

TECHNICAL MEMORANDUM BCWA

Date: February 11, 2015
To: *Bear Creek Watershed Association*
From: Russell N. Clayshulte, Manager
Re: **TM 2014.02 - Summit Lake Monitoring**



Sampling Program

Bear Creek Watershed Association maintained four sampling stations at Summit Lake and upper Bear Creek, Mt Evans Wilderness, Clear Creek County Colorado. The Association selected sampling Site 36 (Summit Lake near the outfall culverts), Upper Bear Creek Site 37 downstream of ponds #1 and #2 on the mainstem of Bear Creek, site 65 between ponds #1 and #2, and Site 63 at the bottom of the plume. The 2014 monitoring data is summarized in the technical memorandum.

In 2014, there was a concern raised by the Denver Department of Environmental Health that the BCWA doesn't have sufficient data to conclude there is a pollution plume at Summit Lake. Denver Department of Environmental Health notes *"That said, when presenting it in the report, I don't feel its scientifically sound to present it as a conclusive finding that this (vaults) is the one cause of all deleterious effects observed or measured in the headwaters."*

The BCWA has not overstated its conclusions. The 2013 annual report Summit Lake section reads:

Bear Creek Watershed Association continued to monitor four sampling stations at Summit Lake and upper Bear Creek, Mt Evans Wilderness, Clear Creek County Colorado (BCWA Technical Memorandum 2013.01 - Sampling Program Summit Lake). The Association historic sampling Site 36 (Summit Lake at outfall) and Upper Bear Creek Site 37 monitor "background" conditions. Monitoring data show atypical water quality results for an alpine ecoregion. The station data demonstrates there is a pollution source(s) causing elevated nutrient loads, low pH conditions and reduced dissolved oxygen. Association observations suggest that one origin of the pollutants was the new/old toilet vaults at the Summit Lake parking lot. Denver Parks and Recreation in 2013 repaired the new vaults.

The new state interim Total Phosphorus standard for cold-water streams is 110 ug/l and the concentration measured in the plume exceeds 4,112 ug/l. The Association measured nearly 3,108 ug/l of Total Nitrogen and the new state interim Total Nitrogen Standard for cold-water streams is 1,250 ug/l. While these measured results aren't technically a standards violation at this time, they are indicative of a significant pollution problem degrading the aquatic biota and habitat. This nutrient loading contributed to excessive (100% coverage) attached algal growth (periphyton) on rock substrate in Bear Creek. The Association has also documented fish kills that appear attributable to the pollution plume. The Association provides the City and County of Denver, Colorado Department of Parks

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and Wildlife, Colorado Water Quality Control Division, State Forest Service and National Forest Service technical memorandums with data results and conclusions. Denver has committed to additional characterizations of the water quality problem(s) and is working towards mitigation of any problem(s) associated with the Denver Mountain Park Facilities.

In 2005, the Colorado Water Quality Control Division staff requested that the BCWA begin to look upstream of Evergreen Lake to determine potential causes for low macroinvertebrate scores at the Keys-on-the-Green site. It was suggested that temperature and nutrients were causing potential impairment. In 2006, the BCWA established a monitoring site on upper Bear Creek at the Clear Creek County line. Initial data showed elevated total ammonia concentrations coming from unknown upstream sources. As such, the BCWA in 2007 established a monitoring site above the Singing River Ranch on Bear Creek where there were no apparent anthropogenic sources. The expected condition at this site was low nutrients, which was not the case. There were elevated concentrations of total phosphorus and nitrate-nitrogen above expected conditions for both the 2007 and 2008 data collection seasons. After consultation with WQCD staff, they suggested the BCWA take a sample at and below Summit Lake to establish the most upstream “background” conditions. Based on the EPA Rocky Mountain Alpine ecoregion II data sets, there should be extremely low levels of phosphorus (e.g., 0-5 ug/l) and nitrogen (e.g., 0-50 ug/l) at the Summit Lake sites.

In 2009, the BCWA established sites 36 and 37 at Summit Lake. As such, the BCWA has a 5-year data set for the upper Bear Creek segments. The phosphorus and nitrogen data in 2009 exceeded the expected conditions for an ecoregion II environment. The BCWA was particularly surprised by the high total ammonia concentrations. This data resulted in the BCWA conducting a more detailed investigation of the site. The BCWA also researched fens, atmospheric depositions and other natural causes. It was field observations that help suggest the origin of pollutants came from the vicinity of the parking lot and vaults.

The preliminary data analyses from just visually tracing high algal productivity in the fen ponds showed extremely elevated nutrients, that were higher than found anywhere else in the watershed. In 2013, measurements from only a single estimated emergent point of the plume had a seasonal average total phosphorus of 1,801 ug/l (maximum 4,112 ug/l), with a conservative estimate of 129 pounds/month discharged into upper Bear Creek (potentially over 400 pounds in the warm season). That is potentially more total phosphorus discharged into Bear Creek than 10 out of 16 wastewater treatment plants discharge in an entire year.

In 2014, the nutrient loading from the plume monitoring site has declined with a peak measured total Phosphorus concentration of 735 ug/l and an estimated total phosphorus load of 52 pounds during the monitoring season. The total nitrogen load estimate was also reduced at 46 pounds. These declining load values are encouraging and suggest that the leaking problem from the vaults may be resolved.

The BCWA has not simply singled out the Summit area for noting a pollution plume, the conclusion is based on data, science and professional experience. It is clear there is an anthropogenic source at Summit Lake. A five-year data set is more than sufficient to conclude there is a pollution source. The BCWA has an obligation under the Control Regulation to identify pollution where it is found in the watershed that affects water quality. In other locations within the

watershed the BCWA has found elevated parameters that exceed standards or impair classified uses and reports these as “pollution”.

The reporting has used soft terms like “suggest the origin” and the BCWA reporting has never claimed the vaults were *the one cause of all deleterious effects observed or measured in the headwaters*. Subtract out natural nutrient sources based on alpine ecoregion II environments (even using maximum values from similar Rocky Mountain alpine ecoregions), the remaining nutrient load is over 95% anthropogenic. It is also important to note, that the BCWA has only looked at nutrients and not any of the other potential pollutants that could be associated with the discharge of untreated human waste. The 2014 monitoring program continues to support the BCWA conclusion about a pollution plume at Summit Lake.

Field Data and Chemistry

Table 1 **Field Measurements and Observations**

	20-Jun	18-Jul	15-Aug	18-Sep
	Site 36 Outlets			
Time	9:20	9:40	9:10	9:10
Temperature C	3.80	8.10	6.90	5.30
pH	6.43	8.52	7.57	8.80
Specific Conductance ms/cm	0.024	0.023	0.024	0.026
Dissolved Oxygen mg/l	10.39	8.61	7.82	8.36
	Site 37 Bear Creek			
Time	9:57	10:16	9:50	9:50
Temperature C	7.50	8.30	7.40	6.80
pH	5.75	7.29	7.23	7.35
Specific Conductance ms/cm	0.024	0.023	0.023	0.024
Dissolved Oxygen mg/l	9.30	8.44	7.83	7.92
	Site 63 Bottom Plume			
Time	9:30	9:53	9:25	9:18
Temperature C	4.80	5.90	5.60	4.50
pH	5.82	7.76	5.87	7.45
Specific Conductance ms/cm	0.033	0.046	0.051	0.044
Dissolved Oxygen mg/l	3.15	1.66	1.63	0.89
	65 - Between Ponds			
Time	9:41	10:00	9:33	9:30
Temperature C	4.40	8.70	6.50	4
pH	5.57	7.30	6.62	7
Specific Conductance ms/cm	0.023	0.022	0.023	0.024
Dissolved Oxygen mg/l	10.37	8.76	6.39	8
	Estimated Flow cfs			
site 36 through Culverts	0.50	1.30	0.30	0.10
site 37 - Bear Creek	2.40	2.00	2.70	1.06
site 63 - Bottom Plume @ flow site	0.021	0.010	0.030	0.010
site 65 - Between Pond #1 and #2	2.40	1.900	2.10	0.98

	20-Jun	18-Jul	15-Aug	18-Sep
	Periphyton Coverage			
site 36 - within Summit lake	0%	1%	10%	10%
site 37 - Bear Creek	15%	15%	25%	40%
site 65 - Between Pond #1 and #2	1%	5%	15%	20%
End Pond #2, Bear Creek	20%	5%	35%	25%
	Fish Present			
site 36 - within Summit lake	11	12	1	3
site 37 - Bear Creek	0	3	0	0
site 65 - Between Pond #1 and #2	3	12	1	6
End Pond #2, Bear Creek	14	0	0	3
Channel from Culvert to Pond #1	4	35	1	0

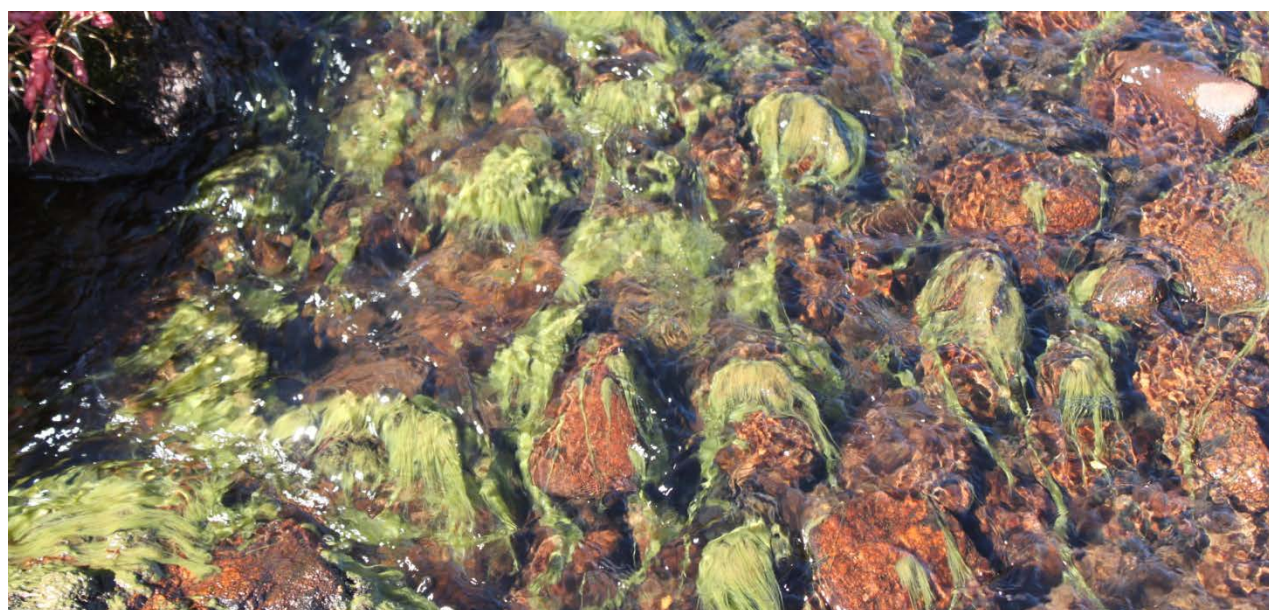


Figure 1 **Increased Periphyton Coverage on Substrate seen in 2014**

Table 2 **Chemistry**

Site	Parameter	6/20/2014	7/18/2014	8/15/2014	9/18/2014	Average
BCWA Segment Sample Sites						
36 - Outlet Summit Lake	Total Nitrogen, ug/l	317	307	287	286	299
36 - Outlet Summit Lake	Nitrate/Nitrite as N, dissolved, ug/l	133	84	92	61	93
36 - Outlet Summit Lake	Nitrogen, ammonia, ug/l	18	17	15	5	14
36 - Outlet Summit Lake	Phosphorus, total, ug/l	6	27	8	2	11
65 - Between Pond #1 & #2	Total Nitrogen, ug/l	273	311	892	269	436
65 - Between Pond #1 & #2	Nitrate/Nitrite as N, dissolved, ug/l	131	87	2	85	76
65 - Between Pond #1 & #2	Nitrogen, ammonia, ug/l	20	16	26	5	17
65 - Between Pond #1 & #2	Phosphorus, total, ug/l	4	8	735	2	187
37 - Upper Bear Creek	Total Nitrogen, ug/l	363	297	326	246	308
37 - Upper Bear Creek	Nitrogen, ammonia, ug/l	130	112	106	97	111

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Site	Parameter	6/20/2014	7/18/2014	8/15/2014	9/18/2014	Average
37 - Upper Bear Creek	Nitrate/Nitrite as N, dissolved, ug/l	17	17	17	5	14
37 - Upper Bear Creek	Phosphorus, total, ug/l	4	10	27	2	11
Summit Plume Discharge						
63- Est Bottom Plume	Total Nitrogen, ug/l	442	170	892	5	377
63- Est Bottom Plume	Nitrogen, ammonia, ug/l	4	7	2	2	4
63- Est Bottom Plume	Nitrate/Nitrite as N, dissolved, ug/l	19	40	26	12	24
63- Est Bottom Plume	Phosphorus, total, ug/l	209	223	735	73	310

Table 3 Load Estimates. These load estimates are reduced from the 2013 sampling, which suggests the leaky vault problem may be repaired.

Flow acre-feet/month					
	June	July	August	Sep	Season Totals
site 36 through Culverts	30	80	18	6	134
site 37 - Bear Creek	143	123	166	63	495
site 63 - Bottom Plume @ flow site	1	1	2	1	4
Site 63 - Bottom Plume Adjusted	12	6	18	6	41
Site 65 - Between Pond #1 and #2	143	117	129	58	447
Total Phosphorus, Pounds/month					
site 36 through Culverts	0.49	5.88	0.40	0.03	7
site 37 - Bear Creek	1.56	2.68	332.19	0.34	337
Site 63 - Bottom Plume Adjusted	6.75	2.70	42.55	0.08	52
site 65 - Between Pond #1 and #2	1.56	2.54	258.37	0.32	263
Total Nitrogen, Pounds/month					
site 36 through Culverts	25.7	66.8	14.4	4.6	112
site 37 - Bear Creek	141.1	99.4	147.3	42.2	430
Site 63 - Bottom Plume Adjusted	6.8	3.5	35.1	1.1	46
site 65 - Between Pond #1 and #2	106.1	98.9	313.6	42.7	561
Nitrate/Nitrite as N, dissolved, Pounds/month					
site 36 through Culverts	10.8	18.3	4.6	1.0	35
site 37 - Bear Creek	6.6	5.7	7.7	0.9	21
Site 63 - Bottom Plume Adjusted	0.6	0.6	1.2	0.2	2.7
site 65 - Between Pond #1 and #2	50.9	27.7	0.7	13.5	93
Ammonia Nitrogen, Pounds/month					
site 36 through Culverts	1.5	3.7	0.8	0.1	6
site 37 - Bear Creek	50.5	37.5	47.9	16.7	153
Site 63 - Bottom Plume Adjusted	0.1	0.1	0.1	0.0	0.4
site 65 - Between Pond #1 and #2	7.8	5.1	9.1	0.8	23



Figure 2 Discharge water from lower plume into Bear Creek remains nutrient rich. Noted oily film discharging from plume water.



Figure 3 The algal mats in Pond #2 were very thick (5-20 cm) by August sampling period. As the algal growth increased, the fish populations declined.

Table 4 Special Fen Study. It is possible that the BCWA at site 76 stumbled on the legacy plume. More evaluation of the Fens is needed at Summit Lake.

9/17/2014

Site	Temp	pH	SC	DO	Total Nitrogen	Total Phosphorus
36 Summit Lake	5.3	8.80	0.0258	8.36	286	2
63 Bottom Plume	4.5	7.45	0.0440	0.89	5	73
74 Fen #1	4.4	7.12	0.0393	1.32	529	165
65 BC Ponds	4.4	7.43	0.0240	8.00	269	2
75 Fen #2	4.5	7.19	0.0355	1.91	225	45
37 Bear Creek	6.8	7.35	0.0235	7.92	246	2
76 Fen #3	4.6	7.43	0.0240	6.83	3,754	660

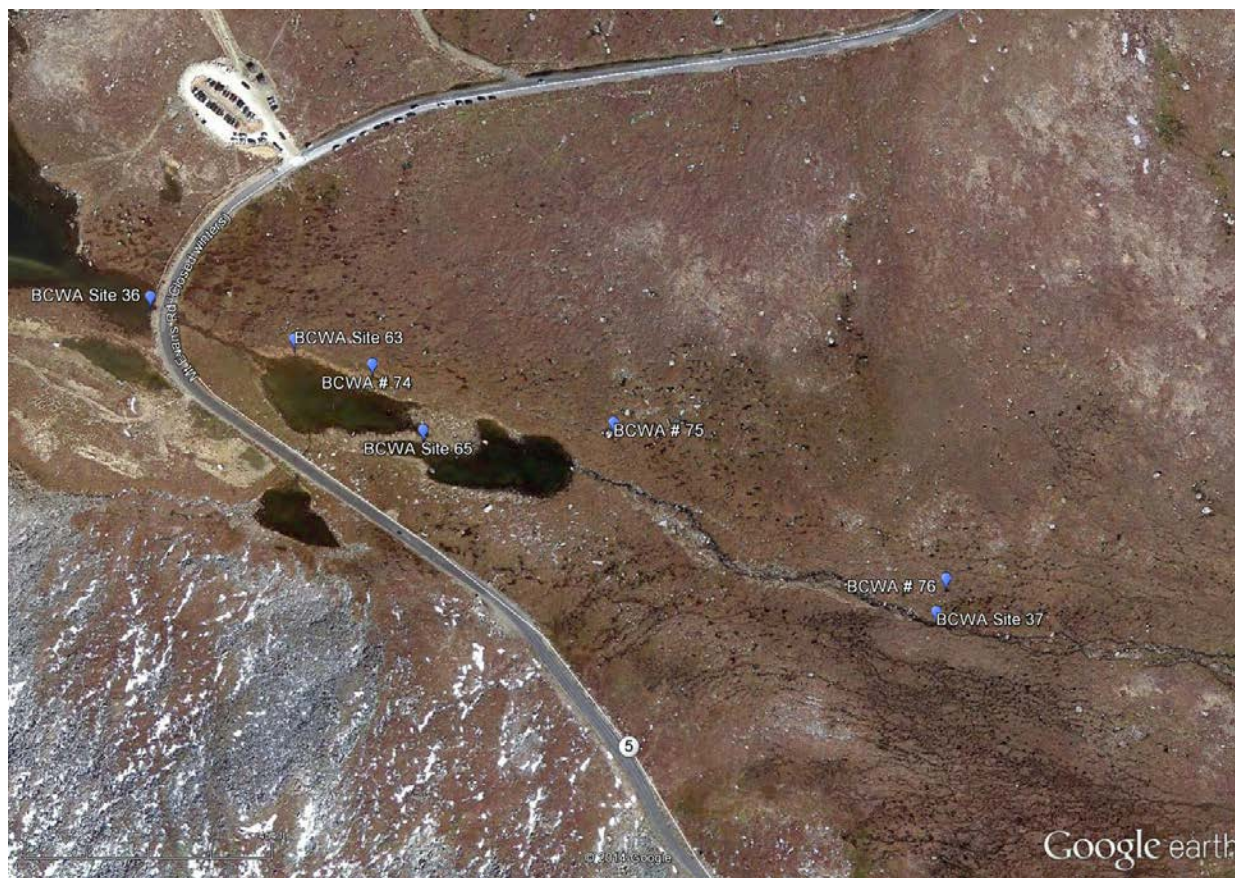


Figure 4 BCWA Site 74 (Edge of Pond #1 Fen, possible plume edge, heavy red algal growth, no insects); BCWA Site 75 (End Pond #2 Fen near Mouth Bear Creek, not likely affected by plume, insect life, no red algae, but common green algal growth); BCWA Site 76 (Fen out of flow line of bear Creek near BCWA Site 37, not affected by plume, insect life, no major algal growth). Site had field measurements and sampled for TP and TN only.



Figure 5 **Site 74 and 75**



Figure 6 **Site 76**