

Bear Creek Watershed Association

2006 Annual Report for the Water Quality Control Commission



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

Bear Creek Watershed Association

The Bear Creek Watershed Association (Association) is identified in the Bear Creek Watershed Control Regulation (Regulation #74; 5 CCR 1002-74) as the local water quality implementation agency responsible for monitoring and tracking water quality in the Bear Creek Watershed (Figure1). The Association membership includes counties, local general-purpose governments, special districts, associate agencies, and local citizen groups (Table1). The Association monitors both point sources and characterizes nonpoint source loadings within the watershed. The Association provides detailed watershed reporting as posted on the Association website www.bearcreekwatershed.org, which serves to keep local governments and others informed on the state of the watershed. The Association also has specific reporting requirements identified in the Control Regulation, which keeps the Water Quality Control Commission and Water Quality Control Division staff updated on progress of the Association in implementing the Control Regulation.

Table 1 Bear Creek Watershed Association Membership and POTWs

Members and Associates	Wastewater Discharger	2006 Association Participation
<u>Counties</u>		
Jefferson County		Active
Clear Creek County		Active
Park County		Not Active
<u>City and Towns</u>		
City of Lakewood		Active
Town of Morrison	Yes	Active
<u>Water & Sanitation Districts</u>		
Aspen Park Metropolitan District	Yes	Active
Bear Creek Cabins	Yes	Not Active
Brook Forest Inn	Yes	Not Active
Conifer Sanitation Association	Yes	Active
Conifer Metropolitan District	Yes	Active
Evergreen Metropolitan District	Yes	Active
Forrest Hills Metropolitan District	Yes	Not Active
Genesee Water & Sanitation District	Yes	Active
Geneva Glenn	Yes	Not Active
Jefferson County School District (Conifer High School & Evans Outdoor School)	Yes	Intermittent
Kittredge Water & Sanitation District	Yes	Active
Singing River Ranch	Yes	Not Active
The Fort Restaurant	Yes	Intermittent
Tiny Town Foundation, Inc.	Yes	Not Active
West Jefferson County Metropolitan District	Yes	Active
<u>Associate Agencies</u>		
Aspen Park Homeowners Association		Active
Colorado Department of Transportation		Intermittent
Denver Regional Council of Governments		Active
Department of Public Health & Environment		Active
Jefferson County Health Department		Active
Natural Resources Conservation Service		Active
U.S. Army Corps of Engineers		Intermittent

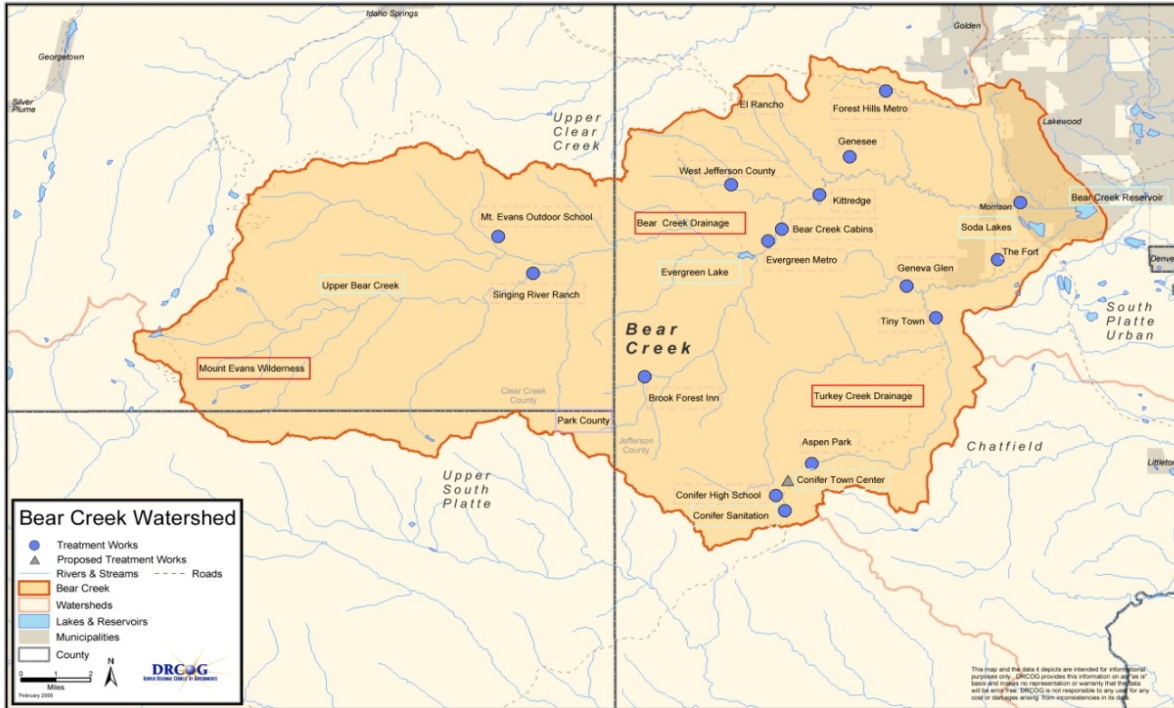


Figure 1 Bear Creek Watershed

Control Regulation Requirements

The Bear Creek Watershed Control Regulation (Regulation #74; 5 CCR 1002-74) specifically identifies reporting conditions for presentation to the Water Quality Control Commission by the Association. These control regulation reporting elements are a subset of the information contained within the Association’s annual reporting documents.

The five annual reporting requirements as listed in the Control Regulation are:

1. Summarize status of water quality in the watershed for the previous calendar year.
2. Information on the wastewater treatment facilities loading and compliance with permit limitations
3. The nonpoint source loading and appropriate best management practices,
4. In-stream and reservoir data analyses that indicate whether water quality goals and standards for the watershed are being met.
5. Information about water quality projects planned or implemented in the watershed

Status of Water Quality in the Watershed

Figure 2 shows the 1986-2006 annual flow discharge in Bear Creek Reservoir (Association 2006). While Bear Creek Watershed demonstrated some drought flow recovery in 2005, the hydrology shows a return to drought runoff conditions in 2006. The watershed hydrology remains low compared with the wetter mid 1990’s period.

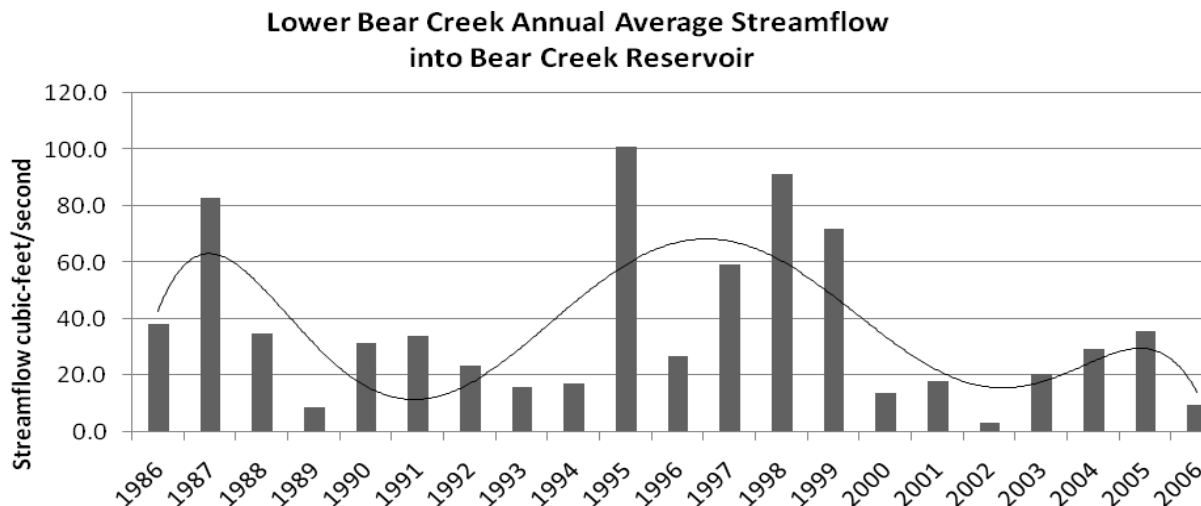


Figure 2 Annual Flow into Bear Creek Reservoir

Colorado State Regulation #38 also lists a narrative phosphorus standard for Bear Creek Reservoir as follows. The reservoir narrative standard requires shifting the reservoir trophic index from a eutrophic-hypereutrophic condition toward the mesotrophic-eutrophic boundary condition:

Narrative Phosphorus Standard for Segment 1c of Bear Creek. “Concentrations of total phosphorus in Bear Creek Reservoir shall be limited to the extent necessary to prevent stimulation of algal growth to protect beneficial uses. Sufficient dissolved oxygen shall be present in the upper half of the reservoir hypolimnion layer to provide for the survival and growth of cold-water aquatic life species. Attainment of this standard shall, at a minimum, require shifting the reservoir trophic state from a eutrophic and hypertrophic condition to a eutrophic and mesotrophic condition.”

The reservoir monitoring program evaluates nutrient (nitrogen and phosphorus) concentrations, chlorophyll-a, total suspended sediments and Secchi depth as key trophic index indicators. These parameters, in part, determine attainment with the narrative standard adopted for the reservoir in Regulation #38. The 5-year reservoir data and the long-term trends from 1991 through 2006 are summarized in Table 3.

The management program targets reduction of total phosphorus reaching the reservoir on an annual basis. The monitoring data indicates management efforts have helped shift the trophic index away from the poor hypereutrophic conditions originally monitored in the reservoir. There is a reduce trend in total phosphorus loading over time. The nitrogen data has shown greater fluctuation over the years with no clear trend. The surface chlorophyll concentration declined in 2006. The reservoir aeration system has helped reduce the chlorophyll productivity. The internal nutrient loading problem triggering algal blooms is also partly controllable through the reservoir aeration system. The total suspended sediment load in the reservoir has been generally constant over the monitoring period with periodic storm events dumping large volumes of sediment into the reservoir. The Association has measured a reservoir depth decline of about 3 meters (10-11 feet) since 1991 (Association 2006). Bottom sediments are fine sand, silt and mud. Bottom sediments observed by the Association in 2006 were predominately-fine mud.

Table 2 Bear Creek Reservoir 2006 - Selected Trophic Indicators

Trophic Indicator	Reservoir
Chlorophyll	
Average Growing Season Chlorophyll-a [ug/l (surface waters only)]	13.2
Peak Chlorophyll-a [ug/l]	28.7
Phosphorus	
Average Annual Total Phosphorus [ug/l]	24
Seasonal Annual Total Phosphorus [ug/l]	25.5
Peak Annual Total Phosphorus [ug/l]	84.8
Average Annual Ortho Phosphorus ug/l]	14.1
Seasonal Average Ortho Phosphorus [ug/l]	21.9
Peak Annual Ortho Phosphorus [ug/l]	45.7
Nitrogen	
Average Annual Nitrate-Nitrogen [ug/l]	153
Seasonal Average Nitrate-Nitrogen [ug/l]	102
Peak Annual Nitrate-Nitrogen [ug/l]	389
Clarity	
Average Annual Secchi Depth (m)	2.4
Seasonal Average Secchi Depth [meters]	2.4
Total Suspended Sediments	
Annual Average Total Suspended Sediments [mg/l]	6.1
Seasonal Average Total Suspended Sediments [mg/l]	7.4
Peak Total Suspended Sediments [mg/l]	59.4
Phytoplankton Species	
Phytoplankton Species Co-dominant Species	
<i>Asterionella formosa, Fragilaria crtonensis, Ankyra judayi, Chlorella minutissima, Chromulina sp., Ochromonas reflexa, Plagioselmis nannoplantica, Aphanizomenon flos-aquae, Aphanocapsa delicatissima, Aphanothece smithii, Cyanobium sp., Microcystis aeruginosa, Pseudanabaena mucicola, Woronichinia compacta, Monomastrix sp., Chrysochromulina parva</i>	
Peak Phytoplankton Density	
<i>Aphanothece smithii</i>	147,500 cells/ml
Zooplankton Diversity	
11 species Copepoda	Rare & intermediate to common
5 species Cladocera	Rare to intermediate
13 species Rotifera	Generally rare

The monitoring program characterizes nutrient loading into Bear Creek Reservoir from two primary drainages: Bear Creek and Turkey Creek drainages. The total phosphorus load from the watershed comes from a combination of wastewater treatment plant point source loads and a nonpoint sources, including stormwater runoff. The total phosphorus load in 2006 from all sources reaching the reservoir was 564 pounds at a flow of 11,365 acre-feet (Figure 3). Although the point source discharges of total phosphorus were about 2,000 pounds, the water diversions above the reservoir are removing most of this phosphorus load and inflow water before it reaches the reservoir. The nitrate (19,000 pounds) loading was very low and not typical of past conditions (Figure 4). There were no nutrient loading problems in 2006.

Table 3 Reservoir Trends for Select Trophic Parameters

Parameter	Site	Reservoir Averages					
		2002	2003	2004	2005	2006	91-06 Mean
Chlorophyll-a (ug/L)	Top	15.4	14.8	6.6	15.4	9.1	15.2
	Mid						9.4
	Water Column	15.4	14.8	6.6	15.4	9.1	12.5
Nitrate-Nitrogen (ug/L)	Top	289	268	268	193	158	368
	Mid	288	271	249	207	150	358
	Bottom	268	259	224	221	151	336
	Water Column	282	266	247	207	153	340
Total Phosphorus (ug/L)	Top	46	79	24	33	67	67
	Mid	49	63	27	34	66	66
	Bottom	56	56	44	47	97	97
	Water Column	50	66	32	38	77	80
Total Suspended Solids (mg/L)	Top	5	7	3	5	6	6
	Mid	5	6	5	6	7	7
	Bottom	5	8	9	7	10	10
	Water Column	5.0	7.0	5.7	6.4	7.9	7.9
Secchi Depth (m)	Top	3.0	1.7	2.6	2.1	2.4	2.2

2006 Bear Creek Reservoir Total Phosphorus Load (Pounds, %)



Figure 3 Total Phosphorus loading in 2006

2006 Bear Creek Reservoir Nitrate Loading (Pounds, %)



Figure 4 Nitrate loading in 2006

Wastewater Treatment Facilities Loading and Compliance

The total wasteload allocation of phosphorus from all point sources in the Bear Creek Watershed is 5,255 pounds per year. Table 4 lists the permitted wastewater treatment facilities. Each individual discharger in the Bear Creek Watershed is limited to an annual wasteload of total phosphorus, which cannot be exceeded, except as provided through trading provisions (Table 4). Point source discharges cannot exceed a total phosphorus

effluent concentration of 1.0 mg/l as a 30-day average. All point source dischargers must meet the 1.0 mg/l total phosphorus concentration effluent limitation as a permit condition. All reporting facilities were in attainment with the assigned wasteload allocation. There were no permit violations reported to the Association in 2006.

Table 4 Point Source Wasteload Allocations

Treatment Plant	TMAL Phosphorus Pounds/ year	2006 Phosphorus Pounds/ year
Evergreen Metropolitan District	1,500	453.1
West Jefferson County Metro District	1,500	616.1 ¹
Genesee Water and Sanitation District	1,015	274.2
Town of Morrison	600	79
Kittredge Sanitation and Water District	240	58.1
Jefferson County Schools - Conifer High School	110	5.3
Forest Hills Metropolitan District	80	55.1 ¹
Conifer Center Sanitation Association	40	No Report
Aspen Park Metropolitan District	40	No Report
Conifer Town Center	40	0 ²
West/Brandt Foundation - Singing River Ranch	30	No Report
Jefferson County Schools – Mt. Evans Outdoor School	20	1.9
The Fort	18	0 ³
Geneva Glen	5	No Report ⁴
Bear Creek Development Corp. - Tiny Town	5	No Report
Bear Creek Cabins (Bruce & Jayne Hungate) ⁵	5	No Report
Mary Ann Gallagher - Brook Forest Inn	5	No Report
Reserve Pool	2	Not used
Total Point Source Phosphorus Wasteload	5,255 lbs/year	1,542.8

- 1 Forest Hills Metro District has trade agreement with West Jefferson County Metro District and complies with permit. 134.4 pounds was added into the West Jefferson County allocation, which was 482 pounds for a total West Jefferson County Metro District discharge of 616 pounds.
- 2 Site Approval and Permit; treatment plant constructed; No 2006 monitoring data
- 3 Septic system over 2,000 gallons per day; site application in progress; No established monitoring; Working with Association
- 4 The Geneva Glen treatment plant is not discharging as reported to the Association.
- 5 The Bear Creek Cabins exceeded total phosphorus monthly allocations 5 times in two years and may have exceeded the annual total phosphorus allocation.

No Report - No Annual Wastewater total phosphorus allocation reporting or discharge data provided to Bear Creek Watershed Association.

Nonpoint Source Loading and Appropriate Best Management Practices

The management of nonpoint sources in the Bear Creek Watershed is a component of the planning and management program. Based on water quality data, point source controls have significantly reduced phosphorus loading to Bear Creek Reservoir. However, phosphorus reduction from nonpoint sources is still required to maintain the reservoir goal at the mesotrophic & eutrophic boundary as measured by modeled trophic indexes. Available Association resources and implementation authority limit the implementation of a nonpoint source program.

The Association is involved in a nonpoint source project to help restore severe erosion on Coyote Gulch. Coyote Gulch can contribute up to 1,000 pounds of total phosphorus per year directly into Bear Creek Reservoir. Other management strategies used by the Association are shown in Table 5.

Table 5 Association Nonpoint Source Management Strategies

Summary of Management Strategies	Summary Of Implementation Tools
1. Local support	1. Local involvement in associated programs & activities; presentations; information source 2. Review agency for community plans 3. Provide data and information support to other agencies and special projects 4. Provide educational support and information 5. Technology transfer
2. Stable funding source	6. Member funding support 7. Seek nonmember funding and grants
3. Provide recommendations to Counties on projects	8. Referral agency for land use projects in Jefferson County and Clear Creek County 9. Low impact Development Policy 10. Manure management Policy 11. Septic Management Policy 12. Maintain a list of appropriate best management practices for review
4. Characterize trends in water quality	13. Maintain a trend water quality monitoring network to measure inputs & output from the reservoir
5. Track nonpoint source nutrient loading in Bear Creek & Turkey drainage systems	14. Characterize nutrient loading from the two major drainage systems: Turkey Creek & Bear Creek
6. Maintain watershed & reservoir models	15. Maintain & use reservoir models (Trophic index, Secchi depth and nutrient loading) developed during the Clean Lake Study
7. Annually review best management practices	16. Update BMPs as appropriate
8. Actively promote the implementation of water quality projects & activities	17. Maintain a repository of documents, data & other information; support local water quality plans and efforts as feasible
9. Support other watershed efforts and groups	18. Continued involvement in groundwater studies, ISDS regulation review & sediment & erosion control

Meeting Water Quality Goals and Standards for the Watershed

Reservoir Temperature Exceedance - Bear Creek Reservoir is listed as class 1 cold water, the normal pattern of summer temperatures shows the reservoir to be transitional cool water that cannot meet the existing cold-water temperature criteria. The Association temperature data set clearly shows Bear Creek Reservoir will not meet a chronic temperature standard of 20 °C (Maximum Weekly Average Temperature: MWAT). The temperature profile data in the reservoir often shows a uniformly higher temperature pattern throughout the water column as characteristic of a small reservoir system. As such, an adequate temperature/ dissolve oxygen refugium is not present for aquatic life below the mixed layer (either epilimnion or mesolimnion), which can be near the bottom of the reservoir within the hypolimnion. The Association is not aware of any recent aquatic life impairment concerns for the reservoir and there is no indication of an existing problem.

Bear Creek Segment 1a Temperature Issue – Bear Creek Segment 1a is classified as a class 1 cold water. The Association has collected a detailed 5-year data set on a portion of

Bear Creek segment 1a from just above Evergreen Lake to Morrison. This portion of Bear Creek is a 4th order stream segment below an elevation of 7,300 feet. This segment exhibits thermal behavior indicative of transitional cool water. This “not sensitive” (criteria are applied where cutthroat trout and brook trout are not expected to occur) segment would not consistently meet the underlying chronic temperature standard of 18.2 °C (MWAT). Under very low flow conditions, small portions of this segment also would have a problem meeting an interim chronic temperature standard of 20 °C (MWAT). The Association supports a chronic temperature standard of 20 °C (MWAT) until a site-specific temperature standard can be considered, which includes potential resegmentation of the segment.

Reservoir Narrative Standard – The reservoir narrative standard requires shifting the reservoir trophic index from a eutrophic-hypereutrophic condition toward the mesotrophic-eutrophic boundary condition. The Association uses both the Walker Trophic Index (seasonal and annual) and the Carlson Trophic Index (seasonal; and annual) to determine reservoir compliance with the narrative phosphorus standard. A trophic index provides a composite characterization of the reservoir overall quality compared to general water quality categories. Growing Season values over “65” on either the Carlson trophic Index (Figure 5) or Walker Trophic Index (Figure 6) defines a waterbody as being hypereutrophic, which is considered poor quality with a likely beneficial use impairment.

The narrative standard targets an average growing season trophic condition throughout the reservoir water column that ranges from “45-60”; with a preferred trophic index range from “45-55”. The average trophic state for the reservoir over the period of record is “63” Carlson and “65” Walker, which is a eutrophic waterbody. In the last ten years, the reservoir has met the narrative mesotrophic-eutrophic target 30% of the time. However, the management program has altered the historic trophic state away from a poor quality hypereutrophic system. To consistently meet the reservoir narrative standard, additional reductions in nonpoint source phosphorus are required in the watershed.

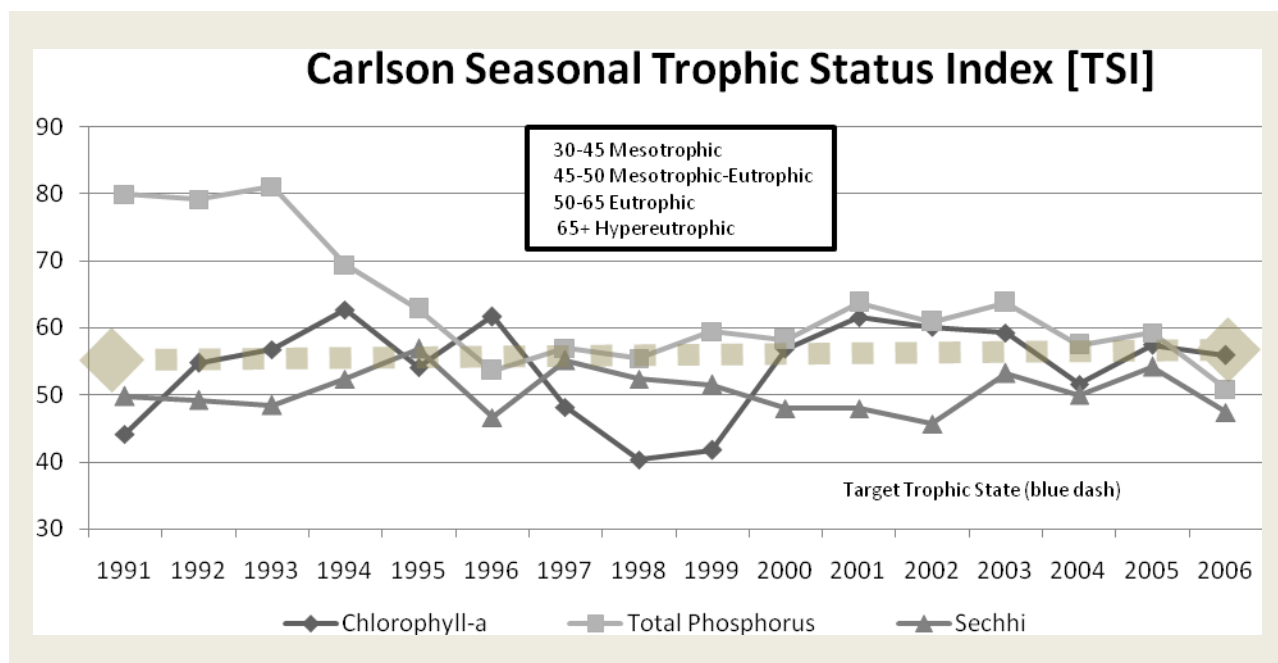


Figure 5 Carlson Seasonal Trophic Index Trend in Bear Creek Reservoir

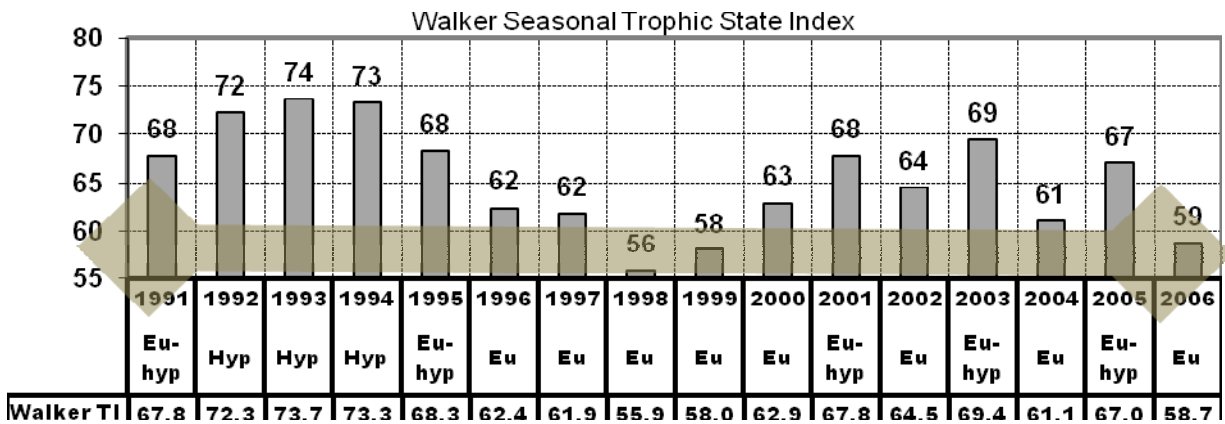


Figure 6 Walker Seasonal Trophic Index Trend in Bear Creek Reservoir

Water Quality Projects Planned or Implemented In the Watershed

The Association is assembling a comprehensive water quality, biological and physical characterization data set that can be used to define reference sites and conditions. The Association will continue data collection efforts and work cooperatively with the WQCD to quantify technical components necessary for watershed management. The Association planned or implemented projects include:

1. Continued Monitoring of Bear Creek Segment 1a - The 2004 and 2006 Colorado Monitoring and Evaluation List identify Bear Creek segment 1a as potentially impaired due to aquatic life, temperature and ammonia (2004 only). The Association obtains water quality data at over 20 sites to determine if temperature and ammonia are water quality problems. The Association will continue the special monitoring efforts on Bear Creek from the Lost and Found site in upper Bear Creek to the Harriman Ditch in Morrison.
2. Expand Monitoring in Watershed - The Association will begin in 2007 to expand the temporal and spatial monitoring efforts on Bear Creek and within the Turkey Creek drainages. The Association special monitoring has not demonstrated a temperature or ammonia toxicity problem; consequently, the supplemental monitoring effort will assess gaps in the monitoring program. The supplemental data set allows the Association to determine if chemistry is part of the problem. Based on more detailed stream data analyses, the Association can determine the best location and sampling protocol to characterize Bear Creek segment 1a and Turkey Creek drainages.
3. Continues Routine Water Quality Monitoring Program – The Association routine monitoring program will remain unchanged for 2007.
4. Begin Nutrient Characterization In Watershed - The Association has begun collection of more nutrient data (total phosphorus and nitrate) throughout the watershed. This nutrient database will require several years to assemble.
5. Collect Data Compatible For Modeling - The Association will obtain water quality data for future stream modeling and predictions. Additional evaluation and modeling of the temperature information is necessary to determine a management strategy for the watershed. The Association has begun special temperature monitoring on Turkey Creek drainages in preparation for potential site-specific standards.

6. Continue Fishery and Stream Characterizations – Support Division of Wildlife fishery surveys. Characterization how trout populations are responding to both natural and human induced alternations. Collect macroinvertebrate data. Conduct additional stream flow studies. Add a new fish-monitoring site in the upper portion of Bear Creek near Lost and Found Day Camp site. Determine fishery composition in Turkey Creek drainages.
7. Finalize The Fishery Analysis and Protocols Guidance.
8. The Technical Review Committee recommends management strategies to the Association for implementation.
9. Review scientific bases for control regulation at a watershed level.
10. Support Coyote Gulch Restoration Project – The City of Lakewood is restoring a portion of Coyote Gulch in Bear Creek Park. The Association supports the water quality-monitoring program for this development project. The Association will develop a post-construction nutrient load estimate and then monitor nutrient changes after construction in 2007.
11. Community Plan Development and Development Reviews – The Association supports Jefferson County in the update and development of community plans for select portions of the watershed. The Association is an active referral agency.
12. The Association helps with Evergreen Earthday Activities and Other Education Programs - The Association provides information to the community on water quality management and environmental issues and supports educational programs.

Additional Association Annual Reporting

The Association developed a detailed 2006 watershed annual report (Bear Creek Watershed Association September 2007), which includes watershed characterization and water quality summary sheets. The annual report provides information on the watershed configuration, regulatory framework, Bear Creek partnerships, scope of Bear Creek Watershed efforts, management program and water quality trend and annual summaries. The Association also produces an annual data summary as a *2006 Master Data Spreadsheet* that includes data analyses, trends and raw data (posted on Association website www.bearcreekwatershed.org). This data report is also directly transmitted to the Water Quality Control Division Staff. The watershed monitoring program is summarized in an appendix to the Association annual report (*Appendix A 2006 Segment 1a Report*, Bear Creek Watershed Association February 2006). All of the Association annual reporting documents are available electronically and posted on the website. The Association provides multiple reporting documents designed to meet multiple functions and groups. The reporting helps member entities with reporting to their respective boards, commissions and groups. There is also a citizen interest in the watershed and reporting helps keep the public informed. Many educational groups visit the watershed and it has become a widely used outdoor classroom. Reporting materials are provided for these various educational uses. No single document meets all of these needs and requirements. As such, the Association will maintain its current annual report format with fact sheets and provide a separate report to fulfill requirements of the Water Quality Control Division and Commission.