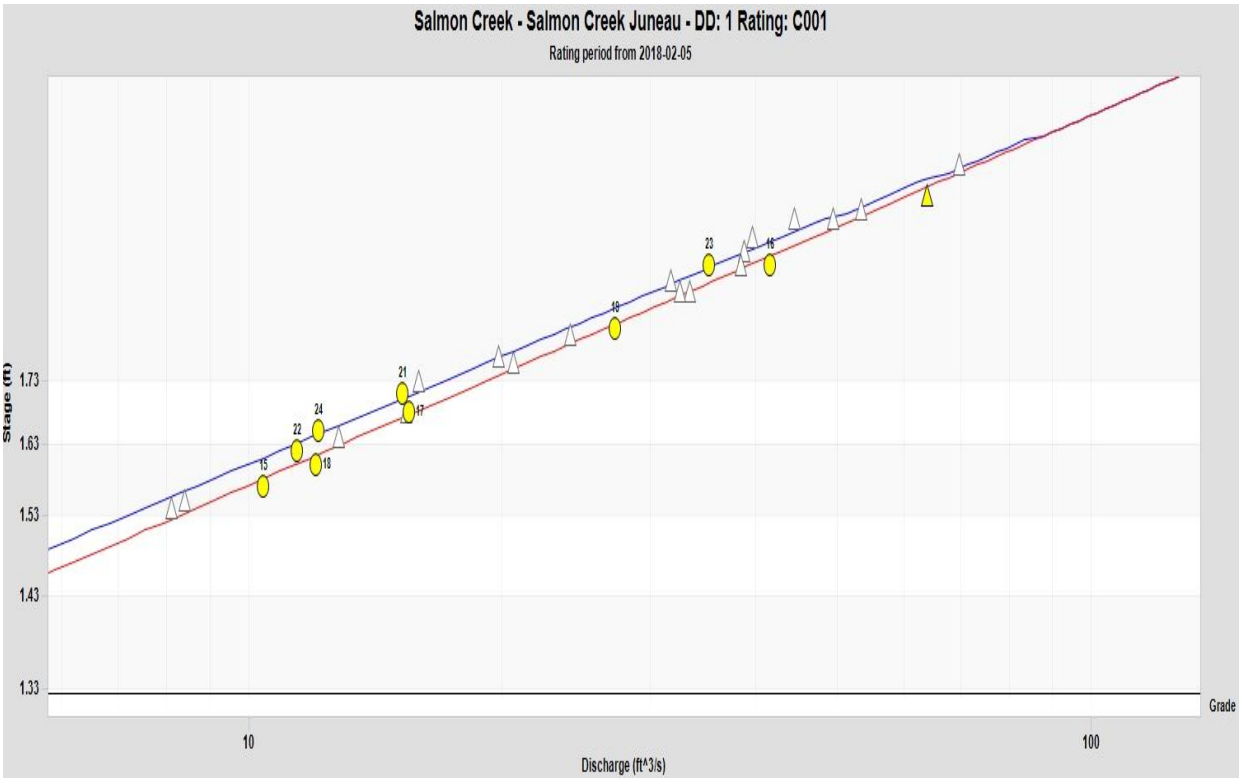


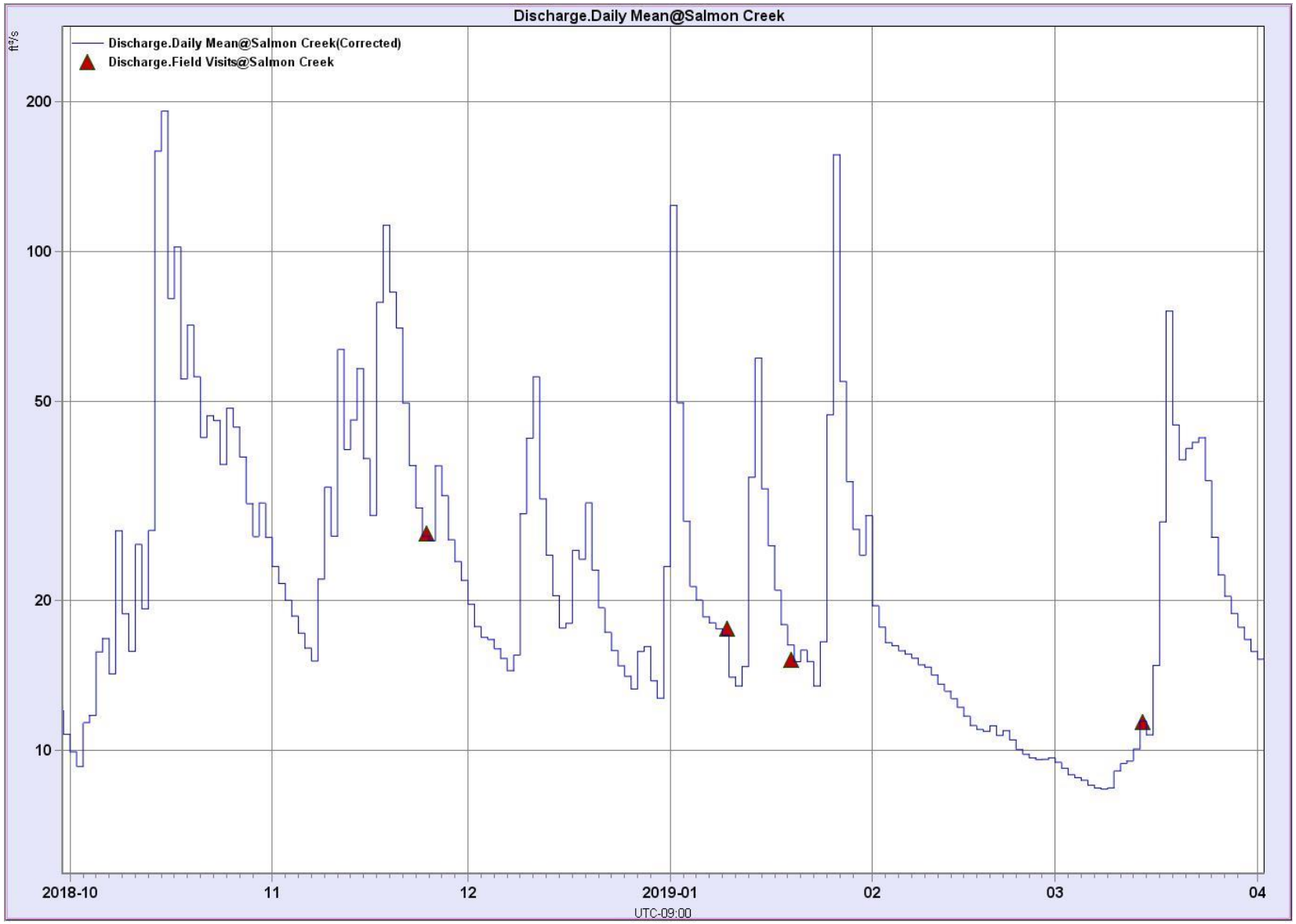
Figure 5. Salmon Creek rating number two (log scale) shown with stage variable shift used to compute discharge from January 01, 2019 through the remainder of the 2019 water year.

REMARKS.— Records of discharge are complete. Discharge records are fair to good for discharges below 300 ft^3/s and poor for larger discharges due to the relatively poor gage reach and lack of cross sections available to consistently make good discharge measurements. Discharges estimated due to backwater from ice are poor.

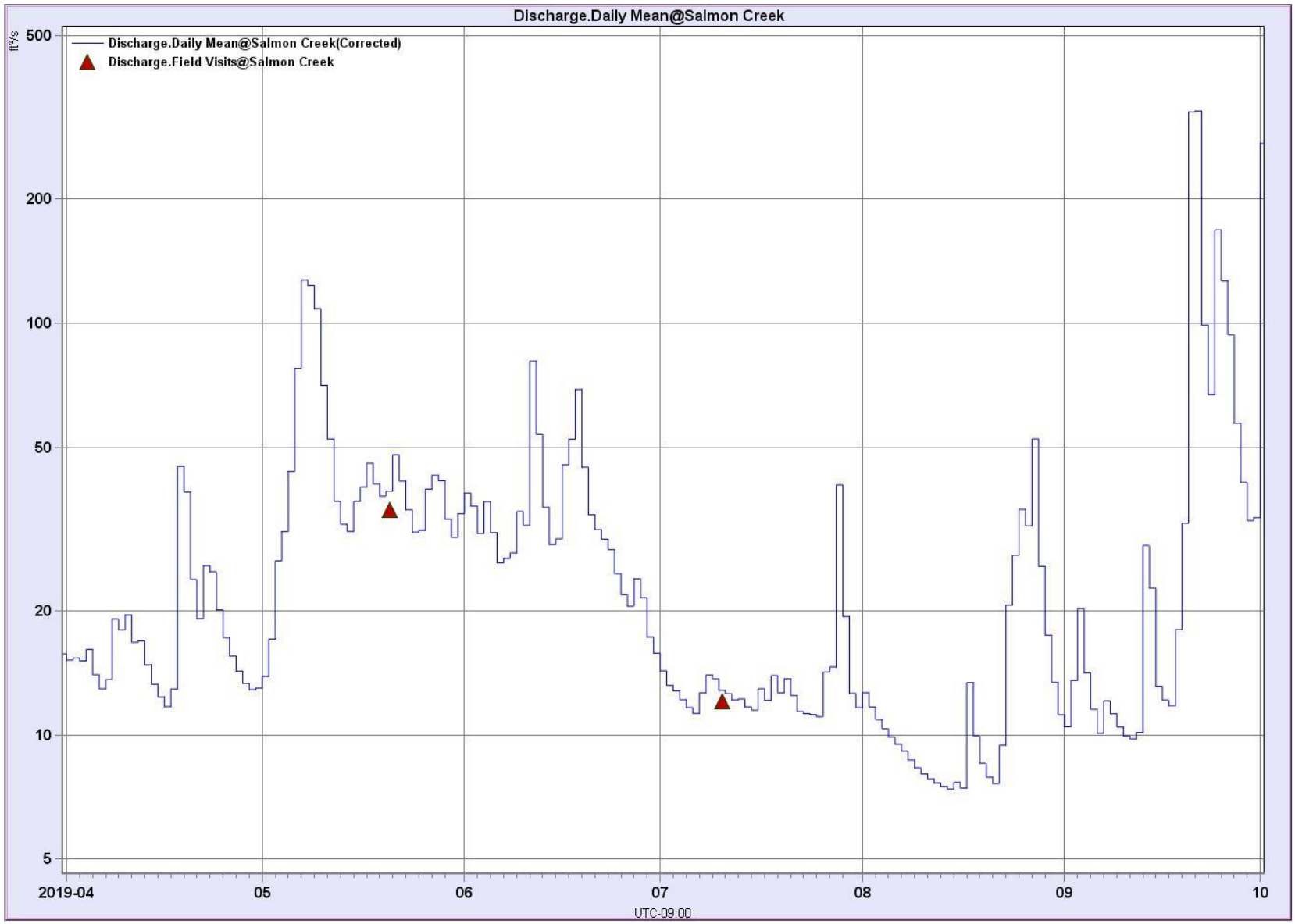
The following files were included as an attachment to this document:

Salmon Creek 15 min. 2019 Final.

Salmon Creek Daily Mean 2019 WY Final.



Computed daily mean discharge and field measurements for Salmon Creek near Juneau, Alaska from October 2018 to April 2019.



Computed daily mean discharge and field measurements for Salmon Creek near Juneau, Alaska from April 2019 to October 2019.

Identifier: Discharge.Daily Mean@Salmon Creek
Location: Salmon Creek Juneau
Units: ft^3/s
Filter: None

Daily Mean Discharge 2019 WY - Salmon Creek

Year: 2018 **Aggr:** 32 **Min:** 7.4 **Max:** 600

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	9.9	23	20	120	19	9.5	15	14	39	14	13	10
2	9.3	22	18	50	18	9.2	15	17	36	13	12	14
3	11	20	17	29	16	8.9	15	26	31	13	11	20
4	12	19	17	21	16	8.8	16	31	37	12	10	14
5	16	17	16	20	16	8.7	14	44	31	12	9.9	12
6	17	16	15	18	16	8.5	13	78	26	11	9.5	10
7	14	15	14	18	15	8.4	14	130	27	13	9.2	12
8	28	22	16	18	15	8.3	19	120	28	14	8.7	11
9	19	34	30	17	15	8.4	18	110	35	14	8.3	10
10	16	27	42	14	14	9.1	20	71	32	13	8.1	10
11	26	64	56	13	14	9.4	17	52	81	13	7.8	9.8
12	19	40	32	15	13	9.5	17	37	54	12	7.7	10
13	28	46	25	35	13	10	15	33	36	12	7.5	29
14	160	58	20	61	12	11	13	31	29	12	7.4	23
15	190	38	18	33	12	11	12	37	30	11	7.7	13
16	81	30	18	26	11	15	12	40	45	13	7.4	12
17	100	79	25	21	11	29	13	46	52	12	13	12
18	56	110	24	18	11	76	45	41	69	14	10	18
19	71	83	31	16	11	45	39	38	45	13	8.6	33
20	56	70	23	15	11	38	24	39	34	14	7.9	330
21	42	50	19	16	11	40	19	48	32	12	7.6	330
22	47	37	17	15	10	41	26	41	30	11	9.5	99
23	46	31	16	13	10	42	25	35	28	11	21	67
24	37	27	15	16	9.8	35	20	31	25	11	27	170
25	49	26	14	47	9.6	27	17	31	22	11	35	130
26	44	37	13	160	9.6	22	16	40	21	14	32	94
27	39	32	16	55	9.6	20	14	43	24	15	52	57
28	31	26	16	35	9.6	19	13	41	22	40	26	41
29	27	24	14	28		18	13	33	17	19	17	33
30	31	22	13	25		17	13	30	16	13	13	34
31	27		23	30		16		35		12	11	
Aggr	44	38	21	33	13	21	18	47	34	14	14	55
Min	9.3	15	13	13	9.6	8.3	12	14	16	11	7.4	9.8
Max	190	110	56	160	19	76	45	130	81	40	52	330

Date Processed: November 16, 2019 21:45