Bear Creek Watershed Association

2023 Annual Report

Bear Creek Watershed Association
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July 19, 2024

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. WQCC Summary

The Bear Creek Watershed is a specific geographic area identified in the Bear Creek Watershed Control Regulation (Regulation #74, 5 CCR 1002-74) that requires special water quality management. The Bear Creek Watershed Association is the local water quality agency responsible for implementation of monitoring and tracking water quality in the Bear Creek Watershed.

Regulation #74 identifies the Association's annual reporting requirements for presentation to the Water Quality Control Commission (WQCC). The Bear Creek Watershed Association Annual Report includes five reporting requirements as listed in the control regulation: 1) Summarize status of water quality in the watershed for the previous calendar year. 2) Provide information on the wastewater treatment facilities loading and compliance with permit limitations. 3) Nonpoint source loading and appropriate best management practices. 4) Demonstrate through in-stream and reservoir data analyses the status of water quality goals and standards for the watershed. 5) Characterize any active phosphorus trading programs.

1. Status of Water Quality

The average inflow into Bear Creek Reservoir from both Turkey Creek & Bear Creek (1987-2023) was 28,573 acre-feet per year. The 2023 inflow is estimated at 23,918 acre-feet (Figure 1) with the June runoff flow at 32% of the annual total flow. There were two flood stage events (> 2,000 ac-ft) for BCR. The reservoir was below normal (<1,500 acre-feet) from January through early May. The U.S. Army Corps of Engineers maintained a normal pool in BCR from September to December of about 1,800 ac-ft.

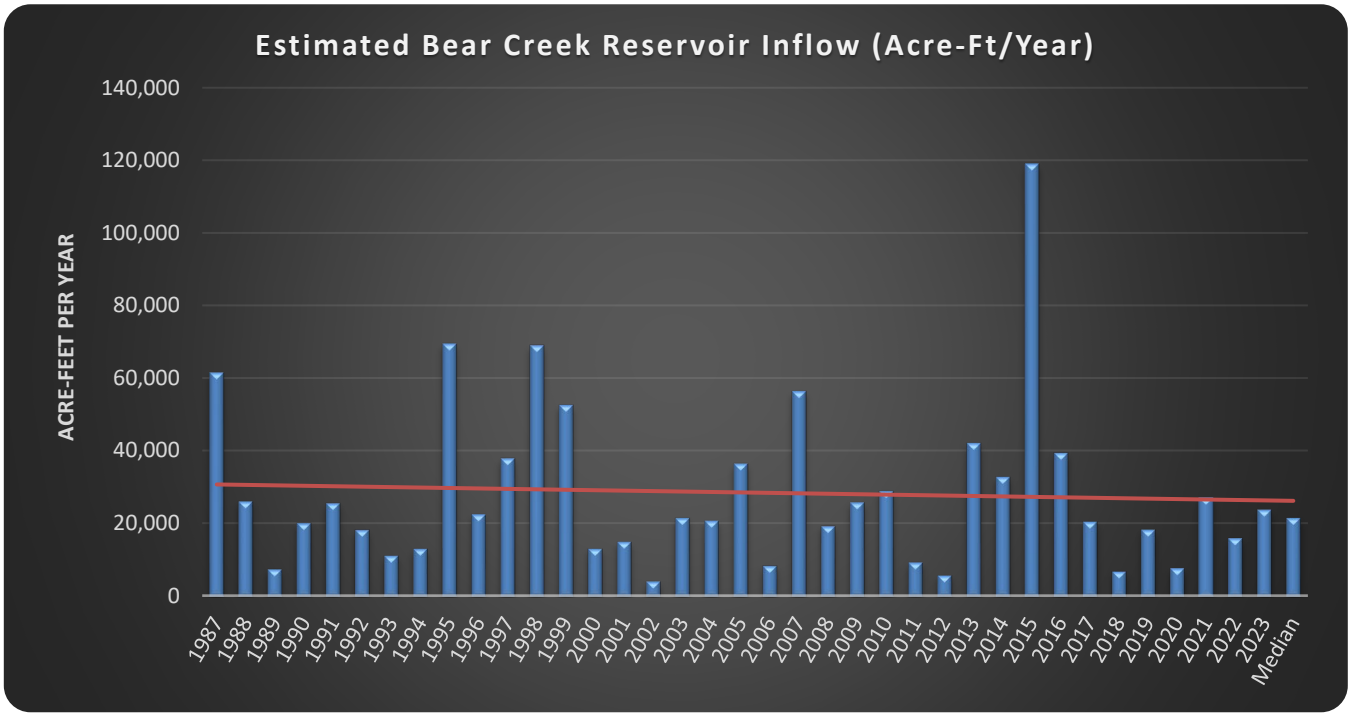


Figure 1 **Estimated Bear Creek Reservoir Inflow 1987-2023**

The estimated annual Bear Creek inflow into Bear Creek Reservoir was about 17,747 acre-feet (74%) and 9,488 acre-feet (26%) from Turkey Creek. Although there was minimal net phosphorus deposition into bottom sediments in 2023, the internal loading problem (total phosphorus) within Bear Creek Reservoir has not diminished over the last 16-years (Figure 2). The total phosphorus deposition into reservoir bottom sediments is about 36,395 pounds since 2008. The median annual deposit is about 728 pounds per year.

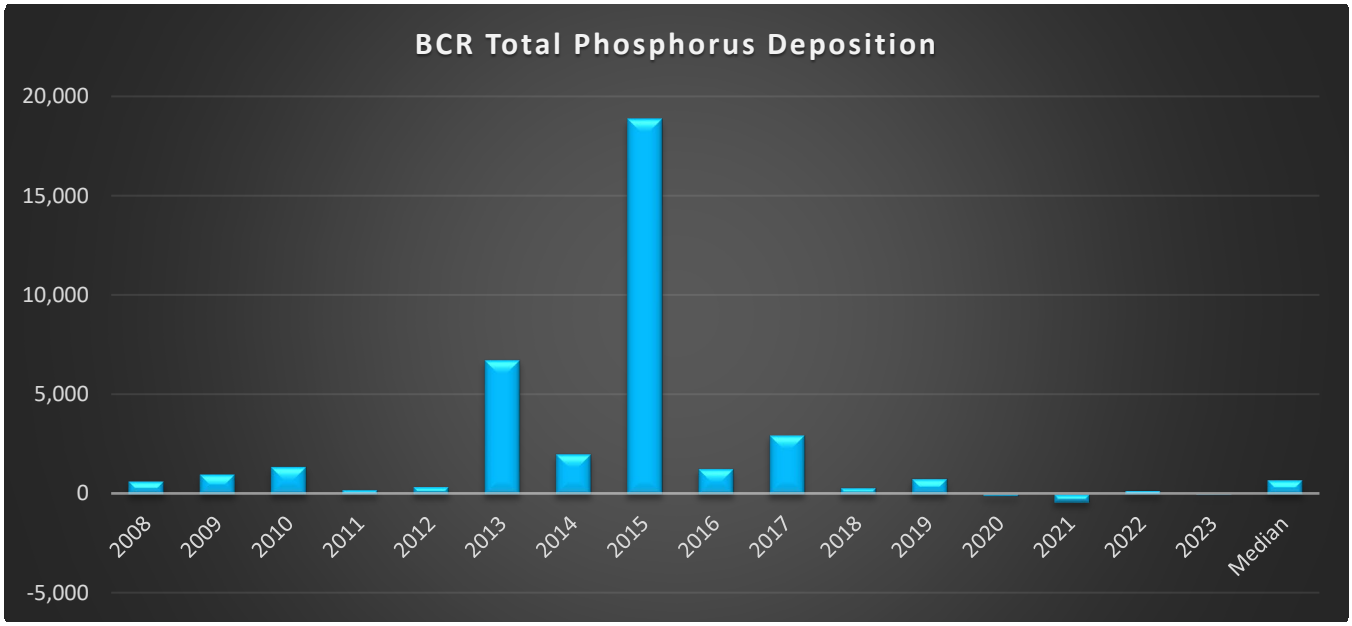


Figure 2 **Annual Total Phosphorus Pounds Deposition into Bear Creek Reservoir Bottom Sediments**

The reservoir continues to experience late summer phytoplankton blooms (2023 peak density of *Aphanizomenon flos-aquae*, peak biovolume of 20,836,200 um3/ml (BCWA TM 2023.09 BCR Phytoplankton Summary), which is linked to the internal nutrient loading problem. The problematic bluegreen algae were *Aphanizomenon flos-aquae* and *Anabaena flos-aquae* with potentially toxic peak blooms (Table 1). The July and August phytoplankton blooms near Bear Creek dam contained 2 species of bluegreens, which are common in the reservoir. Cyanobacteria, in high concentrations (> 20,000 cells/ml of water), can produce toxins. Release of toxins during an algal bloom occurs when algal cells die or are subject to lysis (i.e., cell wall ruptures). Most commonly occurring genera of bluegreens found in Bear Creek Reservoir over the last 10-years are Microcystis, Anabaena, Oscillatoria, and Aphanizomenon. Potential cyanotoxins found in reservoir blooms are microcystins, cylindrospermopsin, anatoxins and saxitoxins. The 2023 biovolume of *Aphanizomenon* is considered a high risk for cyanotoxin production.

Table 1 **Potential Toxin Risk of Bluegreen Algae in Bear Creek Reservoir**

	Peak Density, cells/ml	Peak Biovolume, um3/mL	Potential Toxin Risk
2013	16,695	2,132,808	Low
2014	64,431	454,538	Moderate
2015	1,356	2,019,887	Low
2016	57,081	40,202,900	Moderate
2017	75,154	2,268,627	Moderate
2018	21,370	1,083,089	Moderate
2019	38,843	517,523	Moderate
2020	22,370	3,583,517	Moderate
2021	98,365	10,013,291	Moderate
2022	112,750	163,374,750	High
2023	115,033	20,836,200	High
	HAB Risk Range Cell/ml		**Potential Toxin Risk**
	<20,000		Low
	>20,000	<100,000	Moderate
	>100,000	<10,000,000	High
	>10,000,000		Very High

BCWA Fact Sheet 57 Cyanotoxins provides information on the potential toxic risk from high concentrations of bluegreens and BCWA Fact Sheet 58 Cyanobacteria Guide BCR can be used be visually identify major species. Fact Sheet 60 Managing Harmful Algal Blooms and Fact Sheet 61 HABs Exposure and Risks were developed by

the BCWA to help manage problem bluegreen blooms. Fact Sheet 66 discusses the problem with HABs and Pets. Several pets were reported to the Association as sick in 2023 likely caused by cyanotoxins. The BCWA has identified some strategies to address the internal loading problem (BCWA Policy 20 Preferred Management Strategies EGL and BCR). The summer peak density of bluegreens has been increasing since 2007 with 2021 through 2023 having more problematic blooms (Figure 3).

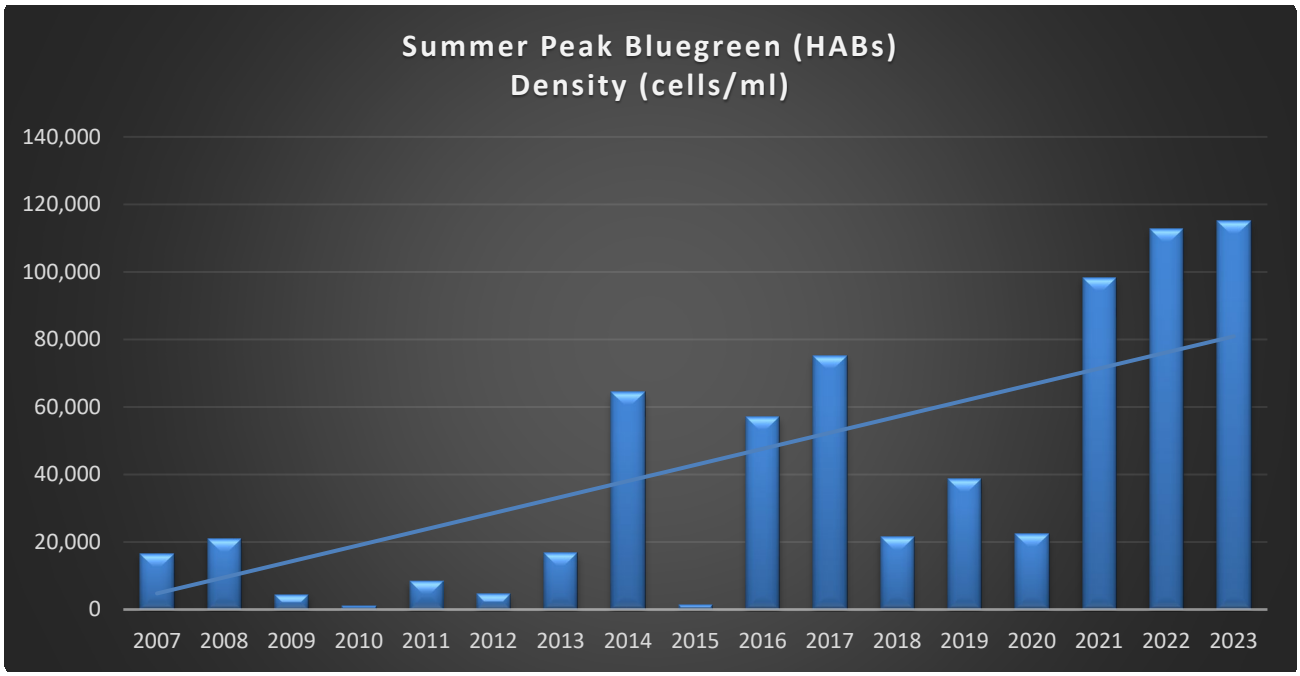


Figure 3 Summer Peak Bluegreen Density in Bear Creek Reservoir

The total phosphorus load from the watershed comes from a combination of wastewater treatment plant point source loads, other sources (e.g., onsite disposal systems; see *BCWA Policy 11 Vault & SS Disposal Systems*), nonpoint sources (e.g., onsite wastewater treatment systems, stabling operations [*BCWA Policy 4 BC Manure Management*], roads, public lands, illegal dumping [BCWA *Policy 18 Illegal Dumping*], and regulated stormwater runoff). The estimated total phosphorus load in 2023 from all sources reaching the reservoir was normal with about 3,052 pounds (76% from Bear Creek). There was about 50,775 pounds of total nitrogen loading into the reservoir with 72% derived from the Bear Creek drainage.

The Association monitors watershed nutrients by major stream segments beginning near Mt. Blue Sky (segment 7) and extending downstream to Bear Creek Reservoir and down to Wadsworth on Lower Bear Creek. 2023 was a typical nutrient loading year with 80% of the total phosphorus (Figure 4) and 65% of the total nitrogen (Figure 5) load occurring in the spring runoff period and early summer months of May to July. Most nutrient load is generated within the urbanized corridor of segment 1a (above Evergreen Lake to the Clear Creek County Line), and segment 1e, which is the mainstem of Bear Creek from Evergreen Lake to the Harriman Ditch Diversion. Although nutrient concentrations from the tributaries may be high (e.g., Figure 4 and 5, Site 32), the actual poundage loading is reduced because of lower flows (Figure 6 and 7, site 32).

There was an high 1,104 pounds of total phosphorus passing through Evergreen Lake, with an additional 391 pounds added from the Cub Creek drainage. Additional total phosphorus loading into Bear Creek between Evergreen to Morrison was over 2,000 pounds during the monitoring season. The BCWA has established specific monitoring sites to better characterize specific tributary drainages with elevated total phosphorus loading and develop improved management strategies for these areas (*BCWA Policy 15 Nonpoint Source Strategies and BMPs*). The BCWA also improved integrated planning efforts with other agencies to help resolve several identified pollutant loading problems (*BCWA Policy 29 BCWA Integration with Other Planning Efforts*).

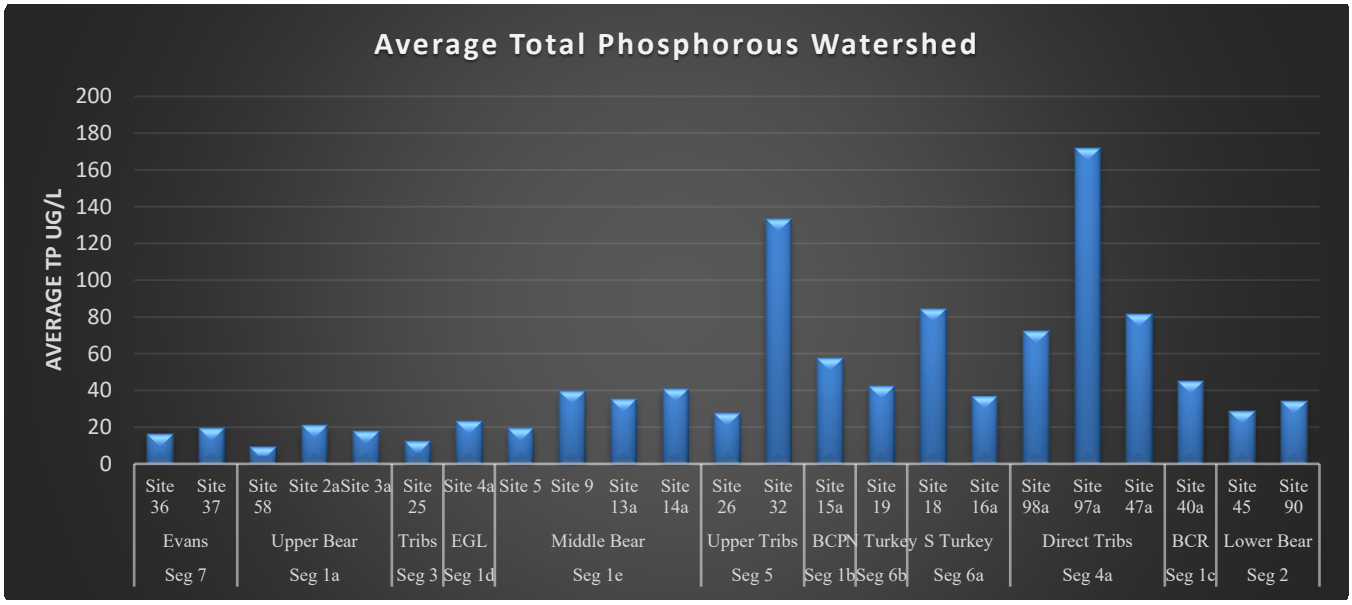


Figure 4 **Total Phosphorus Concentrations by Stream Segments in the Watershed**

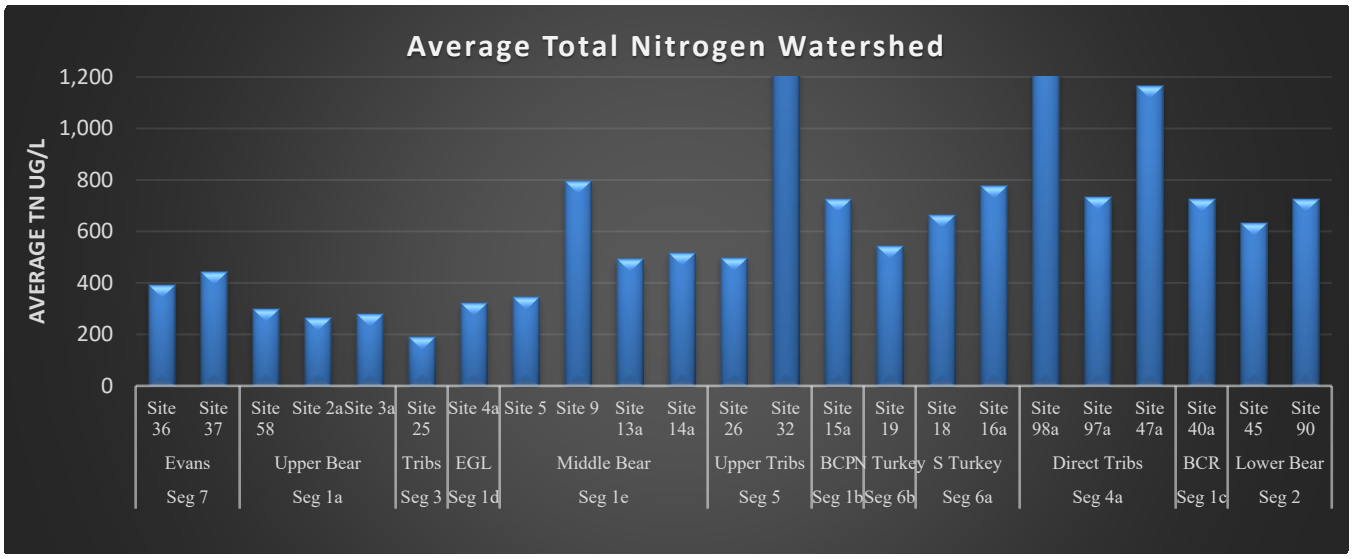


Figure 5 **Total Nitrogen Concentrations by Stream Segment in the Watershed**

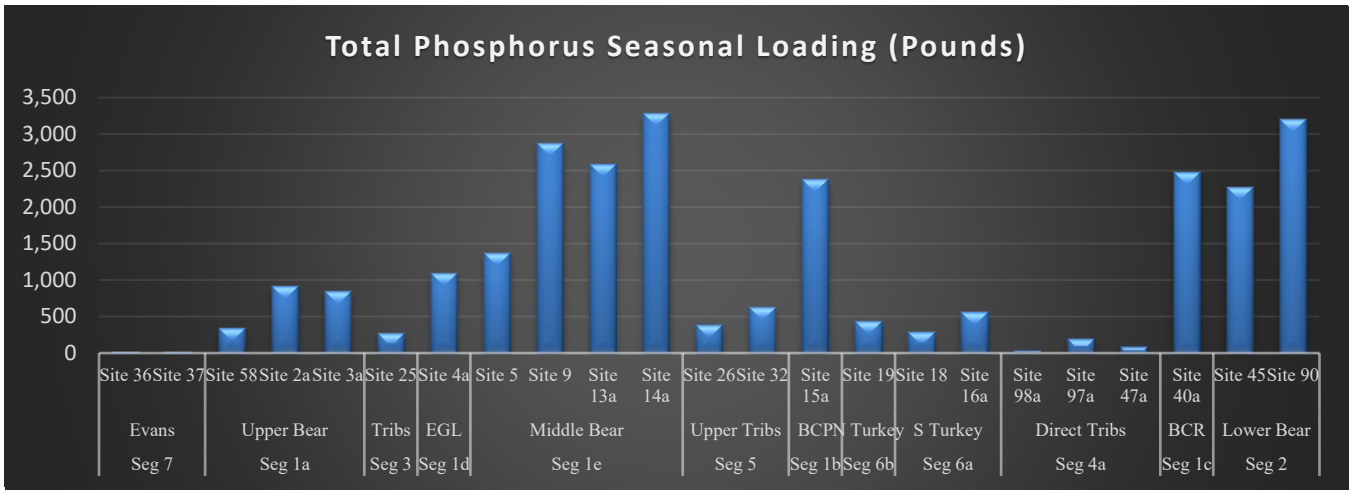


Figure 6 **Total Phosphorus Loading (pounds) by Stream Segment in the Watershed**

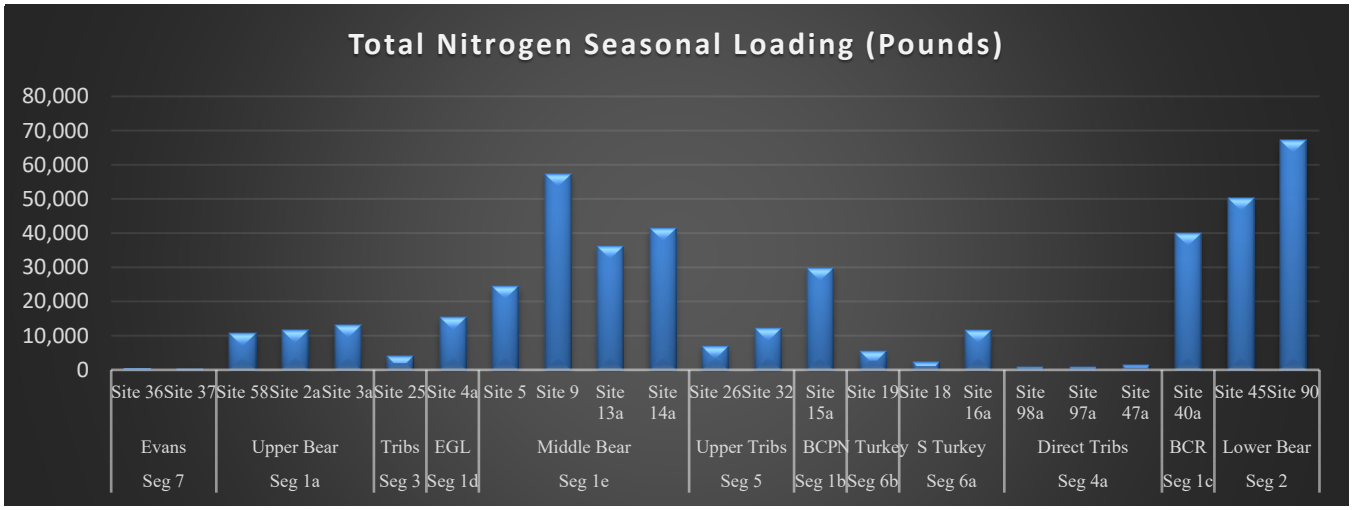


Figure 7 Total Nitrogen Loading (pounds) by Stream Segment in the Watershed

2. Wastewater Treatment Facilities Loading and Compliance

In 2023, wastewater dischargers total phosphorus waste load contributions were 1,333 pounds annually (26% of allocated load). BCWA analysis of the total phosphorus data record indicates that only about 20-35% of this total phosphorus load from permitted dischargers reaches the Bear Creek Reservoir (Table 2). Geneva Glen remains under compliance orders with the Water Quality Control Division until an acceptable new wastewater treatment option is approved by the WQCD permit section. The Brook Forest Inn treatment facility is under new ownership but is not utilizing the existing wastewater treatment works. This discharge permit should be closed, and the plant decommissioned. At closure (2018), the treatment works were not in compliance with Bear Creek Control Regulation #74.

Table 2 Loading Trends for WWTFs Total Phosphorus Reaching Bear Creek Reservoir

Total Phosphorus lbs/yr						
	Total Discharge WWTFs	Assume 25% PS Reaches BCR	Inflow Estimated Reservoir Total	Reservoir NPS	% Nonpoint Source Load	TP Deposition
Average 2000-2009	2,312	578	2,141	1,563	60%	841
Average 2010-2023	1,128	282	5,575	5,292	85%	2,516

The Bear Creek Cabins and the Singing River Ranch permitted wastewater treatment facilities are formally closed and converted to onsite wastewater treatment systems. These two former treatment works are still listed in Control Regulation #74. They no longer participate in the Association cost share program. The Tiny Town operation continues hauling wastewater off site and the treatment facility is non-operational.

Regulation 85 monitoring and reporting that took effect in 2014, continues as a watershed program. The program collects nutrient monitoring data for most surface discharging wastewater dischargers. Some larger WWTFs chose to participate in BCWA watershed level Regulation 85 sampling and reporting in conjunction with stream sampling for data comparability.

3. Nonpoint Source Loading

The BCWA tracks nutrient loading in the watershed. Results and watershed data from the last 30-years indicate the annual nonpoint phosphorus base-flow load from all sources in the watershed ranges from 5,000 to 6,000 pounds, annually. A single major flood event in the watershed can generate anywhere from 1,000 to 30,000 pounds of total phosphorus, as demonstrated in 2013. Only a fraction of this load transports to the Bear Creek Reservoir on an annual basis (Table 3).

The point source load of total phosphorus in 2023 (Table 3) was 1,333 pounds. Part of the estimated nonpoint source load in Bear Creek above the Harriman Diversion is diverted into the Harriman Diversion. On average over 23 years of data record, only about 30% of the total phosphorus load reaching Bear Creek Reservoir is

attributable to point sources (Figure 8). Some of the nonpoint source load reduction can be attributed to improved Jefferson and Clear Creek County management practices for road maintenance, construction practices, stormwater controls and land use controls. This 2023 nonpoint source phosphorus loading was heavily influenced by two storm events.

Table 3 Point Source versus Nonpoint Source Phosphorus Loading, Bear Creek Reservoir

	2023 Total Phosphorus Loading (Pounds)				
	Total TP Load	PS	%PS	NPS	%NPS
Turkey Creek Drainage	740	11	1.5%	729	98%
Bear Creek Drainage	2,311	1,388	60.1%	923	40%
Discharged into Reservoir	3,052	1,400	45.9%	1,652	54%
Site 45 Outflow BCR	3,085				
BCR Total Phosphorus Deposition	-34				
Site 90 - Lower Bear Creek	4,290				
NPS load increase between 45 and 90	28%				

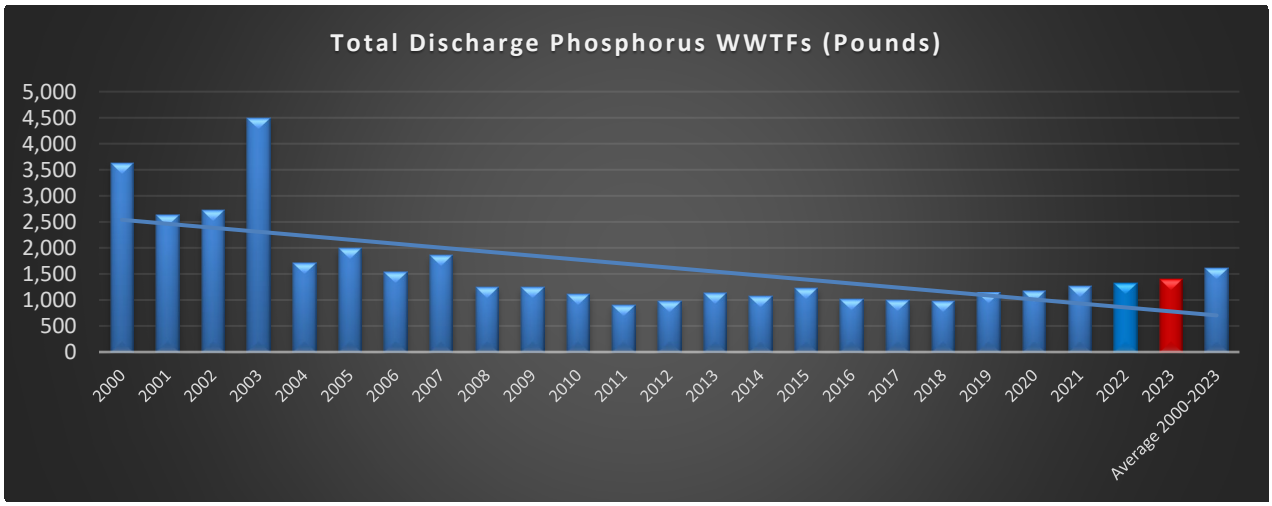


Figure 8 Point Source Load Reaching Bear Creek Reservoir

The nutrient data shows three areas along the mainstem of Bear Creek where elevated nonpoint source nutrients are commonly measured: the mainstem of Bear Creek between Golden Willow and the Keys on the green (Upper Bear Creek), downtown Evergreen, and below Idledale. The Tributaries with elevated nutrient loading are Yankee Creek and Vance Creek drainages in upper Bear Creek, Troublesome drainage, Cub Creek drainage and Mt. Vernon drainage in middle Bear Creek. Upper Bear Creek, Troublesome and Mt. Vernon are addressed in *BCWA WQSD02 Upper Bear*, *BCWA WQSD01 Troublesome* and *BCWA WQSD04 Mt Vernon*.

The early spring (May and June) runoff watershed sampling period above Evergreen Lake represented the higher flow conditions on both the mainstem and tributaries throughout the upper watershed. In this higher flow period, Upper Bear segment was the largest source of total phosphorus (90%) load. Under historic flow conditions, Vance Creek tributary is only about 7-8% of both the TP and TN load to Bear Creek.

The BCWA special studies have shown an estimated 30-75% of the total phosphorus on the Troublesome Drainage comes from a cluster of homes on OWTS located at the lower confluence of Stagecoach and the northern drainage system. This same area contributes 90-111% of the total nitrogen load in the middle drainage. A single horse stabling operation in lower Troublesome contributes about 25-60% of the TP load and about 12% of the TN load reaching Bear Creek.

A special study of Cub Creek from 2013-2016 and more recent annual data collection at the mouth of Cub Creek shows this tributary discharge ranges from 20 to 3,040 pounds of total phosphorus per monitoring season into

Bear Creek downstream of Evergreen Lake. The 2023 total phosphorus load was estimated at about 391 pounds during the monitoring season. There are an estimated 5,450 people in the Cub Creek drainage that utilize OWTS. The phosphorus load in this drainage is likely a result of seepage from these OWTS located within the alluvial corridor.

Watershed plan and administration policies were developed by the Association, related to: priority zones, park latrines, plan development, watershed boundaries, data collection, nonpoint source loading and strategies, membership, recycling, illegal dumping, trading eligibility, and reservoir management strategies (See the BCWA *PGO1 Master Index List* and *PGO2 Document Categories,> 20 categories of documents*). Association policies (37) are an essential component of the Association's interactive online *watershed plan*. The Association's adaptive electronic watershed plan (www.bearcreekwatershed.org) helps to continually improve watershed-planning efforts and provide tools and information to understand watershed dynamics. The Association keeps the community informed about water quality, watershed programs and management activities through a newsletter.

4. Status of Water Quality Goals and Standards

The Association has over 40 years of active service to the watershed in Clear Creek, Jefferson, and Park Counties. The Association has 39 years of data and studies to support watershed science. During this time, the Association has removed or immobilized about 392 tons of phosphorus in the watershed. The +90 volunteer-years of effort by Association membership has helped waters in the watershed meet standards and classified uses.

In 2015, the Water Quality Control Commission revised the chlorophyll standard to 12.2 µg/L. The exceedance threshold of 12.2 µg/L was derived with a "translator" developed with data from Bear Creek Reservoir. The translator connects the concentration at the allowable exceedance frequency (once in five years) to the typical concentration at the mesotrophic-eutrophic boundary (8 µg/L). The Commission also revised the phosphorus standard to 22.2 µg/L. The standard is calculated in two steps based on the methodology used to develop statewide nutrient criteria for the 2012 Nutrient hearing. The first step involves the creation of a statistical "linkage" between phosphorus and chlorophyll based on summer average concentrations measured in Bear Creek Reservoir. The linkage is used to define the phosphorus concentration corresponding to the mesotrophic-eutrophic boundary in the reservoir; that concentration is 16 µg/L. The second step involves a translator for phosphorus that performs the same function described for the chlorophyll translator. The concentration at the exceedance threshold is 22.2 µg/L.

The 2023 average seasonal total phosphorus of 55.6 µg/L in Bear Creek Reservoir far exceeds the 22.2 µg/L goal standard. Average seasonal chlorophyll-a of 10.1 µg/L was below the 12.2 µg/L standard. The trophic status of the reservoir remained at the Hypertrophic based on Carlson and Walker indices. Seasonal average reservoir temperature in the top 2-meters of the water column were normal. There were no exceedances at Site 40 of the *Weekly Average Temperature* (MWAT 23.3 °C) or the *Daily Maximum Temperature* (DM 23.8 °C) (Figure 9).

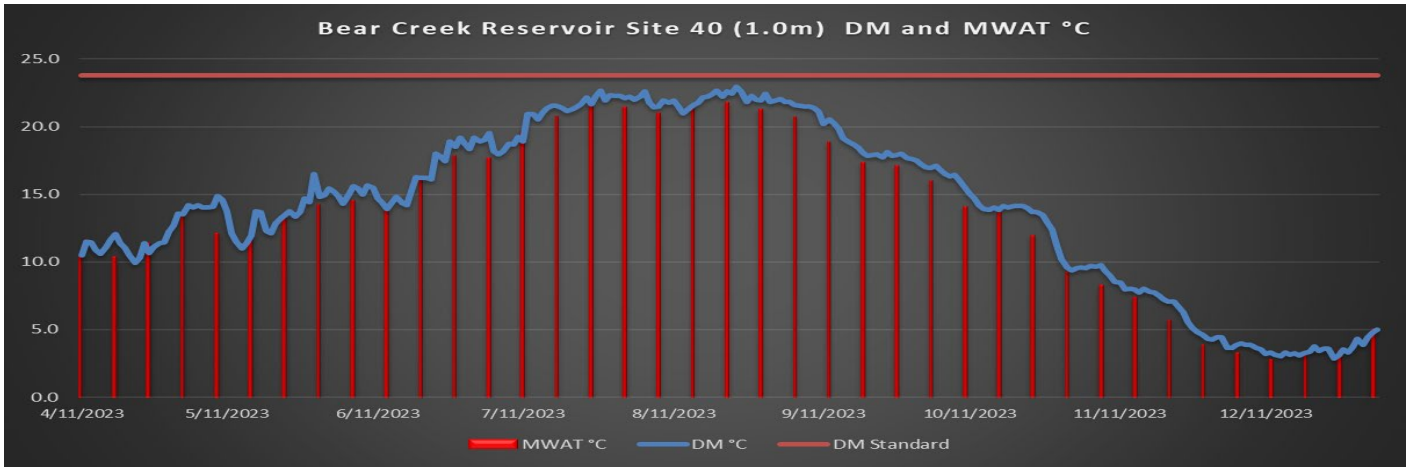
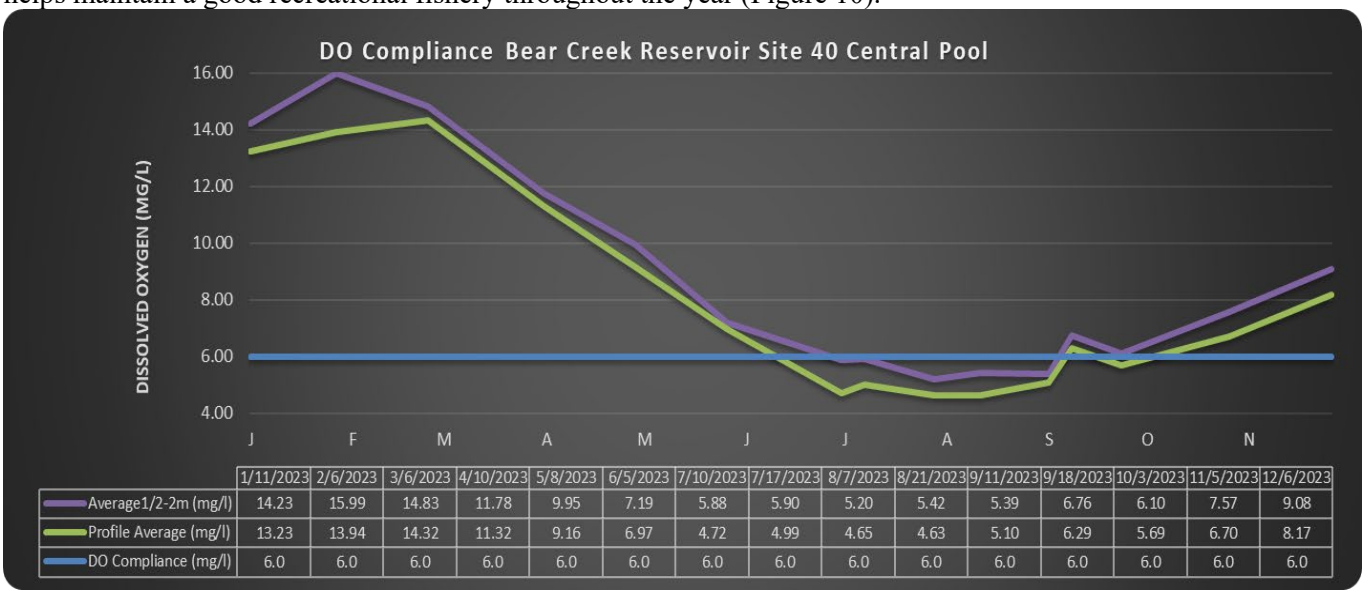


Figure 9 **Bear Creek Reservoir Daily Maximum Temperatures at Site 40(0.5m)**

The Association is monitoring the effectiveness of the aeration configuration and oxygen transfer during the growing season (BCWA Fact Sheet 47 New BCR Aeration System, BCWA Fact Sheet 62 BCR Aeration System

Operation and BCWA Fact Sheet 63 2014 BCR Aeration System Evaluation). Lake aeration was not able to maintain dissolved oxygen levels above 6 mg/L throughout most of the growing season. The aeration system helps maintain a good recreational fishery throughout the year (Figure 10).



	1/11/2023	2/6/2023	3/6/2023	4/10/2023	5/8/2023	6/5/2023	7/10/2023	7/17/2023	8/7/2023	8/21/2023	9/11/2023	9/18/2023	10/3/2023	11/5/2023	12/6/2023
Average1/2-2m (mg/l)	14.23	15.99	14.83	11.78	9.95	7.19	5.88	5.90	5.20	5.42	5.39	6.76	6.10	7.57	9.08
Profile Average (mg/l)	13.23	13.94	14.32	11.32	9.16	6.97	4.72	4.99	4.65	4.63	5.10	6.29	5.69	6.70	8.17
DO Compliance (mg/l)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0

Figure 10 Dissolved Oxygen Compliance in Bear Creek Reservoir

In the Turkey Creek segments, there were 26 temperature compliance problems in the warm seasons. In Bear Creek segments, there was one warm season exceedance of the daily maximum (DM). No weekly average temperatures (WATs) exceeded standards in middle Bear Creek. Sampling and monitoring were performed at 38 sites within the watershed at varying intervals. Measurements of pH complied with standards. Dissolved Oxygen measurements were compliant with standards except for sites near Summit Lake (segment 7). There were exceedances for the proposed Total Nitrogen target of 1250 ug/L at Summit Lake, Bear Creek mainstem near Bear Creek Reservoir, below the reservoir and on several tributaries. The proposed Total Phosphorus target of 110 ug/L below the treatment facilities was exceeded on both Turkey Creek and Bear Creek mainstem and tributaries. There were exceedances of the new total phosphorus target measured at the site-specific Summit Lake Fen study area (*BCWA TM 2022.02 UBCW Summary*). The Summit Lake sites continue to show elevated nutrients.

5. Phosphorus Trading Program

There was no active total phosphorus trading by Association membership in 2023 (See Table 32 in the *BCWA 2023 Annual Report* for a status of trading activity summary). The Association has established four trading policies and a Trading Guidance Plan to improve future trading programs (*BCWA Policy 1 Trading Program, BCWA Policy 19 Nutrient Trading Program Eligibility, BCWA Policy 26 Trade Administration, and BCWA Policy 35 Membership Entity Termination and Permit Closure*). The Association Coyote Gulch Restoration Project has established the annual available total phosphorus trade pounds consistent with the Association trade program at 42.1 pounds (*BCWA TM 2023.03 Coyote Gulch Summary*).

6. Nutrient Reduction Projects

The Bear Creek Watershed Foundation (BCWF) and Bear Creek Watershed Association (BCWA) are actively working on 7 nutrient reduction programs (Coyote Gulch, Coyote Crossing, Rooney Gulch, Wilmot Drainage, Horseshoe stormwater inlet and Pond, Evergreen Lake and Big Soda Reservoir). Special nutrient loading studies have been completed on 11 additional tributaries within the watershed that are candidates for nutrient filtration systems (Summit Fen Complex, Yankee Creek, Vance Creek, Buffalo Creek, Cemetery Creek, Cub Creek, Troublesome Creek, Kerr and Swede Gulches, Turtle Pond and Mt Vernon Creek). The active pilot projects are 18-month tests of nutrient reduction technology. Demonstration projects are longer-term growing season projects (4-5 years) based on successful field-tested technology with proven total phosphorus and total nitrogen reduction potential. Projects targeting total phosphorus removal have proven to also reduce total nitrogen. These projects

permanently removed about 50% of the total phosphorus and 55% of the total nitrogen load from small watershed tributaries under normal flow and nutrient load conditions.

The BCWA and BCWF are developing improved installation methods with multi-year tributary treatment designs. These demonstration projects target approximately 55% nutrient reductions in the annual growing season for total phosphorus and total nitrogen. Collectively, the pilot and demonstration projects over a 4-year period have permanently removed over 300 pounds of total phosphorus from reaching Bear Creek Reservoir. The BCWA has linked the nutrient reduction program to the established total phosphorus trading program as established in the Bear Creek Control Regulation. The BCWA anticipates an active nutrient reduction program to establish total phosphorus trades needed by the wastewater treatment facilities as part of their permit compliance.

The Coyote Gulch project was established in 2006. This long-term managed wetland project has effectively reduced total phosphorus loading by about 75% on an annual basis prior to the 2021 fire (Figure 1). The passive wetlands from 2007 through 2020 prevented over 100 pounds of total phosphorus from reaching the reservoir. The wetlands also reduced the total nitrogen load by over 700 pounds. This nutrient load was incorporated into the established wetland vegetation. On going wetland plant harvesting was necessary to maintain nutrient removal efficiency. The BCWA added a nutrient filtration system to augment the wetland reduction efficiency.

The wetland and grassland complex upstream of the project was heavily burned in a wildland fire, February 7, 2021. (TM 2022.03 Coyote Gulch Summary). A major portion of upper Coyote Gulch and most of Coyote Crossing drainage within the Bear Creek Lake Park was burned. The monitoring program was shifted to monthly sampling to better track burn water quality impacts. The 2023 runoff increased nutrient loading throughout the year reaching Bear Creek Reservoir. The nutrient loads for Total Nitrogen were significantly increased from historical conditions. The nutrient loading increased about 1250% over the previous post construction baseloads. There was also an increased sediment loading, and subsequent erosion in the upper Coyote Gulch and along Coyote Crossing. Even with this greatly increased nutrient loading, the wetlands in combination with a newly installed nutrient filtration system reduced the total phosphorus load by an average of 63%.

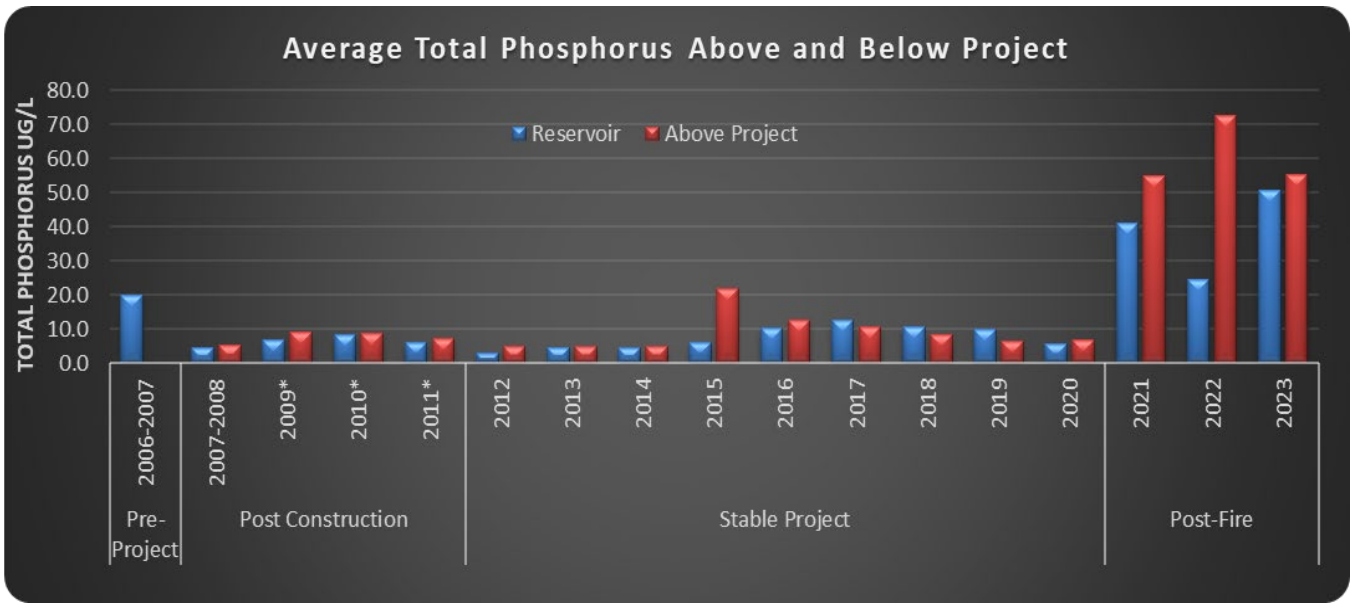


Figure 11 Total Phosphorus Reduction at Coyote Gulch Restoration Site

The BCWA and Lakewood completed a pilot study in the stormwater inflow water to Horseshoe Pond. The nutrient filtration project was designed to reduce phosphorus loading into Horseshoe Pond and potentially reduce summer bluegreen blooms. The pilot project ran from July 2021 through fall of 2022. An ongoing demonstration project (beginning spring 2023) will extend through a 3–5-year operational program. The BCWA used EutroSORB (a phosphorus filtration system) to reduce phosphorus loading from a portion of the stormwater inflow into Horseshoe Pond. This stormwater inflow had high nutrient loading as evident by the pre-project total nitrogen load of 270 pounds and total phosphorus 26 pounds in a 3-month period. EutroSORB filters proved to be an efficient and economical solution designed for intercepting total and free reactive phosphorus (SRP) from

moving water, as well as total nitrogen. EutroSORB reactive filter media removed about 50% of the total nitrogen load, 48% of the total phosphorus load and 38% of the ortho-phosphorus (free) load. The pilot project permanently removed over 102 pounds of total phosphorus in a two-year period.

The BCWA and Evergreen Metro District conducted a nutrient filtration pilot study in the inflow water from Wilmot drainage. The pilot was designed to reduce phosphorus loading into Evergreen Lake. The pilot project ran from July 2021 – fall 2023. A new demonstration project was established in 2024 and will be operational for 3-5 years. The BCWA used EutroSORB (a phosphorus filtration system) to reduce phosphorus loading from a portion of the Wilmot flow. EutroSORB reactive filter media removed on average 40% of the total nitrogen load, 67% of the total phosphorus load and 61% of the ortho-phosphorus (free) load. The pilot project permanently removed over 32 pounds of total phosphorus from entering Evergreen Lake. There have been no major bluegreen blooms in Evergreen Lake after this nutrient reduction program was established on Wilmot drainage.

The BCWA has identified a significant nutrient load problem on Rooney Gulch. From 2021 to early 2023, there were 116 pounds of Total Phosphorus and 1818 pounds of Total Nitrogen discharged into Bear Creek from this tributary. A nutrient filtration system was installed in 2023. This tributary discharge is carried through a culvert under Morrison Road and discharges into Bear Creek near the park entrance. Historically, this was an intermittent drainage receiving flow from the large Rooney Valley area (2,740 acres). In the last 2-4 years, this discharge has flowed more frequently, and during 2023 there was flow most of the year. There is a substantial new development and land clearing operation just north of Morrison Road in Rooney Valley. In the 2023 demonstration period, the EutroSORB reactive filter media removed on average 36% of the total nitrogen load, and 40% of the total phosphorus load. The project permanently removed over 200 pounds of total phosphorus in the first year of operation.

The BCWA has identified a nutrient load problem on Coyote Crossing. In 2023, this tributary contributed over 220 pounds of total phosphorus and 1,110 pounds of total nitrogen. This tributary discharges directly into Bear Creek Reservoir alongside the boat launch/fishing parking lot. This tributary was historically an intermittent flow system from Green Mountain. In the last 7 years, this drainage system has annually increased flows with flow year-round flow, although the winter flows are very low. The new and continued development on Green Mountain has resulted in increased base flows and much larger stormwater flows. In 2023 a new demonstration nutrient filtration project was installed. The EutroSORB reactive filter media removed on average 33% of the total nitrogen load, and 30% of the total phosphorus load in the 2023 growing season. This gulch was extensively burnt in the 2021 fire. A high flow event in 2023 caused extensive stream bank erosion and reduced the effectiveness of this project. Even with this reduced efficiency, the project permanently removed over 100 pounds of total phosphorus in the first year of operation.

Big Soda Lake has experienced increased harmful algal blooms in recent years that have resulted in the closure of the swim beach and limited or restricted other water activities. In 2023, an application was done to strip water column phosphorus (EutroSORB WC). The phosphorus within the water column was reduced by 89.8% within the first 3-days after treatment and remained reduced after 5-months (98.2%). The dual treatment allowed Big Soda to reopen within days of treatment. Even after treatment, there was still substantial total phosphorus in the lower water column and within the bottom sediments. Sediments samples were collected and analyzed for labile, reductant-soluble, and organic phosphorus fractions. There are over 1,300 pounds of phosphorus within the surface sediments in the deeper portion of the lake. There is a substantial internal total phosphorus problem in Big Soda Lake. Ongoing treatment will be needed to prevent future bluegreen blooms in summer months. The BCWA, BCWF and Lakewood have devised a 5-year nutrient reduction and management program for Big Soda Lake. Big Soda Lake was made a primary sample site within the park for nutrient sampling. Follow-up treatment will extend through 2026. Since treatment, there have been no major harmful algal blooms.

II. Bear Creek Watershed Association Program

The Bear Creek Watershed (Figure 12) 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 (*BCWA Policy 13 Watershed Boundary*). The watershed extends from the Mount Evans Wilderness on the western end to the Town of Morrison on the eastern end (*BCWA Map 01 Watershed Boundary*). 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 (*BCWA Fact Sheet 10 Control Regulation 74*). The Bear Creek Watershed Association (Association) oversees implementation of the Control Regulation (*BCWA Fact Sheet 1 BCWA Overview*; *BCWA Policy 12 Vision Mission & Targets*).

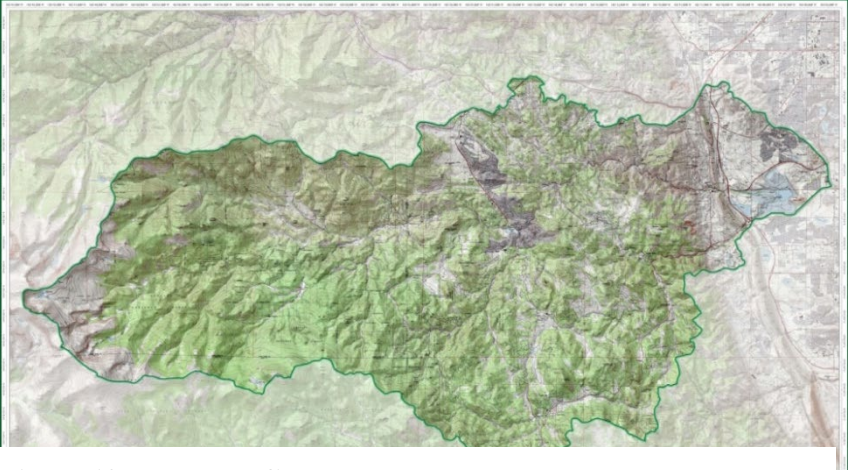


Figure 12 Bear Creek Watershed

The Association is the local water quality agency responsible for implementation of monitoring and tracking water quality in the Bear Creek Watershed (*BCWA Policy 13 Watershed Boundary*). The Association membership includes counties, local general-purpose governments, special districts (wastewater dischargers), associate agencies, and local citizen groups (Table 2). 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 (*BCWA Policy 28 BCWA Watershed Plan*).

The Association provides watershed reporting as posted on the Association Website www.bearcreekwatershed.org, which serves to keep federal, state, 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 (*BCWA Policy 29 BCWA Integration with Other Planning Efforts*).

Table 4 Association Membership, Dischargers and Participation

Members & Participants	Wastewater Discharger	2023 Participation
Counties		
Jefferson County		Active
City and County of Denver		Active
Clear Creek County		Active
City and Towns		
City of Lakewood		Active
Town of Morrison	Yes	Active
Water & Sanitation Districts		
Aspen Park Metropolitan District	Yes	Active
Conifer Sanitation Association	Yes	Active
Evergreen Metropolitan District	Yes	Active
Forest Hills Metropolitan District	Yes	Active
Genesee Water & Sanitation District	Yes	Not Active
Geneva Glen	Yes	Active
Jefferson County School District	Yes	Active
Kittredge Water & Sanitation District	Yes	Active
Tiny Town Foundation, Inc.	Yes	Paid, Not Active
West Jefferson County Metropolitan District	Yes	Active
Other Member		

Members & Participants	Wastewater Discharger	2023 Participation
Denver Water Department		Active
Participant Agencies		
U.S. Army Corps of Engineers		Active
Jefferson Conservation District		Active
WQCD		Attended

[1] – Active membership is defined as attending 2 or more Board and/or TRS meetings (*BCWA PGO32 By-Laws*).

III. Status of Water Quality in Reservoirs and Watershed

Monitoring Program Update

The BCWA monitoring plan details the 2023 reservoir and watershed monitoring programs as approved by the BCWA Board and submitted to 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 2023 monitoring program (version 2023.01) details changes, updates, major continuation studies and monitoring program elements. The *BCWA Policy 14 Data Collection in the Bear Creek Watershed* defines expectations for other groups or agencies that conduct overlapping monitoring activities within the watershed.

Figure 13 Reservoir Monitoring Stations; Site 40 is the Routine P1 Station

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 13; 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 (Site 43 and site 44 were not monitored in 2023). 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 ½ and 1-meter intervals at all reservoir sites. The current monitoring program optimizes data generation to evaluate reservoir inflow loading, chemical and biological changes within the reservoir, and reservoir outflow, while minimizing monitoring cost. Figure 14 shows all active and historic monitoring stations within Bear Creek Park. The Association maintains maps of recent and historic sampling sites, wastewater treatment plant locations and special study areas in the Association's electronic watershed plan.

Figure 14 Monitoring Stations (Active and Historic) in Bear Creek Lake Park

Watershed Studies

Stream Flow Studies

The BCWA obtains stream flow data at multiple stations throughout the watershed. Manual flows were measured with most watershed-sampling events. For watershed sites, manual flows are measured at up to 17 sites during the May to November timeframe. Year-round flows are measured at the P1 sites. The Association also conducts tributary stream flow studies.

Hydrology

The average inflow into Bear Creek Reservoir from both Turkey Creek & Bear Creek (1987-2023 was 28,573 acre-feet per year (Table 5). The 2023 inflow is estimated at 23,936 acre-feet (Figure 15) with the June flow at 32% of the annual total flow. There were two flood stages (> 2,000 ac-ft) for BCR (Figure 16). The reservoir was below normal (<1,500 acre-feet) from January through May. The U.S. Army Corps of Engineers lowered BCR from January to May by about 400 ac-ft.

Table 5 Average and Median Reservoir Inflow Over Period of Record

	Years	Reservoir Inflow (Acre-Ft/Year)
Average	1987-2023	28,573
Median	1987-2023	21,641
Average	1987-2010	28,639
Average	2010-2023	28,493
5-Yr Average	2019-2023	18,656

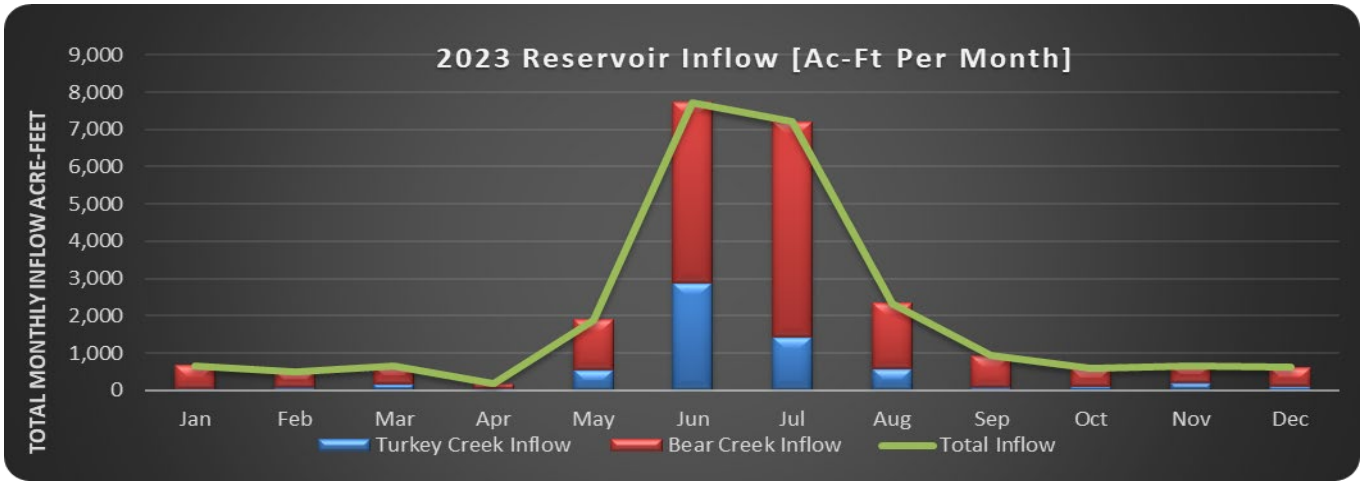


Figure 15 In-Flow Estimates by Month into Bear Creek Reservoir

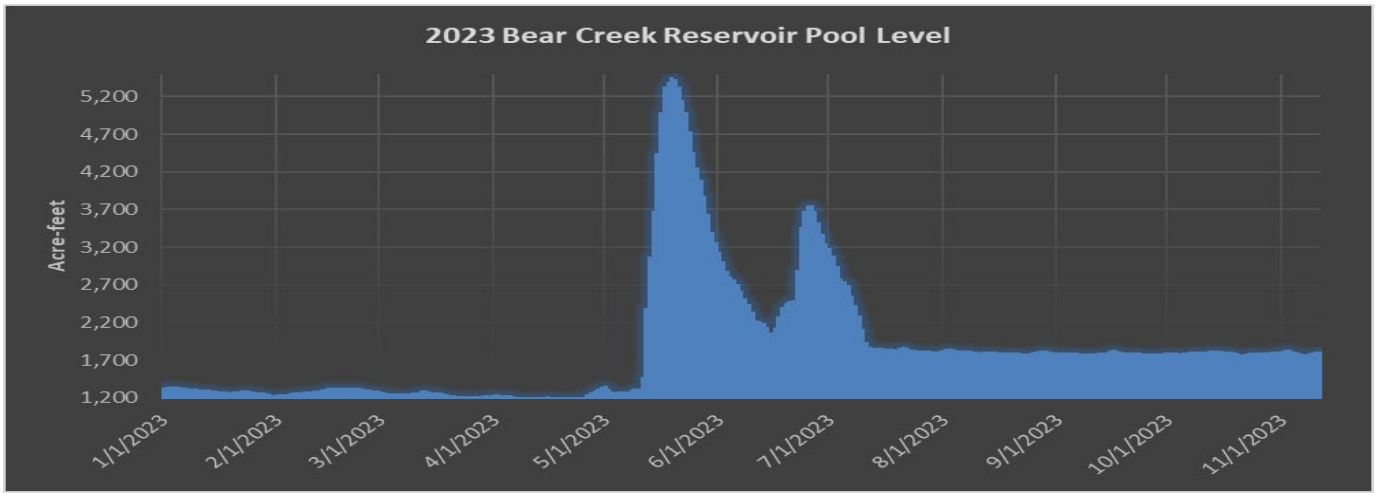


Figure 16 Flood Stage in Bear Creek Reservoir

Bear Creek flow diverts at the Harriman Ditch in Morrison, and a portion of the Turkey Creek flow diverts for water users. 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 dewater lower Bear Creek for periods of up 15 consecutive days. For example, the Harriman can divert water for up to 275 days with about 5,000 acre-feet of removal as reported by Denver Water Department. Lower Bear Creek between the Harriman/ Ward ditch diversions and the inlet into Bear Creek reservoir is often dewatered (<5 cfs flow) for about 50 days annually or 15% of the time. The BCWA analyzed the nutrient load removal from the Harriman Ditch (Table 6). The diversion reduces the total phosphorus load to Bear Creek Reservoir by about 20%. The 2023 diversion record is like the 1992-2018 data record.

Table 6 Harriman Ditch Nutrient Load Removal

DWD Harriman Ditch					
Segment	BCWA Site	Season May-October			
		Nitrate Pounds	TN Pounds	TP Pounds	Ac-Ft
Seg 1e	Site 14a	12,468	25,806	3,275	24,885
Seg 4a	Site 34	2,803	4,572	85	1,468
Total Above Harriman		15,271	30,378	3,360	26,353
Seg 1b	Site 15a	11,536	25,095	2,652	16,519
Removal Harriman		3,735	5,283	708	9,834
% Removal		24%	17%	19%	37%

Comparing in-flow estimates at the Morrison gaging station (2023 - 27,373 ac-feet) and at the BCWA site in Bear Creek Park (2023 – 17,747 ac-feet) provides an estimate of the amount of water diverted from the watershed by the Arnett-Harriman Canal and Ward Ditch. For example, in 2023 the Bear Creek water use diversions reduced flow to the reservoir by about 9,625ac-ft (-35 %).

The reservoir inflow represents flows below the water diversions and is not representative of the total watershed flows. Figure 17 compares the 2023 reservoir monthly inflow estimates from Bear Creek 74%) and Turkey Creek (26%). Peak spring and stormwater runoff occurred in June and July 2023 (62% of annual flow). Figure 18 shows the Bear Creek in-flow estimates (1987-2023) above Bear Creek Reservoir, in Bear Creek Park. Figure 19 shows the flow estimates at the Evergreen station. Additionally, the longer time trends shown in 19 depict a basic linear trend of declining flow in Bear Creek.

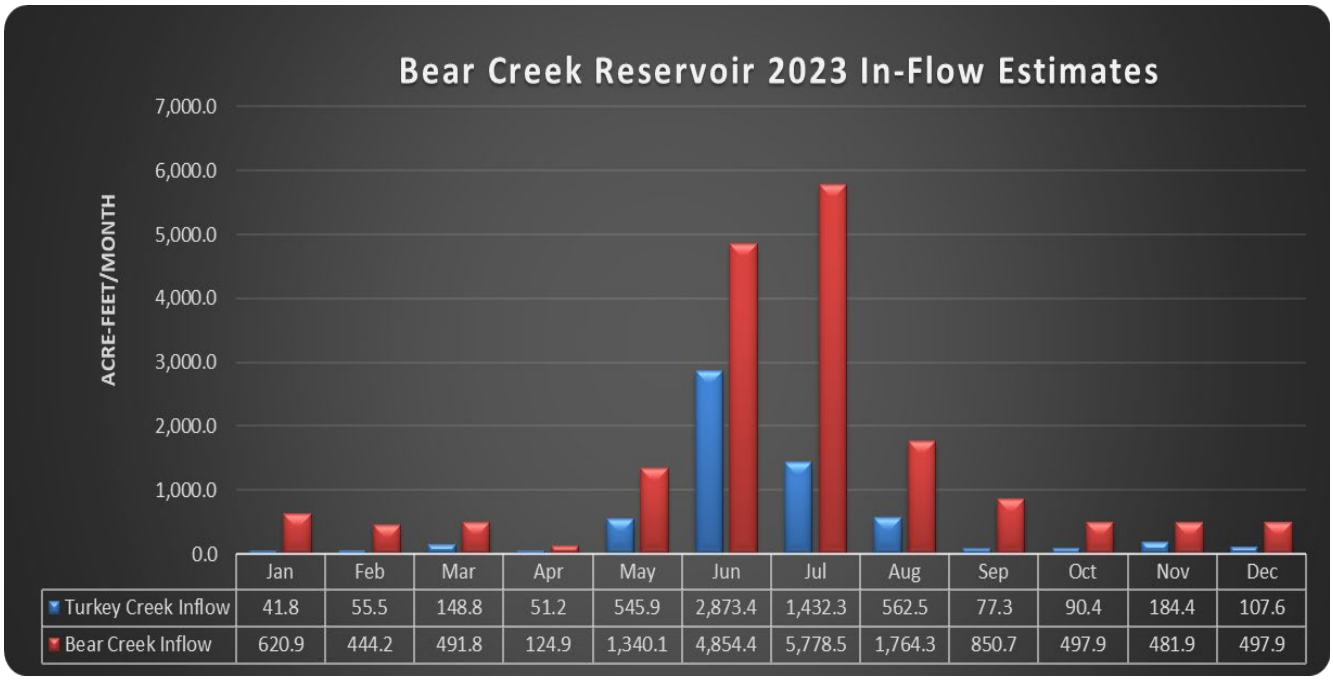


Figure 17 Annual Flows into Bear Creek Reservoir

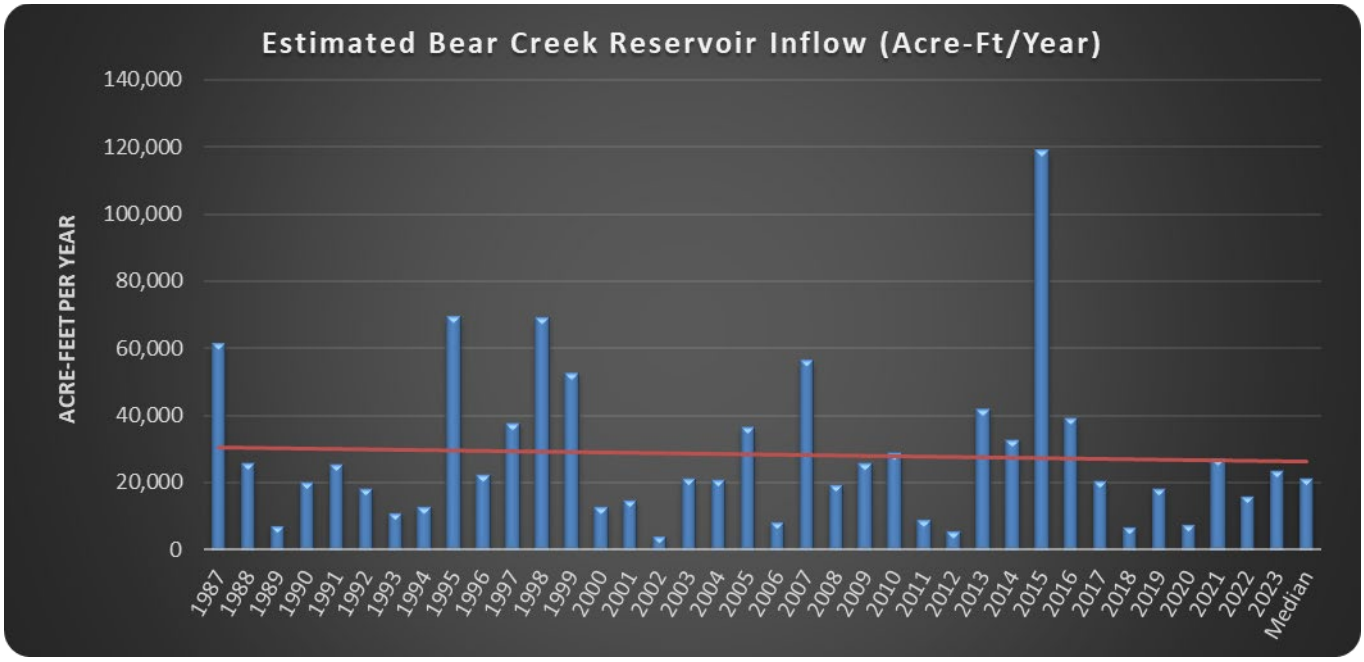


Figure 18 Bear Creek Reservoir Inflow Estimates

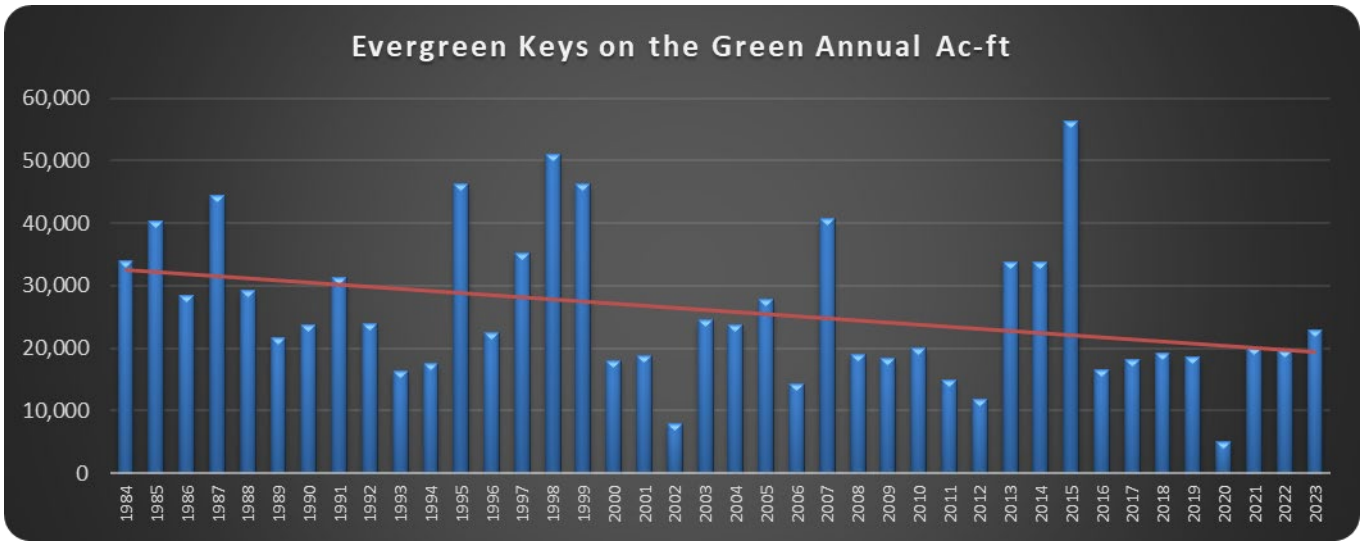


Figure 19 Bear Creek at Keys-on-the-Green, above Evergreen

Water Quality Studies

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, as defined in the ***Water Monitoring Program and Sample Analyses Plan Version 2023.01, BCWA January 2023 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 2023.01 and subsequent annual updates.***

3. Special water quality characterization and analyses studies completed on a site-specific basis.

The 2023 P1 data results are contained in the MS*2023 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. Stream and lake sampling and monitoring data, including pH, Temperature, Dissolved Oxygen, Specific Conductance, Total Nitrogen and Total Phosphorous were collected from July through September. Stream and lake temperature data-loggers were placed at 17 sites, including the Evergreen Lake profile station, and the Bear Creek Reservoir profile station. Six selected sites collected data logger temperatures from January through December. The remaining sites collected temperature data from April through September and May through October. Some data-loggers were lost. All loggers were removed, and data downloaded after October 2023. The Association produces an annual series of technical memorandums designed to summarize the site-specific studies for any given year.

Table 7 lists the 2023 tributary and mainstem Bear Creek seasonal average chemistry results (full results shown in 2023 Master Spreadsheet). Table 8 lists the Summit Lake area watershed chemistry results (full results shown in 2023 Master Spreadsheet).

Table 7 Middle Watershed Chemistry

		Site ID	Site Location by Stream Segment	Seasonal Average		May-Oct	Seasonal Pounds	
				TN Ug/l	TP Ug/l	Ac-ft	TN	TP
Seg 7	**Evans**	Site 36	Summit Lake	393	16	393	421	18
		Site 37	Bear Creek Below Summit Lake	442	20	282	339	15
Seg 1a	**Upper Bear**	Site 58	Bear Creek below Wilderness	299	10	13,379	10,902	346
		Site 2a	Golden Willow Road UBC	266	21	16,015	11,585	916
		Site 3a	Above Evergreen Lake at CDOW Site	280	18	17,417	13,272	846
Seg 3	**Tribs**	Site 25	Vance Creek Blue Sky Wilderness drainage)	192	12	8,079	4,216	271
Seg 1d	**EGL**	Site 4a	Evergreen Lake	324	23	17,500	15,416	1,104
Seg 1e	**Middle Bear**	Site 5	Above EMD WWTP, CDOW downtown	344	19	26,104	24,464	1,374
		Site 9	O'Fallon Park, west end at CDOW Site	796	40	26,503	57,433	2,875
		Site 13a	Below Idledale, Shady Lane at CDOW site	492	35	27,008	36,147	2,586
		Site 14a	Morrison Park west, CDOW Site	519	41	29,471	41,623	3,290
Seg 5	**Upper Tribs**	Site 26	Cub Creek, Mouth	498	28	5,193	7,047	391
		Site 32	Troublesome Mouth	2,556	133	1,764	12,276	640
Seg 1b	**BCP**	Site 15a	Bear Creek Park	726	58	15,086	29,834	2,379
Seg 6b	**N Turkey**	Site 19	North Turkey Creek Flying J Ranch Bridge	545	42	3,819	5,666	440
Seg 6a	**S Turkey**	Site 18	South Turkey Creek Aspen Park	664	85	1,288	2,328	296
		Site 16a	South Turkey Creek, Park	777	37	5,582	11,817	559
Seg 4a	**Direct Tribs**	Site 98a	Rooney Gulch	1,655	72	189	851	37
		Site 97a	Coyote Crossing	735	172	420	840	196
		Site 47a	Coyote Gulch	1,166	82	414	1,314	92
Seg 1c	**BCR**	Site 40a	Bear Creek Reservoir	725	45	20,232	39,916	2,486
Seg 2	**Lower Bear**	Site 45	Bear Creek below BCR	632	29	29,232	50,326	2,282
		Site 90	Bear Creek Wadsworth	725	35	34,143	67,373	3,208

Table 8 Upper Watershed (Summit Lake) Chemistry

Site	Parameter	6/15/2023	7/11/2023	8/8/2023	9/5/2023	10/2/2023	Seasonal Average
BCWA Segment Sample Sites							
36 - Outlet Summit Lake	TN ug/l	535	322	306	417	387	**395**
	TP ug/l	30	11	5	10	26	**14**
37 - Upper Bear Creek	TN ug/l	554	343	381	418	514	**424**
	TP ug/l	12	15	5	11	55	**11**
Site 63 - Bottom Fen	TN ug/l	673	582	426	422	1371	**526**
	TP ug/l	58	136	241	185	844	**155**
Flow acre-feet/month							
	June	**July**	**August**	**Sep**	**Oct**	**Season Totals**	
site 36 through Culverts	20.84	247.81	58.48	66.01	22.58	**393.1**	
site 37 - Bear Creek	18	171	48	45	29	**281.4**	
Site 63 - Bottom Fen	2.1	3.0	4.2	3.0	4.3	**12.2**	
Total Phosphorus, Pounds/month							
site 36 through Culverts	1.70	7.42	0.80	1.80	1.60	**11.7**	
site 37 - Bear Creek	0.58	6.97	0.66	1.34	4.28	**9.5**	
Site 63 - Bottom Fen	0.33	1.10	2.73	1.50	9.84	**5.7**	
Total Nitrogen, Pounds/month							
site 36 through Culverts	30.4	217.3	48.7	74.9	23.8	**371.3**	
site 37 - Bear Creek	26.9	159.5	50.0	50.8	40.0	**287.2**	
Site 63 - Bottom Fen	3.8	4.7	4.8	3.4	16.0	**16.8**	

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 total phosphorus and total nitrogen monthly. The Association has established preferred management strategies for Bear Creek Reservoir (*BCWA Policy 20*). 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 9,000 septic systems in the watershed. The estimated total phosphorus load in 2023 from all sources reaching the reservoir was 3,052 pounds at a flow of about 23,918 acre-feet. Bear Creek drainage contributed 931% of the TP load (Figure 20).

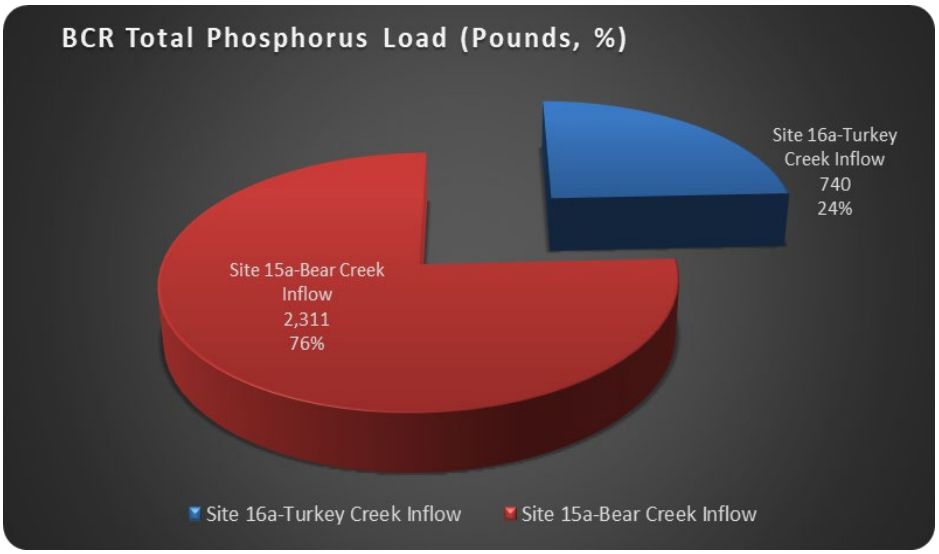


Figure 20 Estimated Total Phosphorus loading into Bear Creek Reservoir

The management program targets reduction of total phosphorus reaching the reservoir on an annual basis. Figure 21 shows the total phosphorus reservoir loading trend from 1990 through 2023 in 5-year blocks. The total nitrogen loading (Figure 22, about 29,878 pounds) had 85% of the load coming from Bear Creek. Figure 23 shows the Total Nitrogen trend in BCR. Since 2011 the total nitrogen loading has shown an increasing trend into Bear Creek Reservoir, with 2023 as an average loading year.

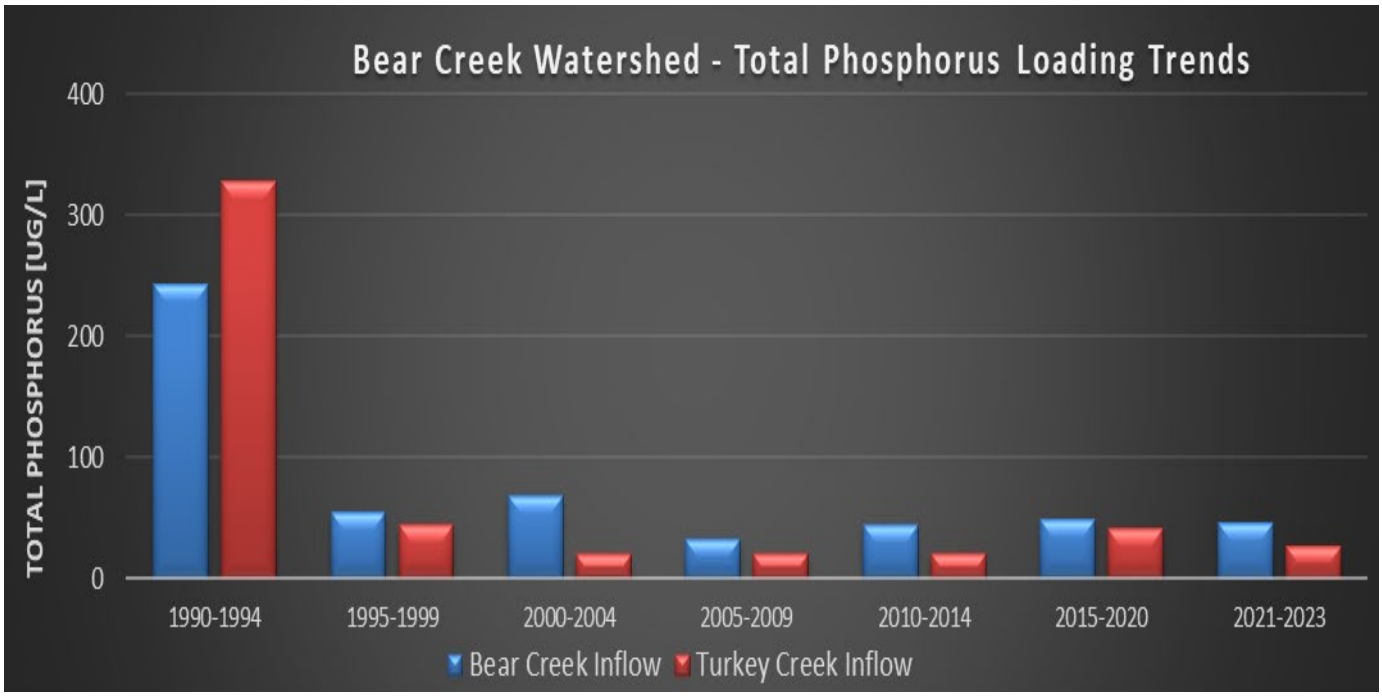


Figure 21 5-Year Average Total Phosphorus Trend BCR Compared with 2021

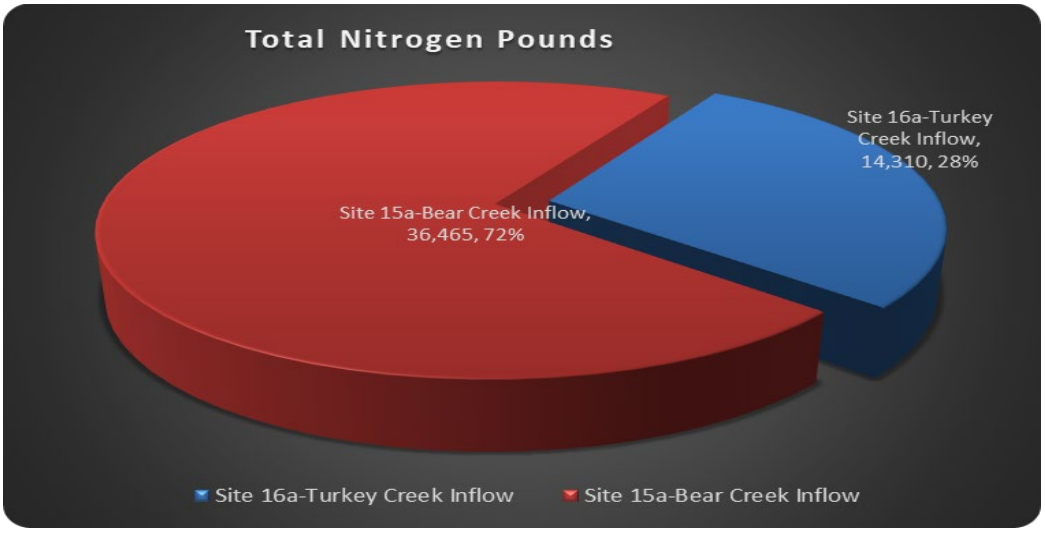


Figure 22 Total Nitrogen Loading into Bear Creek Reservoir

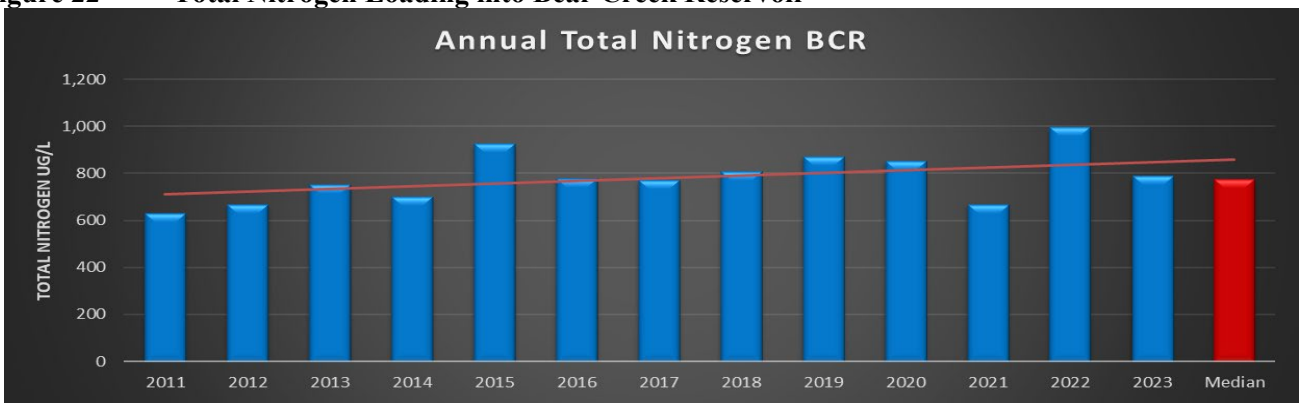


Figure 23 Estimated Total Nitrogen Loading Trend for Bear Creek Reservoir

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 (rarely), dissolved oxygen, pH, specific conductance, Secchi depth, and phytoplankton population dynamics as trend variables. Table 9 lists the summary statistics for the monitoring variables. Tables 10 and 11 summarize the reservoir loading data. Table 11 compares 2023 data with the long-term patterns from 1991 through 2022. In 2023, the chlorophyll concentrations were lower than the long-term trends, nitrogen loads, and total phosphorus loads were also normal. Table 12 summarizes the phytoplankton data. Figure 24 shows the general clarity trend in the water column using Secchi measurements. April through May had the poorest clarity caused by phytoplankton blooms.

Table 9 Bear Creek Reservoir Summary Statistics (July September)

Reservoir Monitoring Parameters	Reservoir
Chlorophyll (Site 40)	
Average Growing Season Chlorophyll-a [ug/l (-1m)]	10.1
Average Annual Chlorophyll-a [ug/l (-1m)]	9.4
Peak Chlorophyll-a [ug/l]	39.6
Total Phosphorus	
Average Annual Total Phosphorus [ug/l]: Water Column	49.4
Average Annual Total Phosphorus [ug/l] -1m	29.8
Average Annual Total Phosphorus [ug/l] -10m	68.9
Growing Season Total Phosphorus [ug/l]: Water Column	55.6
Growing Season Total Phosphorus [ug/l]: -1m	36.2
Growing Season Total Phosphorus [ug/l]: -10m	75.0
Peak Annual Total Phosphorus [ug/l] Water Column	247.0
Total Nitrogen	

Reservoir Monitoring Parameters	Reservoir
Average Annual Total Nitrogen [ug/l]: Water Column	790
Average Total Nitrogen [ug/l]: -1m	777
Average Total Nitrogen [ug/l]: -10m	804
Growing Season Total Nitrogen [ug/l]: Water Column	750
Growing Season Total Nitrogen [ug/l]: -1m	741
Growing Season Total Nitrogen [ug/l]: -10m	759
Clarity (All Profiles)	
Average Annual Secchi Depth (meters)	1.2
Growing Season Average Secchi Depth (meters)	1.1
Dissolved Oxygen (site 40 Profile)	
Annual Average at -1/2m - 2m [mg/l]	8.75
Seasonal Average at -1/2 - 2m [mg/l]	5.76
Seasonal Minimum at -1/2 - 2m [mg/l]	0.82
pH	
Annual Average at -1/2m - 2m [mg/l]	7.82
Seasonal Average at -1/2 - 2m [mg/l]	7.83
Seasonal Maximum at -1/2 - 2m [mg/l]	8.64
Specific Conductance	
Annual Average at -1/2m - 2m [uS/cm]	490.0
Seasonal Average at -1/2 - 2m [us/cm]	409.7
Seasonal Minimum at -1/2 - 2m [us/cm]	304.9
Phytoplankton Species	
Phytoplankton Co-dominant Species - Site 40 (July- October 2023)	*Anabaena flos-aquae*
	Aphanizomenon flos-aquae
	Cryptomonas erosa
	Diatoma vulgare
	Stephanodiscus niagarae
	Asterionella Formosa
Peak Phytoplankton	
	Density cells/ml = 115,035
	Peak Biovolume (um^3/mL) = 20,836,200

Table 10 Annual Bear Creek Reservoir Load Estimates

Loading - Annual Pounds	
Total Nitrogen -Total Load Into BCR	50,775
Total Nitrogen -Total Load From BCR	69,238
Total Nitrogen -Total Deposition into BCR	-18,463
Total Phosphorus -Total Load Into BCR	3,052
Total Phosphorus -Total Load From BCR	3,085
Total Phosphorus -Total Deposition into BCR	-34

Table 11 Bear Creek Reservoir Select Trend Parameters

Parameter		2023	91-2022 Mean	91-2022 Median
Chlorophyll-a (ug/L)	Top	9.4	14.6	13.2
Total Nitrogen ug/l	Top	777	795	780
	Bottom	804	776	797
	Water Column	790	786	785
Total Phosphorus (ug/L)	Top	30	55	39
	Bottom	69	83	62
	Water Column	49.4	66.5	50.3

Table 12 Bear Creek Reservoir Phytoplankton Summary Data

	4/10/2023	5/8/2023	6/5/2023	7/10/2023	7/17/2023	8/7/2023	8/21/2023	9/11/2023	9/18/2023	10/2/2023	11/6/2023	12/6/2023
Total Density (#/mL):	5,617	4,132	538	342	388	1,856	386	1,236	15,576	7,269	13,600	2,035
Total Biovolume (um3/mL):	1,980,341	3,550,016	91,774	98,628	85,991	2,709,735	332,086	1,460,766	21,743,148	11,535,605	18,835,627	986,774
Trophic State Index:	54.8	59.0	32.7	33.2	32.2	57.0	41.9	52.6	72.1	67.5	71.0	49.8
Total Species												
Bluegreen					1	2	2	2	3	1	2	2
chrysophyte	3	2	1	2								1
cryptophyte	2	1	2	2	2	1	2	2	2		1	2
diatom	5	5	3	9	11	8	7	5	11	10	1	6
green		1	3	2	2	3	2		1		1	1
euglenoid	1							1				
dinoflagellate		1		1	1			1				

Bear Creek Reservoir		
Species with >100,000 Biovolume um3/mL		
Anabaena flos-aquae	1,895,430	bluegreen
Aphanizomenon flos-aquae	20,836,200	bluegreen
Chrysococcus rufescens	128,945	chrysophyte
Cryptomonas erosa	383,760	cryptophyte
Asterionella formosa	3,271,578	diatom
Diatoma vulgare	9,616,708	diatom
Melosira granulata	103,354	diatom
Melosira granulata angustissima	401,575	diatom
Rhoicosphenia curvata	202,950	diatom
Stephanodiscus hantzschii	108,240	diatom
Stephanodiscus niagarae	501,111	diatom
Ceratium hirundinella	100,909	dinoflagellate
Trachelomonas volvocina	231,855	euglenoid

Figure 24 Secchi Depth Bear Creek Reservoir

The reservoir had several algal blooms in 2023 as evidenced by peak April through May chlorophyll concentrations, and the fall peak in September (Figure 25). Historically, blue-green phytoplankton species are associated with major blooms in the reservoir (*BCWA Fact Sheet 57 Cyanotoxins, BCWA Fact Sheet 58 Cyanobacteria Guide BCR, Fact Sheet 60 Managing Harmful Algal Blooms, and Fact Sheet 61 HABs Exposure and Risks*).

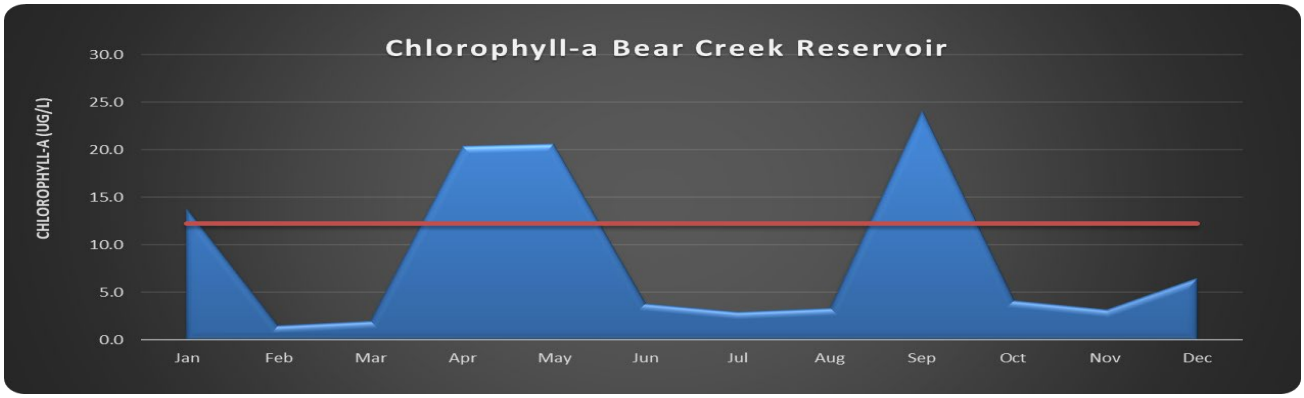


Figure 25 Bear Creek Reservoir Chlorophyll Trend

The reservoir continues to experience late summer phytoplankton blooms (2023 peak density of *Aphanizomenon flos-aquae*, peak biovolume of 20,836,200 um3/ml), which is linked to the internal nutrient loading problem. The problematic bluegreen algae was *Aphanizomenon flos-aquae* with potentially toxic peak blooms (Table 13). The August and early September phytoplankton samples taken near Bear Creek dam contained 3 species of bluegreens, which are common in the reservoir. Cyanobacteria, in high concentrations (> 20,000 cells/ml of water), can produce toxins. Release of toxins during an algal bloom generally occurs when algal cells die or are subject to lysis (i.e., cell wall ruptures). Most commonly occurring genera of bluegreens found in Bear Creek Reservoir over the last 10-years are Microcystis, Anabaena, Oscillatoria, and Aphanizomenon (Table 14). Potential cyanotoxins found in reservoir blooms are microcystins, cylindrospermopsin, anatoxins and saxitoxins. The biovolume of *Aphanizomenon* is considered a moderate to high risk for cyanotoxin production.

The genus *Limnothrix* is a filamentous cyanobacteria. This bluegreen produces a novel toxin called Limnothrixin, which has been associated with damage in liver, lungs, and gastrointestinal tract of mice (Humpage et al., 2012) as well as toxic activity against Bufo marinus larvae (frogs) (Daniels et al., 2014).

Anabaena circinalis is well known as a producer of potent neurotoxins. This Cyanobacteria species is particularly worrisome. Not only does this species produce toxins, but it is also a nitrogen fixer. By providing the nutrients that increase *A. circinalis* populations, additional reactive nitrogen further disrupts the ecosystem. Literature reports widespread occurrence of saxitoxins and related neurotoxins in blooms of *Anabaena circinalis* in rivers and water storage reservoirs. *Anabaena circinalis* produces heat-stable neurotoxin, anatoxin a, which has been found to be a blocking agent for postsynaptic neuromuscular transmission.

Table 13 Potential Toxin Risk of Bluegreen Algae

	Peak Density, cells/ml	Peak Biovolume, um3/mL	Potential Toxin Risk
2013	16,695	2,132,808	Low
2014	64,431	454,538	Moderate
2015	1,356	2,019,887	Low
2016	57,081	40,202,900	Moderate
2017	75,154	2,268,627	Moderate
2018	21,370	1,083,089	Moderate
2019	38,843	517,523	Moderate
2020	22,370	3,583,517	Moderate
2021	98,365	10,013,291	Moderate
2022	112,750	163,374,750	High
2023	115,033	20,836,200	High
	HAB Risk Range Cell/ml		**Potential Toxin Risk**
	<20,000		Low
	>20,000	<100,000	Moderate
	>100,000	<10,000,000	High
	>10,000,000		Very High

Table 14 Bluegreen Species in Bear Creek Watershed

Genera	Species
Anabaena	Anabaena flos-aquae
	Anabaena variabilis
	Anabaena circinalis
	Anabaena planctonica
	Anabaena lemmermannii
Aphanizomenon	Aphanizomenon flos-aquae
Gloeotrichia	Gloeotrichia echinulata
Limnothrix	Limnothrix sp.
Lyngbya	Lyngbya sp.
Microcystis	Microcystis aeruginosa
	Microcystis wesenbergii
Oscillatoria	Oscillatoria limosa
	Oscillatoria sp.
Woronichinia	Woronichinia naegeliana

Ceratium hirundinella, a dinoflagellate, was found in Bear Creek Reservoir. Ceratium species belong to the group of dinoflagellates known as dinophysiales, meaning they contain armored plates. Ceratium species do not produce toxins, however they are considered as "harmful algae", since they deplete nutrients under bloom conditions. Ceratium are found in the upper regions of the water, where there is enough light for photosynthesis. Unlike other dinoflagellate species, Ceratium are relatively harmless organisms. Although Ceratium hirundinella is non-toxic, they can cause a red tide if conditions allow for excessive blooming. While this red tide is not toxic, it can deplete resources in its environment, causing strain on the ecosystem.

The reservoir trophic state was hypereutrophic (Walker Index, Figure 26). The Carlson Index shows a similar eutrophic trend. External nutrient loads were near normal to historic trends. The reservoir continues to have an internal nutrient loading problem, which causes eutrophic water quality conditions.

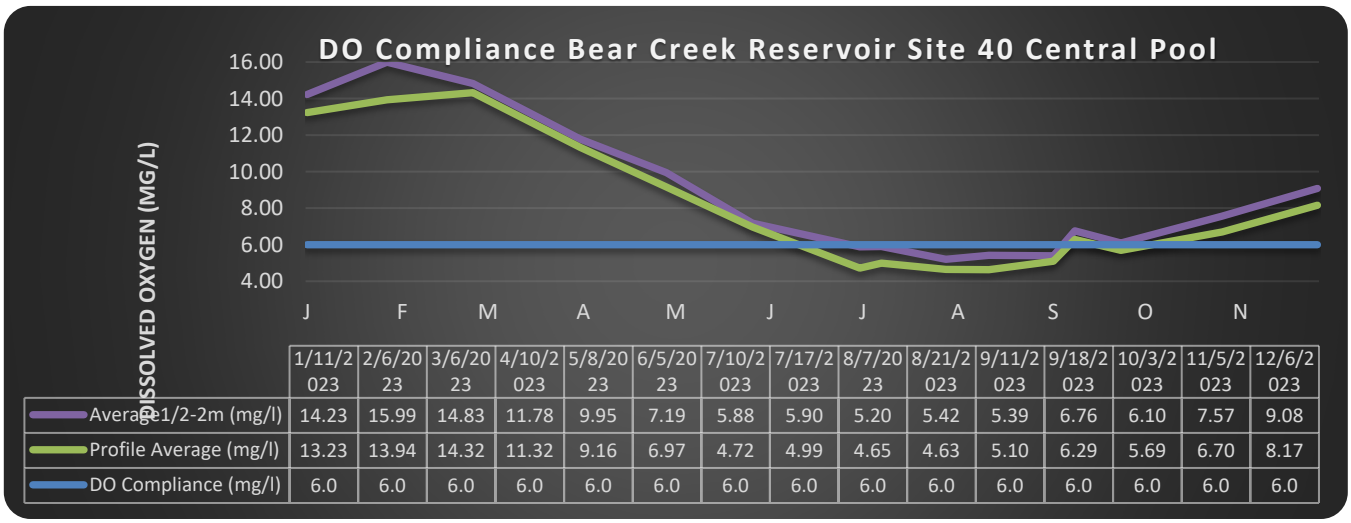
Figure 26 Walker Trophic Index Trend Bear Creek Reservoir

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 (*BCWA Policy 8 Bear Creek Reservoir Aeration*). The Association adopted Policy 8 to make 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 long-term or permanent management practice necessary to protect the quality reservoir fishery 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 aeration system has been operational since the summer of 2002 and uses a fine-bubble diffusion system with aerators distributed across the hypolimnion. In 2022, the Association and Lakewood operated the aeration system to maximize oxygen transfer during phased on-off cycling (Figure 27 and 28), with the aeration system phased on in the growing season. In

2023, the dissolved oxygen in the lower water column was below the standard from July through September. The aeration system can increase the dissolved oxygen concentrations throughout the water column by about 2 mg/l within a two-week period.



	1/11/2023	2/6/2023	3/6/2023	4/10/2023	5/8/2023	6/5/2023	7/10/2023	7/17/2023	8/7/2023	8/21/2023	9/11/2023	9/18/2023	10/3/2023	11/5/2023	12/6/2023
Average1/2-2m (mg/l)	14.23	15.99	14.83	11.78	9.95	7.19	5.88	5.90	5.20	5.42	5.39	6.76	6.10	7.57	9.08
Profile Average (mg/l)	13.23	13.94	14.32	11.32	9.16	6.97	4.72	4.99	4.65	4.63	5.10	6.29	5.69	6.70	8.17
DO Compliance (mg/l)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0

Figure 27 Bear Creek Reservoir 2023 Dissolved Oxygen Trend

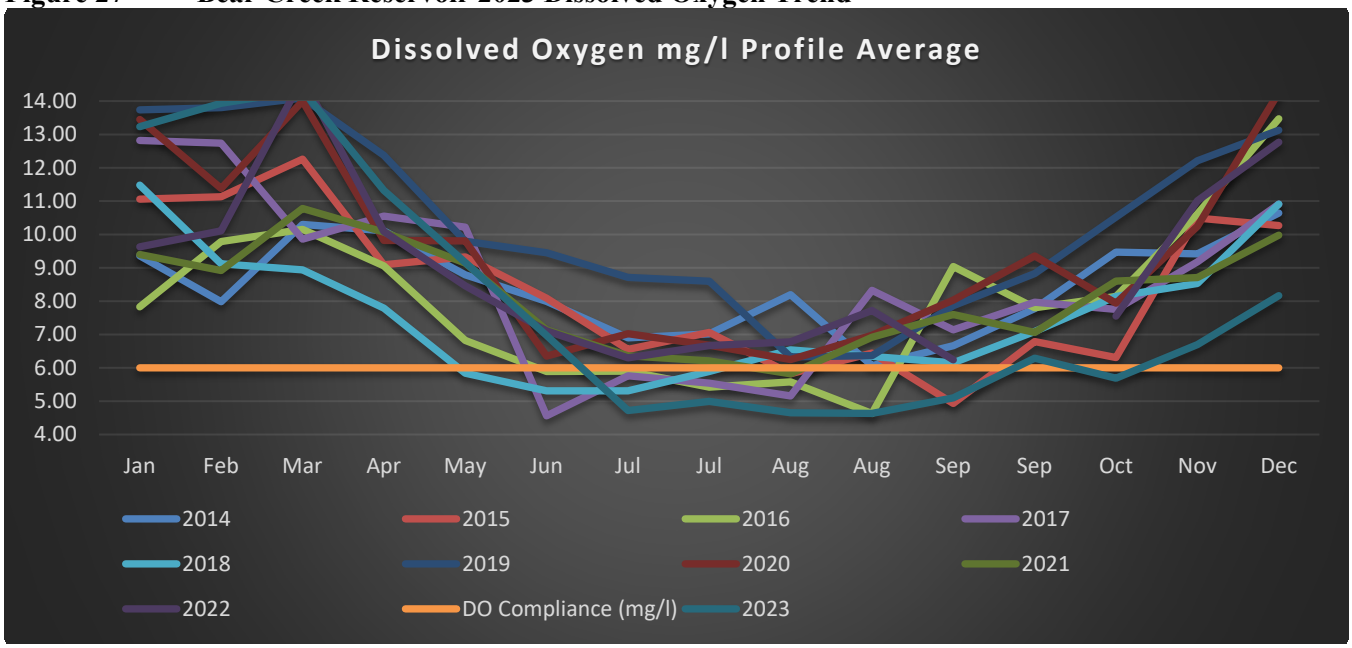


Figure 28 Dissolved Oxygen Trend 2014-2023

Aeration System BCR

The September 2013 flood event used Bear Creek Reservoir as a major flood control structure, which caused displacement and reduced efficiency of the in-reservoir aeration system as installed by the City of Lakewood and monitored by the BCWA (*BCWA Fact Sheet 6 Aeration BCR)*. A video survey was completed on the BCR aeration system on April 30, 2014 (*BCWA TM2014.01 BCR Video Survey Aerators*). The survey demonstrated air supply line damage (kinks and holes), aeration pan displacement, overturned aeration pans, reduced function, and some losses, which reduced the overall system efficiency by 40-70% (*BCWA Fact Sheet 47 New BCR Aeration System*).

Since FEMA requires *like-kind* replacement, Lakewood determined it would be more cost effective to upgrade and replace the aeration system using Lakewood funding. The BCWA assisted with new aeration configuration, system requirements and replacement options. BCWA and Lakewood staff removed most of the old aeration system and recycled these materials. The company *Underwater Repairs Specialist* installed 6 Quad Duraplate Diffusers (DDP9X4 Keeton Industries) and weighted line in November 2014 with assistance of Lakewood staff that corresponds to the pattern shown in Figure 29. The diffusers are fine-bubble (air supplied by a 15 hp

compressor) and they will increase the dissolved oxygen transfer into the reservoir water column. Lakewood and BCWA conducted an eight-year evaluation (2016-2023) on the effectiveness and efficiency of the new aeration system in the spring/ summer growing season (*Fact Sheet 62 BCR Aeration System Operation* and *Fact Sheet 63 2014 BCR Aeration System Evaluation*). The Association and Lakewood recommend the addition of several new aeration modules in the reservoir.

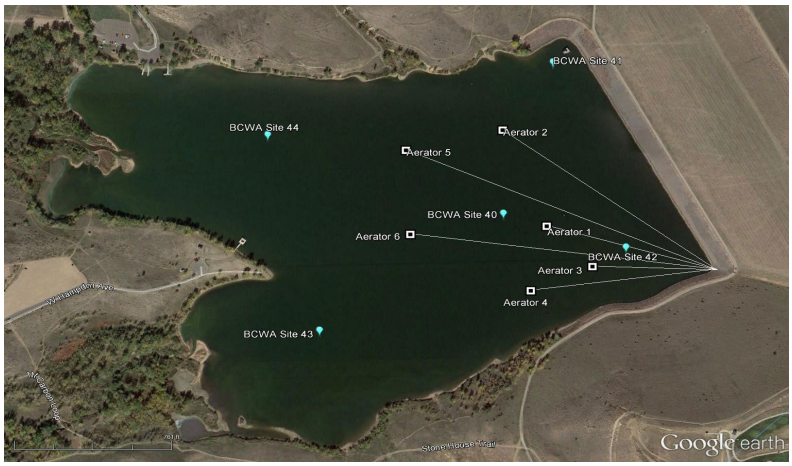


Figure 29 BCR Aeration Configuration

Sediment Studies Bear Creek Reservoir and Evergreen Lake

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. Bottom sediments are a mixture of fine sand, silt, and mud. The September 2013 flood event introduced extremely large amounts of sediments. The BCWA had no reliable method to determine the total amount of sediment transported by the 2013 floods. The BCWA approximated the amounts deposited into Evergreen Lake (Table 15) and Bear Creek Reservoir (Table 16). It is very apparent that storm waters moved millions of pounds of sediment. There was extensive erosion throughout the watershed. Streambanks were lost, and channel configurations were altered throughout segment 1e.

Table 15 Estimated Sediment Load into Evergreen Lake

Evergreen Reservoir			
Sep-13		Oct-13	
TSS Based (SSL Load)		TSS Based (SSL Load)	
Tons/month	Cubic Yards/Month	Tons/month	Cubic Yards/Month
905	745	28	23
Estimated Bedload		Estimated Bedload	
Tons/month	Cubic Yards/Month	Tons/month	Cubic Yards/Month
13,582	11,179	142	117

Table 16 Estimated Sediment Load into Bear Creek Reservoir

Bear Creek Reservoir			
Sep-13		Oct-13	
TSS Based (SSL Load)		TSS Based (SSL Load)	
Tons/month	Cubic Yards/Month	Tons/month	Cubic Yards/Month
40,933	33,690	1,587	1,306
Estimated Bedload		Estimated Bedload	
Tons/month	Cubic Yards/Month	Tons/month	Cubic Yards/Month
1,023,331	842,248	7,933	6,529

Evergreen Lake

Evergreen Lake (Segment 1d) is a small reservoir constructed in 1927 and serves as a major direct use water supply (DUWS) 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 rock structures that support the road and walking paths, maintains erosion control 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 17). The Association has established preferred management strategies for Evergreen Lake (*BCWA Policy 20*).

In the last few years, the dissolved oxygen concentrations in the water column were becoming exceptionally 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 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 general DO compliance in 2023 monitoring program. There was no daily maximum temperature (DM) exceedance and 3 exceedances of the weekly average temperature standard (MWAT). The water quality summary data is shown in Tables 17 and 18. The Association monitoring program data supports the designation of Evergreen Lake as a direct use water supply (DUWS).

Table 17 Water Quality Data Summary for Evergreen Lake

	Evergreen Lake, Segment 1d							
Site	**Parameter (ug/l)**	5/10/2023	6/14/2023	7/12/2023	8/9/2023	9/13/2023	10/11/2023	**Average**
EGL 4a	Total Nitrogen	289	358	342	331.0	269	352	324
	Phosphorus, total	19	10	18	15	26	51	23
	Chlorophyll a Average	3.7	0.8	2.6	2.1	3.2	2.1	2.4
EGL 4e	Total Nitrogen	399	441	548	737	529	246	483
	Phosphorus, total	31	18	29	49	35	6	28
								Total
EGL 4a	Total Nitrogen, Pounds/month	1490.0	4668.4	5112.2	2454.5	1054.5	1037.0	15,816.7
	Total Phosphorus, Pounds/month	98.0	130.4	269.1	111.2	101.9	150.3	860.8

Table 18 Field Summary Data Evergreen Lake

	Parameter Summary	5/10/2023	6/14/2023	7/12/2023	8/9/2023	9/13/2023	10/11/2023	Avg
Water Column	Secchi m	1.5	1.1	1.8	1.5	2.1	2.4	1.72
	Dissolved Oxygen 1/2-2m	9.41	8.61	7.51	6.93	6.31	8.12	7.81
	Temperature (C) 1/2-2m	9.14	8.45	14.35	15.78	14.70	10.23	12.11
	pH water column	7.63	7.50	7.36	7.26	7.32	7.54	7.44
	Specific Conductance (us/m)	96.27	81.35	81.61	82.97	88.41	80.07	85.11
Flows	Bear Creek Keys (ac-ft/month)	**1893.4**	**4788.9**	**5489.5**	**2723.3**	**1439.7**	**1081.9**	17,417
	Bear Creek EGL (cfs) daily	30.8	80.5	89.3	44.3	24.2	17.6	287

There was a dinoflagellate (*Glenodinium* species) identified from an Evergreen Lake phytoplankton sample in 2020. The biovolume was 4,047 um^3/mL, which was about 2.5% of the sample. *Glenodinium is in the* genus *Gymnodinium,* a genus of freshwater dinoflagellate algae (family *Gymnodiniaceae*). Dinoflagellates are unicellular eukaryotes that can produce toxins or paralytic algal blooms. All dinoflagellates feature two flagella and they have both plantlike and animal-like characteristics. Some may be bioluminescent. They can form periodic water blooms that tend to color water yellow or red. A few species produce toxins similar to that of the dinoflagellate *Gonyaulax*; these toxins are fatal to fish and can irritate the nose and throat of humans, if inhaled. Natural toxins like saxitoxin, yessotoxin, and brevetoxins are produced by dinoflagellates. There are 10–12 species of Dinoflagellata that can produce toxins or other poisonous substances. The famous red tides are created by the poisonous or harmful blooms produced by dinoflagellates.

The 2023 phytoplankton data is shown in Table 19. There was one species of bluegreen in the August sample: *Anabaena flos-aquae*. Bluegreens, which are common in Bear Creek Reservoir, are newer to Evergreen Lake. The bluegreens found in Evergreen are species that can produce toxins. Cyanobacteria, in high concentrations (> 20,000 cells/ml of water), generally produces toxins. Release of toxins during an algal bloom generally occurs when algal cells die or are subject to lysis (i.e., cell wall ruptures). Most commonly occurring genera of

bluegreens found in Bear Creek Reservoir over the last 10-years are Microcystis, Anabaena, Oscillatoria, and Aphanizomenon. Potential cyanotoxins found in reservoir blooms are microcystins, cylindrospermopsin, anatoxins and saxitoxins. The 2023 biovolume of Anabaena measured in Evergreen Lake was considered a low risk for cyanotoxin production.

Table 19 Phytoplankton in Evergreen Lake

	5/10/2023	6/14/2023	7/12/2023	8/9/2023	9/13/2023	10/11/2023
Total Density (#/mL):	2,042	469	883	258	747	381
Total Biovolume (um3/mL):	297,337	79,688	62,556	78,263	290,067	157,549
Trophic State Index:	41.1	31.7	30.0	31.5	40.9	36.6
Total Species						
Bluegreen				1		
chrysophyte	4	3		3		3
cryptophyte	2	2	1	2	2	2
diatom	13	14	15	8	9	6
green			1	2	2	2
euglenoid						1
dinoflagellate	1					

The trophic state of Evergreen Lake is currently balanced on the Eutrophic boundary (Figure 30 and 31). The Walker Index suggests the reservoir has already tipped into a Eutrophic state (Figure 30). The Carlson Index suggests the reservoir is at the mesotrophic/eutrophic boundary (Figure 31).

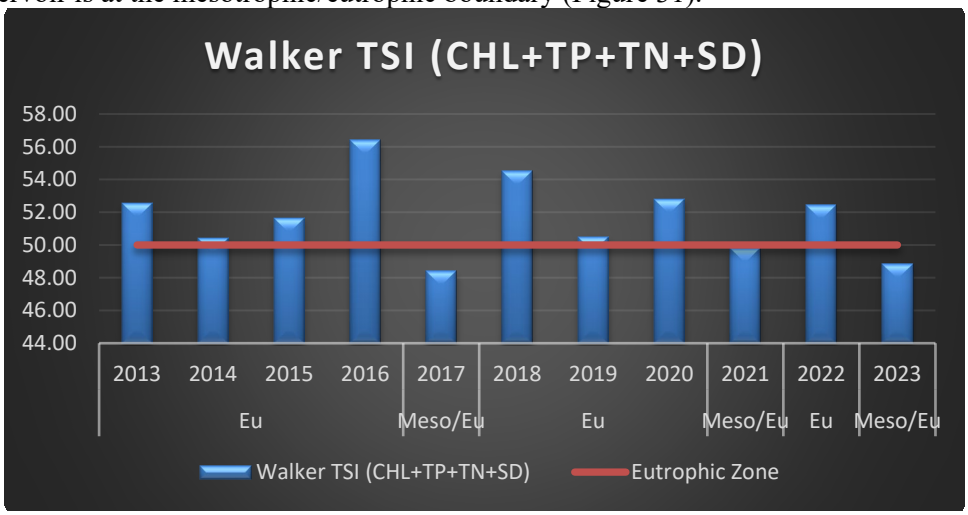


Figure 30 Trophic State of Evergreen Lake using Walker Index

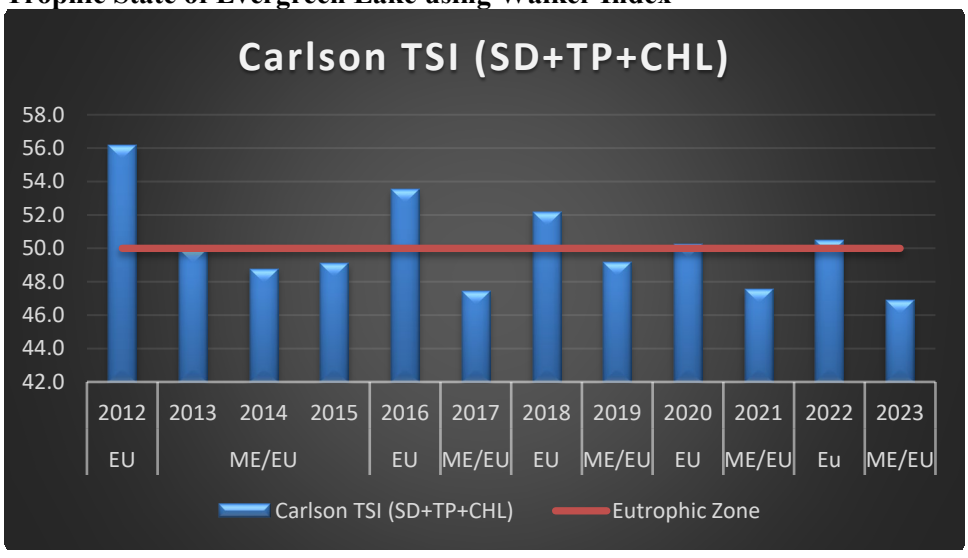


Figure 31 Trophic State of Evergreen Lake using Carlson Index

Nutrient Reduction Programs and Activities

The Bear Creek Watershed Foundation (BCWF) and Bear Creek Watershed Association (BCWA) are actively working on 7 nutrient reduction programs (Coyote Gulch, Coyote Crossing, Rooney Gulch, Wilmot Drainage, Horseshoe stormwater inlet and Pond, Evergreen Lake and Big Soda Reservoir). Special nutrient loading studies have been completed on 11 additional tributaries within the watershed that are candidates for nutrient filtration systems (Summit Fen Complex, Yankee Creek, Vance Creek, Buffalo Creek, Cemetery Creek, Cub Creek, Troublesome Creek, Kerr and Swede Gulches, Turtle Pond and Mt Vernon Creek). The active pilot projects are 18-month tests of nutrient reduction technology. Demonstration projects are longer-term growing season projects (4-5 years) based on successful field-tested technology with proven total phosphorus and total nitrogen reduction potential. Projects targeting total phosphorus removal have proven to also reduce total nitrogen. These projects permanently removed about 50% of the total phosphorus and 55% of the total nitrogen load from small watershed tributaries under normal flow and nutrient load conditions.

The BCWA and BCWF are developing improved installation methods with multi-year tributary treatment designs. These demonstration projects target approximately 55% nutrient reductions in the annual growing season for total phosphorus and total nitrogen. Collectively, the pilot and demonstration projects over a 4-year period have permanently removed over 300 pounds of total phosphorus from reaching Bear Creek Reservoir. The BCWA has linked the nutrient reduction program to the established total phosphorus trading program as established in the Bear Creek Control Regulation. The BCWA anticipates an active nutrient reduction program to establish total phosphorus trades needed by the wastewater treatment facilities as part of their permit compliance.

Evergreen Wilmot Pilot Project

The BCWA and Evergreen Metro District conducted a pilot study in the in-flow water from Wilmot drainage. The pilot was designed to reduce phosphorus loading into Ever-green Lake. The pilot project ran from July 2021 through October 2023. The BCWA used EutroSORB (a phosphorus filtration system) to reduce phosphorus loading from a portion of the Wilmot flow. EutroSORB reactive filter media can remove on average 40% of the total nitrogen load (11-86%), 67% of the total phosphorus load (53-95%) and 61% of the ortho-phosphorus (free) load (33-82%). The pilot project permanently removed over 15 pounds of total phosphorus.

The EutroSORB reactive filter media is contained in mesh bags that were placed within the flow channel and left for the study period. The filter media is safe to aquatic life and does not dissolve. The filter bags will be removed in the spring of 2023 and composted.

There were some problems with bag movement during higher flow events and some bags got buried. Additionally future work will be necessary to better secure bags to minimize movement, burial, and damage (For example, see BCWF Technical 2 BDA for one method to improve filter protection). Based on the phosphorus trading program established by the BCWA (Policy 1 Trading Program, Policy 19 Nutrient Trading Program Eligibility, and Policy 26 Point to Point Trade Administration), the total phosphorus trade reduction value of the pilot project was about $75,500. The project cost including filter media, monitoring and management was about $11,000. The pilot was a cost effective and potentially valuable phosphorus and total nitrogen reduction best practice. The EutroPHIX EutroSORB reactive filter media were predicted to bind one-pound of phosphorus per 100 pounds of filters, however the pilots were binding two-pounds of phosphorus per 100 pounds of filters with an operational life of two plus years.

Lakewood Horseshoe Pond Pilot Project

The BCWA and Lakewood completed a pilot study in the stormwater inflow water to Horseshoe Pond. The project was designed to reduce phosphorus loading into Horseshoe Pond and potentially reduce summer bluegreen blooms. The pilot project ran from July 2021 through fall of 2023. The BCWA used EutroSORB (a phosphorus filtration system) to reduce phosphorus loading from a portion of the stormwater inflow. EutroSORB filters proved to be an efficient and economical solution de-signed for intercepting total and free reactive phosphorus (SRP) from moving water, as well as total nitrogen. EutroSORB reactive filter media can remove about 30 to 90% of the total nitrogen load, 20-98% of the total phosphorus load and 7-79% of the ortho-phosphorus (free) load.

The EutroSORB reactive filter media were contained in mesh bags that were placed within the flow channel and left for the study period. The filter media is safe to aquatic life and does not dissolve. The filter bags were removed from the environment at the completion of the pilot study and composted.

There were some problems with bag movement during higher flow events and some bags got buried. There was also a problem with an upstream beaver dam, new beaver damming activity and damage to the bags by the beavers incorporating into dams. Additionally future work will be necessary to better secure bags to minimize movement, burial, and damage (For example, see BCWF Technical 2 BDA for one method to improve filter protection). There were several nutrient re-lease events, probably caused by the beaver damage. The pilot project permanently removed about 52 pounds of total phosphorus. Based on the phosphorus trading program established by the BCWA (Policy 1 Trading Program, Policy 19 Nutrient Trading Program Eligibility, and Policy 26 Point to Point Trade Administration), the total phosphorus trade reduction value of the pilot project was about $260,000. The project cost including filter media, monitoring and management was about $11,500. The pilot was a cost effective and potentially valuable phosphorus and nitrogen reduction best practice.

Coyote Gulch Nonpoint Source Restoration

The Coyote Gulch project was established in 2006. This long-term managed wetland project has effectively reduced total phosphorus loading by about 75% on an annual basis prior to the 2021 fire (Figure 1). The passive wetlands from 2007 through 2020 prevented over 100 pounds of total phosphorus from reaching the reservoir. The wetlands also reduced the total nitrogen load by over 700 pounds. This nutrient load was incorporated into the established wetland vegetation. On going wetland plant harvesting was necessary to maintain nutrient removal efficiency. The BCWA added a nutrient filtration system to augment the wetland reduction efficiency.

The Association and the City of Lakewood 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 20). Table 21 identifies the annual available total phosphorus trade pounds consistent with the Association trade program. Based on 15 years of data, there are 75.4 pounds of total phosphorus available for the trade program (Table 21). Figure 32 shows the total phosphorus reduction, pre-fire event and post-fire event.

Table 20 Coyote Gulch Nutrient Base Loads

			Loading Pounds/Period	
Location	Date	Flow Estimate	Total Nitrogen	Total Phosphorus
Upper Coyote	Jan	36.3	180.6	2.8
	Feb	9.4	42.5	0.5
	Mar	28.3	127.3	1.4
	Apr	14.3	35.7	0.4
	May	32.0	49.1	1.2
	Jun	83.3	269.9	16.6
	Jul	144.5	491.7	48.4
	Aug	56.6	181.7	17.9
	Sep	65.4	165.0	17.5
	Oct	32.0	163.9	5.7
	Nov	58.9	399.6	5.8
	Dec	215.2	1716.6	19.3
Lower Coyote	Jan	30.1	149.2	2.2
	Feb	6.7	25.7	0.3
	Mar	12.3	47.5	0.5
	Apr	13.1	28.0	0.4
	May	14.8	16.8	0.4
	Jun	71.4	221.4	14.0
	Jul	103.9	343.1	35.9
	Aug	44.3	138.0	12.9
	Sep	55.9	160.0	14.9
	Oct	24.6	97.2	3.1
	Nov	44.0	281.0	2.8
	Dec	178.3	1330.1	11.2

Table 21 Coyote Gulch Total Phosphorus Trade Pounds

Total Phosphorus Trade Pounds				
	Total Base Flow		Trade Ratio Pounds	
	Monthly	Annual	Monthly	Annual
Average	12.9	155.4	3.5	**42.1**
Median	7.4	88.8	6.3	**75.4**
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 =75.4 Pounds Total Phosphorus				

On February 7, 2021, a wildfire was reported at about 1330 in Bear Creek Lake Park (BCLP) and Fox Hollow Golf Course. A grass fire occurred at Bear Creek Lake Park near Morrison Road. The fire spread rapidly due to high winds, spread east past the dam into Fox Hollow, and resulted in many evacuations in neighborhoods near the golf course. The fire burned significant grassland, shrub, riparian and wetland areas in the northeast portion of Bear Creek Lake Park, both faces of the main dam embankment, the spillway area to the Fox Hollow entrance, and multiple areas within Fox Hollow golf course. No buildings were lost, and the aeration system was not damaged. Multiple fire and law enforcement agencies assisted during the incident. BCLP remained closed to the public on February 8 as multiple fire agencies completed fire mop-up operations.

A major portion of upper Coyote Gulch and most of Coyote Crossing drainage within the BCLP was burned. There were several hot spots where the vegetation and ground were severely burned, but not lithified. The established willows and cattails in both drainages were mostly burned above ground, with root systems probably okay. The fire in Coyote Gulch did not burn the restoration project. The burn was contained about 100 yards upstream of the project. Park staff removed several hazard trees in both drainages, and several areas along Coyote Crossing gulch will require careful monitoring for vegetation and erosion control.

Damage to park infrastructure was minor and included: damage to the bridge on Cattail Trail; damage to several park signs; damage to one park bench; and damage to several fences. Park staff are concerned about trail user's shortcutting and following fire vehicle tracks and have posted multiple closure areas and recruited park volunteers to assist with public education. The fire damage within BCLP can be seen in the aerial.

A water quality sample was taken at the Coyote Crossing and Coyote Gulch monitoring sites on February 11th. There was evidence of new melt runoff from the wildfire at the sites, but samples did not appear to have a significant water quality impairment (based on sediment observations). There was some ash in the water samples. It was apparent that the wildfire could alter upstream water quality in the spring runoff period, which could affect sediment loading, nutrient loading, water temperatures, dissolved oxygen, specific conductance, and pH. Additional water quality monitoring and flow measurements were done in 2021-2023 to determine the magnitude of water quality degradation and loadings caused by the fire (Table 21 and Figure 32).

The monitoring program was shifted to monthly sampling to better track burn water quality impacts. The 2022 runoff greatly increased nutrient loading throughout the year reaching Bear Creek Reservoir. The February nutrient loads for Total Nitrogen and Total Phosphorus were significantly increased from historical conditions (Figures 33 and 34). The nutrient loading increased about 1000% over the previous post construction baseloads (Table 22). There was also an increased sediment loading, and subsequent erosion in the upper Coyote Gulch and along Coyote Crossing.

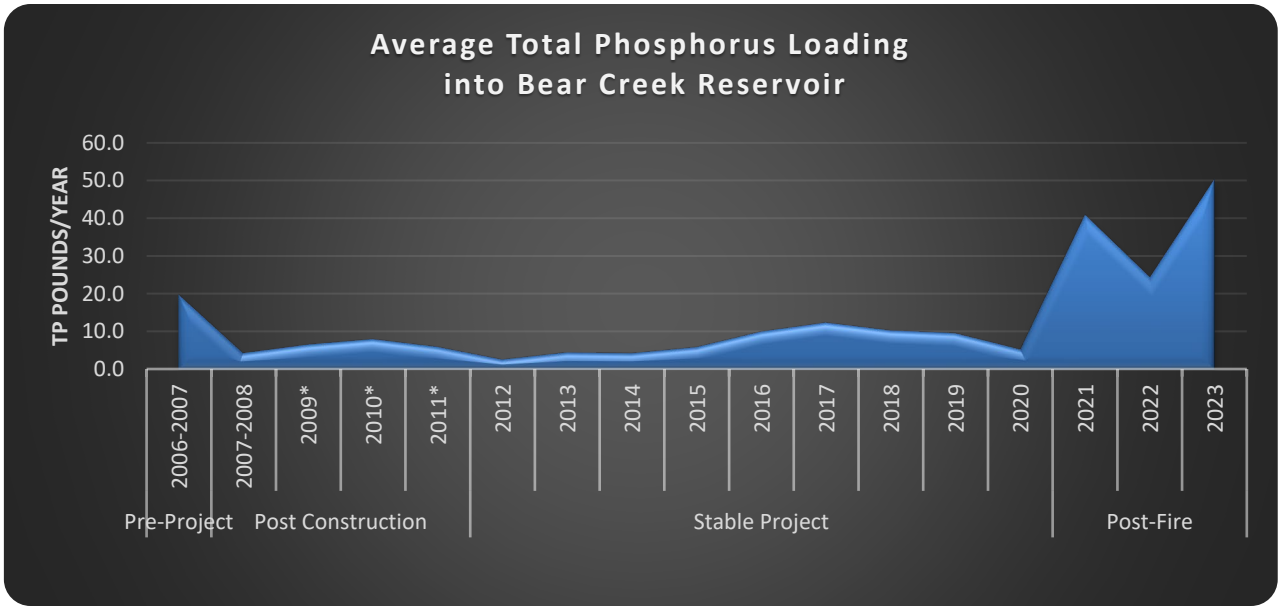


Figure 32 **Total Phosphorus Reduction at Coyote Gulch Project**

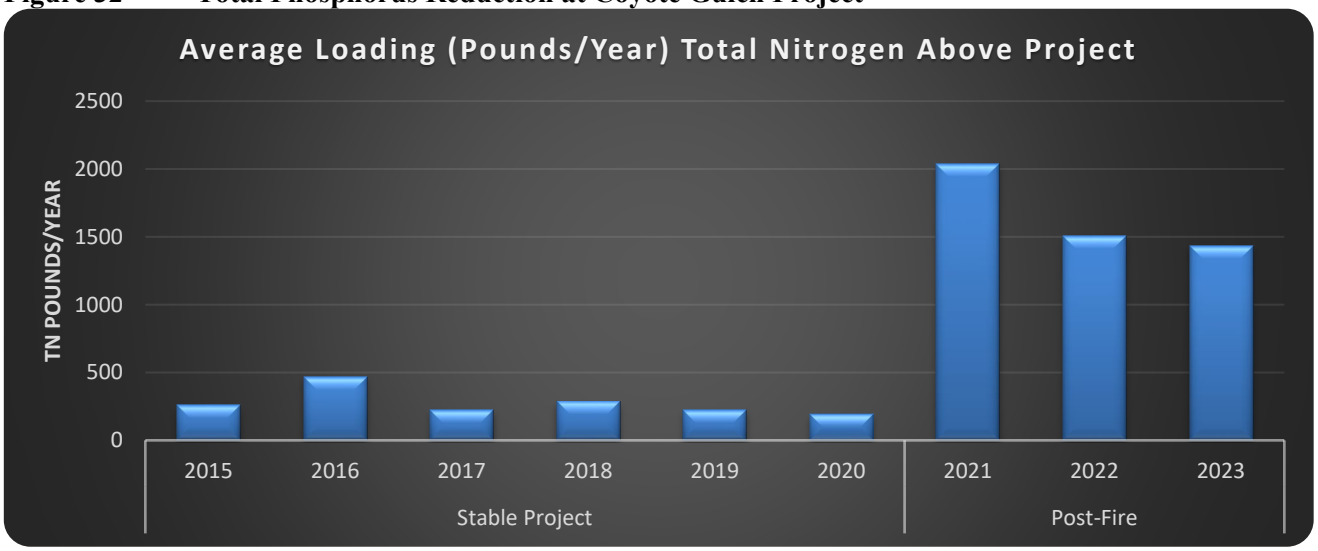


Figure 33 **Total Nitrogen Increases Caused by Wildfire Event**

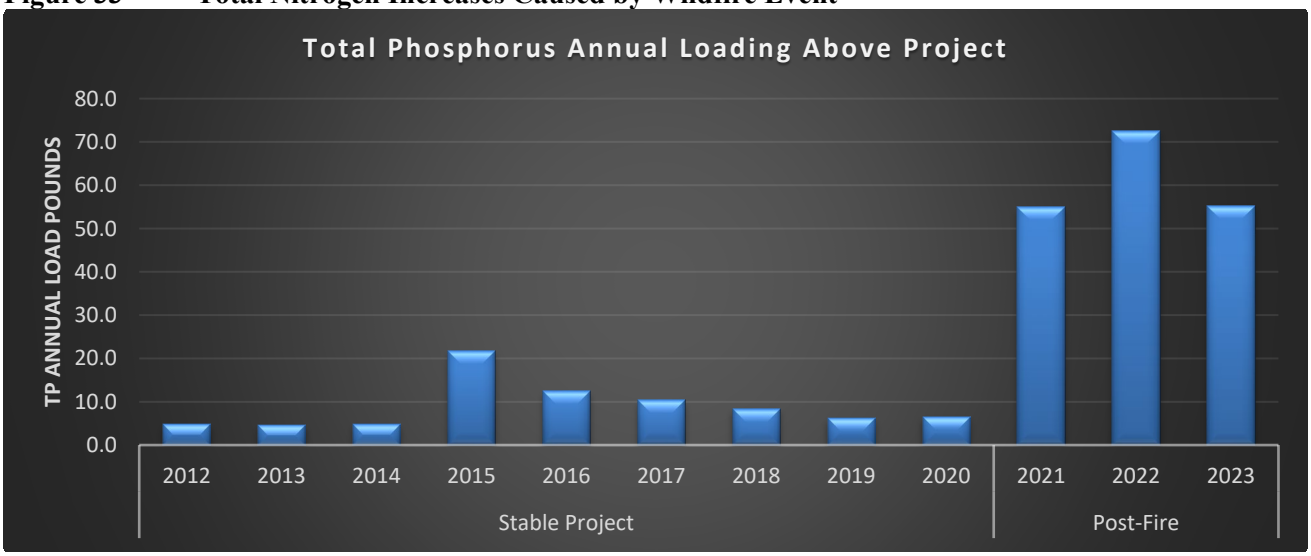


Figure 34 **Total Phosphorus Increase Caused by Wildfire Event**

Table 22 Nutrient Loading from Wildfire Event

	2023 Annual Pounds		
	Flow Estimate ac-yr	Total Nitrogen	Total Phosphorus
Upper Coyote	776.0	3823.6	137.3
Lower Coyote	599.3	2838.0	98.6
		Total Nitrogen	Total Phosphorus
	Pre-Fire Average Annual Loading 2015-2020		
Upper Coyote		315.0	11.0
Lower Coyote		277.0	9.0
	After Fire Average Annual Loading 2021-2023		
Upper Coyote		1075.0	63.8
Lower Coyote		1773.0	32.8
	Percent Load Increase		
Upper Coyote		1214%	1248%
Lower Coyote		1025%	1096%

Coyote Crossing and Rooney Gulch

Coyote Crossing discharges directly into Bear Creek Reservoir at the boat launch parking lot. Historically, this was an intermittent drainage that received flows from Green Mountain. In the last 3-5 years, this discharge tended to flow year-round with very low winter flows. The new development on Green Mountain has resulted in increased flows. The new monitoring site 97a is located at the road crossing bridge near the parking lot. The site is monitored for background Total Nitrogen and Total Phosphorus. It appears some of the flow comes from a leak in the Ward Ditch near Morrison Road. This drainage has produced amphibian and bird kills in Bear Creek Reservoir in the past. The increased development on Green Mountain is likely to make this a year-to-year loading source to the reservoir. There are some opportunities for mitigation above the maximum pool level within the park.

The BCWA has identified a nutrient load problem on Coyote Crossing. In 2023, this tributary contributed over 200 pounds of total phosphorus and 1,110 pounds of total nitrogen. This tributary discharges directly into Bear Creek Reservoir alongside the boat launch/fishing parking lot. This tributary was historically an intermittent flow system from Green Mountain. In the last 4-7 years, this drainage system has increased flows with flow year-round flow, although the winter flows are very low. The new and continued development on Green Mountain has resulted in increased base flows and much larger stormwater flows. In the 2023 demonstration period the EutroSORB reactive filter media removed on average 33% of the total nitrogen load, and 30% of the total phosphorus load. The project permanently removed over 100 pounds of total phosphorus.

The BCWA has identified a nutrient load problem on Rooney Gulch. In 2023, there were 57 pounds of Total Phosphorus and 1778 pounds of Total Nitrogen discharged into Bear Creek from this tributary. This tributary discharge is carried through a culvert under Morrison Road and discharges into Bear Creek near the park entrance. Historically, this was an intermittent drainage receiving flow from the large Rooney Valley area (2,740 acres). In the last 2-4 years, this discharge has flowed more frequently, and during 2023 there is flow most of the year, even in this average flow year. There is a substantial new development and land clearing operation just north of Morrison Road in Rooney Valley. In 2023 demonstration period the EutroSORB reactive filter media removed on average 36% of the total nitrogen load, and 40% of the total phosphorus load. The project permanently removed over 200 pounds of total phosphorus.

The monitoring site 98a is in the park below the culvert (difficult access). The specific conductance remains exceptionally high at this site (2023 average 4,500 uS). It is highly likely that this site will receive year-round flow in the coming years and will be a significant nutrient loading point to Bear Creek Reservoir. The sites are monitored monthly for background Total Nitrogen and Total Phosphorus (Figure 35 and 36).

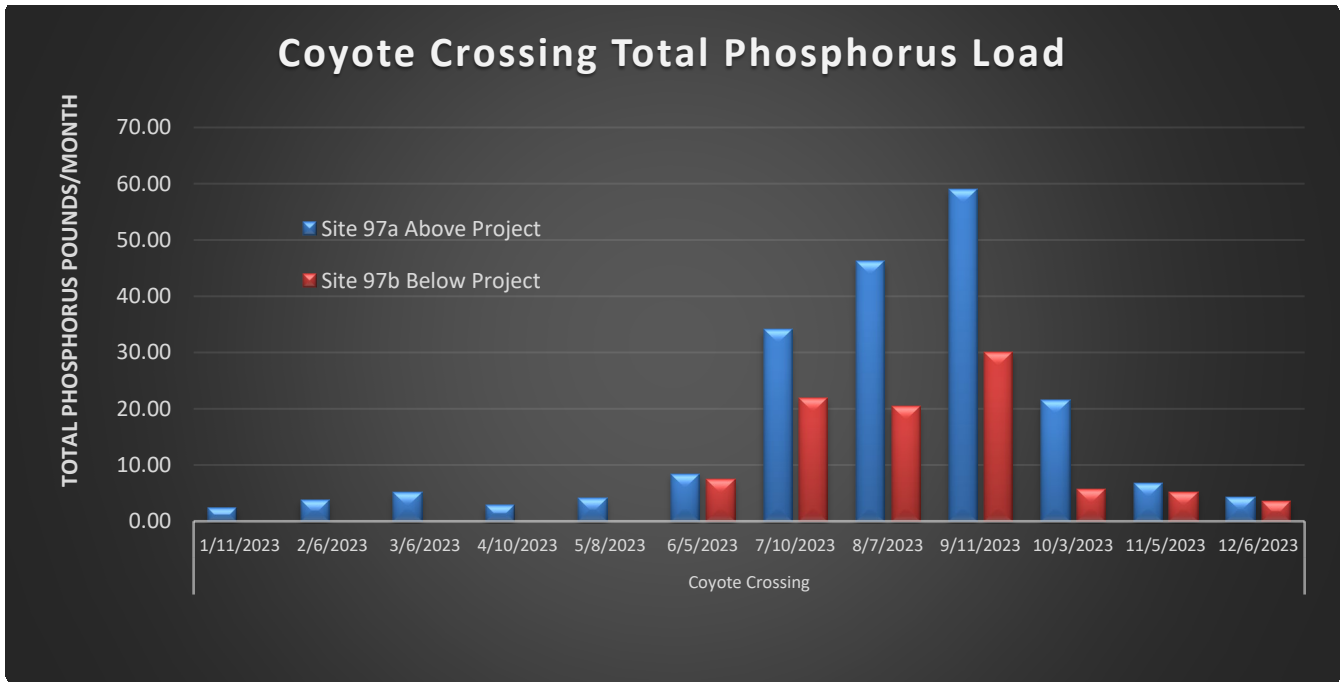


Figure 35 Total Phosphorus Loading in Coyote Crossing

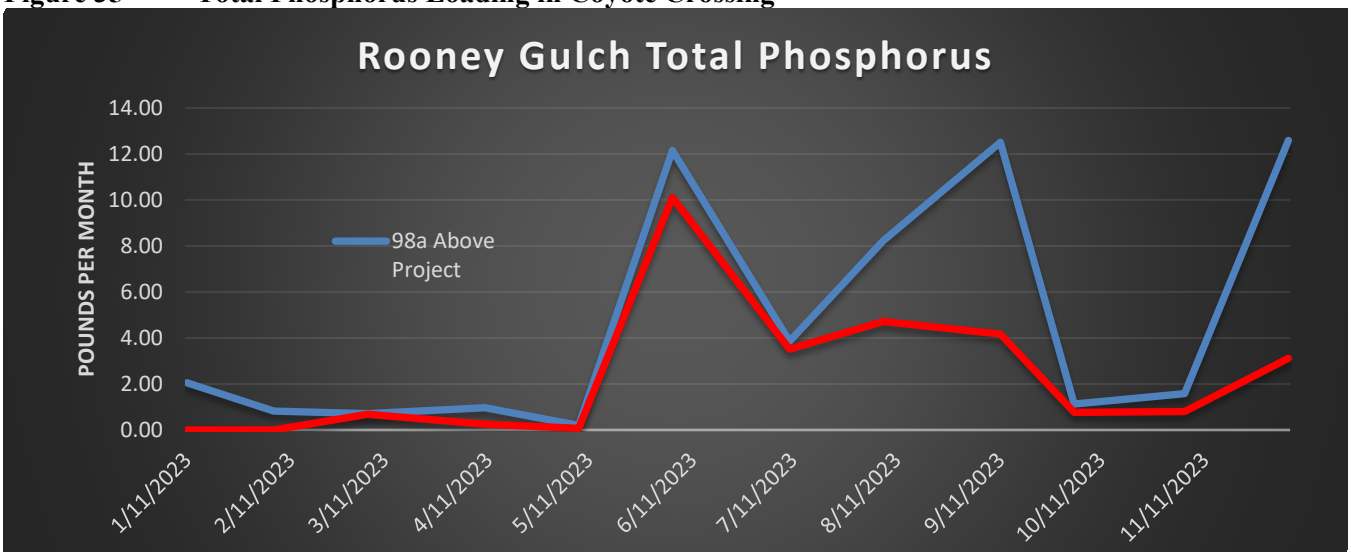


Figure 36 Total Phosphorus Loading in Rooney Gulch

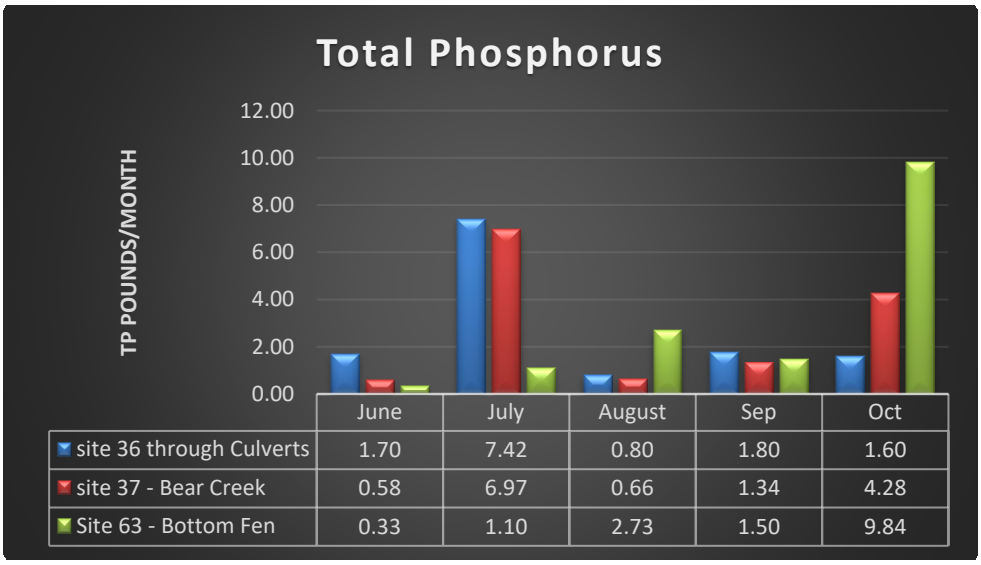
Big Soda Lake Bear Creek Park

Big Soda Lake has experienced increased harmful algal blooms in recent years that have resulted in the closure of the swim beach and limited or restricted other water activities. A significant cyanobacteria bloom occurred in July and August 2022 with positive test results for toxins (Microcystin-LR). On August 15-16th a peroxide algaecide treatment was done to reduce the biovolume of bluegreens. Additionally, an application was done to strip water column phosphorus (EutroSORB WC). The phosphorus within the water column was reduced by 89.8% within the first 3-days after treatment and remained reduced after 5-months (98.2%). The dual treatment allowed Big Soda to reopen within days of treatment. Even after treatment, there was still substantial total phosphorus in the lower water column and within the bottom sediments. Sediments samples were collected and analyzed for labile, reductant-soluble, and organic phosphorus fractions. There are over 1,300 pounds of phosphorus within the surface sediments in the deeper portion of the lake. There is a substantial internal total phosphorus problem in Big Soda Lake. Ongoing treatment will be needed to prevent future bluegreen blooms in summer months. The BCWA, BCWF and Lakewood have devised a 5-year nutrient reduction and management program for Big Soda Lake. Big Soda Lake was made a primary sample site with the park for nutrient sampling.

Big Soda Lake has experienced increased harmful algal blooms in recent years that have resulted in the closure of the swim beach and limited or restricted other water activities. In 2023, an application was done to strip water column phosphorus (EutroSORB WC). The phosphorus within the water column was reduced by 89.8% within the first 3-days after treatment and remained reduced after 5-months (98.2%). Follow-up treatment will extend through 2026. Since treatment, there have been no major harmful algal blooms.

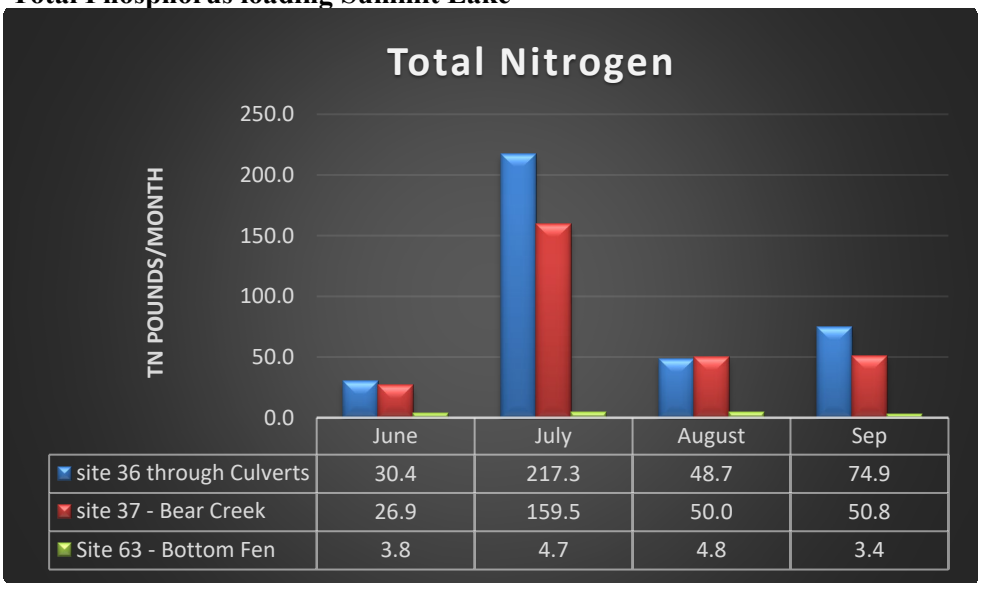
Summit Lake

Bear Creek Watershed Association continued to monitor three sampling stations at Summit Lake and upper Bear Creek, Mt Evans Wilderness, and Clear Creek County Colorado. The Association historic sampling Site 36 (Summit Lake at outfall) and Upper Bear Creek Site 37 monitor "background" conditions. An elevated nutrient source is monitored at station 63, which is at the bottom of the fen complex, which carries surface and shallow groundwater from the Summit parking lot area, prior to discharge into upper Bear Creek. Monitoring data at station 63 shows atypical water quality results for an alpine ecoregion. Based on water quality data over multiple years and best professional judgement, the station data demonstrates there is a human-caused source(s) causing elevated nutrient (nitrogen and phosphorus) loads (Figures 37 and 38). The site also frequently has low pH conditions and reduced dissolved oxygen, which could be a result of the surface/ groundwater conditions of the Fen complex. The Association will continue monitoring these three sites for the foreseeable future.



	June	July	August	Sep	Oct
site 36 through Culverts	1.70	7.42	0.80	1.80	1.60
site 37 - Bear Creek	0.58	6.97	0.66	1.34	4.28
Site 63 - Bottom Fen	0.33	1.10	2.73	1.50	9.84

Figure 37 Total Phosphorus loading Summit Lake



	June	July	August	Sep
site 36 through Culverts	30.4	217.3	48.7	74.9
site 37 - Bear Creek	26.9	159.5	50.0	50.8
Site 63 - Bottom Fen	3.8	4.7	4.8	3.4

Figure 38 Total Nitrogen Loading Summit Lake

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 and the 2023 water quality data suggests this helped resolve part of the nutrient loading. The Association provides the City and County of Denver, Colorado Department of Parks 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.

Although the Fen monitoring site 63 continues to produce an elevated phosphorus loading, this load is not reflected in the concentrations and load measured downstream at site 37 in the Bear Creek mainstem. This indicates that algal productivity is consuming much of the nutrient load prior to this monitoring site. Most of the recent algal growth appears to be several species of green algae. There does continue to be a potential problematic bluegreen algae that may be associated with the ongoing observed fish kills. Almost much of this algal mat material within the stream channel will die over the winter and flush downstream in the spring runoff. As such, a portion of the nutrient load gets flushed downstream as organic matter.

Fen Complex Study Summit Lake

A type of tributary wetland in the watershed is called a fen. In the Mt. Evans portion of the watershed, these wetland fens are an important and unique wetland type. They are ancient ecosystems 8,000 to 12,000 years old. They "provide important headwater quality functions," including carbon storage, water storage, wildlife habitat, and biodiversity. Fens are peat-forming wetlands that receive nutrients from sources other than precipitation: usually from upslope sources through drainage from surrounding mineral soils and from groundwater movement (*BCWA Fact Sheet 49 Wetlands, Fens and WQ BCW).*

In 2014, the Association conducted a special survey of three Fen ponds to establish background or expected conditions on "natural" Fen Ponds (*BCWA Fact Sheet 52 Mt Evans Fen WQ*). The Association selected three Fen Pond sizes to establish backgrounds: a small Fen (25 square feet, about 1-foot-deep), medium Fen (85 square feet, about 2 feet deep), and a larger Fen (125 square feet, about 4 feet deep). There were no indications of any anthropogenic influences on these Fen ponds. The Fen ponds were sampled on September 17, 2014, with an expectation that this would show the season low nutrient conditions. The results for total nitrogen and total phosphorus were much higher than suspected. The median total phosphorus for this limited special survey was 165 ug/l. The preliminary data shows the chemistry and nutrient dynamics in the Fen complex are more complicated than predicted. As such, the Association began a ten-year special study to establish the background or expected nutrient conditions for the Fen complex.

The Association summarized evidence in the Regulation #38 Rulemaking Hearing for South Platte Basin Standards that suggests fen wetlands have background phosphorus levels that exceed Table Value Standards (TVS) even though streams in the same segment do not have elevated phosphorus levels (*Fact Sheet 53 BCR 2015 Regulation 38 Update*). It is not yet known what background level would be appropriate or if it varies among these fens. The Colorado Water Quality Commission applauds the efforts of BCWA to obtain data that improves our understanding of existing conditions. Site-specific standards are needed for all, or part, of Segment 7 for which phosphorus standards are required, but there is uncertainty about the habitat type or the geographic scope of applicability for site-specific standards (or conversely for the TVS). Resolving the uncertainty will require additional sampling to obtain representative data. Delaying the effective date by five years gives BCWA time to collect additional data and propose site-specific phosphorus and total nitrogen standards as appropriate for the Fen complex. Total phosphorus standards were delayed until an effective date of 12/31/2020. In 2017, the Association established a control fen located on the south side of Bear Creek. This site has no visible human impact. All the fens on the north side of Bear Creek have varying degrees of anthropogenic degradation (*BCWA TM 2020.02 UBCW Summary*) (Figure 39).

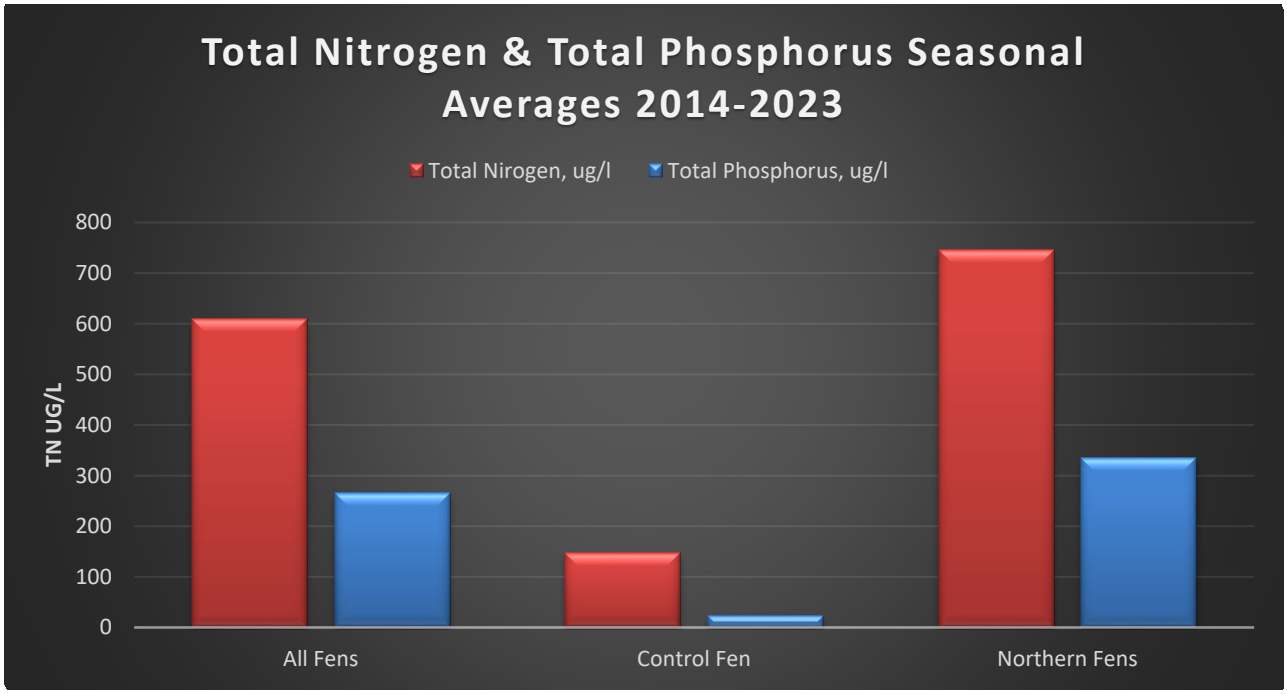
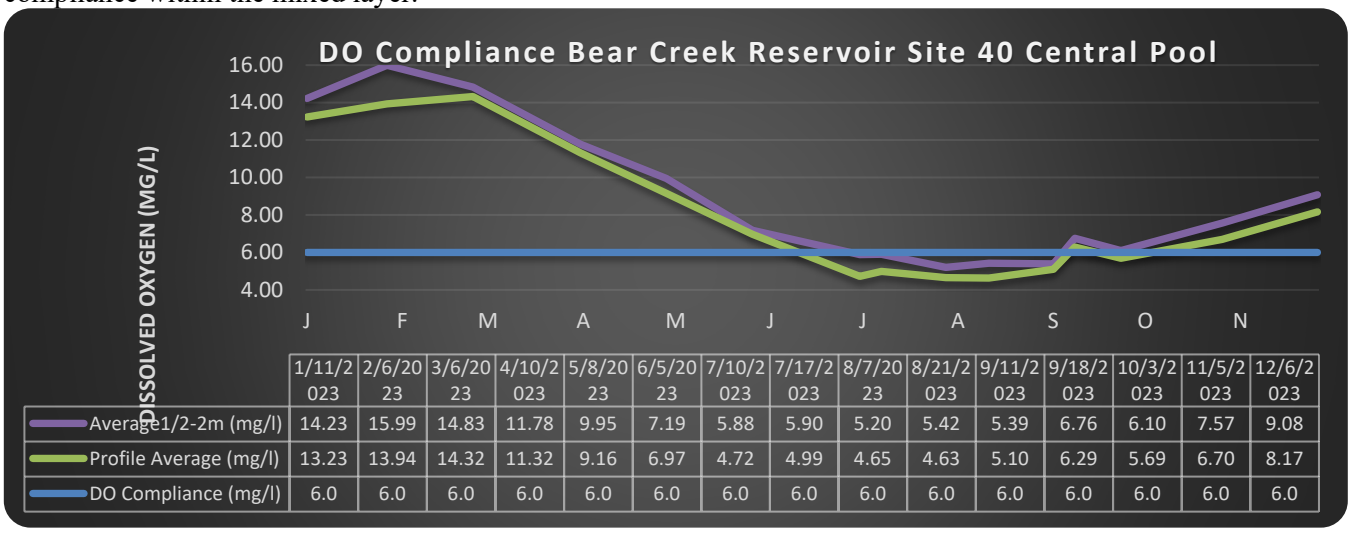


Figure 39 Total Phosphorus and Total Nitrogen Seasonal Averages in Fen Complex

IV. Meeting Water Quality Goals and Standards for the Watershed

Dissolved Oxygen Compliance in Bear Creek Reservoir

The Association takes multiple profile readings at three profile stations in the reservoir to determine dissolved oxygen compliance. The Association dissolved oxygen data set from 2003-2023 for Bear Creek Reservoir shows over 99% compliance with the standard for the upper water column (surface through the mixed layer). The monthly dissolved oxygen values in the mixed layer in 2023 were generally below 6 mg/l (Figure 40) during the growing season. There was an oxygen sag beginning in late June and extended through October, which correlated with a phytoplankton blooms. Data collected in the 2023 growing season shows the aeration system adds a maximum of 1.5 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.



	1/11/2023	2/6/2023	3/6/2023	4/10/2023	5/8/2023	6/5/2023	7/10/2023	7/17/2023	8/7/2023	8/21/2023	9/11/2023	9/18/2023	10/3/2023	11/5/2023	12/6/2023
Average1/2-2m (mg/l)	14.23	15.99	14.83	11.78	9.95	7.19	5.88	5.90	5.20	5.42	5.39	6.76	6.10	7.57	9.08
Profile Average (mg/l)	13.23	13.94	14.32	11.32	9.16	6.97	4.72	4.99	4.65	4.63	5.10	6.29	5.69	6.70	8.17
DO Compliance (mg/l)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0

Figure 40 DO Compliance Bear Creek Reservoir

Temperature Standards Bear Creek Watershed

Table 23 shows the adopted temperature standards by segment for the watershed. The Association deploys up to twenty-five temperature data loggers at various sites within the watershed. The data loggers collect temperature data in a 30-minute interval. The loggers used in the program are Onset Computer Corporation brand, Temp Pro

v2 (U22) programmable dataloggers. Every other year all model dataloggers are returned to Onset for a NIST (National Institute of Standards and Technology) one-point certification and a tune-up. Downloaded temperature data is maintained in a spreadsheet format. The data is evaluated against the underlying standards including Weekly Average Temperature (WAT) criteria, Daily Maximum Temperature (DM) criteria and for Bear Creek Reservoir Maximum Weekly Average Temperature (MWAT) criteria.

Bear Creek Watershed Site-Specific Temperature Standards and Longevity Plan

There are three site-specific temperature standards adopted for the watershed: Bear Creek Reservoir, the mainstem of Bear Creek from the outlet of Evergreen Lake to the Harriman Ditch in Morrison and from the Harriman Ditch to the inlet of Bear Creek Reservoir Table 23 (highlighted in red). The Association continues to collect temperature data on these segments to support retaining these site-specific standards. Data loggers are annually deployed to collect temperatures on a 30-minute interval for both the warm and cold seasons. Annually, the Association collects about 280,000 individual temperature data points at up to twenty-five data logger sites within the watershed (about 6 million temperature data points over the period of record). This temperature data logging is intended to meet the site-specific standard longevity plan assessment requirements in Regulation 31 (1.7(1)(b)(ii) and (iii) and 31.7(1)(c)). The Association longevity plan provides for ongoing collection of evidence like that used to support the development and adoption of the site-specific temperature standards (Rulemaking Hearing Regulation 38, June 2009). The ongoing data collection supports retaining the adopted site-specific temperature standards.

The cold- and warm-season period is defined in Regulation 38, which assigned calendar dates by segment for cold-season and warm season regarding water quality standards for temperature. The cold season is defined as November to March, depending on specific stream segments (which are outlined in Appendix C of Reg. 74). Cold-season locations include sites in all segments excluding segment 1d situated in Evergreen Lake, Segment 1a (Sites 58, 2a and 3a), Segment 1b (Site 15a), Segment 1e (5,8a, 9,12, 13a, and14a), Segment 3 (Site 25), Segment 5 (Site 26), Segment 6a (Site 18 and 16a), and Segment 16b (Site 19). Many of these sites only record data during the shoulder season the month before the warm season begins and post warm season. The warm-season program locations included twenty-five sites in Bear Creek Segments 1a, 1b, 1c, 1d, 1e, 2, 3, 5, (including four totals at the Evergreen Lake profile station, and the Bear Creek Reservoir profile station), and three sites in Turkey Creek Segments 6a and 6b.

Table 23 Temperature Standards in Bear Creek Watershed

Segment	Description	Standard	Month	STANDARD (°C)		Month	STANDARD (°C)	
				(MWAT)	(DM)		(MWAT)	(DM)
1a	Mainstem Bear Creek from Mt. Evans Wilderness to Evergreen Lake	T=TVS(CS-I) °C	June-Sept	17.0	21.2	Oct-May	9.0	13.0
1b	Mainstem Bear Creek from Harriman Ditch to Bear Creek Reservoir	T=TVS(CS-II) °C, April-Oct; T(WAT)=19.3 °C	April-Oct	19.3	23.8	Nov-March	9.0	13.0
1c	Bear Creek Reservoir	T=TVS(CLL) °C; April-Dec; T(WAT)=23.3°C	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
1e	Mainstem Bear Creek from Evergreen Lake to Harriman Ditch	T=TVS(CS-II) °C; April-Oct; T(WAT)=19.3 °C	April-Oct	19.3	23.8	Nov-March	9.0	13.0
2	Mainstem Bear Creek from Bear Creek Reservoir to 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 from source to outlet of Evergreen Lake	T=TVS(CS-I) °C	June-Sept	17.0	21.2	Oct-May	9.0	13.0
4a	All tributaries to Bear Creek from the outlet of Evergreen Lake to South Platte River	T=TVS(WS-I) °C	March-Nov	24.2	29.0	Dec-Feb	12.1	14.5
5	Swede, Kerr, Sawmill, Troublesome, and Cold Springs Gulches, and mainstem of Cub Creek	T=TVS(CS-II) °C	April-Oct	18.2	23.8	Nov-March	9.0	13.0
6a	Turkey Creek system from source to Bear Creek Reservoir	T=TVS(CS-II) °C	April-Oct	18.2	23.8	Nov-March	9.0	13.0
6b	Mainstem of North Turkey Creek	T=TVS(CS-I) °C	June-Sept	17.0	21.2	Oct-May	9.0	13.0
7	Mainstem and all tributaries 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 Mt. Evans Wilderness area	T=TVS(CL) °C	April-Dec	17.0	21.2	Jan-Mar	9.0	13.0
9	Lakes and reservoirs from Mt. Evans Wilderness area to Evergreen Lake	T=TVS(CL) °C	April-Dec	17.0	21.2	Jan-Mar	9.0	13.0

Segment	Description	Standard	Month	STANDARD (°C)		Month	STANDARD (°C)	
				(MWAT)	(DM)		(MWAT)	(DM)
10	Lakes and reservoirs in drainages of Swede Gulch, Sawmill Gulch, Troublesome Gulch, and Cold Springs Gulch	T=TVS(CL) °C	April-Dec	17.0	21.2	Jan-Mar	9.0	13.0
11	Lakes and reservoirs from the outlet of Evergreen Lake to South Platte River	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	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 three profile stations in the reservoir and has a temperature data-logger set at site 40 to determine temperature compliance. Figure 31 shows temperature standards and the monthly sampling compliance record for Bear Creek Reservoir. The temperature probe string at site 40 measures temperature in the top 2m of the water column (-1/2m, -1m, -1.5m, and 2m). The reservoir had no daily maximum (DM) or weekly average (MWAT) temperature exceedances in 2023 during the warm season. Figure 41 shows the daily maximum temperatures in the reservoir.

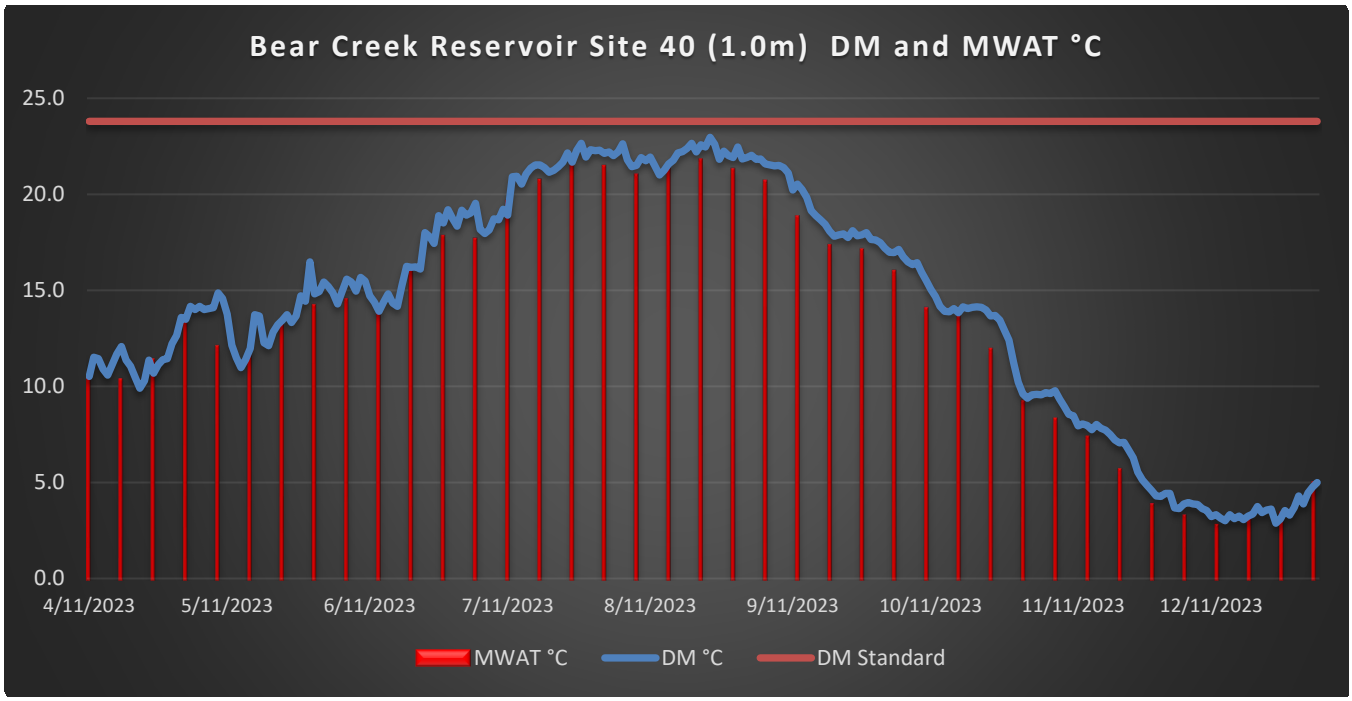


Figure 41 Temperature Compliance Bear Creek Reservoir

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.

About 120,000 individual temperature data points were obtained from eighteen data logger sites within the watershed. The warm-season temperature compliance summary is shown in Table 24. A number of temperature compliance problems occurred during the warm season. Some of the daily maximum exceedances were a result of people tampering with the temperature probes and periodically removing them from flow, and exposure of the probes during exceptionally low flow conditions.

Table 24 Watershed Temperature Compliance Summary Warm Season

Segment	Months	Warm Season	
Segment 7 Summit	**June-Sep**	**17°C WAT**	**21.2°C DM**
# Exceedances		0	0
Segment 3 Upper Trib	**June-Sep**	**17°C WAT**	**21.2°C DM**
# Exceedances		0	9

Segment	Months	Warm Season	
Segment 1a Upper BC	**Apr-Sept**	**17°C WAT**	**21.2°C DM**
# Exceedances		0	0
Segment 1d EGL	**Apr-Dec**	**18.2°C WAT**	**23.8°C DM**
# Exceedances		0	0
Segment 1e Middle BC	**Apr-Oct**	**19.3°C WAT**	**23.8°C DM**
# Exceedances		0	1
Segment 1b BCP	**Apr-Oct**	**19.3°C WAT**	**23.8°C DM**
# Exceedances		2	14
Segment 5 Upper Trib	**Mar-Nov**	**18.2°C WAT**	**23.8°C DM**
# Exceedances		x	x
Segment 6a S Turkey	**Apr-Oct**	**18.2°C WAT**	**23.8°C DM**
# Exceedances		0	0
Segment 6b N Turkey	**Apr-Oct**	**17°C WAT**	**21.2°C DM**
# Exceedances		3	23
Segment 2 Lower BC	**Mar-Nov**	**27.5°C WAT**	**28.6°C DM**
# Exceedances		0	0
Segment 1c BCR	**Apr-Oct**	**23.3°C WAT**	**23.8°C DM**
# Exceedances		0	0
Total Exceedances DM			**47**
Total Exceedances MWAT		5	

Stream and lake sampling and monitoring data, including pH, temperature, dissolved oxygen, specific conductance, total nitrogen and total phosphorous was collected from May through November. Manual flows measured at 18 sites during the May to December timeframe. An aeration system was installed and operational for Evergreen Lake. There were several exceedances of proposed nutrient standards in 2023.

303(d) Listing

Table 25 shows the stream segments in the Bear Creek Watershed that are on the Colorado 303(d) list. In January 2017, the Colorado Water Quality Control Commission adopted a revised 303(d) list of priority pollutants causing impairment or those needing further monitoring and evaluation (Effective date March 2018).

Table 25 303(d) List Bear Creek Watershed

WBID	Segment Description	Portion	Colorado's M & E List	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.	Bear Creek below the confluence of Yankee Creek		Temperature	H
COSPBE01b	Mainstem of Bear Creek from Harriman Ditch to the inlet of Bear Creek Reservoir	all		Temperature	M
COSPBE01c	Bear Creek Reservoir	all		Chl-a, phosphorus	H
COSPBE01e	Mainstem of Bear Creek from the outlet of Evergreen Lake to the Harriman Ditch.	Kerr/Swede to Mt Vernon Creek		Temperature	H
COSPBE01e	Mainstem of Bear Creek from the outlet of Evergreen Lake to the Harriman Ditch.	Mount Vernon Creek to the Harriman Ditch		Cu, Temperature	H
COSPBE02	Bear Creek below Bear Creek Reservoir to South Platte River	Below Wadsworth Boulevard		*E. coli (May-Oct)*	H
COSPBE02	Bear Creek below Bear Creek Reservoir to South Platte River	Kipling to South Platte		Aquatic Life (provisional), As	L/L
COSPBE03	All tributaries to Bear Creek, from the source to the outlet of Evergreen Lake	Vance Creek		Temperature	H
COSPBE06a	Turkey Creek system, including all tributaries from the source to the inlet of Bear Creek Reservoir	Turkey Creek below Parmalee Gulch	Temperature		
COSPBE06b	Mainstem of North Turkey Creek, from the source to the confluence with Turkey Creek	all	Temperature		
COSPBE11	Lakes and reservoirs in the Bear Creek system from the outlet of Evergreen Lake to the confluence with the South Platte River	Harriman Reservoir	As		

Barr/Milton Model Input and Bear Creek Load Predictions

The Bear Creek Watershed is in the defined "datashed" 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 established the limiting 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 2023, the average Total

Phosphorus at BCWA site 45 was 2,540 pounds/year. The Association annually provides the Barr/Milton Watershed Board with a technical memorandum detailing water quality data at site 45.

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 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 spatial and temporal variation at each site. Table 33 summarizes existing macroinvertebrate data. There was no macroinvertebrate sampling done in 2020 due to exceptionally low water conditions and Covid 19 restrictions.

The 2022 sampling sites replicated the 2019 sampling sites (Table 26), except sampling site 8b at Bear Creek Cabins was dropped as a site due to stream access concerns at this site. The 9 selected sites were monitored on August 18, 2022. There were stream bed alterations at most sample sites. There were no duplicates taken in 2023.

A contract laboratory analyzed samples collected by the BCWA for benthic macroinvertebrates. Samples collected by the Association follow the *BCWA M04 Macroinvertebrate Field Sample Method*. Data for samples are reported as the number of organisms per square meter. Percent of total is also reported. The species are counted consistent with the Colorado Water Quality Control Division EDAS import columns for taxa and species. This data is then converted into Multimetric Index (CO MMI) scores. MMI scores were calculated using the CDPHE EDAS Access database. All collected species are confirmed against the EDAS database.

The Colorado Multimetric Index (CO MMI) scores were calculated using the Colorado Department of Public Health and Environment's (CDPHE) policy approved in August 2017 (Policy 10-402017). When calculating CO MMI, CDPHE requires samples with greater than 360 individuals in the subsample be randomly resampled using Colorado's Ecological Data Application System (EDAS) to bring the organism subsample count to a range of 240 – 360 organisms. Eight sites (15a-BCP, 14a-Morrison, 13a-Idledale, 12-Lair O'Bear, 9-O'Fallon, 3a-Keys, 2a-Golden Willow, and 90-Wadsworth), had more than 360 individuals in the original subsample and were statistically resampled. In some of the EDAS resampling data sets taxa were excluded, decreasing the total taxa richness of the sample. All samples were checked for large and rare taxa. The large and rare taxa are included in the subsample count and used in the calculation of the CO MMI.

Two sites (BCWA site 9 at O'Fallon and BCWA Site 90a Lower Bear Creek) had low MMI scores that are below the attainment threshold and constitute potential impairment (Table 26).

The long-term suspected impairment at site 5 is potentially caused by parking lot sealing operations that were done just prior to the August sampling. The sealant used on the parking lot contained coal tar, which is known to degrade water quality and impair macroinvertebrates (BCWA *PGO20 Coal Tar Concerns and Alternatives*). Coal-tar-based sealant is a thick black liquid that is applied to many parking lots, driveways, and road surfaces in the Bear Creek Watershed, including the Evergreen parking lot across from Little Bear. The sealant is used to protect against cracking, natural deterioration, and water & snow-melt damage. A significant component of coal tar is polycyclic aromatic hydrocarbons, or PAHs. Some PAHs are highly toxic chemicals. They have known harmful impacts on humans and animals (terrestrial and aquatic). BCWA Site 5 was extensively altered by flooding and stream bed scouring, which has produced a poor habitat.

BCWA Site 90 at Wadsworth also has poor habitat and not a good fast riffle environment. Site 9 at O'Fallon was extensively scoured during runoff events and left a poor fast riffle environment.

Table 26 MMI Attainment and Impairment Summary for Bear Creek Watershed

WQCD Station ID	BCWA Station ID	Location	Biotype	MMI													
				2009	2010	2011	2012	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
5756a	15a	BCLP @ bridge	Transition					66.4	59.1	67.0	56.4	51.0	30.2	na	53.8	57.3	65.0
122	14a	Morrison @ Gage	Transition	69.8	80.5	74.5	72.9	48.8	73.5	72.0	63.9	66.0	55.6	na	60.0	77.9	69.1
122C	13a	Idledale	Transition	62.1	69.8	57.1	68.0	59.3	59.2	50.0	62.2	65.0	51.3	na	56.1	67.0	69.9
122a	12	Lair O' Bear	Transition	58.5	62.2	56.4	51.3	49.5	72.2	46.0	62.9	52.0	54.7	na	63.1	na	na
122b	9	O' Fallon	Transition	53.6	57.7	45.5	49.9	44.8	59.1	57.0	60.1	56.0	44.2	na	50.8	70	48.6
5762	8b	BCC @ Bridge	Transition	55.6	39.1	51.1	44.3	49.6	62.3	59.0	57.4	50.0	48.4	na	na	na	na
5763	5	Little Bear	Transition	52.3	56.6	42.9	40.0	56.2	68.9	75.0	38.4	29.0	37.6	na	47.9	46.0	52.6
5764	3a	Keys @ bridge	Mountain	38.6	36.9	45.3	46.9	43.9	63.6	37.0	57.9	51.0	41.4	na	47.6	64.4	53.8
5768d	2a	Golden Willow	Mountain				71.9	60.8	56.6	65.0	58.1	64.0	51.8	na	66.3	66.3	61.8
5768c	58	Mt Evans Wilderness	Mountain			55.5	72.5	67.0	53.8	67.0	75.6	68.0	72.2	na	75.0	68.5	79.9
BCWA90	90	Wadsworth	Transition							55.0	39.9	60.0	49	na	47.5	45.5	42.6

V. 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 34 lists the permitted wastewater treatment facilities. Each discharger 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. No facility exceeded the assigned wasteload allocations (Table 27).

Table 27 Treatment Facility Wasteload Allocations

Bear Creek Watershed Wastewater Treatment Plants by Drainage Basin	WQCC Adopted Phosphorus WLA Pounds/ year	2023 Discharged Phosphorus Pounds/year	% Allocation Used by WWTF
Bear Creek Drainage			
Jefferson County Schools – Mt. Evans Outdoor Lab	**20**	1.07	5%
Brook Forest Inn[1]	**5**	0	0%
Evergreen Metropolitan District	**1,500**	504.72	34%
West Jefferson County Metro District	**1,500**	357.13	24%
Kittredge Sanitation and Water District	**240**	39.06	16%
Genesee Water and Sanitation District	**1,015**	384.5	38%
Forest Hills Metropolitan District	**80**	29.138	36%
Town of Morrison	**600**	72.7	12%
Bear Creek Total	**4,960**	**1,388.32**	**28%**
Turkey Creek Drainage			
Conifer Metropolitan District	**40**	2.5	6%
Conifer Sanitation Association	**40**	1.2	3%
Aspen Park Metropolitan District	**40**	5.732	14%
Jefferson County Schools - Conifer High School	**110**	0.80	1%
Geneva Glen[2]	**5**	1	20%
Bear Creek Development Corp. - Tiny Town[3]	**5**	0	0%
Turkey Creek Total	**240**	**11.23**	**5%**
Total Operational Facilities Lbs./year	***5,200***	***1,399.55***	27%
Reserve Pool[4]	**55**	0	0%
Total Phosphorus Wasteload lbs./year	**5,255**		

1-Brook Forest Inn - Under Compliance Advisory, Still permitted with no reported flow

2-Geneva Glen was open in 2023

3-Columbia Sanitary Services hauled 2,500 gallons to South Platte Renewal Partners

4- The reserve pool in the Control Regulation is 2 pounds of total phosphorus, the 55 pounds listed by the BCWA includes pounds from closed treatment facilities (Singing River Ranch (30), The Fort Restaurant (18), Bear Creek Cabins (5))

Permit Compliance and Plant Expansions/Actions

Table 28 shows permitted and closed wastewater treatment facilities (still listed in control regulation) in the watershed, estimated 5-year 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 does continuous planning and review efforts for all facilities and produced a series of summary information sheets specific for dischargers.

Table 28 Wastewater Treatment Plant Planning Status

Facility	Wastewater Utility Plan	Electronic Planning Documents	Recent Upgrades (3 yrs.)	Facility Upgrades [2018-2022]	Existing Compliance Concerns[1]	Informational Sheet
Evergreen Metropolitan District	Yes	WQCD Fact Sheet, WQA, Permit	Lift Station	Yes	TIN	IFS01
West Jefferson County	Yes	WQCD Fact Sheet, WQA, Permit	Lift Station	Yes	TIN	IFS03
Genesee	Yes	WQCD Fact Sheet, WQA, Permit	No	Yes	TIN	IFS04
Morrison	Yes	WQCD Fact Sheet, WQA, Permit	No	Yes	Mixing zone, Low Flows	IFS05
Kittredge	Yes	WQCD Fact Sheet, WQA, Permit	No	Yes	TIN	IFS02
Forest Hills Metropolitan District	Yes	Site Application Engineering Report, Permit (2009)	No	No	No	IFS06
Conifer Metropolitan District	Yes	WQCD Fact Sheet, WQA, Permit	Yes, Filter	Yes	TDS	IFS08
Conifer Sanitation Association	Yes	Lift Station Rpt	No	Yes	Lift Station Line Breaks	IFS08
Aspen Park Metro District	Yes	WQCD Fact Sheet, WQA, Permit	No	Yes	Gallery Operation	IFS07
JCS Conifer High School	Yes	Site Application, Lift Station	UV	No	No	IFS10
JCS Mt Evan Outdoor	Yes	Site Application, New Plant Rpt	New Plant	No	No	IFS11
Bear Creek Development Corp. - Tiny Town	No	Land Application Rpt	Hauling Columbia	Yes	Reporting, WLA	No
Bear Creek Cabins	No	Permit	New OWTS	Closed Permit	No	Closed
Brook Forest Inn	No	WQCD Rational, WQA, Permit, Review	No	Closed Facility	Compliance Order	IFS09
Geneva Glen	No	Permit, WQA, WQCD Fact Sheet	No	Yes, Not Determined	WLA/TP, Compliance Order	In Progress
The Fort	Yes	Site Application Closed	New OWTS	Closed Permit	No	Closed
Singing River Ranch	No	WQCD Fact Sheet, WQA, Permit	OWTS	Closed Permit	No	Closed

[1] - All treatment facilities are expecting new discharge limits (within 5-years) for total phosphorus and temperature. Several facilities are monitoring for temperature. Under Regulation 85 there are expected new nitrogen limits are expected to meet stream nitrogen standards.

Utility Supported Programs

Pharmaceutical Recycling Program

The Association financially supported a used medicine drop-off location in Evergreen (BCWA Fact Sheet 23). 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 on 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 on 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 2022) 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 29 lists all Association trades. The reserve pool held 55 pounds in 2022, due to the closure of three WWTFs. The trades in the watershed remain consistent with the total wasteload allocations listed in Table 29. The Association has developed three policies to support the trading program:

1. BCWA Policy 1 Trading Program - The BCWA supports nutrient (nitrogen and phosphorus) trading as a long-term and necessary water-quality management practice for the Bear Creek Watershed. The BCWA will maintain and periodically update Nutrient Trading Guidelines.

2. BCWA Policy 19 Nutrient Trade Eligibility - The BCWA defines eligible participants and sets minimum criteria for eligibility in a Bear Creek Association Trade Agreement.

3. BCWA Policy 26 Trade Administration – The BCWA establishes a trade administration program to help assist small wastewater dischargers in the watershed and sets a value to phosphorus trade credits.

Table 29 Phosphorus Trading Activity in Bear Creek Watershed

Involved Agencies	Type of Trade	Active Trading in 2023
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 2022
The Fort Restaurant	Reserve Pool to Point Source (Return to Reserve Pool)	Closure complete; 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

VI. 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 2023, Municipal Stormwater Permit No.: COS-000002*; City of Lakewood, April 1, 2024). The Stormwater Management Program for the City of Lakewood, Part I.B.1 of the City's permit, consists of six different programs: Commercial/Residential Management Program, Illicit Discharges Management Program, Industrial Facilities Program, Construction Sites Program, Municipal Facility Runoff Control Program, and the Wet Weather Monitoring Program.

Rooney Road Recycling Center (RRRC)

Lakewood supports many stormwater management programs in the watershed, including the *Rooney Road Recycling Center (RRRC)*, which also serves as watershed pollution prevention BMP. The RRRC mission is to provide affordable Household Hazardous Waste (HHW) collection, recycling and disposal services to residents and businesses in participating jurisdictions within Jefferson County. Member jurisdictions include Jefferson County (unincorporated areas) and the cities and towns of Arvada, Edgewater, Golden, Lakeside, Lakewood, Morrison, Mountain View, and Wheat Ridge. HHW includes household chemicals and other wastes such as paints, batteries, light bulbs, propane gas cylinders and electronics. RRRC continues safeguarding our environment by preventing more than 10,531,666 pounds of pollutants from contaminating surface and ground water resources since 1994. More information about Lakewood's RRRC collection efforts is contained in their CDPS Stormwater Permit Annual Report.

Floating Islands/Nutrient Reduction

Horseshoe Pond was found to be feasible for retrofit/maintenance due to excessive nutrient inputs generating blue green algae blooms and low dissolved oxygen readings during the growing season (April through October). Using staff and volunteers, floating islands were installed to provide biological uptake of phosphorus and nitrogen. As of this report, the islands appear to be functioning as designed. For the last two years, overall algae production has decreased with no closures of the waterbody for toxic blue green algae blooms. Retrofit

operations were completed and the project was fully installed in 2021 and monitored for effectiveness in 2022-2023. In 2023, the city continued the existing program to incorporate water quality elements into the design of all proposed flood management projects as required in Part I.B.1.a.4 of the permit. This project was linked to the BCWA pilot project for nutrient reduction.

Jefferson County MS4 Program

Jefferson County has a Municipal Separate Storm Sewer System (MS4) permit and 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 (Table 30). Jefferson County provides opportunities for residents and visitors in the watershed to learn and be involved in environmental stewardship and programs that promote water quality.

Jefferson County continues to participate with Rooney Road Recycling Facility and in 2023 the facility collected over 350,000 pounds of household hazardous waste. Household hazardous waste (including electronic waste, household chemicals, paints, propane cylinders and automotive products) materials have been collected at the Rooney Road Recycling facility since 1994 and total more than 8,000,000 pounds of materials. This facility provides residents a way to properly dispose of leftover materials, keeps materials out of onsite wastewater treatment systems and helps reduce illegal dumping in the watershed.

Jefferson County holds a Drug Take-Back Day twice a year which provides the public an opportunity to surrender expired or unwanted medications. The Drug Take-Back Days provides residents a way to properly dispose of leftover medications and keeps them out of onsite wastewater systems and wastewater treatment facilities.

In addition, Jefferson County hosted a public cleanup of the Clear Creek corridor on National Public Lands Day in 2023. There were 700 volunteers that removed 25,000 pounds of trash/debris along 22 miles of the corridor.

Jefferson County participated in both virtual and in-person public events to reach diverse audiences for their MS4 and floodplain management programs.

Jefferson County also maintains a land disturbance program throughout the County. The County maintains a small-site erosion control manual that explains the basic principles of erosion and sediment control and illustrates techniques to control sediment from small development sites. Jefferson County has an inspection program for illicit discharges, construction activities, and post-construction inspections.

Jefferson County regularly reports to the Bear Creek Watershed Association on stormwater management practices and programs. More information about Jefferson County's stormwater program is contained in their CDPS Stormwater Permit Annual Report.

Table 30 Summary of 2023 MS4 Programs for Inspections and Enforcement Actions

Land Use Agency	Permit Inspections			Permit Enforcement Actions		
	Illicit Discharges	Construction	Post Construction	Illicit Discharges	Construction	Post Construction
Jefferson County	26	703	45	26	39	0

BCWA Stormwater Monitoring Program

The Association may gather 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 actively identifies erosion problem areas for potential future projects. The *BCWA Policy 3 4-Step Review Process* 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 several 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.

VII. Nonpoint Source Program

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.

Onsite Wastewater Treatment System Management

The Association data suggests that OWTS in several specific areas in the Bear Creek Watershed contribute to water quality degradation. There are 9,000 + onsite systems in the watershed, depending on the estimation method. Based on existing county taxing records, there are an estimated 12,000+ lots where there is a permitted onsite system, un-permitted system, or developable lot.

The Association has two policies directed toward site-specific wastewater treatment/ disposal systems in the watershed.

1. *BCWA Policy 11 Site-Specific Wastewater Treatment/ Disposal Systems* - There are five types of human-generated wastewater treatment/disposal types currently in use within the Bear Creek Watershed. Besides point sources, there are four types of small site-specific wastewater treatment/disposal systems including both publicly owned and individual or private systems. State and county regulations cover these systems (Clear Creek, Jefferson, and Park counties). There are no good inventories, only rough estimates, available to the BCWA for these small site-specific wastewater treatment/disposal systems. *The BCWA asserts any publicly owned and operated site-specific wastewater treatment/disposal systems (SSWDs) have the potential to adversely affect water quality within the Bear Creek Watershed. Pollution caused by SSWDs will be considered by the BCWA as "point sources". As such, nutrient point source pollution sources in the watershed may be subject to a wasteload allocation under existing regulation. Water quality degradation associated with publicly owned SSWDs may be included in the BCWA annual report to the Colorado Water Quality Control Commission as an unregulated point source pollution problem.*

2. *BCWA Policy 11 Supplement* – 1) Clear Creek County ISDS Vault and Privy Regulations and 2) Jefferson County ISDS Vault and Privy Regulations

Kerr/Swede Gulch and Cub Creek

The Association completed two special monitoring efforts to determine surface water quality affected from areas on OWTS: Kerr/Swede Gulch and Cub Creek. The Kerr/Swede Gulch focused on a limited number of OWTS (<35) that potentially add nutrients to the lower portion of the drainage between site 52 (Confluence) and site 53 (Riefenberg). The monitoring program suggests there is a nutrient load that is potentially related to OWTS discharge (*TM 2015.03 Kerr Swede 2015 Complete)*.

The Association also monitored upstream and downstream on Cub Creek where there are > 1,000 OWTS. Many of these systems are located within the alluvial corridor. These systems have a greater potential to seep nutrients into Cub Creek (*BCWA WQSD06 Nutrient Loading Cub Creek 2013-2016*). Total nitrogen and total phosphorus concentrations and loads from Cub Creek [BCWA Sites 38 and 88 (Upper Cub Creek and Site 50 (lower Cub Creek Cub Creek)], indicate a nutrient loading concern that is not attributable to the Brook Forest Inn wastewater

discharge *(BCWA WQSD06 Cub Creek*). There was speculation that this nutrient loading could be associated with other unspecified upstream nonpoint source loads. The BCWA sampled Cub Creek from 2012-2016, as part of the watershed sampling program. In 2016, a special field investigation was done to identify potential upstream "hot" spots along this creek. The special survey's nutrient results are included in this data summary. The total phosphorus load distinctly increases from upstream to downstream. The measured nitrogen levels appear to decrease with instream uptake. The visual evidence of nutrient loading in Cub Creek is very evident at the lower site (50) with the coverage of periphyton (algal growth) on hard substrate in the stream often exceeding 50% by late summer.

Cub Creek from 2012-2016 discharged from 250 to 3,040 pounds of total phosphorus per monitoring season into Bear Creek downstream of Evergreen Lake. The seasonal average total phosphorus load in upstream waters is 304 pounds with the downstream average increasing to 1,378 pounds. While there are other types of nonpoint source nutrient sources within the Cub Creek corridor, OWTS are the source for the excess total phosphorus loading along Cub Creek. This nutrient loading has also been seen on other tributaries within the watershed that have OWTS (e.g., Kerr/ Swede Gulch, *TM 2015.03 Kerr Swede 2015 Complete* and Yankee Creek, *BCWA WQSD02 Upper Bear*) or at special monitoring sites located downstream of an OWTS cluster (Troublesome, *BCWA WQSD01 Troublesome*). Consequently, the BCWA believes the phosphorus load in this drainage is a result of seepage from these OWTS located within the alluvial corridor. This is a major nutrient contributing tributary in the middle of the watershed.

NPS Policy Direction

The Association has established policies to help manage nonpoint sources within the watershed:

1. *BCWA Policy 15 Nonpoint Source Strategies and BMPs* - The Association maintains a comprehensive watershed-monitoring program to determine sources, including nonpoint sources, of nutrient loading into waterways. The policy shows management strategies and implementation tools used by the Association.

2. *BCWA Policy 17 Beneficial Recycling of Natural Resources in Bear Creek Watershed* - The Association considers recycling as a best management practice that can help manage natural resources and protect water and environmental quality in the watershed. Recycling programs protect water quality by reducing or eliminating pollutants before they become a problem. Recycling programs can manage household hazardous waste products, organic material/yard wastes, slash, manure generated at stabling operations, clean fill material, recyclable materials (e.g., cans and bottles).

3. *BCWA Policy 18 Illegal Material Dumping as a Pollutant in Bear Creek Watershed* - The Association considers the disposal of, including but not limited to, construction waste, yard waste, organic material (e.g., pine needles) or other plant materials into waterways within the watershed as nonpoint source pollution. This form of waste disposal can harm water quality and is not an acceptable practice in the watershed.

4. *BCWA Policy 27 Source Water Protection* - The BCWA supports the designated areas of concern identified in the Phase 2 Bear Creek Wildfire/Watershed Assessment Report and acknowledges that there is a potentially high risk from wildfires that could significantly impact water supply infrastructure and source waters within portions of the watershed.

Water Quality Monitoring Tiers

Activities, unregulated point sources and nonpoint sources in the watershed have the potential to generate water quality pollutants. However, not all activities, unregulated point sources or minor "non-point" sources of pollutants cause measurable degradation of waters within the watershed. As such, the BCWA asserts it will be more effective over the next 6-years (through 2023) to target a more limited subset of unregulated point and non-point sources within the watershed that have the greatest potential to cause either site-specific or watershed–wide water quality degradation (*BCWA Policy 10 Water Quality Monitoring Priority Tier Designations*).

Nonpoint Source Analysis in EPA BASINS GWLF-E

The CSU research project included detailed analysis of non-point source pollution and system complexity and uncertainty. Wastewater dischargers have already reduced phosphorus discharges by over ninety percent with little effect on seasonal total phosphorus and chlorophyll-a levels or Bear Creek Reservoir trophic status, which

remains stably eutrophic. Therefore, it is important to determine other potential sources of nutrients to improve water quality in Bear Creek Reservoir. Geographic Information Systems were used to develop thematic layers for subbasins, soils, landuse, elevation, horse densities and pastures, paved and unpaved roads, streams, point discharges, weather, and urban areas. This information was used in EPA BASINS GWLF-E mass balance analysis to provide a screening level estimate of potential nutrient sources.

Results indicate that the over 9,000 septic systems in the watershed may contribute a similar total phosphorus load as wastewater discharges or slightly more. The many roads adjacent to streams, and unpaved private drives, in addition to streambank erosion and urban development, contribute fifteen times more, mostly particulate, phosphorus. The large contribution of sediment-based phosphorus agrees with the original 1990 Clean Lakes Study estimates, USGS Sparrow model results for the greater Missouri Basin, and BCWA's own estimates of suspended load from storms, snowmelt runoff, and flooding events. Statistical analysis also indicates that total phosphorus does not typically decrease with increasing flow, which would be expected as wastewater discharges were diluted if they were the main cause. This may indicate further reduction in WWTF discharge load allowances may not improve Bear Creek Reservoir water quality. Therefore, policies and projects that more directly address the effects of nonpoint sources and other reservoir management alternatives will be targeted in future years.

Manure Management

The Bear Creek Watershed Association recognizes animal manure as a nutrient load source, and the associated liquid waste stream is a contributing factor in nonpoint source pollution within Bear Creek Park BCWA Policy 4 Manure Management and as evaluated in BCWA Technical Memorandum 2013.04 - 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 potentially reach surface waters in the watershed or alluvial groundwater. Bear Creek Park staff manages manure control practices that include construction of composting bins for large animal waste products and managing trail crossings at waterways.

Association Land-Use Review

The Association has 42 "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, state, 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, including 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 the Association. The Association completed 6 referrals in 2023 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.

Climate Modeling

The Association conducted two climate change risk assessments using the U.S. Environmental Protection Agency's (EPA) Climate Resilience Evaluation and Awareness Tool (CREAT). BCWA used their assessments to build on existing modeling and monitoring efforts to better understand how climate change threats could affect utility operations and watershed health within the upper watershed above Evergreen and within the lower watershed above Bear Creek Reservoir. Each model assessment provided similar climate change threats, adaptations, and risks but with different management options.

BCWA included several expected climate change threats in their assessments that targeted existing and emerging water quality and quantity issues. Increasing temperatures from climate change could present regulatory and treatment challenges for water and wastewater utilities, in addition to affecting the health of sensitive fish species in the watershed. Minimal temperature increases of 1 to 2°F would present issues for the cold-water fisheries in the upper watershed. Additional concerns include water supply issues from drought, as well as water quality

issues from wildfires and subsequent flooding. Previous flooding events have resulted in significant sedimentation of Evergreen Lake that diminished the reservoir's capacity.
BCWA considered how climate change may increase the severity or frequency of these threats, and assessed the risks of water quality or quantity conditions that would challenge their ability to maintain a reliable supply, to treat the incoming raw water and to protect the health of the watershed ecosystem. The two projected scenarios used CREAT-provided data for moderate conditions with a stormy future and hotter and drier conditions with a stormy future looking out to 2050, which was the model higher probability predicted future condition. This end year of the assessment aligns with the planning horizon of a state water plan. BCWA included annual and monthly data in their scenario to gain a better understanding of the changes in temperature and precipitation patterns throughout the year. Temperatures in March, July, November, and December are critical for snowfall and snowmelt, and temperatures in the winter and shoulder seasons are of the highest concern for temperature-driven water quality events.

The upper watershed can expect a temperature increase from 5.18°F to 6.12°F with much earlier snow melt (17-45 days) and drier summer/fall seasons with an increased drought threat. This data can inform the potential severity of future climate change threats, which are predicted to increase by about 26% within the upper watershed and a 28.6% increase in 100-year storm within the lower watershed by 2050. The models predict more frequent and more intense storm events. This will increase flooding threats. BCWA also considered the 5-, 10-, 15-, 30-, 50- and 100-year storm events in their assessment.

Since the watershed is mostly snowpack-fed, BCWA has concerns about drought, increased surface water temperatures, changes in snowmelt timing and the potential impacts to water availability in the future. Multiple studies and reports for Colorado predict average annual temperatures increasing by a minimum of 2.5°F, with summers warming by 5-7°F and winters by 3-5°F by 2050. Warmer temperatures mean changes in evaporation and soil moisture, reducing snowmelt runoff in each of Colorado's river basins. More precipitation is expected to fall as rain rather than snow, and the state's high-elevation snowpack —the source of much of the state's water supply — could decline by 20 percent and melt earlier than in the past. These sate-wide results are consistent with the CREAT model predictions for the bear Creek Watershed

The CREAT models predict the watershed between 2020 – 2050 will become significantly hotter on average with an increased potential for drier conditions. The lower Bear Creek Watershed Model predicts an average 6.12°F increase in annual temperature in Middle Bear Creek Drainage and at Bear Creek Reservoir by 2050. As with all climate modeling there is an understanding that future conditions can vary from predictions. However, planning for the expected changes of hotter and drier is a prudent management strategy. The results of a CREAT assessment provide information the BCWA can use for long-term watershed water quality planning processes.

Bear Creek Watershed HSPF and CE-QUAL-W2 Models

Colorado Department of Public Health and Environment, three consultants and Region 8 of the U.S. Environmental Protection Agency developed and updated the Bear Creek Watershed HSPF (Hydrologic Simulation Program – FORTRAN) and CE-QUAL-W2 models. The updated and recalibrated models were used to run management scenarios to support the development of TMDL allocations and implementation planning.

Nonpoint Source Education

The Association has an education and outreach program to help raise awareness among watershed citizens of the need for nonpoint source management and controls. Association members are involved in numerous educational and training efforts for schools, clubs, and local agencies and often assist with seminars and conferences. The Association actively promotes use of *smart management practices* to lessen water quality and environmental degradation caused by nonpoint sources (BCWA Policy 15 *Nonpoint Source Strategies and BMPs*).

Watershed Education and Training Efforts

The Association provides information in the form of brochures, fact sheets, maps, training classes and presentations 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, City of Lakewood, and the Clear Creek Water Festival). The Association has a Watershed 101 class for watershed citizens. The Association can be involved in cooperative meetings with the Barr-Milton Watershed Association, the Lower Bear Creek Watershed Group, Denver Department of Environmental Health, and the Colorado Lake

and Reservoir Management Association. The Association was a member of the special Clear Creek/ Bear Creek Fire Hazard Study.

BCWA Newsletter

The Association has established a periodic newsletter that is distributed to membership and many watershed citizens. The newsletter contains one or more articles directed at nonpoint pollution management or education. The Association newsletter can reach over 350 watershed citizens.

Future Watershed Manager Program

The Association has a future watershed manager program and works with high schools and middle 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 develops more courses as requested for the outreach program.

Member Affiliated Programs

Bear Creek Regional Parks, Lakewood

The city of Lakewood has several education and campfire programs held at Bear Creek Park (e.g., Junior Naturalist) that include environmental and water quality elements. Typically, there were >100 education programs for about 4,000 participants (does not include outreach events). The Association has developed education materials, handouts and otherwise supported the park programs. These programs were limited to 2023. However, the total visitation for BCLP exceeded 1,000,000 visitors, excluding bicyclists. The city estimates use for Green Mountain and the Bear Creek Greenbelt (from trail cameras, preliminary estimates) at over 240,000 for the Greenbelt and over 200,000 for Green Mountain.

The City of Lakewood is in their 18th year of recycling and litter management at their regional parks, including Bear Creek Park. In 2023, the program recycled motor oil, scrap metal, mixed paper, cans, glass and plastic, electronics, all batteries, paints, and other chemicals which are disposed of at the Rooney Road Recycling Center. The city continues trash clean up along Bear Creek and Turkey Creek drainages and around the reservoirs. Activities included maintenance of manure management bins, volunteer erosion control projects, willow planting and wetlands enhancement, park clean-up, trail work, trail stream-crossing closures and vegetation management. Volunteer efforts were limited in 2023. Recycle Your Fishing String program also helps keep shorelines clean.

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, downtown Evergreen, and O'Fallon Park. ETU collects over 10 cubic yards of trash and debris. ETU contributes time and materials to the temperature monitoring program. Several Association members are members of ETU.

Jefferson Conservation District

In 2023, the Jefferson Conservation District (JCD) treated about 171 acres of forest restoration and 315 acres of noxious weed management on private lands within the BCWA focus area. This was part of their forest health and wildfire mitigation program. Plans are underway to treat more than 300 acres of forest land in the Bear Creek Watershed in 2024-25. Additionally, JCD continues collaboration with BCWA and the Colorado State University Extension for small pasture management, noxious weed control, and water quality.

Clear/Bear Creek Wildfire/Watershed Assessment

The Association was a partner in a watershed assessment that identified and prioritized sixth–level creek/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

Evergreen Metro District worked with the Colorado Rural Water Association and a steering committee 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 includes the 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 is assimilated into the district's GIS system.

Evergreen Metropolitan District Canal Cleaning Operation

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 of at a location to prevent subsequent erosion into waterways. The district monitors the performance of this catch basin and evaluates if the installation of additional catch basins along upper Bear Creek would benefit the stream.

Evergreen Lake Dam Work

The Evergreen Metropolitan District completed the project in 2023. Based on the results of inspection, the existing pipe needed to be replaced. The engineers finalized a design for the pipe replacement and valve system – Phase 4.

Denver Water Department Watershed Assessment

The Denver Water Department completed an independent review 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 and providing findings and recommendations with the Association.

Aspen Park/ Conifer Waste Recycling Program

The Conifer Area Council has maintained a "Recycling / Sustainability Committee", which supports community recycling. Information from this committee is 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.

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 in the Whitetail parking lot. All trailer and motorized boats require inspection by state certified inspectors at the station for any aquatic invaders. The station is staffed from 6am to 8pm on Fridays and the weekends, then every morning and evening during the week. During the middle of a 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.

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 district 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. The Jefferson Conservation District completed 232.7 acres of noxious weed treatments and 49 acers of seeding projects.

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 has an updated master plan for Bear Creek Dam and reservoir (Bear Creek Dam and Lake Project South Platte River, Colorado, Design memorandum PB-10, July 2012). The Corps of Engineers released a 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 28,762 acre-feet in 1980 to 28,514 acre-feet in 2009, an average of 8.6 acre-feet per year.*

The U.S. Army Corps of Engineers continued clean-up operations to remove debris, upgrades around the outlet structure, road maintenance and dam stabilization projects.

Colorado Water Conservation Board (CWCB) and U.S. Army Corps of Engineers

The Colorado Water Conservation Board (CWCB) and the U.S. Army Corps of Engineers have partnered to conduct a feasibility study on whether Bear Creek Lake can store more water for future use by Coloradans. This study will investigate the feasibility of reallocating reservoir storage for water supply, considering flood protection; safety; environmental, recreational, and economic impacts; and impacts to other resources from additional storage.

The study will be conducted by the U.S. Army Corps of Engineers. The non-federal sponsor is the CWCB, the water policy agency housed within the Colorado Department of Natural Resources. The City of Lakewood has provided recreation and land use data to assist in the determination of potential impacts.

As an existing dam, Bear Creek Lake provides a unique opportunity to store more water for a reasonable cost. An initial study conducted by the Corps in 2015 showed there is potential for additional water to be stored at Bear Creek Lake without impacting its flood control purpose. This feasibility study is a detailed analysis that will further investigate not only impacts to flood control, but also the environmental and recreational impacts from additional storage (Figure 42).

The BCWA is partnering with participating agencies in this feasibility study to reallocate storage. The BCWA provides water quality and environmental reviews. Any change to pool size and configuration has the potential to alter water quality and change management strategies. The aeration system is sized for current reservoir level and would need to be upsized for reservoir raise, including upsizing compressors and adding aerators. At the upper reallocation levels (elevation), the reservoir probably would no longer meet the Aquatic Life Cold 1 Standard because there would be significantly more shallow water area in the reservoir.

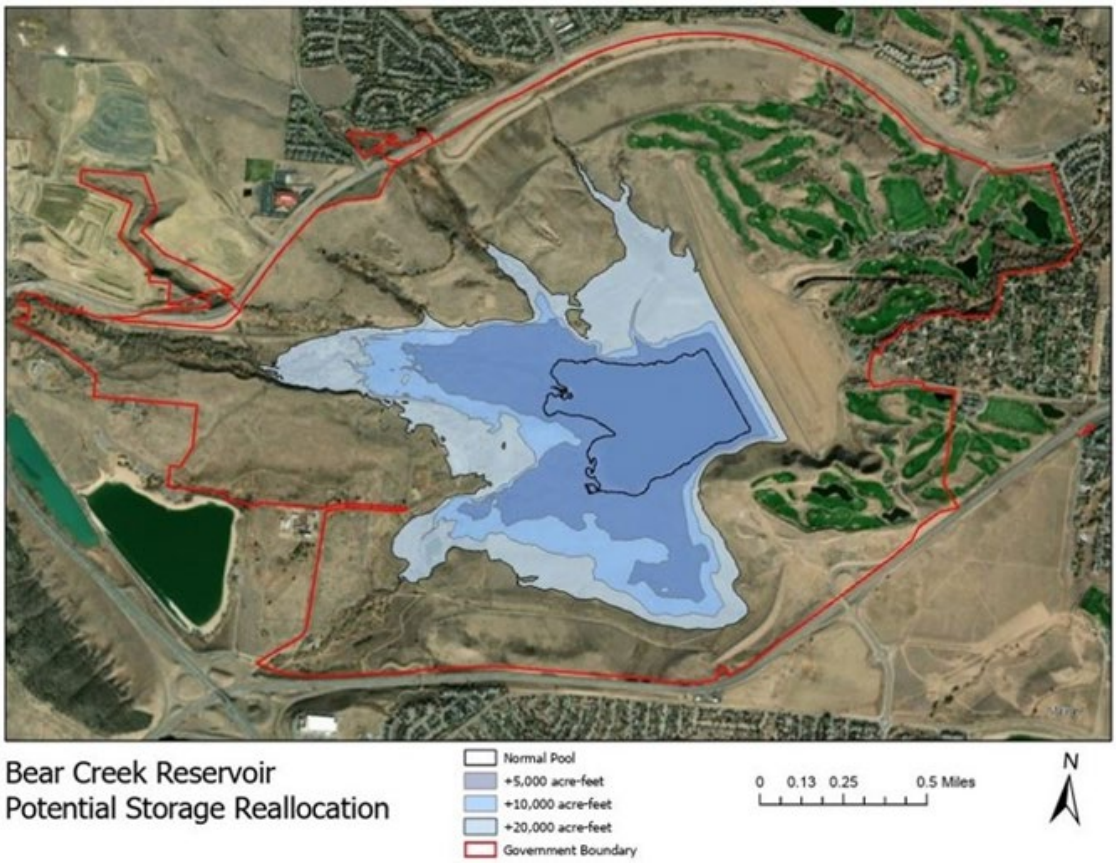


Figure 42 Potential BCR Reallocation

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. The *BCWA Fact Sheet 48 Bass and Saugeye Fishery BCR* summarizes a survey of sports fishing in Bear Creek Reservoir.

Evergreen Community - Stream Restoration

The Bear Creek Watershed Association has identified a problem 2-mile stream reach of Bear Creek that runs through the Town of Evergreen, Colorado. This stream segment needs rehabilitation to meet Colorado State designated water quality and environmental uses (aquatic life, recreational, and drinking water). The water quality standards are periodically impaired based on long-term monitoring by the Bear Creek Watershed Association. The fishery has deteriorated over recent years with declines in species biomass and abundance. Portions of this stream have been artificially altered from past development. This includes straightening the channel and removal of the natural pool and riffle complex. Past rock structures were poorly designed and have reduced fish habitat. There is extensive stream bank erosion and siltation. The stream substrate has low Macroinvertebrate (bugs) Metrics Index (MMI) scores below the Colorado attainment thresholds and constitutes an aquatic life impairment. This stream reach has shown periodic water quality degradation from stormwater runoff associated with paved surfaces in Evergreen.

The full restoration of the Evergreen reach of Bear Creek is a multi-year project that will require extensive cooperation from local business and agencies. The preliminary BCWF estimate of restoration along this reach exceeds 1.25 million dollars. The BCWF proposes doing a phased pro-gram. The first phase will target a section of Bear Creek adjacent to the central parking area. This section of Bear Creek has shown over the last 10-years elevated amounts of asphalt in the sediments and in winter snow conditions; the creek receives most of the snow plowed from the parking lot. The Association data record suggests this snow removal procedure of pushing snow into the creek, which is common through the downtown Evergreen area, is a source of water quality and fishery degradation. The Association believes a redesigned parking lot edge feature along Bear Creek could become an affordable green infrastructure best management practice to reduce pollutant loading from the paved surfaces in the community.

There is a problem throughout the watershed where snow removal/plowing practices result in dirty snow reaching the waterways and causing water quality and fishery degradation. The design, installation, and monitoring of an innovative bio-retention facility/ retaining wall could pro-vide a practical and affordable approach to solving a long-term water quality problem that is prevalent in many locations within the watershed and other mountainous regions of the state with space limitations. If the Association can prove to the community and membership that this type of green infrastructure is a viable watershed management tool, then its widespread application could become a reality in the Bear Creek corridor from Evergreen to Morrison. Phase-two program will focus on stream bank and channel restoration throughout this reach, it will remove construction debris, improve recreational access, and provide excellent aquatic habitat and a restored fishery.

VIII. Association Watershed Plan and Annual Reports

Annual Reporting

The Association produces an annual *Master Data Spreadsheet (June 2023)* that includes data analyses, and raw data (Association website www.bearcreekwatershed.org). The Association transmits these data reports to the Water Quality Control Division staff as requested.

Most 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 (BCWA *PGO2 Document Categories)*. Reporting helps member entities with reporting to their respective boards, commissions, and groups. There is also 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 various educational uses.

BCWA Watershed Plan

The Association has determined and established a policy that generating a single document to serve the watershed planning elements is not a practical or efficient process. A single or fixed watershed plan would be too inflexible and require frequent updating. The Association instead is using a flexible and adaptive watershed planning process maintained electronically and accessible on a designated BCWA web site. The electronic watershed plan is an Association Watershed Plan table of contents with linked PDF files or spreadsheets, and program element descriptions. The Association Watershed Plan is flexible, adaptive, and dynamic. The online watershed plan contains elements and information required to meet 3 types of water quality planning.

The Association has adopted a series of policies, technical reports and factsheets that define the program (*BCWA PGO1 Master Index and PGO2 Document Categories*). The Association maintains a series of standardized maps providing watershed information and characterization. The Association maintains sets of water quality and other environmental data in spreadsheets and data reports. The Association produces annual reports to meet regulatory reporting requirements. The compilation of the various Association watershed planning documents and databases meets the state and Environmental Protection Agency requirements for a watershed plan.

Bear Creek Watershed Foundation

The Bear Creek Watershed Foundation is a funding support organization to benefit the Bear Creek Watershed Association. The Foundation is a 501 (c) (3) non-profit corporation established in January 2020. The Foundation is established as a funding source for projects and programs. It will establish various mechanisms for 1) funding preservation and restoration projects; 2) supporting outreach, education, and training water-shed programs; 3) advocating for and supporting watershed scientific programs and research (focused on water quality or environmental health); and 4) support of other affiliated partnerships, that protect, restore and preserve the Bear Creek Watershed and associated water quality monitoring region.

The Foundation can receive, solicit, administer, and disburse gifts, grants, devices, bequests or other conveyances of real and personal property or the income derived there from for the benefit of the Bear Creek Watershed Association. The Foundation will seek donations from the watershed public and recreational users of the watershed. The Foundation will actively solicit federal, state, and corporate grants.