WQCC Summary

The Bear Creek Watershed is a specific geographic area identified in the Bear Creek Watershed State 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.

The Control Regulation 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 (1987-2014) was 27,100 acre-feet per year. In 2015, 118,925 acre-feet flowed through the reservoir. Mean annual flow in the South Platte River at Waterton (1926-2015) is 119,450 acre-feet. So 2015 was an exceptional flow year (Figure 1). The majority of this flow occurred in May and June. This resulted in a flood stage (> 2,000 ac-ft) for BCR with maximum depths of about 80 feet that lasted from May-August. The peak storage was 12,200 ac-ft. This resulted in a large amount of submerged surrounding vegetation, which resulted in a massive amount of killed or damaged trees and shrubs around the reservoir. In November - December 2015, the U.S. Army Corps of Engineers lowered BCR by about 600 ac-ft for repair work on the outlet structure.

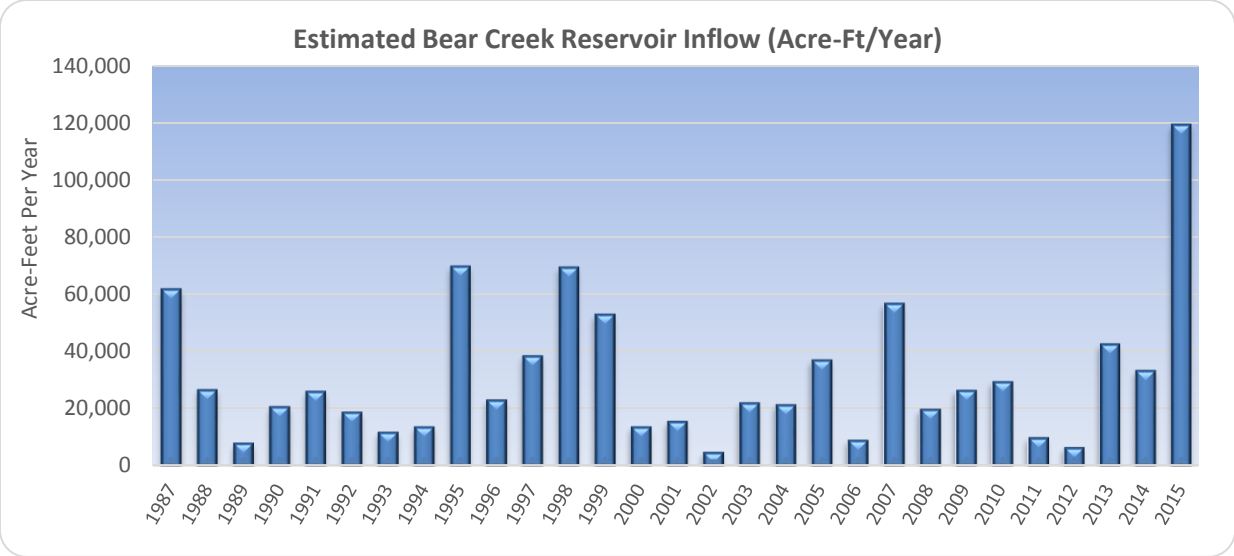

Figure 1 Estimated Bear Creek Reservoir Inflow 1987-2015

The estimated annual discharge from Bear Creek was about 82,905 acre-feet (70%) and 36,025 acre-feet (30%) from Turkey Creek. The internal loading problem with Bear Creek Reservoir has not diminished over the last 8-years (Figure 2). The total phosphorus deposition into reservoir bottom sediments is about 31,330 pounds since 2008. The reservoir continues to experience late summer phytoplankton blooms (2015 peak density of Cryptomonas erosa, Peak Biovolume (um3/mL) = 3,745,806; *BCWA TM 2015.10 BCR Phytoplankton Summary*), which are linked to the internal nutrient loading problem. The BCWA has identified some strategies to address the internal loading problem (*BCWA Policy 20 Preferred Management Strategies EGL and BCR*).

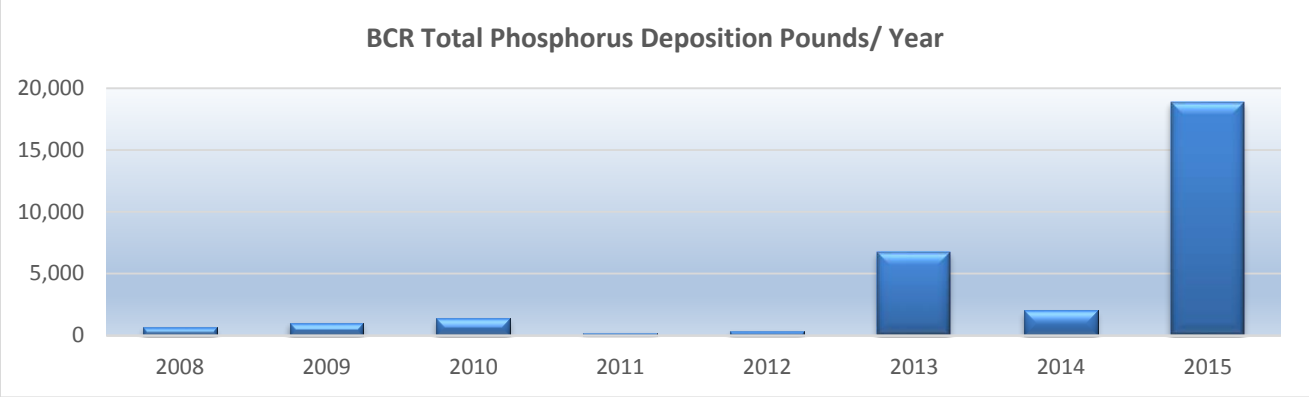

Figure 2 Annual Total Phosphorus Deposition into Bear Creek Reservoir Bottom Sediments

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 2015 from all sources reaching the reservoir was 29,186 pounds (50% from Bear Creek). There was about 166,705 pounds of total nitrogen loading into the reservoir with 95% derived from the Bear Creek drainage.

The Association monitors watershed nutrients by major stream segments beginning near Mt. Evans (segment 7) and extending downstream to Bear Creek Reservoir. 2015 was an exceptional nutrient monitoring year due to the record spring runoff period. In the 2015 monitoring season, the total phosphorus (Figure 3) and total nitrogen (Figure 4) concentrations and loads were very high for May and June sample periods. The majority of nutrient load comes from 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.

There was about 3,745 pounds of total phosphorus passed through Evergreen Lake, with an additional 2,550 pounds added from the Cub Creek drainage. Additional total phosphorus loading into Bear Creek between Evergreen to Morrison was over 8,600 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 pollute loading problems (*BCWA Policy 29 BCWA Integration with Other Planning Efforts*).

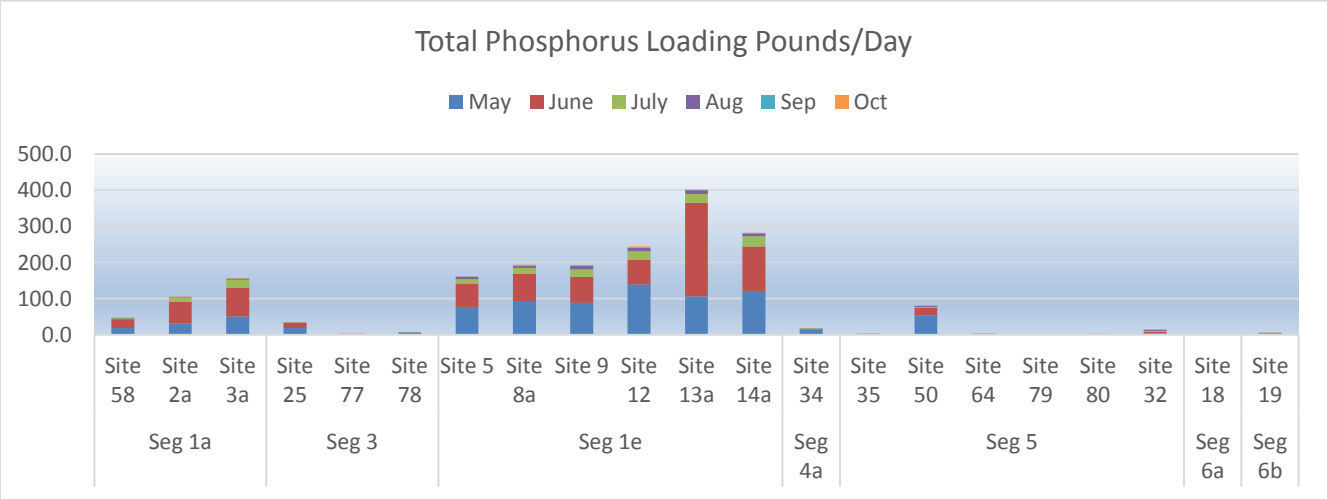

Figure 3 Total Phosphorus Loading by Stream Segments in the Watershed

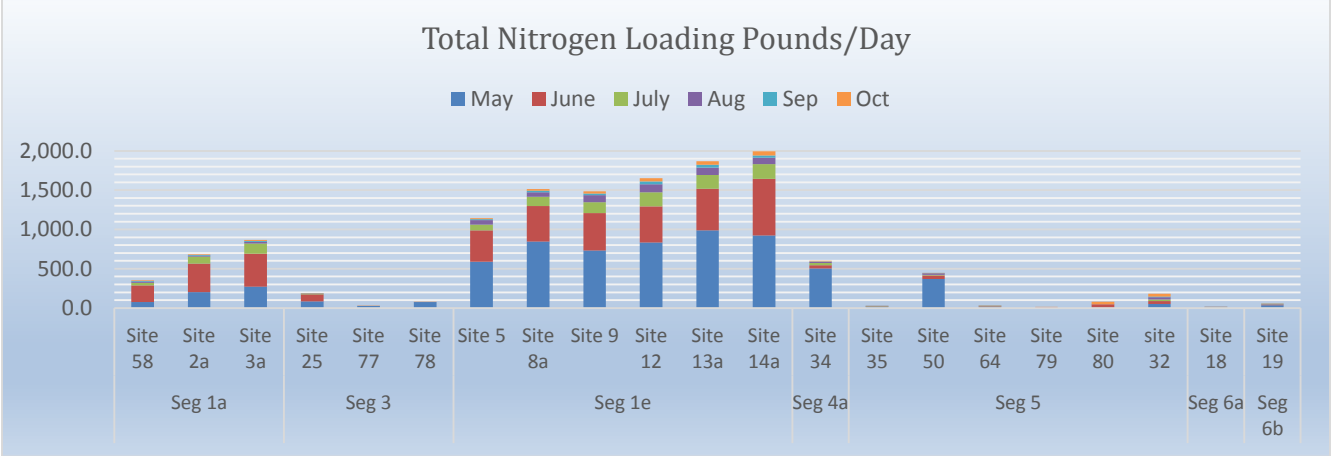

Figure 4 Total Nitrogen Loading by Stream Segment in the Watershed

2. Wastewater Treatment Facilities Loading and Compliance

In 2015, wastewater dischargers reduced total phosphorus waste load contributions to just 1,235 pounds annually. BCWA analysis of the total phosphorus data record indicates that only about 20-35% of this total phosphorus load from permitted dischargers actually reaches the Bear Creek Reservoir. The only significant permit compliance problem was for the Conifer Metropolitan District for total dissolve solids, which is being addressed under a compliance order. The District will seek a TDS variance in their permit after demonstrating high natural TDS levels in their groundwater source.

The Singing River Ranch facility has been plugged and non-operational since 2009. However, this facility was never formally closed and was served a notice of violation/ cease and desist order in November 2015. The owner has initiated a formal closure process.

The Bear Creek Cabins facility was closed and the property converted to an OWTS. The tiny Town operation continues hauling wastewater off site and the treatment facility is non-operational. The lysimeters at the Geneva Glenn operation was determined by the Water Quality Control Division permits section to be non-functional and the facility needs to monitor discharge prior to land application for total phosphorus compliance. Some of the smallest dischargers are finding it difficult to meet the total phosphorus permit limit of 1.0 mg/l, but they do meet their annual wasteload allocations.

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. 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 an online system addresses nutrient loading in the watershed. The project developed detailed information on OWTS, horse properties and pastures, and unpaved roads. This data was included in screening level analysis in EPA BASINS GWLF-E to estimate non-point source contributions. Results and watershed data from the last six-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 1,000 to 18,000 pounds of total phosphorus. Clearly, only a fraction of this load transports to the Bear Creek Reservoir on an annual basis (Table 1).

The point source load of total phosphorus in 2015 (Table 1) was 1,235 pounds (4%), while the nonpoint source load reaching Bear Creek Reservoir was about 27,951 pounds (96%). On average over 16 years of data record, only about 28% of the potentially generated nonpoint source total phosphorus reached Bear Creek Reservoir. 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 2015 nonpoint source phosphorus loading was heavily influenced by a record spring runoff period.

Table 1 Point Source versus Nonpoint Source Phosphorus Loading, Bear Creek Reservoir

	2015 Total Phosphorus Loading (Pounds)			
	Total TP Load	**PS**	**NPS**	**%NPS**
Turkey Creek Drainage	14,670	15	14,655	100%
Bear Creek Drainage	14,516	1,220	13,296	92%
Discharged into Reservoir	29,186	1,235	27,951	96%
Site 45 Outflow BCR	10,320			
BCR Total Phosphorus Deposition	18,867			

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 Troublesome drainage, Cub Creek drainage and Mt. Vernon drainage. Upper Bear Creek, Troublesome and Mt. Vernon are addressed in *BCWA WQSD02 Upper Bear*, *BCWA WQSD01 Troublesome* and *BCWA WQSD04 Mt Vernon*.

The May watershed sampling period above Evergreen Lake represented an unusually high flow condition with excessive flows on both the mainstem and tributaries throughout the upper watershed. In this higher flow period, Vance Creek was the largest tributary nutrient source. Under normal flow conditions, the tributaries are only about 7-8% of both the TP and TN load to Bear Creek. The Association special studies have shown an estimated 30-75% of the total phosphors 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.

The Association online system is a permanent management policy (BCWA Policy 21, December 2013). 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 (35) are an essential component of the Association's interactive online *watershed plan*. The Association 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 quarterly newsletter.

4. Status of Water Quality Goals and Standards

The Association has 34-years of active service to the watershed in Clear Creek, Jefferson and Park Counties. The Association has 31-years of data and studies to support watershed science. During this time, the Association has removed or immobilized about 375 tons of phosphorus in the watershed. The 86 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.

Average seasonal total phosphorus of 87.8 µg/L in Bear Creek Reservoir far exceeds the 22.2 µg/L goal-standard. Average seasonal chlorophyll-a of 20.9 µg/L was well over the 12.2 µg/L standard. The trophic status of the reservoir remains at the Eutrophic-Hypertrophic boundary based on Carlson and Walker indices. Seasonal average reservoir temperature generally remained below 20° Celsius. There were no exceedances of the *Weekly Average Temperature* (WAT) or the *Daily Maximum Temperature* (DM). Lake aeration maintained dissolved oxygen levels at or above 6 mg/L throughout the growing season and recreational fishing remained strong.

In Bear Creek and Turkey Creek segments, there were no temperature compliance problems in both the warm and cold seasons. The only water chemistry exceedances of standards measured in the 2015 occurred at the site-specific Summit Lake pollution plume (*BCWA TM 2015.02 UBCW Summary*).

5. Phosphorus Trading Program

There was no active total phosphorus trading by Association membership in 2015 (See Table 25 in the *BCWA 2015 Annual Report* for a status of trading activity summary). The Association has established four trading policies to improve future trading programs (*BCWA Policy 1 Trading Program, BCWA Policy 19 Nutrient Trading Program Eligibility, BCWA Policy 26 Point to Point 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 88 pounds (*BCWA TM 2015.04 Coyote Gulch Summary*). The project has effectively reduced total phosphorus loading by about 75% on an annual basis (Figure 5).

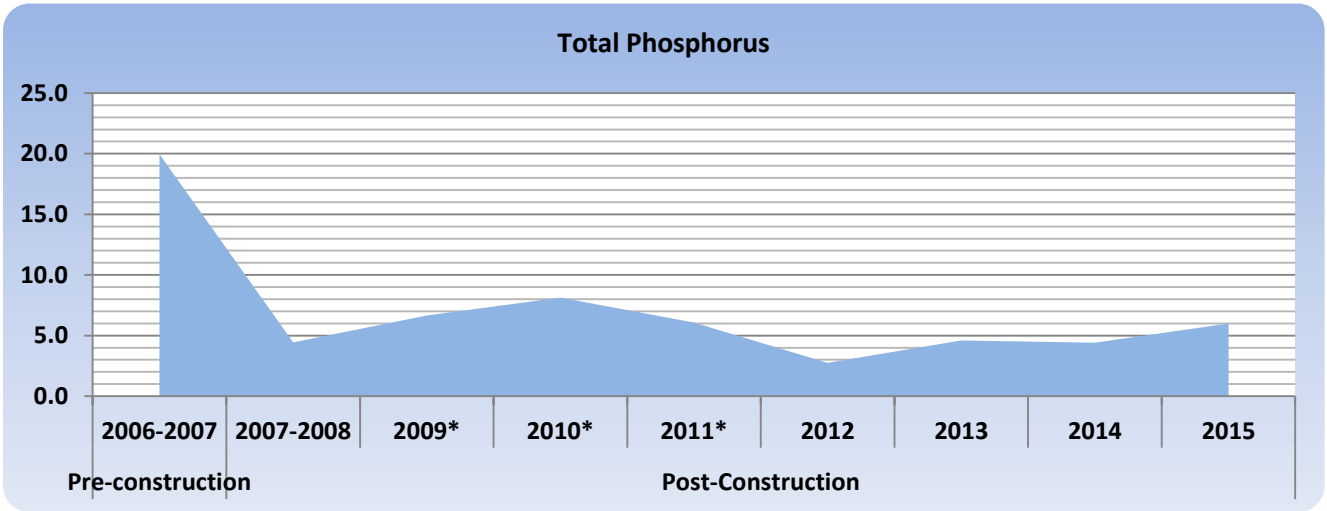

Figure 5 Total Phosphorus Reduction at Coyote Gulch Restoration Site