Summary of Hydrology Data Collected for Cop 42, 43, 44 & 45 To date
4/22/2019
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Between 9/5/2018 to 3/18/2019, USFWS and Copper River Watershed Project collected flow measurements at sites COP42, 43, 44 and 45 and two pressure transducer gages recorded stage at COP42 and 44 (Table 1). This data summary report includes low flow observations and very tentative peak streamflow estimates. Prior to using the numbers in this report it should be noted that all correlations used are tentative at this point, especially for peak flow. A total of 6 flow measurements were used and a single high flow measurement collected on 12/7/2018 heavily influences all relationships. Confidence in low flow values is much greater than peak flow values.

Low Flow Conditions
The flow record from The COP42 gage proved useful for low flow observations, while the COP44 gage experienced a falling base level that resulted in considerable uncertainty in discharge (Figure 3, 4 & 5). The COP44 gage may have behaved differently due to downstream beaver activity or ice diverting flow away from this pipe. Given the issues with the COP44 gage, the flow measurements from the ungaged sites, COP 43 and COP45, were correlated to the COP42 gage to create a record of daily flow for all sites (Figure 6 ,7 & 8).

The lowest flows were observed in January, February and March (Figure 1) where flows <0.1 cfs were observed at all four sites (Figure 2). The lowest mean daily flows for the months of September and October may be a good low design flow for fish movement (Figure 2). Between COP42, 43 and 45 the lowest daily mean flow for the months of September and October ranged from 0.2 - 1 cfs, while COP44 had a higher low flow during those months at 1.2 cfs. Low flow fish passage channel design could potentially be 0.2 cfs for COP 45, and approximately 1 cfs for both COP43 and COP44.

Peak flow Estimates
To develop peak flow estimates, I took the sum of discharge for the 3 sites slated for replacement (COP43, 44, & 45) and correlated their combined flow to the USGS "Glacier River Trib" gage # 15215900 record (Figure 9, Table 2). Summing the 3 sites was meant to eliminate the problems caused by the shifting flow between sites. For comparison I also made peak flow estimates by summing all 4 sites investigated (COP42, 43, 44, 45) as it appears they are all related (Table 2). The USGS gage record provides 7 years of peak flows. I have low confidence in the peak flow estimates until data is collected on additional high flow events.

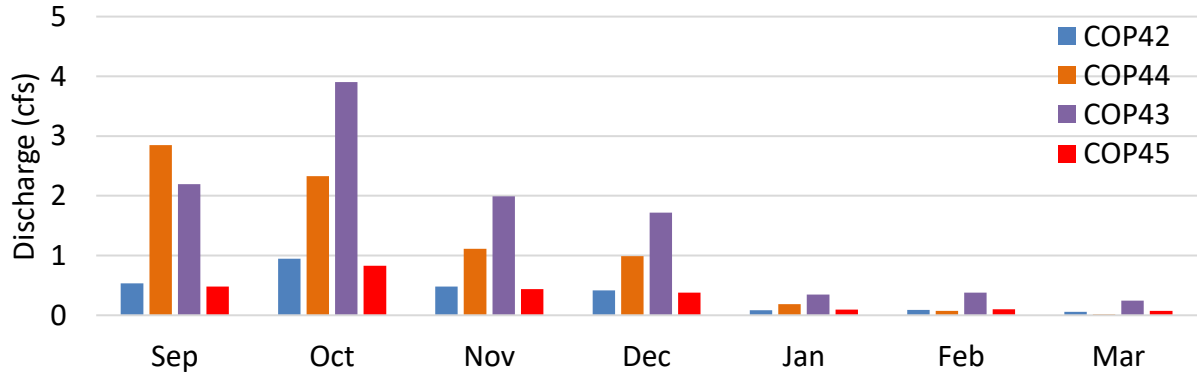

Figure 1. Average monthly discharge at COP 42, 43, 44 and 45 from mean daily discharge data.

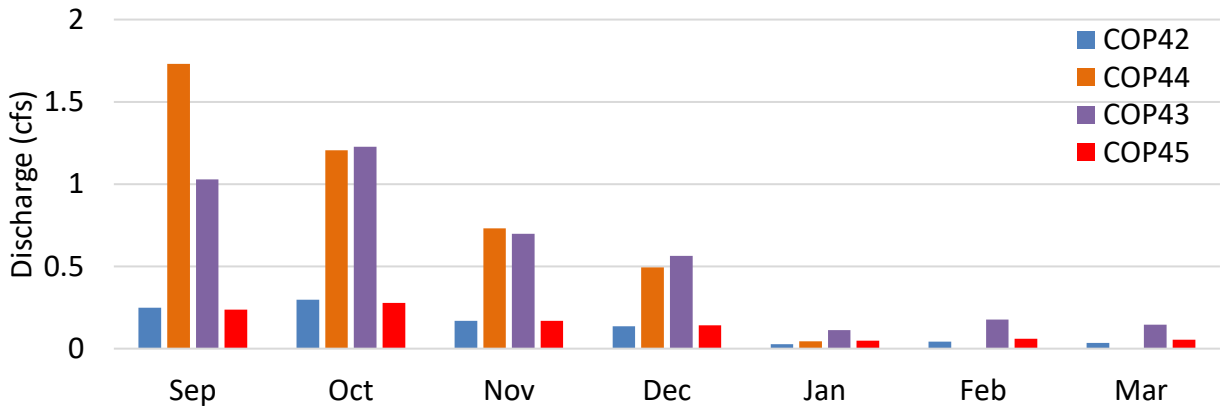

Figure 2. Lowest mean daily discharge at sites COP42, 43, 44 and 45 in each month.

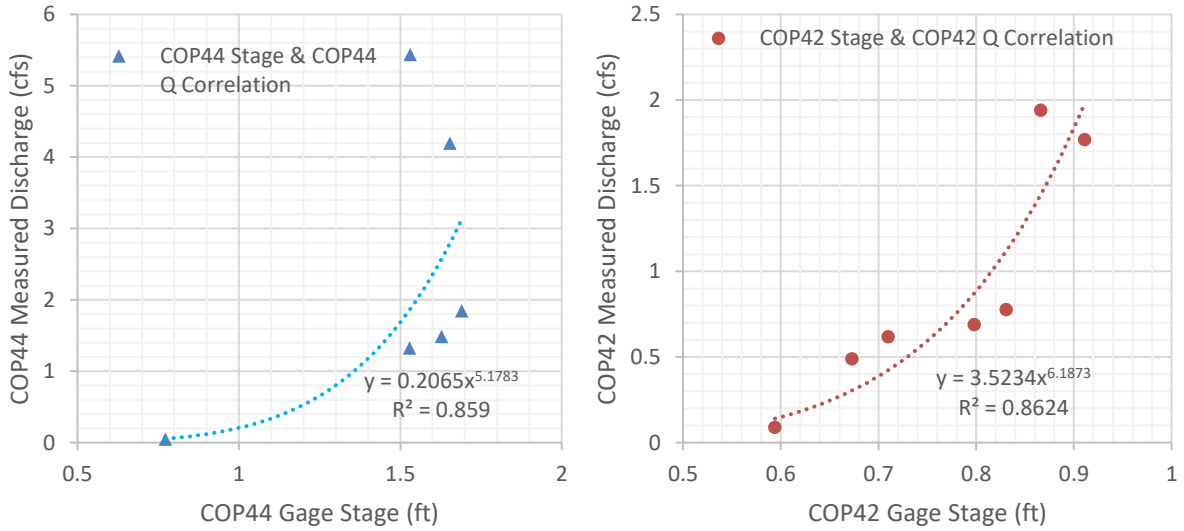

Figure 3. Correlations between the COP 42 and COP 44 gage stage (ft) to the measured discharge (cfs) at each site to create a record of continuous discharge (Figure 4 & 5).

Table 1. Flow measurements taken to date at COP 42, 43, 44 ,45.

Site number	Measure #	Date	Time	Area (ft)	Width (ft)	Flow (cfs)	Gage Stage (COP42)	Gage Stage (COP44)	Method	# of stations	Team
COP44	1	9/5/2018	10:52	7.4	4.8	4.2		1.65	OTT	17	FD
COP44	2	10/9/2018	19:00	4.04	3.9	1.33		1.53	pygmy	12	FD
COP44	3	10/10/2018	17:33	4.39	3.55	1.85		1.69	pygmy	18	FD
COP44	4	10/11/2018	10:49	4.39	3.8	1.49		1.63	pygmy	14	FD
COP44	5	12/7/2018	10:00	5.21	3.94	5.44		1.53	OTT	14	KJ
COP44	6	3/18/19	10:00	1	3.94	0.05		0.77	estimate		FD
COP42	1	9/5/2018	11:24	1.741	4	0.49	0.67		OTT	12	FD
COP42	2	10/9/2018	18:02	0.99	2.4	0.69	0.80		pygmy	12	FD
COP42	3	10/10/2018	16:34	1.06	2.55	0.78	0.83		pygmy	14	FD
COP42	4	10/11/2018	11:31	0.97	2.35	0.62	0.71		pygmy	12	FD
COP42	5	12/7/2018	11:15	4.52	3.28	1.77	0.91		OTT	11	KJ
COP42	6	12/7/2018	11:45	3.99	4.59	1.94	0.87		OTT	15	KJ
COP42	7	3/18/2019	10:23	0.15	1.5	0.09	0.59		pygmy	3	FD
COP43	1	9/5/2018	10:00			0			estimate		FD
COP43	2	10/9/2018	18:42	1.02	2.4	1.27	0.85	1.85	pygmy	14	FD
COP43	3	10/10/2018	17:06	1.54	3.35	1.74	0.78	3.17	pygmy	17	FD
COP43	4	10/11/2018	11:14	1.09	2.6	1.39	0.44	2.56	pygmy	12	FD
COP43	5	12/7/2018	10:45	3.24	3.12	9.99	2.03	1.88	OTT	11	KJ
COP43	6	3/18/2018	9:45	1.03	3.28	0.71	0.13	0.05	OTT	10	KJ
COP45	1	9/5/2018	10:27	8.139	8.99	0.74	0.29	2.64	OTT	15	FD
COP45	2	10/9/2018	19:18	0.54	3.2	0.10	0.87	1.86	pygmy	7	FD
COP45	3	10/10/2018	18:11	1.15	2.2	0.34	0.80	3.13	pygmy	12	FD
COP45	4	10/11/2018	11:52	1.13	2.3	0.21	0.44	2.58	pygmy	11	FD
COP45	5	11/28/2018	10:15	4.24	3.61	0.71	0.65	1.52	OTT	11	KJ
COP45	6	11/28/2018	10:45	2		1.17	0.67	1.56	OTT	14	KJ
COP45	7	12/7/2018	9:30	1.97	4.27	2.08	2.22	1.81	OTT	13	KJ
COP45	8	3/18/2019	10:00			0.03	0.13	0.05	estimate		FD

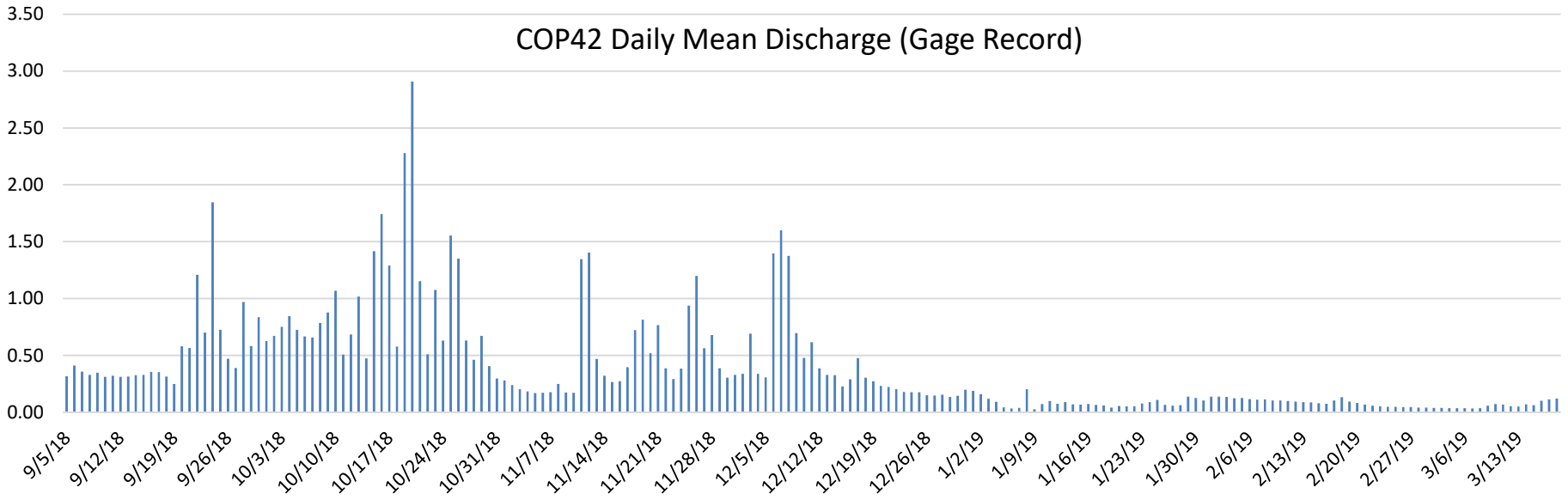

Figure 4. Mean daily discharge for COP42 derived from the COP42 pressure transducer gage and seven flow measurements. The gage indicated the highest daily mean flow was on 10/20/2018 (2.91 cfs) and the lowest was on 1/6/2019 (0.03 cfs).

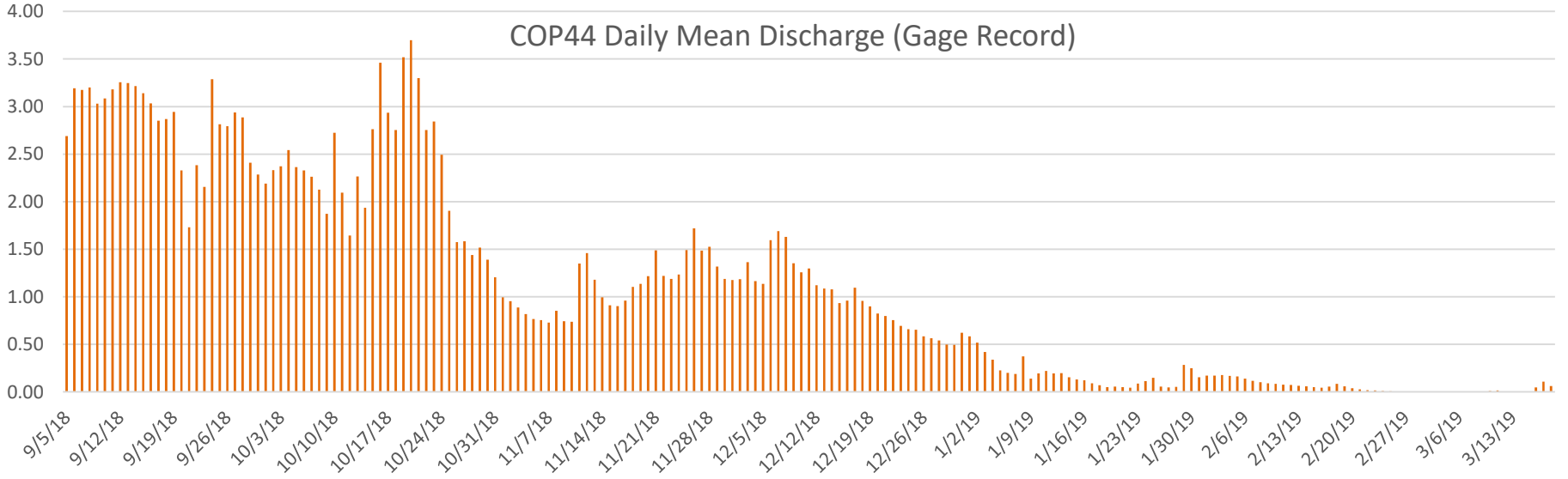

Figure 5. Mean daily discharge for COP44 derived from the COP44 pressure transducer gage and six flow measurements. The gage indicated the highest daily mean flow was on 10/20/2018 (3.70 cfs) and the lowest were in February and March (0.0 cfs).

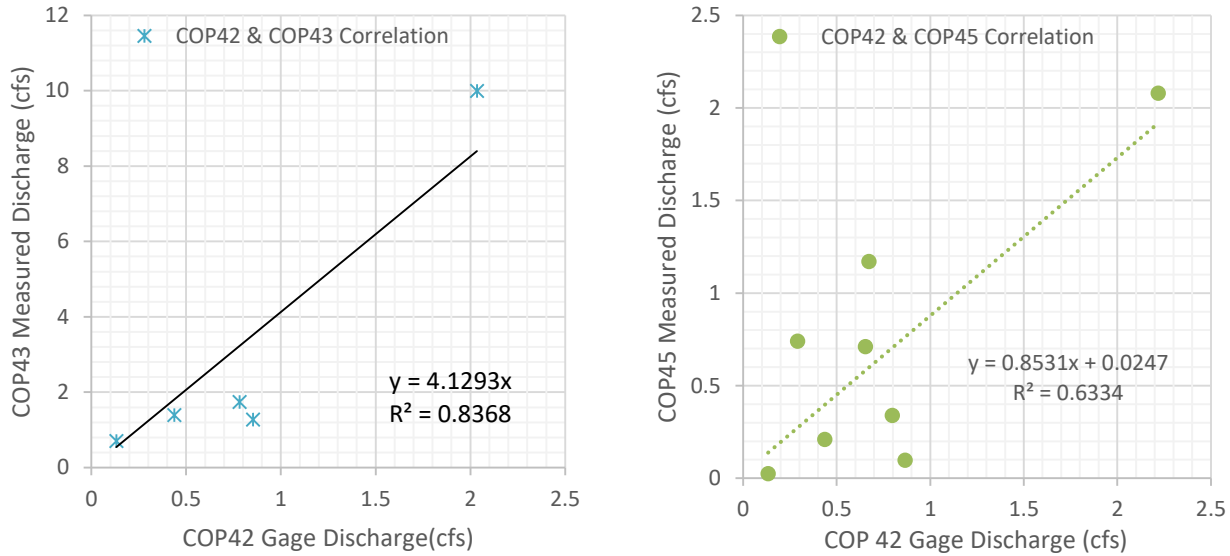

Figure 6. Correlations between the COP 42 gage discharge record and the flow measurements collected at COP43 and COP45. The regression equations were used to create continuous flow records for both ungaged sites (Figure 7 & 8).

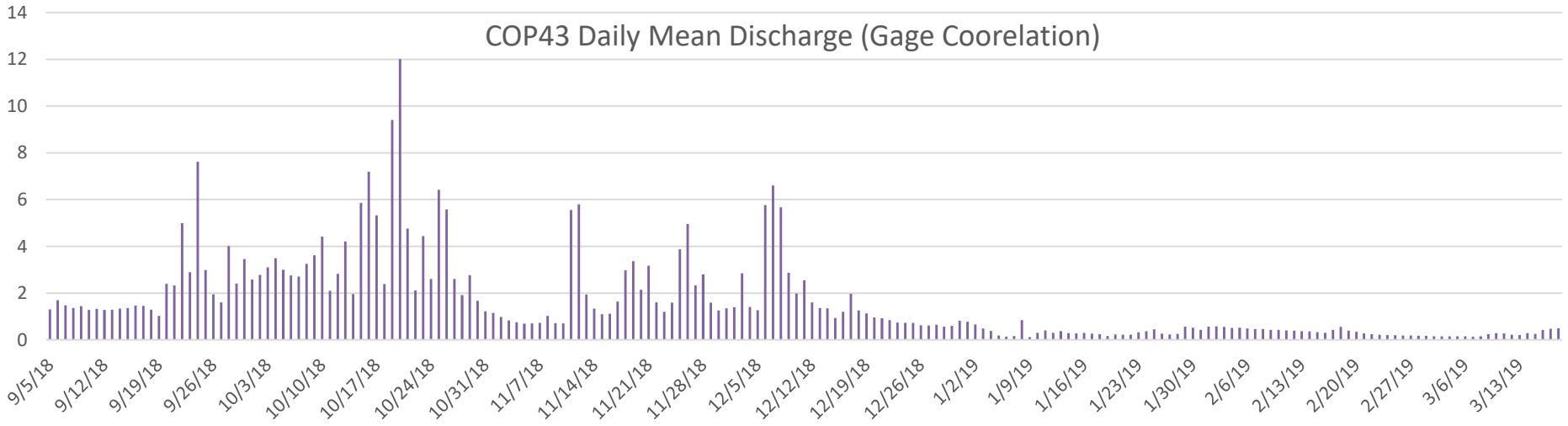

Figure 7. Mean daily discharge for COP43 derived from the COP42 pressure transducer gage record and the 6 flow measurements taken at COP43. Flow measurements ranged from 1.5 to 9.99 cfs (when flow was not blocked by beaver activity), but the gage correlation indicated the highest daily mean flow was on 10/20/2018 (11.8 cfs) and the lowest was on 1/9/2019 (0.6 cfs).

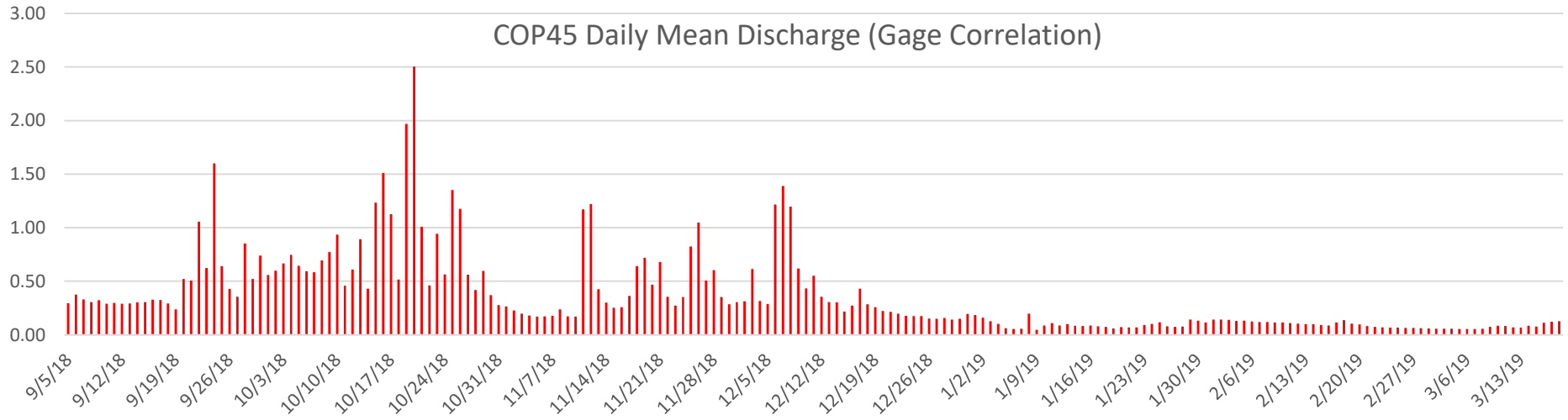

Figure 8. Mean daily discharge for COP45 derived from the COP42 pressure transducer gage record and the 8 flow measurements taken at COP45. Flow measurements ranged from 0.025 to 2.08 cfs, but the gage correlation indicated the highest daily mean flow was on 10/20/2018 (2.5 cfs) and the lowest was on 3/7/2019 (0.05 cfs).

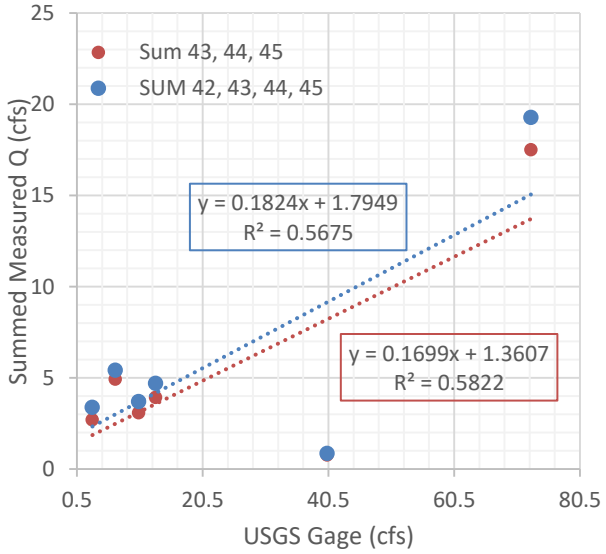

Figure 9. The correlation between the summed site discharges and the USGS Gage. Six flow measurements were included between 9/5/2018 to 3/18/2019. The relationship is strongly influenced by the single large flow measured on 12/7/2018. Also, if the observation from 3/18/2019, which plots below the trend line, is removed the R^2 improves to 0.9.

Table 2. Peak streamflow magnitude and frequency estimates based on the correlation between the sum of flow measurements to the USGS "Glacier River Trib" Gage # 15215900. The gage relationship is strongly influenced by the single large flow measured on 12/7/2018. Also, if the flow measurement from 3/18/2019 is removed from the gage correlation, the peak flow magnitudes increase by approximately 25%.

RI	Sum of COP 43, 44, & 45 Q (cfs)	Sum of COP 42, 43, 44, & 45 Q (cfs)
1.0001	45	48
2	**73**	**79**
5	82	89
10	88	95
20	93	100
25	94	101
40	97	104
50	98	106
100	**102**	**110**
200	106	114