2017 ANNUAL REPORT ON ACTIVITIES

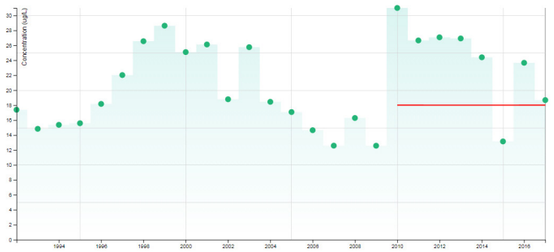
MARCH 31, 2018

CHERRY CREEK BASIN WATER QUALITY AUTHORITY

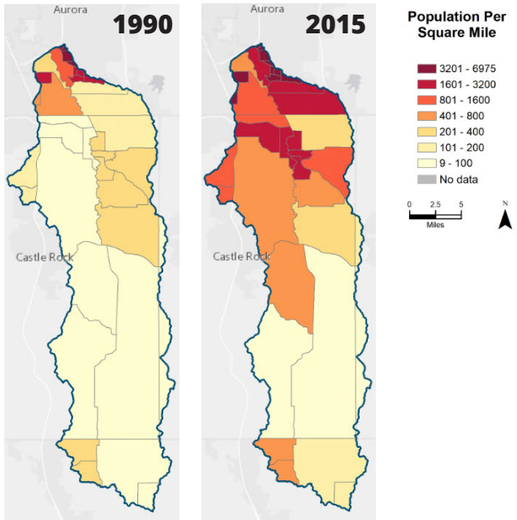
2017 Executive Summary

In 2017, Cherry Creek Reservoir's chlorophyll α standard of 18.0 µg/L was nearly achieved. The 2017 seasonal mean concentration was 18.8 µg/L.

The range in chlorophyll α values over the years is seen in the graphic below.



As shown in the maps below, the basin's population more than tripled between 1990 and 2015; however, a commensurate increase in chlorophyll α in the reservoir has not occurred. Significant efforts taken by the Authority and others have helped achieve this.



Formed in the late 1980s, the Cherry Creek Basin Water Quality Authority is tasked with improving, protecting, and preserving water quality in the watershed and reservoir for beneficial uses. Together with our partners, we have targeted several key goals in 2017.

A two-dimensional hydrodynamic water quality model was completed that will be used to:

- Better understand the causes of chlorophyll α standard exceedances,
- Determine the impacts of the reservoir destratification system, and
- Predict the effectiveness of future management strategies.

We also initiated development of a watershed model that will be used in conjunction with the reservoir model to evaluate potential watershed management techniques.

The Authority spent $1.3 million on Pollutant Reduction Facilities, including the construction of grade control/drop structures and bank stabilization to minimize erosion of phosphorus-containing sediment along a ¾-mile reach of Piney Creek.

We began to explore riparian protection programs, including land acquisition, conservation easements, riparian buffers, overlay zoning, and cluster development.

The Authority continued its support of the Cherry Creek Stewardship Partners in public education efforts that actively engage organizations, citizen scientists, and the interested public in protecting the natural resources of the Cherry Creek watershed.

Our wastewater treatment facilities all met phosphorus and nitrogen discharge limits; in fact, phosphorus discharges were well below the natural background levels in Cherry Creek, often by a factor of 5 times or more, thus "diluting" the stream.

Our Municipal Separate Storm Sewer Systems (MS4s) conducted over 19,000 inspections of construction and permanent best management practices, and undertook 1,650 enforcement actions.

The Authority also developed an interactive online data portal that allows users to easily explore water quality throughout the basin. Users can dive into the data, explore relationships between parameters and locations, compare changes in water quality over time, and identify correlations between parameters. To obtain a portal login, email your request to CCBWAportal@gmail.com

2017 Annual Report on Activities
Cherry Creek Basin Water Quality Authority

CCBWQA Board and TAC Leadership

Board Members	TAC Members
Stephanie Piko	Rick Goncalves
Tom Bishop	Jim Dederick
John McCarty	Steve Miller
Nancy Sharpe	Jill Piatt-Kemper
David Weaver	David Van Dellen
Brad Pierce	Lanae Raymond
George Teal	Ann Woods
Susan Squyer	John Cotten
Joshua Rivero	Jacob James
Pieter Van Ry	Rich Borchardt
Roger Kilgore	Max Grimes
Myrna Poticha	Casey Davenhill
Alan Vajda	Elaine Hassinger
Christopher Lewis	Jason Trujillo
Ron Weidmann	Tim Rose
John Woodling	Bahman Hatami
Lora Thomas	

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"As the Denver Metropolitan Area expands up the Cherry Creek Watershed and surrounds Cherry Creek Reservoir, the CCBWQA continues its effort to maintain water quality and beneficial uses through good public policy decisions. The Annual Report provides an easy-to-read update about the CCBWQA's 2017 efforts, and reflects the leadership provided by the Board and TAC. " - Chuck Reid, CCBWQA Manager

Look for the Link symbol thoughout this report for opportunities to explore water quality data on your own.

There are also many hyperlinks to existing documents, denoted in blue underline.

Contents

Who We Are

We are the Cherry Creek Basin Water Quality Authority (Authority), tasked with improving, protecting, and preserving water quality for beneficial uses. The Authority was formed following the completion of a Clean Lakes Study in 1984, which led to the development of our first Master Plan in 1985. Subsequent to the adoption of the Master Plan, the local governments in the Cherry Creek Basin formed an Authority by intergovernmental agreement and worked diligently to gain State approval of legislation to create the Cherry Creek Basin Water Quality Authority. That goal was accomplished during the 1988 General Assembly with the Governor signing the Cherry Creek Basin Water Quality Authority Statute, House Bill 1029, on April 28, 1988 (C.R.S. 25-8.5-101 *et seq.*).

Authority Board

The governing body of the Authority is its Board of Directors ("Board"). According to our Statute, the Authority Board is to include representatives from the following:

- Arapahoe and Douglas Counties;
- The Cities and/or Towns of Aurora, Castle Pines, Castle Rock, Centennial, Foxfield, Greenwood Village, Lone Tree, and Parker;
- One member representing the seven special districts providing wastewater services in the Authority's boundaries; and
- Seven citizens representing sports persons, recreational users, and concerned citizens appointed by the Governor.

Technical Advisory Committee (TAC)

The Authority's Bylaws allow each entity member (municipality, county, and the one (1) wastewater district member) to appoint one representative to serve on the TAC. The Board may also appoint other individuals who represent educational or public interest groups having an interest in stormwater drainage and water quality in the Cherry Creek Basin, and any governmental or quasi-governmental agencies that are not members of the Authority, but have an interest in stormwater drainage or water quality in the Basin. The role of the TAC is to consider and report to the Board on matters of a scientific or technical nature.

The following entities and interests are represented on the Board and TAC:

	Board	TAC
2 Counties	Arapahoe	Arapahoe
	Douglas	Douglas
8 Municipalities	Aurora	Aurora
	Castle Pines	Castle Pines
	Castle Rock	Castle Rock
	Centennial	Centennial
	Foxfield	Foxfield
	Greenwood Village	Greenwood Village
	Lone Tree	Lone Tree
	Parker	Parker
Others	**1 Special District**	
	Representative from Water & Sanitation Districts	Representative from Water & Sanitation Districts
	7 Governor Appointees	**Public Interest/Local Government (appointed at the Board's discretion)**
	Sports person or recreational organization with members that use Cherry Creek Reservoir (must be Colorado resident)	Southeast Metro Stormwater Authority (SEMSWA) (governmental entity)
	Sports person or recreational organization with members that use Cherry Creek Reservoir (must be Colorado resident)	Cherry Creek Stewardship Partners (non-profit public interest)
	Citizen or environmental organization interested in water quality with members that use Cherry Creek Reservoir or live in Cherry Creek Basin.	Colorado Parks and Wildlife (CPW) (governmental entity)
	Citizen or environmental organization interested in water quality with members that use Cherry Creek Reservoir or live in Cherry Creek Basin.	Urban Drainage & Flood Control District (UDFCD) (governmental entity)
	Person with background or professional training in water quality issues.	Tri-County Health Department (TCHD) (governmental entity)
	Person with background or professional training in water quality issues.	Cherry Creek State Park (governmental entity)
	Person with background or professional training in water quality issues.	TAC Chair (other individual with interest in Cherry Creek Basin)

In 2017, there were Board and TAC vacancies for both Castle Pines and Foxfield.

Our Regulation 72 Responsibilities

Just as the State Legislature created the Cherry Creek Basin Water Quality Authority to improve, protect, and preserve the water quality of Cherry Creek and Cherry Creek Reservoir, the Legislature also created a Water Quality Control Commission (Commission) to develop and implement a program for the prevention, control, and abatement of water pollution and for water quality protection throughout the state.

The Commission has broad powers to promulgate water quality rules and regulations. The Commission establishes beneficial uses for waters of the state and assigns numeric and/or narrative water quality criteria to protect the beneficial uses, along with an antidegradation process to protect existing quality.

Once water quality standards are developed, there are several tools that can be used to ensure the standards are achieved. These include options such as issuing discharge permits, limiting the allowable load of a particular pollutant to a water body, issuing compliance schedules, and developing control regulations.

Cherry Creek Reservoir has a Control Regulation, which is designated "Regulation 72" by the Commission. A control regulation can contain limitations on pollutants that are discharged, management requirements, or precautionary measures to prevent or minimize pollutants entering the water. The Cherry Creek Reservoir Control Regulation 72 prescribes activities necessary to reduce the inflow of total phosphorus concentrations to Cherry Creek Reservoir to attain the chlorophyll α standard.

Regulation 72 requires:

- **Construction of nonpoint source projects, called Pollutant Reduction Facilities (PRFs)**
- **Inclusion of phosphorus permit limits for point source dischargers**
- **Inclusion of Best Management Practices (BMPs) in stormwater permits**
- **Collaboration in pursuing incentives, grants, and cooperative programs for agricultural sources**
- **Implementation of a public information and education program**
- **Limitations on the construction of new Onsite Wastewater Treatment Systems (OWTS)**
- **Consideration of floodplain, riparian corridor, and wetlands projects**
- **Nutrient monitoring**
- **Submission of an Annual Report to the Commission on these activities**

WATER QUALITY STANDARDS =

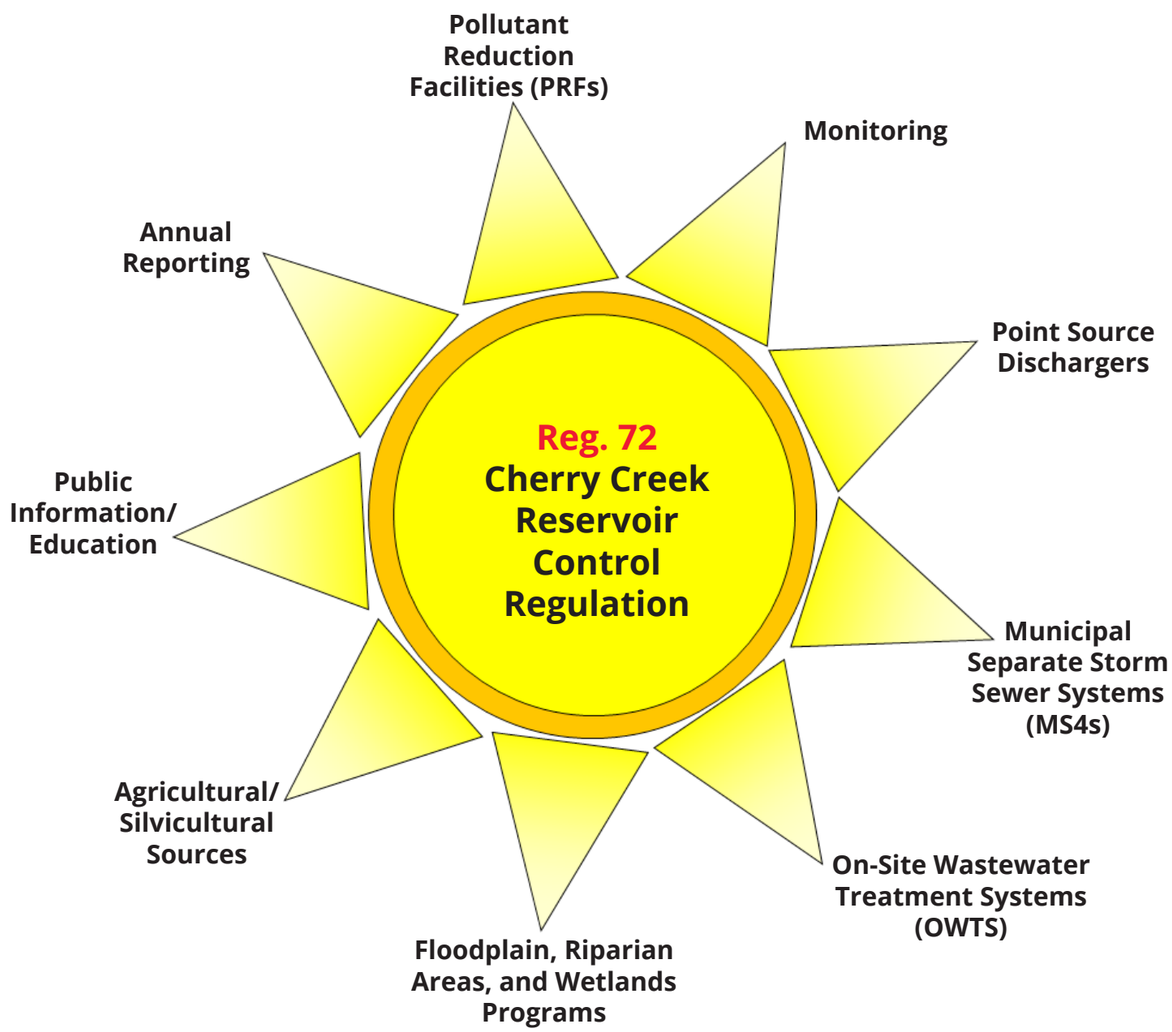
BENEFICIAL USES

+ CRITERIA TO PROTECT USES

+ ANTIDEGRADATION REQUIREMENTS

The activities required under Regulation 72 are assigned to different entities.

- **The Authority** is to construct Pollutant Reduction Facilities, implement a public information and education program, and conduct water quality monitoring. The Authority may collaborate on floodplain, riparian corridor, conservation easements, and wetlands projects.
- **The Colorado Water Quality Control Division (Division)** is to include limits and water quality requirements in point source and Municipal Separate Storm Sewer System (MS4) permits. The Division is also directed to collaborate with agricultural and silvicultural owners/operators in pursuing incentives, grants, and cooperative programs to study and control nonpoint sources, as well as collaborate with local governments to encourage connection of existing OWTS and new development to central wastewater facilities.
- **Tri-County Health Department** cannot allow construction of new Onsite Wastewater Treatment Systems in the 100-year floodplain.



What Makes Us Unique

The Cherry Creek Basin Water Quality Authority was formed by Statute, and given powers and authorities unique to our basin, such as the ability to establish rates, tolls, fees, and charges for the Authority's facilities and program. No other watershed in the state has a statute specifically designed to protect its reservoir.

Although our reservoir is also subject to the Cherry Creek Reservoir Control Regulation 72 (as are many other Colorado reservoirs with similar control regulations), it is the additional powers in our Statute that sets us apart.

The Statute's Purposes include:

Preserving water quality in Cherry Creek and Cherry Creek Reservoir

Preserving waters for recreation, fisheries, water supplies, and other beneficial uses

Promoting the health, safety, and welfare of the people of Colorado

Providing for effective efforts by counties, municipalities, districts, and landowners to protect water quality

Providing that new developments & construction activities pay their equitable proportion of costs for water quality preservation and facilities

Additional Opportunities in Our Statute

Several unique powers are given to the Authority by the State Legislature. The Statute gives the Authority expansive opportunities to protect and improve water quality.

Statutory Opportunities

- Incur debts/liabilities/obligations
- Enter into contracts/agreements
- Acquire/lease/hold/dispose of/encumber real property
- Establish rates, tolls, fees, charges, penalties, Cherry Creek State Park fees, taxes on property, bonds
- Develop and implement plans for water quality controls for the reservoir and watershed to achieve and maintain water quality standards
- Acquire, construct, lease, rent, improve, equip, relocate, maintain, and operate water quality control, nonpoint source, and drainage facilities
- Conduct studies concerning the development of water quality solutions
- Develop and implement programs to provide credits, incentives, and rewards for water quality projects
- Recommend erosion controls and urban runoff control standards
- Conduct educational programs
- Recommend septic system maintenance programs

In addition to general administrative functions, the Statute identifies several methods by which the Authority can raise funds, as well as implement various water quality control mechanisms. Guidelines include:

- Funds must be spent on improving, protecting, and preserving water quality of Cherry Creek Reservoir and the watershed, and on achieving and maintaining the existing water quality standards.
- At least sixty percent of revenues collected by the Authority must be spent on construction and maintenance of Pollution Abatement Projects.

Many of these water quality control techniques are already being implemented, as discussed in this report. For example, the Authority is currently exploring ideas to help preserve water quality in the basin, through developing reservoir and watershed models, and exploring expanded riparian protection options.

How We Fund Authority Activities

Our Statute provides several funding mechanisms that the Authority can use in a manner that is consistent with its statutory purpose to improve, protect, and preserve the water quality of Cherry Creek and Cherry Creek Reservoir.

The Authority levies property taxes (one-half mill) on all taxable property within the Authority's boundaries. Current development fees include $60 per single family residence and $0.04 per square foot of impervious area in commercial and multi-family developments; agricultural lands are exempt from the collection of these fees. Wastewater fees are $0.25 per 1,000 gallons of treated wastewater discharged in the Cherry Creek basin.

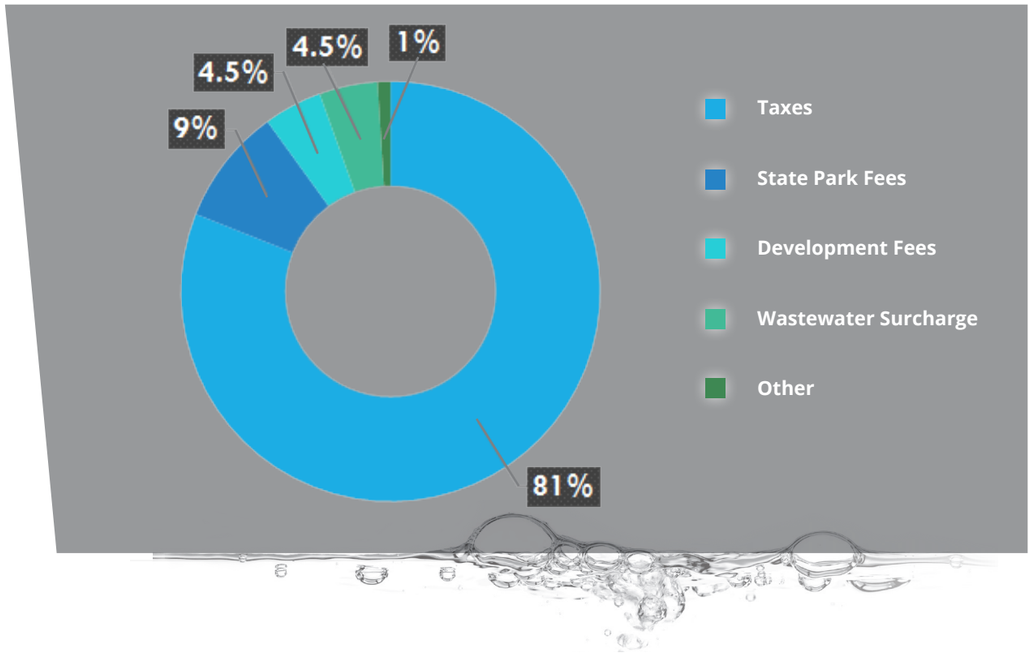
The Authority also receives $3 on annual passes and $1 on single-day passes user fees from Cherry Creek State Park visitors.

The 2018 budget shows $2.6 million in revenues.

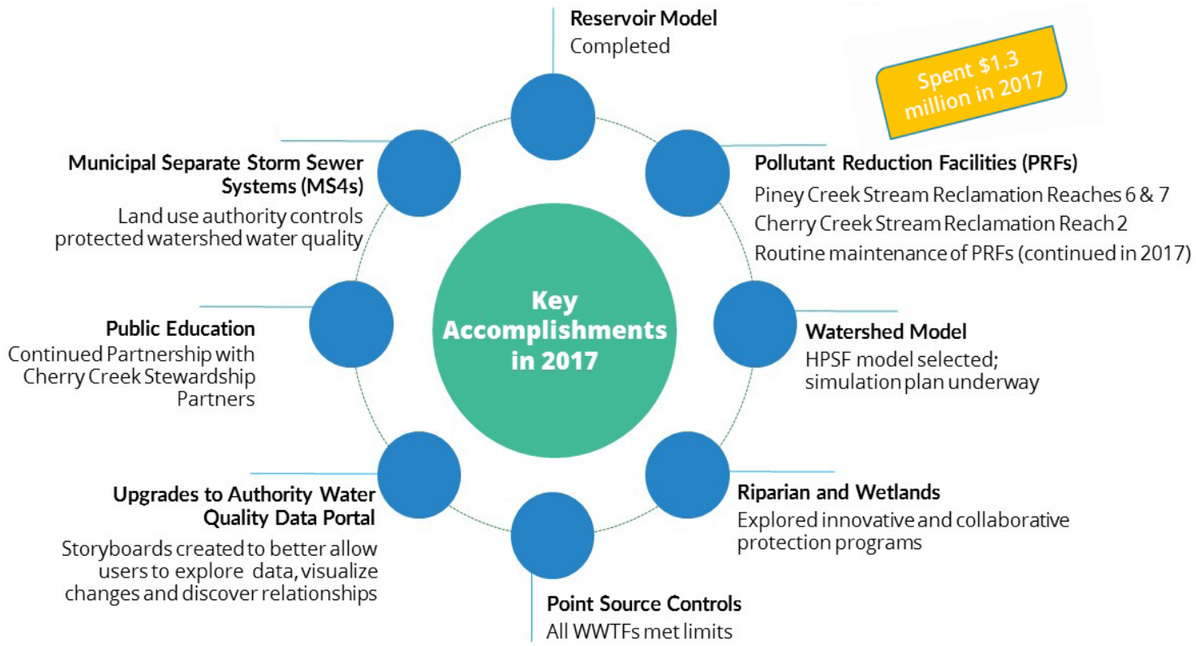
Expenditures and revenues are often not matched each calendar year because implementation and timing of project costs for the Capital Improvement Plan (CIP) can vary significantly from year to year.

The Statute mandates that the Authority spend at least 60% of the annual revenues on the construction and maintenance of Pollution Abatement Projects. The remaining 40% is allocated towards monitoring, special studies, planning documents, technical reports or memoranda, and administrative costs. Because expenditures and revenues are not matched each calendar year, the Authority interprets the 60/40 split referenced above as a multi-year mandate and does not account for this in any one year. In 2017, the Authority did not achieve the 60% requirement, and needs to spend approximately $180,000 on Pollution Abatement Projects in future years to be compliant.

Projected 2018 Revenues



Key Accomplishments in 2017



RESERVOIR COMPLIANCE

Chlorophyll α: The 2017 seasonal average was 18.8 µg/L, which exceeded the water quality standard of 18 µg/L. This is improved from 2016.

Dissolved Oxygen (DO): The 2017 average value was 4.62 mg/L, which exceeds the standard of 5.0mg/L. This occurred in the reservoir's top layer (0.5 to 2.0m) on one day (August 8, 2017) at one site (CCR-1-northwestern part of reservoir). With this one exception, the DO standard was met.

Authority efforts continue to focus on continued improvement in water quality and attainment of standards. Detailed 2017 information is found in the Annual Monitoring Report.

Pollutant Reduction Facilities (PRFs)

PRFs are structural measures that include, but are not limited to, detention, wetlands, filtration, infiltration, and other technologies with the primary purpose of reducing pollutant concentrations entering the reservoir and protecting the beneficial uses of the reservoir. A PRF reduces pollutants in stormwater runoff; it does not discriminate as to the source of the stormwater. It removes pollutants from all upstream stormwater, whether regulated or not. In-channel PRFs effectively treat runoff from recent as well as past development.

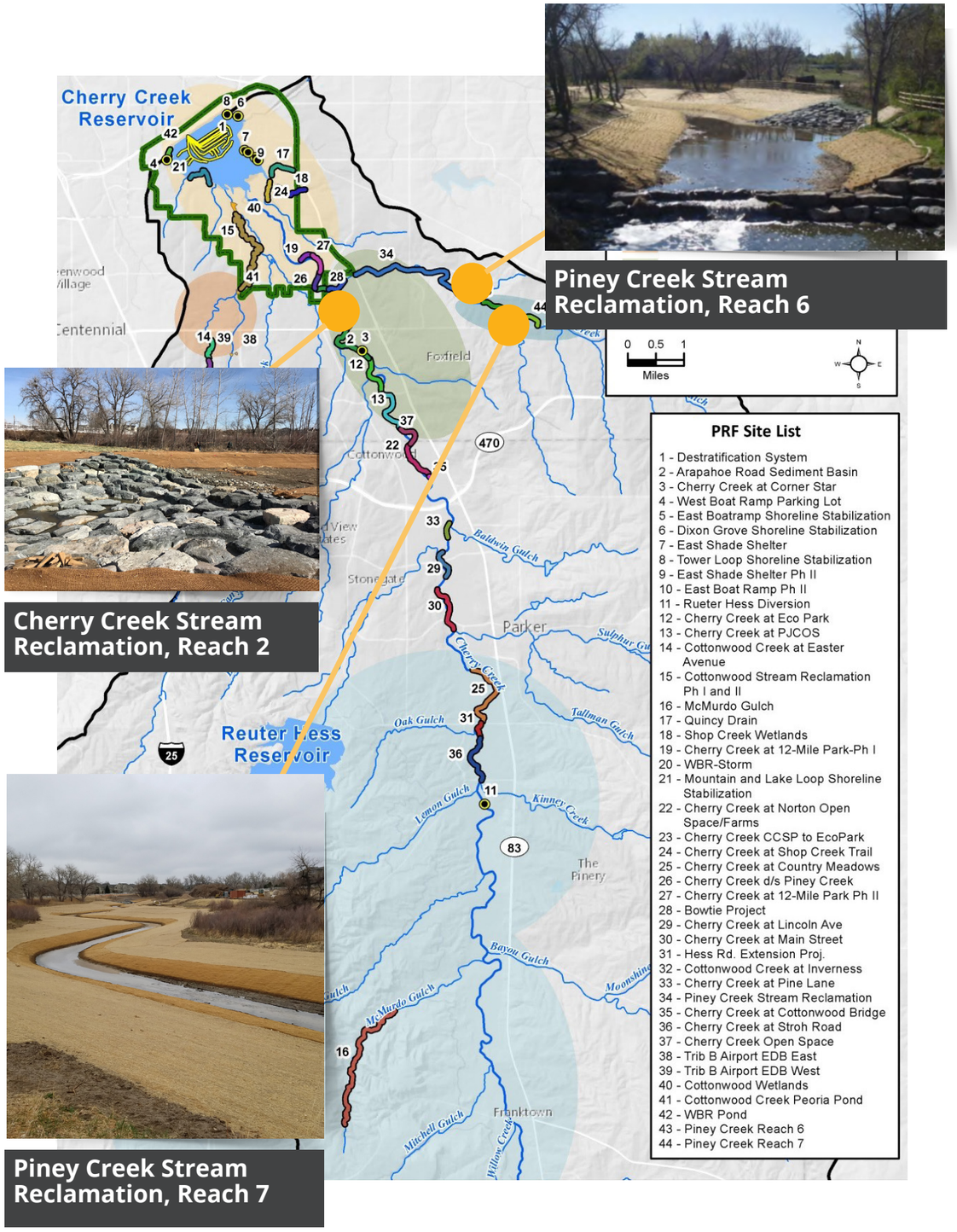
Stormwater Controls

Stormwater controls consist of PRFs constructed by the Authority and similar type projects constructed by local governments. Authority PRFs include water quality controls such as stream reclamation, shoreline stabilization, detention, wetlands, and other activities that provide water quality benefits for the reservoir by reducing pollutants carried by stormwater from existing and future land disturbances.

Funding of PRFs

The costs and benefits of all potential PRFs are evaluated at the conceptual level. If these appear to be reasonable, the PRF is added to the master list maintained by the Authority. Each year the Authority compiles its 10-year CIP, a list of projects to fund in the coming years. Annually, the Board selects projects from the 10-year CIP (see table on page 18) for implementation, based on recommendations from the TAC and subject to available funds.

Past and Current PRF Activity



Highlighted PRF Projects

In 2017, there were 3 key pollutant reduction facilities projects either under construction or completed:

- **Cherry Creek Stream Reclamation - Reach 2**
- **Piney Creek Stream Reclamation - Reach 6**
- **Piney Creek Stream Reclamation - Reach 7**

Piney Creek Stream Reclamation - Reach 6

Total Cost: $2,100,935
Authority Share: $ 525,234

Piney Creek Reach 6 has severely eroded and continues to experience significant erosion during storm events. This continued erosion threatens water quality within the basin, sensitive riparian areas, and wildlife habitat as well as existing trails and utilities.

The project includes construction of grade control / drop structures and bank stabilization to mitigate the existing erosion and minimize future erosion on Piney Creek. Pre, during, and post-project conditions are shown below in Photos 1, 2, and 3.

The project raised the streambed and re-established the water table to prevent further loss of vegetation and down-cutting, erosion, and sediment transport. The overall project goal is restoring and enhancing the aquatic, wetland, and riparian functions of Piney Creek.

Reach 6 Project Before, During, and Post-Construction (counter-clockwise)

Piney Creek Stream Reclamation - Reach 7

Total Cost: $2,693,034
Authority Share: $ 682,556

Likewise, Piney Creek Reach 7 has also severely eroded and continues to experience significant erosion during storm events, which have the same effects on water quality and various habitats within the basin.

Similarly to the Reach 6 project, grade control / drop structures were built and the bank was stabilized to help existing erosion and minimize future impact to that area of the creek. Pre, during, and post-project conditions are shown below in Photos 1, 2 and 3.

Four constructed grouted boulder drop structures and two riffle drops were incorporated to flatten and control the longitudinal grade. The overall project goal is the same - to restore and enhance the aquatic, wetland, and riparian functions of Piney Creek.

Reach 7 Project Before, During, and Post-Construction (clockwise)

> **"Partnering: that is what the multi-year, multi-phased Piney Creek Stream Reclamation Project has been about. Partnering helps meet water quality issues in a rapidly urbanizing watershed and improves quality of life."**
>
> **- Stephanie Piko, CCBWQA Chairman and Centennial Mayor**

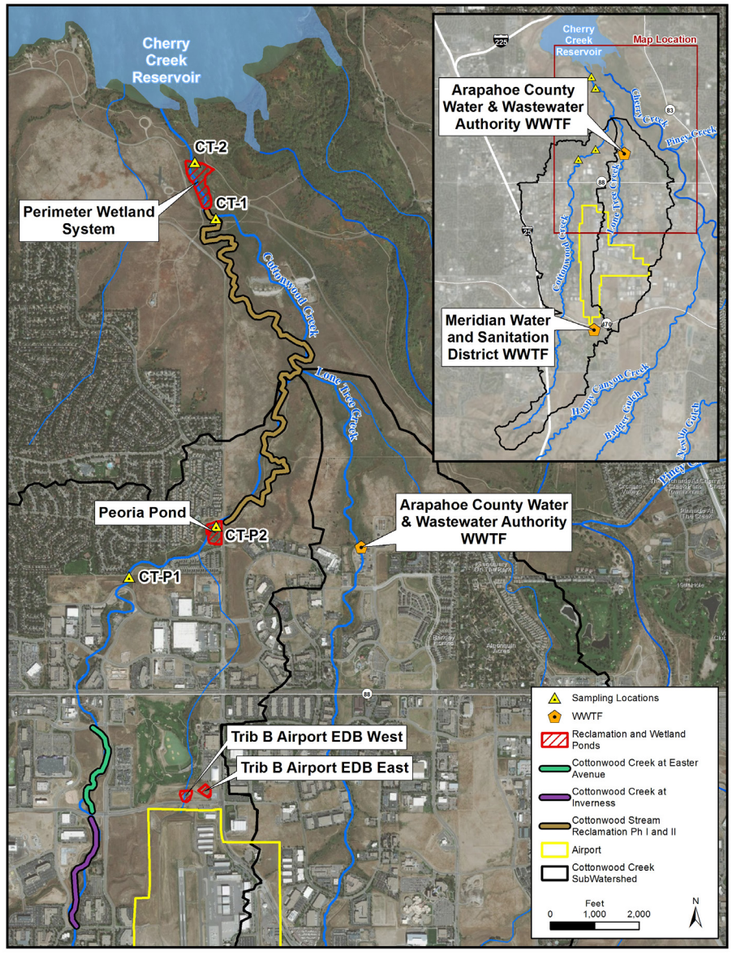
PRF Effectiveness

The Cottonwood Creek Pollutant Reduction Facilities provide phosphorus and sediment reduction during storm events. Together, stream reclamation and wetland detention systems comprise a passive treatment train approach widely implemented by the Authority throughout the basin since the 1990s as an effective water quality strategy.

The combined PRFs are very effective in removing total phosphorus (TP) and total suspended sediments during storm events (see table on next page showing monitoring results for the six storm events monitored during 2017.)

Individually, the upstream Peoria Pond and the downstream Perimeter Wetland System (within the State Park) were each also effective in removing TP and total suspended solids during baseflow periods.

The Perimeter Wetland System was monitored 12 times during WY2017, both upsteam and downstream. TP was reduced across the wetland in all but one sampling event, and total suspended solids were reduced during all 12 events. Total nitrogen increased during 10 of these sampling events.



WATER YEAR: The Authority uses a Water Year system that runs from October 1 - September 30, abbreviated "WY".

The Peoria Pond was sampled seven times in WY2017, both upstream and downstream. About half of the time, TP and total suspended sediments decreased. Total nitrogen decreased across the Perimeter Pond during only one sampling event.

The map above shows other potentially significant water quality influences, positive and negative, in the section between Peoria Pond and the Perimeter Wetland System. Potential influences include Lone Tree Creek, discharges from two wastewater treatment plants, and runoff from the airport and its water quality detention ponds.

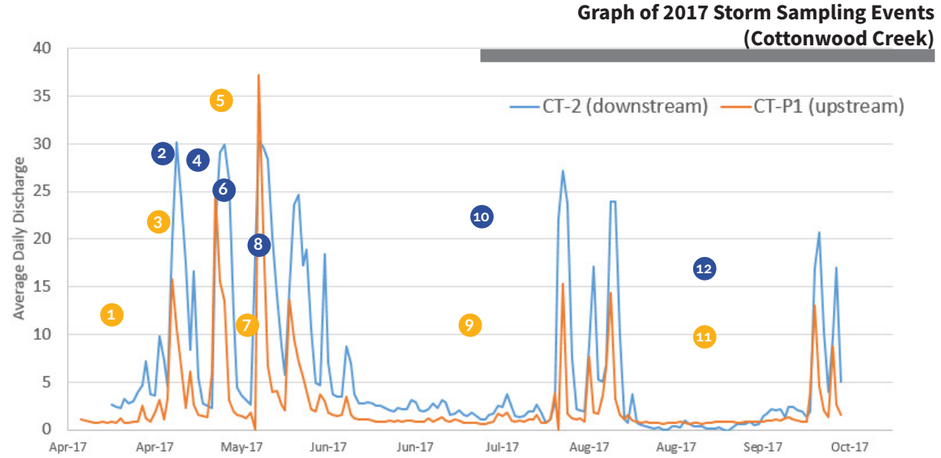
In this section, concentrations of pollutants were more likely to increase. Of the seven paired sampling events, total phosphorus increased five times, total nitrogen increased six times, and total suspended solids four times.

Individual storms were sampled six times in WY2017, with results shown in the table below. Storm events occurred either right before or right after the baseflow sampling at both PRFs twice, once in May and once in August. During both of these events, TP, total nitrogen, and total suspended sediments decreased across each individual PRF, but both TP and total nitrogen increased significantly in the reach between the two PRFs (total suspended sediments also significantly increased between the two ponds during the August storm event).

2017 Storm Sampling Events on Cottonwood Creek Treatment Train, Sites CT-P1 (upstream) and CT-2 (downstream)

	Date Sample Collected	Location	Total Phosphorus (mg/L)	Total Dissolved Phosphorus (mg/L)	Soluble Reactive Phosphorus ("orthophosphate") (mg/L)	Total Nitrogen (mg/L)	Ammonia + Nitrate + Nitrate, as N (mg/L)	Total Suspended Solids (mg/L)
1	4/29/2017	CT-P1 (upstream)	0.274	0.011	0.003	1.56	0.366	80
2	4/30/2017	CT-2 (downstream)	0.044	0.019	0.015	1.65	1.34	6
3	5/8/2017	CT-P1 (upstream)	0.562	0.029	0.002	1.84	0.411	230
4	5/9/2017	CT-2 (downstream)	0.065	0.025	0.013	1.44	0.852	8
5	5/17/2017	CT-P1 (upstream)	0.21	0.008	0.003	1.34	0.511	106
6	5/18/2017	CT-2 (downstream)	0.063	0.045	0.032	1.54	1.225	7
7	5/28/2017	CT-P1 (upstream)	0.11	0.045	0.035	0.851	0.46	41
8	5/29/2017	CT-2 (downstream)	0.041	0.027	0.019	1.15	0.884	3.6
9	8/9/2017	CT-P1 (upstream)	0.099	0.021	0.014	1.14	0.16	19
10	8/9/2017	CT-2 (downstream)	0.111	0.059	0.046	1.13	0.359	12
11	9/23/2017	CT-P1 (upstream)	0.334	0.091	0.082	3.55	0.569	117
12	9/23/2017	CT-2 (downstream)	0.141	0.084	0.071	3.67	1.395	26

Graph of 2017 Storm Sampling Events (Cottonwood Creek)



CIP Table

Summary of Recommended PRFs (Capital and O&M) 2018 – 2027 Budget Projects (1000$)					
Project Title	Current Project Budget		Proposed 2018 Budget	Out-year Budget	Funding Year(s)
	Total	Authority Portion			
Cherry Creek Stream Stabilization at Main Street (Parker)	$1,776	$200	---	$200	2025
Cherry Creek Stream Stabilization at Lincoln Avenue (Parker)	$1,447	$304	---	$304	2026
Cherry Creek Stream Reclamation – Reach 2	$2,771	$475	$270	---	---
Cherry Creek Stream Reclamation – Reach 3	$2,567	$640	---	$640	2020-2021
Cherry Creek Stream Reclamation – Reach 4	$2,720	$680	---	$680	2019-2020
Cherry Creek Stream Reclamation – Cherry Creek State Park Reach 1	$2,220	$2,220	$230	$2,060	2021-2024
Cherry Creek Stream Reclamation upstream of Scott Road (Parker)	$650	$163	---	$163	2019
Piney Creek Stream Stabilization at Caley Avenue	$11,000	$2,750	$500	---	---
McMurdo Gulch Reclamation (Castle Rock)	$1,515	$379	$34	$345	2019-2022
Stream Corridor Preservation	$100	$100	---	$450	2019-2027
East Boat Ramp Shoreline Stabilization Phase II	$80	$80	---	$80	2020
East Shade Shelter Shoreline Stabilization Phase II	$60	$60	---	$60	2020
West Shade Shelter Shoreline Stabilization PRF	$950	$950	$120	$740	2019
Tower Loop Shoreline Stabilization Phase II	$100	$100	---	$100	2020
Nonpoint Pollutant Management	$100	$100	---	$450	2019-2027
Install 1 Meteorological Station at CCSP	$20	$20	$20	---	---
Interpretive PRF Signage at 12-Mile Park (2 signs) & West Boat Ramp (1 sign)	$30	$30	$30	---	---
Total Capital Projects	**$28,106**	**$9,251**	**$1,204**	**$6,272**	
Rehabilitation	---	---	$43	$360	2019-2027
Restorative	---	---	$60	$920	2019-2027
Routine	---	---	$173	$ 1,788	2019-2027
Total Operations and Maintenance	**---**	**---**	**$276**	**$3,068**	

> "The Authority continues to prioritize CIP funding to new reclamation projects and maintenance of existing PRFs that benefit the watershed as a whole."
>
> - Jim Swanson, CIP Manager

Annual PRF Inspection Results

The annual inspection is a requirement of the Operations and Maintenance Agreement between the Authority and CCSP dated January 14, 2006.

The inspection assesses whether the PRFs are functioning as designed and identifies rehabilitative, restorative, and routine maintenance requirements. The TAC uses this report to provide recommendations to the Board for the following fiscal year budgeting of maintenance activities.

In 2017, the inspection of PRFs fell into 2 groups:

- **Group 1** ***(inspected at least annually and after significant storm events)***: Shop Creek, Cottonwood Creek, Cottonwood Wetlands (aka Perimeter Wetland System) and Cherry Creek at 12-Mile Park
- **Group 2** ***(inspected as needed, or upon recommendation/request of authorized agencies)***: East Boat Ramp, East Shade Shelter, Dixon Grove, Tower Loop, Quincy Drain, Mountain/Lake Loop Shoreline Stabilization and West Boat Ramp

All areas in both groups were inspected at least once between June 7 and June 19, 2017.

Other Capital Project Work

12-mile Dog Off-leash Area Fence Extension Project

Educational/Interpretive Signage Replacement at Cherry Creek State Park

Cherry Creek Stream Reclamation – Arapahoe Road
Design and construction of stream reclamation in partnership with SEMSWA, UDFCD, Aurora, and Arapahoe County. Overall project extends from Cherry State Park boundary to Eco-Park (Reaches 2 - 5). SEMSWA is the lead agency. The project is approximately 50% complete

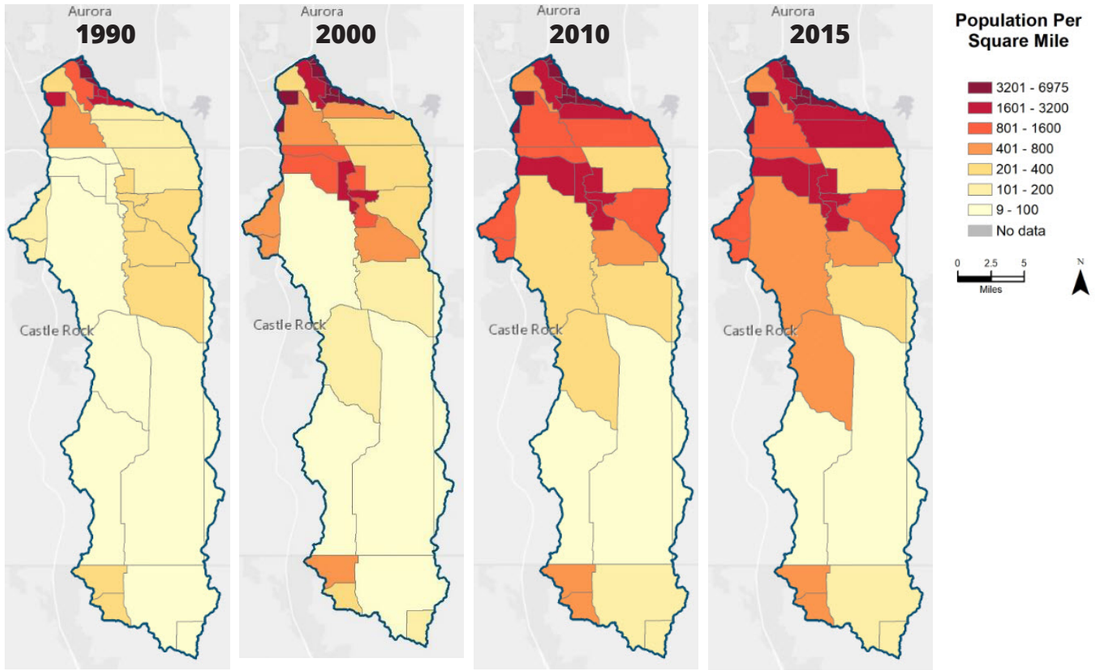
Reservoir Destratification Operations
Seasonal routine operations and maintenance of aeration distribution system and compressor.

PRF Weed Control
Weed control at PRFs within Cherry Creek State Park performed annually (spring and fall applications) in accordance with the Authority's maintenance agreement with Parks.

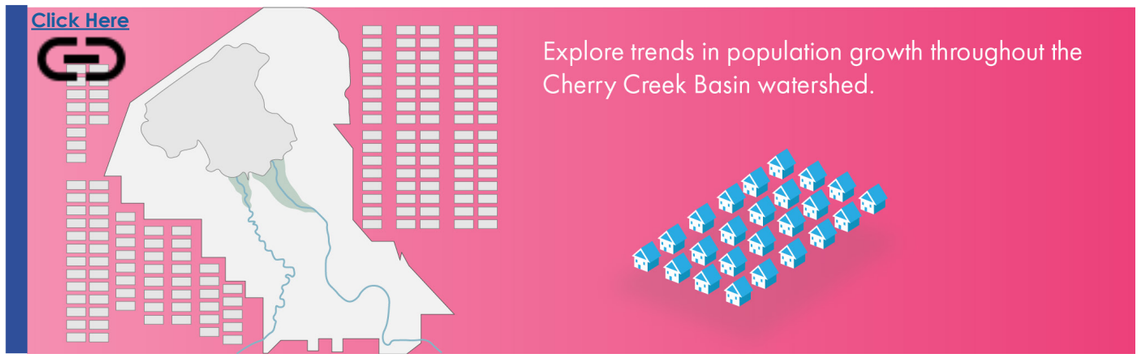
PRF Reseeding at CCSP
Routine restoration of PRF vegetation at Cherry Creek State Park.

Population

The 2015 population in the basin was 3½ times higher than it was in 1990. Population increases generally impact water quality with increased runoff and point and nonpoint source pollutants. However, through strong partnerships with local, state, and federal stakeholders, the Authority has worked to moderate nutrient productivity in the reservoir. The tables on the next page show land use data that correlate with population growth in the basin.



If you click just above the Link symbol thoughout this report, you will jump to the CCBWQA Data Portal (a user-friendly window into our database) and see opportunities to explore water quality data on your own. To obtain a portal login, email your request to CCBWQportal@gmail.com



Land Use Referrals

Annual Summary of Authority 2017 Land Use Reviews					
Year	Total LURs Reviewed	Commercial	Residential	Mixed-Use	Other[1]
2017	198	128	43	2	25
2016	265	147	60	4	54
2015	198	96	54	2	46
2014	154	81	44	0	29

[1] Other includes Open Spaces/ Parks /Rec. Ctrs, Highway / Roadway / Bridge, Utility, and Other.

Approximate Areas of Land Disturbance[1] From the Summary of Authority 2017 Land Use Reviews					
		Land Use Category			
Year	Total Land Disturbance[1] (Acres)	Commercial	Residential	Mixed-Use	Other[2]
2017	1641	777	735	28	101
2016	1338	533	510	18	277
2015	1351	270	1021	0	60
2014	1732	389	1168	0	175

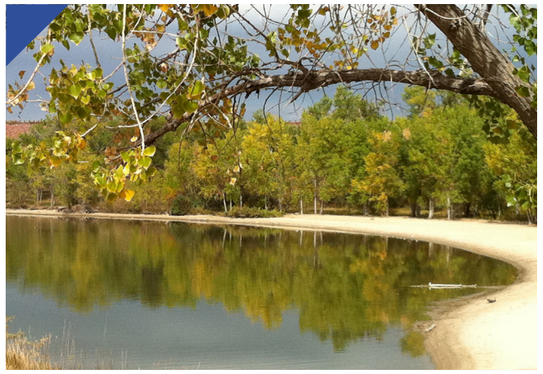
[1] All acreages shown are those of the parcel / lot or tract, are approximate, don't represent the specific area of disturbance with in the parcel / lot or tract and are taken from referral submittal documents. Some referral submittals contain large tracts of land that many develop over a multi-year period.

[2] Other includes, Open Space, Parks, Recreation Centers, Highways and Bridges.

Reservoir Model

Cherry Creek Reservoir is a flood control reservoir that has had periodic blue-green algae blooms and high chlorophyll α concentrations.

To increase oxygen at the bottom of the reservoir and reduce the amount of internal nutrient loading, a destratification system was installed in the reservoir in 2008. The system was also intended to help control cyanobacteria in the reservoir by disrupting their buoyancy. However the destratification system has not achieved these goals. Additionally, there has not been enough evidence to show how the destratification system may influence cyanobacteria blooms.



Due to continued water quality concerns, a water quality model of the reservoir was developed to:

- Better understand the causes of chlorophyll α standard exceedances and cyanobacteria blooms;
- Determine the impacts of the destratification system; and
- Provide a tool to help predict the effects of future management strategies.

The Authority chose a two-dimensional hydrodynamic and water quality model of the Cherry Creek Reservoir that simulated in-reservoir water quality for 2003-2013 (an update with data through 2017 is in progress). The model included a sensitivity analysis, which identified five management scenario runs that to consider changes to:

1) Inflow nutrient concentrations,

2) Destratification system mixing effectiveness, and

3) Inflow nitrogen-to-phosphorus ratios.

FIVE DIFFERENT MANAGEMENT SCENARIOS WERE TESTED; EXAMPLE RUNS ARE SHOWN ON THE FOLLOWING PAGE.

1

Best Anticipated Watershed Control of Nutrients

How would the reservoir respond to the best currently-anticipated reduction of nutrients (nitrate [NO_3], ammonia [NH_4], and orthophosphate [PO_4]) through watershed controls?

2

Increased Destratification System Mixing

How much increased vertical mixing is needed for the destratification system to meet the original bottom DO design target of 5 mg/L?

3

Best Watershed Controls Plus Increased Destratification

How would the reservoir respond to a combination of the best anticipated watershed controls and destratification mixing that achieves 5 mg/L DO at the bottom?

4

Inflow PO_4 % Reduction to Meet Chlorophyll Standard

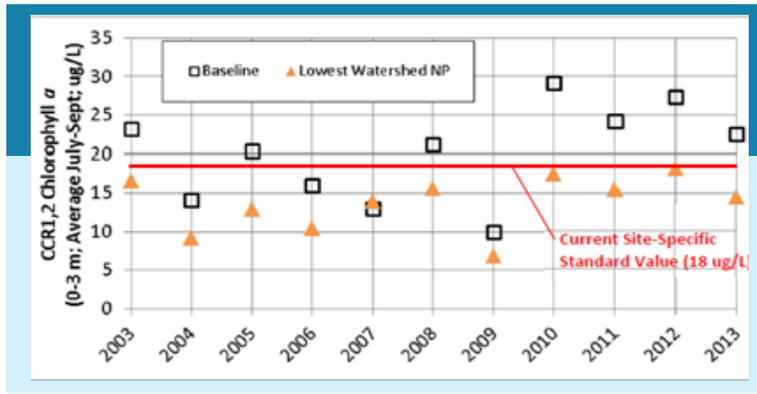
What percent reduction in inflow PO4 concentration is needed to meet the 18 ug/L chlorophyll α standard value for all simulated years?

5

Nitrogen-to-Phosphorus Ratio

Does the model indicate an adverse effect of increased cyanobacteria in response to a disproportionate reduction of inflow nitrogen (NO_3 and NH_4) relative to PO_4 in this nitrogen-limited system?

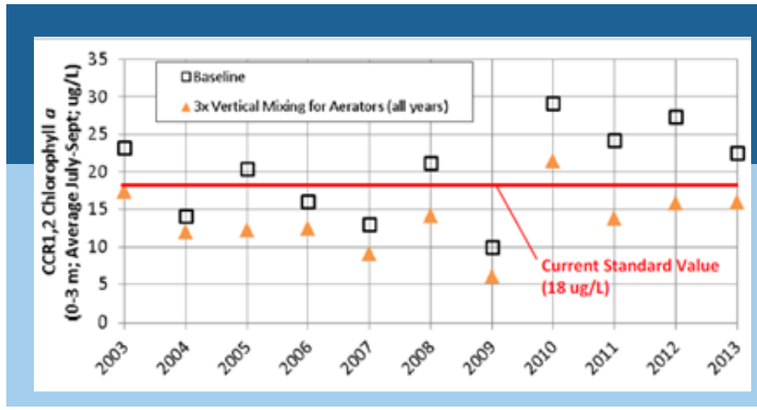
Reservoir Model Example Runs



1

Best Currently Anticipated Watershed Control of Nutrients

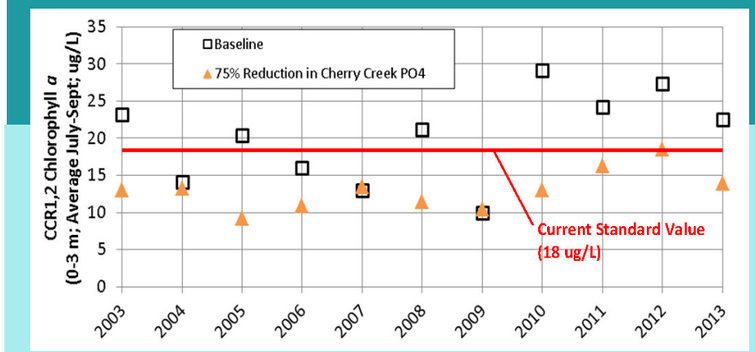
The model shows that if major reductions in both phosphorus and nitrogen are assumed, concentrations of chlorophyll α would decrease from July – September by an average of 6.4 ug/L



2

Increase Destratification System Mixing

Increasing the Vertical Mixing of the current system three times would results in at least 5 mg/L of dissolved oxygen (DO), and it would also decrease chlorophyll α concentrations during the summer months.



4

Inflow PO_4% Reduction to Meet Chlorophyll Standard

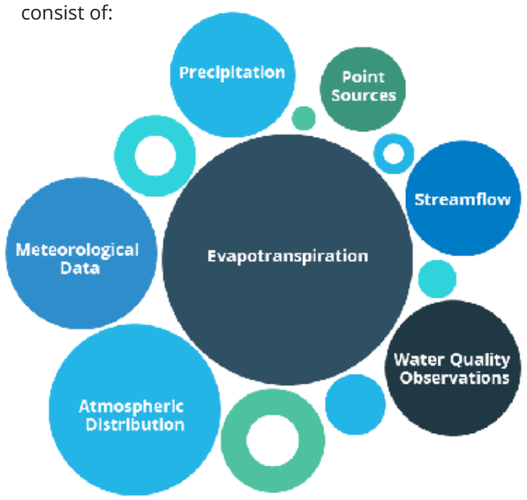
The model indicates that a 75% reduction in inflow PO4 concentrations from Cherry Creek was needed to meet the chlorophyll α value in all of the simulated years.

Watershed Model

In 2017, the Authority initiated development of a new watershed model, to be used in conjunction with the reservoir model. The modeling software selected to model the Cherry Creek Watershed was the US Environmental Protection Agency Hydrologic Simulation Program-FORTRAN (HSPF). The primary goal of the Cherry Creek Watershed Model is to provide detailed information on hydrologic, sediment and nutrient loading as inputs to the Cherry Creek Reservoir and as boundary conditions for the reservoir model. In addition, the Cherry Creek Watershed Model must represent and quantify loadings from multiple land uses, pollutant sources, along with impacts of water quality controls, and instream processes that affect the pollutant loadings to the reservoir.

The Simulation Plan for Cherry Creek details the model setup, procedures, and assumptions, calibrations, and validation time periods, constituents to be simulated, model scales and resolution, model performance targets, and an initial discussion of potential management scenario runs to be investigated as part of the project.

Hydrology and water quality simulation input data will consist of:

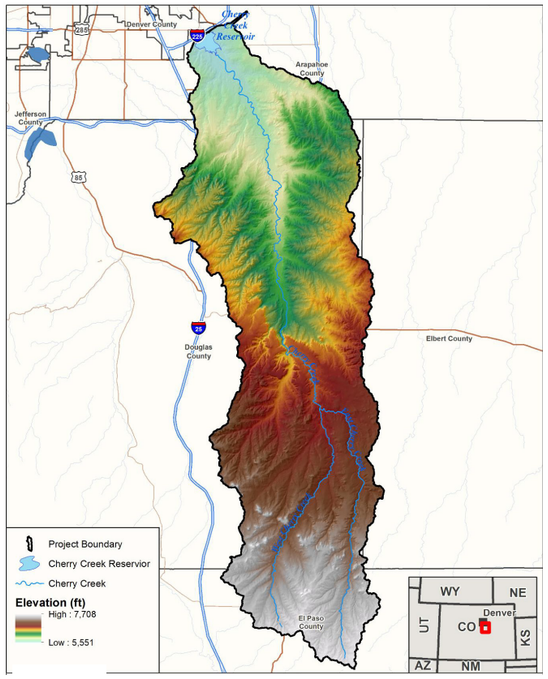


In addition to the hydrology and water quality, the simulation will incorporate segmentation and characteristics of the Cherry Creek Watershed. Watershed segmentation is based on spatial characteristics of the watershed which include:

- Topography
- Drainage Patterns
- Land uses and Distribution
- Meteorological Variability
- Soils Conditions

We anticipate that the model will be completed in 2018. The watershed model will be used to more accurately assess the level of watershed nutrient controls that can be achieved. These will then be used as inputs to the reservoir model.

Watershed Elevations



How We Protect Riparian Areas & Wetlands

Many of the Authority projects re-integrate the stream channel and floodplain along the corridor of Cherry Creek and its tributaries. Re-integration will cause more frequent stormflows to spill out of the channel onto the riparian and floodplain area, and increase filtration/infiltration of the overflow banks. Revegetation along the corridor with wetland plants, grasses, shrubs, and trees provides an aesthetic buffer and promotes enhanced riparian habitat.

Riparian preservation is protection of natural or present condition of a riparian area to prevent its destruction, degradation, or alteration in any manner.

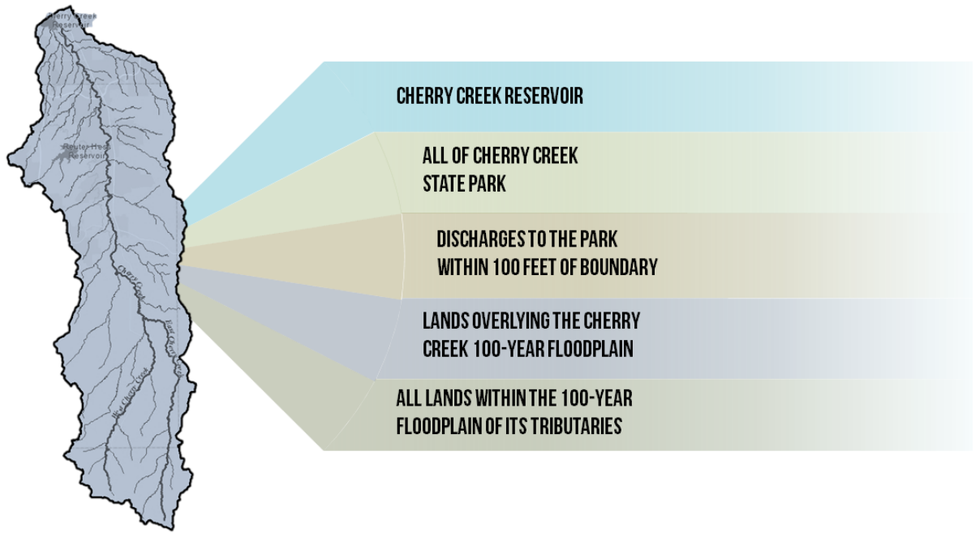
Stream Preservation Areas are specifically identified in Regulation 72, with additional water quality requirements for Cherry Creek Reservoir, all of Cherry Creek State Park, surface drainage and discharges to the Park within 100 feet of the Park boundary, lands overlying the Cherry Creek 100-year floodplain, and all lands within the 100-year floodplain of Cherry Creek tributaries.

The Authority began exploring riparian protection programs that have been implemented in other areas in Colorado, such as:

- Land acquisition
- Conservation easements
- Riparian Buffers and Setbacks
- Overlay Zoning
- Cluster Development

Next steps will be dependent on both the findings of the watershed model, and interest from potential partners.

Stream Preservation Areas Defined in Regulation 72



"The Town of Parker and UDFCD are investigating opportunities to implement native preservation and creation within development areas to encourage increased stormwater infiltration. This collaborative approach with developers will provide healthy native vegetation areas within development as an amenity and provide a watershed approach to runoff reduction and increased water quality." ***- Jacob James, PE - Stormwater Manager, Town of Parker***

WHY STREAM PRESERVATION?

A stream corridor encompasses an active channel, and floodplain surfaces above and outside of the channel banks. Riparian areas are adjacent to streams, rivers, lakes, ponds, and wetlands. Riparian areas act as buffers between upland areas and the stream, and help filter pollutants like nutrients and sediment. Properly functioning stream and riparian areas are critical to maintain water quality, water quantity, riparian habitat, wildlife, fish populations, and diversity, as well as protect downstream beneficial uses.

Note the beaver prints crossing the bridge.

Benefits to a Healthy Riparian Vegetation Area

Reduces stream bank erosion which maintains stable stream channel geomorphology and reduces the velocity of flow

Provides support of sediment deposition on floodplains during periods of overbank flow, which removes total suspended sediments and attached phosphoruis that can degrade water quality

Provides shade, which works to lower water temperatures (lower water temperatures support higher dissolved oxygen levels which are important to maintain fisheries)

Removes phosphorus, nitrogen, and sediment from surface runoff (through plant uptake and filtering) where approximately 80% or more of nitrogen in surface runoff and shallow groundwater can be removed after passing through riparian zone

How We Implement Public Education

The Authority is responsible for developing and implementing a public information and education program, which it fulfills by partially funding and utilizing the service of the Cherry Creek Stewardship Partners (Partners) www.cherry-creek.org.

The Partners formed in response to the need for cross-jurisdictional coordination and communication on watershed issues such as open space, recreation, and water quality in our streams and reservoir.

The Partners bring together representatives from land use jurisdictions, state and federal resource management agencies, conservation, recreation and historic preservation groups, business communities, and interested citizens. In 2017, the Partners held more than 40 public activities for more than 6,000 participants. Recurring events included the Annual Hawk Walk, Solstice and Equinox Walks at the Cherry Creek Valley Ecological Park, the annual Cherry Creek Stewardship Conference, and the Unique to the Creek walks.

For almost 20 years, the Partners have provided a forum for active engagement with the natural resources of the Cherry Creek watershed.

Education and Outreach

The Authority has been a sponsor of the Denver Metropolitan Regional Science Fair since 2007. In 2017, the Fair included more than 500 students in grades 6 to 12. The Partners engaged with businesses, schools, churches, stormwater permit holders, Colorado Parks and Wildlife, and other scientific and cultural organizations to support water quality goals for the Cherry Creek Basin. The Partners hosted over 500 school-age students and parents at the 17-Mile House Farm Park to promote outdoor education, explore the landscape and practice outdoor observation skills.

PRFs and Water Quality Education

PRFs and stream stabilization projects have been constructed in the upper watershed of the Cherry Creek Reservoir. These projects help slow the transport of sediment and create a natural connection filled with native grasses, forbs and shrubs that are home to hundreds of bird, insect, reptile and mammal species. The publicly accessible Cottonwood Creek PRFs provide an opportunity for residents to learn about long-term maintenance of PRFs.

The Partners regularly invite bird and wildlife fans to walk the Cherry Creek basin trails and learn about benefits of stream stabilization and riparian buffers. The annual Hawk Walk on Cottonwood Creek in Cherry Creek State Park is the perfect opportunity to explore the ecology of our watershed and consider the effects of human activity in the Cherry Creek Basin. Additionally, backyard birders and botanists have enjoyed the annual Unique to the Creek walks near Tagawa Garden Center.

The Right Message at the Right Time and Place

In 2017, Tagawa Gardens invited the Partners to repeat their successful soil chemistry classes, geared to local homeowners.

In addition, the Partners were asked to participate with users at the Dog Off-leash Area at Cherry Creek State Park to promote good dog etiquette.

Annual Stewardship Partners Conference

This conference brings a broad range of watershed interests together to learn from one another. In 2017, the Partners explored topics such as "Cherry Creek Tributaries Master Drainageway Plan 2018", "Making Science a Fun Part of Your Everyday Life; Using App Technology for Worldwide Citizen Science", and "Ask an Ungulate: What Ranchland Data Collection Can Tell Us About Stream Health in the Upper Cherry Creek Basin".

2017 Educational Flyers

Cherry Creek Stewardship Partners

Walk in the Park
Saturday, June 24, 2017
8:00 am – 10:00 am
Exploring the Ecology of Cherry Creek

Join Master Birders from the Audubon Society and representatives from land use agencies who are engaged in stream reclamation and flood control projects along Cherry Creek for a look at our local waterway – from a bird's eye view.

The Cherry Creek Stewardship Partners will lead a Summer Solstice Tour as part of the quarterly census of wildlife activity at the Park. Who lives here? How have they adapted their lifestyle to their home? How have they adapted their home to their lifestyle? Learn about nature and science at this unique open space park in Arapahoe County.

This is our sixth annual Summer Solstice walk.

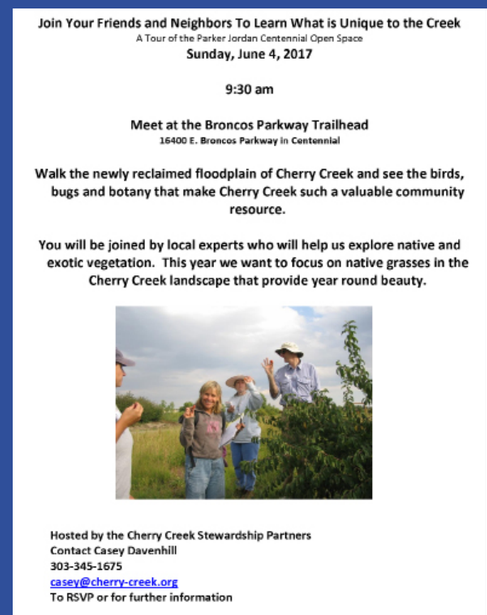
Here is a short list of what we see at the Park.

Turkey Vultures Western Meadowlark Killdeer Say's Phoebe
Barn Owl Red-tailed Hawk Song Sparrow Pine Grosbeak
House Wren Various Swallows Goldfinch Downy Woodpecker
Flicker Cabbage White Butterfly Tadpoles & Frogs
Damselflies & Dragonflies Rabbits Coyote tracks and scat

7500 S Jasper Ct, Centennial, CO 80112
The Park can be accessed from the intersection of Arapahoe and Jordan roads. Take Jordan Road south approximately 1.3 miles, turn left on Jamison Street and then left on Jasper Court. The Park is open from dawn to dusk daily.

Cherry Creek Basin Water Quality Authority, Arapahoe County, City and County of Denver, Douglas County, City of Aurora, Parker Jordan Metro District, Arapahoe County Water and Wastewater Authority, Arapahoe County SPLASH, SEMSWA, Douglas County Open Space and Natural Resources

Direct inquiries to Casey Davenhill: 303.345.1675; casey@cherry-creek.org



Join Your Friends and Neighbors To Learn What is Unique to the Creek
A Tour of the Parker Jordan Centennial Open Space
Sunday, June 4, 2017

9:30 am

Meet at the Broncos Parkway Trailhead
16400 E. Broncos Parkway in Centennial

Walk the newly reclaimed floodplain of Cherry Creek and see the birds, bugs and botany that make Cherry Creek such a valuable community resource.

You will be joined by local experts who will help us explore native and exotic vegetation. This year we want to focus on native grasses in the Cherry Creek landscape that provide year round beauty.

Hosted by the Cherry Creek Stewardship Partners
Contact Casey Davenhill
303-345-1675
casey@cherry-creek.org
To RSVP or for further information

What's New with Point Source Controls in 2017

Wastewater treatment facilities (WWTFs) in the basin provide TP removal through advanced wastewater treatment processes, followed by direct discharge, or further treatment through land application. Some WWTFs also remove total inorganic nitrogen (TIN) to meet permit limits (10 mg/L). There are currently five permitted WWTPs in the basin that discharge to Cherry Creek waters. Another, Plum Creek Water Reclamation Authority, is located outside the watershed but applies some of its treated effluent as irrigation water within the watershed.

Wastewater and industrial process wastewater sources are limited in the amounts of phosphorus they are allowed to discharge to the Cherry Creek Reservoir watershed. Limits contained in the point source discharge permits in the basin effectively reduce nutrient concentrations in the receiving streams. For example, TP discharge limits for WWTPs, which for most dischargers are less than 0.05 mg/L TP as a 30-day average, are significantly less than the flow-weighted TP concentrations currently entering the reservoir from aggregated sources (surface and groundwater inflows, precipitation). Actual concentrations discharged by wastewater treatment plants continue to be consistently below their permit limits and well below the 0.200 mg/L flow-weighted phosphorus concentration goal established for flows into the reservoir.

Evaluation of Permit Compliance and Effectiveness in Reducing Nutrient Concentrations

All WWTFs in the basin met their phosphorus discharge limits. Required effluent limits for TP concentrations discharging from wastewater facilities and industrial process wastewater sources (i.e., for most dischargers, less than 0.05 mg/L TP concentration as a 30-day average) are significantly less than the flow-weighted TP concentration goal of 0.200 mgL. Actual effluent concentrations were consistently below their limits. WWTFs also met their TIN limits in 2017.

Monthly TP and TIN concentrations for each WWTP are outlined in the table on the following page. Concentrations are based on monthly Discharge Monitoring Reports that are discharger-submitted. In 2017, no permits were in violation of phosphorus concentration limits. All wastewater treatment facilities are removing substantial amounts of phosphorus, especially the forms of phosphorus that are readily available for algal or bacterial uptake in the reservoir.

As of 2017, only three WWTFs have TIN limits on their permits: Pinery, Parker, and Stonegate. All three facilities were in compliance with their TIN limits.

Phosphorus and Nitrogen Effluent Concentrations

Facility	Parameter	30-day Avg. TP Limit (mg/L) or Daily Maximum TIN Limit (mg/L)	Reporting Requirements	Maximum Reported Value (mg/L)	Met Permit Limits? (yes/no)	
					TP	TIN
Arapahoe County Water & Wastewater Authority	TP	≤ 0.05 (30-day avg) Discharges to Lone Tree Creek.	Monthly	0.036 (30-day avg)	Yes	
	TIN	No Limit or Reporting Requirement.	--	--		***
Pinery Water & Sanitation District	TP	≤ 0.05 (30-day avg) (Outfall 002A: Discharges to Cherry Creek)	Monthly	0.04 (30-day avg)	Yes	
	TIN	10 (daily max) (Outfall 002A: Discharges to Cherry Creek)	2 Days/Month	9.34 (daily max)		Yes
Parker Water & Sanitation District	TP	≤ 0.05 (30-day avg) (Outfall 002A-NT: Combined North & South WRFs Discharge to Regional Reservoir)	2 Days/Month	0.04 (30-day avg)	Yes	
		≤ 0.05 (30-day avg) (Outfall 003A: Combined North and South WRFs Discharge to Sulfur Gulch)	2 Days/Month	0.04 (30-day avg)	Yes	
	TIN	10 (daily max) (Outfall 002A-NT: Combined North and South WRFs Discharge to Regional Reservoir)	3 Days/Week,	6.7 (daily max)		Yes
		10 (daily max) (Outfall 003A: Combined North and South WRFs Discharge to Sulfur Gulch)	3 Days/Week	8.07 (daily max)		Yes
Meridian Metropolitan District	TP	≤ 0.5 * (90-day avg) ** Land Application.	Quarterly	no 30-day reporting requirements in Notice of Authorization **	Yes	
	TIN	No Limit or Reporting Requirement	--	--		***
Stonegate Village Metropolitan District	TP	≤ 0.25* (30-day avg) (Outfall 001A: Discharges to storage)	Monthly	0.14 (30-day avg)	Yes	
		≤ 0.05 (30-day avg) (Outfall 002A: Discharges to Cherry Creek)	Monthly	0.04 (30-day avg)	Yes	
	TIN	10 (daily max) (Outfall 002A: Discharges to Cherry Creek)	2 Days/Month	9.08 (daily max)		Yes
Plum Creek Water Reclamation Authority	TP	≤ 0.05 (30-day avg) (Outfall 007A: Cherry Creek Basin)	Monthly	0.03 (30-day avg)	Yes	
	TIN	No Limit or Reporting Requirement	--	--		***

* The flow-weighted average phosphorus concentration must be ≤ 0.05 mg/L TP, divided by the land application return flow factor.

** TP limit is a 30-day average, unless a 90-day average is approved by the Division at the request of the discharger.

*** No TIN permit limit

Approved Site Location Applications

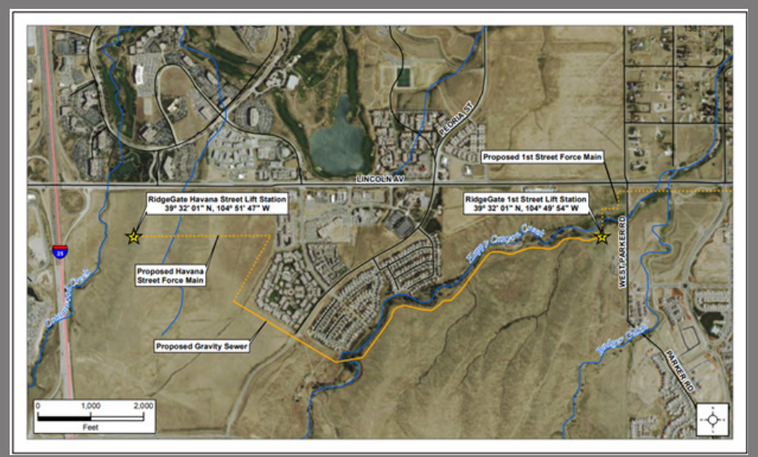
As the designated regional water quality management agency for the Cherry Creek Reservoir watershed, the Authority reviews site applications for domestic wastewater treatment works, including WWTFs and lift stations. Application reviews address protection of Cherry Creek Reservoir and the watershed with respect to phosphorus and nitrogen, general water quality, protection of downstream water quality to protect water supplies, and adequacy of proposed design processes and capacity to protect water quality. As required by Regulation 72, the Authority must report annually on approved site applications. In 2017, only one site application was received by the Authority.

The Happy Canyon Interceptor Sewer will convey future wastewater flows from the RidgeGate development to the First Street Lift Station. The interceptor sewer crosses Happy Canyon Creek at one location. The preliminary construction plans show the interceptor sewer installed within a casing pipe with all pipe joints restrained.

Additionally, the interceptor sewer crosses the floodplain in one location. At this location the pipe is encased in concrete.

Parker Water and Sanitation District will own and operate the system following construction and acceptance of the force main. The Emergency Response Plan (an additional regulation of the Authority) includes a list of personnel roles and emergency notifications / response procedures and how they are to be managed and completed.

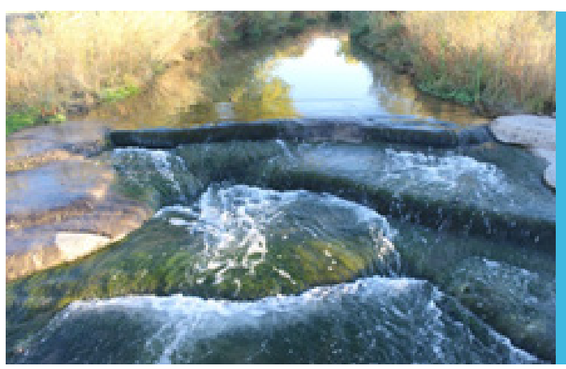
RidgeGate Happy Canyon Interceptor Sewer Site Application



STATUS
Board Approved 1/18/2018

APPLICANT
Parker Water and Sanitation District (PWSD)

OWNER
PWSD



Control requirements for point source dischargers were effective in reducing phosphorus concentrations to the watershed and reservoir.

What's New with Our MS4s in 2017

All Municipal Separate Storm Sewer Systems (MS4s) in the watershed have adopted stormwater regulations that set water quality requirements, consistent with Regulation 72 , for construction and post-construction of new development and redevelopment projects within their jurisdictions

The following table summarizes the 2017 stormwater permits, inspections, and enforcement actions for construction and post-construction development. Further information on each MS4's program can be found in their annual reports, due to the Division on March 10 (Phase II MS4s) and April 1 (Phase I MS4s).

Land Use Agency	Construction Sites	Construction BMPs			Permanent BMPs	
	Total Sites	Number of Inspections	Number of Enforcement Actions	Number of BMPs (or BMP Sites Constructed)	Number of Inspections	Number of Enforcement Actions
Arapahoe County	29	520	6	0	6	0
Douglas County	1,338	10,428	332	2 (New)	53 (Total for all BMPs, new and existing)	26 (Total for all BMPs, new and existing)
City of Aurora	69	761	37	0	6	0
SEMSWA (City of Centennial)	85	1,018	16	5	39	0
City of Greenwood Village	0	0	0	22	16	0
City of Lone Tree	9	128	3	0	0	0
City of Castle Pines	6	31	0	3	3	0
Town of Castle Rock	1,688	4,271	1,166	3	244	1
Town of Parker	124	1370	63	26	322	0
CDOT	1 Arapahoe/ Cherry Creek	12 (Completed Sites)	0	0	0	0

MS4 Public Information & Education

Aurora Youth Water Festival: Held every May, this event is a free one-day festival for 5th graders at the Community College of Aurora. Aurora Water helps these students learn about water through fun hands-on activities and exhibits. Aurora Water also continued their program "Forests to Faucets", a free three-day workshop for educators who can earn 1.5 semester hours of K-12 graduate/recertification.

Arapahoe County SPLASH Education and Outreach Program: This program teaches community members how local actions can impact stormwater and water pollution. The SPLASH program prepares educational materials such as flyers, soil test kits, and other ways community members can help reduce excess nutrients (nitrogen and phosphorus) from entering the Cherry Creek Reservoir.

Parker Water and Sanitation District continued to partner with Tagawa Gardens to offer free community workshops on ways to introduce drought-tolerant landscaping that can save water and reduce water bills.

Parker Water and Sanitation District has completed the master plan for Rueter-Hess Reservoir, which will serve as storage, and a source of clean drinking water as well as provide recreational opportunities.

SEMWSA Staff are involved with numerous varied outreach activities that strengthen the connection between people and their watershed.

Data Portal

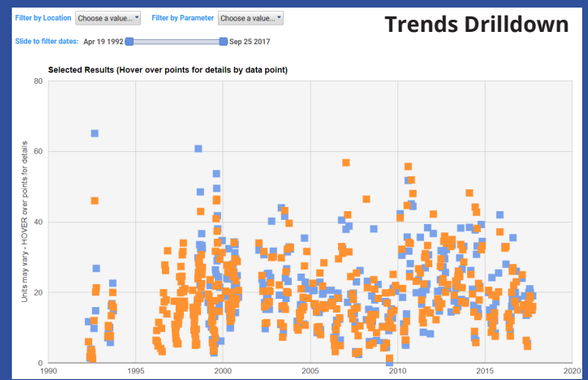
Over the last 25 years, the Authority has developed an expansive water quality dataset throughout the Cherry Creek Basin. Working with large datasets and parsing out the stories they have to tell can be a tall order, requiring expertise and large investments of time. Recognizing these complexities, the Authority sought to develop an interactive online data portal that allows users to easily explore water quality throughout the basin.

The Portal is a secure online data exploration platform that can be accessed from any web browser and is found at http://ccbwqportal.org/. See next page for instructions on obtaining a login.

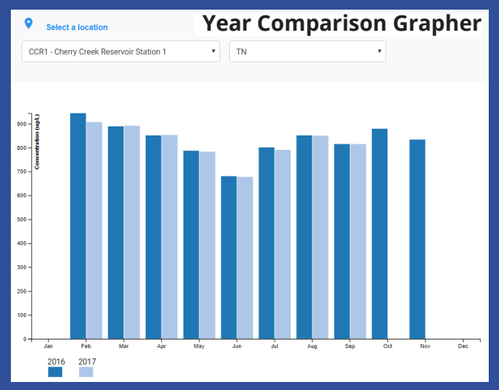
Available tools for the Portal match questions identified for exploration throughout the watershed. Users can dive into the data and explore relationships between parameters and locations, compare changes in water quality data seasonally over many years, and discern correlation between parameters. Users can also export data from the portal through the data download tool.

What Questions Can Be Explored?

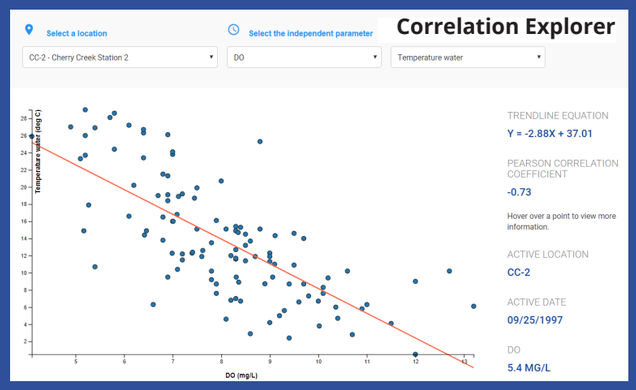
A variety of questions can be explored through the storyboards provided on the Portal. The storyboards are a set of tools designed to answer specific questions regarding water quality throughout the Cherry Creek Basin.



Easily explore water quality data throughout the Basin using the Data Explorer page. Visualize individual sampling results through graphs and tables to learn more about water quality throughout the basin.



Use the Year Comparison Grapher tool to select a location and parameter and explore how water quality has changed over the years. Easily compare year-to-year changes in water quality throughout the basin on a monthly basis.



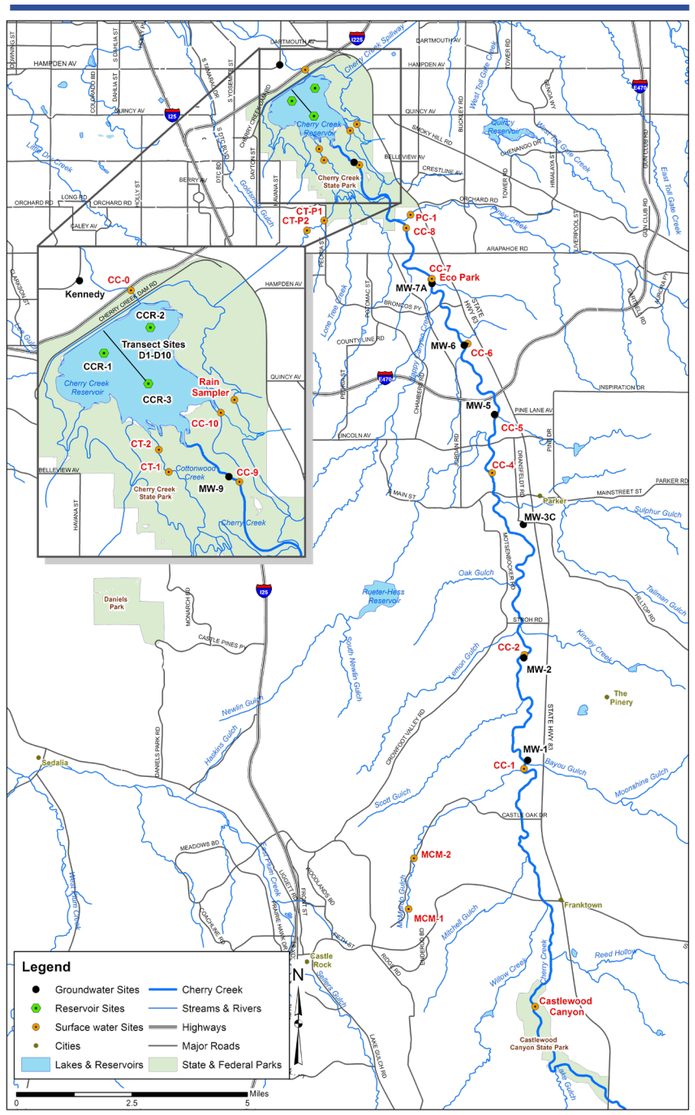
Curious how two parameters might be related to one another? Use the Correlation Explorer to plot any two parameters against each other for a selected location and view the results in the graph.

2017 Monitoring Results

In accordance with Regulation 72, the Authority has implemented a water quality monitoring program in both the watershed and the reservoir to characterize water quality of inflows and of the Reservoir to determine regulatory compliance.

- Surface water, groundwater, reservoir, and precipitation are sampled at 26 sampling locations.
- Over 2,700 lab analyses are completed annually.
- The data are used to evaluate attainment of water quality goals, compliance with water quality standards, and to characterize water quality trends.

The Authority's monitoring program is conducted in accordance with Cherry Creek Reservoir Control Regulation No. 72 and the Cherry Creek Sampling and Analysis Program and Quality Assurance Procedures and Protocols.



MAP 7.1: SAMPLING SITES ON CHERRY CREEK RESERVOIR, SURFACE WATER MONITORING SITES AND ALLUVIAL GROUNDWATER SITES

Click Here

What Data are Available Through the Portal?

Monitoring Areas

- Cherry Creek
- Cottonwood Creek
- McMurdo Gulch
- Cherry Creek Reservoir
- Shop Creek
- Monitoring Wells
- Cherry Creek Reservoir Sediment Sites

Parameter Groups

- Nutrients, Algae and Bacteria
- Physical Parameters
- Metals and Chemistry
- Sediments
- Radioactivity

Links to the Portal are included in the following pages; we invite you to explore the data yourself! You can also find locations of monitoring sites on the Maps tab.

To obtain a portal login, email your request to **CCBWQportal@gmail.com**

2017 Regulatory Results

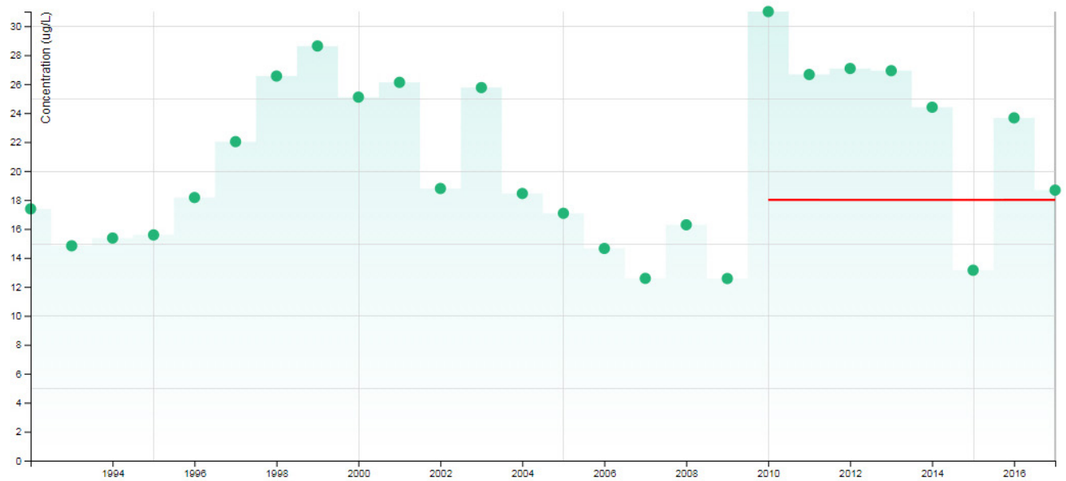
Water Quality Standards Compliance

In WY2017, the temperature and pH reservoir standards were met. Chlorophyll α and dissolved oxygen standards were not achieved.

Chlorophyll α

The seasonal average chlorophyll α in 2017 was 18.8 ug/L, exceeding the water quality standard of 18 ug/L. The seasonal mean concentration is measured in the upper three meters of the water column (photic zone), with an allowable exceedance frequency of once in five years. The reservoir has exceeded the chlorophyll α standard in four of the last five years.

Seasonal Mean Concentrations of Chlorophyll α Measured in Cherry Creek Reservoir



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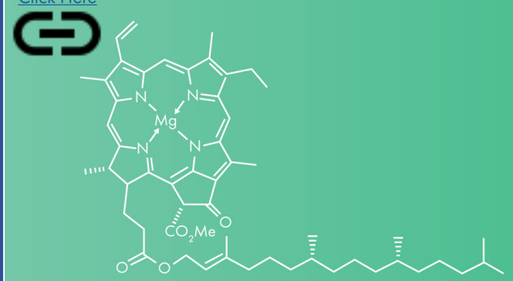
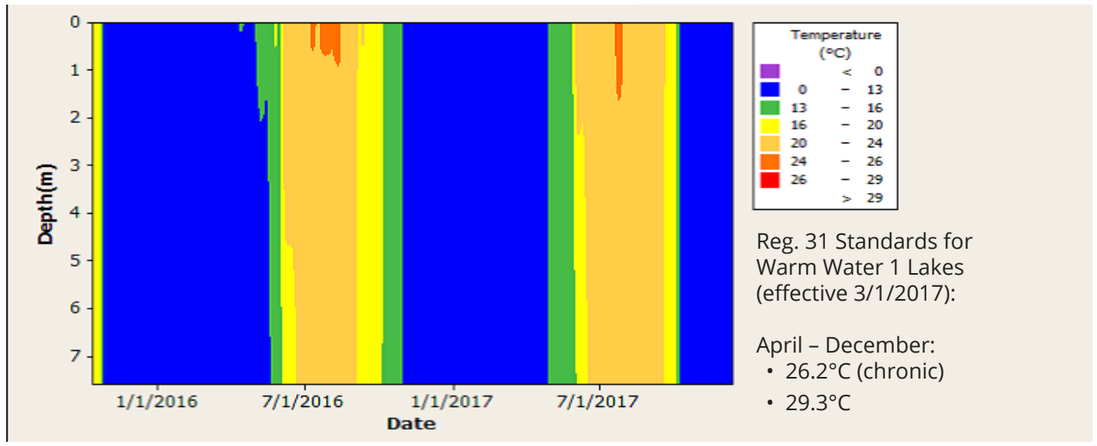


Explore Chlorophyll-a levels throughout the reservoir and understand annual and seasonal trends. Use the seasonal trends tool to compare seasonal mean concentrations in the reservoir to the water quality standard. For a deeper dive, use the CCR Drilldown tool to investigate individual sampling events at all three reservoir sites.

Dissolved Oxygen (DO)

DO concentrations are above the standard of 5.0 mg/L throughout the majority of the time in the top layers of the reservoir. However, on August 8, 2017, an average value of 4.62 mg/L was observed at CCR-1 (northwest part of the reservoir). This was only exceedance of the DO standard in 2017. Same-day average oxygen levels at the other two reservoir sampling sites were 5.08 mg/L and 5.32 mg/L, respectively, which met the standard.

Temperature at CCR-2

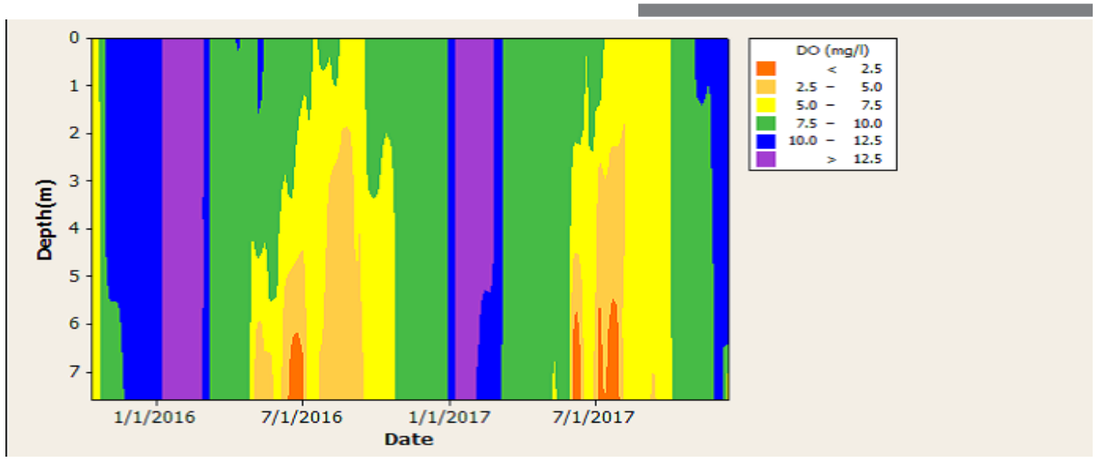


Reg. 31 Standards for Warm Water 1 Lakes (effective 3/1/2017):

April – December:

- 26.2°C (chronic)
- 29.3°C

Dissolved Oxygen at CCR-2

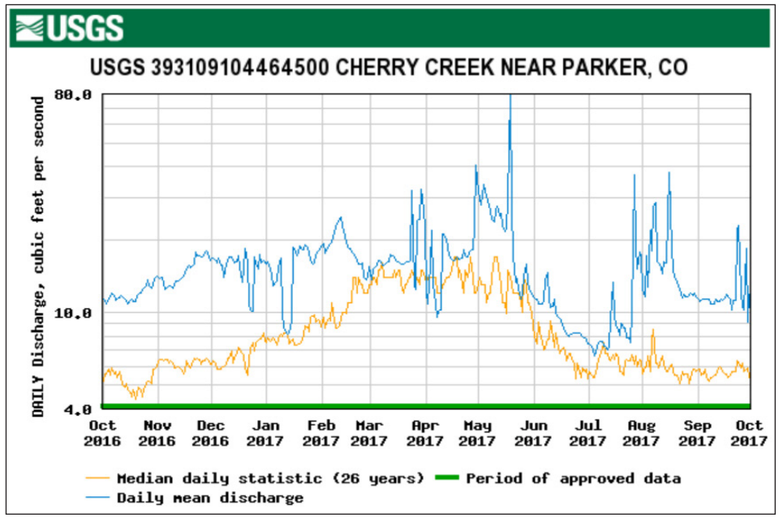


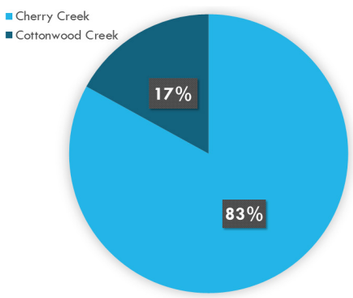
Flow Data

In WY2017, higher than normal streamflow was measured in Cherry Creek. For example, at the USGS gage near Parker, located approximately 9 miles upstream of the Cherry Creek Reservoir, WY2017 flows totaled 11,052 ac-ft, with an average daily discharge rate of 15.3 cfs. This is approximately 37 percent higher than the long-term (WY1992-WY2017) average daily rate of 11.1 cfs.

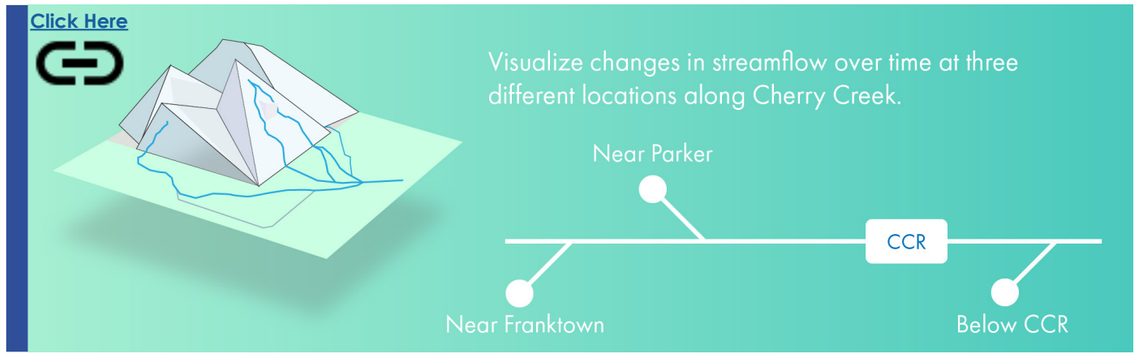
Compare this to the Authority's continuous recording gage at site CC-10, just upstream of the reservoir on Cherry Creek, where WY2017 flows totaled 17,362 ac-ft, with an average daily discharge rate of 24.0 cfs. These values are approximately 57 percent greater than those observed at the USGS gage near Parker.

The Authority also operates continuous recording equipment on Cottonwood Creek. WY2017 flows at site located just upstream of the reservoir, CT-2, totaled 3,431 ac-ft, with an average daily discharge rate of 4.7 cfs.





Cherry Creek contributes the majority of surface water into the reservoir.



Nutrient Inputs to Reservoir

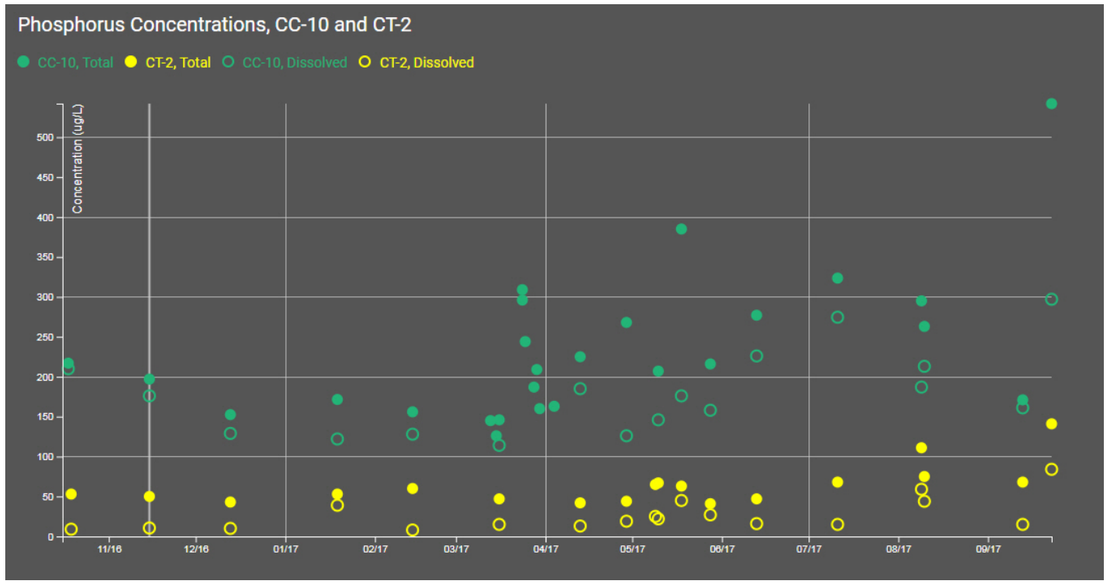
Surface Water Quality

Phosphorus at the mouth of Cherry Creek was mostly dissolved, except during storm-related high flows when large amounts of sediment (and phosphorus) were transported in Cherry Creek.

The flow-weighted total phsophorus (TP) concentration at CC-10 for WY2017 was 229 µg/L, which was lower than concentrations during the previous 8 years, which ranged between 231 µg/L and 276 µg/L.

The WY2017 flow-weighted average TP concentration for Cherry Creek station CC-10 remains much higher than the WY2017 flow weighted total phosphorus concentration of 62.2 µg/L calculated for station CT-2 in lower Cottonwood Creek.

The level of phosphorus is lower in Cottonwood Creek than in Cherry Creek in WY2017, but concentrations of nitrogen measured at CT-2 in lower Cottonwood Creek in WY2017 were higher than that observed in Cherry Creek.



Long-term Watershed Input Trends

In 2009, the Commission adopted a concentration-based management strategy for phosphorus control in the Cherry Creek Basin. The goal is to achieve an average flow-weighted phosphorus at or below 200 µg/L for all inflows to the reservoir. The 200 µg/L value was determined by the Authority and the Commission to be the background concentration for phosphorus in the basin.

Cottonwood and Cherry Creek

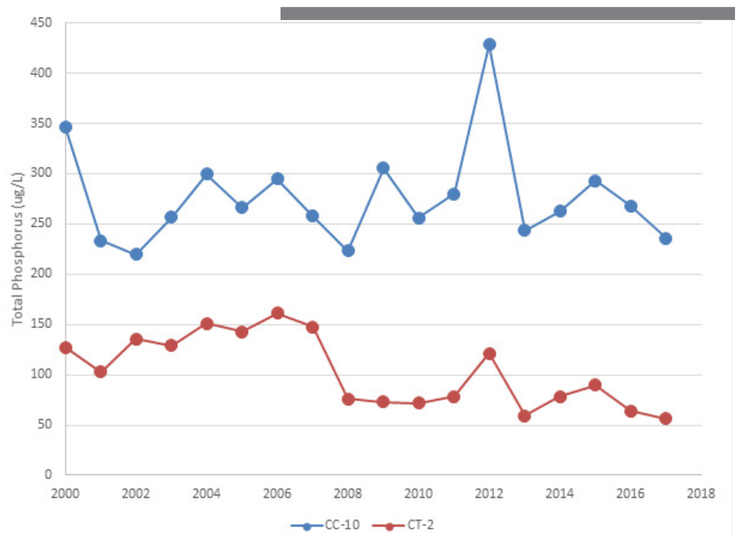
The average TP concentration at CC-10, just upstream of the reservoir on Cherry Creek, during WY2017 was 233 µg/L, 10% less than the WY2016 TP average of 256 µg/L. During the period 2000-2017, Cottonwood Creek TP concentrations measured at CT-2, just upstream of the reservoir on Cottonwood Creek, are approximately ¼ of the average TP measured in Cherry Creek.

Concentration-Based Control of Phosphorus means the flow-weighted concentration of total phosphorus in the inflow to Cherry Creek Reservoir that is intended to result in the attainment of water quality standards for Cherry Creek Reservoir.

Flow-weighted Phosphorus Concentrations means the total external load, including precipitation, groundwater, stream flow, and ungaged runoff, divided by total inflow volume.

Since 2008, when the Cottonwood PRFs were completed, the CT-2 station demonstrates a decreasing trend in TP concentration, showing the effectiveness of the PRFs and projects of others. During the last 17 years, total phosphorus entering the reservoir from Cherry Creek (CC-10) does not appear to decrease or increase over time.

Concentrations of Total Phosphorus Over Time in Cherry Creek and Cottonwood Creek



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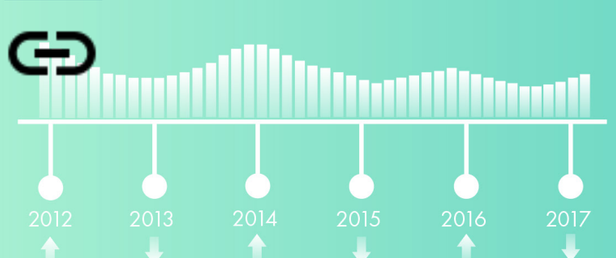
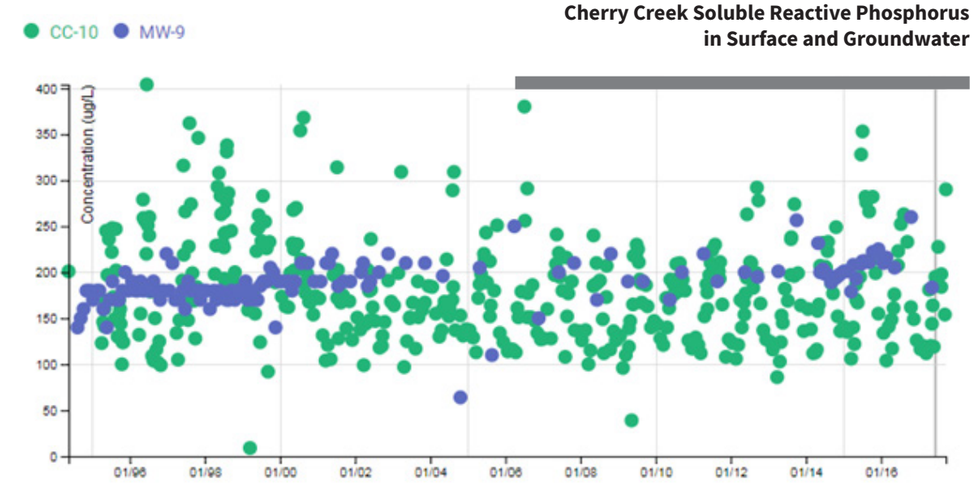


Visualize changes in water quality over time using the year comparison grapher.

Groundwater vs Surface Water Long-term Watershed Inputs to Reservoir

Long-term concentrations of total phosphorus in the alluvial inflow (MW-9) to Cherry Creek Reservoir are more stable than surface water inflows (CC-10). Note that the alluvial groundwater concentrations are consistently around the 200 µg/L background phosphorus level.

Cherry Creek Soluble Reactive Phosphorus in Surface and Groundwater

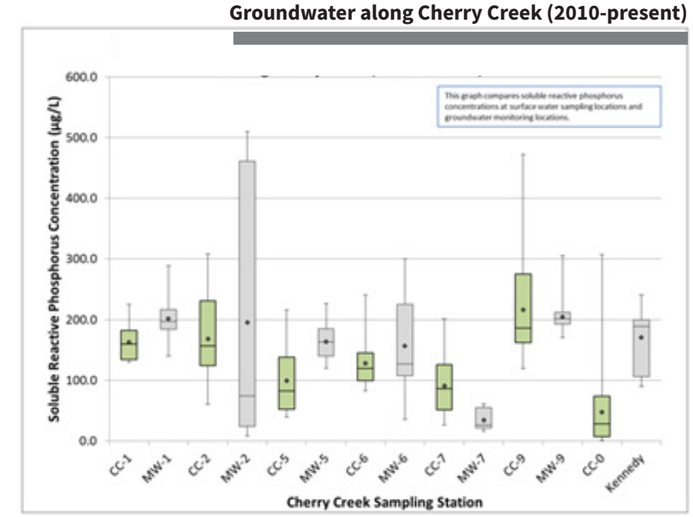


Cherry Creek Surface and Groundwater

Median soluble reactive phosphorus (SRP) levels in the Cherry Creek alluvial groundwater (2010–present) were generally similar to median concentrations observed in nearby Cherry Creek surface water.

The TP trend observed in WY2017 is documented in the Cherry Creek alluvial SRP data. Upstream of the reservoir, the median SRP levels (the horizontal line located in rectangle of each box and whisker plot) in the alluvial groundwater were generally similar to median concentrations observed in nearby surface water.

Soluble Reactive Phosphorus in Surface Water and Groundwater along Cherry Creek (2010-present)



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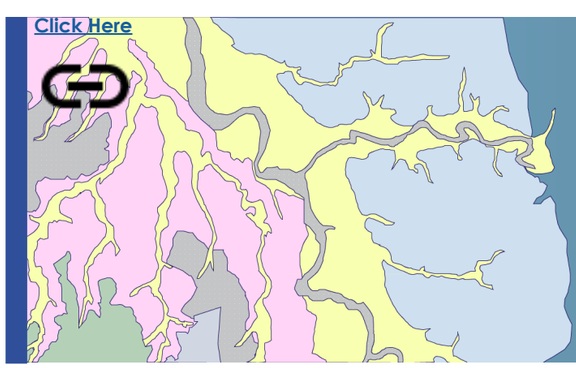
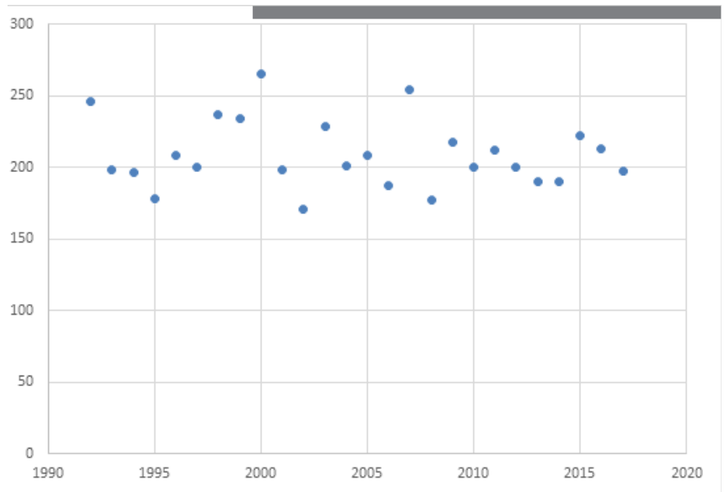


Discover the relationship between surface water and groundwater by exploring nutrient concentrations at Cherry Creek surface water sampling sites and monitoring wells.

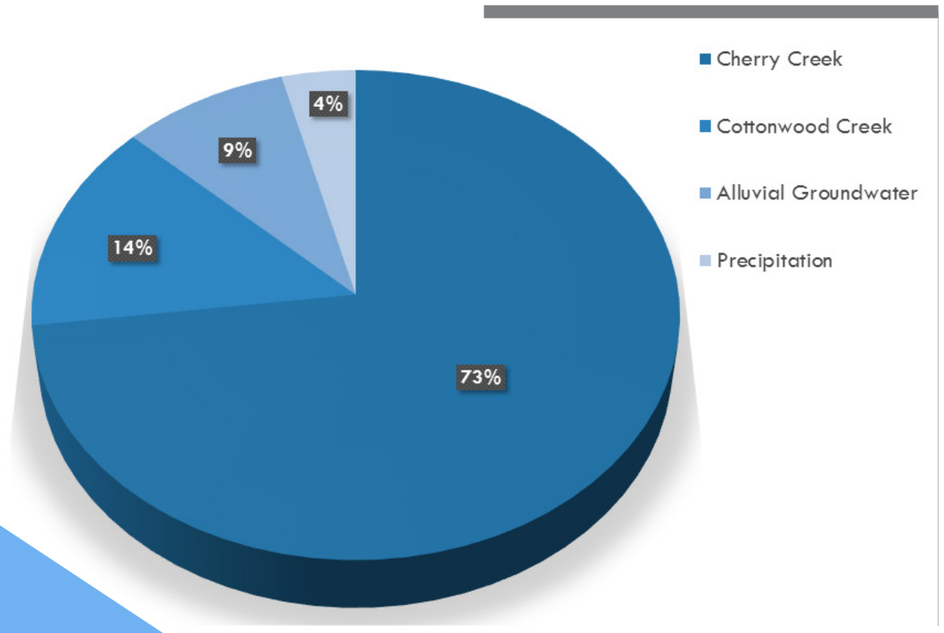
Flow Weighted Concentrations from All Reservoir Inputs

The overall WY2017 flow-weighted TP inflow concentration was 197 µg/L\, which includes inputs from Cherry Creek, Cottonwood Creek, alluvial groundwater, and precipitation. The data range from 160 µg/L- 260 µg/L; the long-term median of 201 µg/L.

Phosphorus Flow-weighted Average (1990 - 2017)



Relative Contribution of Cherry Creek Inflows to Reservoir Phosphorus Balance in WY2017



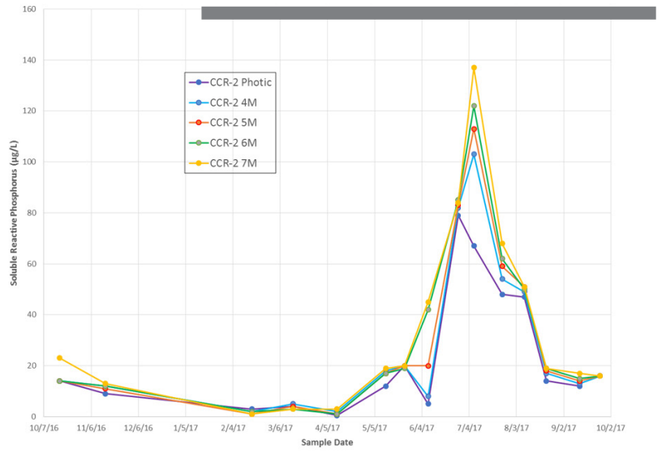
2017 Reservoir Highlights

Flow and Nutrients

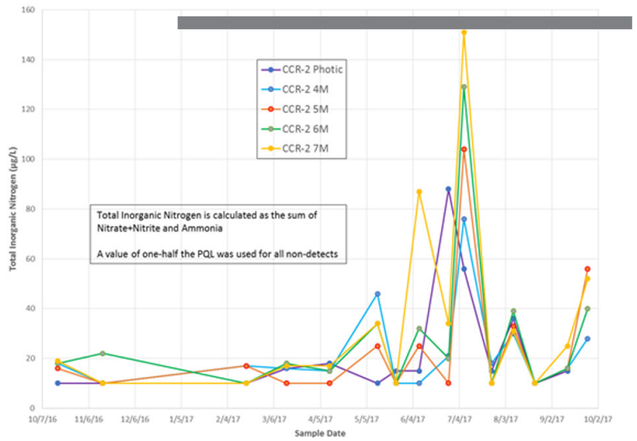
Increased flushing rate benefitted the reservoir's water quality in 2017. The US Army Corps of Engineers operates Cherry Creek Reservoir for flood control purposes. The higher 2017 inflows from the Cherry Creek watershed resulted in a higher-than-average annual pass-through volume from the reservoir outlet works, an average of 28.6 cfs, or approximately 20,700 acre-feet. This was three times the 56-year average daily discharge of 9.2 cfs. The increased flushing rate of the reservoir helped water quality improve in WY2017.

While the reservoir continued to retain much more phosphorus and nitrogen on a mass basis than it was flushing, the increased flush in the outflow provided an improvement that would have otherwise resulted in greater water quality impacts to the reservoir.

WY 2017 Soluble Reactive Phosphorus in Cherry Creek Reservoir



WY 2017 Total Inorganic Nitrogen in Cherry Creek Reservoir



Phytoplankton and Zooplankton Data

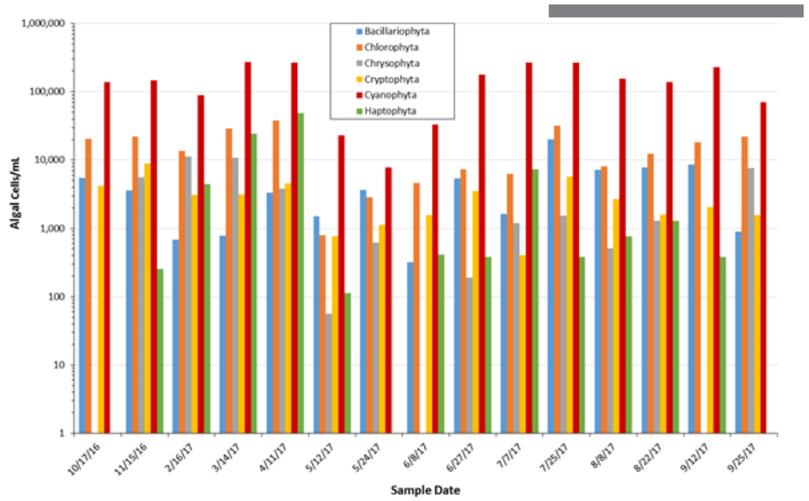
In WY2017, there were no algal blooms observed in the reservoir that were harmful to the resident population. The Authority works in close coordination with Colorado Parks and Wildlife to protect recreational and aquatic life uses in the reservoir.

Phytoplankton and zooplankton data continued to exhibit characteristics of an over-productive and nutrient-rich reservoir, as indicated by WY2017 planktonic communities. The phytoplankton taxa of biggest concern included an abundance of Cyanophyta ("blue-green algae", depicted in red) and Chlorophyta ("green algae", depicted in orange).

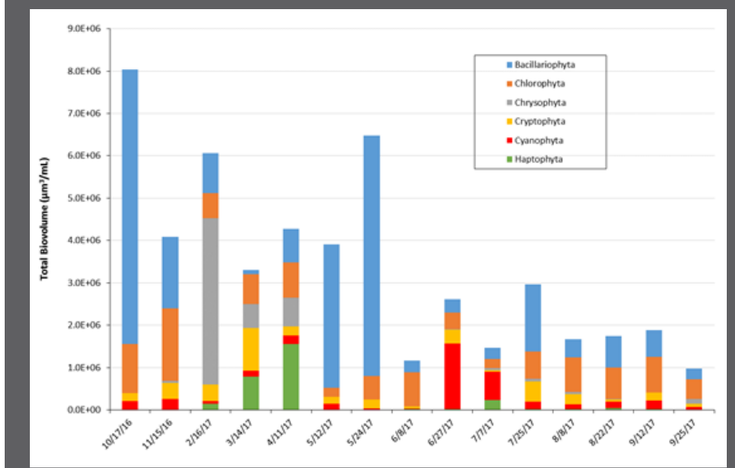
Cell concentrations in excess of 100,000 cells/mL for blue-green algae and over 10,000 cells/mL for green algae can cause water quality issues in the reservoir throughout the summer, including elevated chlorophyll α concentrations.

The best water quality conditions were observed in the reservoir in early June, as reflected in the plankton data, as well as low concentrations of chlorophyll α and TP, as well as greater water clarity. This was following a period of higher than normal precipitation and resultant increased reservoir inflow and releases and during a period of destratification system operation.

Algal Cell Concentrations



Algal Total Biovolumes



Algal biomass in WY2017 was dominated by diatoms and green algae. Chlorophyta ("green algae", depicted in orange) and Bacillariophyta ("diatoms", in blue) were dominant, although different phytoplankton briefly dominated the community. A significant amount of biomass energy from phytoplankton and bacteria was also stored in the sediments as organic carbon, which contributed to excess nutrient production during this timeframe.

BACILLIARAPHYTA "DIATOMS"

PERIOD OF OCCURRENCE, ECOLOGICAL BENEFITS AND/OR STRESSORS

- Typically the first algae to bloom in early spring; when nutrients and light conditions in upper mixed layer are right, their competitive edge and rapid growth rate allows them to dominate phytoplankton
- Important contributors to the food chain; food resource for zooplankton
- Freshwater diatoms commonly observed in reservoir are indicators of eutrophic (over-enriched) conditions; their degradation contributes to increased oxygen demand and phosphorus recycling

CHLOROPHYTA "GREEN ALGAE"

PERIOD OF OCCURRENCE, ECOLOGICAL BENEFITS AND/OR STRESSORS

- Appear during periods of high nutrient concentrations; indicates both nitrogen and phosphorus are in excess supply
- Colonial and single-celled greens are a good food source for zooplankton
- Filamentous and large colonial greens do not add to food web, and create water quality problems

CYANOPHYTA (CYANOBACTERIA*) "BLUE-GREEN ALGAE"

PERIOD OF OCCURRENCE, ECOLOGICAL BENEFITS AND/OR STRESSORS

- Appear during periods of over-abundant enrichment and with very high nutrient levels, especially phosphorus
- Do not contribute greatly to food web; few people view cyanobacteria as beneficial organisms in a lake
- Create water quality problems; e.g., oxygen depletion when excessive growth produces blooms
- Some species may produce cyanotoxins under certain conditions

CRYPTOPHYTA "CRYPTOMONADS"

PERIOD OF OCCURRENCE, ECOLOGICAL BENEFITS AND/OR STRESSORS

- Cryptophytes can live through the winter, under ice-cover and with little solar radiation for photosynthesis
- Important food for zooplankton; zooplankton, in turn, are food for fish and other organisms in food web

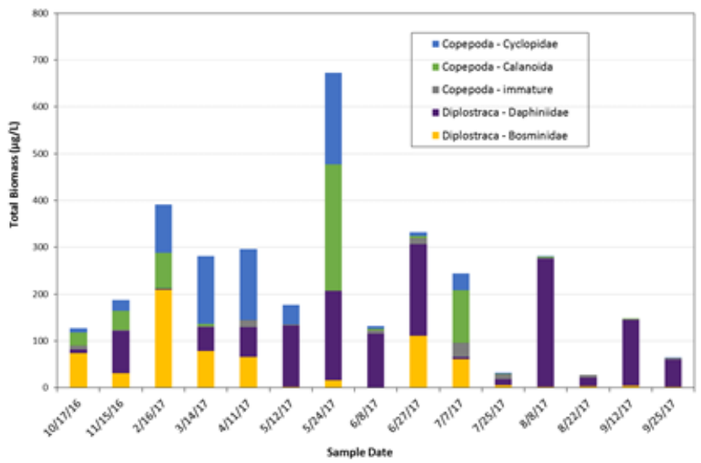
Zooplankton. A generally higher Daphnid biomass was present in May and June, and again in August and September, indicating this preferred fish food was available and abundant for the fishery.

Fisheries. Cherry Creek Reservoir is a high-quality walleye fishery, and one of the top producers of walleye eggs in the State. Walleye populations throughout Colorado are dependent on gizzard shad as a prey base.

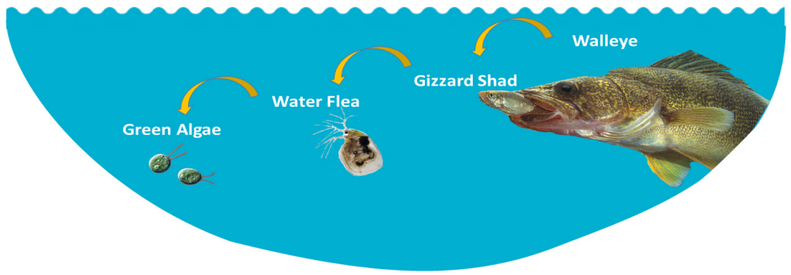
Understanding fluctuations in fish populations is important from a recreational fishery perspective and also as it relates to interpretation of zooplankton, phytoplankton, and general water quality response.

A 2014 study concluded that, during the preceding 40-year period, the walleye population in Cherry Creek Reservoir appears to have been quite strong. Growth was good, body condition was very good, and medium and large size fish were always present.

Total Zooplankton Biomass



Food Chain in Cherry Creek Reservoir



Key Takeaways 2017

Pollutant Reduction Facilities (PRFs)
- Cottonwood Creek treatment train is the best-performing PRF; we strive to match this in the entire basin
- Annual maintenance keeps PRFs working
- PRFs improve stream health and reduce sediment and nutrient loads

Reservoir Model
- Will use this tool to investigate which strategies and activities will best improve the reservoir

Watershed Model
- Watershed model will better predict reservoir contributions of nutrients from various watershed sources
- Data inputs to reservoir model

Riparian and Wetlands
- Critical for stormwater management
- In-park wetlands work well as final step in water quality improvement

Point Source WWTFs
- WWTFs are doing a good job at removing pollutants while meeting some of the lowest phosphorus limits in the State

Public Education
- Partners engaged over 6000 participants to promote the watershed's natural resources
- Educating the new generation of citizen stewards is key

Upgrades to Authority Water Quality Data Portal
- Choose your own adventure using the flexible tools and focused storyboards on the Authority's data portal to investigate and answer questions

Municipal Separate Storm Sewer Systems (MS4s)
- Expanding upon past work done by Authority
- Advancements make it easier and more cost-effective to implement meaningful water quality controls

Monitoring Program
- Rigorous and comprehensive monitoring program contributes to the 25-year warehouse of watershed information
- Next-generation monitoring on the horizon
- Reservoir was very close to achieving compliance for chlorophyll a and TP in 2017

List of Abbreviations and Acronyms

WY2017	Water Year 2017	CCR	Cherry Creek Reservoir
Authority	Cherry Creek Basin Water Quality Authority	DO	Dissolved Oxygen
Board	Authority's Board of Directors	mg/L	Milligram per Liter
TAC	Technical Advisory Committee	µg/L	Micrograms per Liter
CPW	Colorado Parks and Wildlife	NO_3	Nitrate
SEMSWA	Southeast Metro Stormwater Authority	NH_4	Ammonia
UDFCD	Urban Drainage and Flood Control District	PO_4	Orthophosphate
TCHD	Tri-County Health Department	WWTF	Wastewater Treatment Facility
Commission	Water Quality Control Commission	TP	Total Phosphorus
PRF	Pollutant Reduction Facility	TIN	Total Inorganic Nitrogen
BMP	Best Management Practices	IGA	Intergovernmental Agreement
OWTS	On-site Wastewater Treatment System	CCSP	Cherry Creek Stewardship Partners
Division	Water Quality Control Division	SRP	Soluble Reactive Phosphorus
MS4	Municipal Separate Storm Sewer System	HAB	Harmful Algae Bloom
CIP	Capital Improvement Program	cfs	Cubic Feet per Second

Key Links

Statute
Regulation 72
Annual Monitoring Report

CHERRY CREEK
BASIN WATER
QUALITY AUTHORITY