

Bear Creek Watershed Association



2012 Annual Report for the Water Quality Control Commission



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Adopted by Motion June 12, 2013

The Bear Creek Watershed Association protects & restores water & environmental quality within the Bear Creek Watershed from the effects of land use

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I. Bear Creek Watershed Control Regulation

The Bear Creek Watershed (Figure 1) is a specific geographic area identified in the Bear Creek Watershed State Control Regulation (Regulation #74, 5 CCR 1002-74) (Control Regulation) requiring special water quality management. The watershed includes all tributary water flows that discharge into Bear Creek Reservoir. The watershed extends from the Mount Evans Wilderness on the western end to the Town of Morrison on the eastern end. The two major tributaries are Bear Creek and Turkey Creek. The goal of the Control Regulation is to attain site-specific water quality standards and classifications through control of total phosphorus and chlorophyll. The Bear Creek Watershed Association (Association) oversees implementation of the Control Regulation.

Bear Creek Watershed Association

The Association is the local water quality agency responsible for implementation of monitoring and tracking water quality in the Bear Creek Watershed. The Association membership includes counties, local general-purpose governments, special districts (wastewater dischargers), associate agencies, and local citizen groups (Table 1). The Association membership monitors point sources and tracks nonpoint source practices, programs and loadings within the watershed. The Association management and implementation programs are at a watershed level.

The Association provides watershed reporting as posted on the Association website www.bearcreekwatershed.org, which serves to keep federal, state, and local governments and others informed on the state of the watershed. The Control Regulation defines specific reporting requirements, which helps the Association keep the Water Quality Control Commission and Water Quality Control Division staff updated on progress of the Association in implementing the Control Regulation.

Table 1 Association Membership, Dischargers and Participation

Members and Associates	Wastewater Discharger	Program Participation
<u>Counties</u>		
Jefferson County		Active
Clear Creek County		Active
<u>City and Towns</u>		
City of Lakewood		Active
Town of Morrison	Yes	Active
<u>Water & Sanitation Districts</u>		
Aspen Park Metropolitan District	Yes	Dues Paid, Not Active
Bear Creek Cabins	Yes	Active (In-kind Service)
Brook Forest Inn	Yes	Active (In-kind Service)
Conifer Sanitation Association	Yes	Dues Paid, Not Active
Conifer Metropolitan District	Yes	Dues Paid, Not Active
Evergreen Metropolitan District	Yes	Active
Forrest Hills Metropolitan District	Yes	Dues Paid, Not Active
Genesee Water & Sanitation District	Yes	Dues Paid, Not Active
Geneva Glen	Yes	Dues Paid, Not Active
Jefferson County School District	Yes	Active
Kittredge Water & Sanitation District	Yes	Active
Singing River Ranch	Yes	Dues Paid, Not Active
The Fort Restaurant	Yes	Dues Not Paid, Not Active
Tiny Town Foundation, Inc.	Yes	Dues Paid, Not Active
West Jefferson County Metropolitan District	Yes	Active
<u>Associate Agencies</u>		
Denver Water Department		Active
Evergreen Trout Unlimited		Active
U.S. Army Corps of Engineers		Active

Bear Creek Watershed 2011

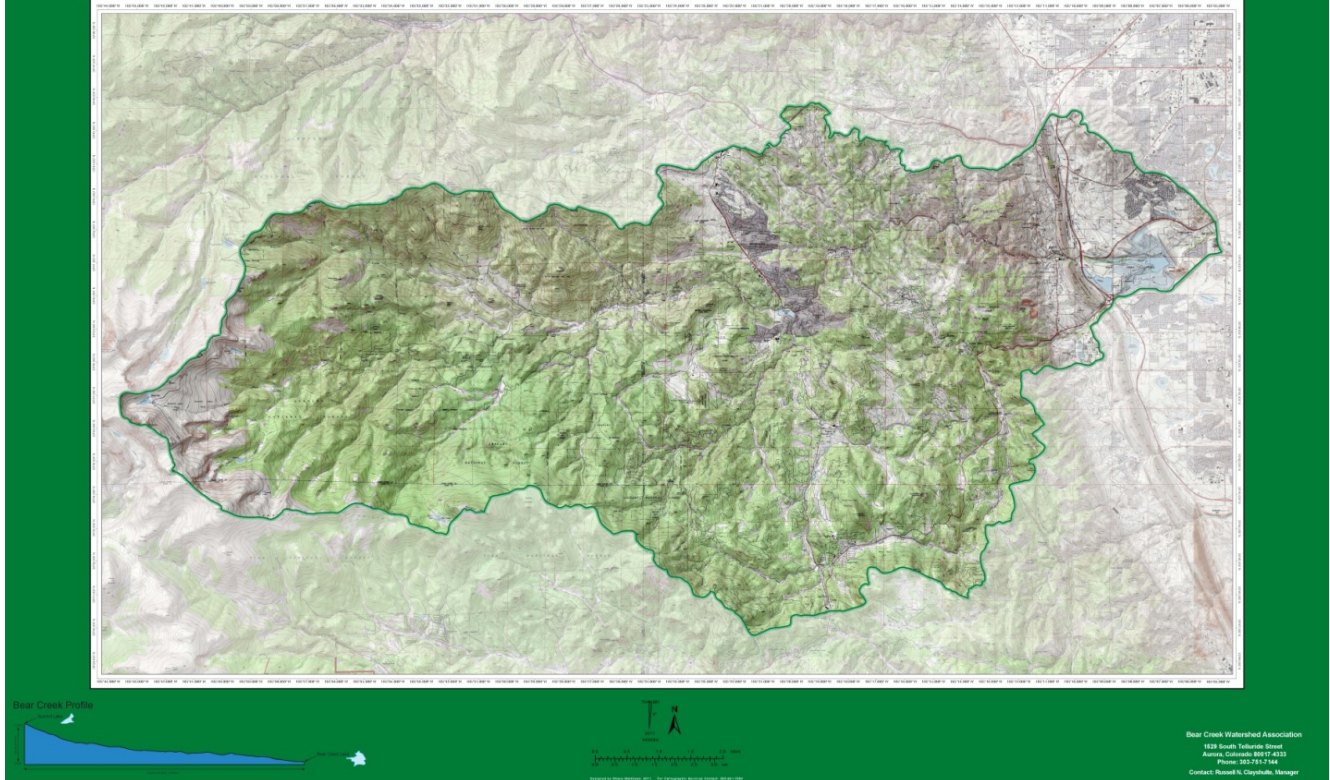


Figure 1 Bear Creek Watershed

Control Regulation Requirements

The Control Regulation (Regulation #74; 5 CCR 1002-74) identifies the Association's annual reporting requirements for presentation to the Water Quality Control Commission. The Association also produces reports and technical memorandums on additional activities. The remainder of this report addresses these reporting requirements: 1) Summarize status of water quality in the watershed for the previous calendar year. 2) Information on the wastewater treatment facilities loading and compliance with permit limitations. 3) The nonpoint source loading and appropriate best management practices. 4) In-stream and reservoir data analyses that indicate whether water quality goals and standards for the watershed are being met. 5) Information about water quality projects planned or implemented in the watershed. 6) Information on phosphorus trading programs.

II. Status of Water Quality in the Reservoirs and Watershed

Monitoring Program Update

The monitoring plan details the 2012 reservoir and watershed monitoring programs as approved by the BCWA Board and accepted by the Water Quality Control Division staff (WQCD). This monitoring plan serves as a supplement to the adopted Association Quality Assurance Project Plan (Bear Creek Watershed Association, 2006). The 2012 monitoring program (version 2012.01) details changes, updates, major continuation studies and monitoring program elements.

The routine monitoring program (P1) focuses on Turkey Creek drainage and Bear Creek drainage inputs, and discharge from Bear Creek Reservoir into lower Bear Creek with a central pool characterization of the reservoir near the dam (Figure 2; BCWA site 40). The outlet structure is near

BCWA site 41 with Bear Creek inflow near BCWA site 44 and Turkey Creek inflow near BCWA site 43. The reservoir chemistry and biological characterization monitoring occurs at BCWA site 40. Vertical probe samples for specific conductance, temperature, dissolved oxygen, and pH measured at 1/2 and 1-meter intervals at all reservoir sites. The current monitoring program optimizes data generation to evaluate reservoir inflow loading, trophic state changes within the reservoir, and reservoir outflow, while minimizing monitoring cost. The aeration sites are visible in Figure 2. Figure 3 shows all monitoring stations within Bear Creek Park. The Association maintains maps of recent sampling sites and wastewater treatment plant locations on the Association web site.

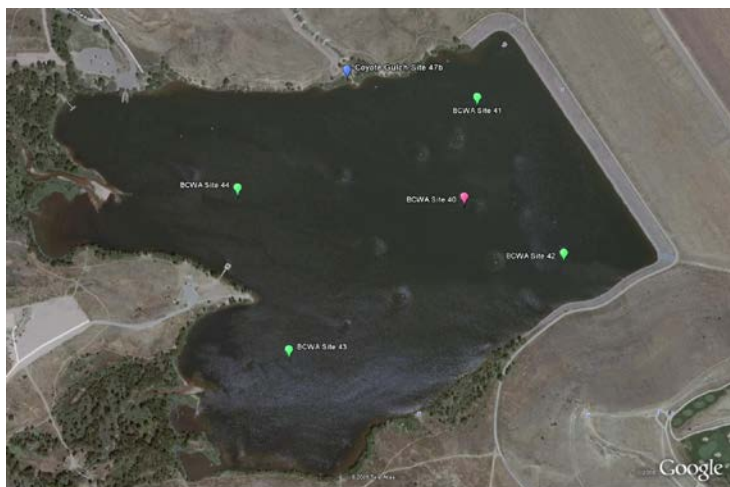


Figure 2 Reservoir Monitoring Stations; Site 2 is the Routine P1 Station

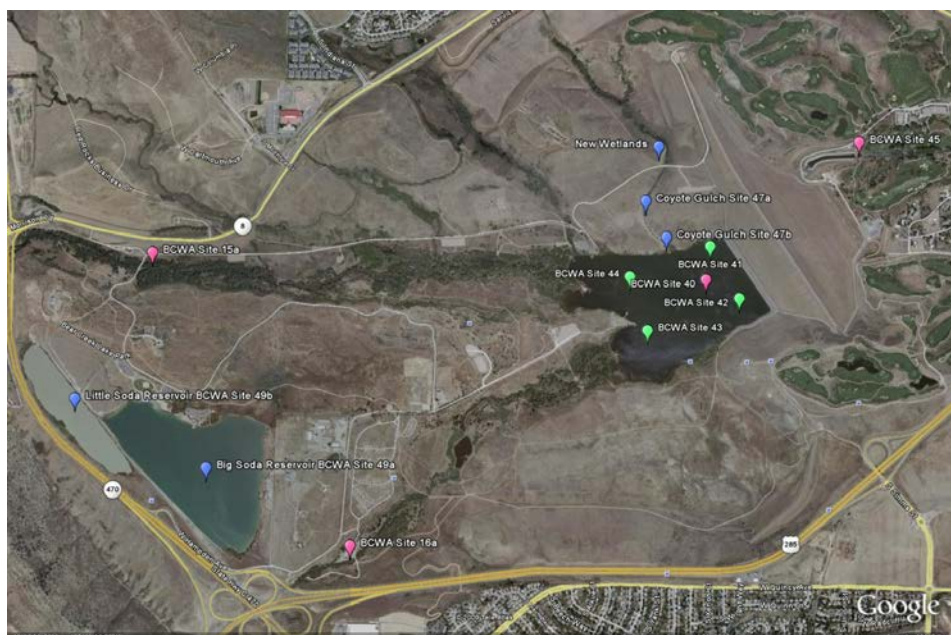


Figure 3 Monitoring Station in Bear Creek Park

Watershed Studies

Stream Flow Studies

The BCWA obtains stream flow data at multiple stations throughout the watershed. Manual flow measurements are obtained with each watershed-sampling event. Manual flows measured at 17 sites in the watershed during the July to September timeframe and 5 sites during the cold season months.

The Association installed stream staff gages and involves members to help gather daily/weekly stream data at selected sites. Flow curves have been developed for six sites. Additional staff gauges will be installed, and use citizen monitoring teams. The Association also conducts tributary stream flow studies.

Hydrology

The BCWA evaluates the basin hydrology, as well as biology and chemistry. In 2012, the total estimated annual discharge into Bear Creek Reservoir was about 5,868 acre-feet (Figure 4) with about 4,207 acre-feet flow through and 1,660 acre-feet of evaporation. Figure 5 shows the total reservoir inflow trend from 1987-2012.

Bear Creek flow diverts at the Harriman Ditch in Morrison, and a portion of the Turkey Creek flow diverts for water uses. Bear Creek flow diverts into the Arnett-Harriman during the irrigation season. The Arnett-Harriman ditch reduces flows in lower Bear Creek below 10 cfs in the operational season about 35% of the time. The ditch systems can completely dewatered lower Bear Creek for periods of up 15 consecutive days. In 2012, lower Bear Creek was dewatered (<5 cfs flow) for 145 days or 42% of the time.

The reservoir inflow represents flows below the water diversions and is not representative of the total watershed water flows. Figure 4 compares the 2012 reservoir monthly inflow estimates from Bear Creek (78%) and Turkey Creek (22%). Peak runoff occurred in May 2012. The increased Bear Creek flows in July and October came from two large rainfall events in the Evergreen area. Figure 5 shows the Bear Creek in-flow estimates (1987-2012) above Bear Creek Reservoir, in Bear Creek Park. Figure 6 shows the flow estimates at the Evergreen station.

Comparing in-flow estimates at the Morrison gaging station (2012, 11,193 ac-feet) and at the BCWA site in Bear Creek Park (2012, 5,868) provide an estimate of the amount of water diverted from the watershed by the Arnett-Harriman Canal. For example, in 2012 the Bear Creek water use diversion reduced flow to the reservoir by about 5,325 ac-ft (-52 %). Additionally, the longer time trends shown in Figures 5 and 6 depict a basic linear trend of declining flow in Bear Creek.

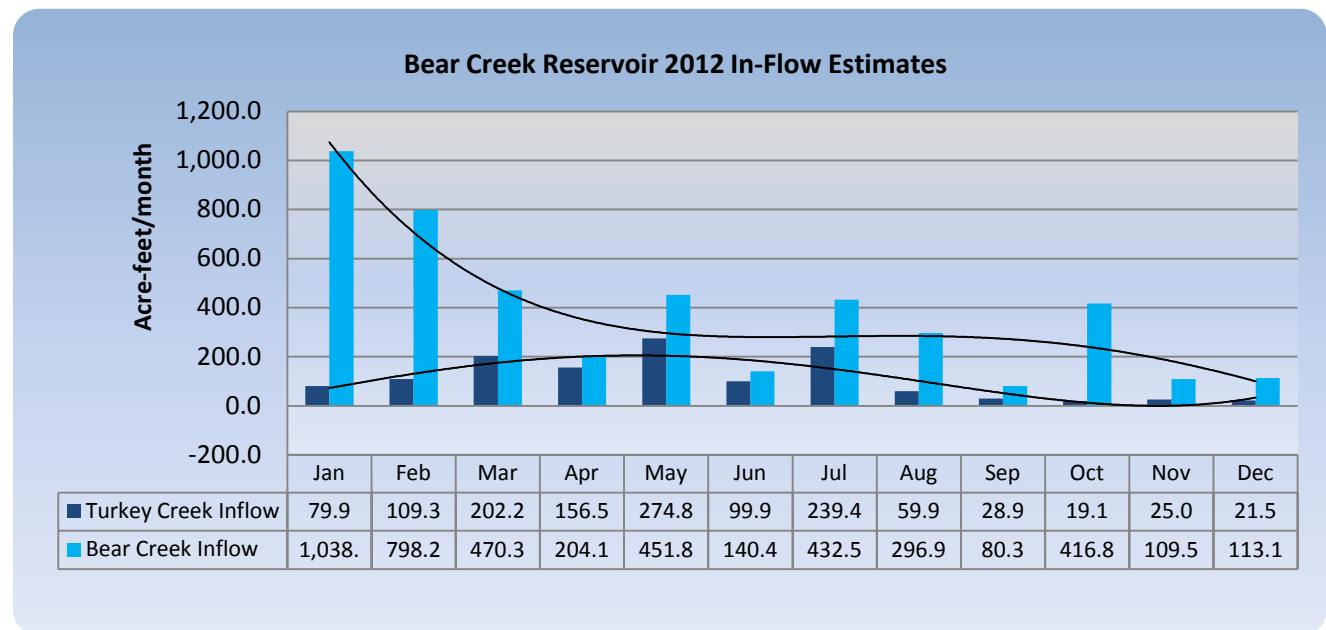


Figure 4 Bear Creek Reservoir Inflow and Outflow

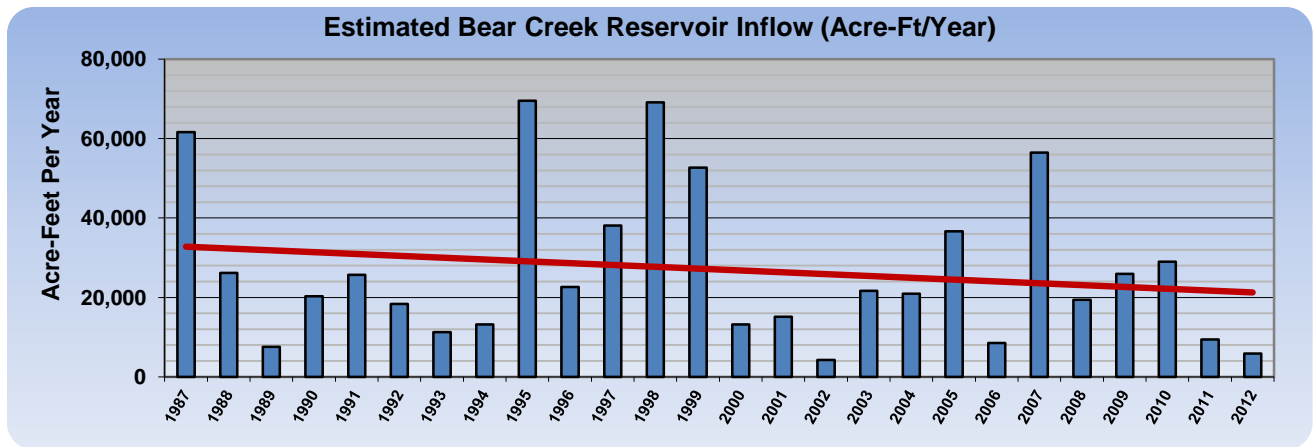


Figure 5 Annual Flows into Bear Creek Reservoir

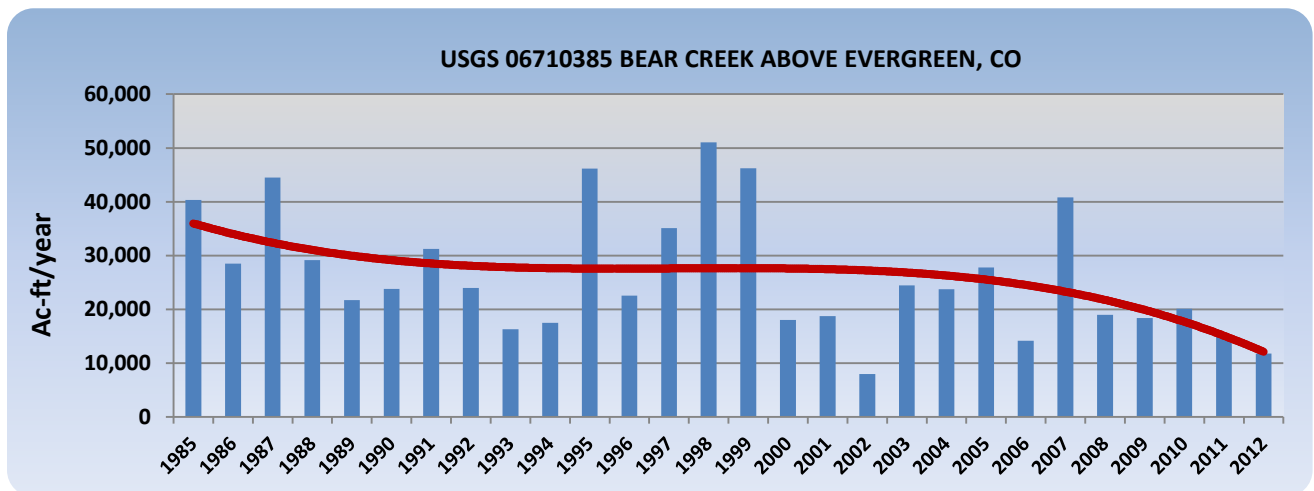


Figure 6 Bear Creek above Evergreen Annual Acre-feet/year Flow

Water Quality Studies

The BCWA summarizes its watershed-monitoring program in a data report (Bear Creek Watershed Association Data Report, June 2013). The BCWA collects annual water quality data from multiple sampling locations throughout the watershed. The watershed monitoring program has three major water quality and environmental data generating elements, which is defined in the *Water Monitoring Program and Sample Analyses Plan Version 2012.01, BCWA February 2012, and subsequent annual updates*:

1. Bear Creek Watershed surface water characterizations during selected months beginning at the headwaters of both Bear Creek and Turkey with a primary focus on nutrients and base field parameters,
2. Bear Creek Watershed surface water temperature characterization by major stream segments for both the cold and warm seasons, which is also defined in the *Water Monitoring Program and Sample Analyses Plan Version 2012.01, BCWA February 2012, and subsequent annual updates*.
3. Special water quality characterization and analyses studies on a site-specific basis.

The 2012 data results are contained in the *2012 Bear Creek Master Spreadsheet* posted on the Association website monitoring page and a specific watershed spreadsheet for the temperature data.

Monthly summary reports are provided to the Association Board and these data files are posted to the website.

Stream and lake sampling and monitoring data, including pH, Temperature, Dissolved Oxygen, Specific Conductance, Ammonia, Nitrate +Nitrite, Total Inorganic Nitrogen (calculated), Total Nitrogen, Dissolved Phosphorus, Total Phosphorous, and Total Suspended Solids were collected from July through September, at 27 sites including the special pollution study sites in Mount Evans Wilderness Area. Stream and lake temperature data loggers were used at 29 sites, including the Evergreen Lake profile station, the Genesee reservoir profile station, and the Bear Creek Reservoir profile station, excluding the five WWTPs. Eight selected Sites collected data logger temperatures from January 1 through December 31st, 2012. The twenty-one remaining sites collected temperature data from April through September and May through October. Table 2 lists the 2012 watershed chemistry results.

Table 2 Watershed Chemistry

Site ID	Site Location by Stream Segment	7/12/2012				8/9/2012				9/6/2012			
		NO3-NO2 Ug/l	TN Ug/l	Ammonia Ug/l	T Phos Ug/l	NO3-NO2 Ug/l	TN Ug/l	Ammonia Ug/l	T Phos Ug/l	NO3-NO2 Ug/l	TN Ug/l	Ammonia Ug/l	T Phos Ug/l
Segment 1a													
Site 2a	Golden Willow Road	17	132	29	22	51	171	18	16	36	118	15	10
Site 3a	Above Evergreen Lake at CDOW Site	22	208	28	32	28	199	18	16	12	48	15	31
Segment 1d													
Site 4b	Evergreen Lake Profile Station, 1-m	5	395	38	30	13	390	15	48	7	135	56	33
Site 4e	Evergreen Lake Profile Station, 4-m	3	474	21	44	16	335	36	37	4	104	51	29
Segment 1e													
Site 5	Above EMD WWTP, CDOW downtown site	3	410	25	48	15		18	40	18		35	30
Site 8a	Bear Creek Cabins at CDOW Site	186	598	16	53	147		27	36	108		125	81
Site 9	O'Fallon Park, west end at CDOW Site	200	602	38	48	60	280	20	31	103	240	28	35
Site 12	Lair o' the Bear Park, at CDOW site	252	603	46	60	231		19	42	523		23	39
Site 13a	Below Idledale, Shady Lane at CDOW site	292	656	46	63	132		22	44	281		16	46
Site 14a	Morrison Park west, CDOW Site	177	433	36	60	102	385	19	43	256	443	14	45
Segment 3													
Site 25	Vance Creek (Mt. Evans Wilderness)	5	92	22	12	10		24	14	2		10	17
Segment 5													
Site 35	Cub Creek, Upstream @ Brookforest Inn	266	397	30	16	242		27	14	136		16	14
Site 50	Cub Creek, Upstream of Cub Creek Park	175	361	24	28	9		16	21	14		14	17
Segment 6a													
Site 18	South Turkey Creek	36	313	40	27	8		32	46	6		18	80
Segment 6b													
Site 19	North Turkey Creek Flying J Ranch Bridge	12	483	41	18	16		26	11	29		36	29
Segments 7 and 8													
Site 36	Summit Lake outfall	3	254	25	13	24	178	21	4	141	190	24	10
Site 37	Bear Creek, Mainstem from Lake	33		25	9	52		14	8	65	189	30	7
Site 58	Bear Creek Above Singing River	36	182	40	19	72	185	20	9	50	67	15	15
Segment 10													
Site 39a	Genesee Res -1m	178		22	14	51		20	13	107		42	11
Site 39b	Genesee Res -5m	273		67	22	215		61	18	100		36	9

Kerr/Swede Gulch E. coli Study

The Colorado 303(d) list includes Swede Gulch as a low priority for E. coli. The mainstem is Kerr/Swede Gulch with the western gulch upstream of the upper confluence as Kerr Gulch and the eastern tributary as Swede Gulch (Figure 7). The Division and Association agree this area maybe a good candidate to understand the contribution of nutrients from septic systems to the water quality in tributaries. The Division and Association agree there is a water quality problem that requires further investigation.

The Association completed the 3rd year of a 5-year monitoring program to evaluate E. coli and nutrients on Kerr/Swede Gulch (confluence with Bear Creek, below confluence of Swede Gulch and just upstream of confluence on Kerr Gulch) and lower Swede Gulch. The Association monitors E. coli at 4-sites (Figure 7) from January (provided winter flows) through December. The Association also collects data for temperature, pH, specific conductance and Dissolved Oxygen using the field probe and nutrient samples for laboratory analyses. The Association is conducting the E. coli analyses.

Table 3 shows the 2012 data summary for Kerr/Swede Gulch sample sites. Table 4 shows the Geometric means for E. coli. The E. coli standard is 126/100ml (Measured as a geometric mean of data). There were no exceedances of the E. coli standard. The Association is also monitoring nitrogen and phosphorus, flow and standard field parameters. Technical Memorandum 2012.03 (BCWA, January 2013) summarizes all data for this study.

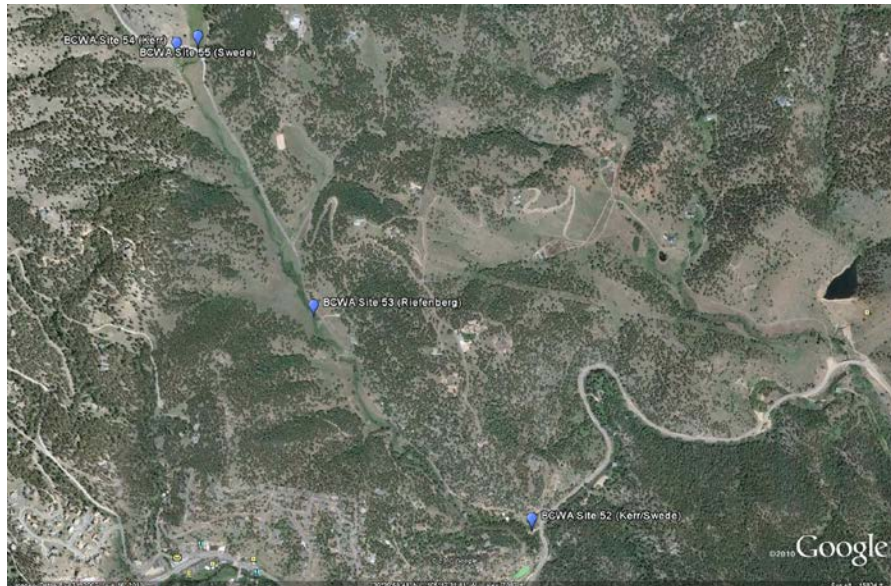


Figure 7 Kerr/Swede Gulch Sample Sites

Table 3 Kerr/Swede Gulch Data Summary

BCWA Site	Time	Temp (C)	pH	SC (ms/cm)	DO (mg/l)	E. Coli (Cells/100ml)
1/23/2012						
Site 52 - Confluence	9:58	0	7.38	0.877	12.14	1
Site 53 - Riefenberg	10:10	0.2	7.8	0.875	11.29	3
Site 54 - Kerr	10:22	0.6	7.71	0.904	10.8	2
Site 55 - Swede	10:27	0.1	7.98	0.869	11.46	1
2/27/2012						
Site 52 - Confluence	10:50	0.0	8.53	0.92	12.57	1
Site 53 - Riefenberg	11:02	0.3	8.26	0.902	11.75	18
Site 54 - Kerr	11:17	0.7	8.17	0.926	11.02	42
Site 55 - Swede	11:16	0.1	8.34	0.878	11.74	1
3/26/2012						
Site 52 - Confluence	12:45	7.2	8.61	0.78	11.49	1
Site 53 - Riefenberg	12:58	9.7	8.26	0.78	9.69	1

BCWA Site	Time	Temp (C)	pH	SC (ms/cm)	DO (mg/l)	E. Coli (Cells/100ml)
Site 54 - Kerr	1:07	11.2	7.94	0.77	8.46	1
Site 55 - Swede	1:13	10.8	8.02	0.77	8.8	1
4/23/2012						
Site 52 - Confluence	1:15	13.3	8.53	0.85	8.94	1
Site 53 - Riefenberg	1:28	16.2	8.23	0.85	7.63	1
Site 54 - Kerr	1:40	17.2	8.13	0.84	6.76	1
Site 55 - Swede	1:38	19.1	8.14	0.87	6.44	1
5/23/2012						
Site 52 - Confluence	1:00	11.3	8.12	0.85	9.12	1
Site 53 - Riefenberg	1:11	12.2	8.2	0.85	8.66	22
Site 54 - Kerr	1:25	12.4	8.15	0.84	8.12	8
Site 55 - Swede	1:21	15.5	8.19	0.9	8.06	2
6/26/2012						
Site 52 - Confluence	12:25	18.7	7.7	0.84	5.76	82
Site 53 - Riefenberg	12:37	22.4	7.99	0.8	6.97	20
Site 54 - Kerr	12:52	22.6	7.82	0.87	4.21	28
Site 55 - Swede	dry					
7/24/2012						
Site 52 - Confluence	10:21	16.5	7.39	0.98	7.94	12
Site 53 - Riefenberg	10:33	15.4	7.95	0.84	10.14	80
Site 54 - Kerr	10:51	17.8	7.98	0.86	8.58	80
Site 55 - Swede	10:45	18.3	8.17	0.93	8.51	148
8/27/2012						
Site 52 - Confluence	1:40	17.9	8.61	0.89	8.46	1
9/25/2012						
Site 52 - Confluence	1:16	11.6	8.26	0.9	9.53	5
Site 53 - Riefenberg	1:30	12	7.96	0.83	8.98	2
Site 54 - Kerr	1:44	12.6	7.94	0.82	7.29	160
Site 55 - Swede	1:41	12.2	8	0.616	7.47	22
10/22/2012						
Site 52 - Confluence	1:13	7.3	8.56	0.86	9.99	56
Site 53 - Riefenberg	1:23	9.4	8.32	0.82	9.07	1
Site 54 - Kerr	1:36	10.2	8.2	0.73	8.08	11
Site 55 - Swede	1:33	11.4	8.31	0.84	8.57	4
11/28/2012						
Site 52 - Confluence	1:25	2.3	8.48	0.826	11.1	12
Site 53 - Riefenberg	1:35	1.8	8.24	0.203	10.62	1
Site 54 - Kerr	1:48	0.1	8.02	0.796	10.23	8
Site 55 - Swede	1:44	0.4	8.21	0.809	10.74	10
12/12/2012						
Site 52 - Confluence	1:34	0.3	8.61	0.211	11.56	1
Site 53 - Riefenberg	1:21	1.4	7.75	0.819	10.91	1
Site 54 - Kerr	1:05	0.1	7.75	0.823	10.34	6
Site 55 - Swede	1:00	0.4	8.11	0.818	11.9	1

Table 4 Kerr/ Swede Gulch E. Coli Geometric Mean Summary

E. coli Summary, Geometric Mean									
BCWA Site	2010		2011						
	May-Dec	J-D (Annual)	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	May-Oct
	n=36	n=48	n=8	n=8	n=8	n=8	n=8	n=8	n=24/6
Sites 52-53			14	2	6	5	6	2	6
Site 52 - Confluence	10	6							15
Site 53 - Riefenberg	13	4							9
Site 54 - Kerr	16	5							3
Site 55 - Swede	11	3							2
			2012						
Sites 52-53		5	3	1	11	26	10	3	13
Site 52 - Confluence		3							6
Site 53 - Riefenberg		4							9
Site 54 - Kerr		10							32
Site 55 - Swede		3							13

Reservoirs

Bear Creek Reservoir and Inflow Nutrients

The watershed-monitoring program characterizes nutrient loading into Bear Creek Reservoir from two primary drainages: Bear Creek and Turkey Creek. The Association monitors for total phosphorus, dissolved phosphorus, nitrate-nitrite nitrogen, and total nitrogen on a monthly basis.

The total phosphorus load from the watershed comes from a combination of wastewater treatment plant point source loads, un-regulated point sources, and nonpoint sources, including runoff. There are over 27,000 septic systems in the watershed. The estimated total phosphorus load in 2012 from all sources reaching the reservoir was 634 pounds at a flow of about 5,868 acre-feet. Bear Creek drainage contributed 80% of the load (Figure 8). Although the point source discharges of total phosphorus were about **1,000** pounds, the water diversions above the reservoir and natural stream vegetation uptake are removing a portion of this phosphorus load and inflow water before it reaches the reservoir.

The nitrate loading (10,900 pounds) was lower than past flow conditions (Figure 9) with 89% of the load coming from Bear Creek. Figure 10 estimates the total nitrogen loading into Bear Creek Reservoir. There was about 15,900 pounds of total nitrogen loading with 87% derived from the Bear Creek drainage. Figure 11 shows the 2012 total phosphorus concentrations at the routine watershed monitoring stations. The management program targets reduction of total phosphorus reaching the reservoir on an annual basis. Figure 12 shows the total phosphorus reservoir trend. Figure 13 shows the 2012 nitrate concentrations at routine watershed monitoring stations. Figure 14 shows the 2012 total nitrogen trends. The reservoir nitrogen data shows a general reduction over the years (Figure 15).

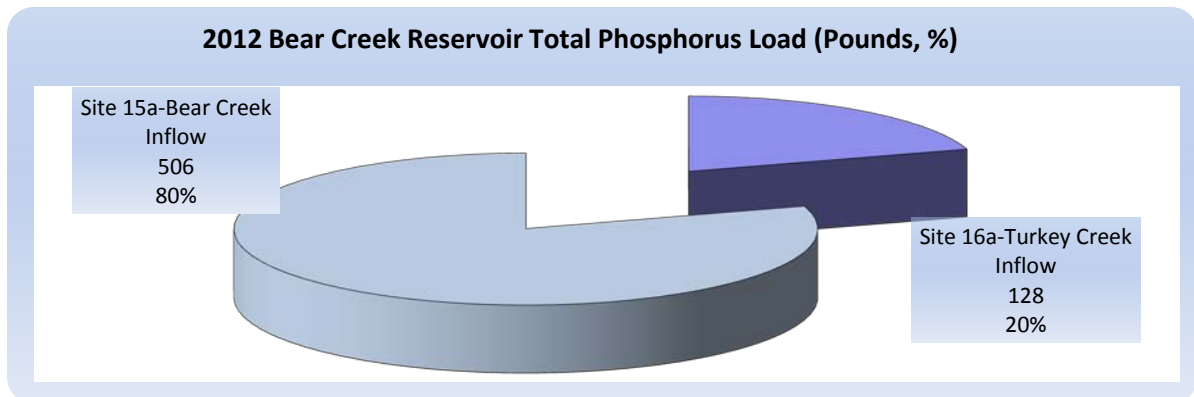


Figure 8 Estimated Total Phosphorus loading into Bear Creek Reservoir

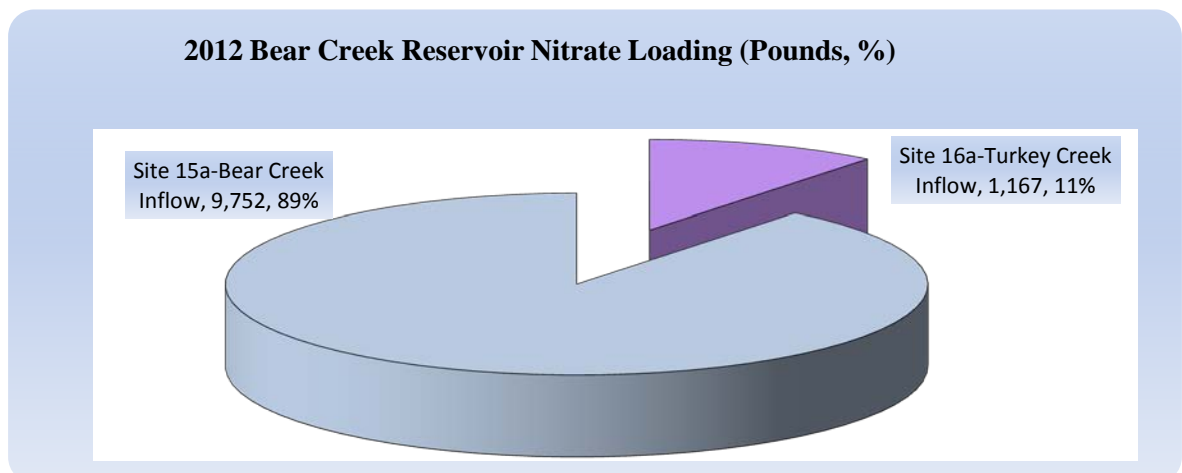


Figure 9 Estimated Nitrate loading into Bear Creek Reservoir

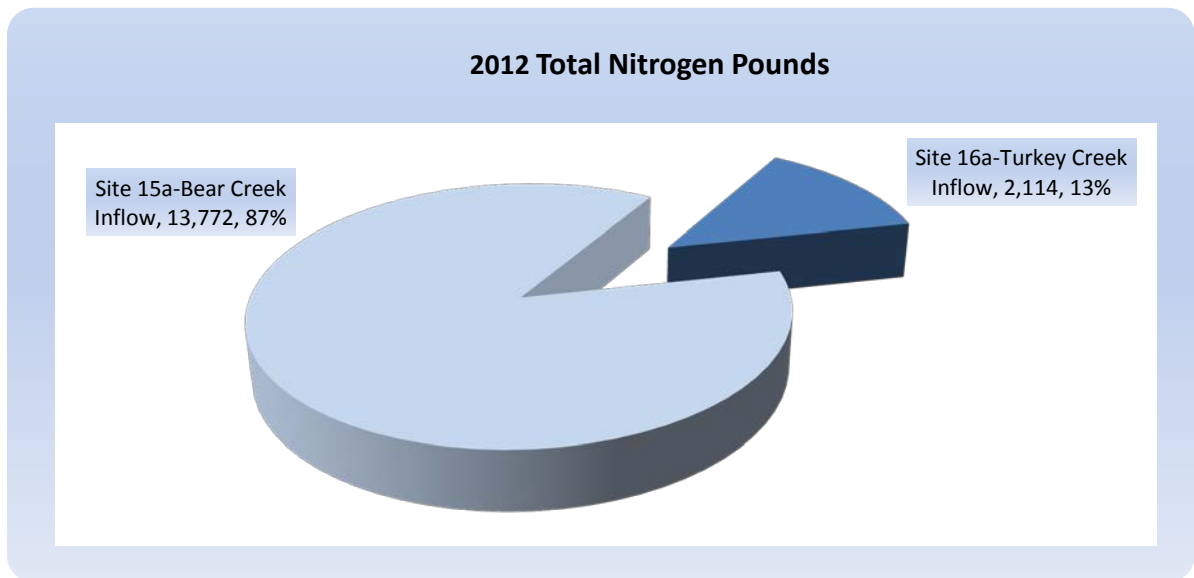


Figure 10 Estimated Total Nitrogen Loading into Bear Creek Reservoir

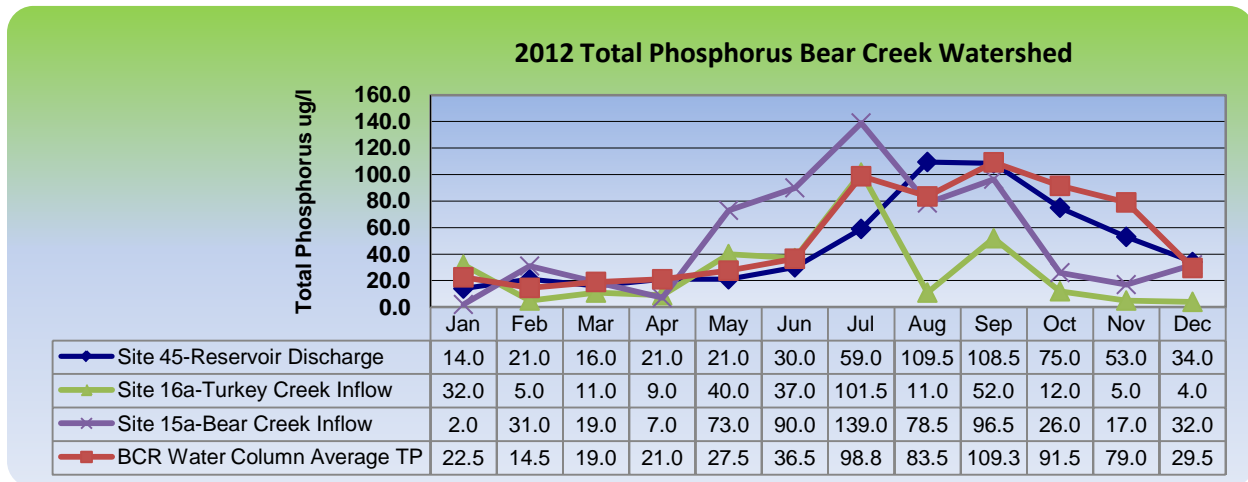


Figure 11 Total Phosphorus Annual Trend at Bear Creek Reservoir

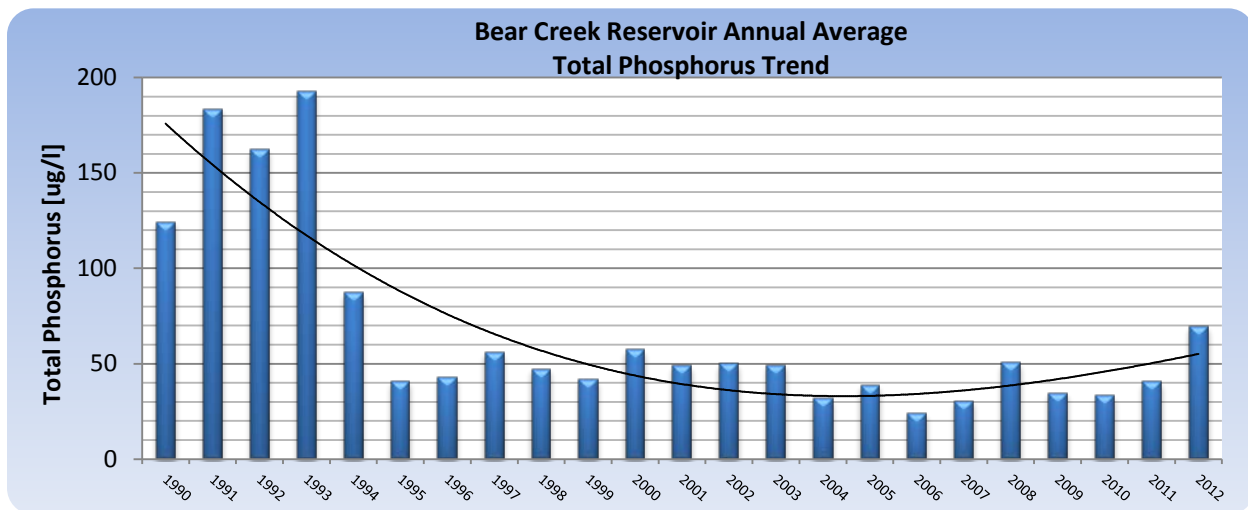


Figure 12 Annual Total Phosphorus Bear Creek Reservoir

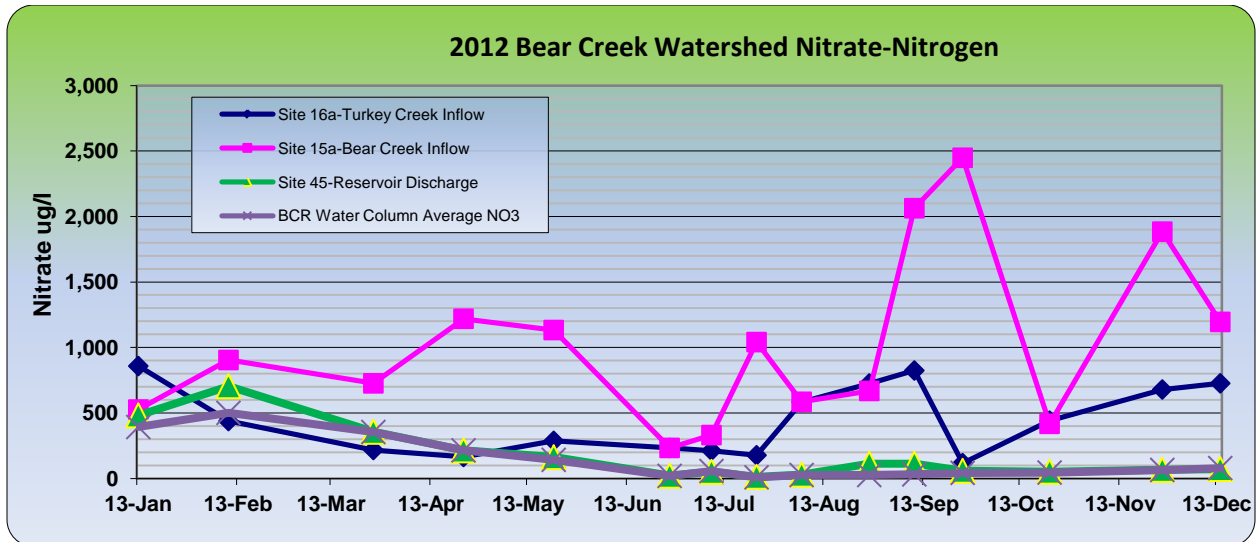


Figure 13 Bear Creek Reservoir Nitrate-Nitrogen Concentrations

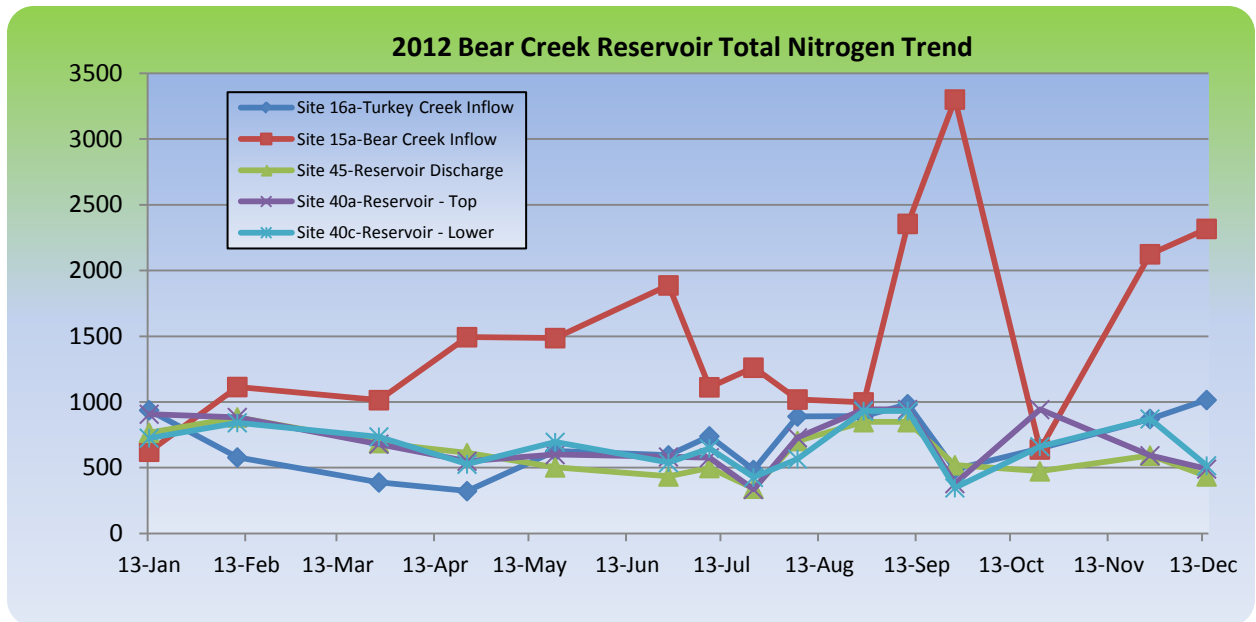


Figure 14 Total Nitrogen Bear Creek Reservoir

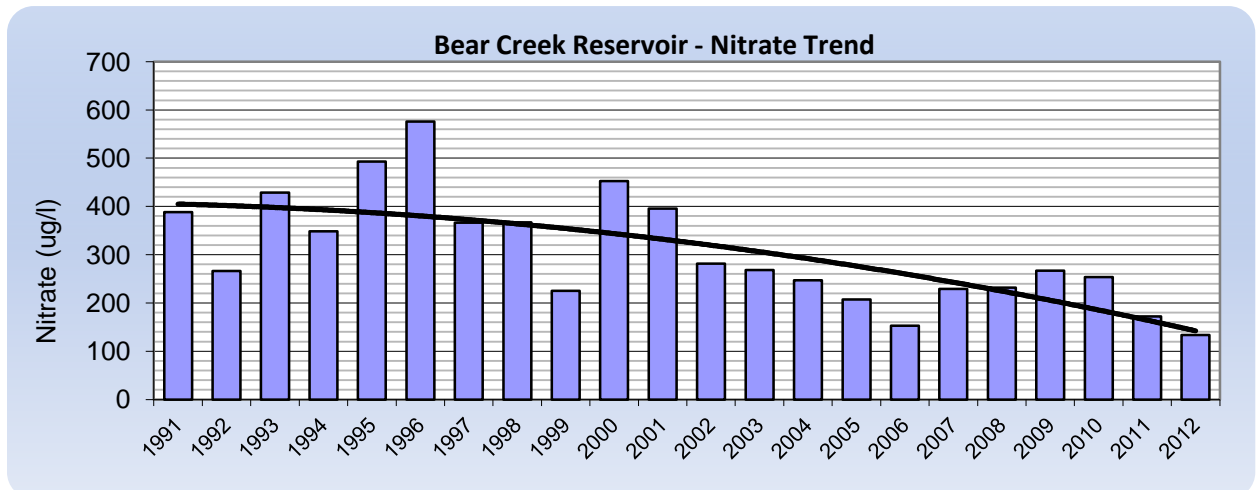


Figure 15 Annual Bear Creek Reservoir Nitrate Trend

Bear Creek Reservoir Indicator Trend Variables

The Association’s reservoir monitoring program collects samples to analyze nutrient (nitrogen and phosphorus) concentrations, chlorophyll-a, total suspended sediments, dissolved oxygen, pH, specific conductance, Secchi depth, and phytoplankton population dynamics as trend variables. Table 5 lists the summary statistics for the monitoring variables. Table 6 summarizes the 2012 reservoir loading data. Table 7 compares 2012 data with the long-term patterns from 1991 through 2012. Overall, 2012 water quality is similar to historic trends. Table 8 summarizes the phytoplankton data. Figure 16 shows the phytoplankton total density during summer sampling period. Figure 17 shows the general clarity trend in the water column using Secchi measurements. March and April had the poorest clarity caused by runoff.

Table 5 Bear Creek Reservoir Summary Statistics (July September)

Reservoir Monitoring Parameters	Reservoir
Chlorophyll (Site 40)	
Average Growing Season Chlorophyll-a [ug/l (-1m)]	25.1
Average Annual Chlorophyll-a [ug/l (-1m)]	14.9
Peak Chlorophyll-a [ug/l]	52.9
Phosphorus	
Average Annual Total Phosphorus [ug/l]: Water Column	61.5
Average Annual Total Phosphorus [ug/l] -1m	53.4
Average Annual Total Phosphorus [ug/l] -10m	69.8
Growing Season Total Phosphorus [ug/l]: Water Column	97.2
Growing Season Total Phosphorus [ug/l]: -1m	91.7
Growing Season Total Phosphorus [ug/l]: -10m	102.7
Peak Annual Total Phosphorus [ug/l] Water Column	139
Average Annual Ortho Phosphorus ug/l Water Column	28
Growing Season Average Ortho Phosphorus [ug/l] Water Column	47.5
Peak Annual Ortho Phosphorus [ug/l] Water Column	73.0
Nitrogen	
Average Annual Nitrate-Nitrogen [ug/l] Water Column	134
Growing Season Average Nitrate-Nitrogen [ug/l] Water Column	32
Peak Annual Nitrate-Nitrogen [ug/l] Water Column	704
Average Annual Total Nitrogen [ug/l]: Water Column	670
Average Total Nitrogen [ug/l]: -1m	676
Average Total Nitrogen [ug/l]: -10m	664
Growing Season Total Nitrogen [ug/l]: Water Column	647
Growing Season Total Nitrogen [ug/l]: -1m	652
Growing Season Total Nitrogen [ug/l]: -10m	642
Clarity (All Profiles)	
Average Annual Secchi Depth (meters)	2.21
Growing Season Average Secchi Depth (meters)	1.4
Total Suspended Sediments	
Annual Average Total Suspended Sediments [mg/l]	9.9
Growing Season Average Total Suspended Sediments [mg/l]	15.1
Peak Total Suspended Sediments [mg/l]	41.2
Dissolved Oxygen (site 40 Profile)	
Annual Average at -1/2m - 2m [mg/l]	9.45
Annual Minimum at -1/2m - 2m [mg/l]	6.22
Seasonal Average at -1/2 - 2m [mg/l]	7.79
Seasonal Minimum at -1/2 - 2m [mg/l]	6.22
pH	
Annual Average at -1/2m - 2m [mg/l]	8.61
Annual Minimum at -1/2m - 2m [mg/l]	9.2
Seasonal Average at -1/2 - 2m [mg/l]	8.68
Seasonal Minimum at -1/2 - 2m [mg/l]	8.7
Specific Conductance	

Reservoir Monitoring Parameters	Reservoir
Annual Average at -1/2m - 2m [uS/cm]	0.552
Annual Minimum at -1/2m - 2m [us/cm]	0.707
Seasonal Average at -1/2 - 2m [us/cm]	0.570
Seasonal Minimum at -1/2 - 2m [us/cm]	0.670
Phytoplankton Species	
Phytoplankton Co-dominant Species - Site 40 (July- September 2012)	Anabaena flos-aquae
	Anabaena planctonica
	Aphanizomenon flos-aquae
	Oscillatoria limosa
	Cryptomonas erosa
	Cymbella affinis
	Diatoma vulgare
	Epithemia sorex
	Fragilaria crotonensis
	Gomphoneis herculeana
	Stephanodiscus niagarae
	Ceratium hirundinella
	Trachelomonas volvocina
Closterium sp.	
Oocystis lacustris	
Peak Phytoplankton	
<i>Aphanizomenon flos-aquae</i>	Density cells/ml = 4510
<i>Aphanizomenon flos-aquae</i>	Peak Biovolume (um ³ /mL) = 7,387,380

Table 6 Annual Bear Creek Reservoir Load Estimates

Loading - Annual Pounds	
Total Nitrogen -Total Load In to BCR	15,887
Total Nitrogen -Total Load From BCR	7,897
Total Nitrogen -Total Deposition into BCR	7,990
Total Phosphorus -Total Load In to BCR	634
Total Phosphorus -Total Load From BCR	260
Total Phosphorus -Total Deposition into BCR	374
TSS -Total Load In to BCR	570,320
TSS -Total Load From BCR	231,401
TSS -Total Deposition into BCR	338,918

Table 7 Bear Creek Reservoir Select Trend Parameters

Parameter		2012	1991-2012 Mean	1991-2012 Median
Chlorophyll-a (ug/L)	Top	14.9	14.5	13.7
Total Nitrogen ug/l	Top	491.0		
	Bottom	516.0		
	Water Column	503.5		
Nitrate-Nitrogen (ug/L)	Top	165	319.9	289.0
	Bottom	102	290.9	259.0
	Water Column	134	314.2	267.5
Total Phosphorus (ug/L)	Top	53.4	58.4	38.0
	Bottom	69.8	83.7	56.0
	Water Column	62	67.6	50.0
Total Suspended Solids (mg/L)	Top	6.4	6.6	6.2
	Bottom	13.4	10.7	9.0
	Water Column	10	8.2	8.0
Secchi Depth (m)	Top	2.2	2.2	2.2

Table 8 Bear Creek Reservoir Phytoplankton Summary Data

	23-Jul	6-Aug-12	27-Aug-12	10-Sep-12	25-Sep-12
Total Density (#/mL):	1,248	5,185	2,383	1,583	1,453
Total Biovolume (um³/mL):	928,151	4,831,476	2,935,807	1,441,568	2,605,244
Trophic State Index:	49	59	55	52	57

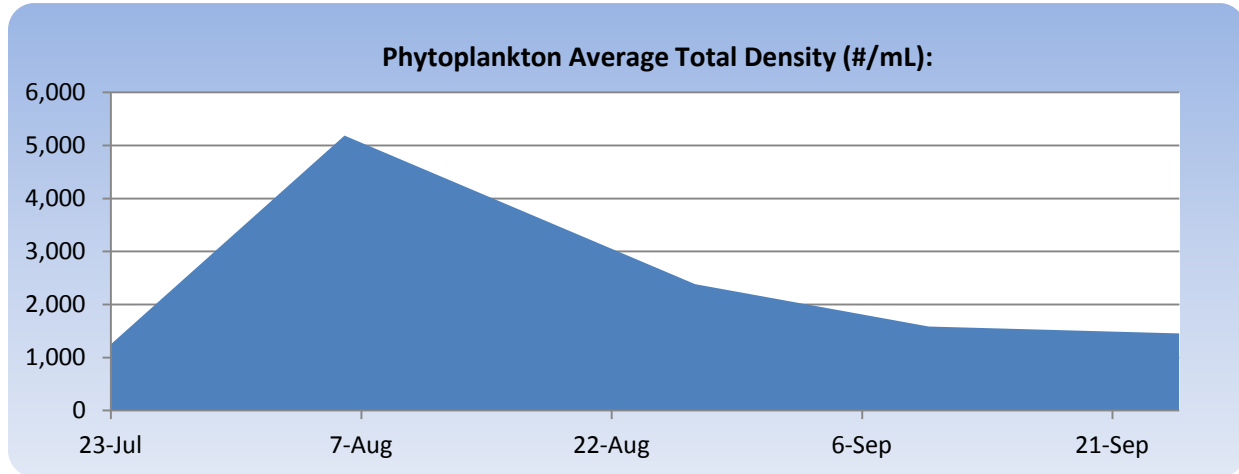


Figure 16 Bear Creek Reservoir Phytoplankton Summer Total Density

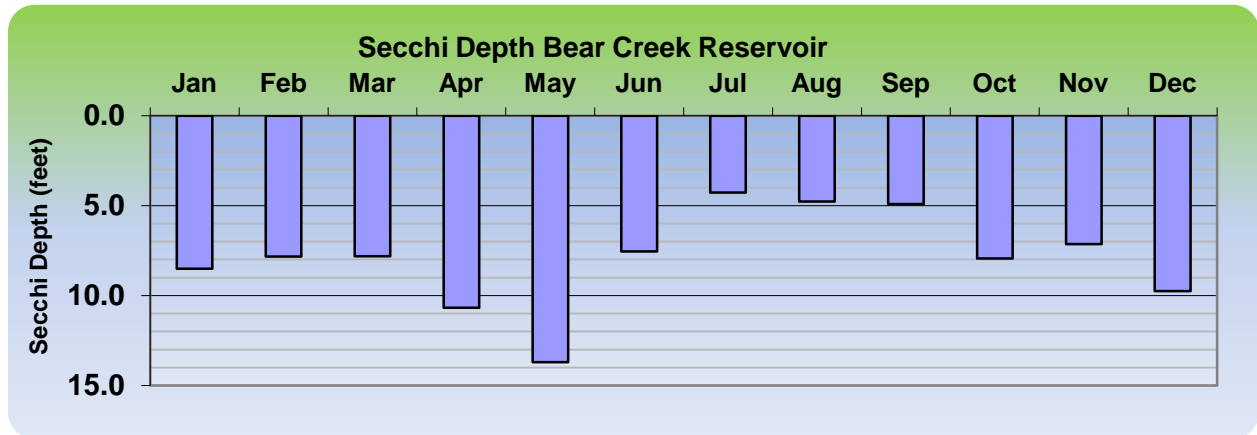


Figure 17 Secchi Depth Bear Creek Reservoir

The reservoir had several algal blooms in 2012 as evidenced by the peak September chlorophyll concentration of 36.9 ug/l (Figure 18). The peak phytoplankton density in 2012 was 7,387,380 um³/mL caused by a blue-green phytoplankton species. Historically, blue-green phytoplankton species are associated with major blooms in the reservoir.

Generally, the reservoir trophic state in 2012 was eutrophic (Walker Index, Figure 19). The Carlson Index shows a similar eutrophic trend. Although external nutrient loads were lower than historic trends, the reservoir continues to have an internal nutrient loading problem, which causes eutrophic water quality conditions.

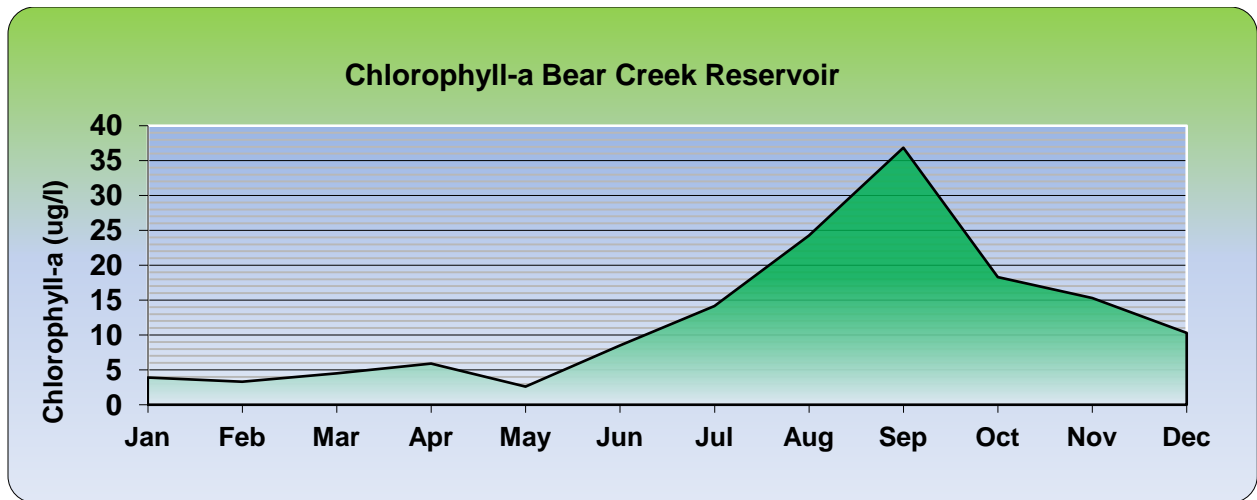


Figure 18 Bear Creek Reservoir Chlorophyll Trend

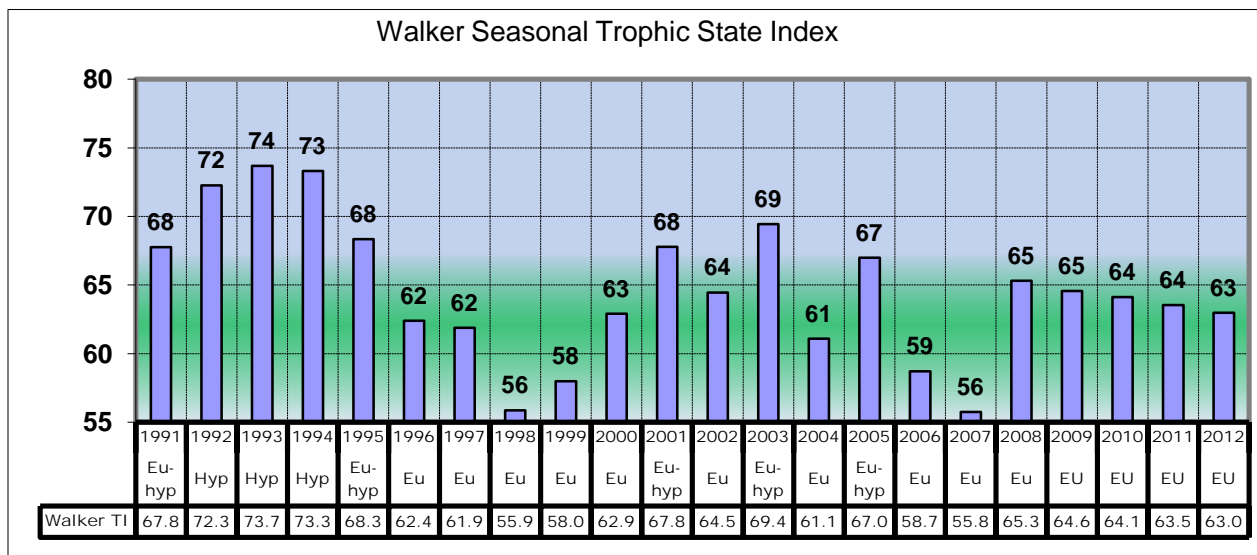


Figure 19 Walker Trophic Index Trend Bear Creek Reservoir

Bear Creek Reservoir Aeration Practice Manages Summer Dissolved Oxygen

The reservoir aeration system reduces chlorophyll productivity, possibly through the partial control of internal nutrient loading that can trigger algal blooms. The Association adopted a policy that makes the reservoir aeration system a permanent reservoir management tool. The Association determined through ongoing monitoring that the de-stratifying aeration system in Bear Creek Reservoir is a necessary and long-term or permanent management practice necessary to protect the quality reservoir fishery (Figure 20) and prevent Dissolved Oxygen standard exceedances during summer months of June 1-September 30.

Reservoir aeration is also a necessary management tool in low flow conditions. The current aeration system has been operational since the summer of 2002 and uses a fine-bubble diffusion system with aerators distributed across the hypolimnion. In 2012, the Association and Lakewood operated the aeration system to assure oxygen transfer during phased on-off cycling (Figure 21), with the aeration system phased primarily on in the growing season. The aeration system can increase the Dissolved Oxygen concentrations throughout the water column by about 2 mg/l within a two-week period.



Figure 20 Fishing Very Popular on Bear Creek Reservoir

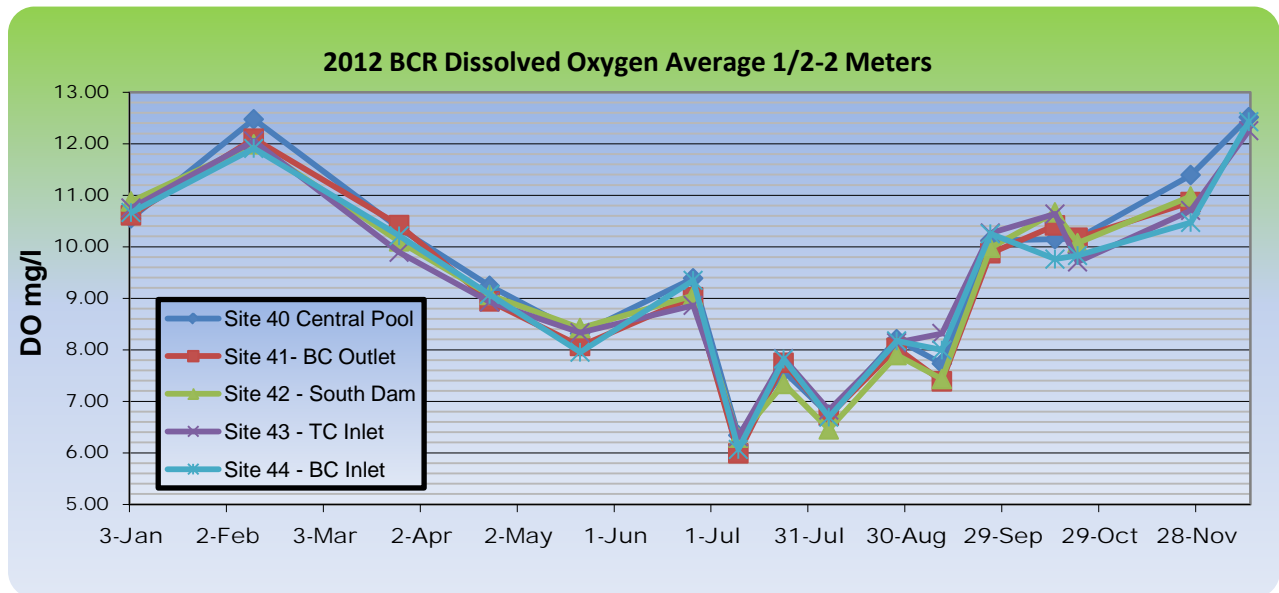


Figure 21 Bear Creek Reservoir Dissolved Oxygen Trend

Bear Creek Reservoir Sediment Study

The total suspended sediment load in the reservoir has been generally constant over the historic monitoring period with periodic storm events dumping large volumes of sediment into the reservoir. The Association in 2012 noted no significant change in reservoir depth. Bottom sediments remain a mixture of fine sand, silt and mud.

Field sampled on October 15, 2012. Bottom samples obtained with a medium sized clamshell sampler. This sampler takes a grab of the top 5-6 cm of the mud bottom. One dredge drop results in about 0.5 liters of bottom mud. The locations in Figure 22 are estimates. A sub-sample was bagged from the composite mud sampled at the site for out-side laboratory (SePro) analysis. Samples air-dried in a warm room for 48 to 72 hours. A number of the mud samples contained red worms that were about 1/2 cm long. The number of worms observed ranged from 1-14 per sample.



Figure 22 Bear Creek Reservoir Bottom Sample Sites

Figure 23 summarizes the total organic carbon (TOC) in bottom sediments for the 3-years of analyses. The TOC ranges from 3-18 % within the top 1/4m of the bottom sediments. The Association determined the total phosphorus content of the sediment (mg TP/kg Mud) as shown in Table 9. The total phosphorus content ranges from 0.4 to 11.5 mg TP/kg Mud. As seen in the SePro analyses (acidified the mud), there is a considerable amount of phosphorus within the bottom muds. Figure 24 characterizes the total phosphorus measured over three years at each site. The bottom sediment contains about 20% clays and silts. The Association will continue the sediment program in 2014.

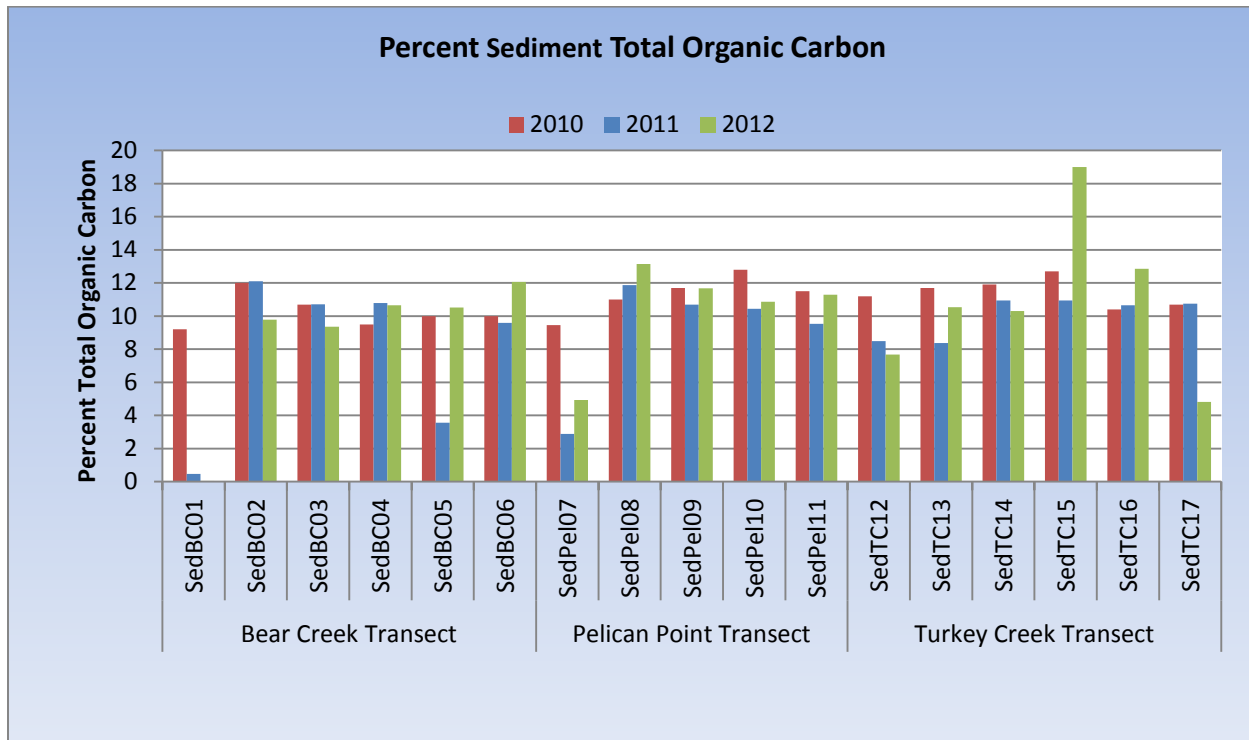


Figure 23 Total Organic Carbon in Bear Creek Reservoir Sediments

Table 9 Bear Creek Reservoir Total Phosphorus Sediment Summary

Transect		2010	2011	2012	2012 SePRO
		mgP/kg Mud	mgP/kg Mud	mgP/kg Mud	TP Sed, Mg/kg
		Filter	Filter	Filter	EPA 365.3, Modified
Bear Creek Transect	SedBC01	2.64	2.42	1.30	
	SedBC02	6.43	4.37	4.99	
	SedBC03	4.12	6.11	3.06	844.92
	SedBC04	5.32	2.75	4.61	
	SedBC05	3.50	5.21	4.38	1129.92
	SedBC06	4.09	1.08	4.56	
Pelican Point Transect	SedPel07	5.39	4.14	2.47	
	SedPel08	7.47	3.39	4.89	1100.76
	SedPel09	6.25	11.50	3.34	
	SedPel10	3.13	2.20	3.19	1052.08
	SedPel11	7.71	6.86	4.66	
Turkey Creek Transect	SedTC12	2.69	0.52	0.38	
	SedTC13	1.74	3.22	0.93	632.82
	SedTC14	7.32	8.11	3.88	
	SedTC15	6.99	8.15	3.18	
	SedTC16	5.76	1.91	3.90	831.88
	SedTC17	8.16	3.18	1.34	
	Average	5.22	4.42	3.24	932.06
Std	2.02	2.91	1.48	194.52	

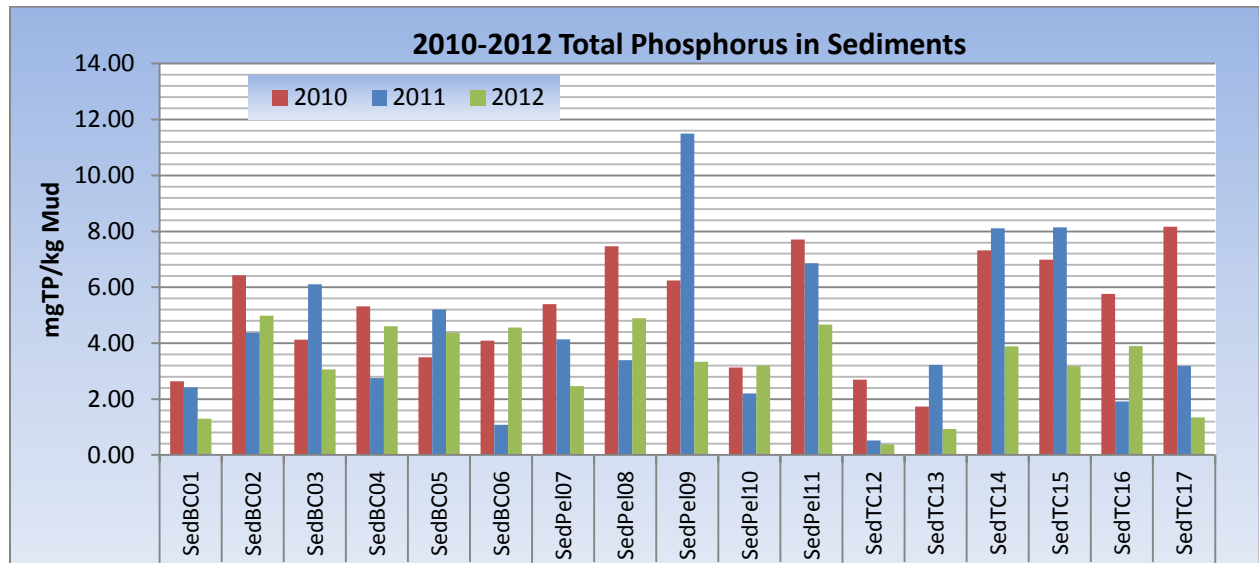


Figure 24 Estimated Total Phosphorus in Bear Creek Reservoir Bottom Muds

Evergreen Lake Study

Evergreen Lake (Segment 1d) is a small reservoir constructed in 1927 and serves as a major direct use water supply for the Evergreen community. The lake is an important year-round recreational facility with fishing and winter ice activities. The Evergreen Park & Recreation District provides maintenance around Evergreen Lake. These efforts aid in maintaining good water quality. The District maintains the wetlands located on the west end of the lake, retaining walls and rocks structure that support the road and walking paths, minimizes emotional features of the area and periodically removes rooted vegetation located along the shoreline and in the lake. In recent years, the Association has increased monitoring efforts to better characterize the reservoir and help protect the quality (Table 10). In last

few years, the dissolved oxygen concentrations in the water column were becoming very low with periodic bottom waters having less than 5 mg/l DO. The Evergreen Metropolitan District in cooperation with the recreation district installed an aeration system near the dam outlet area to help maintain elevated DO levels throughout the lake. The districts in cooperation with the Colorado Department of Parks and Wildlife introduced Grass Carp into the reservoir with the first release of about 100 fish at 20 inches length. This program reduces some of the excess Elodea algal (introduced invasive species) growth that contributes to the depressed DO problem. The combination of the aeration system and grass carp program resulted in DO compliance in 2012 monitoring program (Table 10). The Association monitoring program data to supports the designation of Evergreen Lake as a direct use water supply.

Table 10 Water Quality Data Summary for Evergreen Lake

Site	Parameter (ug/l)	7/12/2012	8/9/2012	9/6/2012
4a	Total Nitrogen	395	390	189
	Nitrate/Nitrite as N, dissolved	5	13	7
	Nitrogen, ammonia	38	15	56
	Phosphorus, total	30	48	33
	Total Dissolved Phosphorus	11	10	14
	Residue, Non-Filterable (TSS)	7.8	10.6	11.5
4e	Total Nitrogen	474	335	104
	Nitrate/Nitrite as N, dissolved	3	16	4
	Nitrogen, ammonia	21	36	51
	Phosphorus, total	44	37	29
	Total Dissolved Phosphorus	12	7	11
	Residue, Non-Filterable (TSS)	11.2	10	12.4
Parameter Summary		7/12/2012	8/9/2012	9/6/2012
Dissolved Oxygen 1/2-2m		9.67	5.94	6.12
Temperature (C) 1/2-2m		19.23	18.68	16.90
pH water column		6.80	7.66	7.46
Specific Conductance (us/m)		0.075	0.058	0.058

Genesee Reservoir Study

Genesee Reservoir is small water supply reservoir completed in 2007 for the Genesee Water and Sanitation District. The dam is 95 feet tall and 550 feet across with a water depth of about 80 feet. The district pumps water from Bear Creek (Segment 1e) into the direct use water supply reservoir. The reservoir is classified as segment 5. There is some minor inflow from upland drainage areas. The Association has collected some limited water quality data to characterize this supply reservoir. Table 11 shows water quality summary for Genesee Reservoir. The reservoir has both a temperature and dissolved oxygen compliance problem. Fish presumably (species unknown) from Bear Creek were introduced into the reservoir. The DO concentrations below 3-m commonly in late summer drop below 3 mg/l with temperatures in the 1/2-2m zone exceed standards.

Table 11 Water Quality Summary for Genesee Reservoir.

Site	Parameter (ug/l)	7/13/2012	8/9/2012	9/6/2012
Genesee Site 39a- -1m	Nitrate/Nitrite as N, dissolved	178	51	107
	Nitrogen, ammonia	22	20	42
	Phosphorus, total	14	13	11
Genesee Site 39b- -5m	Nitrate/Nitrite as N, dissolved	273	215	100
	Nitrogen, ammonia	67	61	36
	Phosphorus, total	22	18	9
Parameter Summary		7/13/2012	8/9/2012	9/6/2012
Dissolved Oxygen 1/2-2m		9.29	6.41	5.15
Temperature (C) 1/2-2m		19.34	19.60	17.90
pH water column		8.43	8.67	8.03
Specific Conductance (us/m)		0.192	0.158	0.144

III. Meeting Water Quality Goals and Standards for the Watershed

Dissolved Oxygen Compliance in Bear Creek Reservoir

Bear Creek Reservoir is on the Colorado monitoring list for Dissolved Oxygen. As such, the Association takes multiple profile readings at five profile stations in the reservoir to determine Dissolved Oxygen compliance. The Association Dissolved Oxygen data set from 2003-2012 for Bear Creek Reservoir shows over 99% compliance with the standard for the upper water column (surface through the mixed layer). The Dissolved Oxygen values in the mixed layer in 2012 were greater than 6 mg/l (Table 12, Figure 25). Data collected in the 2012 growing season shows the aeration system adds a maximum of 2.5 mg/l dissolved oxygen to the water column when under normal operation. Generally, the aeration system increases water column dissolved oxygen by about 1 mg/l, which results in dissolved oxygen compliance within the mixed layer.

Table 12 DO Compliance in Bear Creek Reservoir

Reservoir Site 40	2012 DO Compliance Bear Creek Reservoir															
	Jan	Feb	Mar	Apr	May	Jun	Jul	Jul	Aug	Aug	Sep	Sep	Oct	Oct	Nov	Dec
Total Depth Profile (m)	10.6	10.6	10.6	10.7	10.6	10.3	10.8	10.2	10.3	9.8	9.5	10.0	10.7	10.3	9.9	9.9
Average 1/2-2m (mg/l)	10.6	12.5	10.4	9.2	8.3	9.4	6.3	7.6	6.7	8.2	7.7	10.1	10.1	10.2	11.4	12.5
Profile Average (mg/l)	8.1	8.3	9.2	7.7	6.1	8.8	5.9	7.2	6.1	8.2	7.3	9.8	9.0	10.3	11.3	

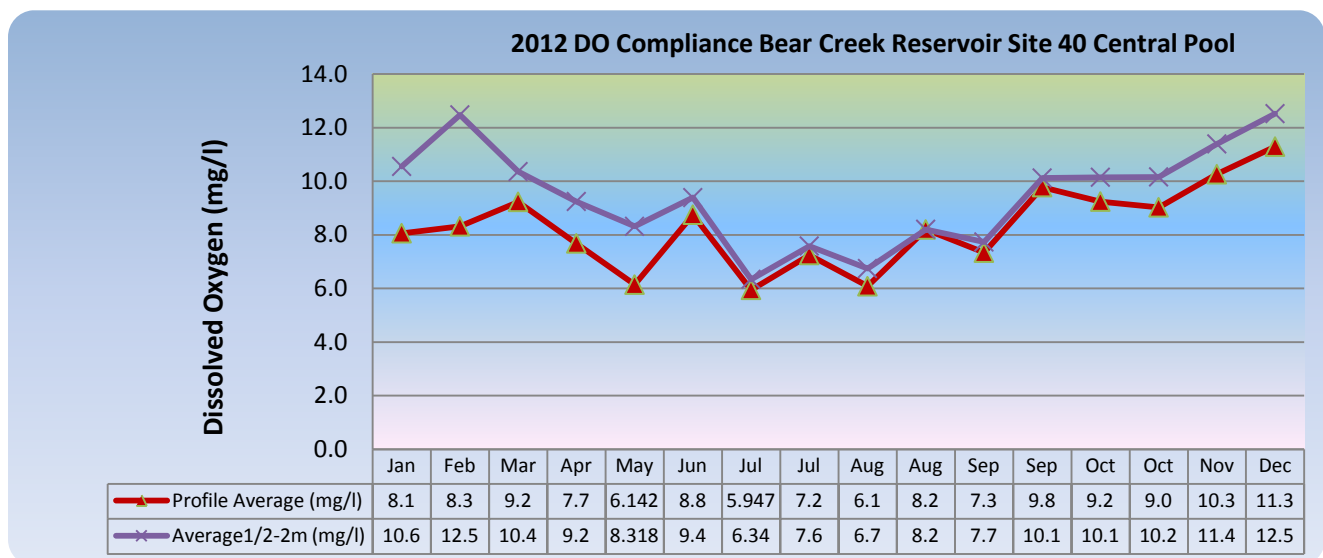


Figure 25 DO Compliance Bear Creek Reservoir

Temperature Standards Bear Creek Watershed

Table 13 shows the adopted temperature standards by segment for the watershed.

Table 13 Temperature Standards in Bear Creek Watershed

Segment	Segment	Standard	Month	STANDARD (°C)		Month	STANDARD (°C)	
				(MWAT)	(DM)		(MWAT)	(DM)
1a	Mainstem of Bear Creek from the boundary of the Mt. Evans Wilderness area to the inlet of Evergreen Lake	T=TVS(CS-I) °C	June-Sept	17.0	21.2	Oct-May	9.0	13.0
1b	Mainstem of Bear Creek from Harriman Ditch to the inlet of Bear Creek Reservoir	T=TVS(CS-II) °C, April-Oct; T(WAT)=19.3 oC	April-Oct	19.3	23.8	Nov-March	9.0	13.0
1c	Bear Creek Reservoir.	T=TVS(CLL) °C; April-Dec; T(WAT)=23.3oC	April-Dec	23.3	23.8	Jan-Mar	9.0	13.0
1d	Evergreen Lake.	T=TVS(CLL) °C	April-Dec	18.2	23.8	Jan-Mar	9.0	13.0

Segment	Segment	Standard	Month	STANDARD (°C)		Month	STANDARD (°C)	
				(MWAT)	(DM)		(MWAT)	(DM)
1e	Mainstem of Bear Creek from the outlet of Evergreen Lake to the Harriman Ditch.	T=TVS(CS-II) °C; April-Oct; T(WAT)=19.3 oC	April-Oct	19.3	23.8	Nov-March	9.0	13.0
2	Mainstem of Bear Creek from the outlet of Bear Creek Reservoir to the confluence with the South Platte River.	T=TVS(WS-II) °C	March-Nov	27.5	28.6	Nov-March	13.7	14.3
3	All tributaries to Bear Creek, including all wetlands, from the source to the outlet of Evergreen Lake, Except for specific listings in Segment 7.	T=TVS(CS-I) °C	June-Sept	17.0	21.2	Oct-May	9.0	13.0
4a	All tributaries to Bear Creek, including all wetlands, from the outlet of Evergreen Lake to the confluence with the South Platte River, except for specific listings in Segments 5, 6a, and 6b.	T=TVS(WS-I) °C	March-Nov	24.2	29	Dec-Feb	12.1	14.5
5	Swede, Kerr, Sawmill, Troublesome, and Cold Springs Gulches, and mainstem of Cub Creek from the source to the confluence with Bear Creek.	T=TVS(CS-II) °C	April-Oct	18.2	23.8	Nov-March	9.0	13.0
6a	Turkey Creek system, including all tributaries and wetlands, from the source to the inlet of Bear Creek Reservoir, except for specific listings in Segment 6b.	T=TVS(CS-II) °C	April-Oct	18.2	23.8	Nov-March	9.0	13.0
6b	Mainstem of North Turkey Creek, from the source to the confluence with Turkey Creek.	T=TVS(CS-I) °C	June-Sept	17.0	21.2	Oct-May	9.0	13.0
7	Mainstem and all tributaries to Bear Creek, including wetlands, within the Mt. Evans Wilderness Area.	T=TVS(CS-I) °C	June-Sept	17.0	21.2	Oct-May	9.0	13.0
8	Lakes and reservoirs in the Bear Creek system from the sources to the boundary of the Mt. Evans Wilderness area.	T=TVS(CL) °C	April-Dec	17.0	21.2	Jan-Mar	9.0	13.0
9	Lakes and reservoirs in the Bear Creek system from the boundary of the Mt. Evans Wilderness area to the inlet of Evergreen Lake.	T=TVS(CL) °C	April-Dec	17.0	21.2	Jan-Mar	9.0	13.0
10	Lakes and reservoirs in drainages of Swede Gulch, Sawmill Gulch, Troublesome Gulch, and Cold Springs Gulch from source to confluence with Bear Creek.	T=TVS(CL) °C	April-Dec	17.0	21.2	Jan-Mar	9.0	13.0
11	Lakes and reservoirs in the Bear Creek system from the outlet of Evergreen Lake to the confluence with the South Platte River, except as specified in Segments 1c, 10, and 12; includes Soda Lakes.	T=TVS(CL) °C	April-Dec	17.0	21.2	Jan-Mar	9.0	13.0
12	Lakes and reservoirs in the Turkey Creek system from the source to the inlet of Bear Creek Reservoir	T=TVS(CL) °C	April-Dec	17.0	21.2	Jan-Mar	9.0	13.0

Bear Creek Reservoir Temperature Compliance

The Association takes multiple profile readings at five profile stations in the reservoir to determine temperature compliance. Figure 26 show temperature standards and the monthly sampling compliance record for Bear Creek Reservoir. The Association in 2012 placed a temperature probe string at site 43 to better qualify the temperature in the top 2m of the water column (-1/2m, -1m, -1.5m, and 2m). Table 14 summarizes the temperature record. The reservoir exceeded the WAT 9-times and the daily maximum 57 times.

Table 14 Temperature Compliance Summary Bear Creek Reservoir

All Temperatures °C	30-Min Temp.	April 1-Dec 31 Res Std. WAT (23.3°C)	April 1-Dec 31 2-HR Avg. Temp.	April 1-Dec 31 DM (23.8°C)
Min	1.8	4.3	1.8	3.3
Max	25.5	24.1	25.2	25.2
Avg	16.3	16.4	16.3	16.7
Measurements	36,645	108	9,159	762
# 23.3°C WAT exceeded		9		
% Compliance WAT		92%		
# 23.8°C DM exceeded				57
% Compliance DM				93%

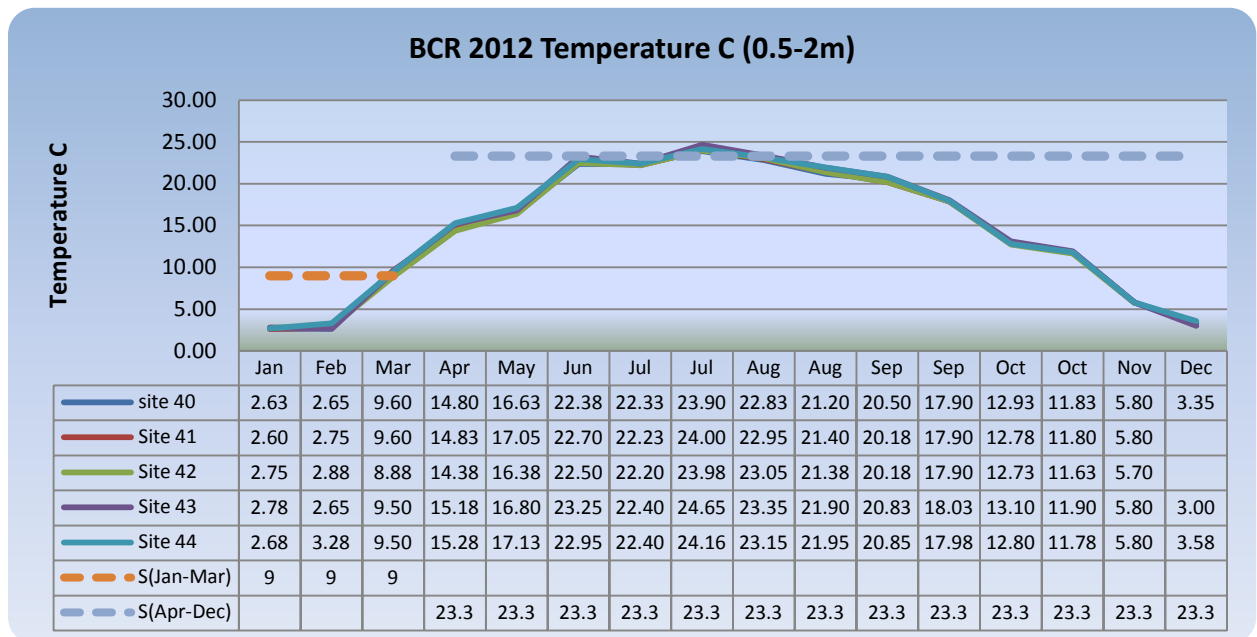


Figure 26 Temperature Compliance Bear Creek Reservoir

Watershed Stream and Lake Compliance

The Association conducts special stream monitoring programs within the Bear Creek Watershed including Bear Creek, and a portion of the Turkey Creek Drainage (North and South Turkey Creek). The monitoring year divides into a warm-season period with more intense sampling and a cold-season period, designed to provide minimal winter and spring data. The Association 2012 Data Report summarizes temperature and water quality monitoring data, sampling results obtained from in-stream locations, and data from five-wastewater treatment plant effluents. The complete water quality data set is an electronic data report.

There were 338,333 individual temperature data points obtained from the twenty-nine data logger sites within the watershed (excluding the WWTP data). The warm-season and cold-season temperature compliance summary is shown in Table 15. A number of temperature compliance problems occurred in both the warm and cold seasons.

Table 15 Watershed Temperature Compliance Summary Warm/ Cold Seasons

	Cold-season		Warm Season	
Segment 3	9°C WAT	13°C DM	17°C WAT	21.2°C DM
# Exceedances	3	33	0	12
% Compliance	73%	59.76%	100%	90%
Segment 1a	9°C WAT	13°C DM	17°C WAT	21.2°C DM
# Exceedances	8	48	6	34
% Compliance	85%	88%	82%	86%
Segment 1d	9.0°C WAT	13.0°C DM	18.2°C WAT	23.8°C DM
# Exceedances			36	0
% Compliance				100%
Segment 1e	9°C WAT	13°C DM	19.3°C WAT	23.8°C DM
# Exceedances	0	0	20	27
% Compliance	100%	100%	88%	98%
Segment 1b	9°C WAT	13°C DM	19.3°C WAT	23.8°C DM
# Exceedances	0	1	6	12
% Compliance	100%	99%	80%	94%
Segment 5	9°C WAT	13°C DM	18.2°C WAT	23.8°C DM

	Cold-season		Warm Season	
# Exceedances	0	0	0	0
% Compliance	100%	100%	100%	100%
Segment 6a	9°C WAT	13°C DM	18.2°C WAT	23.8°C DM
# Exceedances	0	1	1	0
% Compliance	100%	99%	98%	100%
Segment 6b	9°C WAT	13°C DM	17°C WAT	21.2°C DM
# Exceedances	2	33	0	6
% Compliance	88%	72%	100%	95%
Segment 10	9°C WAT	13°C DM	17°C WAT	21.2°C DM
# Exceedances			38	0
% Compliance			72%	100%
Segment 2	13.7°C WAT	14.3°C DM	27.5°C WAT	28.6°C DM
# Exceedances	0	0	0	0
% Compliance	100%	100%	100%	100%
Segment 1c	9°C WAT	13°C DM	24.0°C WAT	26.0°C DM
Exceedances			9	57
% Compliance			92%	93%

Stream and lake sampling and monitoring data, including pH, Temperature, Dissolved Oxygen, Specific Conductance, Ammonia, Nitrate+Nitrite, Total Inorganic Nitrogen (calculated), Total Nitrogen and Total Phosphorous was collected from July through September (Table 16). Stream and lake temperature dataloggers located at 33 Sites, including the Evergreen Lake profile station and Bear Creek Reservoir profile station, excluding the five-wastewater treatment plants. Manual flows measured at 24 sites during the July to September timeframe. Low Dissolved oxygen values in the upper water column were measured in Genesee Reservoir. An aeration system was installed and operational for Evergreen Lake. The other water chemistry exceedances of standards measured in the 2012 watershed-monitoring program occurred at Summit Lake.

Table 16 Water Quality Compliance at Watershed Monitoring Sites

	Stream Std. pH (6.5-9 SU)	Stream Std. DO (6.0 mg/L 2-meter avg.)	Stream Std.		Proposed Stream Std.	
			NH3-N ug/L (TVS)	NO3-N (10,000 ug/L)*	TN (1250 ug/L)	TP (110 ug/L)
Segment 8						
# Exceedances	1	0	0	0	0	0
# Measurements	7	7	7	7	7	7
% Compliance	85.71%	100%	100%	100%	100%	100%
Segment 7 *						
# Exceedances	5	9	0	0	2	5
# Measurements	18	18	18	18	15	18
% Compliance	72%	50%	100%	100%	86.66%	72.22%
Segment 3						
# Exceedances	0	0	0	0	0	0
# Measurements	3	3	3	3	3	3
% Compliance	100%	100%	100%	100%	100%	100%
Segment 1a						
# Exceedances	0	0	0	0	0	0
# Measurements	9	9	9	9	9	9
% Compliance	100%	100%	100%	100%	100%	100%
Segment 1d						
# Exceedances	0	0	0	0	0	0
# Measurements	30	30	6	6	6	6
% Compliance	100%	100%	100%	100%	100%	100%
Segment 1e						
# Exceedances	0	0	0	0	0	0
# Measurements	18	18	18	18	10	18
% Compliance	100%	100%	100%	100%	100%	100%

	Stream Std.	Stream Std.	Stream Std.		Proposed Stream Std.	
	pH (6.5-9 SU)	DO (6.0 mg/L 2-meter avg.)	NH3-N ug/L (TVS)	NO3-N (10,000 ug/L)*	TN (1250 ug/L)	TP (110 ug/L)
Segment 1b	No Sites in Segment 1b were sampled and monitored by association mgr.					
Segment 5						
# Exceedances	0	0	0	0	0	0
# Measurements	6	6	6	6	2	6
% Compliance	100%	100%	100%	100%	100%	100%
Segment 6a						
# Exceedances	0	1	0	0	0	0
# Measurements	3	3	3	3	1	3
% Compliance	100%	66.66%	100%	100%	100%	100%
Segment 6b						
# Exceedances	0	0	0	0	0	0
# Measurements	3	3	3	3	3	3
% Compliance	100%	100%	100%	100%	100%	100%
Segment 10						
# Exceedances	4	1	0	0	N/A	0
# Measurements	27	27	6	6	N/A	6
% Compliance	85.19%	91.66%	100%	100%	N/A	100%

* Signifies special Summit Lake Pollution Plume study represented in this segment.

*- Samples were analyzed for NO3+NO2-N but compared to the Nitrate water quality standard of 10 mg/L.

303(d) Listing

Table 17 shows the stream segments in the Bear Creek Watershed that are on the Colorado 303(d) list. The Association is evaluating potential causes and water quality problems in these listed segments. The Association suspects' road (both dirt and paved) and parking lot sand/silt and debris runoff has localized affects on stream quality. These fine sediments cause sections of the streambed to become embedded with fine sands and silts, which reduces habitat for macroinvertebrates and may result in poor MMI scores in segments 1e and 2. The Association has designed a project to address this problem and is actively seeking funding for the project(s).

Barr/Milton Model Input and Bear Creek Load Predictions

The Bear Creek Watershed is in the defined "data" shed for the BMW pH/DO TMDL. Discharge from Bear Creek Reservoir is identified as a "point" source and input to the BMW pH/DO TMDL and model. As such, the BCWA site 45 is a source that contributes about 1.8 % of the external load of Total Phosphorus. The BMW pH/DO TMDL defines the contribution of Total Phosphorus from Bear Creek for both Barr Lake and Milton Reservoir at 1,167 kg/year or 2,672.7 pounds/year. In the period from 2000 through 2012, the average Total Phosphorus at BCWA site 45 was 1,785 pound/year. The Association annually provides the Barr/Milton Watershed Board a memorandum detailing water quality data at site 45.

Table 17 303(d) List Bear Creek Watershed

WBID	Segment Description	Portion	Colorado's Monitoring & Evaluation	Clean Water Act Section 303(d) Impairment	303(d) Priority
COSPBE01a	Mainstem of Bear Creek from the boundary of the Mt. Evans Wilderness area to the inlet of Evergreen Lake.	Witter Gulch to inlet of Evergreen Lake		Temperature, Aquatic Life (provisional)	H
COSPBE01c	Bear Creek Reservoir	all	-	Chl-a, phosphorus	H
COSPBE01e	Mainstem of Bear Creek from the outlet of Evergreen Lake to the Harriman Ditch.	all	Aquatic Life		-
COSPBE01e	Mainstem of Bear Creek from the outlet of Evergreen Lake to the Harriman Ditch.	From the outlet of Evergreen Lake to Kerr/Swede Gulch		Temperature	<u>H</u>

WBID	Segment Description	Portion	Colorado's Monitoring & Evaluation	Clean Water Act Section 303(d) Impairment	303(d) Priority
COSPBE02	Bear Creek below Bear Creek Reservoir to South Platte River	Below Kipling Parkway (CO 390)	Aquatic Life	E. coli (May-Oct)	H
COSPBE05	Swede, Kerr, Sawmill, Troublesome and Cold Springs Gulches and Cub Creek	Swede/Kerr Gulch		E. coli	L

Macroinvertebrate Analysis and Aquatic Life Compliance

Since 2004, the Association has conducted macroinvertebrate sampling and data collection at 14 sites, including Colorado Parks and Wildlife fish survey sites along Bear Creek: Morrison (west end), Idledale, Lair o' the Bear Park, O' Fallon Park, Bear Creek Cabins, Main Street Evergreen (across from the Little Bear), above Evergreen Lake upstream within Dedisse Park, Bear Tracks, above Singing River Ranch at the Mt. Evans Boundary area, and Golden Willow Bridge. The cooperative macroinvertebrate sampling is done by the Association in September with analyze by the Water Quality Control Division. The Division calculates the MMI, OE, HBI and Shannon index values for these samples and reports the results to the Association. The sampling design in Bear Creek has targeted a combination of slow and fast riffles with various amounts of cobble substrate at the sites. The program provides information on site variation, including both spatially and temporally variation at each site. The 2012 macroinvertebrate data is summarized in Table 18.

Four sites were below the attainment threshold for macroinvertebrate standards in 2012: Lair O' Bear, O'Fallon Park, Bear Creek Cabins, and Keys on the Green. Little Bear in Downtown Evergreen was below the impairment threshold, The WQCD considers the Bear Creek Cabins site to be "stressed". Four sites were below the attainment threshold for macroinvertebrate standards in 2012: Lair O' Bear, O'Fallon Park, Bear Creek Cabins, and Keys on the Green. Little Bear in Downtown Evergreen was below the impairment threshold, The WQCD considers the Bear Creek Cabins site to be "stressed".

The macroinvertebrates at the new Golden Willow Bridge site show no indications of stress or impairment and the Keys on the Green site continues to show a stressed macroinvertebrate population. The stream segment from Evergreen Lake inlet to the Golden Willow Bridge is on the Colorado 303(d) monitoring and evaluation list as potential impaired for aquatic life. The MMI data currently supports this listing. The Association suspects the problem is in part the poorer quality stream habitat within Dedisse Park. However, the Association monitoring program does show a general trend of increased total phosphorus associated with this segment. The three sites showing the most long-term stress to macroinvertebrates are Keys on the Green, Little Bear in downtown Evergreen and Bear Creek Cabins. The Association notes that these three sites have a greater amount of sand/silt and debris embedded into the stream bottom. The Association is evaluating potential solutions to address this problem.

Table 18 MMI Attainment and Impairment Summary for Bear Creek Watershed

BCWA Site	WQCD Site	Location	Zone	Stream Segment	Total Taxa	MMI	O/E	Shannon Index	HBI
14a	122	Morrison Park	Transition	1e	27	72.9	0.79	3.8	4.9
13a	122C	Idledale	Transition	1e	24	51.3	0.71	2.5	4.6
12	122a	Lair O' Bear	Transition	1e	22	49.9	0.80	3.9	4.4
9	122b	O'Fallon	Transition	1e	33	68.0	0.93	3.7	3.7
8	5762	Bear Creek Cabins	Transition	1e	25	44.3	0.79	3.6	2.9
5	5763	Little Bear, Downtown	Transition	1e	21	40.0	0.53	3.8	4.2
3a	5764	Keys on the Green	Mountain	1a	31	46.9	0.92	3.5	4.2
58	5768C	Boundary MEW	Mountain	1a	34	72.5	0.89	3.4	4.6
2a	5768D	Golden Willow	Mountain	1a	31	71.9	0.86	4.0	4.6

IV. Wastewater Treatment Facilities Loading and Compliance

Wasteload Compliance

The total wasteload allocation of phosphorus from all wastewater treatment facilities in the Bear Creek Watershed is 5,255 pounds per year. Table 19 lists the permitted wastewater treatment facilities. Each individual discharger in the Bear Creek Watershed is limited to an annual wasteload of total phosphorus, except as provided through trading provisions. Wastewater discharges cannot exceed a total phosphorus effluent concentration of 1.0 mg/l as a 30-day average. One reporting facility exceeded the assigned wasteload allocations (Table 18).

Table 19 Treatment Facility Wasteload Allocations

Bear Creek Watershed Wastewater Treatment Plants	Phosphorus Pounds/ year	2012 Phosphorus Pounds/ year
Evergreen Metropolitan District	1,500	251.62
West Jefferson County Metro District	1,500	168.92
Genesee Water and Sanitation District	1,015	271.94
Town of Morrison	600	112.34
Kittredge Sanitation and Water District	240	49.91
Forest Hills Metropolitan District ¹	80	89.9
Conifer Metropolitan District	80	13.05
Aspen Park Metropolitan District	40	9.52
Jefferson County Schools – Mt. Evans Outdoor Lab	20	1.79
Jefferson County Schools - Conifer High School	110	1.06
Bear Creek Development Corp. - Tiny Town	5	0.01
Bear Creek Cabins (Bruce & Jayne Hungate)	5	0.20
Brook Forest Inn	5	1.66
Geneva Glen ³	5	0
Total Operational Facilities		971.92
The Fort ²	18	No Monitoring
Singing River Ranch	30	Not Operational
Reserve Pool	2	Not used 2012
Total Phosphorus Wasteload	5,255 lbs/year	

1 Forest Hills Metro District no longer has an operational trade agreement.

2 Permit; No established monitoring

3 The Geneva Glen treatment system land applies, dry lysimeters in 2012 and no phosphorus reported on DMRs

Permit Compliance and Plant Expansions/Actions

Table 20 shows permitted wastewater treatment facilities in the watershed, status of wastewater planning, and reported permit compliance problems. All wastewater treatment plants in the watershed are minor facilities using the WQCD permit classification system. The Association worked on planning and review efforts for Forest Hills Metro District and Town of Morrison.

Table 20 Wastewater Treatment Plant Planning Status

Facility	Wastewater Utility Plan	Any Updates, Lift Station, or Amendments	Facility Upgrades [2012-2016]	Compliance Problems
Evergreen Metropolitan District	Yes	Lift Stations	No	No
West Jefferson County	Yes	No	No	No
Genesee	Yes	No	No	No
Kittredge	Yes	No	No	No
Morrison	Yes	Updated Utility Plan, upgrades 2013	In-progress	No

Facility	Wastewater Utility Plan	Any Updates, Lift Station, or Amendments	Facility Upgrades [2012-2016]	Compliance Problems
Jefferson County Schools Conifer High School	Yes	No	No	No
Jefferson County Schools Mt Evan Outdoor	Yes	New facility Design	Yes	Yes
Forest Hills Metropolitan District	No	New Plant	No	Yes, WLA
Conifer Sanitation Association	Yes	No	Yes	No
Aspen Park Metro District	Yes	Infiltration gallery, Outfall	Yes	Yes, Gallery Operation
Conifer Metro District (CMD)	Yes	No	Yes	Chloride -2-yr to correct problem
The Fort	Yes	New Treatment Works, Monitoring	Yes	No
Bear Creek Development	No	No	No	No
Bear Creek Cabins	No	No	Yes	No
Singing River Ranch	Yes	Plugged Influent	No	No
Brook Forest Inn	No	Yes, new upgrades	Yes	No
Geneva Glen	Yes	No	Better Monitoring	No

Utility Supported Programs

Pharmaceutical Recycling Program

The Association financially supports a used medicine drop-off location. The utilities have sent notices with their monthly billings to support pharmaceutical recycling programs.

Sanitary Sewer Incentive Programs in the Evergreen Area.

The Evergreen Metropolitan District and Upper Bear Creek Water and Sanitation District offer a 50% discount to the current sewer tap fee to property owners within the District Boundaries with Individual Septic Disposal Systems willing to connect.

The West Jefferson County Metropolitan District offers a discount of \$9,000 to the current sewer tap fee to property owners within the District Boundaries willing to connect their ISDS to the distribution system.

Trading Program

The Association maintains a pollutant-trading program as defined in *Trading Guidelines* (Association 2006) and in *Bear Creek Reservoir Control Regulation #74* for total phosphorus trades specific to the Bear Creek Watershed: Point source to point source trades (regulation and permit); and Nonpoint source to point source total phosphorus trading specific to the Bear Creek Watershed (*Trading Guidelines*). The *Bear Creek Trading Guidelines* allow permitted point source dischargers (Colorado Wastewater Discharge Permits) to either receive phosphorus pounds for new or increased phosphorus wasteload allocations in exchange for phosphorus loading reductions from nonpoint source pollutant reduction or through approved point source trades. Table 21 lists all Association trades. The reserve pool remained at 2 pounds and no changes made in 2012. The trades in the watershed remain consistent with the total wasteload allocations listed in Table 18.

Table 21 Phosphorus Trading Activity in Bear Creek Watershed

Involved Agencies	Type of Trade	Active Trading in 2012
Forest Hills Metro District (FHMD) had trade agreement with West Jefferson County Metro District(WJCMD) ¹	Point Source to Point Source	No- Discontinued in 2012
City of Lakewood Coyote Gulch Project	Nonpoint source trade credits	Under data collection/ reviewed by Association; trade credit calculated in 2011/ confirmed 2012

Involved Agencies	Type of Trade	Active Trading in 2012
The Fort Restaurant	Reserve Pool to Point Source	Permit in Progress; Trade reflected in reserve pool limit previously granted by the WQCC
Jefferson County Schools (Conifer High School and Mt. Evans Outdoor School)	Point Source to Point Source	In Discharge Permits; no change in pounds; reallocation between facilities
Conifer Metropolitan District	Reserve Pool to Point Source	Trade reflected in reserve pool limit previously granted by the WQCC

Watershed Stormwater Management

City of Lakewood MS4 Program

The City of Lakewood has a municipal separate storm sewer permit (*CDPS Stormwater Permit Annual Report for 2012, Municipal Stormwater Permit No.: COS-000002*; City of Lakewood, May 2012).

Lakewood supports many stormwater management programs in the watershed, including the *Rooney Road Recycling Center*, which also serves as watershed prevention BMP. Lakewood collected waste products for proper disposal (includes oil, paint, antifreeze, misc. chemicals, and solid wastes) from an Evergreen area collection in 2012. This process keeps materials out of septic systems and helps reduce illegal dumping in the watershed. Lakewood regularly reports to the Association on stormwater management practices and programs. More information about Lakewood's municipal stormwater program is contained in their CDPS Stormwater Permit Annual Report for 2012.

On October 31st, 2012, the organic recycling program at *Rooney Road Recycling Center* was closed by Jefferson County. The worst fire season in history along with advancing pine beetle infestation bolstered the Rooney Road Organic Recycling Program throughout its final season. Program fees ranged from \$5 to \$40 per vehicle depending on size. There were more than 22,000 participants with nearly 80% of the participants from the watershed. This included individuals with pick-up trucks, trailers and dump trucks. An estimated 70 million pounds or 85,000 cubic yards of material were 100% recycled.

Jefferson County MS4 Program

Jefferson County has a municipal separate storm sewer permit. Jefferson County's program includes Public Education and Outreach; Public Participation and Involvement; Illicit Discharge Detection and Elimination; Construction Site Runoff Control; Post Construction Site Runoff Control; and Pollution Prevention/Good Housekeeping. The county provides opportunities for residents and visitors in the watershed to learn and be involved in environmental stewardship and programs that promote water quality. The county has a comprehensive storm sewer outfall map to trace sources of potential illicit discharges and illegal dumping in the watershed.

Jefferson County also maintains an erosion and sediment control program as part of their MS4 permit. The county maintains a small-site erosion control manual that explains the basic principles of erosion control and illustrates techniques to control sediment from small development sites. Jefferson County has an inspection program for illicit discharges, construction activities, and includes post-construction Inspections (Table 22).

Table 22 Jefferson County Storm Water 2012 Activities and Actions

Activity	Inspections/ Action
Illicit Discharge Verbal Notification of Violation	2
Illicit Discharge Monetary Penalty/Fine	0
Construction Sites Covered by Program	274
Construction Inspections	1591
Enforcement Verbal Notification of Violation	73
Post-Construction Inspections	4
Storm drain marking program	Ongoing

BCWA Stormwater Monitoring Program

The Association gathers data prior to, during and after storm events occurring in the watershed. Continuous monitoring of storm events could allow up to 36 hours of data. The parameters are temperature, dissolved oxygen, pH, and conductivity. The intent is to measure changes in these parameters due to run off from adjacent properties including roadways, parking lots and open spaces. The Association is developing a separate stormwater data set.

The Association monitors selected stormwater loadings in locations in the middle section of the watershed. The Association identified a number of potential stormwater runoff locations requiring corrective land use controls. The Association works with local businesses that cause minor nonpoint source runoff from their business sites with the implementation of runoff controls. These runoff control programs are successful. The Association actively identifies erosion problem areas for potential future projects.

The BCWA Policy 3 used by the Association (referral processes for land use applications from Jefferson and Clear Creek Counties) is directed at land disturbances that have a potential to cause water quality degradation. Specifically, the policy directs the Association to evaluate stormwater runoff and determine if the application contains appropriate techniques to mitigate any significant runoff that could degrade receiving water quality.

Clear Creek County Stormwater Management Program

Clear Creek County has posted a number of educational materials on the county website directed at stormwater management on home-sites, commercial properties, along mountain roadways and driveways, to protect groundwater and surface water resources. The report *Managing Stormwater to Protect Water Resources in Mountainous Regions of Colorado* (Clear Creek County Community Development, July 2009) outlines appropriate best management practices, techniques to maintain pre-development hydrology, and resource impacts from development in mountainous terrain.

V. Nonpoint Source Program

Septic System Management

In 2012, the Association continued limited discussions with Jefferson County Health Department based on previous presentations made to the Jefferson County Board of Health and the Jefferson County Commissioners. Jefferson and Clear Creek counties reviewed their septic system regulations. The Association predicts onsite wastewater systems in a number of specific areas in the Bear Creek Watershed contribute to water quality degradation. There are 16,000- 20,000-onsite systems in the watershed, depending on the estimation method. Based on existing county taxing records, there an estimated 27,000+ lots were there is a permitted onsite system, un-permitted system or developable lot.

The Association has two special monitoring efforts in progress to determine surface water quality affected from areas on septic systems: Kerr/Swede Gulch and Cub Creek. The Kerr/Swede Gulch focus on a limited number of septic systems (<35) that potential add nutrients to the lower portion of the drainage between site 52(Confluence) and site 53 (Riefenberg) (Figure 27). The monitoring program suggests there is a nutrient load that potentially related to septic system discharge.

The Association is also monitoring upstream and downstream on Cub Creek where there are > 1,000 septic systems. The total phosphorus load distinctly increases from upstream to downstream by 90% on average. However, the nitrogen decreases in comparison, with instream uptake. The coverage of hard substrate in lower Cub Creek in late summer is generally over 50%.

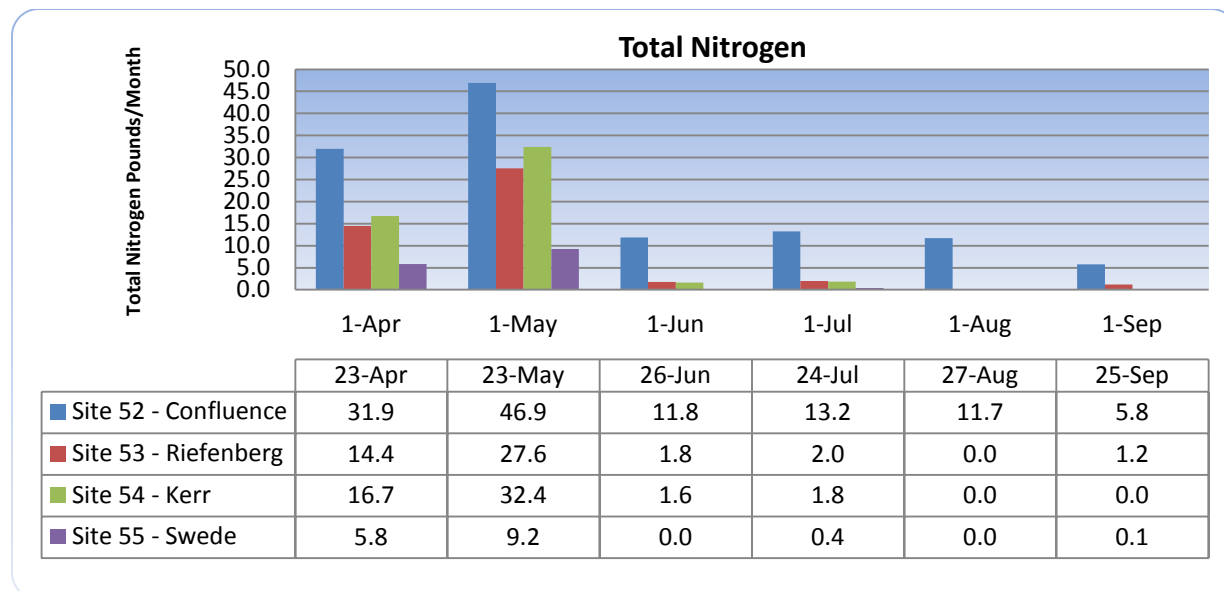


Figure 27 Onsite System Study - Comparison of Total Nitrogen Between Sites 52 and 53

Selected Watershed Nonpoint Source Programs

The management of nonpoint sources in the Bear Creek Watershed is a component of the Association planning and management programs. Phosphorus reduction from nonpoint sources is still required in the watershed. A lack of implementation authority limits the nonpoint source program. The Association does maintain a comprehensive watershed-monitoring program to determine sources of nutrient loading into waterways.

Nonpoint Source Education

The Association has an active education and outreach program to help raise awareness with watershed citizens on the need for non-point source controls. The Association provides information to the community on water quality management and environmental issues and supports educational programs/ activities (e.g., Evergreen Chamber Duck Races, earthday, Audubon, Evergreen Trout Unlimited, and the Clear Creek water festival). Association members are involved in numerous educational and training efforts for schools, clubs, and local agencies and often assist with seminars and conferences.

Junior Watershed Manger Program

The Association developed a junior watershed manger program and works with the 5 watershed high schools to provide educational opportunities, training classes and materials related to watershed and water quality management. The Association has a “Watershed 101” training course and will develop more courses as part an outreach program. The Association worked with students at Evergreen High School to develop several monitoring and restoration projects on the school property and along Wilmont Creek. The students designed and with funding support from the Association built a rain garden that fixes a stormwater runoff problem at the school.

Geo-Locate Sign Program

The Association is developing and installing a new educational signage project in the watershed. The 11 kiosks have educational messages that target nonpoint problems and solutions. Signs are located at public accessible sites beginning at the Jefferson County Outdoor School to the Lakewood City buildings. Each sign has a base message and a site-specific message. People will be able to Geo-locate BCWA signs, collect the keywords from each sign, and share your findings on our website.

[Bear Creek Regional Parks, Lakewood](#)

The city has a number of education and campfire programs held at Bear Creek Park (e.g., Junior Naturalist) that includes environmental and water quality elements. The Association has developed education materials, handouts and otherwise supported the park programs.

[Evergreen Trout Unlimited](#)

The Association works with Evergreen Trout Unlimited and other partners in identifying and implementing new stream restoration projects/programs. Evergreen Trout Unlimited conducts spring and fall cleanout operations in Evergreen Lake, Bear Creek downtown, O'Fallon. ETU collects over 10 cubic yards of trash and debris, annually. Several Association members are member of ETU.

[Wilmot Elementary School in Evergreen](#)

Annually, the fourth grade classes at Wilmot Elementary School in Evergreen participate in a one-day class on centered on the ecology of Evergreen Lake. They do walking tours around the lake. Several sites around the lake are set up for each group to spend time at, including a stop at the Evergreen Metropolitan District Water Treatment Facility.

[Manure Management](#)

The Bear Creek Watershed Association recognizes animal manure and associated liquid waste stream is a contributing factor in nonpoint source pollution within the Bear Creek Park (BCWA Technical Memorandum 2012.09 - Manure Management Bear Creek Park, Lakewood). An *Animal Facility* or similar project can lead to an accumulation of nutrients in the park over the long term, especially in areas with repeated applications, such as the stables and trails. Manure management strategies used in the Bear Creek Park should not increase the total annual load of total nitrogen or total phosphorus above ambient conditions where such waste can or potentially can reach surface waters in the watershed or within alluvial groundwater. Bear Creek Park staff began manure management practices that included construction of composting bins for large animal waste products and managing trail crossings at waterways.

[Summit Lake](#)

Bear Creek Watershed Association established two sampling stations at Summit Lake and upper Bear Creek, Mt Evans Wilderness, Clear Creek County Colorado (BCWA Technical Memorandum 2012.02 - Sampling Program Summit Lake/ Denver Mountain Parks and National Forest Service lands and 2012 Water Quality Data and Observations). The Association selected sampling Site 36 (Summit Lake at outfall) and Upper Bear Creek Site 37 to monitor assumed high quality "background" conditions. However, past monitoring data showed atypical water quality results. The station data suggested there is a pollution source causing elevated nutrient loads, low pH conditions and reduced dissolved oxygen. Association observations suggested the origin of the pollutants was the new/old toilet vaults at the Summit Lake parking lot. Deleterious effects to aquatic life are associated with the pollution plume. The new state interim Total Phosphorus standard for cold-water streams is 110 ug/l and the concentration measured in the plume exceeds 1,825 ug/l. The Association measured nearly 2,366 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 provided the City and County of Denver, Colorado Department of Parks and Wildlife, Colorado Water Quality Control Division, State Forest Service and National Forest Service the Association technical memorandum. Denver has committed to further characterize the water quality problem and work towards mitigation of any problems attributable to the Denver Mountain Park Facilities.

Snow Storage and Parking Lot Green-Infrastructure

Space is limited in the community of Evergreen and for other small communities in the Bear Creek Watershed where most development, especially commercial, is located adjacent to the creeks and tributaries. Consequently, most parking lots and roadways are constructed right to the edge of the normal high watermarks for the streams and creeks. As such, winter snow removal simply pushes the snow load into the waterways. This plowing procedure inevitably includes asphalt and debris from the roadsides. In the central parking lot in Evergreen, the process has led to collapse of about 8-feet of a portion of the lot into Bear Creek. The parking lot collapse point is where a major stormwater drainage system discharges into the stream. The Association has spoken with Evergreen Trout Unlimited and members of the Evergreen Area Chamber of Commerce, and the parking lot owner about ways to improve runoff from the central parking lot and other drainage points in the community. The Association is actively pursuing grant opportunities to establish and test a new snow storage and parking lot maintenance practice. The Association and community have discussed the concept of green infrastructure best management practice for the central parking lot. Snow removal deposition into waterways and stormwater management are a high priority for water quality management within the Bear Creek Watershed.

Clear/Bear Creek Wildfire/Watershed Assessment

The Association was a partner in a watershed assessment that identified and prioritized sixth-level watersheds based upon their hazards of generating flooding, debris flows and increased sediment yields following wildfires that could have impacts on water supplies. The study expanded on current wildfire hazard reduction efforts by including water supply watersheds as a community value. The watershed assessment followed procedures prescribed by the Front Range Watershed Protection Data Refinement Work Group (2009). This Bear Creek assessment provides an identification of opportunities and constraints for each Zone of Concern in the watershed (<http://www.jw-associates.org/clearbearcreek.html>).

Evergreen Metropolitan District Source Water Assessment

In 2012, Evergreen Metro District began work with the Colorado Rural Water Association to develop a Source Water Protection Plan (SWPP). Source water protection is a voluntary, non-regulatory, proactive approach to preventing the pollution of lakes, rivers, streams, and groundwater that serve as sources of drinking water. A SWPP includes: the area in need of protection, the potential sources of contaminants, and management approaches that could help to reduce the risk of contaminants entering the source waters. The wildfire watershed assessment report identifies a zone above the reservoir as a high priority zone of concern. The protection plan will include necessary best management practices necessary to lessen the water quality impact to Evergreen Lake following a major upstream wildfire. It is anticipated that significant nonpoint source pollution could be generated by storm events following a major fire. The district has identified areas in need of protection and several potential sources of contamination. This data will be assimilated into the district's GIS system. The district will track additional sources of contamination and begin developing the management plan to help reduce the risks of these contaminants from reaching Evergreen Lake.

Evergreen Metropolitan District Canal Cleaning Operation

District crew installed large-boulder riprap along the side of the sedimentation channel that enters Evergreen Lake. The access road had eroded away to the point where it was difficult for cleaning operations. The rock was donated by CDOT from piles along Highway 74. The crew placed approximately 35-50 yards of rock. The district monitors and maintains a storm sewer catch basin at Evergreen Lake. Generally, the district on an annual basis removes fine sand and silt from the inlet channel to Evergreen Lake to reduce the sedimentation rate in the lake. In previous years, this material was disposed at a location to prevent subsequent erosion into waterways. In 2012, there was no sediment removal because of a lack of a disposal site for removed material. The channel to the lake had not silted in since the removal of the sediment the previous year. Prior to the fall of 2013, staff

will look for potential sites or users for the material. The Association monitors the performance of this catch basin and evaluated if the installation of additional catch basins along upper Bear Creek would of benefit stream.

Coyote Gulch Nonpoint Source Restoration

The Association is involved in a nonpoint source project sponsored by the City of Lakewood that restored a severely eroded section of Coyote Gulch. Coyote Gulch revegetation began in June 2007 and became well established in 2008. The Association has a paired water-sampling program, which allows a determination on the effectiveness of the restoration effort at phosphorus reduction (Table 23). The Association has monitored flow and limited chemistry since March 2006 in Coyote Gulch. The Association Technical memorandum Coyote Gulch Summary (TM 2012.05) provides a detailed summary of the monitoring and data. Table 24 identifies the annual available total phosphorus trade pounds consistent with the Association trade program. Figure 28 shows the total phosphorus reduction.

Table 23 Coyote Gulch Nutrient Base Loads

		Average Loading Pounds By Year			
		Reservoir		Above Project	
		Nitrate	T Phos	Nitrate	Total Phosphorus
Pre-construction	2006-2007	200.7	20.0		
Post-Construction	2007-2008	128.7	4.4	160.9	5.2
	2009*	142.0	6.7	185.9	8.9
	2010*	203.7	8.1	222.3	8.5
	2011*	103.0	6.1	163.9	7.0
	2012	106.6	2.7	104.4	4.8
		Loading Pounds After Stable			
		Reservoir		Above Project	
		Nitrate	T. Phos	Nitrate	Total Phosphorus
Total Pounds		8,662	551	10,279	637
Average		152	10	180	11
Median		88	4	118	4
2009*/2010*/2011 average loadings per year excludes April storm loadings					

Table 24 Coyote Gulch Total Phosphorus Trade Pounds

Total Phosphorus Trade Pounds				
	Total Base Flow		Trade Ration Pounds	
	Monthly	Annual	Monthly	Annual
Average	5.6	67.3	7.2	86.1
Median	6.1	72.9	6.9	83.3
Monthly TRP=PC Base Load-TBF Monthly Pounds/2				
The base trade ratio is 2:1 for Association Trade Projects				
Base Flows Exclude April Storm Loadings				
Annual Trade Pounds Available = 81.8 pounds Total Phosphors				

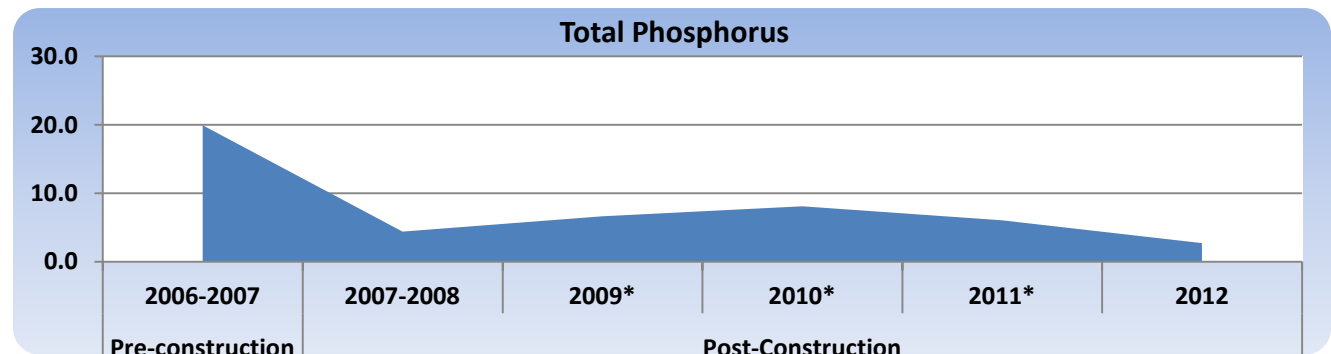


Figure 28 Total Phosphorus Reduction at Coyote Gulch Project

Association Land-Use Review

The Association has 12 “policies” to help with management of the watershed program. The Association is a referral agency to land use agencies within the Bear Creek Watershed, including cities and counties. The Association reviews referral applications for consistency with local, regional and state water and environmental regulations, associated policies and the watershed management plan. To assist the Association in the referral process, a “Referral Review Guidance” (Association 2007) outlines general components of the Association land disturbance mitigation preferences, Association review and comment guidance. This guidance addresses nonpoint sediment loading before it becomes a watershed problem. Referred land use applications that cause a land disturbance and/or a potential to degrade water quality are subject to review and comment by Association.

The Association completed six referrals in 2012 that addressed issues related to erosion, septic management, land disturbance, re-zoning, water quality degradation and appropriate use of best management practices. The Association supports Jefferson County and Clear Creek County in the update and development of community plans for select portions of the watershed. There are three community plans in the update process.

BCWA and Membership Special Programs

Denver Water Department Watershed Assessment

The Denver Water Department completed an independent review project of water quality in the Bear Creek Watershed and a cost alternative analysis to determine cost-effective clean-up options (Bear Creek / Turkey Creek Watershed Water-Quality Alternatives and Costs Bear Creek / Turkey Creek Watershed Project Technical Memorandum 2 Contract Number 13223A , Prepared for the Denver Water Board, Hydro Consultants, April 15, 2011). DWD is evaluating implementation programs as addressed in the study.

Lakewood Regional Parks Recycling Efforts

The City of Lakewood is in their 9th year of recycle and litter management at their regional parks, including Bear Creek Park. In 2012, the program recycled motor oil (10 gallons), aluminum (200 pounds scrap and 300 pounds of cans), steel and tin (11,100 pounds), glass (6 cubic yards), plastic and paper products (72 cubic yards), light bulbs, tires, all batteries (56 pounds), paints, and other chemical, which disposed at the Rooney Road Recycling Center. The city continues trash clean up along Bear Creek and Turkey Creek drainages and around the reservoirs. In 2012, manure management bins, volunteers did erosion control, willow planting and wetlands enhancement, park clean-up, trail work, trail stream-crossing closure and vegetation management. Recycle your fishing string program helped keep shorelines clean.

Aspen Park/ Conifer Waste Recycling Program

The Conifer Area Council has maintained a “Recycling / Sustainability Committee”, which supported community-recycling efforts in 2012. Information from this committee distributed to the Association membership. The committee has begun a slash removal program for pine beetle damaged trees. The program also takes recycled materials to the Rooney Road Recycling Center.

The Rooney Road Recycling Center

The Rooney Road Recycling Center provides proper disposal programs for residents of Unincorporated Jefferson County and the cities and towns of, Arvada, Golden, Lakewood, Mountain View, Lakeside, Edgewater, Morrison, Westminster and Wheat Ridge, to recycle their household hazardous waste (HHW). HHW includes electronic waste, household chemicals, paints, propane cylinders and automotive products. HHW materials collected at the facility since 1994 total more than 5 million lbs of potential surface water and ground water pollutants. The HHW program serviced over 4,000

participants, with City of Lakewood accounting for over 25 % of the total participation and the Bear Creek Watershed accounting for 38% of the total participants.

Invasive Species Protection Programs

Aquatic Nuisance Species Bear Creek Reservoir

Bear Creek Lake Park is involved in Colorado efforts to stop the spread of Aquatic Nuisance Species in Colorado waters. A Watercraft Inspection and Decontamination station is located in the Whitetail parking lot. All trailer and motorized boats require inspection by state certified inspectors at the station for any aquatic invaders. Station staffed from 6am to 8pm on Fridays and the weekends, then every morning and evening during the week. During the middle of weekday, the entrance gate would call out when a boat came in and the nearest staff member would do the inspection. Annually, the lake closes from November 15 to March 15. The park did > 2,000 standard inspections with no positive samples.

Aquatic Nuisance Species Evergreen Lake

The Evergreen Park & Recreation District requires a permit for all personal watercraft to be on Evergreen Lake. This is an opportunity to do the mussel inspection at the Lake House prior to launch. The Recreation District staff inspects boats and trailers.

The recreation district and the Evergreen Metropolitan District have a program to harvest and compost the invasive algal species Elodea from the lake in the summer months. The districts introduced grass carp to manage the Elodea growth.

Noxious Weed Management

Clear Creek, Jefferson and Denver Counties have noxious weed management programs. The Association reports sightings of noxious weeds and otherwise cooperates with these programs.

Invasive Algal Species in Bear Creek and Turkey Creek

The Association has begun collecting and identifying invasive algal species found in streams throughout the watershed.

U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers updated the master plan for Bear Creek Dam and reservoir in 2012 (Bear Creek Dam and Lake Project South Platte River, Colorado, Design memorandum PB-10, July 2012). This master plan for the Bear Creek Dam and Lake Project updated the original 1980 Bear Creek Dam and Lake Master Plan and subsequent 1988 partial update.

The Corps of Engineers released an updated sedimentation analysis for Bear Creek Reservoir (Tri-Lakes Sedimentation Studies Area-Capacity Report Revised: July 2011; M.R.B. Sediment Memorandum 23a). There has been a decrease in gross storage capacity:

Gross storage capacity in Bear Creek Lake has decreased from the original capacity of 78,101 acre-feet in 1980 to 77,293 acre-feet in 2009, the year of the latest sediment range line survey. This amounts to a total storage reduction of 808 acre-feet, or an average depletion rate of 27.9 acre-feet per year. The original projected storage depletion rate for Bear Creek Lake was approximately 20 acre-feet per year. The Bear Creek Lake flood control pool storage capacity has decreased from of 28,762 acre-feet in 1980 to 28,514 acre-feet in 2009, an average of 8.6 acre-feet per year.

Colorado Department of Parks and Wildlife

The Association supports the Division of Parks and Wildlife fishery surveys. These surveys characterize how trout populations respond to both natural and human induced alterations, including

changes to water and environmental quality. The Association maintains a Fishery Analysis and Protocols Guidance. There were no fishery surveys in 2012 due to low water conditions.

VI. Association Annual Reporting

The Association produces an annual data summary as a *2012 Master Data Spreadsheet (February 2013)* that includes data analyses, and raw data (Association website www.bearcreekwatershed.org). The Association transmits this data report to the Water Quality Control Division Staff. The watershed-monitoring program summarized in an Association data report (Bear Creek Watershed Association Data Report, June 2013).

All of the Association annual reporting documents are available electronically and posted on the website. The Association provides multiple reporting documents designed to meet the multiple functions of various groups. The reporting helps member entities with reporting to their respective boards, commissions and groups. There is also a citizen interest in the watershed and reporting helps keep the public informed. Many educational groups visit the watershed and it has become a widely used outdoor classroom. The Association supplies water quality and environmental materials for these various educational uses. Technical memorandum published by the Association in 2012 includes:

- 2012.02 Summit Plume
- 2012.02 Technical Memo Summit Plume
- 2012.03 Kerr Swede Summary 2012
- 2012.04 BCR Water Quality Summary
- 2012.05 Coyote Gulch Summary January 2013
- 2012.06 Recreation Use Bear Creek Park
- 2012.07 Bear Creek Reservoir Summary Statistics
- 2012.08 BCWA Barr Milton TMDL Summary
- 2012.09 Manure Management
- 2012.10 Macroinvertebrates