Cherry Creek Basin Water Quality Authority
Technical Advisory Committee Meeting Agenda
Thursday, November 2, 2023, 9:00 a.m.

In-person attendance is encouraged due to audio limitations in the meeting room.

In-Person: SEMSWA
7437 S. Fairplay St.
Centennial, CO 80112

Virtual: Zoom[1]
https://us06web.zoom.us/j/87425775963 Passcode: CCBWQA
Phone (646)931-3860 Mtg ID: 874 2577 5963# Passcode: 815374

TAC Meeting Documents can be found online at the link below.
https://drive.google.com/drive/folders/12BoEhmFbnnMCxivnpjY2l7T5TzP8AzIq?usp=sharing

1. Call to Order *(9:00) (5 minutes)*
    a. Introduce Diana Rashash, Senior Water Quality Specialist with Arapahoe County Public Health replacing Steve Chevalier on the TAC effective November 1, 2023
    b. Introduce Laura Kindt, Castle Rock Water's new Stormwater Manager who will eventually replace David VanDellen.
2. Meeting Minutes from October 5, 2023 (enclosed)
3. Highlights from the October 19, 2023 Board Meeting (Clary) *(9:05) (5 minutes)*
4. Action Items *(9:10) (45 minutes)*
    a. Recommendation on 2023 Annual PRF/PAP Observation and Maintenance Report (Goncalves, enclosed)
    b. Recommendation on 2024-2033 CIP (Borchardt, enclosed)
    c. Recommendation on CCBWQA 2024 Draft Budget (Clary, enclosed)*
    d. Recommendation on Position on Regulation 72 Dewatering Proposal
        i. Revised Regulation 72 Dewatering Proposal (Rebecca Tejada & Mike Smith)
        ii. TAC Communication to Board Regarding Technical Merits of Revised Proposal (Clary, enclosed)*
5. Presentations *(9:55) (15 minutes)*
    a. USACE Reservoir Release Proposal (Katie Seefus, USACE, enclosed)
6. Discussion Items *(10:10) (40 minutes)*
    a. Modeling Subcommittee Recommendations (Alan Leak, RESPEC, enclosed)
    b. Monitoring Discussion (Stewart, enclosed)
        i. SAP Considerations
        ii. Monitoring Report Update and Schedule Considerations*
    c. 2024 TAC Chairman and Vice Chairman Positions (Erickson)
    d. 2024 TAC Appointments (Erickson/Endyk, enclosed)
    e. Regulation 38 Site Specific Standards Letter to CDPHE and Updated Hydros Technical Memorandum (Clary/Hawley, enclosed)
7. Updates *(10:50) (15 minutes)*
    a. Cherry Creek Stewardship Partners (Davenhill)
    b. TAC Members
    c. TAC Subcommittees
        i. Modeling Subcommittee
        ii. Watershed Plan Subcommittee
        iii. Cherry Creek Reservoir to Lakeview Drive Alternatives Analysis Subcommittee

[1] If you are unable to participate on the CCBWQA's Zoom platform, please email val.endyk@ccbwqa.org

d. Contractors
    i. Water Quality Update and (Stewart)
    ii. Pollution Abatement Projects
        a. CIP Status Report (Borchardt, enclosed)
        b. Wetland Harvesting (Stewart)
    iii. In-Park PRF and RDS Maintenance and Operations Report (Goncalves, enclosed)
    iv. Regulatory (DiToro)
    v. Land Use Referral Tracking (Endyk)
e. Manager (Clary)
    i. CU-Boulder Landscape Transformation Proposal
    ii. Regulation 38 Site Specific Standard Update
    iii. Peoria Pond
    iv. PAPM RFQ
    v. RPA Runoff Reduction Study
8. Adjournment

* Supplemental Packet agenda items to be sent October 31, 2023

Cherry Creek Basin Water Quality Authority
Minutes of the Technical Advisory Committee Meeting
Thursday, October 5, 2023, 9:00 a.m.

TAC Members Present
Alex Mestdagh, Town of Parker
Ashley Byerley, SEMSWA
Caitlin Gappa, Douglas County Health Department (zoom)
Cayla Cappello, City of Greenwood Village
Jacob James, City of Lone Tree
Jeremiah Unger, CDOT (zoom)
Jessica La Pierre, City of Aurora (zoom)
Jim Watt, Board Appointee, Mile High Flood District
Joseph Marencik, City of Castle Pines
Jon Erickson, TAC Chair, Board Appointee, Colorado Parks and Wildlife
Lisa Knerr, TAC Vice Chair, Arapahoe County (zoom)
Rebecca Tejada, Board Appointee, Special Districts, Parker Water and Sanitation District (zoom)
Rick Goncalves, Board Appointee
Ryan Adrian, Douglas County (zoom)
Steve Chevalier, Arapahoe County Public Health

Board Members Present
Bill Ruzzo, Assistant Secretary, Governor's Appointee
Roger Hudson, City of Castle Pines
Tom Downing, Governor's Appointee (zoom)

Others Present
Erin Stewart, LRE Water
Jane Clary, Wright Water Engineers, CCBWQA Technical Manager
Jessica DiToro, LRE Water
Lindsey Ledden, LRE Water (zoom)
Michelle Seubert, Cherry Creek State Park (zoom)
Richard Borchardt, R2R Engineers
Val Endyk, CCBWQA

1. **Call to Order**
   a. **Introduce Michelle Seubert, Cherry Creek State Park**

   Jon Erickson called the meeting to order at 9:00 am.
   Introduction of Michelle Seubert, the new Cherry Creek State Park manager was moved to later in the meeting.

2. **Meeting Minutes from September 7, 2023**

   Rick Goncalves moved to approve the meeting minutes from September 7, 2023. Seconded by Steve Chevalier. The motion carried.

3. **Highlights from the September 21, 2023 Board Meeting and Watershed Plan Workshop**
Jane Clary provided an update on actions taken at the September 21, 2023 Board meeting and highlighted the successful Watershed Plan Workshop. Minutes from the meeting can be found here.

4. **Action Item**

a. Recommendation on IGA Amendment for Cherry Creek at Scott Road

Rich Borchardt provided the TAC with an Action Item Memo detailing the Cherry Creek near Scott Road Project in Douglas County. The partners are Douglas County, CCBWQA, and Mile High Flood District, which is the project lead. Muller Engineering is the design consultant. It is estimated that this 0.81 mile long-project will immobilize 73 pounds of phosphorus annually.
The AIM provides background details including funding and budget information.
Rich Borchardt also provided the redlined IGA Amendment for the TAC's review.

Jacob James moved to recommend that the Board authorize the execution of the Amendment to the Intergovernmental Agreement (IGA Amendment) for the stream improvements on Cherry Creek upstream of Scott Road and an expenditure for an amount not to exceed $409,000. Seconded by Ashley Byerley. The motion carried.

b. Recommendation on IGA for Dove Creek Construction Phase 2

Rich Borchardt provided the TAC with an Action Item Memo detailing Phase 2 of the Dove Creek project.
The design has been completed on Dove Creek from Otero Avenue to Pond D1 located upstream of Broncos Parkway in the City of Centennial. RESPEC is the design engineer. The construction of the first phase from Otero Avenue to Chambers Road was completed early this year by Concrete Express. The Project sponsors are CCBWQA and the Southeast Metro Stormwater Authority (SEMSWA), which is the project lead. It is estimated that this 0.51 mile long project will immobilize 46 pounds of phosphorus annually. The second phase of construction between Chambers Road and Pond D1 is scheduled for early 2024.

The TAC discussed the project cost and made a recommendation for future AIMs to include a table with length of project, cost per cubic yard, cost per pound of phosphorus removed, and other data points. Bill Ruzzo requested additional information be provided to the Board regarding why this project is more expensive on a per mile basis. Rich noted that the project also includes sediment capture areas that provide additional water quality benefits.

Rick Goncalves moved to recommend that the Board authorize the preparation of the Intergovernmental Agreement (IGA) with SEMSWA for the second phase of construction of the Dove Creek Stream Reclamation, an expenditure for an amount not to exceed $540,000, and a member of the executive committee to execute the IGA. Seconded by Cayla Cappello. The motion carried.

5. **Discussion Item**

Jon Erickson introduced Michelle Seubert, the new Cherry Creek State Park manager.

a. CCBWQA 2024 Draft Budget

Jane Clary provided the TAC with a memo that outlines the details of the 2024 Budget Worksheet Draft.
General Fund highlights:

Jane highlighted a new addition to the general fund for information and education coordination (as an optional item). Also noted was the decrease in regulatory support and website costs. Erin Stewart provided an explanation for the increase in data management due to updates required to the outdated database to continue to utilize the new data visualization tools as well as an increase to cover the watershed plan updates scheduled for 2024.

Pollution Abatement Fund highlights:

Rich Borchardt's transition as PAPM manager affects the PAF fund expenses. These costs will likely be refined in the next draft of the budget.
PRF Repairs and Maintenance expenses may be updated after Rick Goncalves' 2023 operations and maintenance report findings are completed.

Pollution abatement project cost increases reflect inflation. Project budgets have included input from partners.

Enterprise Fund highlights:

Studies completed in 2023 will not appear in the 2024 budget.

RDS distribution analysis is included as a potential project due to the aging system. (Work on this task will need to be authorized by the Board.)

The 2024 budget will be brought back to the TAC in November, following input at the October Board meeting.

Discussion regarding a future pollution abatement project (PAPM) manager and the skill set needed for that position as Rich Borchardt transitions included:

Project management skills, cost estimating and planning, construction observation/completion field review, engineer/PE with experience in the Cherry Creek Basin, innovative and willing to do field work. The TAC recommended CCBWQA pursue developing a scope of services for a PAPM.

b. 2024-2033 Capital Improvement Program

Rich Borchardt provided the TAC with the 10 Year CIP Draft

Table 1 highlights the previously completed historical projects, current projects, and future potential projects.

Table 2 highlights the 10-year CIP plan.

In preparing the 10-year CIP draft, Rich coordinated with partners and adjusted schedules as necessary.

c. CCBWQA Routine Sampling and Analysis Plan (SAP/QAPP) Updates

Erin Stewart discussed that there are currently no recommended changes to the SAP/QAPP for 2024. A fairly extensive review was completed in 2022 for the 2023 updates. There was no feedback from RESPEC during the recent modeling efforts regarding changes to the monitoring. Hydros did not identify needed changes in terms of the reservoir model.

Erin requested TAC input on future SAP/QAPP updates as the Authority works on the watershed planning update.

d. Modeling Subcommittee Recommendations - postponed to a future meeting

6. Presentations

a. Social Media Initiative Options for CCBWQA

Lindsey Leyden with LRE Water presented some options/ ideas to the TAC regarding social media initiatives for the Authority. These services will be included in the LRE Water 2024 scope of services as an optional task.

7. Updates

a. Cherry Creek Stewardship Partners (Davenhill)

Casey Davenhill provided a third quarter update to the TAC.

b. TAC Members

c. TAC Subcommittees

i. Modeling Subcommittee

ii. Watershed Plan Subcommittee (Clary/ Stewart)

iii. Cherry Creek Reservoir to Lakeview Drive Alternatives Analysis Subcommittee (Borchardt)

d. Contractors

i. Water Quality Update (Stewart)

Erin updated the TAC that the wetland harvesting has been completed.

ii. Pollution Abatement Projects

a. CIP Status Report (Borchardt, enclosed)

b. **Wetland Harvesting (Stewart)**

iii. **In-Park PRF and RDS Maintenance and Operations Report (Goncalves)**
Rick Goncalves reported that annual RDS maintenance was completed and the RDS system was shut down for the season as of October 5, 2023.

iv. **Regulatory (DiToro)**

v. **Land Use Referral Tracking (Endyk)**

e. **Manager (Clary)**

i. **Confluence at the Confluence, October 17, 2023**

8. **Adjournment**

Jon Erickson adjourned the meeting at 11:11 am.

RG AND ASSOCIATES, LLC
4885 Ward Road, Suite 100 • Wheat Ridge, CO 80033
Del Norte • Gypsum • Wheat Ridge
303-293-8107 • www.rgengineers.com

TASK MEMORANDUM

DATE:	October 25, 2023
TO:	TAC and Board of Directors, CCBWQA Jane Clary, Wright Water Engineers, CCBWQA Technical Manager
CC:	Cherry Creek State Park (CCSP) Park Manager
FROM:	Ricardo Gonçalves, PE
SUBJECT:	2023 Annual Inspection of Pollution Reduction Facilities (PRFs) at CCSP

Introduction

The CCBWQA has a contractural agreement with RG and Associates, LLC to perform a Field Observation annually of the PRFs constructed by the CCBWQA at CCSP, and to perform observations on those PRFs after a storm event of more than 1" per hour of intensity or reported visible damage to PRF facilities in the CCSP.

The purpose of the annual Field Observation is to assess whether the PRFs are functioning as designed and to identify routine restorative and rehabilitative maintenance requirements. The TAC of the CCBWQA will use this report to provide recommendations to the board for the following fiscal year's budgeting of maintenance activities. Restorative and rehabilitative maintenance are the responsibility of the CCBWQA. Routine maintenance is the responsibility of the CCSP. Other items, such as educational/interpretive sign replacement and weed control, as outlined in the Agreement are shared 50/50 by CCSP and CCBWQA. The West Boat Ramp PRF's routine, restorative and rehabilitative maintenance responsibility is 100% the responsibility of the CCSP and/or the Marina.

As defined in the Agreement, the term "Restorative and Rehabilitative Maintenance"shall mean all maintenance and repair reasonably necessary to keep the structural and other essential components or portions of a PRF in good working order and functioning as designed, including but not limited to the repair of walls, embankments, pipes, gates, monitoring facilities, erosion and riprap, the removal of sediment, and the replacement of vegetation within the disturbed area of a PRF as needed to maintain or restore the PRFs function."Routine Maintenance" shall mean any and all maintenance that is necessary (other than Restorative and Rehabilitative Maintenance) to keep a PRF in a clean, visually appealing and safe condition, free from

debris and rubbish, and protected from vandalism and malicious mischief to the same extent as any other public facility located within the CCSP.

The PRFs that are part of the Stream and Drainage System are observed at least annually and after storm events since they are more likely to have changes in their condition. The PRFs that are Shoreline Stabilization are observed on an as needed basis, or as the CCBWQA, CCSP and or United States Army Corps of Engineers personnel identify issues or concerns during the year. This year, because of the unusual flooding that occurred in May and June, the Shoreline Stabilization PRFs were inspected for maintenance and repair needs.

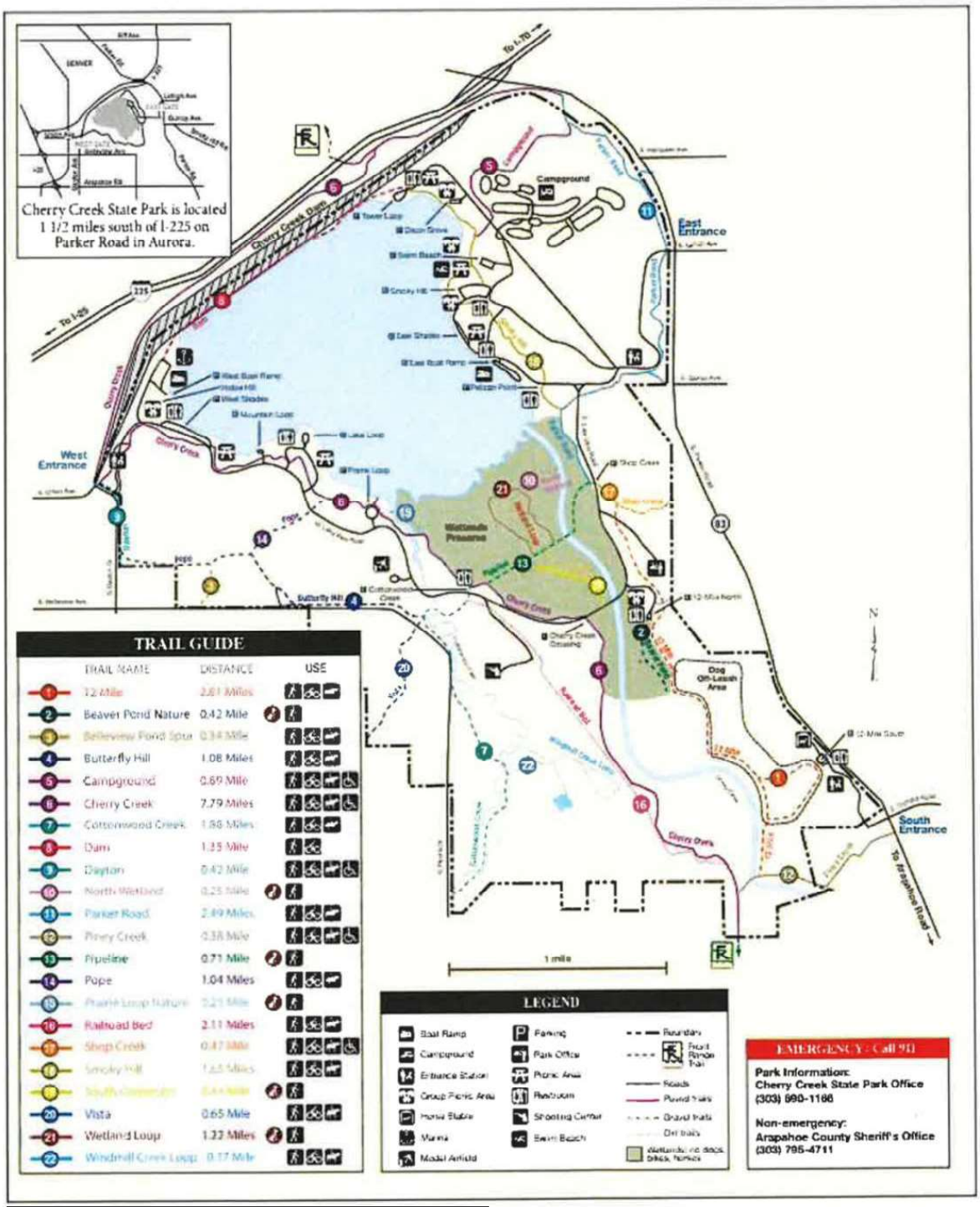
A map of the park from the CCSP brochure is shown on the following page to show the general vicinity of the In-Park PRFs.

The following facilities are included in the In-Park PRFs:

Stream and Drainage System
Shop Creek
Cherry Creek 12 mile Park (All Phases)
Cottonwood Wetlands
Cottonwood Stream Reclamation
Quincy Drainage
West Boat Ramp

Shoreline Stabilization
Tower Loop
Dixon Grove
East Shade Shelters
East Boat Ramp
Mountain and Lake Loop

All the PRFs were observed. The field observation was conducted on September 26, 27, 28, 29 and October 3rd. Parks officials did not accompany the inspections as they were too busy and requested a walkthrough later in the fall.



CCSP Brochure Map

General Assessments

The general assessments for the Annual Field Observation and photos are provided on the following pages.

Cottonwood Wetlands: Some aquatic vegetation and cattail debris was observed on the surface of the water. The water level was down significantly from the month before, but still high enough that water was overflowing the access trail. The educational signs were in good shape and did not appear to have been damaged in any way by the storm. Compaction from last year's harvesting activities was observed, but otherwise, there was no plant stress observed from this year's floods. Some compaction was noticed from this year's harvesting activities. Maintenance for consideration is decompaction and reseeding of the area along the trail and cleaning out of the outlet structure grate.

Outlet structure

Compaction from last year's harvesting activities

Compaction and wheel-tracking from this year's harvesting activities

Cottonwood Creek Stream Reclamation: This PRF is highly functional, with the vegetation striving all the way to the water's edge, and the riffle drops operating well. Evidence of high-water debris was observed, and the only apparent damage from the May and June storms was to the approach slab of the bridge on Lakeview Dr. No other damage was observed at any of the drop structures or crossing structures. Over-bank flooding only caused one minor eroded area in the fields, indicating that the low design velocities were successful in retaining the floodplain vegetation. Damage from the recent floods was observed to the gravel trails and access roads by the over-bank flooding. Some noxious weeds in the form of Russian Olives and Common Reed were observed and two active beaver dams were noted. Evidence of this year's harvesting activities was noted with some wheel-tracking compaction evident. No maintenance activities were specifically identified, however, monitoring and coordination with CCSP staff regarding noxious weeds is recommended. Monitoring of the wheel-tracking should be done next spring to determine to what extent any decompaction and re-seeding might be required. Also, CCSP will need to do some significant trail maintenance.

Thriving vegetation

Thriving vegetation

Erosion on access road

Riffle structure at lower trail crossing

Riffle structure near old Cottonwood alignment and shooting center

Riffle structure near confluence of Lone Tree Creek

Crossing east of S Cherry Creek Drive and Peoria St.

Beaver Dam north of above crossing

High-water debris but little plant stress and no evidence of erosion was typical

Cherry Creek 12-mile Park-All Phases:

All three phases of the project were examined from upstream to downstream, beginning at the first access point. Overall, the storms this last May and June accelerated the erosion from behind the boulder edging and washed out some of the boulder edging. Backfill in some of the erosion areas at the base of the access stairs would classify as needing maintenance attention, for pedestrian safety, the height from the bottom timber step to the ground surface being greater than the height from timber step to timber step. This would be a CCSP cost.The erosion behind the boulder edging where the concrete trail abuts the boulder edging is severe enough that the trail undercut areas should grouted to protect the trail. The rest of the damage will need to be rectified in near-future stabilization projects. The displacement of the "breakout" area is, perhaps, the most significant area needing stabilization attention, as well as the lost boulder edging downstream of Access Number 4. The entire area upstream of the grade control structure has suffered extreme bed erosion to such an extent that tree islands 2-3 feet high have been created. It also appears that the main channel has deviated from previous years. Of additional concern is whether stabilization of the east bank of Cherry Creek with the boulder edging is actually creating an off-set destabilization of the stream bottom and even of the west bank. All of this indicates that a serious re-evaluation of the original design concepts should be done to determine their functionality and applicability to stabilizing or reclaiming a stream that is constantly changing its course and if some alterations of those original design concepts should be effected prior to simply repairing the damaged areas back to the way they were before. Also, what should be addressed is the appropriateness of the design storms that should be utilized in examining the hydraulic design of the stream system. Due to the re-evaluation, no repairs are recommended, and CCSP will have some maintenance on the access stairways. All of the repair work should be part of a Capital Improvements Project, once a direction is established. It recommended that an outside consultant should be contracted to perform the re-evaluation.

Behind-the-boulder edging erosion at third access point

Behind the boulder edging erosion

Behind-the-boulder edging erosion at the Fourth Access Point

Boulder edging erosion just below Fourth Access Point

Boulder edging erosion below Access 4. Also note in-stream sediment deposition almost to the level of the original boulders.

Boulder erosion at Access 6

Tree islands caused by extreme bed scour

Beginning of beach area- severe erosion behind the boulder edging and of the beach itself, starting a second channel behind the boulder edging

Severe erosion behind boulder edging just before the beach area.

The boulder edging is now a spine, away from the water and the high point of the bank, with beach on both sides, not an "edge" of anything.

Erosion behind boulders undercutting trail.

Erosion behind boulders undercutting trail.

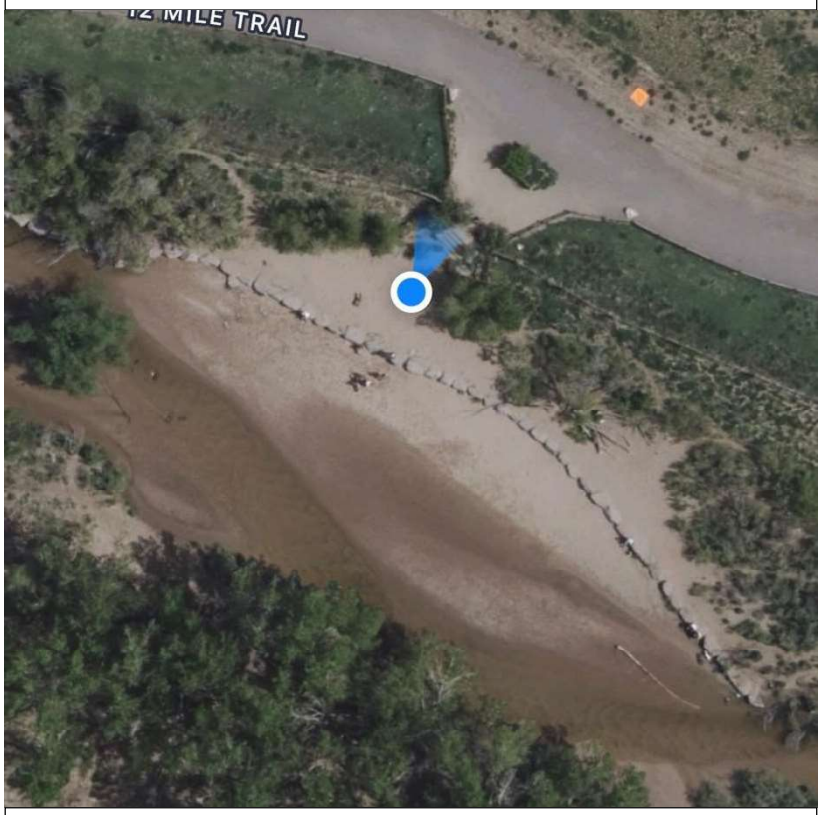
Grade control structure continued to work well

Severe erosion at breakout area

Severe erosion at breakout area

Severe bank and bed erosion downstream of the breakout area

Downstream of the breakout area



Satellite photo of DOLA beach showing how the creek doesn't follow the path that was used for the boulder edging design.

Shop Creek: There are 5 drop structures within CCSP numbered 1 through 5 from upstream to downstream, and an additional drop structure outside of the CCSP Boundary. All of the drops have the same basic problems with spalling concrete along their crests, seepage between layers of roller-compacted concrete on some, vegetation growing on downstream faces, and severe erosion and spalling around their outlet structures. The recent floods did not appear to have created any of the damage, most of it being created through general wear and tear. Repair of the concrete around the outlet structures, herbicide application, one tree removal is recommended for maintenance and repair. The information signs were in good repair and not in any need of attention.

Drop No.1

Drop No. 1 outlet structure overtopped and clogged with weeds

Drop No. 2

Drop No. 2 Outlet

Drop No.3

Drop No. 3 Outlet

Drop No. 4

Drop No. 4 Outlet

Drop No.5

Drop No. 5 Outlet

Shop Creek Informational Sign

Shop Creek Informational Sign

Quincy Drainage: Debris clogging was observed at the outlet structure, as were numerous plants growing in the energy dissipators of the outlet structure at the Lakeview Dr. crossing. These plants may need to be eradicated in the next couple of years. CCSP staff will take care of debris removal. At this time, no maintenance or repair needs were identified, except for weed control, although a capital project for stream reclamation may be needed in the future.

Debris clogging of the outlet structure

Outlet of the outlet structure

Outlet at Lakeview Dr. becoming clogged with plants

Outlet at Lakeview Dr. becoming clogged with plants.

Tower Loop: Reservoir elevation on this day September 27, was 5550.04. This PRF consists of boulders and riprap stabilization of the shoreline. While there was some minor subsidence of the boulders due to the floods, and the minor loss of some backfill behind the boulders, the only maintenance and repair item identified was minor backfill of the boulder edging. The floods created some bank erosion areas above the normal reservoir operating level and away from the older boulder stabilization area that could be included in a current capital stabilization project that is being designed. Some boulders were displaced but probably by human hands for seating purposes. The informational sign was in good shape and in no need of attention.

Informational sign in good condition

Human-displaced boulders

Boulder backfill material washed away from sidewalk

Eroded material from behind the grout at the fishing points

Backfill behind boulders washed away

Backfill washed away

Dixon Grove: Reservoir elevation this day, September 27, 2023, was 5550.04. Boulders and riprap serve as protection of shoreline for this PRF. There is a water quality capture area that treats runoff from the parking lot. No maintenance needs were identified. An area of shoreline south of the west shoreline stabilization area could be a good candidate for a future shoreline stabilization capital project. Various dead trees and debris from the floods was identified for CCSP maintenance.

East Shore of Stabilized area

Vibrant water quality capture area

Area south as candidate for future Shore Stabilization CIP project

Area south as candidate for future Shore Stabilization CIP project

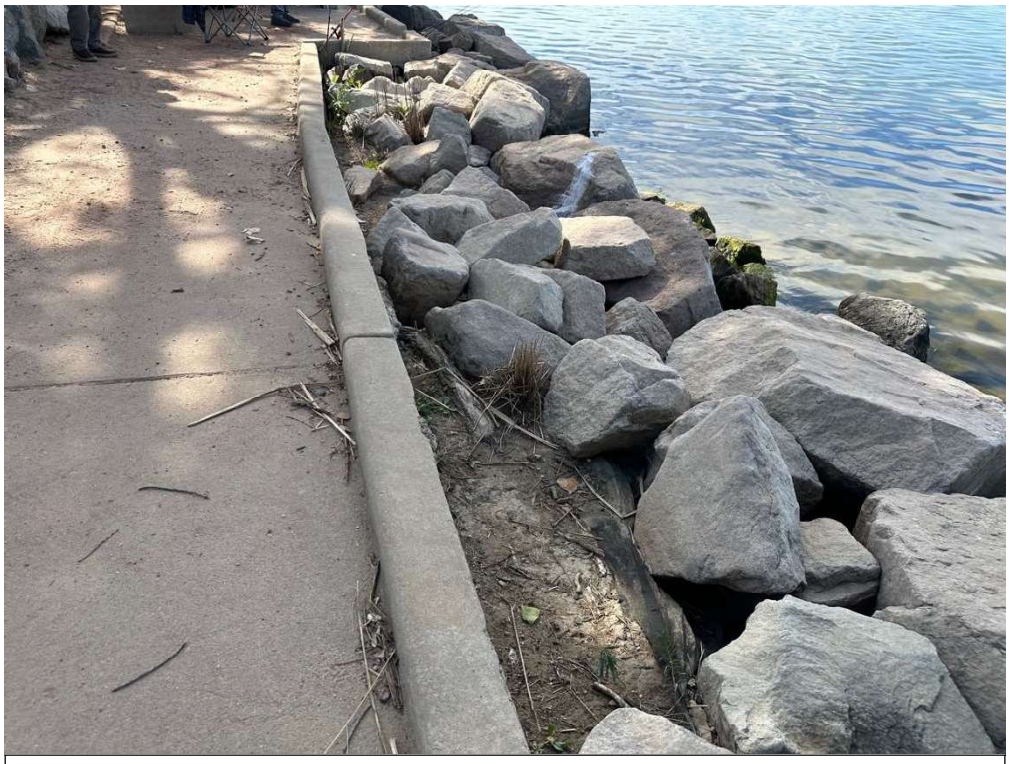
East Shade Shelters: Reservoir elevation at the time of inspection, September 28, 2023 was 5550.05 feet.The north section was not inspected as it is currently part of a capital project to stabilize the shoreline. The south section inspection showed some shifting of the boulders, some trail undermining and bank erosion above the 5552-elevation due to the high flood elevations. As these erosive areas are above the shore stabilization levels they would be good candidates for CCSP reseeding and stabilization projects. A discussion should be held to decide whether the Shore Stabilization philosophy should extend to shore stabilization above the normal reservoir operating level that the current projects are designed for. Maintenance needs are only minor boulder edging backfill and some weed control. The shoreline generally appeared to be stable from earlier stabilization projects, even with the minor boulder displacement and some erosion areas. A separate planning effort should be done, that would identify more specifically the work needed, priority and costs.

Flood caused above stabilization level erosion

Bank erosion above operating level caused by flood not previously riprapped.

Above flood level bank erosion

Vertical bank erosion caused by flood overtopping curb and fisherman access.



Trail edge erosion

Old riprap displacement judging from moss-laden riprap rocks in the water.

East Boat Ramp: Reservoir water level on this day of inspection, September 28, 2023 was 5550.05. Boulders and riprap serve as protection of the shoreline. The maintenance identified for this area is revegetation of the maintenance project that was completed in October of last year, where the seeding and mulch were washed out of the riprap by the flood, and for weed control.

Reseed and mulch 2022 maintenance project, eroded by the floods of 2023-Remove weeds from observation deck.

Reseed and mulch 2022 maintenance project.

Mountain and Lake Loops: Reservoir water surface elevation on this inspection date, September 28, 2023 was 5550.05. Boulders and riprap serve as protection of the shoreline for these facilities. About 100 feet of shoreline has been eroding up to and is exposing the tree roots. As such, there is a maintenance project in place to stabilize this portion of shoreline. Bank erosion above the normal high-water line and trail material erosion was caused by overland flow from the floods running to the reservoir. The bank erosion should be monitored and CCSP should regrade the trails. No maintenance needs were identified.

100-foot eroding shoreline that will be stabilized by current maintenance project.

Access steps need CCSP maintenance

Current condition of shoreline stabilization

West Boat Ramp: All maintenance for this PRF is the responsibility of the CCSP. Maintenance identified for CCSP was cutting and clearing of all the vegetation inside the bounds of the pond, especially at the outlet.

Outlet clogged with plant material

Plant-clogged inlet

Total facility clogged with plants

Conclusions:

1. All the In-Park PRFs appear to be performing their functions well, with the exception of, possibly, the 12-mile Park projects.
2. The field observation general assessments include thoughts on maintenance, monitoring and planning efforts for future capital projects.
3. The summary of the maintenance work identified for consideration and budget estimates is shown in Appendix A of this report. The operations and maintenance costs developed from this 2023 Annual Field Inspection are $143,296 for Restorative and Rehabilitation work, and 12,500 for weed control.
4. Concerns and issues that were located outside limits of the original PRF or require additional analysis and study beyond the engineering already done on the original PRF were suggested as planning efforts. These planning efforts should include identification of the capital project, the priority, identification of the water quality benefits, and estimated costs. The identified planning efforts include:
    a. Cherry Creek 12 Mile Park-continued planning on Cherry Creek from Lakeview Dr to CCSP Boundary, including an analysis of the goals and objectives of the original design concepts and what .
    b. Dixon Grove and all Shoreline stabilization projects- a planning effort to address new areas for shore stabilization, like the one to the south of the existing stabilized area at Dixon Grove, and all other areas from and including Tower Loop to Mountain and Lake Loops, and the appropriateness of the original design concepts, and how those concepts might need to change, especially in light of the effects of the two floods that occurred this year.
    c. Quincy Drainage-Planning for stream reclamation on Quincy Drainage from Lake View Dr to the PRF.

Appendix A

Cherry Creek Basin Water Quality Authority
Summary of 2024 Operation & Maintenance (O&M) Costs
Prepared / Updated: October 24, 2022

Project	Quantity			CCSP Work	CCBWQA Purchases Seed with CCSP Installation	CCBWQA Work					Comments	
	Each	Hours	Acres	Herbicide Application[1]	Tractor Reseeding (Seed Cost Only)[2]	Weed Control[1]	Tree Planting[3]	Shrub Planting[3]	Misc.	Restorative / Rehabilitation work[4]		
Shop Creek	1					$ 3,000					Herbicide treatment of vegetation growing on faces of drops at 100% CCBWQA, since it isn't weed control related.	
	1									$ 17,244	Project carryover from 2023 to 2024, Concrete Repair at Crests of 3 drop structures.	
Cottonwood Wetlands	1			$ 1,000		$ 1,000				$ 30,550	PRF Routine, Decompaction and revegetation of access along embankment. Cleaning of outlet grate.	
Cottonwood Stream Reclamation				$ 2,000		$ 2,000				$ -		
Tower Loop				$ 1,000		$ 1,000				$ 2,950		
Dixon Grove				$ 1,000		$ 1,000						
East Shade Shelter				$ 1,000		$ 1,000				$ 2,950		
East Boat Ramp				$ 500		$ 500				$ 15,970		
Mountain/Lake Loop Shoreline	1			$ 1,000		$ 1,000				$ 65,282	Project carryover from 2023 to 2024, stabilize shoreline area.	
Cherry Creek 12-mile All Phases	1			$ 2,000		$ 2,000				$ 8,350	Weed Control for noxious weeds at 100% CCBWQA, since within 5 years of PRF construction.	
Subtotal				$ 9,500	$ -	$ 12,500	$ -	$ -	$ -	$ 143,296		

Totals

CCSP =	**$ 9,500**
CCBWQA =	**$ 155,796**
Combined =	**$ 165,296**

Note 1. CCBWQA performs weed control (mechanical until native grasses mature, then herbicide) for first 5 years after PRF construction; afterwards 50/50 split between CCBWQA and CCSP.
Note 2. Reseeding Rate = $3,250/acre. CCBWQA purchases seed CCSP installs it with their tractor and the seed attachment purchased by CCBWQA.
Note 3. Tree Replacement = $1,300/ea. Shrub Replacement =$65/ea.. CCBWQA Participation @ 100%.
Note 4. PRF Function Repair/Maintenace. Project Specific Estimate. CCBWQA Participation @ 100%.

2023 PRF Inspection

Cherry Creek 12-Mile Park 2024 Repair

Date: 10/24/2023

No.	Item	Quantity	Unit	Unit Price	Extension
1	Mobilization	1	EA	$ 500.00	$ 500.00
2	Boulder edging backfill/grout	10	CY	$ 250.00	$ 2,500.00
3	Material removal from operating pool	10	CY	$ 250.00	$ 2,500.00

Subtotal		$ 5,500.00	
Contingency	20%	$ 1,100.00	
Subtotal		$ 6,600.00	
Surveying			
Engineering, Permitting & Const Svs	30%	$ 1,750.00	USACOE permit
Total Estimated Construction Cost		**$ 8,350.00**	

2023 PRF Field Observation
Cottonwood Wetlands 2024 Repair

Date: 10/24/2023

No.	Item	Quantity	Unit	Unit Price	Extension
1	Mobilization	1	LS	$ 500.00	$ 500.00
2	Decompaction	0.2	AC	$ 6,500.00	$ 1,300.00
3	Reseeding and Mulch	0.2	AC	$ 6,500.00	$ 1,300.00
4	Clean out Outlet Structure	1	LS	$ 650.00	$ 650.00
5	Remove material from flood storage pool per USACOE	81	CY	$250	$ 20,250.00

Subtotal		$	24,000.00
Contingency	20%	$	4,800.00
Subtotal		$	28,800.00
Surveying			
Engineering, Permitting & Const Svs		$	1,750.00
Total Estimated Construction Cost		**$**	**30,550.00**

2022 PRF Inspection
East Boat Ramp 2024 Repair

Date: 10/24/2023

No.	Item	Quantity	Unit	Unit Price	Extension
1	Mobilization	1	EA	$ 1,200.00	$ 1,200.00
3	Seed	0.1	AC	$ 3,250.00	$ 325.00
4	Mulch	0.1	AC	$ 3,250.00	$ 325.00
5	Remove material from flood storage pool per USACOE	40	CY	$ 250.00	$ 10,000.00

Subtotal		$	11,850.00
Contingency	20%	$	2,370.00
Subtotal		$	14,220.00
Surveying			
Engineering, Permitting & Const Svs	30%	$	1,750.00
Total Estimated Construction Cost		**$**	**15,970.00**

USACOE Permit

2023 PRF Inspection
East Shade Shelter 2024 Repair

Date: 10/24/2023

No.	Item	Quantity	Unit	Unit Price	Extension
1	Mobilization	1	EA	$ 500.00	$ 500.00
2	Boulder Edging Backfill	1	CY	$ 250.00	$ 250.00
3	Remove material from flood storage pool per USACOE	1	CY	$ 250.00	$ 250.00

Subtotal		$	1,000.00
Contingency	20%	$	200.00
Subtotal		$	1,200.00
Surveying			
Engineering, Permitting & Const Svs	30%	$	1,750.00
Total Estimated Construction Cost		**$**	**2,950.00**

2023 PRF Inspection

Mountain and Lake Loop 2024 Repair

Date: 10/24/2023

No.	Item	Quantity	Unit	Unit Price	Extension
1	Mobilization	1	EA	$ 1,560.00	$ 1,560.00
2	Construction Fence	800	LF	$ 5.85	$ 4,680.00
3	Erosion Control Log	80	LF	$ 3.90	$ 312.00
4	Type M Soil Riprap	85	CY	$ 250.00	$ 21,250.00
5	Seed	0.5	AC	$ 3,250.00	$ 1,625.00
6	Mulch	0.5	AC	$ 3,250.00	$ 1,625.00
7	Remove and Reset Fence for Access	50	LF	$ 42.00	$ 2,100.00
8	Remove material from flood storage pool per USACOE	85	CY	$ 250.00	$ 21,250.00

Subtotal		$	54,402.00
Contingency	20%	$	10,880.40
Subtotal		$	65,282.40
Surveying			
Engineering, Permitting & Const Svs	30%		
Total Estimated Construction Cost		**$**	**65,282.40**

Permitting will be done in 2023

2023 PRF Field Observation
Shop Creek 2024 Repair

Date: 10/24/2023

No.	Item	Quantity	Unit	Unit Price	Extension
1	Mobilization	1	LS	$ 1,000.00	$ 1,000.00
2	Concrete Repair at Crests	1	LS	$ 6,500.00	$ 6,500.00
3	Water Control	1	LS	$ 1,300.00	$ 1,300.00
4	Concrete Washout	1	EA	$ 975.00	$ 975.00
5	Tree Removal	1	LS	$ 1,137.00	$ 1,137.00
6	Remove material from flood storage pool per USACOE	2	CY	$ 1,000.00	$ 2,000.00

Subtotal		$	12,912.00
Contingency	20%	$	2,582.40
Subtotal		$	15,494.40
Surveying			
Engineering, Permitting & Const Svs		$	1,750.00
Total Estimated Construction Cost		**$**	**17,244.40**

2023 PRF Inspection
Tower Loop 2024 Repair

Date: 10/24/2023

No.	Item	Quantity	Unit	Unit Price	Extension
1	Mobilization	1	EA	$ 500.00	$ 500.00
2	Boulder void backfill	1	CY	$ 250.00	$ 250.00
3	Remove material from flood storage pool per USACOE	1	CY	$ 250.00	$ 250.00

Subtotal		$	1,000.00
Contingency	20%	$	200.00
Subtotal		$	1,200.00
Surveying			
Engineering, Permitting & Const Svs	30%	$	1,750.00
Total Estimated Construction Cost		**$**	**2,950.00**

CHERRY CREEK BASIN WATER QUALITY AUTHORITY

TABLE 1 - SUMMARY OF POTENTIAL POLLUTANT REDUCTION FACILITIES

REVISIONS FOR 2024 - 2033 CIP

Date: **October 26, 2023**

Color Code:

Blue: Project Completed

Green: Planned for design/construction within 10-year CIP (see Table 2)

* Project updated based on best available information. Projects have best accounting information that includes total project costs of design, construction, construction management, and permit clearance. Other information such as stream length was adjusted based on information noted in comments on spreadsheet. O&M costs were adjusted to be similar cost baseline. Projects that were bid/constructed in phases, were separated into those phases to facilitate adjustment to 2023 costs on PRFs for WQ Analysis.

\# Site specific analysis used for project to support CCBWQA's funding level

See comment in spreadsheet for more information and include in presentation to TAC and Board.

Projects highlighted so that original project information compared with updated project information (denoted with *).

Proj. Designation	Project Title	Status	Description	Design Basis				Projected Loads					Projected Treatment			Cost Estimate (1000$)								Unit Cost ($/pound)		Note
			PRF Type	Quantity	Unit	Rate	Volume	Rate		Total		Source	Removal	lbs Removed		Capital	Land Acquisition	Water Augment[8]	Capital Replace[9]	O&M	Annual Cost @ 4%	CCBWQA Share (%)	CCBWQA Share ($)	w/o cost sharing	w/cost sharing	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)		(9)		(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)
CCR-1	Reservoir Destratification (mixing)	Officially start-up April 2008	Use inlake mixing to minimize algae blooms, therefore chlorophyll a	369	sq mi	n/a	n/a	n/a		n/a		n/a		810	lbs/season	$ 968				$ 28	$ 80	100%	$968	$ 99	$ 99	
CCB-1	CCSP Wetlands	Prelim design prepared in 2003 (Ref 1, 8)	Restore 60 Acres of wetlands in multiple phases	369	sq mi	3.5 cfs avg daily flow	1415 af/210 days	0.35	mg/l	1050	lbs/yr	Base flow		600	lbs/season	$ 1,928	$ -	$ -	$ -	$ 19	$ 123	100%	$1,928	$ 204	$ 204	18
CCB-5.2	Arapahoe/Douglas County Line Stream Stabilization	Project completed w/o Authority participation	Local stream stabilization (L = 2700 ft)	0.51	mi			100	lbs/mi	51	lbs/yr	Storm Flow	90%	46	lbs/year	$ 1,062	$ -	$ -	$ -	$ 1	$ 58	0%	$0	$ 1,258	$ -	2
CCB-5.3	Cottonwood Bridge Stream Stabilization	Project completed by Parker w/o Authority participation	Local stream stabilization (L = 2700 ft)	0.51	mi			100	lbs/mi	51	lbs/yr	Storm Flow	90%	46	lbs/year	$ 436	$ -	$ -	$ -	$ 2	$ 25	0%	$0	$ 551	$ -	2
CCB-5.5	Stroh Road Stream Stabilization	Project completed by Parker w/o Authority participation	Stream stabilization (L = 5000 ft)	0.95	mi			100	lbs/mi	95	lbs/yr	Storm Flow	90%	85	lbs/year	$ 218	$ -	$ -	$ -	$ 1	$ 13	0%	$0	$ 149	$ -	2
CCB-5.7	Cherry Creek Stream Stabilization at Eco-Park (SEMSWA)	IGA w/SEMSWA for design in 2010 and construction in 2011/2012	Local stream stabilization (L = 6850 ft)	1.30	mi			100	lbs/mi	130	lbs/yr	Storm Flow	90%	117	lbs/year	$ 4,756	$ -	$ -	$ -	$ 1	$ 256	24%	$1,155	$ 2,191	$ 532	2, 3
CCB-5.7*	Cherry Creek Stream Stabilization at Eco-Park (SEMSWA)	IGA w/SEMSWA for design in 2010 and construction in 2011/2012	Local stream stabilization (L = 4850 ft)	0.92	mi			100	lbs/mi	92	lbs/yr	Storm Flow	90%	83	lbs/year	$ 4,756	$ -	$ -	$ -	$ 2	$ 257	19%	$905	$ 3,106	$ 591	2, 3, 7
CCB-5.9.1	Cherry Creek Stream Stabilization at 12-Mile Park (CCSP) - Phase I	Design completed in 2011 for Phase I.	Local stream stabilization (L = 500 ft)	0.09	mi			100	lbs/mi	9	lbs/yr	Storm Flow	90%	9	lbs/year	$ 296	$ -	$ -	$ -	$ 1	$ 17	100%	$296	$ 1,979	$ 1,979	2, 20
CCB-5.9.2	Cherry Creek Stream Stabilization at 12-Mile Park (CCSP) - Phase II	Design completed in 2013 for Phase II.	Local stream stabilization (L = 2500 ft)	0.47	mi			100	lbs/mi	47	lbs/yr	Storm Flow	90%	43	lbs/year	$ 1,429	$ -	$ -	$ -	$ 1	$ 78	100%	$1,429	$ 1,820	$ 1,820	2, 20
CCB-5.10	Cherry Creek Stream Stabilization at PJCOS (Vermillion Creek, PJMD.)	Design completed by PJMD. Authority is funding partner in design	Local stream stabilization (L = 5100 ft)	0.97	mi			100	lbs/mi	97	lbs/yr	Storm Flow	90%	87	lbs/year	$ 3,017	$ -	$ -	$ -	$ 2	$ 164	21%	$643	$ 1,882	$ 401	2, 3
CCB-5.11	Cherry Creek Stream Stabilization at Norton Farms (Parker)	Conceptual design by UDFCD identified priority 3	Local stream stabilization (L = 2200 ft)	0.42	mi			100	lbs/mi	42	lbs/yr	Storm Flow	90%	38	lbs/year	$ 900	$ -	$ -	$ -	$ 1	$ 49	28%	$252	$ 1,313	$ 368	2, 3
CCB-5.11*	Cherry Creek Stream Stabilization at Norton Farms (Parker)	Conceptual design by UDFCD identified priority 3	Local stream stabilization (L = 2500 ft)	0.47	mi			100	lbs/mi	47	lbs/yr	Storm Flow	90%	43	lbs/year	$ 1,103	$ -	$ -	$ -	$ 1	$ 60	23%	$255	$ 1,410	$ 326	2, 3
CCB-5.12	Cherry Creek Stream Stabilization at Pine Lane	Project completed by Parker w/o Authority participation	Local stream stabilization (L = 1500 ft)	0.28	mi			100	lbs/mi	28	lbs/yr	Storm Flow	90%	26	lbs/year	$ 500	$ -	$ -	$ -	$ 1	$ 28	0%	$0	$ 1,087	$ -	
CCB-5.14	Cherry Creek Stream Reclamation - CCSP to Eco Park (Ph II to V)	IGA w/SEMSWA for design in 2010	Local stream stabilization (L = 11000 ft)	2.08	mi			100	lbs/mi	208	lbs/yr	Storm Flow	90%	188	lbs/year	$ 10,200	$ -	$ -	$ -	$ 1	$ 547	25%	$2,499	$ 2,920	$ 715	
CCB-5.14B	Cherry Creek Stream Reclamation - Valley Country Club	Projects with UDFCD, SEMSWA, and Aurora. Phases started in 2010.	Local stream stabilization (L = 2000 ft.=1400 ft on Cherry Creek and 600 ft. on Tributary)	0.38	mi			100	lbs/mi	38	lbs/yr	Storm Flow	90%	34	lbs/year	$ 2,284	$ -	$ -	$ -	$ 1	$ 123	21%	$484	$ 3,607	$ 764	2, 3
CCB-5.15	Cherry Creek Stream Reclamation at Country Meadows (Hess Rd)	Project by Town of Parker and Douglas County	Local stream stabilization (L = 7700 ft)	1.46	mi			100	lbs/mi	146	lbs/yr	Storm Flow	90%	131	lbs/year	$ 2,170	$ -	$ -	$ -	$ 2	$ 118	24%	$520	$ 901	$ 216	2, 3
CCB-5.15*	Cherry Creek Stream Reclamation at Country Meadows (Hess Rd)	Project by Town of Parker and Douglas County	Local stream stabilization (L = 4200 ft)	0.80	mi			100	lbs/mi	80	lbs/yr	Storm Flow	90%	72	lbs/year	$ 2,788	$ -	$ -	$ -	$ 2	$ 151	25%	$695	$ 2,114	$ 527	2, 3, 7
CCB-5.16	Cherry Creek Stream Reclamation - 12 Mile Phase III	Project w/in CCSP identified as Reach 1 in Project CCB-5.14 work.	Local stream stabilization (L =30 ft,)	0.01	mi			100	lbs/mi	1	lbs/yr	Storm Flow	90%	1	lbs/year	$ 300	$ -	$ -	$ -	$ 3	$ 19	100%	$300	$ 37,299	$ 37,299	2, 20
CCB-5.17.1A	Cherry Creek Stream Reclamation at KOA	Preliminary design completed 2019, Extension Requested by UDFCD and Parker in 2019	Local stream stabilization (L =1400 ft original, L=2000 ft with 600 ft extension)	0.38	mi			100	lbs/mi	38	lbs/yr	Storm Flow	90%	34	lbs/year	$ 2,035	$ -	$ -	$ -	20	$ 129	20%	$375	$ 3,795	$ 776	2, 3
CCB-5.17.1A*	Cherry Creek Stream Reclamation at KOA	Preliminary design completed 2019, Extension Requested by UDFCD and Parker in 2019	Local stream stabilization (L =1400 ft original, L=2000 ft with 600 ft extension)	0.38	mi			100	lbs/mi	38	lbs/yr	Storm Flow	90%	34	lbs/year	$ 1,806	$ -	$ -	$ -	$ 1	$ 98	18%	$333	$ 2,868	$ 529	2, 3, 7
CCB-5.17.1B	Cherry Creek Stream Reclamation at Dransfeldt	Design in 2021, Construction in 2023	Local stream stabilization (L =2400 ft original)	0.45	mi			100	lbs/mi	45	lbs/yr	Storm Flow	90%	41	lbs/year	$ 7,274	$ -	$ -	$ -	$ 1	$ 391	12%	$837	$ 9,551	$ 1,099	2, 3
CCB-6.1	Piney Creek Stream Stabilization - Project 1	Authority funded $118,000 Arapahoe County in 2002.	Restore 5200 lf upstream of Parker Road	22.90	sq mi	n/a	n/a	100	lbs/mi	100	lbs/yr	Storm Flow	90%	90	lbs/year	$ 997	$ -	$ -	$ -	$ 10	$ 63	13%	$130	$ 705	$ 92	2, 3
CCB-6.2	Piney Creek Stream Stabilization - Project 2 U/S Buckley Rd	Project completed w/o Authority participation	Reclaim 1700 lf upstream of Buckley Road	0.32	mi			100	lbs/mi	32	lbs/mi	Storm Flow	90%	29	lbs/year	$ 998	$ -	$ -	$ -	$ 1	$ 54	12%	$120	$ 1,880	$ 226	2, 3
CCB-6.4	Piney Creek Stream Reclamation - Reachs 6 & 7	Request from UDFCD in 2014	Local stream stabilization (L = 6,000 ft)	1.14	mi			unk		365	lbs/yr	Storm Flow	90%	329	lbs/year	$ 11,000	$ -	$ -	$ -	$ 2	$ 591	25%	$2,750	$ 1,800	$ 450	12
CCB-6.4A *	Piney Creek Stream Reclamation - Reach 7	Request from UDFCD in 2014	Local stream stabilization (L = 2,340 ft)	0.44	mi			100	lbs/mi	44	lbs/mi	Storm Flow	90%	40	lbs/year	$ 3,765	$ -	$ -	$ -	$ 1	$ 203	14%	$512	$ 5,082	$ 691	2, 3, 7
CCB-6.4B.1 *	Piney Creek Stream Reclamation - Reach 6 upstream of Caley	Request from UDFCD in 2014	Local stream stabilization (L = 1,600 ft)	0.30	mi			100	lbs/mi	30	lbs/yr	Storm Flow	90%	27	lbs/year	$ 2,896	$ -	$ -	$ -	$ 1	$ 156	14%	$394	$ 5,726	$ 779	2, 3, 7
CCB-6.4B.2 *	Piney Creek Stream Reclamation - Reach 6 Phase 2	Request from UDFCD in 2014	Local stream stabilization (L = 2,580 ft)	0.49	mi			100	lbs/mi	49	lbs/yr	Storm Flow	90%	44	lbs/year	$ 2,659	$ -	$ -	$ -	$ 1	$ 143	14%	$361	$ 3,262	$ 443	2, 3, 7
CCB-7.1	McMurdo Gulch Reclamation (Castle Rock)	Project completed in 2011	Stream Reclamation (L = 15,000 lf)	2.84	mi			100	lbs/mi	284	lbs/yr	Storm Flow	90%	256	lbs/year	$ 1,470	$ -	$ -	$ -	$ 28	$ 107	43%	$630	$ 419	$ 180	
CCB-7.2	McMurdo Gulch Reclamation (Castle Rock) 19/20 Project	Design in 2019, Construction in 2020	Stream Reclamation (L = 2,000 lf)	0.38	mi			100	lbs/mi	38	lbs/yr	Storm Flow	90%	34	lbs/year	$ 1,677	$ -	$ -	$ -	17	$ 107	25%	$420	$ 3,127	$ 783	2, 3
CCB-7.2 *	McMurdo Gulch Reclamation (Castle Rock) 19/20 Project	Design in 2019, Construction in 2020	Stream Reclamation (L = 2,000 lf)	0.38	mi			100	lbs/mi	38	lbs/yr	Storm Flow	90%	34	lbs/year	$ 1,156	$ -	$ -	$ -	$ 1	$ 63	25%	$289	$ 1,846	$ 462	2, 3, 7
CCB-7.3	McMurdo Gulch Reclamation (Castle Rock) 20/21/22 Project	Design in 2020, Construction 2021	Stream Reclamation (L = 3,700 lf)	0.70	mi			100	lbs/mi	70	lbs/yr	Storm Flow	90%	63	lbs/year	$ 2,460	$ -	$ -	$ -	$ 25	$ 156	25%	$615	$ 2,480	$ 620	2, 3
CCB-7.3 *	McMurdo Gulch Reclamation (Castle Rock) 20/21/22 Project	Design in 2020, Construction 2021	Stream Reclamation (L = 3,700 lf)	0.70	mi			100	lbs/mi	70	lbs/yr	Storm Flow	90%	63	lbs/year	$ 1,940	$ -	$ -	$ -	$ 1	$ 105	24%	$466	$ 1,664	$ 400	2, 3, 7

CHERRY CREEK BASIN WATER QUALITY AUTHORITY

TABLE 1 - SUMMARY OF POTENTIAL POLLUTANT REDUCTION FACILITIES

REVISIONS FOR 2024 - 2033 CIP

Date: **October 26, 2023**

Color Code: Blue: Project Completed

Green: Planned for design/construction within 10-year CIP (see Table 2)

* Project updated based on best available information. Projects have best accounting information that includes total project costs of design, construction, construction management, and permit clearance. Other information such as stream length was adjusted based on information noted in comments on spreadsheet. O&M costs were adjusted to be similar cost baseline. Projects that were bid/constructed in phases, were separated into those phases to facilitate adjustment to 2023 costs on PRFs for WQ Analysis.

\# Site specific analysis used for project to support CCBWQA's funding level

See comment in spreadsheet for more information and include in presentation to TAC and Board.

Projects highlighted so that original project information compared with updated project information (denoted with *).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD
48	CCB-12	Bowtie Property PRF	Purchase completed 2003	Stabilize confluence (Ph I) and construct sediment pond (Ph 2)	22	sq mi	2-year flood	300 af	500	mg/l/ton	85	lbs/yr	base flow and minor flood	70% pond 65% wetlands	235	lbs/year	$ 826	$ 300	$ 63	$ 1.8	$ 6	$ 70	100%	$826	$ 299	$ 299	2			
49	CCB-13.1	Cottonwood\Peoria Wetlands Pond	Completed 2003. Restorative maintenance required in 2009	Joint funded project with UDFCD, GWV, Arapahoe County	8.30	sq mi							base and flood flows	measured	363	lbs/year	$ 1,636	$ -	$ -	$ -	$ 5	$ 93	12%	$196	$ 255	$ 31	2			
50	CCB-13.2	Cottonwood Stream Reclamation in CCSP	Phase I completed in 2004. Phase II completed June 2008 (Ref 2)	11,600 lf of stream reclamation from Peoria to Perimeter Rd. Pond	2.20	mi			100	lbs/mi	220	lbs/yr	base and flood flows	see separate calcs	730	lbs/year	$ 2,200	$ -	$ -	$ -	$ 55	$ 173	100%	$2,200	$ 237	$ 237	2			
51	CCB-13.3	Cottonwood Creek Stream Stabilization at Easter Avenue	Authority contributed $338,000 for construction in 2010.	2,600 lf of stream reclamation from Easter Ave to Briarwood Ave	0.49	mi			100	lbs/mi	49	lbs/yr	Storm Flow	90%	44	lbs/year	$ 1,350	$ -	$ -	$ -	$ 1	$ 73	25%	$338	$ 1,655	$ 414	2			
52	CCB-13.4	Peoria Trib B/Airport East and West Pond (Outfall C-1)	Cottonwood Creek Master Planned Improvements. Ponds combined into one.	Combined existing detention ponds and provided EURV	0.35	sq mi			400	lbs/sq mi	140	lbs/yr	Base and storm flow	40%	56	lbs/yr	$ 523	$ -	$ -	$ -	$ -	$ 28	25%	$131	$ 500	$ 125				
53	CCB-17.2	Reservoir Shoreline Stabilization Mountain Loop Trail	Scheduled for construction beginning in 2012	CCSP Recreation sites: Mountain, Lake and Cottonwood Creek Loops (2,300 ft of shoreline)											54	lbs/yr	$ 1,131	$ -	$ -	$ -	$ 5	$ 66	100%	$1,131	$ 1,215	$ 1,215	1, 16			
54	CCB-17.3	West Boat Ramp Parking Lot WQ Improvements	Final design completed in 2012	Provide water quality treatment of parking lot runoff.	3.43	ac prkg lot					3	lbs/yr	parking lot	70%	2	lbs/yr	$ 330	$ -	$ -	$ -	$ 1	$ 19	100%	$330	$ 8,903	$ 8,903	1			
55	CCB-17.4	East Boat Ramp Shoreline Stabilization Phase II	Identified during 2012 annual PRF inspection	105 lf of bank stabilization	105	lf	0.1 cy/yr/ft		0.14	lbs/lf	14.7	lbs/yr	bank erosion	80%	12	lbs/yr	$ 91	$ -	$ -	$ -	$ 2	$ 7	100%	$91	$ 585	$ 585	1, 16			
56	CCB-17.5	East Shade Shelter Shoreline Stabilization Phase II	Identified during 2012 annual PRF inspection	20 lf of bank stabilization	20	lf	0.1 cy/yr/ft		0.14	lbs/lf	2.8	lbs/yr	bank erosion	80%	2	lbs/yr	$ 18	$ -	$ -	$ -	$ -	$ 1	100%	$18	$ 431	$ 431	1, 16			
57	CCB-20.1	Detention Pond Retrofit Program - McMurdo Gulch	Phase 1 - McMurdo Gulch	Modify existing ponds to meet current standards for WQ	1	Each			0.40	lbs/Trib Acre	0.4	lbs/yr	Residential		9	lbs/pond/yr	$ 60	$ -	$ -	$ -	$ 0	$ 4	100%	$60	$ 396	$ 396	1, 17			
58	CCB-22..2	Happy Canyon Creek Upstream of I-25 (MHFD)	Requested in 2020	3000 lf of stream reclamation	0.57	mi			100	lbs/mi	57	lbs/yr	Storm Flow	90%	51	lbs/year	$ 5,441	$ -	$ -	$ -	$ 54	$ 346	9%	$500	$ 6,765	$ 622	2, 3			
59	CCB-22..2*	Happy Canyon Creek Upstream of I-25 (MHFD)	Requested in 2020	3000 lf of stream reclamation	0.57	mi			100	lbs/mi	57	lbs/yr	Storm Flow	90%	51	lbs/year	$ 4,021	$ -	$ -	$ -	$ 1	$ 216	9%	$362	$ 4,232	$ 381	2, 3, 7			
60																														
61	**Proj. Designation**	**Project Title**	**Status**	**Description**	**Design Basis**				**Projected Loads**					**Projected Treatment**			**Cost Estimate (1000$)**											**Unit Cost ($/pound)**		**Note**	
62				PRF Type	Quantity	Unit	Rate	Volume	Rate		Total		Source	Removal	lbs Removed		Capital from 2023 to 2032 CIP	Total Project Cost update to 2023 $	Design in 2023 $	Capital in 2023 $	Land Acquisition	Water Augment[8]	Capital Replace[9]	O&M	Annual Cost @ 4%	CCBWQA Share (%)	CCBWQA Share ($)	w/o cost sharing	w/cost sharing		
63	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)			(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)
64	CCB-5.4	Cherry Creek Stream Stabilization at Main Street (Parker)	Conceptual design by UDFCD	Local stream stabilization (L = 4000 ft)	0.76	mi			100	lbs/mi	76	lbs/yr	Storm Flow	90%	68	lbs/year	$ 1,776	$ 5,600	$ 840	$ 4,760	$ -	$ -	$ -	$ 2	$ 302	23%	$1,280	$ 4,430	$ 1,013	2, 3, 7	
65	CCB-5.6	Cherry Creek Stream Stabilization at Lincoln Avenue (Parker)	Conceptual design by UDFCD	Local stream stabilization (L = 2350 ft)	0.45	mi			100	lbs/mi	45	lbs/yr	Storm Flow	90%	40	lbs/year	$ 1,447	$ 3,290	$ 494	$ 2,797	$ -	$ -	$ -	$ 1	$ 177	23%	$755	$ 4,425	$ 1,016	2, 3, 7	
66	CCB-5.14C	Cherry Creek Stream Reclamation at Arapahoe Rd. - Valley Country Club to Soccer Fields, Reaches 3 to 4	Projects with UDFCD, SEMSWA, and Aurora. Phases started in 2010.	Local stream stabilization (L = 5167 ft on Cherry Creek)	0.98	mi			100	lbs/mi	98	lbs/yr	Storm Flow	90%	88	lbs/year	$ 5,287	$ 10,600	$ 1,590	$ 9,010	$ -	$ -	$ -	$ 2	$ 570	16%	$1,665	$ 6,462	$ 1,015	2, 3, 7	
67	CCB-5.16A	Cherry Creek Stream Reclamation - Reservoir to Lake View Drive (Reach 1 in Muller's 2022 Stream Assessment Report)	Project w/in CCSP	Local stream stabilization (L =5400 ft,)	1.02	mi			100	lbs/mi	102.3	lbs/yr	Storm Flow	90%	92	lbs/year	$ 6,842	$ 11,846	$ 1,777	$ 10,069	$ -	$ -	$ -	$ 6	$ 641	100%	$11,846	$ 6,960	$ 6,960	2, 3, 6	
68	CCB-5.16A#	Cherry Creek Stream Reclamation - Reservoir to Lake View Drive (Reach 1 in Muller's 2022 Stream Assessment Report)	Project w/in CCSP	Local stream stabilization (L =5400 ft,)	1.02	mi									1684	lbs/year	$ 6,842	$ 11,846	$ 1,777	$ 10,069	$ -	$ -	$ -	$ 6	$ 641	100%	$11,846	$ 380	$ 380	2, 3, 6, 10	
69	CCB-5.16B	Cherry Creek Stream Reclamation - Lake View Drive to North Side of DOLA (Reach 2 in Muller's 2022 Stream Assessment Report)	Project w/in CCSP	Local stream stabilization (L =4400 ft,)	0.83	mi			100	lbs/mi	83.3	lbs/yr	Storm Flow	90%	75	lbs/year	$ 5,612	$ 7,920	$ 1,188	$ 6,732	$ -	$ -	$ -	$ 6	$ 430	100%	$7,920	$ 5,738	$ 5,738	2, 3, 6	
70	CCB-5.16C	Cherry Creek Stream Reclamation - (Reach 3 in Muller's 2022 Stream Assessment Report)	Projects with UDFCD, SEMSWA, and Aurora. Phases started in 2010.	Local stream stabilization (Cherry Creek Reach 3 L =6200 ft)	1.17	mi			100	lbs/mi	117	lbs/yr	Storm Flow	90%	106	lbs/year	$ 10,054	$ 11,160	$ 1,674	$ 9,486	$ -	$ -	$ -	$ 1	$ 599	100%	$11,160	$ 5,667	$ 5,667	2, 3, 6	
71	CCB-5.16C #	Cherry Creek Stream Reclamation - (Reach 3 in Muller's 2022 Stream Assessment Report)	Projects with UDFCD, SEMSWA, and Aurora. Phases started in 2010.	Local stream stabilization (Cherry Creek Reach 3 L =6200 ft)	1.17	mi									1963	lbs/year	$ 10,054	$ 11,160	$ 1,674	$ 9,486	$ -	$ -	$ -	$ 1	$ 599	100%	$11,160	$ 305	$ 305	2, 3, 6, 10	
72	CCB-5.17.2	Cherry Creek Stream Reclamation U/S Scott Road	Project requested by Douglas County and UDFCD in 2019	Local stream stabilization (L = 4300 ft)	0.81	mi			100	lbs/mi	81	lbs/yr	Storm Flow	90%	73	lbs/year	$ 5,477	$ 5,477	$ 822	$ 4,655	$ -	$ -	$ -	$ 2	$ 295	24%	$1,309	$ 4,031	$ 963	2, 3, 7	
73	CCB-6.5	Piney Creek - Cherry Creek to Parker Road, Reaches 1 to 2 (SEMSWA)	Requested in 2020	2900 lf of stream reclamation	0.55	mi			100	lbs/mi	55	lbs/mi	Storm Flow	90%	49	lbs/year	$ 2,350	$ 4,060	$ 609	$ 3,451	$ -	$ -	$ -	$ 1	$ 219	23%	$930	$ 4,421	$ 1,013	2, 3, 7	
74	CCB-6.6	Piney Creek south of Orchard Rd., Reaches 4 to 5 (SEMSWA)	Requested in 2020	3800 lf of stream reclamation	0.72	mi			100	lbs/mi	72	lbs/mi	Storm Flow	90%	65	lbs/year	$ 3,000	$ 5,320	$ 798	$ 4,522	$ -	$ -	$ -	$ 1	$ 286	23%	$1,220	$ 4,416	$ 1,013	2, 3, 7	
75	CCB-7.4	McMurdo Gulch Reclamation (Castle Rock) 22/23/24/25 Project	Design in 2022- 2023, Construction in 2024	Stream Reclamation (L = 6,550 lf)	1.24	mi			100	lbs/mi	124	lbs/yr	Storm Flow	90%	112	lbs/year	$ 3,298	$ 5,162	$ 774	$ 4,388	$ -	$ -	$ -	$ 2	$ 279	25%	$1,292	$ 1,878	$ 470	2, 3, 7	
76	CCB-13.3.1A	Cottonwood Creek Catail Harvesting from Reservoir to Peoria Street~	Pilot Project - Odd Years Harvest Left Bank	1.7 Acres of Cattail Harvesting	2.90	mi				lbs/mi	30	lbs/yr	Storm Flow	100%	59	lbs/year	$ 60	$ 90	$ -	$ 90	$ -	$ -	$ -	$ -	$ 5	100%	$90	$ 1,525	$ 1,525	4	
77	CCB-13.3.1B	Cottonwood Creek Cattail Harvesting from Reservoir to Peoria Street~	Pilot Project - Even Years Harvest Right Bank	2.0 Acres of Cattail Harvesting	2.90	mi				lbs/mi	237	lbs/yr	Storm Flow	100%	60	lbs/year	$ 60	$ 90	$ -	$ 90	$ -	$ -	$ -	$ -	$ 5	100%	$90	$ 1,500	$ 1,500	4	
78	CCB-13.5.3	Cottonwood Creek Tributary - Shooting Area Tributary (CCSP)	Requested in 2020	600 lf of stream reclamation	0.11	mi			100	lbs/mi	11	lbs/yr	Storm Flow	90%	10	lbs/year	$ 300	$ 720	$ 108	$ 612	$ -	$ -	$ -	1	$ 40	25%	$180	$ 3,870	$ 967	2, 3, 6	
79	CCB-13.5.4	Cottonwood Creek and Tributary C (IWSD)	Requested in 2020	2080 lf of stream reclamation	0.39	mi			100	lbs/mi	39	lbs/yr	Storm Flow	90%	35	lbs/year	$ 1,664	$ 2,496	$ 374	$ 2,122	$ -	$ -	$ -	1	$ 135	25%	$624	$ 3,800	$ 950	2, 3, 7	

CHERRY CREEK BASIN WATER QUALITY AUTHORITY

TABLE 1 - SUMMARY OF POTENTIAL POLLUTANT REDUCTION FACILITIES

REVISIONS FOR 2024 - 2033 CIP

Date: **October 26, 2023**

Color Code: Blue: Project Completed

Green: Planned for design/construction within 10-year CIP (see Table 2)

* Project updated based on best available information. Projects have best accounting information that includes total project costs of design, construction, construction management, and permit clearance. Other information such as stream length was adjusted based on information noted in comments on spreadsheet. O&M costs were adjusted to be similar cost baseline. Projects that were bid/constructed in phases, were separated into those phases to facilitate adjustment to 2023 costs on PRFs for WQ Analysis.

\# Site specific analysis used for project to support CCBWQA's funding level

See comment in spreadsheet for more information and include in presentation to TAC and Board.

Projects highlighted so that original project information compared with updated project information (denoted with *).

CCB-16	Stream Corridor Preservation	No projects identified	Partner with others to purchase property or conservation easements along Cherry Creek													$ 100	$ 100	$ -	$ 100					$ 5	100%	$100			1
CCB-17.2.1	Mountain and Lake Loop - 2021 Shoreline Maintenance	Identified during 2020 annual PRF observation	45 lf of bank stabilization	45	lf	0.1 cy/yr/ft		0.14	lbs/lf	6.3	lbs/yr	bank erosion	80%	5.04	lbs/yr	$ 24	$ 24	$ -	$ 24	$ -	$ -	$ -	$ 1	$ 2	100%	$24	$ 454	$ 454	1, 16, 22
CCB-17.5.1	East Shade Shelter Shoreline Stabilization Phase III	Identified during 2014 annual PRF inspection	400 lf of bank stabilization	400	lf	0.1 cy/yr/ft		0.14	lbs/lf	56.0	lbs/yr	bank erosion	80%	44.8	lbs/yr	$ 906	$ 975	$ 184	$ 791	$ -	$ -	$ -	$ 1	$ 53	86%	$842	$ 1,188	$ 1,026	1, 16, 22
CCB-17.7	Tower Loop Shoreline Stabilization Phase II	Identified during 2014 annual PRF inspection	700 lf of bank stabilization	700	lf	0.1 cy/yr/ft		0.14	lbs/lf	98.0	lbs/yr	bank erosion	80%	78.4	lbs/yr	$ 1,076	$ 1,035	$ 155	$ 880	$ -	$ -	$ -	$ 1	$ 56	100%	$1,035	$ 720	$ 720	1, 16, 22
CCB-21.1	Lone Tree Creek in CCSP downstream of Pond (CCBWQA Only)	Identified in 2014. Request from Arapahoe County Open Space.	500 lf of stream reclamation from CCSP Boundary to Cottonwood Creek	0.09	mi			100	lbs/mi	9	lbs/yr	Storm Flow	90%	9	lbs/yr	$ 340	$ 600	$ 90	$ 510	$ -	$ -	$ -	$ 1	$ 33	100%	$600	$ 3,889.15	$ 3,889	2, 3, 6
CCB-21.3	Lone Tree Creek in CCSP upstream of Pond (Centennial Trail Portion)	Request from Centennial for Participation in Stream Reclamation portion of Trail Project.	710 lf of stream reclamation between CCSP Boundary and Windmill Creek Loop Trail	0.13	mi			100	lbs/mi	13	lbs/yr	Storm Flow	90%	12	lbs/yr	$ 448	$ 448	$ -	$ 448	$ -	$ -	$ -	$ 1	$ 25	25%	$112	$ 2,065.93	$ 516	2, 3, 6
CCB-22.1	Happy Canyon Creek at Jordan Road (SEMSWA)	Requested in 2020	2,500 lf of stream reclamation, project extended another 2000 feet in 2022	0.85	mi			100	lbs/mi	85	lbs/yr	Storm Flow	90%	77	lbs/year	$ 2,731	$ 6,300	$ 945	$ 5,355	$ -	$ -	$ -	$ 2	$ 340	23%	$1,445	$ 4,427	$ 1,015	2, 3, 7
CCB-23.1	Dove Creek Otero Avenue to U/S of Pond D-1 (SEMSWA)	Requested in 2020	2700 lf of stream reclamation (broken into 2 phases, see 23.2A and 23.2 B)	0.51	mi			100	lbs/mi	51	lbs/yr	Storm Flow	90%	46	lbs/year		$ 4,960	$ -	$ 4,960	$ -	$ -	$ -	$ 1	$ 267	16%	$778	$ 5,796	$ 909	2, 3, 7

Proj. Designation	Project Title	Status	Description	Design Basis				Projected Loads			Projected Treatment			Cost Estimate (1000$)								Unit Cost ($/pound)		Note
			PRF Type	Quantity	Unit	Rate	Volume	Rate	Total	Source	Removal	lbs Removed		Capital	Land Acquisition	Water Augment[8]	Capital Replace[9]	O&M	Annual Cost @ 4%	CCBWQA Share (%)	CCBWQA Share ($)	w/o cost sharing	w/cost sharing	
(1)	(2)	(3)	(4)		(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
The projects listed below are older and will likely need to be further evaluated and have costs updated in with future CIP efforts.																								
CCB-8	Limestone Filter Enhancement	Specific project not identified	Construct limestone filter bed downstream of retention pond	1.0	sq mi	n/a	10.7 af/year/sq mile	427	lbs/sq mi	427	lbs/yr	Base and storm flow	20%	85	lbs/year/mi^2	$ 943		$ -	$ 595	$ 1	$ 83	43%	$405	$ 977	$ 420	
CCB-11	Advanced Water Treatment Plant	Conceptual design prepared	Construct 2 MGD AWT plant on Cottonwood Creek to treat Cherry Creek and Cottonwood Creek flows (0.21-mg/ influent, 0.03 mg/l disch)	3	cfs	2-MGD	2260	0.21	mg/l	1272	lbs/yr	Base flow and groundwater	90%	1145	lbs/year	$ 4,593	unknown	unknown		$ 69		100%	$4,593	$ -	$ -	11
CCB-17.4.1	East Boat Ramp Shoreline Stabilization Phase III	Identified during 2012 annual PRF inspection	400 lf of bank stabilization	400	lf	0.1 cy/yr/ft		0.14	lbs/lf	56.0	lbs/yr	bank erosion	80%	44.8	lbs/yr	$ 350	$ -	$ -	$ -	$ 4	$ 23	100%	$350	$ 508	$ 508	1, 16
CCB-17.6	West Shade Shelter Shoreline Stabilization PRF[14]	Identified initially in 2006. UCD Student Project w/WPR in 2013	1,400 lf of bank stabilization	1400	lf	0.1 cy/yr/ft		0.14	lbs/lf	196.0	lbs/yr	bank erosion	80%	179	lbs/yr	$ 704	$ -	$ -	$ -	$ 2	$ 40	65%	$458	$ 222	$ 144	21, 22
CCB-17.8	Dixon Grove Shoreline Stabilization Phase II	Identified during 2019 annual PRF inspection	200 lf of bank stabilization	200	lf	0.1 cy/yr/ft		0.14	lbs/lf	28.0	lbs/yr	bank erosion	80%	22.4	lbs/yr	$ 235	$ -	$ -	$ -	$ 1	$ 14	100%	$235	$ 607	$ 607	1, 16, 22
CCB-18	OWTS Sewer Service	No action to date	Provide Sewer Service for OWTS Areas			To Be Determined		To Be Determined			To Be Determined				To Be Determined					100%	$0	To Be Determined		1
CCB-19	Non-point Pollutant Management	No action to date	Assist agricultural contributors to water quality impact			To Be Determined		To Be Determined			To Be Determined			$ 100	$ -	$ -	$ -	$ -	$ 5	100%	$100	To Be Determined		1

BASIS FOR ANALYSIS:

(A) Unit cost of phosphorus removal based on annualized cost of completed project over 35 years at 4% interest rate. CRF = 0.053577

(B) All projects identified provide for additional phosphorus immobilization beyond minimum requirements, unless noted otherwise.

2024 CIP NOTES:

1. Assumed that augmentation for consumptive use not required
2. Augmentation for naturally established wetlands not required (assumption)
3. Phosphorus Estimated based on Interim Stream Reclamation Paper
4. See 2020 Cattail Harvesting Pilot Project Memo. Phosphorus estimated based on SEMSWA 2020 Data.
5. Pond updates to bring up to current standards and to facilitate maintenance. No phosphorus calculation provided, since ponds already exist.
6. Updated O&M Cost to $6k per mile (increased cost to account for higher public use for projects in CCSP)with a minimum of $1k.
7. Updated O&M Cost to $2k per mile with a minimum of $1k
8. Water costs at $ 6,500 per acre foot
9. Present worth of capital replacement
10. Benefit listed in Muller's Cherry Creek Stream and Water Quality Assessment, Reservoir to State Park Boundary, November 2022
11. Land acquisition and water augmentation not defined. CWSD\ACWWA JWPP project influenced scope of project.
12. Total Phosphorus loading derived from laboratory sediment samples & Stantec Geomorphic Study BANCS analysis.
16. Benefit approximated based on other shoreline projects and estimates
17. Loads and performance based on calculations for 3 McMurdo Gulch ponds.
19. Approach was shifted to focus on stream reclamation (CCB-5.14) and reduction of sediment and nutrient sources from erosion.
20. Joint project with CCSP. Integrate design with Dog Park uses and improvements.
21. Phosphorus: Shoreline 177 lbs/yr + Parking Lot 2 lbs/yr =179 lbs/yr
22. Updated O&M Cost to $2k per 1000' with a minimum of $1k

REFERENCES

1. Muller Eng 2003. *Feasibility Evaluation for Cherry Creek State Park Wetlands Project*
2. Muller Eng 2003. *Feasibility Evaluation for Cottonwood Creek Stream Stabilization Project*
3. AMEC 2005. *Draft Feasibility Report Cherry Creek Reservoir Destratification*
4. AMEC 2006. *Recommendations for Prepurchase of Jamor Equipment for Cherry Creek Reservoir Destratification Project.*
5. Tetra Tech August 2006. *Phosphorus Estimates in Cherry Creek and Cost for Removal via Sediment Trap.*
6 WERF 2000. *Phosphorus Credit Trading in the Cherry Creek Basin: An Innovative Approach to Achieving Water Quality Benefits.*
7. Ruzzo, WP September 5, 2003. Cherry Creek Corridor Master Plan-*Estimate of Phosphorus Reduction from Stream Reclamation*
8. Ruzzo, W. P. September 21, 2006. *Cottonwood Creek Reclamation - Water Rights Augmentation Requirements.*
9. TetraTech December 2006. *Design of Cherry Creek Sediment Basin and Stream Stabilization.*
10. Brown and Caldwell Feb 2007. *Shop Creek Wetlands Pollutant Reduction Facility Wetland Assessment*
11. PBSJ October 2006. *Draft McMurdo Gulch Major Drainageway Master Plan*
12. Brown and Caldwell 2010. *Cherry Creek Stream Reclamation at Shop Creek Trail.*
13. CCBWQA TAC June 16, 2011. *Stream Reclamation Water Quality Benefit Evaluation Interim Status Report*
14. Ruzzo Memo, September 4, 2013, *West Shade Shelter Shoreline Stabilization PRF - Water Quality Analysis.*

CHERRY CREEK BASIN WATER QUALITY AUTHORITY

TABLE 2 - SUMMARY OF RECOMMENDED POLLUTANT REDUCTION FACILITIES

2024 - 2033 BUDGET PROJECTIONS (1000$)

Color Code: See comment in spreadsheet for more information and include in presentation to TAC and Board.

First year in 10-year CIP

	October 26, 2023					Residual PRF Costs	Proposed 2024 Budget				Proposed 2025 Budget	Proposed 2026 Budget	Proposed 2027 Budget	Proposed 2028 Budget	Proposed 2029 Budget	Proposed 2030 Budget	Proposed 2031 Budget	Proposed 2032 Budget	Proposed 2033 Budget	2024-2033 Total
Project No.	Project Title	Total	Authority Portion	Authority Portion		Design	Capital	Land	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
Budget Category - General																				
Budget Category - Reservoir Projects																				
CCR-2	Reservoir Destratification System concept design to replace and optimization in lake distribution system	$ 150	$ 150	100%	$ 150	$ 150	$ -	$ -	***$ 150***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ 150***
CCB-17.5.1	East Shade Shelter Shoreline Stabilization Phase III	$ 975	$ 842	86%	$ 658	$ -	$ 658	$ -	***$ 658***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ 658***
CCB-17.7	Tower Loop Shoreline Stabilization Phase II	$ 1,035	$ 1,035	100%	$ 1,035	$ -	$ -	$ -	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ 155***	***$ 880***	***$ 1,035***
Budget Category - Stream Reclamation Projects																				
CCB-5.4	Cherry Creek Stream Reclamation at Main Street (Parker)	$ 5,600	$ 1,280	23%	$ 1,280	$ -	$ -	$ -	***$ -***	***$ -***	***$ -***	***$ 700***	***$ 580***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ 1,280***
CCB-5.6	Cherry Creek Stream Stabilization at Lincoln Avenue (Parker)	$ 3,290	$ 755	23%	$ 755	$ -	$ -	$ -	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ 411***	***$ 344***	***$ -***	***$ -***	***$ 755***
CCB-5.14C	Cherry Creek Stream Reclamation at Arapahoe Rd. - Valley Country Club to Soccer Fields, Reaches 3 to 4	$ 10,600	$ 1,655	16%	$ 1,104	$ -	$ 300	$ -	***$ 300***	***$ 340***	***$ 340***	***$ 124***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ 1,104***
CCB-5.16A	Cherry Creek - Reservoir to Lake View Drive Alternatives Analysis and Development of Preferred Alternative	$ 438	$ 438	100%	$ 181	$ 181	$ -	$ -	***$ 181***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ 181***
CCB-5.16A, B, C	Cherry Creek all Reaches in CCSP	$ 30,488	$ -	0%	$ -	$ -	$ -	$ -	***$ -***	***$ 770***	***$ 1,110***	***$ 225***	***$ 195***	***$ 1,280***	***$ 500***	***$ 1,190***	***$ 1,470***	***$ 910***	***$ 7,650***
CCB-6.5	Piney Creek - Cherry Creek to Parker Road, Reaches 1 to 2 (SEMSWA)	$ 4,060	$ 930	23%	$ 829	$ 39	$ -	$ -	***$ 39***	***$ 25***	***$ 75***	***$ 150***	***$ 125***	***$ 125***	***$ 125***	***$ 125***	***$ 40***	***$ -***	***$ 829***
CCB-6.6	Piney Creek south of Orchard Rd., Reaches 4 to 5 (SEMSWA)	$ 5,320	$ 1,220	23%	$ 1,220	$ -	$ 75	$ -	***$ 75***	***$ 150***	***$ 235***	***$ 250***	***$ 250***	***$ 260***	***$ -***	***$ -***	***$ -***	***$ -***	***$ 1,220***
CCB-7.4	McMurdo Gulch Reclamation (Castle Rock)	$ 5,162	$ 1,292	25%	$ 1,121	$ -	$ -	$ 1,121	***$ 1,121***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ 1,121***
CCB-13.5.3	Cottonwood Creek Tributary - Shooting Area Tributary (CCSP)	$ 720	$ 180	25%	$ 180	$ -	$ -	$ -	***$ -***	***$ -***	***$ -***	***$ -***	***$ 180***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ 180***
CCB-13.5.4	Cottonwood Creek and Tributary C (IWSD)	$ 2,496	$ 624	25%	$ 624	$ -	$ -	$ -	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ 624***	***$ -***	***$ -***	***$ -***	***$ 624***
CCB-21.1	Lone Tree Creek in CCSP downstream of Pond (CCBWQA Only)	$ 600	$ 600	100%	$ 600	$ 120	$ -	$ -	***$ 120***	***$ 480***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ 600***
CCB-21.3	Lone Tree Creek in CCSP upstream of Pond (Centennial Trail Portion)	$ 448	$ 112	25%	$ 112	$ -	$ 112	$ -	***$ 112***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ 112***
CCB-22.1	Happy Canyon Creek at Jordan Road (SEMSWA)	$ 6,300	$ 1,445	23%	$ 1,264	$ -	$ 50	$ -	***$ 50***	***$ 75***	***$ 75***	***$ 171***	***$ 170***	***$ 170***	***$ 170***	***$ 170***	***$ 170***	***$ 43***	***$ 1,264***
Budget Category - PRF Water Quality/Wetland Ponds																				
Budget Category - PRF Preservation, Acquisition, Lease																				
CCB-16	PRF Preservation, Acquisition, Lease of Land or Water	$ 1,000	$ 1,000	100%	$ 1,000	$ -	$ 100	$ -	***$ 100***	***$ 100***	***$ 100***	***$ 100***	***$ 100***	***$ 100***	***$ 100***	***$ 100***	***$ 100***	***$ 100***	***$ 1,000***
	SUB-TOTALS								***$ 2,906***	***$ 1,940***	***$ 1,935***	***$ 1,720***	***$ 1,600***	***$ 1,935***	***$ 1,930***	***$ 1,929***	***$ 1,935***	***$ 1,933***	***$ 19,763***

CHERRY CREEK BASIN WATER QUALITY AUTHORITY

TABLE 2 - SUMMARY OF RECOMMENDED POLLUTANT REDUCTION FACILITIES

2024 - 2033 BUDGET PROJECTIONS (1000$)

Color Code: See comment in spreadsheet for more information and include in presentation to TAC and Board.

First year in 10-year CIP

		October 26, 2023					Residual PRF Costs	Proposed 2024 Budget				Proposed 2025 Budget	Proposed 2026 Budget	Proposed 2027 Budget	Proposed 2028 Budget	Proposed 2029 Budget	Proposed 2030 Budget	Proposed 2031 Budget	Proposed 2032 Budget	Proposed 2033 Budget	2024-2033 Total
	Project No.	Project Title	Total	Authority Portion	Authority Portion		Design	Capital	Land	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
		OPERATIONS AND MAINTENANCE																			
		Routine Category																			
OM-7		Reservoir Destratification	$ 400	$ 400	100%					***$ 40***	***$ 40***	***$ 40***	***$ 40***	***$ 40***	***$ 40***	***$ 40***	***$ 40***	***$ 40***	***$ 40***	***$ 400***
OM-14.1		PRF Weed Control	$ 103	$ 103	100%					***$ 13***	***$ 10***	***$ 10***	***$ 10***	***$ 10***	***$ 10***	***$ 10***	***$ 10***	***$ 10***	***$ 10***	***$ 103***
OM-14.2		PRF Reseeding at CCSP	$ 45	$ 45	100%					***$ -***	***$ 5***	***$ 5***	***$ 5***	***$ 5***	***$ 5***	***$ 5***	***$ 5***	***$ 5***	***$ 5***	***$ 45***
OM-14.3		PRF Mowing	$ 50	$ 45	100%					***$ -***	***$ 5***	***$ 5***	***$ 5***	***$ 5***	***$ 5***	***$ 5***	***$ 5***	***$ 5***	***$ 5***	***$ 45***
		SUB-TOTAL	$ 598	$ 593						***$ 53***	***$ 60***	***$ 60***	***$ 60***	***$ 60***	***$ 60***	***$ 60***	***$ 60***	***$ 60***	***$ 60***	***$ 593***
		Operations Category																			
O - 1		RDS Utilities	$ 650	$ 650	100%					***$ 65***	***$ 65***	***$ 65***	***$ 65***	***$ 65***	***$ 65***	***$ 65***	***$ 65***	***$ 65***	***$ 65***	***$ 650***
O - 2		RDS Service Plan	$ 172	$ 172	100%					***$ 13***	***$ 14***	***$ 15***	***$ 16***	***$ 17***	***$ 18***	***$ 19***	***$ 20***	***$ 20***	***$ 20***	***$ 172***
O - 3		PRF Emergency Repairs	$ -	$ -	100%					***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***
O - 4		Meteorological Station	$ 30	$ 30	100%					***$ 3***	***$ 3***	***$ 3***	***$ 3***	***$ 3***	***$ 3***	***$ 3***	***$ 3***	***$ 3***	***$ 3***	***$ 30***
		SUB-TOTAL	$ 852	$ 852						***$ 81***	***$ 82***	***$ 83***	***$ 84***	***$ 85***	***$ 86***	***$ 87***	***$ 88***	***$ 88***	***$ 88***	***$ 852***
		Restorative Category																			
OM -		Tree/Shrub Planting	$ 18	$ 18	100%					***$ -***	***$ 2***	***$ 2***	***$ 2***	***$ 2***	***$ 2***	***$ 2***	***$ 2***	***$ 2***	***$ 2***	***$ 18***
OM -		Fence Repair	$ 72	$ 72	100%					***$ -***	***$ 8***	***$ 8***	***$ 8***	***$ 8***	***$ 8***	***$ 8***	***$ 8***	***$ 8***	***$ 8***	***$ 72***
OM -		Shoreline / Bank Restoration																		***$ -***	
		Average Annual Cost	$ 1,755	$ 1,755	100%					***$ -***	***$ 195***	***$ 195***	***$ 195***	***$ 195***	***$ 195***	***$ 195***	***$ 195***	***$ 195***	***$ 195***	***$ 1,755***
		Shop Creek	$ 17	$ 17	100%					***$ 17***										***$ 17***	
		Cottonwood Wetlands	$ 31	$ 31	100%					***$ 31***										***$ 31***	
		Tower Loop	$ 3	$ 3	100%					***$ 3***										***$ 3***	
		East Shade Shelter	$ 3	$ 3	100%					***$ 3***										***$ 3***	
		East Boat Ramp	$ 16	$ 16	100%					***$ 16***										***$ 16***	
		Mountain/Lake Loop Shoreline	$ 65	$ 65	100%					***$ 65***										***$ 65***	
		Cherry Creek 12-mile	$ 8	$ 8	100%					***$ 8***										***$ 8***	
OM -		Wetland Harvesting	$ 900	$ 900	100%					***$ 90***	***$ 90***	***$ 90***	***$ 90***	***$ 90***	***$ 90***	***$ 90***	***$ 90***	***$ 90***	***$ 90***	***$ 900***
		SUB-TOTAL	$ 2,888	$ 2,888						***$ 233***	***$ 295***	***$ 295***	***$ 295***	***$ 295***	***$ 295***	***$ 295***	***$ 295***	***$ 295***	***$ 295***	***$ 2,888***
		Rehabilitation Category																			
OM -					100%																
		SUB-TOTAL	$ -	$ -						***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***
		SUB-TOTAL O&M								***$ 367***	***$ 437***	***$ 438***	***$ 439***	***$ 440***	***$ 441***	***$ 442***	***$ 443***	***$ 443***	***$ 443***	***$ 4,333***
		GRAND TOTAL								***$ 3,273***	***$ 2,377***	***$ 2,373***	***$ 2,159***	***$ 2,040***	***$ 2,376***	***$ 2,372***	***$ 2,372***	***$ 2,378***	***$ 2,376***	***$ 24,096***

CHERRY CREEK BASIN WATER QUALITY AUTHORITY

TABLE 3 - SUMMARY OF POTENTIAL POLLUTANT REDUCTION FACILITIES

REVISIONS FOR 2024 - 2033 CIP

Date: October 26, 2023

Color Code: Blue: Project Completed

Projects taken from Table 1. Project updated based on best available information. Projects have best accounting information that includes total project costs of design, construction, construction management, and permit clearance. Other information such as stream length was adjusted based on information noted in comments on spreadsheet. O&M costs were adjusted to be similar cost baseline. Projects that were bid/constructed in phases, were separated into those phases to facilitate adjustment to 2023 costs on PRFs for WQ Analysis.

Proj. Designation	Project Title	Status	Description	Design Basis				Projected Loads					Projected Treatment			Cost Estimate (1000$)								WQ Unit Cost ($/pound)		Adjusted to 2023 $ (1000$)				2023 WQ Unit Cost ($/pound)		Note
			PRF Type	Quantity	Unit	Rate	Volume	Rate		Total		Source	Removal	lbs Removed		Capital	Land Acquisition	Water Augment[8]	Capital Replace[9]	O&M	Annual Cost @ 4%	CCBWQA Share (%)	CCBWQA Share ($)	w/o cost sharing	w/cost sharing	Bid Date/Construction Date	ENR Factor	Construction Cost	Cost per mile	w/o cost sharing	w/cost sharing	
(1)	(2)	(3)	(4)		(5)	(6)	(7)	(8)		(9)		(10)	(11)	(12)	(13)	(14a)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)							(24)
CCB-5.7*	Cherry Creek Stream Stabilization at Eco-Park (SEMSWA)	IGA w/SEMSWA for design in 2010 and construction in 2011/2012	Local stream stabilization (L = 4850 ft)	0.92	mi			100	lbs/mi	92	lbs/yr	Storm Flow	90%	83	lbs/year	$ 4,756	$ -	$ -	$ -	$ 2	$ 257	19%	$905	$ 3,106	$ 591	August 2012	1.58	$ 7,531	$ 8,199	$ 4,919	$ 936	1, 2
CCB-5.11*	Cherry Creek Stream Stabilization at Norton Farms (Parker)	Conceptual design by UDFCD identified priority 3	Local stream stabilization (L = 2500 ft)	0.47	mi			100	lbs/mi	47	lbs/yr	Storm Flow	90%	43	lbs/year	$ 1,103	$ -	$ -	$ -	$ 1	$ 60	23%	$255	$ 1,410	$ 326	January 2016	1.48	$ 1,634	$ 3,452	$ 2,090	$ 483	1, 2
CCB-5.15*	Cherry Creek Stream Reclamation at Country Meadows (Hess Rd)	Project by Town of Parker and Douglas County	Local stream stabilization (L = 4200 ft)	0.80	mi			100	lbs/mi	80	lbs/yr	Storm Flow	90%	72	lbs/year	$ 2,788	$ -	$ -	$ -	$ 2	$ 151	25%	$695	$ 2,114	$ 527	October 2014	1.51	$ 4,222	$ 5,307	$ 3,202	$ 798	1, 2
CCB-5.17.1A*	Cherry Creek Stream Reclamation at KOA	Preliminary design completed 2019, Extension Requested by UDFCD and Parker in 2019	Local stream stabilization (L =1400 ft original, L=2000 ft with 600 ft extension)	0.38	mi			100	lbs/mi	38	lbs/yr	Storm Flow	90%	34	lbs/year	$ 1,806	$ -	$ -	$ -	$ 1	$ 98	18%	$333	$ 2,868	$ 529	July 2020	1.32	$ 2,378	$ 6,278	$ 3,776	$ 696	1, 2
CCB-6.4A *	Piney Creek Stream Reclamation - Reach 7	Request from UDFCD in 2014	Local stream stabilization (L = 2,340 ft)	0.44	mi			100	lbs/mi	44	lbs/mi	Storm Flow	90%	40	lbs/year	$ 3,765	$ -	$ -	$ -	$ 1	$ 203	14%	$512	$ 5,082	$ 691	December 2016	1.44	$ 5,422	$ 12,234	$ 7,319	$ 995	1, 2
CCB-6.4B.1 *	Piney Creek Stream Reclamation - Reach 6 upstream of Caley	Request from UDFCD in 2014	Local stream stabilization (L = 1,600 ft)	0.30	mi			100	lbs/mi	30	lbs/yr	Storm Flow	90%	27	lbs/year	$ 2,896	$ -	$ -	$ -	$ 1	$ 156	14%	$394	$ 5,726	$ 779	November 2016	1.45	$ 4,194	$ 13,840	$ 8,292	$ 1,128	1, 2
CCB-6.4B.2 *	Piney Creek Stream Reclamation - Reach 6 Phase 2	Request from UDFCD in 2014	Local stream stabilization (L = 2,580 ft)	0.49	mi			100	lbs/mi	49	lbs/yr	Storm Flow	90%	44	lbs/year	$ 2,659	$ -	$ -	$ -	$ 1	$ 143	14%	$361	$ 3,262	$ 443	November 2017	1.40	$ 3,712	$ 7,597	$ 4,554	$ 618	1, 2
CCB-7.2 *	McMurdo Gulch Reclamation (Castle Rock) 19/20 Project	Design in 2019, Construction in 2020	Stream Reclamation (L = 2,000 lf)	0.38	mi			100	lbs/mi	38	lbs/yr	Storm Flow	90%	34	lbs/year	$ 1,156	$ -	$ -	$ -	$ 1	$ 63	25%	$289	$ 1,846	$ 462	February 2020	1.33	$ 1,532	$ 4,045	$ 2,447	$ 612	1, 2
CCB-7.3 *	McMurdo Gulch Reclamation (Castle Rock) 20/21/22 Project	Design in 2020, Construction 2021	Stream Reclamation (L = 3,700 lf)	0.70	mi			100	lbs/mi	70	lbs/yr	Storm Flow	90%	63	lbs/year	$ 1,940	$ -	$ -	$ -	$ 1	$ 105	24%	$466	$ 1,664	$ 400	November 2021	1.14	$ 2,204	$ 3,145	$ 1,890	$ 454	1, 2
CCB-22..2*	Happy Canyon Creek Upstream of I-25 (MHFD)	Requested in 2020	3000 lf of stream reclamation	0.57	mi			100	lbs/mi	57	lbs/yr	Storm Flow	90%	51	lbs/year	$ 4,021	$ -	$ -	$ -	$ 1	$ 216	9%	$362	$ 4,232	$ 381	May 2023	1.02	$ 4,114	$ 7,240	$ 4,330	$ 390	1, 2
																										Calculated partner project historical limit of 25%						Calculated partner project historical limit of 25%	
			Minimum =	0.30												$ 1,410					$ 353			$ 1,532	$ 3,145	$ 1,890		$ 472			
			Maximum =	0.92												$ 5,726					$ 1,431			$ 7,531	$ 13,840	$ 8,292		$ 2,073			
			Mean =	0.52												$ 2,975					$ 744			$ 3,498	$ 6,771	$ 4,064		$ 1,016			
			Median =	0.48												$ 2,987					$ 747			$ 3,913	$ 6,759	$ 4,053		$ 1,013			
			Standard Deviation =	0.20												$ 1,477					$ 369			$ 1,864	$ 3,581	$ 2,137		$ 534			

BASIS FOR ANALYSIS:

(A) Unit cost of phosphorus removal based on annualized cost of completed project over 35 years at 4% interest rate. CRF = 0.053577

(B) All projects identified provide for additional phosphorus immobilization beyond minimum requirements, unless noted otherwise.

2023 CIP NOTES:

1. Corrected project information as noted in comments in spreadsheet.
2. Updated O&M Cost to $2k per mile with a minimum of $1k for projects outside of CCSP

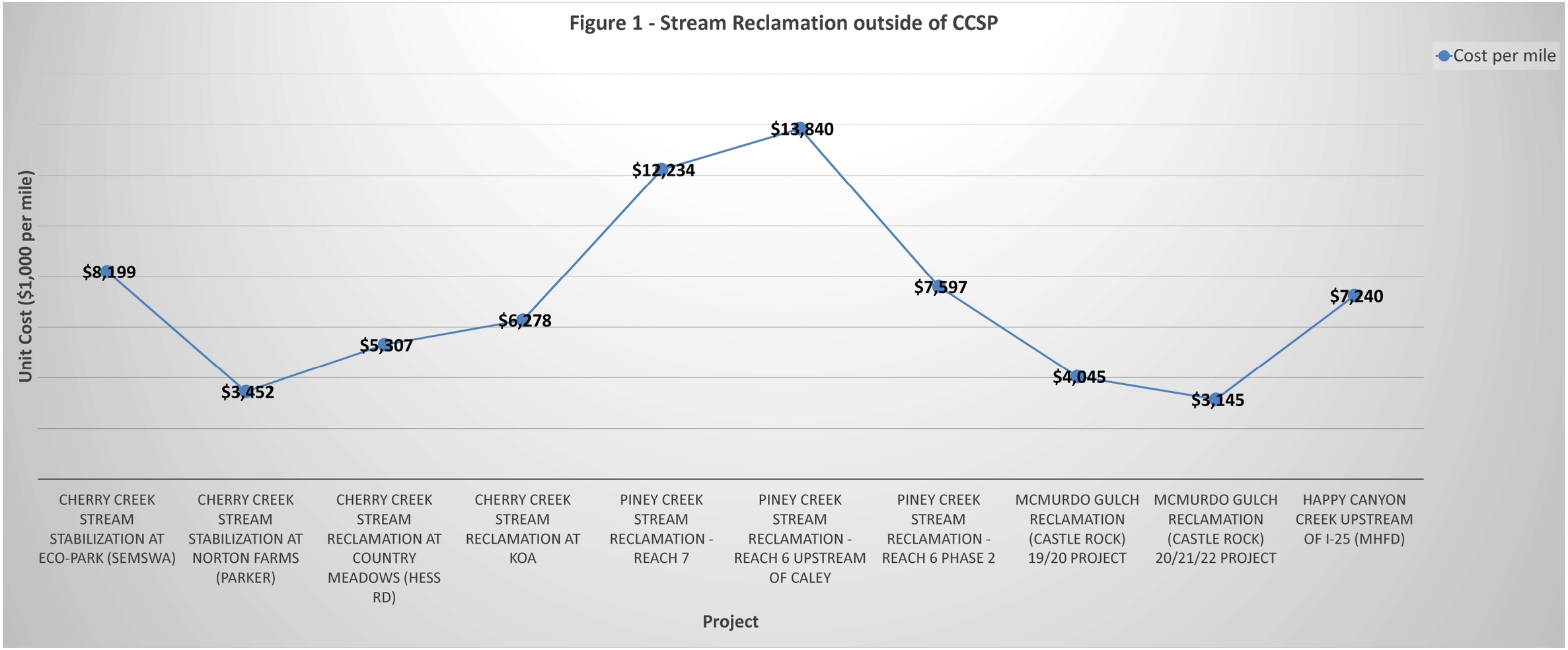


Figure 1 - Stream Reclamation outside of CCSP
Cost per mile
Unit Cost ($1,000 per mile)
$8,199
$3,452
$5,307
$6,278
$12,234
$13,840
$7,597
$4,045
$3,145
$7,240
CHERRY CREEK STREAM STABILIZATION AT ECO-PARK (SEMSWA)
CHERRY CREEK STREAM STABILIZATION AT NORTON FARMS (PARKER)
CHERRY CREEK STREAM RECLAMATION AT COUNTRY MEADOWS (HESS RD)
CHERRY CREEK STREAM RECLAMATION AT KOA
PINEY CREEK STREAM RECLAMATION - REACH 7
PINEY CREEK STREAM RECLAMATION - REACH 6 UPSTREAM OF CALEY
PINEY CREEK STREAM RECLAMATION - REACH 6 PHASE 2
MCMURDO GULCH RECLAMATION (CASTLE ROCK) 19/20 PROJECT
MCMURDO GULCH RECLAMATION (CASTLE ROCK) 20/21/22 PROJECT
HAPPY CANYON CREEK UPSTREAM OF I-25 (MHFD)
Project

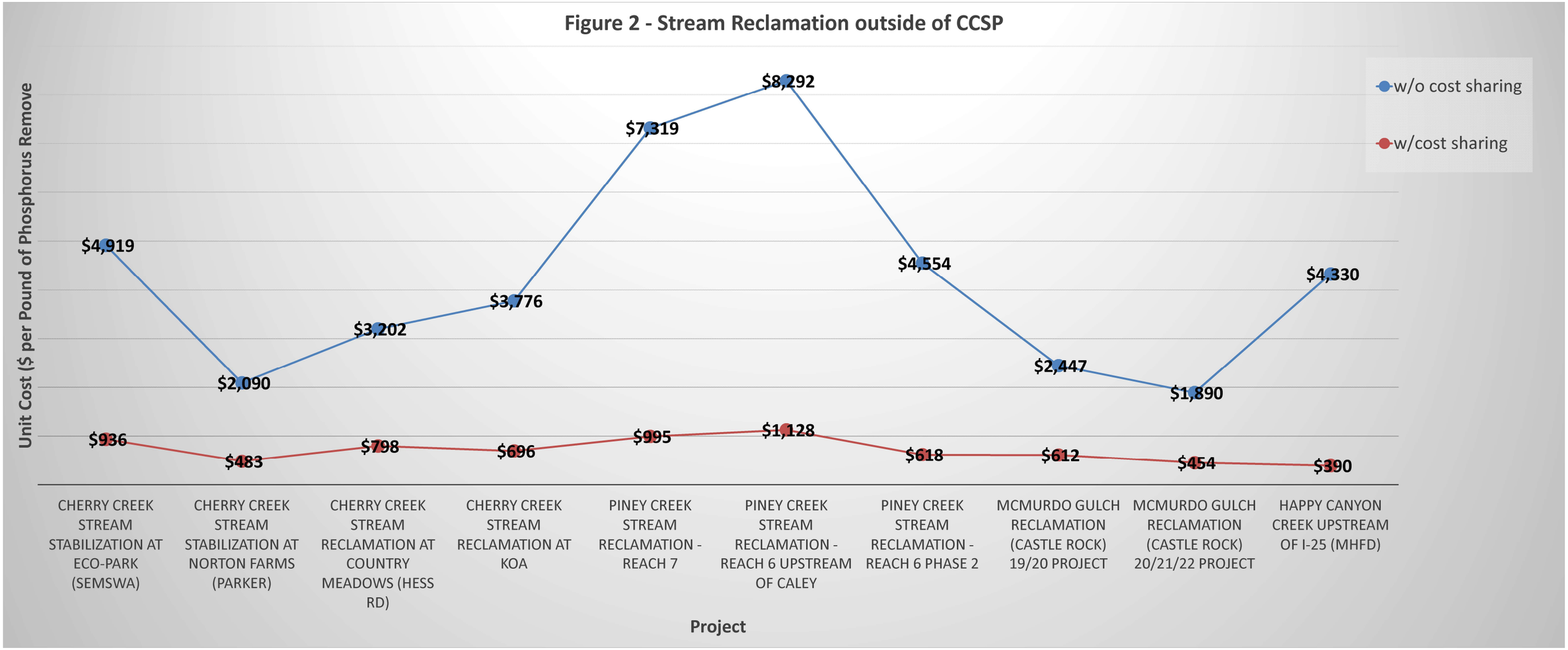


Figure 2 - Stream Reclamation outside of CCSP
Unit Cost ($ per Pound of Phosphorus Remove
w/o cost sharing
w/cost sharing
$4,919
$2,090
$3,202
$3,776
$7,319
$8,292
$4,554
$2,447
$1,890
$4,330
$936
$483
$798
$696
$995
$1,128
$618
$612
$454
$390
CHERRY CREEK STREAM STABILIZATION AT ECO-PARK (SEMSWA)
CHERRY CREEK STREAM STABILIZATION AT NORTON FARMS (PARKER)
CHERRY CREEK STREAM RECLAMATION AT COUNTRY MEADOWS (HESS RD)
CHERRY CREEK STREAM RECLAMATION AT KOA
PINEY CREEK STREAM RECLAMATION - REACH 7
PINEY CREEK STREAM RECLAMATION - REACH 6 UPSTREAM OF CALEY
PINEY CREEK STREAM RECLAMATION - REACH 6 PHASE 2
MCMURDO GULCH RECLAMATION (CASTLE ROCK) 19/20 PROJECT
MCMURDO GULCH RECLAMATION (CASTLE ROCK) 20/21/22 PROJECT
HAPPY CANYON CREEK UPSTREAM OF I-25 (MHFD)
Project

CHERRY CREEK BASIN WATER QUALITY AUTHORITY
CAPITAL PROGRAM BUDGET SPREADSHEET USER INFORMATION

This workbook contains the budget spreadsheets used annually to update the Authority 5-year projections and the annual budget. Because worksheets are connected (i.e.: some cells in each worksheet are referenced to cells in other worksheets), the user needs to be sure to enter information in the correct cell. Therefore the cells used for input are colored "purple". Where formulas, equations, or cell references are shown in the cell, information should NOT be adjusted in the worksheet where formulas, equations, or cell references are shown, except for corrections. In the PRFSummary-Rev" spreadsheet, "green" is used for projects in progress and "blue" is used for completed projects.

Because not all informaton available for each potential project is the same, information in the spreadsheets may be input at that cell, reference another cell, or use an equation. Thus, there are some differences in how calculations are made, such as between the capital and the O&M portions of the spreadsheet. The fact that different procedures are used for different projects, spreadsheet updates need to be checked carefully.

In general, the worksheets are manually updated as follows:

PRFSUMMARY Worksheet

1. This worksheet is used to track the status of the project and to add new PRF projects to the list. The cells with "purple" values are the primary cells where information is updated annually. Note that when referencing cells, the color coding of the referenced cell is NOT transfered.
2. Some cells in column "Q", under "*Cost Estimate/Capital*" references cells in the "*StreamStable*" worksheet for costs information, which are shown in "black". As information on these various projects becomes available, the cost information can be input directly into the cell, eliminating the need for the reference.

2013 BUDGET-5YR Worksheet

1. This worksheet is used to prepare the 5-year CIP projections and is the worksheet generally referred to during the year after all the PRF's are identified.
2. Some information in this worksheet is references the "*PRFSummary*" worksheet. Note that when referencing cells, the color coding of the referenced cell is NOT transfered.
3. In this worksheet, several columns are "hidden" to keep the worksheet to a reasonable size such that for the last 4-years of the projection, only the summary column (i.e.: "*Proposed 20XX Budget*") is shown. Also, completed projects rows can be "hidden" for presentation purposes. However, if there are values in hidden cells, Excel will include that value in any totals. This is readily checked by highlighting the cells shown, which will create a total and comparing the total to the total value shown.
4. In this worksheet, rows in which projects are not included in the 5-year CIP or have been completed are "hidden" and noted by "blue" text/numbers. Costs projections have been set to zero to avoid erroneous cost summaries since "hidden" cells are stil lincluded in column/row totals by Xcel. If a project is reinstated, then need to be sure cells are proprely designated.

2013 BUDGET -5YR Worksheet - Column Description

"Project No.". This is a unique project identifier for tracking purposes and are listed in numerical order in the "PRF Summary" worksheet. The primary number (i.e.: "5" in the CCB-5.1 designation) represents a major stream segment or unique type of project (i.e.: "1" refers to the aeration system, "5" refers to Cherry Creek, "6" to Piney Creek, "7" to McMurdo Gulch, etc.)

"Project Title". This is the project name referenced to a cell in the "PRF Summary" worksheet.

"Current Project Budget".

"Capital". The sum of the design, construction, and construction oversight costs.

"Total". The sum of Capital, Land Acquisition, Water Augmentation, Capital Replacement, and O&M.

Land Acquisition. Since the Authority's projects which have no partners is on land owned by the USACE, there have not been land acquisition costs. When the Authority partners with others outside the USACE property, land aquistion costs are normally included in the "capital costs" prepared by others.

Water Augmentation. So far the Authority has not been required to provide augmentation water rights for the projects because we've \ succesfully argued with the SEO that we are simply "rreplacing" the riparian vegetation lost as the result of channel erosion. This may change in the future.

Capital Replacement. The only Authority project were this cost has been considered replacement of the compressor or components of the aeration system.

O&M. The present worth of annual operations and maintenance costs.

"Authority Portion". These two columns are the allocation of project costs in "$" and "%".

"Residual PRF Costs". Whereas the "Current Project Budget" tracks all the project costs, the "Residual PRF Costs" shows the project costs that were not allocated in previous budget years.

"Proposed 20xx Budget". This section summarizes the "Design", "Capital", and "Total" project costs for that year. Note that "Design" costs are exactracted from "Capital" costs for more precise budget tracking purposes.

STREAMSTABLE Worksheet

1. This worksheet was used to estimate stream stabilizations costs based on the UDFCD master plan for Cherry Creek. Some cost values are referenced by the "*PRFSummary-Rev*" worksheet.

O&M List Worksheet

1. This work sheet tracks the various O&M projects and assigns them an identifier for tracking purposes.

STREAMRECL UNIT COSTS Worksheet

1. This worksheet provides a way to track unit costs per pound of phosphorus.

Cherry Creek Low-Level Release Sustainable Rivers Program Proposal

1. Submitter: Katie Seefus and Brent Dinkel

2. Priority: 1

3. Site: NWO – Cherry Creek, South Platte River Tributary (Cherry Creek Dam)

4. Task Name: Cherry Creek Reservoir Water Quality Improvements through July Low-Level Releases

5. Type of Structure and Task: General (Reservoirs)

6. Category Percentage
    a. Outreach: 40%
    b. Science: 30%
    c. Technology: 0%
    d. Implementation: 30%

7. Background: Cherry Creek Reservoir, located in Denver, Colorado receives some of the most intensive public use of any tributary reservoir within the Omaha District. The reservoir is currently on the State of Colorado's 303(d) list of impaired waters due to high chlorophyll-a levels and low dissolved oxygen conditions not supporting the aquatic life. During the summer the reservoir can become thermally stratified and the volume of water below the thermocline (the hypolimnion) fails to mix with the surface water (the epilimnion). While thermal stratification at the reservoir has historically been limited, there is enough inhibition of mixing to allow hypoxic to anoxic conditions to regularly develop near the reservoir bottom. These low oxygen conditions at the sediment water interface result in sediment release of phosphate and ammonia which build up in the hypolimnion until the reservoir mixes and become available for algal growth (increase in reservoir chlorophyll-a). Come winter, the resulting algal growth dies off and sinks to the bottom of the reservoir, adding to the oxygen demand of the sediment and fueling the development of anoxic conditions in future years. Concentrations of phosphate and ammonia in the hypolimnion of Cherry Creek Reservoir tend to peak in July.
   Proposal Description: The Omaha District is proposing to implement the storage of a small amount of water (1% of the flood control zone), if available, within the first foot of the flood control zone so that it can be released via the reservoir's low-level gate in July. The water control manual currently allows this storage to be used for "maintenance of the multipurpose zone". If water is available, the minimum target discharge for July would be 16 cfs. This release would flush some of the nutrients in the hypolimnion out of the reservoir before they can fuel algal growth. The District has begun to meet with local and state stakeholders to confirm their support for the releases (outreach, in-process). To verify the release of nutrients through the low-level gate, in-pool and outflow nutrient samples and physical data would be collected through the entire summer field season (science/implementation). Funding provided by the Sustainable Rivers Program would assist in funding travel, labor, and laboratory testing of the proposed release.

8. SRP Cost: $42,790

9. Additional Funding and Sources: Unknown

10. Coordination with Operations: The Water Control and Water Quality Section has coordinated with the Tri-Lakes Operation Project Manager who asked that we take the following potential impacts into consideration: Cherry Creek State Park, Colorado water rights, dam safety, and downstream impacts.

11. Months of Effort: October 2023 – September 2024

12. Funding Plans:

	Oct 2023	Nov 2023	Dec 2023	Jan 2024	Feb 2024	Mar 2024	Apr 2024	May 2024	Jun 2024	Jul 2024	Aug 2024	Sept 2024	Oct 2024	Nov 2024	Dec 2024	2025+
Labor	$990.00	$990.00	$990.00	$660.00	$660.00	$3,410.00	$660.00	$4,620.00	$4,620.00	$4,950.00	$7,700.00	$6,490.00	$0	$0	$0	$
Non-Labor	$0.00	$0.00	$0.00	$0.00	$0.00	$1,100.00	$0.00	$770.00	$770.00	$770.00	$1,870.00	$770.00	$0	$0	$0	$

EXTERNAL MEMORANDUM

To: Cherry Creek Basin Water Quality Authority
Modeling Sub-committee

From: Alan J. Leak, P.E.
Principal
RESPEC Company, LLC.
720 South Colorado Blvd., Suite 410 S
Denver, CO 80246

Date: September 20, 2023

Subject: Supplemental Watershed Model Scenarios

At the June 1, 2023, Modeling Sub-committee meeting we discussed several possible supplemental model runs that could be performed that would inform the Sub-committee about the effects on water quality entering Cherry Creek Reservoir from a) possible actions that could be taken in the Cherry Creek Watershed and b) the effect of pre-development conditions on water quality in Chery Creek Reservoir. The four categories and subsets of model scenarios discussed were as follows:

- Wastewater Treatment Improvements:
  - Modeling of WWTFs with technology-based reduction limits on Total Phosphorus (TP) and Total Nitrogen (TN) concentrations.
  - Modeling of WWTF's with zero TP/TN discharge.
- Future Development BMPs:
  - Modeling of future development as having no discharge of TP or TN
- Retrofit of Existing Development
  - Modeling of existing development as having the same removal efficiencies as for future development in the 2030 model based on current water quality design requirements.
- Pre-Development Watershed Conditions
  - Modeling of the watershed assuming no anthropomorphic / pre-development impacts to the watershed.

At that meeting, RESPEC was directed to pursue at this time only those model scenarios whose results could be expected to make reasonable and realistic progress towards reducing nutrient loads to Cherry Creek Reservoir (" best case scenarios") and not focus on what has occurred in the past. The two supplemental modeling scenarios RESPEC was directed to pursue were as follows:

720 SOUTH COLORADO BLVD.
SUITE 410 S
DENVER, CO 80246
303.757.3655

/ Wastewater Treatment Improvements: Model WWTFs with technology-based reduction limits on TP/TN concentrations. This scenario would continue to use the expected discharge flow rates used in the 2030 model.

/ Retrofit Existing Development: Model existing development as having the same removal efficiencies as for future development in the 2030 model based on current water quality design requirements. For this model run we would just apply the parameters used for the 2030 future development model to all development in the watershed. This would attempt to replicate the effects of retrofitting existing facilities based on current water quality design criteria.

The sub-committee also directed RESPEC to reach out to the wastewater treatment providers to obtain their input on the TN levels to be used in the Wastewater Treatment Improvements model run.

RESPEC reached out to the wastewater treatment providers in the Cherry Creek watershed to meet and discuss what should be considered as the "best available technological limits" for discharge of TP and TN that were "economically and rationally feasible". On July 28, 2023, RESPEC met with representatives of Parker Water and Sanitation District (Parker), the Arapahoe County Water and Wastewater Authority (ACWWA), Stonegate Village Metropolitan District, and the Inverness Water and Sanitation District, to discussed economic and rational feasibility for technology-based reductions on TP and TN. (Representatives of the Pinery Water and Sanitation District were contacted but did not respond to the meeting request). The consensus of the participants at the meeting and after further discussions is as follows:

/ Further reductions in TP concentrations would not yield measurable decreases in TP discharged to Cherry Creek Reservoir and would require substantial additional use of chemicals to produce TP lower than the current 0.05 mg/l while impacting the ability to reduce TN. Thus, further reductions in TP were not discussed further.

/ The current wastewater treatment provider's treatment processes limit the ability of the wastewater treatment providers to reduce TN to levels that would require substantial, significant, and expensive overall plant-wide changes in treatment process conversions as well as use of technology that is economically infeasible (i.e. reverses osmosis treatment) due to lack of economic brine disposal options.

/ The ability to reduce TN is more difficult in the winter than the summer due to colder temperatures. Thus, any modeled TN should reflect this condition.

/ Reducing TN will mainly need to be accomplished by reducing nitrates. This will typically require the addition of a carbon source.

Based on the feedback from the wastewater treatment providers, the following is the recommended TN concentrations to model as the "best case scenario" for TN reduction from wastewater treatment facilities:

- / Summer (April – September): TN = 6 mg/l
- / Winter (October through March): TN = 8 mg/l

It should be noted that, in some instances, the TN concentrations from some wastewater treatment facilities modeled in the baseline model are below these levels as those facilities are not operating at full design capacity and thus have been able to reduce TN levels below those that can be accomplished

at full buildout. Thus, the model results using these "best case scenario" TN levels will not reduce TN as much as may be anticipated.

ajl: ajl

MEMORANDUM

To: CCBWQA Technical Advisory Committee
From: Val Endyk - CCBWQA Administrative Assistant
Date: October 27, 2023
Subject: Current TAC Members

Alex Mestdagh	Town of Parker
Ashley Byerley	SEMSWA, representing City of Centennial
Caitlin Gappa	Board Appointee, Douglas County Health
Casey Davenhill	Board Appointee, Cherry Creek Stewardship Partners
Cayla Cappello	City of Greenwood Village
David Van Dellen	Town of Castle Rock
Diana Rashash	Board Appointee, Arapahoe County Public Health
Gene Seagle	Board Appointee, US Army Corps of Engineers
Jacob James	City of Lone Tree
Jeremiah Unger	Board Appointee, CDOT
Jessica La Pierre	City of Aurora
Jim Watt	Board Appointee, Mile High Flood District
Jon Erickson	2023 TAC Chair, Board Appointee, Colorado Parks and Wildlife
Joseph Marencik	City of Castle Pines
Michelle Seubert	Board Appointee, Cherry Creek State Park
Lisa Knerr	2023 TAC Vice Chair, Arapahoe County
Rebecca Tejada	Board Appointee, Special Districts, Parker Water and Sanitation District
Rick Goncalves	Board Appointee, RG Engineers
Ryan Adrian	Douglas County
Wanda DeVargas	Board Appointee, E-470

Cherry Creek Basin Water Quality Authority
cherrycreekbasin.org
303.968.9098
manager@ccbwqa.org

October 25, 2023

Via Email: cdphe.wqcc@state.co.us

Ms. Jojo La
Colorado Water Quality Control Commission
4300 Cherry Creek Drive S.
Denver, CO 80246-1530

Re: Issues Scoping Hearing for the Classifications and Numeric Standards for South Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin, Regulation #38 (5 CCR 1002-38)

Dear Ms. La:

The Cherry Creek Basin Water Quality Authority (CCBWQA) is providing this letter to notify the Water Quality Control Commission (Commission) that it may propose site-specific total phosphorus and total nitrogen standards for Cherry Creek Reservoir (COSPCH02) at the June 2025 Regulation 38 Rulemaking Hearing with a delayed effective date after 12/31/2027.

Background

In Regulation 38, Cherry Creek Reservoir (COSPCH02) has an assigned chlorophyll *a* standard of 18 ug/L. The seasonal mean concentration is measured in the upper three meters of the water column for the months of July through September with an allowed exceedance frequency of once in five years. Additionally, Cherry Creek Reservoir is regulated under Regulation 72, which includes stringent phosphorus control requirements in the basin such as a 0.05 mg/L total phosphorus limit for wastewater treatment plant discharges.

CCBWQA was a party to the April 10, 2023 Rulemaking regarding adoption of Lakes Nutrient Criteria and expressed significant concerns about the applicability of proposed statewide standards to Cherry Creek Reservoir. In this rulemaking, the Commission decided to delay adoption of total phosphorus and total nitrogen standards adopted in Regulation 31.17 (Table V) into basin standards for many lakes, including Cherry Creek Reservoir, until after 12/31/2027. In Section 33.106 (B)(3)(a) Statement of Basis and Purpose of Regulation 38 (5 CCR 1002-38), the Commission stated its intent to consider site-specific nutrient standards for Cherry Creek Reservoir as follows:

> *The commission may also consider site-specific nutrients standards for the following lake and reservoir segments that have existing nutrient control regulations in future rulemaking hearings if information to support appropriate and protective revisions is developed:*

Upper South Platte River: 6b (COSPUS06b; Chatfield Reservoir)

Cherry Creek: 2 (COSPCH02; Cherry Creek Reservoir)

The commission did not adopt total nitrogen or total phosphorus table value standards for either waterbody in this rulemaking hearing.

Summary of Progress Since April 10, 2023 Lakes Nutrients Rulemaking Hearing

Since the April 2023 Lakes Nutrients Criteria Rulemaking Hearing, CCBWQA contracted with Hydros Consulting to help CCBWQA develop a site-specific standards methodology and standards proposal, utilizing CCBWQA's extensive site-specific data set, supplemented by its reservoir model. Hydros' approach utilizes the methodology developed by the Division and produces site-specific total phosphorus and total nitrogen standards falling between the Commission's 2012 "interim values" and the April 2023 values adopted in Regulation 31. On October 11, 2023, CCBWQA representatives met with representatives of the Water Quality Control Division's Standards Unit (Division), U.S. Environmental Protection Agency and Colorado Parks and Wildlife to review the site-specific standards approach and draft site-specific total phosphorus and total nitrogen standards. CCBWQA's approach was generally favorably received with some suggestions for minor revisions to the methodology. Due to the significant early progress on development of the site-specific standards and positive feedback obtained from the Division to date, CCBWQA anticipates moving forward with proposing site-specific standards in June 2025.

Recommendation

CCBWQA recommends that the Commission consider adoption of site-specific total phosphorus and total nitrogen standards for Cherry Creek Reservoir in the June 2025 Regulation 38 Rulemaking Hearing if proposed by the CCBWQA. CCBWQA anticipates submitting a proposal for site-specific standards that will follow the Division's Lake Nutrients Criteria methodology utilizing site-specific data for the Cherry Creek Reservoir. As currently envisioned, CCBWQA's proposal will likely also continue to propose a delayed effective date of these site-specific standards after 12/31/2027 to allow time for the Division and the broader regulated community to continue to work through implementation issues related to Lake Nutrients Criteria on the same schedule.

Submitted on Behalf of the Cherry Creek Basin Water Quality Authority,

Jane Clary, Technical Manager
Cherry Creek Basin Water Quality Authority

DRAFT TECHNICAL MEMORANDUM

TO: Jane Clary, Cherry Creek Basin Water Quality Authority (CCBWQA) Technical Manager

FROM: Christine Hawley and Kevin Bierlein, Hydros Consulting Inc.

SUBJECT: Rev. 1 DRAFT Development of Site-Specific Standard Values for TP and TN in Cherry Creek Reservoir

DATE: October 23, 2023

The Cherry Creek Basin Water Quality Authority (CCBWQA) asked Hydros Consulting (Hydros) to provide technical support in development of site-specific standards for total phosphorus (TP) and total nitrogen (TN) for Cherry Creek Reservoir. That analysis produced proposed site-specific TP and TN standards of 66 ug/L TP and 860 ug/L TN for Cherry Creek Reservoir. This memorandum explains the need for site-specific TP and TN standards in Cherry Creek Reservoir, the analysis conducted to generate the standard values, and associated longevity plan recommendations. This memorandum is organized in seven sections, followed by a listing of references cited:

Section 1: Background

Section 2: Need for Site-Specific TP and TN Standards

Section 3: Consideration of the Secchi-Based Site-Specific Equation

Section 4: Site-Specific TP and TN Standard Development

Section 5: Discussion of Site-Specific TP and TN Standard Values

Section 6: Longevity Plan Recommendations

Section 7: Summary

1 Background

The Water Quality Control Commission (WQCC) adopted new table value standards (TVSs) for TP and TN in Regulation 31 during the recent April 2023 rulemaking hearing. The standards now apply to lakes and reservoirs that have aquatic life and recreational (AL/Rec) use designations and are located above permitted dischargers. At this time it is anticipated that the TVSs for TP and TN will be adopted for all

remaining lakes and reservoirs with AL/Rec uses by 2027. Because Cherry Creek Reservoir is below permitted discharges, TP and TN standards have not yet been adopted but are anticipated by 2027[1].

The TP and TN standards for lakes and reservoirs are designed to correspond to the chlorophyll *a* (Chl*a*) standard for AL/Rec uses, recognizing the critical role that nutrient concentrations play in algal growth. Therefore, TP and TN standards provide a secondary level of protection to support meeting the Chl*a* standard. It is important to recognize that there are no toxicity concerns stemming directly from TP and TN for aquatic life or recreational contact at the concentrations typically observed in Colorado lakes and reservoirs; therefore, the standards are based on TP and TN relationships to Chl*a*.

In the absence of a successful site-specific standard proposal, it is expected that the WQCC will adopt TP and TN standards of 42 ug/L and 620 ug/L, respectively, for Cherry Creek Reservoir. Throughout this document, these values are referred to as the "default" TP and TN standard for Cherry Creek Reservoir. The default values reflect the use of the Water Quality Control Division's (WQCD) State-wide warm lakes Chl*a*:nutrients relationships, with input of Cherry Creek Reservoir's 18 ug/L site-specific Chl*a* standard (Table 1). Note that these values are more stringent than the warm lakes TVSs because they are based on 18 ug/L Chl*a* instead of the warm lakes Chl*a* TVS of 20 ug/L (Table 1). Note also that TP and TN TVSs are notably more stringent that the 2012 Interim Criteria (Table 1), which were the anticipated values until 2022 (WQCD, 2022a).

Table 1. Relevant State Nutrient Standards and Interim Criteria, Including the Default WQCD Standard for Cherry Creek Reservoir

Constituent	Warm Lakes Nutrient Regulatory Values		Default** Cherry Creek Reservoir Standards
	2012 Interim Criteria	TVSs* (TN and TP Adopted in April 2023)	
Chl*a* (ug/L)	20	20	**18**
TN (ug/L)	910	670	620
TP (ug/L)	83	47	42

Note: All are/would be assessed as July through September averages with a one-in-five-year allowable exceedance frequency.

*Currently only applicable to warm lakes above permitted discharges.

**Default TP and TN standards are those likely to be adopted for Cherry Creek Reservoir in the absence of a successful site-specific standard proposal. The TN and TP values were developed from the WQCD State-wide relationships used in the April 2023 RMH, applying the Cherry Creek Reservoir Chl*a* standard of 18 ug/L, in lieu of the warm lakes Chl*a* TVS of 20 ug/L.

[1] The WQCC is planning to consider site-specific nutrient standard proposals for lakes and reservoirs at the next corresponding basin hearing. For Cherry Creek Reservoir, that is the South Platte Basin hearing in June 2025. Currently, CCBWQA is considering proposing site-specific TP and TN standards at the June 2025, with a delayed effective date of 2027, matching the current schedule for planned TP and TN standard adoption for the reservoir.

2 Need for Site-Specific TP and TN Standards for Cherry Creek Reservoir

The default TP and TN standard values for Cherry Creek Reservoir (Table 1; 42 ug/L TP and 620 ug/L TN) are based on State-wide, TP:Chl*a* and TN:Chl*a* relationships for warm lakes developed by the WQCD and used to define the TVSs. For these values to be appropriate for Cherry Creek Reservoir, the underlying relationships must reasonably approximate TP:Chl*a* and TN:Chl*a* relationships in Cherry Creek Reservoir. Cherry Creek Reservoir is fortunate to have an extensive dataset (1992-2022; 31 years) to support a detailed evaluation of this premise, as discussed in the following subsections.

2.1 Observed Concentrations Compared to Default Nutrient Standards

As a first step in evaluating the appropriateness of the default TP and TN standards for Cherry Creek Reservoir, observed data[2] were plotted against the default TP and TN standard values (Figure 1). The observed data indicate that the average summer Chl*a* concentrations were below the Chl*a* standard value in 13 of 31 years of record. In contrast, Cherry Creek Reservoir TP and TN concentrations would have been below the default TP and TN standard values in zero of 31 years of record. This comparison indicates a fundamental disconnect between the underlying Chl*a*:TP and Chl*a*:TN relationships used to develop the default TP and TN standards and the actual algal response to TP and TN concentrations in Cherry Creek Reservoir.

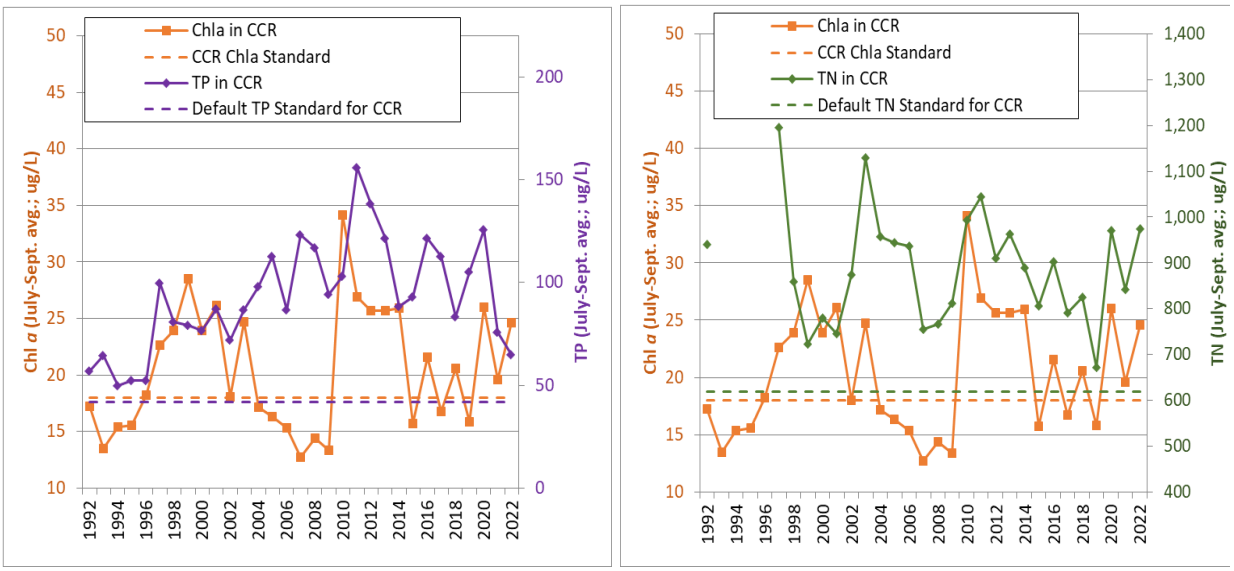


Figure 1. Comparison of Observed Chl*a* and Nutrient Data from Cherry Creek Reservoir to Existing Chl*a* Standard and Default TP and TN Standards for Cherry Creek Reservoir

[2] Note that the observed dataset was compiled from the CCBWQA database. Data reflect sampling photic zone results from the deepest location (CCR2). In a few early year of record (1994, 1995, and 2001 for Chl*a*; and 2001 for TP and TN), the database only includes CCR-Composite sample results (an average result of CCR1, CCR2, and CCR3). Analysis of the full dataset indicates that CCR-Composite results (July through September averages) exhibit excellent predictive capability for CCR2 July through September averages (R^2 = 0.94 for both Chl*a* and TN, and R^2 = 0.93 for TP). Therefore, CCR-Composite results were used to fill in CCR2 values for Chl*a* in 1994, 1995, and 2001, as well as TP and TN in 2001. There were no TN results at any locations in the database for 1993-1996.

2.2 Evaluation of Observed Chl*a* Response to Nutrients Using Cherry Creek Reservoir's Full Dataset

As a first step in direct comparison of site-specific Chl*a*:TN and Chl*a*:TP relationships in Cherry Creek Reservoir to the WQCD State-wide relationships, Cherry Creek Reservoir observed correlations were evaluated (Figure 2 and Figure 3). The first key finding from these graphics showing the full Cherry Creek dataset is the striking lack of a significant relationship between Chl*a* and TP (R^2 = 0.06) and between Chl*a* and TN (R^2 = 0.12). The lack of relationships is indicative of the underlying complexity and numerous factors driving Chl*a* response in Cherry Creek Reservoir. Nutrient concentrations are, of course, important drivers of Chl*a* response, but the data show that they are far from exclusive and independent controls of Chl*a* response in Cherry Creek Reservoir.

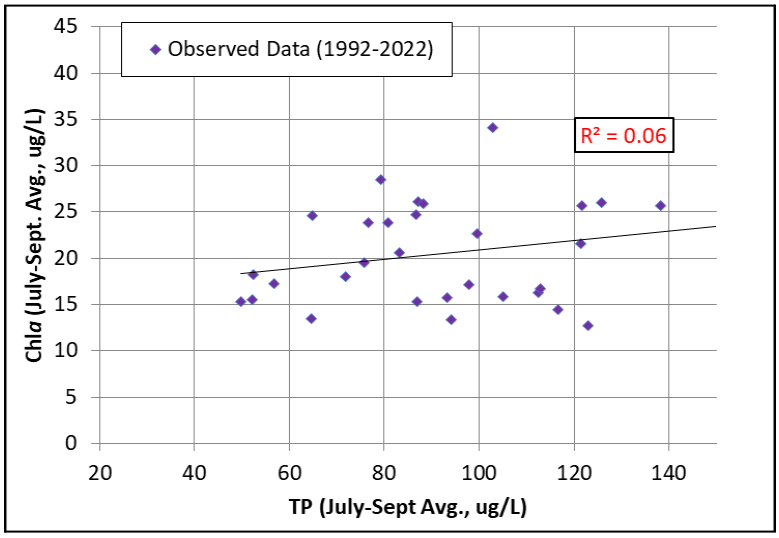


Figure 2. Observed Cherry Creek Dataset; Summer Chl*a* Response Compared to TP Concentrations; 1992-2022

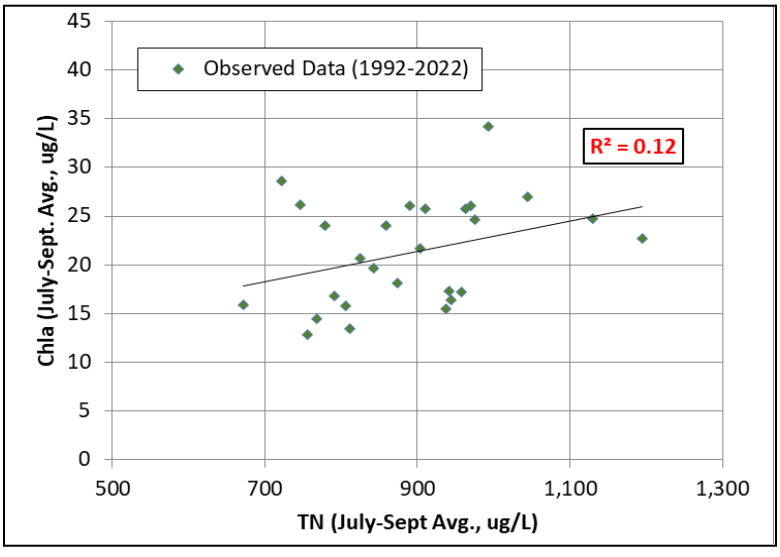


Figure 3. Observed Cherry Creek Dataset; Summer Chl*a* Response Compared to TN Concentrations; 1992-2022

2.3 Comparison of Cherry Creek Reservoir Data to State-Wide Warm Lakes Relationships

Direct comparison shows that the Cherry Creek Reservoir dataset is not well described by the WQCD warm lakes State-wide relationships used to develop the default TP and TN standards (Figure 4 and Figure 5). Specifically, the majority of Cherry Creek Reservoir lake-years (i.e., July through September averages) exhibit notably lower production of Chl*a* for a given nutrient concentration than what is predicted by the State-wide relationship.

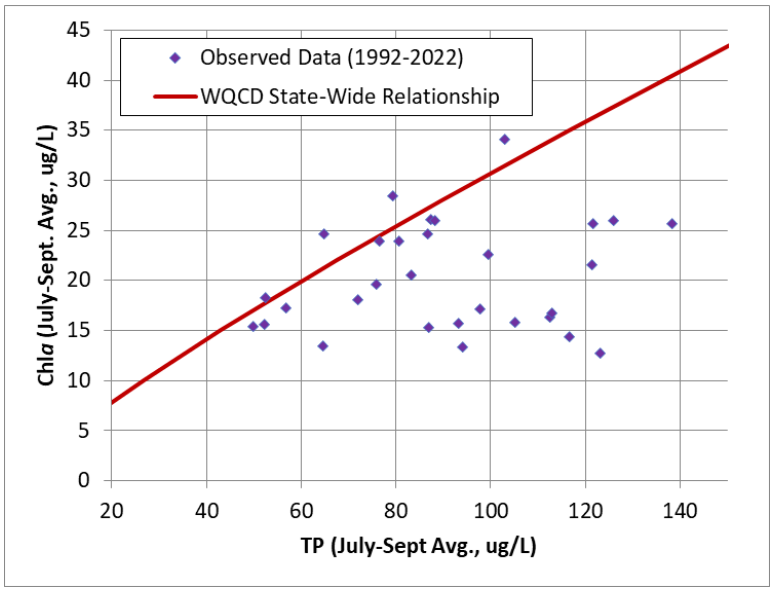


Figure 4. Observed Cherry Creek Dataset Compared to WQCD State-Wide Warm Lakes Relationship for Chl*a* and TP

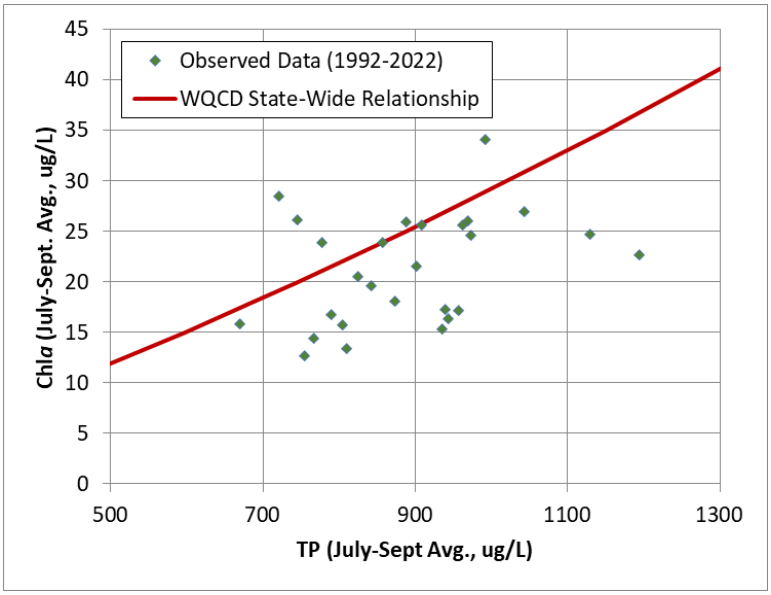


Figure 5. Observed Cherry Creek Dataset Compared to WQCD State-Wide Warm Lakes Relationship for Chl*a* and TN

2.4 Quadrant Plot Review of Default WQCD Nutrient Standards for Cherry Creek Reservoir

The mismatch between the observed response and the default TP and TN standards is also apparent when the Chl*a* standard and the default TP and TN standards are included in the Chl*a*:TP and Chl*a*:TN observed data graphics (Figure 6 and Figure 7). The standards lines on these graphics create quadrant plots similar to those presented by WQCD (WQCD, 2022a), which are helpful to evaluate how each year of data align with the related standards. Specifically, the quadrants on the plots effectively categorize the observed data into groups. These groups indicate how well the underlying relationships used to develop the TN and TP standards reflect the patterns in the observed data, as follows:

- **Aligned**: As shown in Figure 6, the upper right and lower left quandrants correspond to conditions where the observations generally align with the expected response inherent in the related standards. These two "aligned" quandrants indicate cases where both Chl*a* and nutrient standards are exceeded (upper right quadrant) or neither Chl*a* nor nutrient standards are exceeded (lower left quadrant). These conditions match the overall intent of the nutrient standards (i.e., agreement with/support for the Chl*a* standard).
- **Not Aligned**: Lake-year data in the lower right quadrant, where the Chl*a* standard value is met but the nutrient standard value is not met, indicate cases when the nutrient standards may be overly-stringent. Lake-year data in the upper left quadrant correspond to cases when the Chl*a* standard value is not met, but the nutrient standard value is met, indicating years when the nutrient standard may be under-protective for Chl*a* concentration.

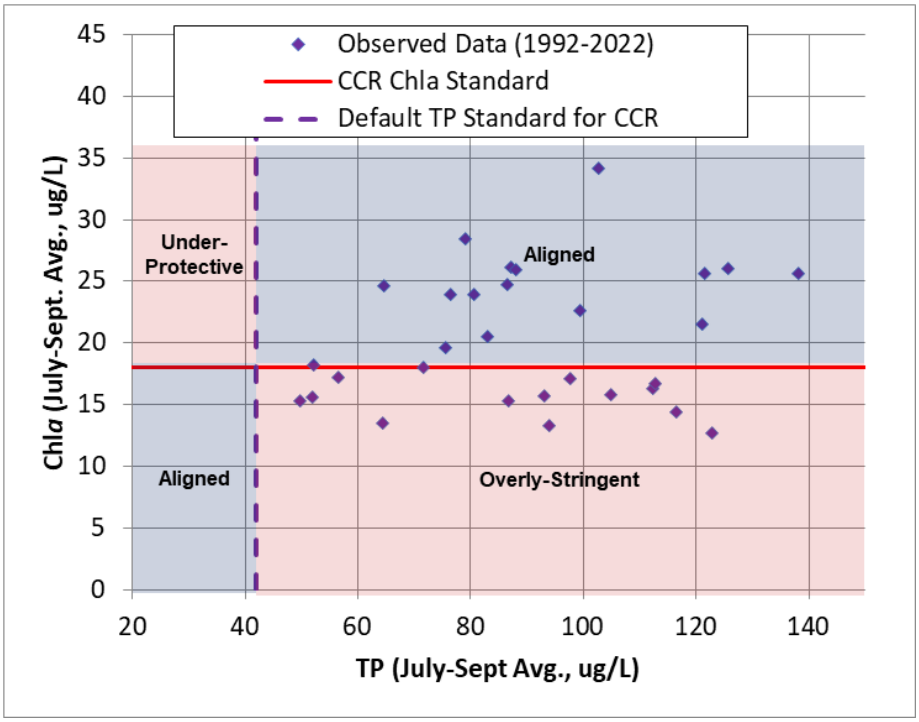


Figure 6. Cherry Creek Reservoir (CCR) Chl*a*: TP Quadrant Plot with the Default TP Standard

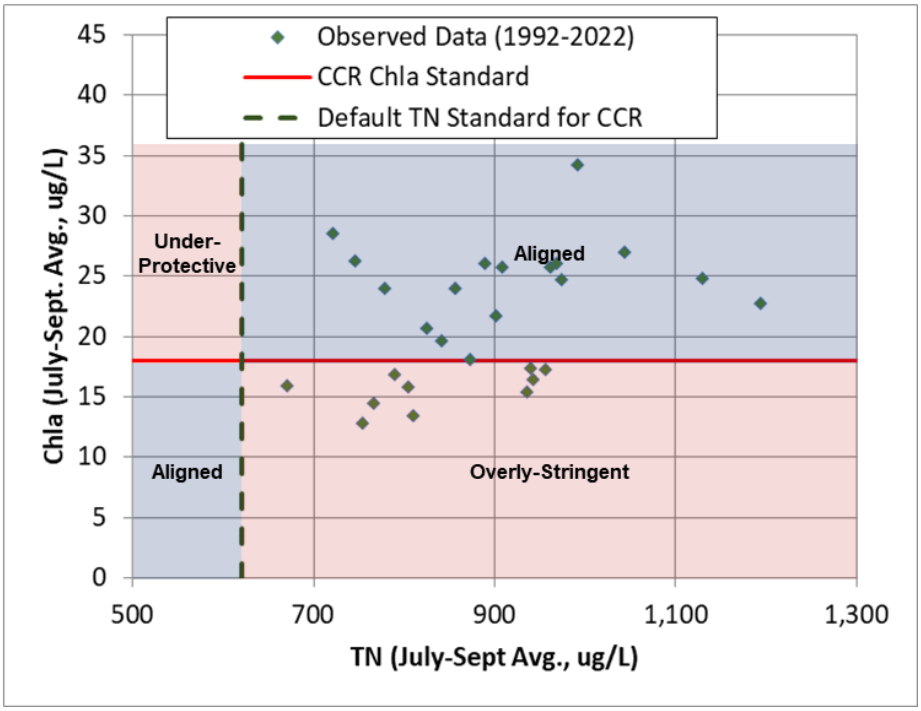


Figure 7. Cherry Creek Reservoir Chl*a*: TN Quadrant Plot with the Default TN Standard

While all lake-year data are not necessarily expected to exhibit perfect alignment on such quadrant plots, given the complexity of Chl*a* response to nutrients, the Cherry Creek Reservoir data show notably poor alignment for both TP (Figure 6) and TN (Figure 7). The quadrant plots indicate that the presumed WQCD TP and TN standards would be overly-stringent in more than 1/3 of the years of record. This further illustrates that the State-wide Chl*a*:TP and Chl*a*:TN relationships are not a good fit for Cherry Creek Reservoir.

Many site-specific factors may explain why Cherry Creek Reservoir does not fit well with the State-wide relationships used by WQCD in standards development. For example, Cherry Creek Reservoir receives high concentrations of TP in inflows, the majority of which is in the form of soluble reactive phosphorus (SRP). The high SRP concentrations have led to frequent nitrogen limitation, affecting the algal response and types of algal species present (Hydros, 2015 and 2019). Further, Cherry Creek Reservoir has a notably shallow bathymetric profile and is in a very windy location, creating a polymictic system that exhibits significant internal loading of nutrients (Hydros, 2015 and 2019). All of these factors affect the Chl*a* response in the Cherry Creek Reservoir and may help to explain why the reservoir does not fit well into the State-wide Chl*a*:TP and Chl*a*:TN relationships used to develop the lake nutrient TVSs.

2.5 Summary of Need for Site-Specific TP and TN Standards for Cherry Creek Reservoir

In summary, the comparisons presented in the preceding sections indicate that the default[3] TP and TN standards are not a good reflection of Chl*a* response to nutrient concentrations in Cherry Creek Reservoir. Further, the default TP and TN standards tend to be overly stringent, which is a significant

[3] Note that, as with the default TP and TN standards, the TVSs would also be overly stringent for Cherry Creek Reservoir and would fail to reflect the observed Chla response to nutrients in this system.

concern for CCBWQA. It is recognized that Cherry Creek Reservoir routinely exceeds the Chl*a* standard, and therefore, TMDLs for nutrients will eventually be established. If these TMDLs were to be based on in-lake nutrient standards that were notably more stringent than needed to meet the target Chl*a* concentrations, this would translate to significant additional costs and feasibility challenges for TMDL implementation. CCBWQA seeks to set appropriate site-specific nutrient standards that are neither under-protective nor overly-stringent, based on the extensive available dataset.

3 Consideration of the Secchi-Based Site-Specific Equations

During development of the TP and TN TVSs adopted in April of 2023, the WQCD also developed additional relationships that could be used on a site-specific basis to develop site-specific standard

proposals. These additional relationships were developed to include Secchi-depth data as a covariate, recognizing the important role that water clarity (including non-algal turbidity) can play in Chl*a* response to nutrient concentrations in some lakes. As such, the equations, termed Secchi-based site-specific equations, were provided by WQCD (WQCD, 2022a) as an optional tool to readily develop site-specific TP and/or TN proposals. Therefore, as a first step in site-specific TP and TN standard development for Cherry Creek Reservoir, the potential utility of the Secchi-based site-specific equations was evaluated.

Fortunately, Cherry Creek Reservoir has an extensive Secchi-depth dataset, meeting the frequency and timing requirements specified in WQCD (2022b) in 29 years of record between 1992 and 2022. Based on that dataset, the critical Secchi O/E[4] value (80th percentile) for Cherry Creek Reservoir was found to be 1.08. Applying the WQCD Secchi-based site-specific equations (WQCD, 2022b) for a Chl*a* standard of 18 ug/L, this corresponds to a TP standard of 28 ug/L and a TN standard of 490 ug/L for Cherry Creek Reservoir. These values are even more stringent than the default TP and TN standards (Figure 8 and Figure 9), which were deemed to be overly-stringent in the analysis in Section 2. Therefore, the Secchi-based site-specific equations do not serve to improve the agreement between the Chl*a* standard and the nutrient standards in Cherry Creek Reservoir and only exacerbate concerns delineated in Section 2 regarding the overly-stringent nature of the default nutrient standards. Based on this, the Secchi-based site-specific equations developed by WQCD are not considered further in site-specific standard development for Cherry Creek Reservoir.

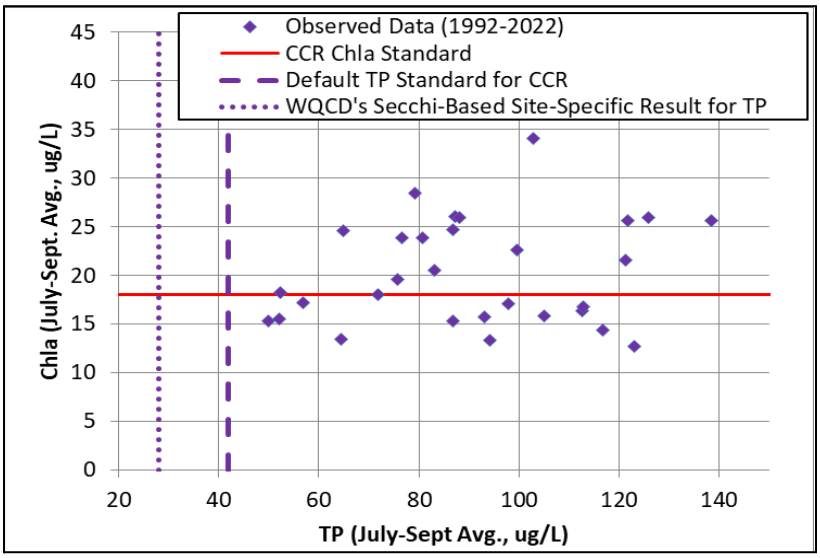


Figure 8. Observed Summertime Chl*a* and TP compared to the Default TP Standard and WQCD's Secchi-Based Site-Specific TP Standard for Cherry Creek Reservoir

[4] O/E refers to the ratio of "observed" to "expected" Secchi depth, where the "expected" value is based on an empirical relationship between Chl*a* and Secchi depth developed by Carlson (1977). Note also that use of this term as a predictor of Chl*a* raises technical concerns given that Secchi O/E is calculated with Chl*a* and is therefore not an independent variable for prediction of Chl*a*. Despite these concerns, testing of the WQCD Secchi-based site-specific equations for Cherry Creek Reservoir was conducted to meet presumed expectations for this analysis.

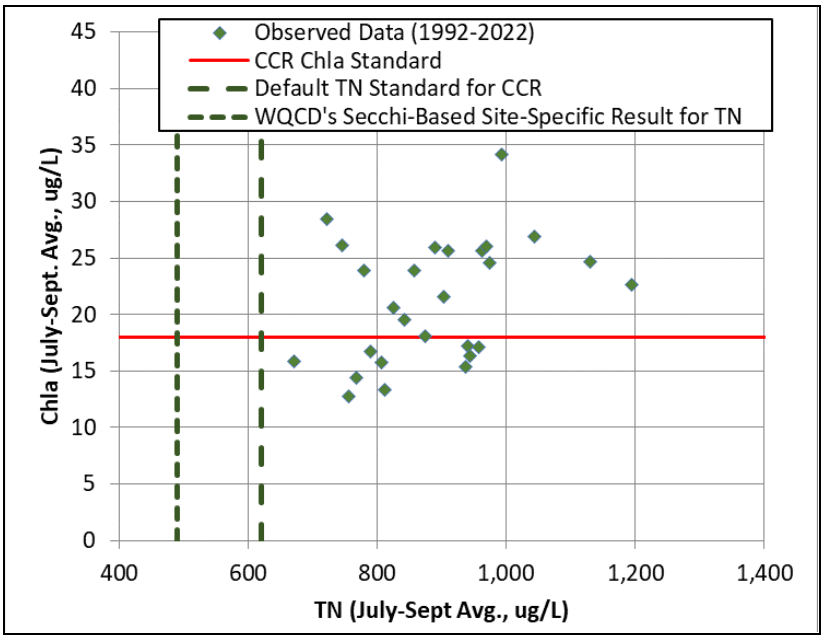


Figure 9. Observed Summertime Chl*a* and TN compared to the Default TN Standard and WQCD's Secchi-Based Site-Specific TN Standard for Cherry Creek Reservoir

4 Site-Specific TP and TN Standard Development

For the reasons explained in Section 2, Cherry Creek Reservoir needs site-specific standards for TP and TN. Further, WQCD's secchi-based site-specific equations do not work for this system (see Section 3); therefore, the site-specific TP and TN standards must be developed from site-specific relationships. This section describes the approach taken to develop the proposed site-specific standard values. Overall the approach follows the WQCD's 4-step method, which was used to develop the TP and TN TVSs adopted in the 2023 Rulemaking Hearing. The discussion begins with an overview of the WQCD's 4-steps (Section 4.1), followed by a detailed presentation of each step as applied to Cherry Creek Reservoir for the site-specific standard development (Section 4.2). Finally, additional analysis to further evaluate the proposed site-specific TP standard is presented in Section 4.3. Note that the approach and findings presented here are specific to Cherry Creek Reservoir, which has an extensive dataset and benefits from a detailed site-specific numerical model. Therefore, this approach to site-specific nutrient standard development may not necessarily be appropriate for other Colorado lakes/reservoirs.

4.1 Overview of the WQCD 4-Step Approach for TP and TN Standard Development

The approach taken to develop the proposed site-specific TP and TN standards for Cherry Creek Reservoir follows the 4-step method applied by the WQCD in development of the TP and TN lakes and reservoirs TVSs (WQCD, 2022a) which were adopted in the 2023 Rulemaking Hearing. The four steps apply relationships based on observed data to translate the Chl*a* standard into corresponding TP and TN standards. The translation approach further underscores that the fundamental purpose of the TP and TN standards is to protect lakes and reservoirs from algal growth in excess of the applicable Chl*a* standard. The four steps can be summarized as follows:

Step 1: Define the Chl*a* standard value.

The Chl*a* standards for lakes and reservoir are already established; therefore, this step simply involves identifying the applicable Chl*a* standard value.

Step 2: Translate the Chl*a* standard to a 50th percentile.

Chl*a* standards are evaluated as a July through September average, with a one-in-five-year allowable exceedance frequency. Because of the one-in-five-year allowable exceedance frequency, the WQCD considers the Chl*a* standard to be reflective of an 80th percentile. To support graphical comparison of observed Chl*a* and nutrient data, the Chl*a* standard value must first be translated from an 80th percentile to a 50th percentile. WQCD developed a State-wide relationship between the 80th percentile and the 50th percentile for summertime Chl*a* concentrations using data from well-sampled lakes and reservoirs. This relationship is used to translate the applicable Chl*a* standard value from Step 1 (reflective of an 80th percentile) to a corresponding Chl*a* concentration reflective of a 50th percentile (Figure 10).

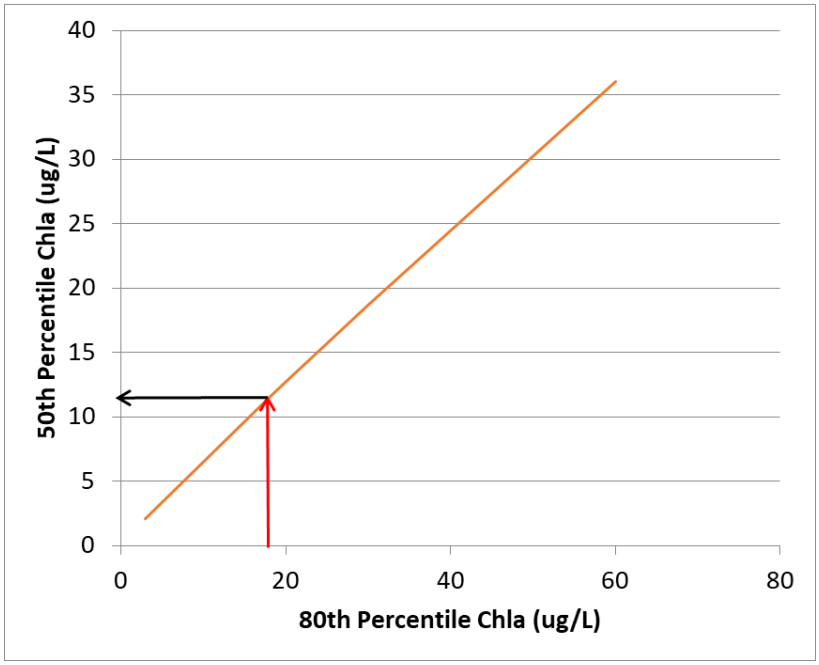


Figure 10. WQCD State-Wide Relationship for Translating Chl*a* Standard Value (80th Percentile) to a 50th Percentile (Step 2); Arrows Show Translation for Chl*a* Standard of 18 ug/L to 50th Percentile of 11.5 ug/L

<u>Step 3</u>: Translate Chl*a* as a 50th Percentile to TP and TN.

The next step is to translate the Chl*a* value (50th percentile) identified in Step 2 to TP and TN concentrations. To do this, the WQCD created State-wide relationships between observed July through September Chl*a* concentrations and TP and TN concentrations. Warm and Cold lakes were distinguished in this step. A fit to the data was found using quantile regression, resulting in an equation relating Chl*a* and TP and an equation relating Chl*a* and TN. Use of quantile regression, which is generally less sensitive to the influence of outliers (as compared to a least squares regression fit), is considered a good choice in this case given the high variability in the observed datasets. The resulting relationships were then used to translate the 50th percentile Chl*a* value to TP and TN concentrations (Figure 11 and Figure 12).

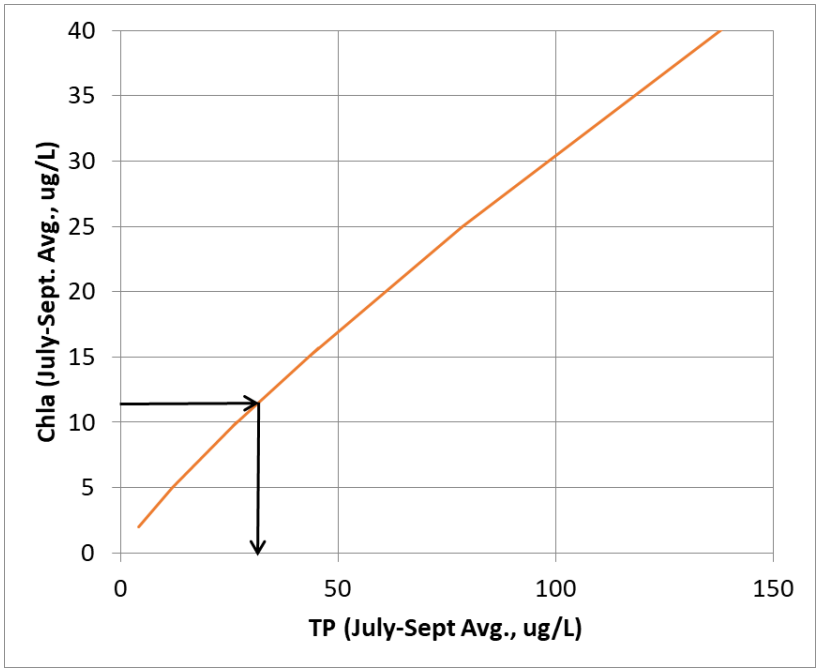


Figure 11. WQCD State-Wide Warm Water Relationship for Translating Chl*a* Standard (as a 50th Percentile) to Average Summertime TP Concentrations; Arrows Show Translation for Chl*a* 50th Percentile of 11.5 ug/L to a TP Concentration of 31.6 ug/L

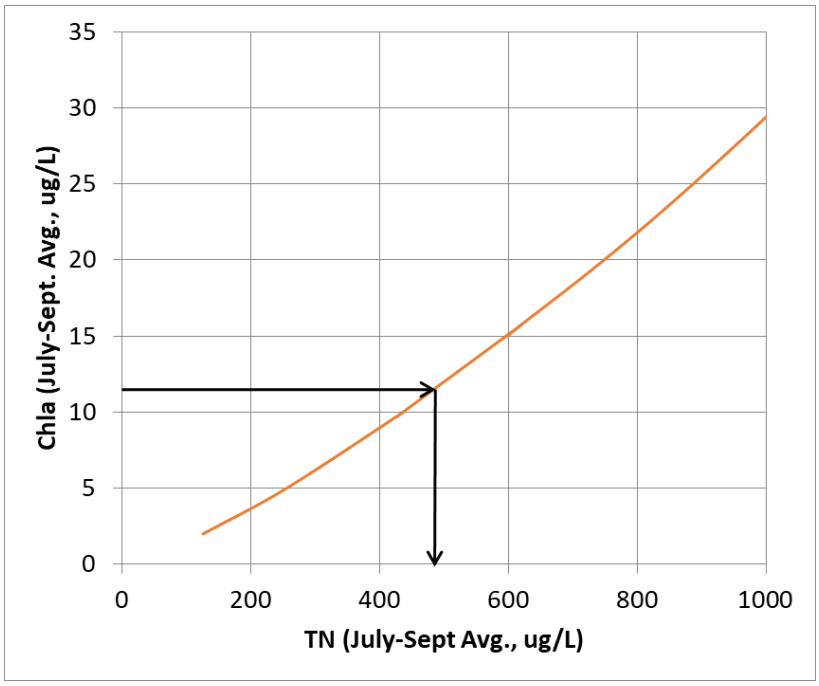


Figure 12. WQCD State-Wide Warm Water Relationship for Translating Chl*a* Standard (as a 50th Percentile) to Average Summertime TN Concentrations; Arrows Show Translation for Chl*a* 50th Percentile of 11.5 ug/L to a TN Concentration of 487 ug/L

<u>Step 4</u>: Translate TP and TN concentrations to 80th percentiles.

The final step of the 4-step process is to convert the summertime average TP and TN concentrations identified in Step 3 to 80th percentiles. The WQCD included this step to create TP and TN standard values that are applicable with a one-in-five-year allowable exceedance frequency. Following the same logic used in Step 2, the WQCD developed State-wide relationships between the 50th percentile and the 80th percentile summertime TP (or TN) concentrations, based on observed data from well-sampled lakes and reservoirs. These relationships were then used to translate the 50th percentile TP and TN values determined in Step 3 into 80th percentile TP and TN concentration values (Figure 13 and Figure 14). The resulting 80th percentile concentration values are the resulting TP and TN standard values, assessed as July through September averages with a one-in-five-year allowable exceedance frequency. Note that WQCD rounds the resulting TP and TN standard values to two significant figures.

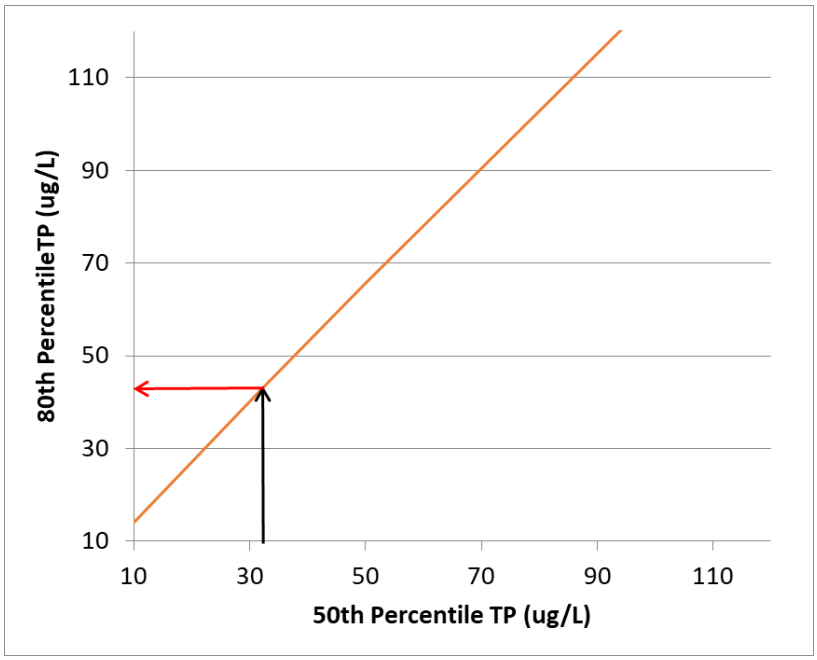


Figure 13. WQCD State-Wide Relationship for Translating Average Summertime TP (as a 50th Percentile) to Average Summertime TP as an 80th Percentile; Arrows Show Translation for 50th Percentile TP of 31.6 ug/L to the 80th Percentile TP Concentration of 42 ug/L

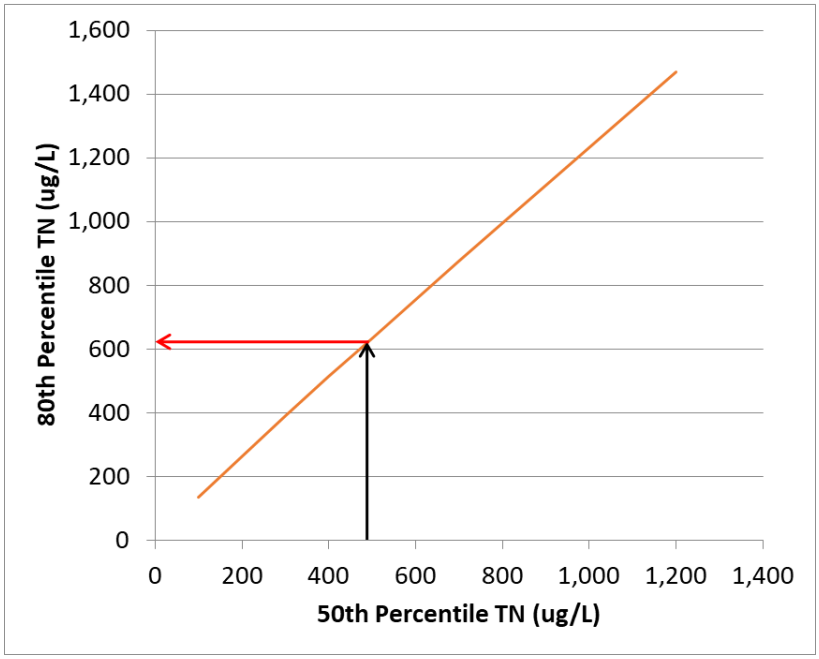


Figure 14. WQCD State-Wide Relationship for Translating Average Summertime TN (as a 50th Percentile) to Average Summertime TN as an 80th Percentile; Arrows Show Translation for 50th Percentile TN of 487 ug/L to the 80th Percentile TN Concentration of 620 ug/L

4.2 WQCD 4-Step Method Applied to Cherry Creek Reservoir

To develop the site-specific TP and TN standards, the WQCD's 4-step method described in Section 4.1 was applied using Cherry Creek Reservoir data instead of the State-wide dataset used to develop the TVSs. The discussion is organized by the four steps:

- **Step 1**: Define the Chl*a* standard value.
- **Step 2**: Translate the Chl*a* standard to a 50th percentile.
- **Step 3**: Translate Chl*a* as a 50th Percentile to TP and TN.
- **Step 4**: Translate TP and TN concentrations to 80th percentiles.

4.2.1 Cherry Creek Reservoir – Step 1: Define the Chl*a* standard Value

The first step is to define the Chl*a* standard value. For Cherry Creek Reservoir, there is an existing, site-specific Chl*a* standard value of 18 ug/L.

4.2.2 Cherry Creek Reservoir – Step 2: Translate the Chl*a* Standard to a 50th Percentile

Continuing to follow the WQCD's 4-step method, the second step is to translate the Chl*a* standard to a 50th percentile. While the WQCD has a strong State-wide relationship based on well-sampled lakes,

CCQWQA has an extensive[5] site-specific dataset to support consideration of whether the State-wide relationship appropriately reflects the distribution of summertime average Chl*a* concentrations in Cherry Creek Reservoir, or if a site-specific relationship should be used instead. The Cherry Creek Reservoir dataset was broken into five-year blocks of time[6] (2018-2022, 2013-2017, etc.) to generate a site-specific 80th percentile to 50th percentile relationship for the summertime average Chl*a*. Five-year blocks were used to produce multiple points to generate a regression line[7], and the resulting relationship is strong (R^2 = 0.86; Figure 16). The WQCD relationship, however, does not do a good job of reflecting the Cherry Creek Reservoir dataset (Figure 16). Specifically, the State-wide relationship is consistently biased low relative to the Cherry Creek Reservoir dataset.

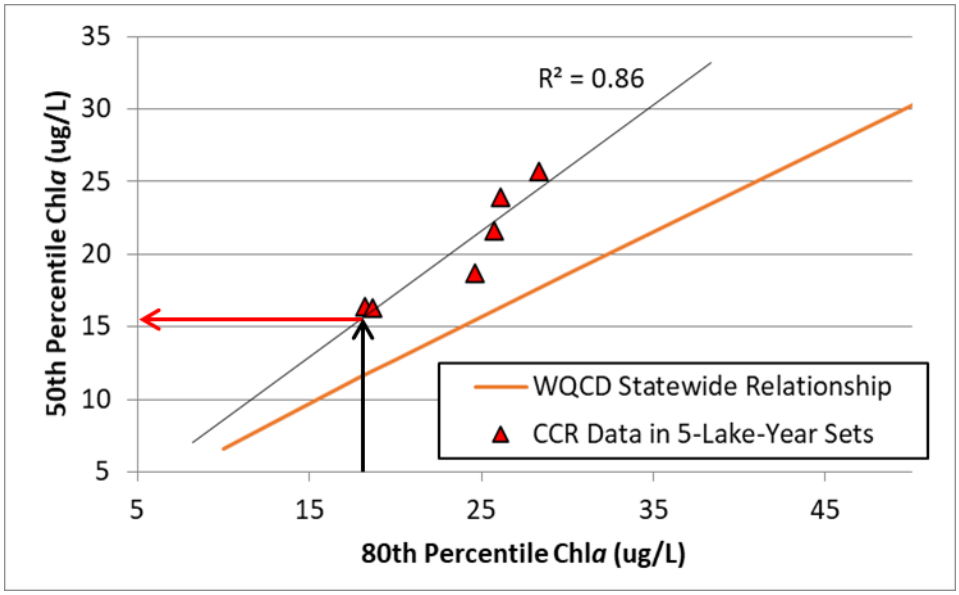


Figure 16. Cherry Creek Reservoir Site-Specific Relationship between Summertime Chl*a* 80th Percentile and 50th Percentile Concentrations (Data Presented in Five-Year Sets) Compared to the WQCD State-Wide Relationship; Arrows Show Translation for Chl*a* Standard of 18 ug/L to 50th Percentile of 15.55 ug/L

It is reasonable to expect that a given water body may exhibit a distribution of summertime Chl*a* concentrations that differs from that defined based on a State-wide dataset. Therefore, given the

[5] Note that Cherry Creek Reservoir dataset includes 31 years of record with 6 to 14 Chl*a* observations each year in the months of July through September (1992-2022).

[6] The five-year block approach is considered reasonable, given the WQCD designation that a lake must include at least five years of record for inclusion in the State-wide 80-50 relationship for Chl*a*. In other words, the WQCD considers five years of data adequate to characterize the 80-50 relationship for Chl*a* for a given lake; therefore, five-year blocks of time should be appropriate for use in the development of a site-specific 80-50 relationship.

[7] Note that use of all the Cherry Creek Reservoir data in a single data group would produce a single 80-50 data point. More than one point is needed to generate a regression line to translate the Chl*a* standard value (representative of an 80th percentile) to a 50th percentile. Further, it would not be appropriate to work from a single point and simply assume that the line should pass through the origin, recognizing that the State-wide relationship also does not pass through the origin.

extensive dataset available for Cherry Creek Reservoir and the apparent differences from the State-wide relationship, the following site-specific relationship was applied for Step 2:

$$\text{Chl}a_{50\text{th \%ile}} = 0.8683*\text{Chl}a_{80\text{th \%ile}} - 0.0772$$

The equation translates the 80th percentile Chl*a* standard value of 18 ug/L to a 50th percentile Chl*a* value of 15.55 ug/L (Figure 16).

4.2.3 Cherry Creek Reservoir – Step 3: Translate Chl*a* as a 50th Percentile to TP and TN

Step 3 is the critical step translating summertime Chl*a* concentrations to summertime TP and TN concentrations based on the observed relationships. As established in Section 2, the WQCD's State-wide warm lakes relationships for Chl*a*:TP and Chl*a*:TN do not perform well in describing the observed algal response in Cherry Creek Reservoir to TP and TN concentrations (Figure 4 and Figure 5). However, it is also noted that the full Cherry Creek dataset lacks clear relationships between Chl*a* and TP (Figure 2) and Chl*a* and TN (Figure 3). Therefore, additional analysis was needed to identify a site-specific relationship to support completion of Step 3.

In review of the 31-year dataset for Chl*a* and nutrients in Cherry Creek Reservoir, an apparent pattern was noted. Specifically, a general pattern match was identified between the response of summertime Chl*a* to TN concentrations from ~2004 through 2022 (Figure 17). In other words, the data show that over that time period there is general agreement between Chl*a* and TN in terms of the direction of change (i.e., when TN increases, Chl*a* generally increases and vice versa). Interestingly, over the same set of years, the pattern is completely absent for TP (Figure 18). This may indicate the dominance of TN (vs. TP) as a primary control on algal growth (nitrogen limitation) in these years (~2004-2022).

Correspondingly, there appears to be a general pattern match between TP and Chl*a* in the preceding set of years in the record (1992-~2003; Figure 18). For 1992-~2003, there is a general pattern match for TP and Chl*a* (1992-~2003), while there is no similar match between TN and Chl*a* in the same years (Figure 17). This may indicate the dominance of TP (vs. TN) as a primary control on algal growth (phosphorus limitation) in this portion of the record (1992-~2003). These earlier years also correspond to a period when TP concentrations were generally lower than the average observed in the more recent years, further supporting the possibility that the patterns indicate TP limitation followed by TN limitation. Note that there is no alternative explanation[8] for this pattern at this time.

[8] There is no change in reservoir operations that corresponds to the 2003/2004 timeframe identified here as a change point in the dataset. While the destratification system operations all occurred in the second timeframe, the destratification system was operated in fewer than half of the summers in the second timeframe (2008-2013, 2021, and 2022). Therefore, destratification system operations are align with or explain this pattern. There are also no clear step changes corresponding to the 2003/2004 timeframe for in-reservoir conditions such as temperature, clarity, non-volatile suspended solids (NVSS), etc. Therefore, the change in phosphorus concentrations is currently thought to be the primary explanation for the change in pattern.

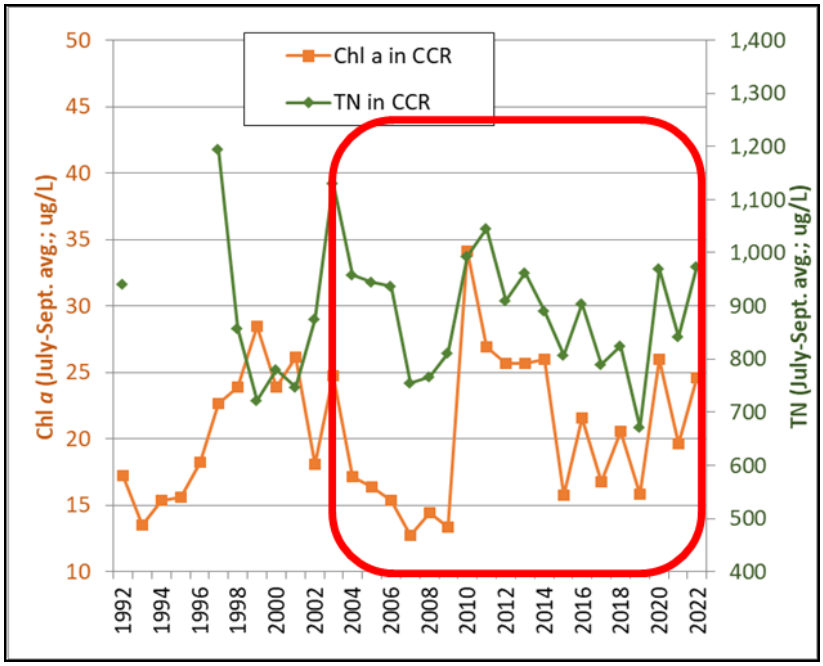


Figure 17. Summertime TN and Chl*a* Concentrations in Cherry Creek Reservoir; Red Outline Indicates Period of Apparent Pattern Match and Possible Dominance of N-Limitation

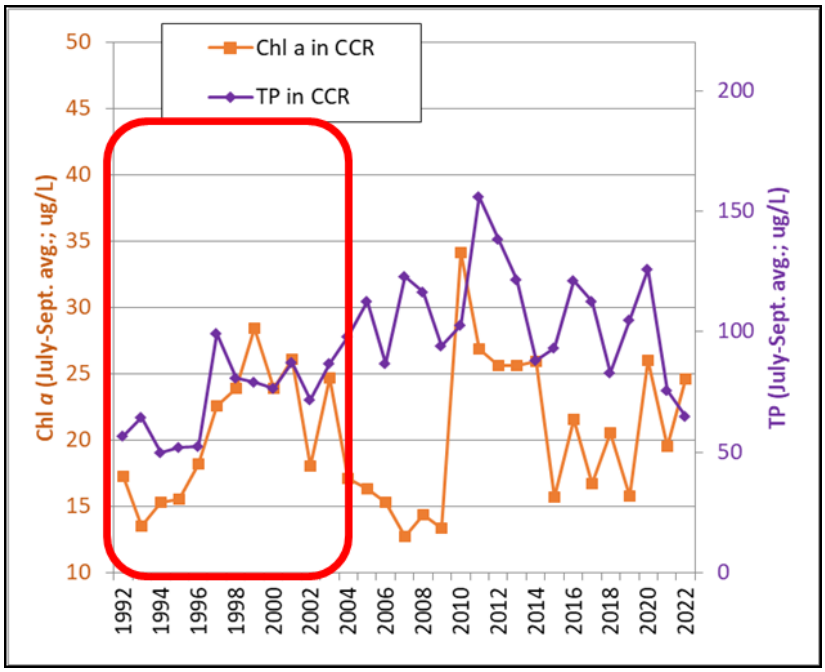
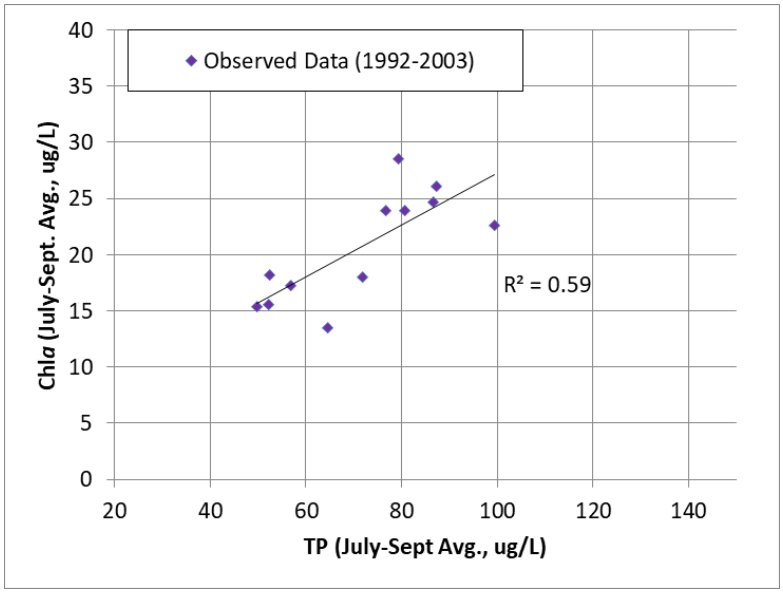


Figure 18. Summertime TP and Chl*a* Concentrations in Cherry Creek Reservoir; Red Outline Indicates Period of Apparent Pattern Match and Possible Dominance of P-Limitation

This pattern change in the observed dataset appears to offer a glimpse into the underlying relationships between TP and Chl*a* and TN and Chl*a* that are not readily apparent in the full dataset. When TP and Chl*a* data from 1992-2003 are plotted, the data exhibit a reasonable correlation (R^2 = 0.59; Figure 19),

which is a dramatic improvement over the lack correlation in the full dataset (R^2 = 0.06; Figure 2). Similarly, when TN and Chl*a* data from 2004-2022 are plotted, the data exhibit a reasonable correlation (R^2 = 0.48; Figure 20), which is a dramatic improvement[9] over the lack of correlation in the full dataset (R^2 = 0.12; Figure 3).

Based on this finding, site-specific relationships for Step 3 were developed by dividing the data into two parts (1992-2003 to identify the Chl*a*:TP relationship, and 2004-2022 to identify the Chl*a*:TN relationship). Fortunately, due to the long (31-year) period of record available for Cherry Creek Reservoir, even the subdivided datasets are still reasonably long (12 years of record used to define the Chl*a* response to TP, and 19 years of record used to define the Chl*a* response to TN).



[9] While these correlations are notable improvements to those based on the full dataset, and these are comparable, in terms of goodness of fit, to the State-wide relationships used to develop TVSs for warm lakes, the relationships are still far from perfect. This is to be expected when attempting to predict Chl*a* from TN or TP alone. First, TN and TP are imperfect measures of biologically available nutrient concentrations. TN and TP include nitrogen and phosphorus associated with recalcitrant organic matter, which is slow to decay rendering the nutrients largely inaccessible for algal uptake. The fraction of TN and TP in recalcitrant organic matter can vary over time, limiting the predictive capability of TN and TP for Chl*a*. Second, Chl*a* is an imperfect measure of algal biomass. The amount of Chl*a* produced by a gram of algal cells can vary widely depending on the algal species and light conditions in the reservoir. Third, algal growth in response to TN and TP can be interdependent, particularly in a system like Cherry Creek Reservoir, which exhibits nitrogen limitation (excess bioavailable phosphorus relative to bioavailable nitrogen) at times and nitrogen-fixing cyanobacteria. Fourth, many factors beyond TN and TP concentrations affect the Chl*a* response in lakes, including vertical mixing dynamics, water temperature, light, etc. In short, there are many reasons to expect an imperfect fit when plotting lake Chl*a* response to TN or TP concentrations.

At the request of EPA (Moon, 2023), non-volatile suspended solids ([NVSS], data available from 2011-2022) was considered as a secondary predictor variable with TN and TP. However, the analysis did not prove fruitful as NVSS was found to be an insignificant predictor of Chl*a,* exhibiting high p-values (>0.25). While there are currently no successful approaches identified for Cherry Creek Reservoir to support consideration of secondary controls on Chl*a* response to nutrients in Cherry Creek Reservoir for the purpose of site-specific standards development, CCBWQA is open to future discoveries.

Figure 19. Observed Cherry Creek Dataset; Summer Chl*a* Response to TP Concentrations; 1992-2003

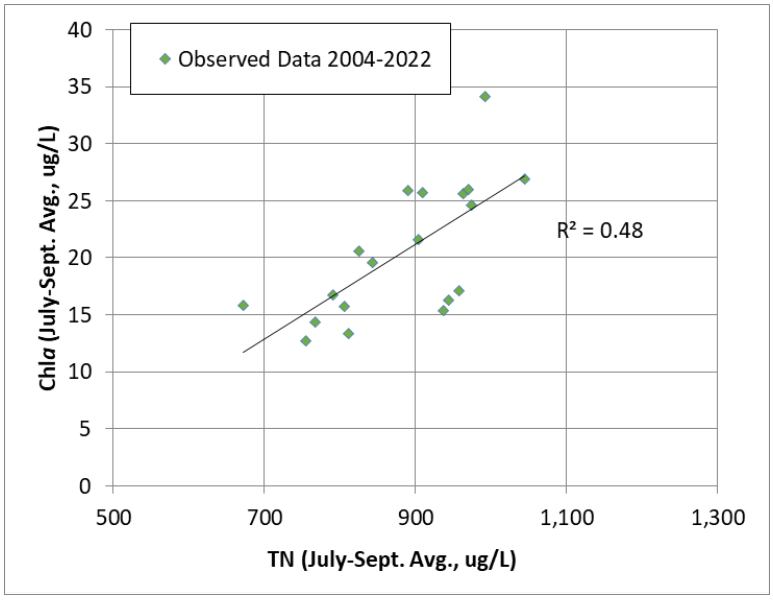


Figure 20. Observed Cherry Creek Dataset; Summer Chl*a* Response to TN Concentrations; 2004-2022

50th quantile regressions[10] were fit to the subsets of data to support completion of Step 3 (Figure 21 and Figure 22). The site-specific 50th quantile relationships for Cherry Creek Reservoir are:

$$TP(ug/L) = 10^{((log_{10}[Chla]+4.09425)/1.83521)}$$

$$TN(ug/L) = 10^{((log_{10}[Chla]+0.31154)/0.88261)}$$

Using these relationships, the Chl*a* value from Step 2 (15.55 ug/L) translates to 50.5 ug/L TP and 759 ug/L TN (Figure 21 and Figure 22).

[10] While the WQCD applied a 75th quantile regression fit to the State-wide warm lakes dataset in an effort to identify the response of highly-productive lakes, it is appropriate to use a 50th quantile fit in a site-specific analysis for a single lake/reservoir.

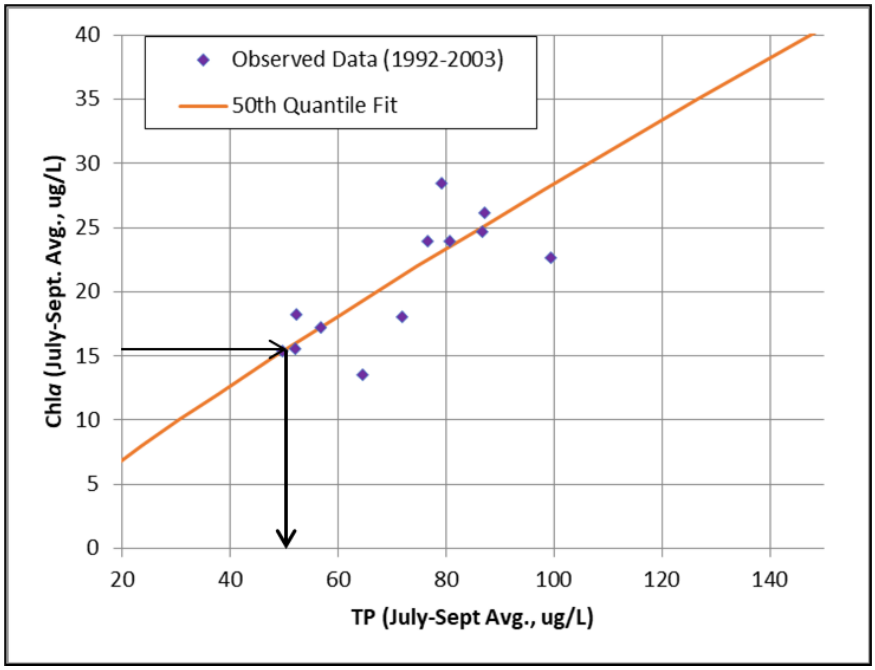


Figure 21. 50th Quantile Fit to Cherry Creek Reservoir Summer Chl*a* Response to Summer TP Concentrations; 1992-2003; Arrows Show Translation for Chl*a* 50th Percentile of 15.55 ug/L to a TP Concentration of 50.5 ug/L

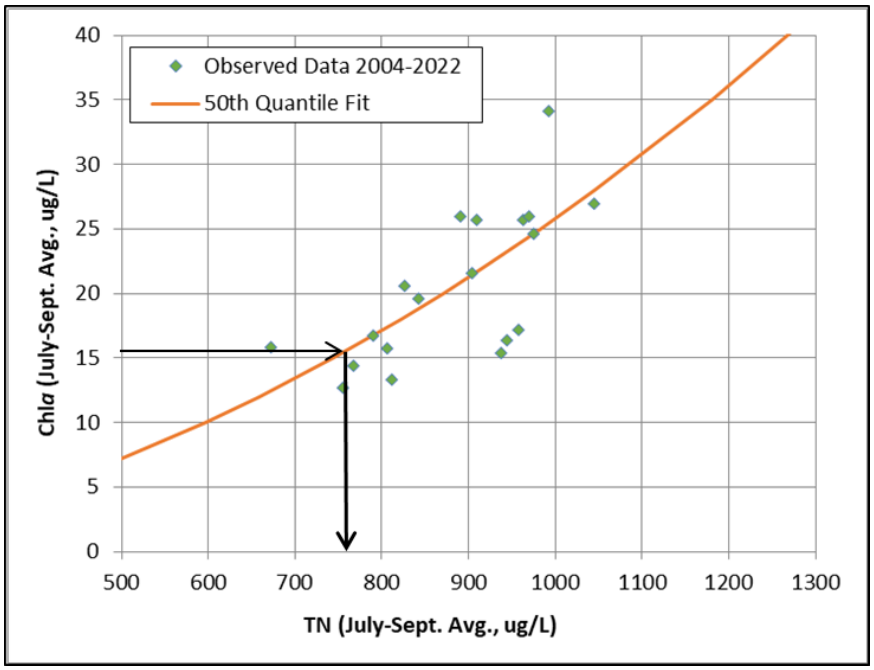


Figure 22. 50th Quantile Fit to Cherry Creek Reservoir Summer Chl*a* Response to Summer TN Concentrations; 2004-2022; Arrows Show Translation for Chl*a* 50th Percentile of 15.55 ug/L to a TN Concentration of 759 ug/L

4.2.4 Cherry Creek Reservoir – Step 4: Translate TP and TN Concentrations to 80th Percentiles

In the final step, the summertime average TP and TN concentrations identified in Step 3 were converted to final standard values reflective of 80th percentiles. While the WQCD has a strong State-wide relationship to translate TP and TN summertime averages (reflective of 50th percentiles) to values reflective of summertime 80th percentiles, Cherry Creek Reservoir has an extensive dataset that exhibits strong site-specific relationships[11] for TP and TN (Figure 25 and Figure 26). Further, the site-specific relationships do not agree well with the WQCD relationships, exhibiting a consistent high bias in 80th percentile response.

As noted for Chl*a* in Section 4.2.2, it is reasonable to expect that a given water body may exhibit summertime TP and TN concentration distributions that differ from relationships based on the State-wide dataset. Therefore, given the extensive dataset available for Cherry Creek Reservoir, the strong relationships, and the apparent difference from the State-wide relationships, the site-specific 50-80 translations for TP and TN were applied (Figure 25 and Figure 26):

$$TP_{80th\ \%ile} = 1.0127 * TP_{50th\ \%ile} + 15.255$$

$$TN_{80th\ \%ile}\ (ug/L) = 0.7346 * TN_{50th\ \%ile} + 307.13$$

The resulting proposed site-specific nutrient standard values are:

- Proposed Site-Specific Standard for TP: **66 ug/L TP**, and
- Proposed Site-Specific Standard for TN: **860[12] ug/L TN.**

As with the TVSs, these site-specific standards would be assessed based on July through September averages, with a one-in-five-year allowable exceedance frequency.

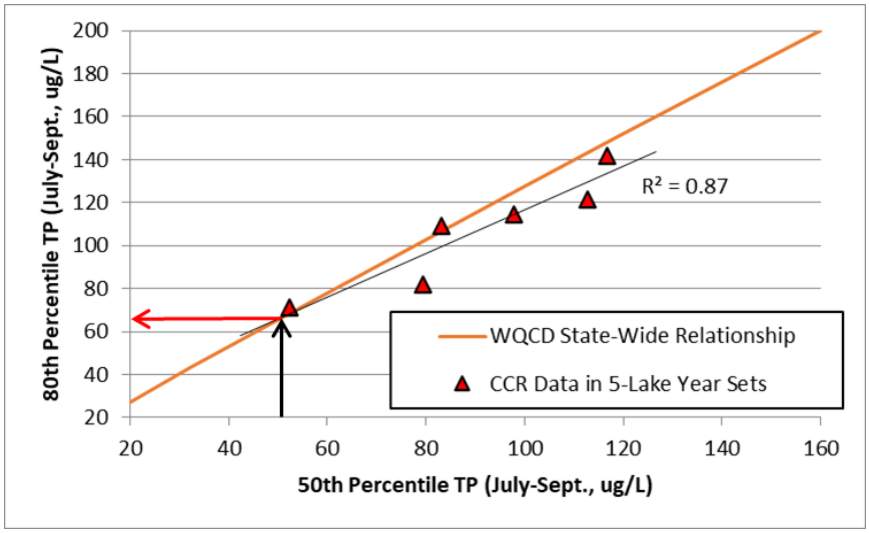


Figure 25. Cherry Creek Reservoir Site-Specific Relationship between Summertime TP 50th Percentile and 80th Percentile Concentrations; Arrows Show Translation for 50.5 ug/L TP (50th Percentile) to 80th Percentile TP Standard Value of 66 ug/L

[11] Following the same reasoning described in Section 4.2.2 for Step 2, the site-specific relationships for Step 4 were developed from five-year blocks of data.

[12] Note that these values follow the WQCD precedent of rounding the TP and TN standard values to two significant figures.

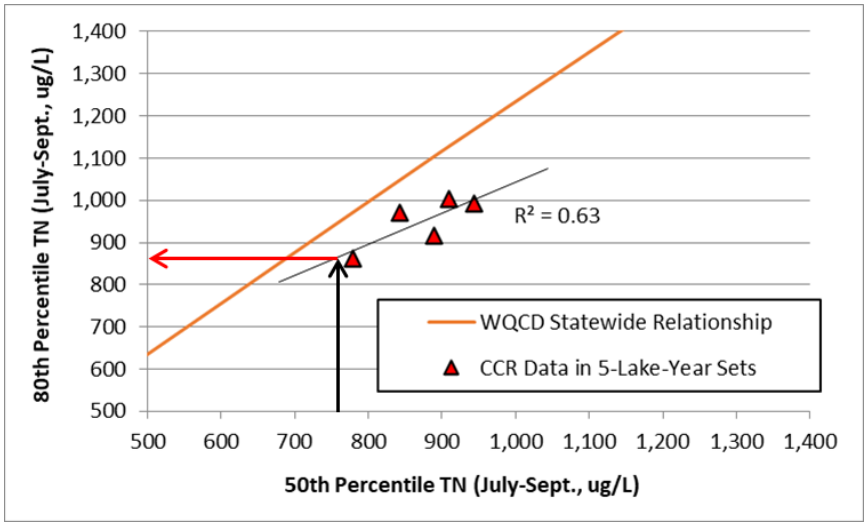


Figure 26. Cherry Creek Reservoir Site-Specific Relationship between Summertime TN 50th Percentile and 80th Percentile Concentrations; Arrows Show Translation for 759 ug/L TN (50th Percentile) to 80th Percentile TN Standard Value of 860 ug/L

4.3 Additional Analysis for TP

The following subsections present additional analysis conducted to further evaluate the proposed site-specific TP standard. Additional analysis was considered useful for TP for two reasons. First, the Chl*a*:TP relationship applied to develop the proposed TP standard is based on the older portion of the observed dataset (1992-2003). Next, the translations for TP in the 4-step process tend to fall at or even slightly below the lower end of the observed range of TP concentrations (e.g., Figure 21). In contrast, the TN proposal is based on the recent 19 years of observed record and does not use extrapolations below the observed ranges.

4.3.1 Clean Lakes Study TP Data Comparison

To further evaluate the site-specific Chl*a*:TP relationship used in Step 3 (Section 4.2.3), historical data from the Cherry Creek Reservoir Clean Lakes Study (DRCOG, 1984) were considered. Samples for TP and Chl*a* were collected through the summer of 1982, providing an additional data point[13] at the lower range of TP concentrations. This data point falls reasonably close to the 50th quantile relationship developed from the 1992-2003 dataset (Figure 27), providing additional confidence in the relationship and in its extrapolation to a TP concentration that is slightly lower than the 1992-2003 observed range (Figure 21). Unfortunately, TN data were not available from the Clean Lakes Study for a similar analysis; however, the TN relationship is based on the 19 years of recent record and the translation is taken from within the observed range of TN concentrations (though it is on the lower end of the range).

[13] The average summertime TP concentration for Cherry Creek Reservoir in 1982 (29.3 ug/L) was based on the average of the July, August, and September values reported on page 72 of the Clean Lakes Study document for Cherry Creek Reservoir (DRCOG, 1984), and the summer average Chl*a* in 1982 (10.7 ug/L) was based on the value reported on page 73 of the document.

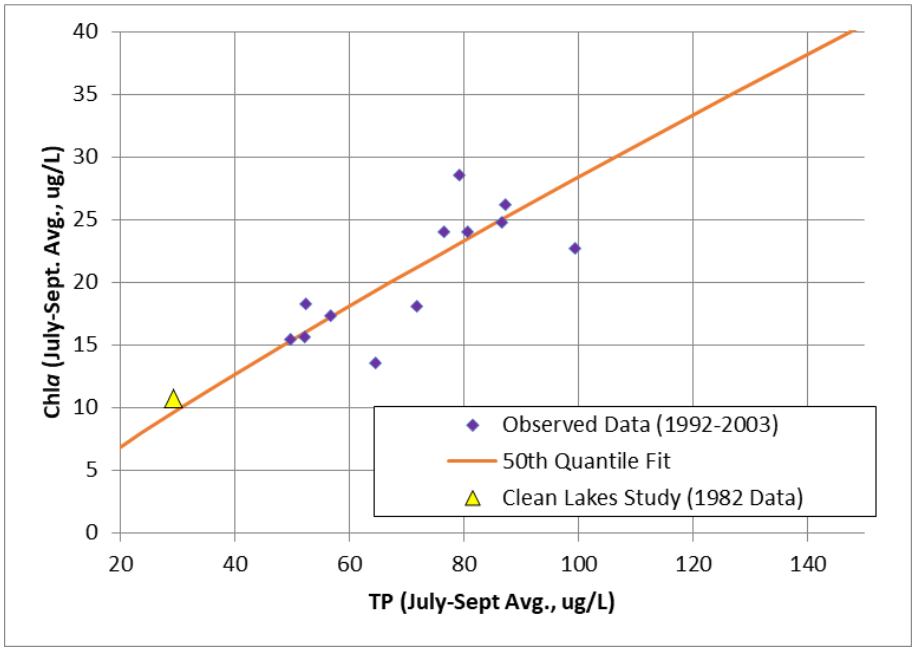


Figure 27. 50th Quantile Fit to Cherry Creek Reservoir Summer Chl*a* Response to Summer TP Concentrations; 1992-2003; Clean Lakes Study 1982 Data Also Shown

4.3.2 Modeling Analysis for TP

To provide further review of the proposed site-specific TP standard for Cherry Creek Reservoir, the existing hydrodynamic and water-quality model of the reservoir (Hydros, 2017 and 2019) was applied. The Cherry Creek Reservoir model is a two-dimensional hydrodynamic and water-quality model developed using CE-QUAL-W2 (Cole and Wells, 2017). The model simulates hydrodynamics, temperature, dissolved oxygen, nutrients, and Chl*a* in Cherry Creek Reservoir from 2003 through 2017, including representation of the effects of the destratification system. The original model development and its extension are documented in detail in Hydros (2017) and Hydros (2019), respectively. The model is considered a useful tool for this purpose because it incorporates much of the complexity absent in the empirical Chl*a*:TP relationships, such as year-to-year differences in residence time, light, water temperature, wind, etc.

The goal in application of the Cherry Creek Reservoir model was to see what the model suggests as an appropriate TP standard corresponding to the Chl*a* standard and consider that relative to the site-specific TP standard developed from the observed data (as described in Sections 4.2 through 4.2.4). This was done by conducting a series of runs that simulated Chl*a* response to reductions in reservoir TP concentrations extending below the current observed range. Run results for summertime TP and Chl*a* concentrations were then used in place of observed data in Step 3 of the WQCD's 4-Step method.

4.3.2.1 Model Runs

Reductions in TP concentrations in the reservoir were simulated in a series of model runs reflecting the two general nutrient control strategies concepts of watershed controls and in-reservoir nutrient management. In addition to the calibration run simulating observed conditions from 2003-2017, the following ten modeling runs were conducted:

- 20% Less TP Inflow (uniform 20% reduction in inflow TP concentrations);
- 50% Less TP Inflow (uniform 50% reduction in inflow TP concentrations);
- 80% Less TP Inflow (uniform 80% reduction in inflow TP concentrations);
- 20% Less TP Int. Load (20% reduction in internal loading rates for TP);
- 50% Less TP Int. Load (50% reduction in internal loading rates for TP);
- 80% Less TP Int. Load (80% reduction in internal loading rates for TP);
- 20% Less TP Inflow; 80% Less TP Int. Load (uniform 20% reduction in inflow TP concentrations and 80% reduction in internal loading rates for TP);
- 50% Less TP Inflow; 50% Less TP Int. Load (uniform 50% reduction in inflow TP concentrations and 50% reduction in internal loading rates for TP);
- 50% Less TP Inflow; 80% Less TP Int. Load (uniform 50% reduction in inflow TP concentrations and 80% reduction in internal loading rates for TP); and
- 80% Less TP Inflow; 80% Less TP Int. Load (uniform 80% reduction in inflow TP concentrations and 80% reduction in internal loading rates for TP)

Note that simulation designs were not constrained to fractional reductions that are currently considered achievable, particularly in terms of watershed controls. Inclusion of such runs is considered reasonable recognizing that the objective of this effort is not to assess attainability but instead to evaluate the modeled relationship between Chl*a* and TP, ideally including conditions below the Chl*a* standard.

4.3.2.2 Modeling Results

Modeling results for the runs listed above were compiled in terms of July through September average concentrations for TP and Chl*a*. A 50th quantile regression was then fit to the full set of run results (Figure 28). The R^2 analog for the 50th quantile regression fit is 0.70 indicating a relatively good correlation. Interestingly, modeling results show that the Chl*a* response to summertime TP predictions becomes more consistent (a better fit) at lower TP concentrations (<~70 ug/L), which may reflect a general turning point to (or toward) phosphorus limitation in the reservoir. Another interesting finding in the results is that TP concentration reductions on the order of 20% (as inflow loading reductions or as internal loading rate reductions) do not change the Chl*a* response enough to bring most years below the Chl*a* standard. To get most years below the Chl*a* standard, the modeling indicates that major reductions are needed (50% to 80% reductions), and a combination of inflow and in-reservoir strategies produce the best results.

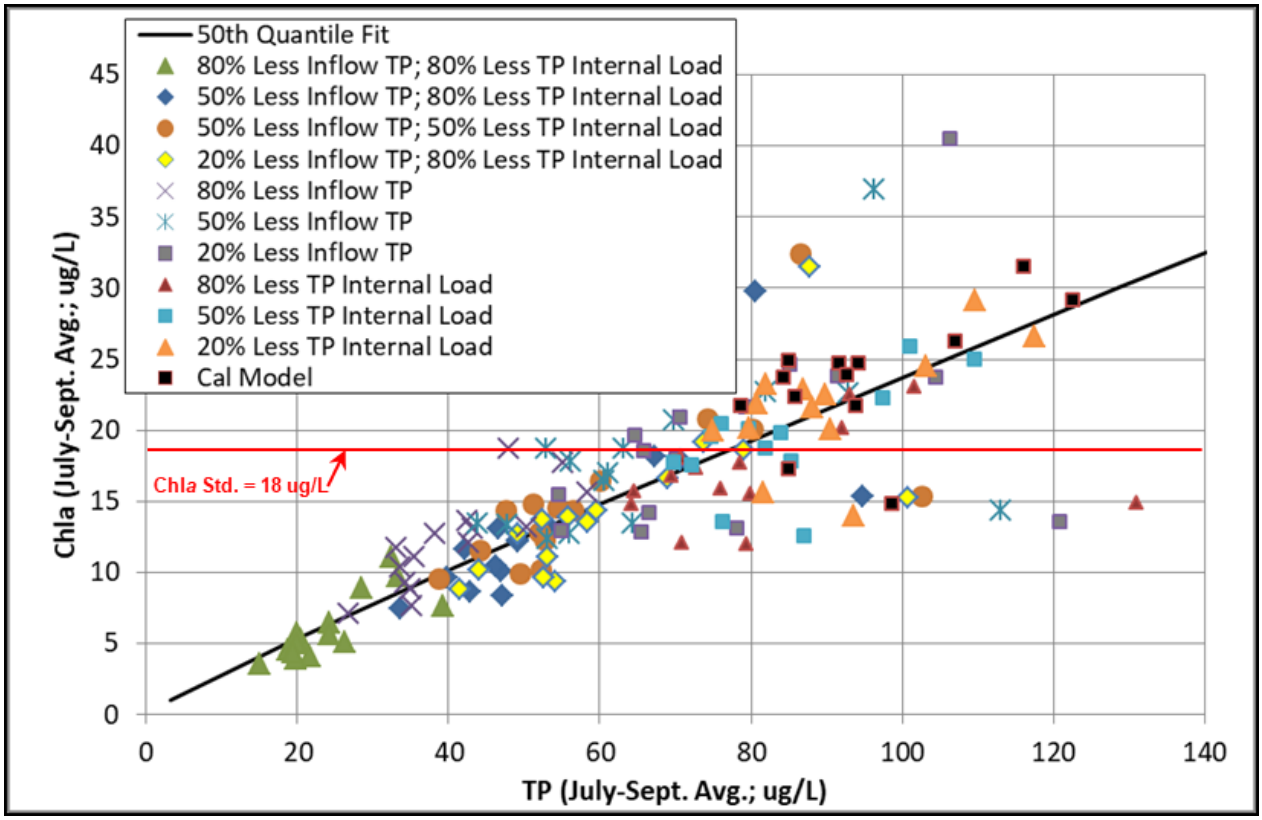


Figure 28. Results of Cherry Creek Reservoir Model Runs Showing Chl*a* Response to Progressive Reductions of Inflow Phosphorus Concentrations and Internal Phosphorus Loading Rates

Using the 50th quantile regression fit from the modeling results[14] in Step 3 of the WQCD's 4-step process (note: all other steps use relationships presented in Sections 4.2, 4.2.2, and 4.2.4), the modeling results produce a site-specific TP standard value of 79 ug/L. This value is higher (less stringent) than the 66 ug/L site-specific TP standard developed from the observed data. The CCBWQA is not planning to propose the modeling-based TP standard (79 ug/L) at this time, but is instead planning to propose the more stringent observation-based site-specific standard value of 66 ug/L TP. The modeling results are considered to provide supporting evidence that a standard value less stringent than the default TP standard for Cherry Creek Reservoir (42 ug/L TP) is justifiable. Further, the modeling results are considered to be an indication that future refinements to the site-specific TP standard for Cherry Creek Reservoir may be warranted, particularly as in-reservoir TP concentrations decrease and the observed data record better reflects the underlying Chl*a*:TP relationship at lower concentrations.

4.4 Summary of Site-Specific TP and TN Standard Development

Site-specific TP and TN standards for Cherry Creek Reservoir were developed following the same 4-step process applied by WQCD to develop the TVSs. In each step, the extensive Cherry Creek Reservoir dataset was used in lieu of the WQCD's State-wide database. The resulting proposed site-specific nutrient standard values are:

[14] $\mathrm{TPug/L} = 10((\log 10[\mathrm{Chla}] + 0.47309)/0.92469)$

- Proposed Site-Specific Standard for TP: **66 ug/L TP**, and
- Proposed Site-Specific Standard for TN: **860[15] ug/L TN.**

As with the TVSs, these site-specific standards would be assessed based on July through September averages, with a one-in-five-year allowable exceedance frequency.

[15] Note that these values follow the WQCD precedent of rounding the standard values to two significant figures.

5 Discussion of Site-Specific TN and TP Standard Values Developed for Cherry Creek Reservoir

Based on the analysis described in Section 4, site-specific TP and TN standards of 66 ug/L TP and 860 ug/L TN were developed for Cherry Creek Reservoir. In this section, these values are discussed in the context of State-wide TP and TN standards for warm lakes as well the observed data record for Cherry Creek Reservoir. The intent of this discussion is to offer perspective on the site-specific standard values relative to the broader regulatory framework and relative to the range of observed conditions in the reservoir.

While the site-specific TP and TN standard values developed for Cherry Creek are less stringent than the default values that the WQCC would assign to the reservoir, they are more stringent than the 2012 Interim Criteria values for lakes and reservoirs that were approved by the Environmental Protection Agency (EPA, 2016; site-specific TP and TN standard values). As such, the site-specific TP and TN standard values are considered to fall within a reasonable range from a regulatory context (i.e., between two sets of EPA-approved nutrients standards for warm lakes in Colorado)[16].

Table 2. Cherry Creek Reservoir Site-Specific TP and TN Standards Compared to Relevant State Nutrient Standards and Interim Criteria

Constituent	Warm Lakes Nutrient Standards		Default** Cherry Creek Reservoir Standards	Site-Specific Standards Developed for Cherry Creek Reservoir
	2012 Interim Criteria	TVSs* (TN and TP Adopted in April 2023)		
Chl*a* (ug/L)	20	20	**18**	**18**
TN (ug/L)	910	670	620	**860**
TP (ug/L)	83	47	42	**66**

Note: All are/would be assessed as July through September averages with a one in five-year allowable exceedance frequency.

*Currently only applicable to warm lakes above permitted discharges.

** Default TP and TN standards are those expected to be adopted for Cherry Creek Reservoir in the absence of a successful site-specific standard proposal. The TN and TP values were developed from the WQCD State-wide relationships used in the April 2023 RMH, applying the Cherry Creek Reservoir Chl*a* standard of 18 ug/L, in lieu of the general warm lakes Chl*a* standard of 20 ug/L.

When compared to the Cherry Creek Reservoir water-quality records, the proposed site-specific TP and TN standards fall on the low end of the observed dataset (Table 3 and Figure 29). While the Chl*a*

[16] While this is considered to be a reasonable range based of EPA-approved standard values, it should be noted that site-specific standard values outside of this range may be appropriate for some warm lakes, depending on the observed system response.

standard value is not routinely met, it is met[17] in 13 of the 31 years of record (Figure 29). Similarly, the proposed site-specific standard for TN would have been met in a similar number of years of record (12 of 27). In contrast, the proposed site-specific standard for TP would have only been met in 6 years of record (Figure 29). This pattern agrees with the overall conceptual understanding of the system, which is generally considered to be further from the optimal TP concentration than the optimal TN concentration. The relevant point is that meeting the proposed site-specific standards for both TP and TN would require in-reservoir summer concentrations well below typically-observed concentrations. As such, the proposed site-specific standards comprise challenging targets for CCBWQA as they continue their mission to protect and improve water quality in the reservoir. The challenge of meeting these targets is further underscored by the modeling results presented in Section 4.3, which indicate that major reductions in inflow nutrient concentrations and/or in-reservoir nutrient internal loading rates (on the order of 50 to 80%) are needed to meet the Chl*a* standard (and, correspondingly, the nutrient standards).

Table 3. Comparison of Site-Specific TP and TN Standards Developed for Cherry Creek Reservoir to Range of Summertime Average Observations

Constituent	Site-Specific Standards* Developed for Cherry Creek Reservoir	Cherry Creek Reservoir Observed Data (1992-2022) Jul.-Sept. Averages (Avg., Range)
Chl*a* (ug/L)	**18**	21 (13-34)
TN (ug/L)	**860**	889 (672-1,195)
TP (ug/L)	**66**	93 (50-156)

*All would be assessed as July through September averages with a one in five year allowable exceedance frequency.

[17] Note the terminology used here is purposeful, referring to a direct comparison of the standard value to the observed data, as opposed to an assessment of compliance with the standard. This analysis is not intended to evaluate compliance. Compliance analysis would require consideration of the one-in-five-year allowable exceedance frequency and does not match the purpose of this comparison conducted here.

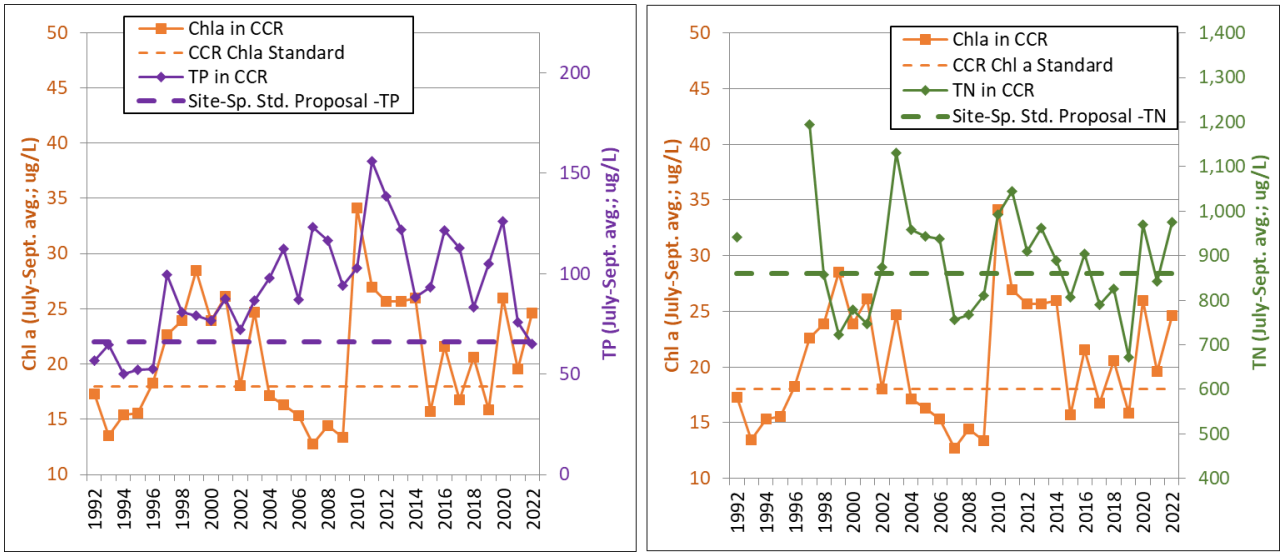


Figure 29. Comparison of Observed Chl*a* and Nutrient Data from Cherry Creek Reservoir to Existing Chl*a* Standard and Site-Specific TP and TN Standards Developed for Cherry Creek Reservoir, 1992-2022

The site-specific TP and TN standards developed for Cherry Creek Reservoir were also reviewed against the observed dataset using the quadrant plot approach (described in Section 2.4). Even with the site-specific proposal values, there are still numerous years of record that fail to show alignment between the Chl*a* standard and the TP and TN standards (Figure 30). In fact, there is no ideal value for the TP and TN standards to lead to good alignment with the full observed dataset. This underscores the underlying complexity of the Chl*a* response to nutrient concentrations in Cherry Creek Reservoir. In other words, TP and TN are clearly not independent controls on Chl*a* in Cherry Creek Reservoir as effectively assumed in the standard development process. That said, following the WQCD's 4-step process using site-specific data is expected to have produced TP and TN standard values that better reflect the underlying relationships between nutrients and Chl*a* in Cherry Creek Reservoir.

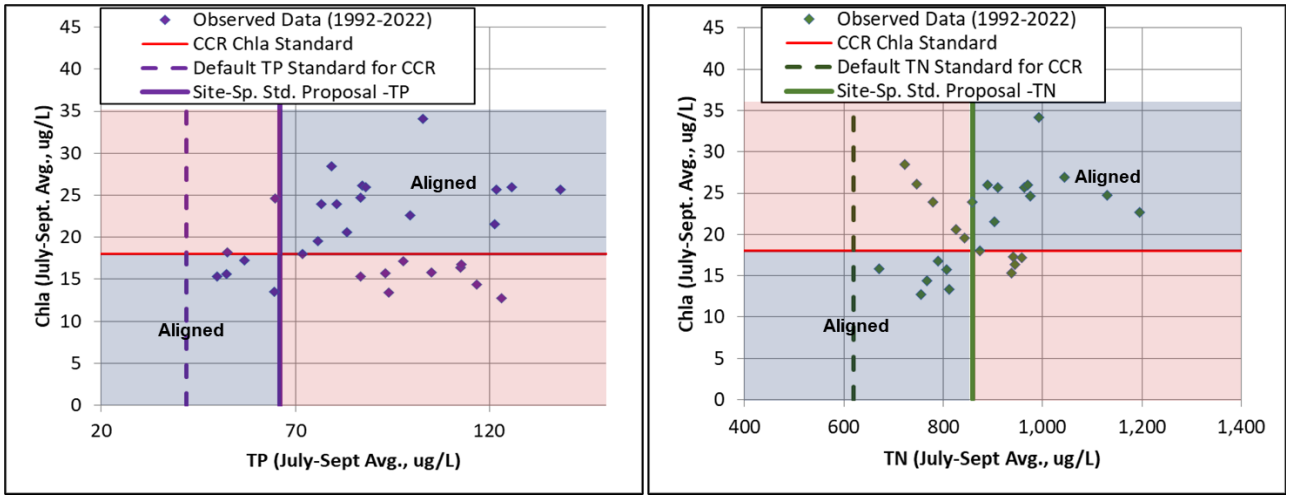


Figure 30. Cherry Creek Reservoir Chl*a*: TP and Chl*a*: TN Quadrant Plots with Site-Specific TP and TN Standards Developed for Cherry Creek Reservoir, 1992-2022

The underlying relationships become more apparent when the quandrant plots are reviewed focusing on the subsets of years used in standard development (Figure 31). As a reminder, the subsets of years used in the site-specific standard development (1992-2003 for TP and 2004-2022 for TN) are expected to generally differentiate between years with a greater tendency toward phosphorus limitation and years with a greater tendency toward nitrogen limitation. Using those data subsets, the proposed site-specific TP and TN standards align reasonably well with the Chl*a* standard in Cherry Creek Reservoir (Figure 31). Further, the site-specific TP and TN standards show much better alignment with the observed dataset as compared to the default TP and TN standards for Chery Creek Reservoir (Figure 31). As noted previously, future refinement of the site-specific standards, particularly for TP, may be needed as concentrations in the reservoir decrease and the observed dataset further illuminates the underlying relationship between TP and Chl*a* at lower concentrations.

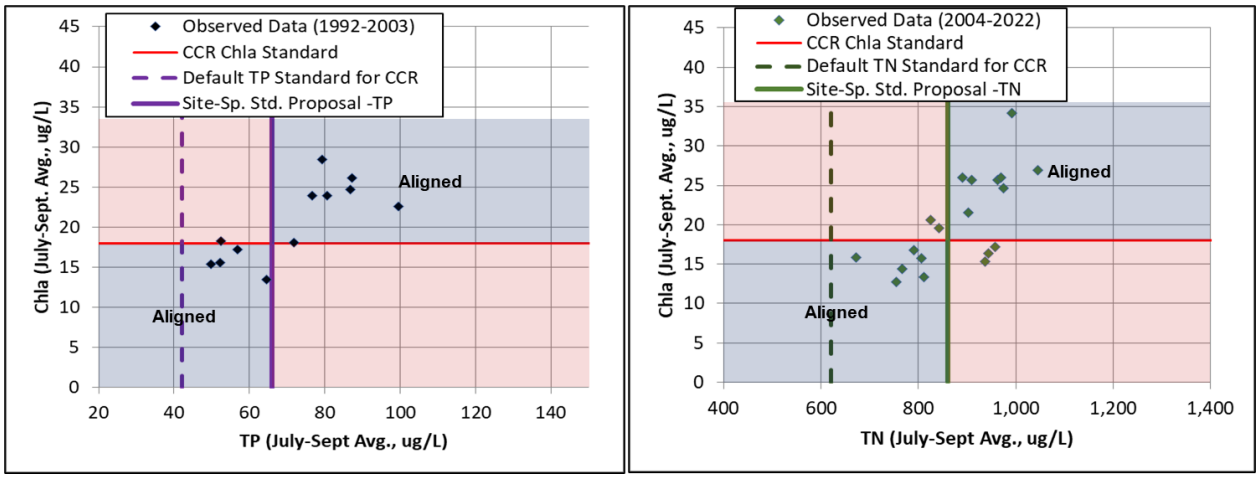


Figure 31. Cherry Creek Reservoir Chl*a*: TP and Chl*a*: TN Quadrant Plots with Site-Specific TP and TN Standards Developed for Cherry Creek Reservoir, Observed Data Limited to Year Sets Used in Standard Development

6 Longevity Plan Recommendations

It is recommended that a Longevity Plan be developed and included in the proposal for site-specific TP and TN standards for Cherry Creek Reservoir. As noted in Regulation 31 (WQCC, 2023) in the Statement of Basis and Purpose for the June 2021 Rulemaking Hearing, the purpose of a Longevity Plan for a site-specific standard is "to guarantee the collection and analysis of information that will be necessary to ensure that a site-specific standard is maintained over time, continues to be scientifically sound, protects the beneficial uses, and can be updated or revised as needed."

Key elements of the Longevity Plan for the site-specific TP and TN standard for Cherry Creek Reservoir should include:

- **Sampling –** The plan should include a commitment by CCBWQA to continue July through September monthly (at a minimum) sampling in the mixed layer at CCR2 for ammonia, nitrate+nitrite, total Kjeldahl nitrogen, SRP, TP, and Chl*a*, with current sampling and analysis methods.

- **Data Analysis** – The plan should include a commitment for analysis of the sampling results to evaluate Chl*a*:TP and Chl*a*:TN response relative to the historical dataset and review of apparent agreement in reservoir response relative to the TP and TN standards as compared to response relative to the Chl*a* standard.
- **Reporting** – The plan should include a commitment to generate a report every three years for the WQCC, corresponding to the triennial review cycle for the basin. Each report should provide the dataset corresponding to data collection commitment, a summary of the data analysis conducted, and a statement of the finding as to whether or not the site-specific TP and TN standards are still considered appropriate for Chery Creek Reservoir and adequately protective of the AL/Rec beneficial uses.

These data collection, analysis, and reporting commitments in a Longevity Plan should support ongoing review of the appropriateness and protectiveness of the site-specific TP and TN standards. It is anticipated that the data analysis may also support subsequent proposals to adjust the site-specific standards in the future, as needed. Note that the sampling and data analysis commitments in the Longevity Plan are intended to provide the minimum adequate information needed to support the WQCC in determining whether there have been any major changes in reservoir response which could indicate that the basis and assumptions used to support adoption of the original site-specific standards have become invalid. As such, the Longevity Plan is not intended to limit, in any way, the information that may be considered or the approach that may be taken to develop revised site-specific TP and TN standard for Cherry Creek Reservoir in the future, as needed.

7 Summary

The State-wide Chl*a*:TP and Chl*a*:TN relationships for warm lakes that were used to develop the AL/Rec TP and TN TVSs do not reflect the observed Chl*a* response to nutrient concentrations in Cherry Creek Reservoir. This mismatch may be due to the polymictic nature of the reservoir, high inflow concentrations of SRP, and/or the existence of strong nitrogen limitation in much of the observed record. Ultimately, the observed data indicate that the default standards are not appropriate for Cherry Creek Reservoir. Further, WQCD's Secchi-based Site-specific equations do not provide improved approximations of observed conditions in Cherry Creek Reservoir. Therefore, site-specific TP and TN standards are needed for Cherry Creek Reservoir.

An analysis of the observed dataset was conducted to identify site-specific nutrient standards for Cherry Creek Reservoir that are neither under-protective nor overly stringent. The resulting proposed site-specific standards for Cherry Creek Reservoir are:

- Proposed Site-Specific Standard for TP: **66 ug/L TP**, and
- Proposed Site-Specific Standard for TN: **860[18] ug/L TN.**

The site-specific TP and TN standards would be assessed with annual July through September averages and a one-in-five-year allowable exceedance frequency. These standards are considered to be defensible and appropriately protective for Cherry Creek Reservoir for the following reasons:

- The site-specific standards presented here were developed using the Cherry Creek Reservoir's extensive dataset (31-year record).
- The site-specific standards presented here were developed using the same 4-step method developed and applied by WQCD to define the TP and TN TVSs for lakes and reservoirs.
- The proposed values better reflect the apparent underlying Chl*a*:TP and Chl*a*:TN relationships present in the Cherry Creek Reservoir datasets, as compared to the default standards for Cherry Creek Reservoir.
- Historical TP data from 1982 (Clean Lakes Study) further support the proposal.
- Reservoir water-quality modeling of Chl*a* response to TP further supports the proposal.
- The proposed site-specific standard values fall into the range between the EPA-approved warm lakes TVSs (adopted in April of 2023) and the EPA-approved 2012 Interim Criteria, suggesting the magnitude of the values is reasonable.
- The proposed site-specific TP and TN standards comprise challenging targets that will not in any way deter CCBWQA from continuing its long-term efforts to drastically reduce nutrient concentrations in the reservoir.

A longevity plan is recommended for inclusion with the site-specific proposal. The longevity plan would include data collection, analysis, and reporting commitments to support ongoing review of the appropriateness and protectiveness of the site-specific TP and TN standards.

[18] Note that these values follow the WQCD precedent of rounding the standard values to two significant figures.

In summary, this analysis provides a strong technical basis for proposal of site-specific TP and TN standards of 66 ug/L TP and 860 ug/L TN for Cherry Creek Reservoir to the WQCC. These values are considered to be protective of the AL/Rec beneficial uses and more appropriate for Cherry Creek Reservoir than the default TP and TN standards.

8 References

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LRE WATER
CONNECTING WATER TO LIFE

MEMORANDUM

Date:	October 18, 2023
To:	Cherry Creek Basin Water Quality Authority Technical Advisory Committee Jane Clary, CCBWQA Technical Manager
From:	Erin Stewart, LRE Water
Subject:	Sampling and Analysis Plan/ Quality Assurance Project Plan Considerations for 2024

Background

The CCBWQA Sampling and Analysis Plan/ Quality Assurance Plan (SAP/QAPP) is updated on an as-needed basis to account for changes to the monitoring program based on regulatory support, modeling inputs, or other technical information needed. Although there were no major suggested revisions and updates to the SAP/QAPP for 2024. However, recent changes have required that the CCBWQA evaluate alternative laboratories for phytoplankton and zooplankton identification, enumeration, and quantification of biovolume/biomass.

Information

The lab that the CCBWQA has been using since 2016, Phycotech, had a unique skill set which included the ability to identify very small plankton species that are less than 1um (picoplankton) as well as classification down to species whenever possible. Although this information is very interesting and can be informative to the dynamics in Cherry Creek Reservoir, picoplankton are often present at very high numbers but their relative biovolume averages less than 3% of the total. Also, smaller picoplankton species and those that have been identified in Cherry Creek Reservoir are not commonly responsible for cyanotoxin production.

Most of the monitoring analysis and modeling efforts focus on biovolume as the metric used to provide a direct measure of the volume or size of phytoplankton cells. Biovolume is valuable because it quantifies the biomass of phytoplankton in a water body. Notable blooms have a higher density of cells or larger cells/ colonies which also often correlates to chlorophyll-a concentrations as well.

BSA Environmental and Enviroscience are two labs that offer a similar scope of services with comparable costs to the previous lab but offer limited or no picoplankton identification.

In addition, during recent communication with Phycotech, potential organizational changes may provide the opportunity to continue analysis with them. No additional information could be provided until the changes are final, so we do not know if that is a feasible option or not.

Recommendation

LRE Water's recommendation is to send October's samples (that have been collected and preserved), as well as possibly one or two additional months (if needed) to both labs (BSA Environmental and Enviroscience) to evaluate and compare the results. Continued communication with Phycotech will also determine if they may still be able to continue analysis as well. At that time an evaluation of the changes of analytical costs to the monitoring program will also be completed.

After the evaluation and comparison have been completed, a recommendation for a lab to complete the analysis moving forward will be made to the TAC, and upon approval, those changes will be included in a future update of the SAP.

CHERRY CREEK BASIN WATER QUALITY AUTHORITY
2023 Capital Project Status Report
October 13, 2023

RESERVOIR PROJECTS

1. East Shade Shelters Phase III and Tower Loop Phase II Shoreline Stabilization (CCB-17.5 and CCB-17.7)
    a. Description: These projects were identified in 2014 through the annual inspection. The Tower Loop Phase II connects to the Phase I project and extends shoreline protection 570 feet to the southeast towards Dixon Grove. The East Shade Shelters Phase III starts on the north end of the Shade Structure and goes 400-feet to the south.
    b. Status: Consultant selection is scheduled for the 1st quarter. A consultant selection committee will be set in February (1/29/21). At the February TAC meeting Jason Trujillo, Jon Erickson, Lanae Raymond, Bill Ruzzo were interested in serving on the consultant selection committee (2/11/21). This selection committee was discussed at the 3/18/21 Board Meeting, and no further members were added. The Request for Proposals (RFP) has been posted on BidNet and Proposals are due 04/21/21 (3/25/21). The pre-proposal meeting was held on 4/7/21. 5 proposals were received on 4/28/21; the selection committee is reviewing them. Interviews were held and a selection is being brought to the May Board meeting (5/14/21). Board authorized negotiations with RESPEC (5/27/21). Agreement has been executed with RESPEC (10/15/21). Field Survey of project areas and topographic mapping is underway (12/30/21). A design kickoff meeting was held on 4/22/22. A design sprint workshop was held on 7/12/22 which included a site visit and evaluation of alternatives. RESPEC is developing a recommended alternative (9/8/22). RESPEC provided updated project costs for budgeting (10/13/22). The 30% submittal was received on 11/16/22 and is under review. CCBWQA provided comments on 30% review on 1/17/23; a value engineering effort is recommended as the project costs exceed the budget. The value engineering meeting was held on 2/24/23. RESPEC's request for additional services was approved by TAC and Board in May (5/25/23). The reservoir water level has come down since the May and June storms and additional erosion was observed on 7/14/23; a site visit was made with RESPEC on 8/1/23 and the erosion areas at East Shade Shelters were measured. *It has been estimated that roughly 14 cubic yards of soil was eroded from the 2023 storms (9/15/23).* A progress meeting was held on 9/15/23, RESPEC will refine the breakout of components between recreational (CPW responsibility), water quality (CCBWQA responsibility), and shared (both CPW and CCBWQA responsibilities) costs and work on 408 review submittal to US Army Corps of Engineers.

STREAM RECLAMATION PROJECTS

1. Cherry Creek Stream Reclamation at Arapahoe Road aka Reaches 3 and 4 (CCB-5.14C)
    a. Description: This project continues the work on Cherry Creek by CCBWQA, MHFD, and local partners. It ties into the previous stream reclamation projects of Cherry Creek Eco Park to Soccer Fields (CCB-5.14A) and Cherry Creek at Valley Country Club (CCB-5.14B). The 5,167 Linear Feet of stream reclamation reduces bed and bank erosion immobilizing approximately 88 pounds of phosphorus annually. The project is anticipated to be funded over several years and likely be broken into phases.
    b. Status: In 2021, and IGA was executed between CCBWQA, MHFD, City of Aurora, and SEMSWA to begin this work. IGA Amendment that brings in 2022 funding is under review (5/13/22). Board authorized IGA Amendment for 2022 funding on 7/21/22 (8/12/22). IGA Amendment has been revised to show Aurora's lower participation; CCBWQA's participation was lowered accordingly to meet 25% partner project level; revised IGA Amendment received TAC recommendation and is being taken to Board for their consideration in October (10/13/22). Board authorized the IGA Amendment for 2022 funding at their 10/22/22 meeting. It appears that CCBWQA's 2023 participation will be reduced as a result of less

partner funding available for this project (2/24/23). The IGA Amendment that brings in 2023 funding was recommended by the TAC and authorized by the Board at their June meetings (6/29/23). *MHFD is starting consultant selection process (10/13/23).*

2. Cherry Creek Stream Reclamation – Upstream of Scott Road (CCB-5.17)
    a. Description: Design and construction of stream reclamation is in partnership with Douglas County and MHFD. It improves 4,100 feet of Cherry Creek and is located upstream of Scott Road.
    b. Status: IGA was approved by the Board at their April 2020 meeting. Muller had been selected as consultant, and design scope of work is being prepared. Kickoff meeting was held on 12/11/20; a follow-up field visit will be scheduled for early 2021. Site visit was held on 1/29/21. Conceptual design is complete, negotiations are underway to contract for 60% design (4/8/21). Muller is working on alternatives (4/30/21). Muller is working on preliminary design and an IGA Amendment to bring in additional 2021 funding from Douglas County is being brought to the Board in October (10/15/21); IGA Amendment has been executed (11/11/21). Muller is preparing 60% Design Submittal (1/28/22). Muller submitted 60% Design on 2/2/22; comments have been provided on 60% Design Submittal (3/10/22). IGA Amendment bringing in 2022 funding is scheduled for TAC and Board consideration in June (5/27/22). IGA Amendment was authorized at the June 16th Board Meeting (6/30/22). Muller is working on Final Design and held a progress meeting on 4/14/23, a site visit is being scheduled to support the 90% design submittal. The 90% site visit was held on 5/22/23. Muller submitted their 90% design submission on 9/14/23; the engineer's estimate confirms that additional funding is needed for construction. *IGA Amendment for additional funding is scheduled for TAC and Board consideration at October meetings and 90% review meeting was held on 10/13/23.*

3. Cherry Creek Stream Reclamation at Dransfeldt (CCB-5.17.1B)
    a. Description: Design and construction of stream reclamation is in partnership with Town of Parker and MHFD. It improves 2,400 feet of Cherry Creek near the future location of Dransfeldt bridge which is just downstream of the Cherry Creek at KOA project.
    b. Status: Initial scoping has begun, and a partners meeting was held on 1/30/21. IGA is scheduled for CCBWQA's May TAC and Board meetings (4/30/21). IGA was approved by all parties and has been executed (6/25/21). Muller Engineering has submitted their Draft Scope of Work for Design Services, and the project sponsors have reviewed it (7/8/21). Design kickoff meeting was held on 10/14/21. Alternatives are being evaluated (12/9/21). Pre-submittal meeting for the 404 permit is being scheduled (12/30/21). CLOMR is being prepared for project (3/10/22) and was submitted to FEMA on 3/31/22. CEI was selected for as project partner to provide contractor input during the design (5/27/22). CLOMR is under review by FEMA (8/12/22). Muller has received comments on CLOMR and is preparing responses; 90% Submittal is scheduled for early February (1/27/23). Comments on 90% Submittal were provided on 2/22/23; project is experiencing substantive cost increases due to current market conditions (2/24/23). TAC at their 3/2/23 meeting recommended that the Board authorized the IGA Amendment to bring in 2023 funding along with an increase in CCBWQA's 2023 funding from $170,000 to $570,000. The Board authorized the IGA Amendment with the increased 2023 funding of $570,000 at their 3/16/23 meeting. The Conditional Letter of Map Revision (CLOMR) was issued by the Federal Emergency Management Agency (FEMA) on April 28, 2023 (5/12/23). The sanitary sewer relocation will be contracted to start with, in order to avoid a pipe material cost increase, and to get it out of the way for the forthcoming stream reclamation (7/13/23). The sanitary sewer relocation has been contracted for with Concrete Express Inc. or CEI (8/11/23).

4. McMurdo Gulch Priority 3 Stream Reclamation (CCB-7.2)
    a. Description: The design and construction of stream reclamation is in partnership with Castle Rock. Castle Rock is the lead agency. This phase continues the work from the previous phase. Muller Engineering is the design consultant.
    b. Status: Board authorized IGA for Priority 3 at their May 19,2022 meeting. Muller submitted

their 30% deliverable on 10/31/22, review comments were returned on 11/8/22. Easements needed for projects have been identified (1/23/22). The 60% Submittal was received on 1/30/23 and comments have been provided on 2/7/23. Muller is working on updating their construction cost estimate (2/8/23). On 2/23/23, Castle Rock requested that CCBWQA's 2023 funding be deferred to 2024 to match their schedule.

5. Lone Tree Creek in Cherry Creek State Park (CCB-21.1)
    a. Description: This project includes a trail connection to Cherry Creek State Park and includes 570 linear feet of stream reclamation on Lone Tree Creek from the State Park Boundary to the Windmill Creek Loop Trail. The City of Centennial is the project lead. CCBWQA participation is for stream reclamation only.
    b. Status: 95% submittal is under review (5/13/22); review comments have been returned (5/27/22). Project funding was brought to TAC at their 7/7/22 meeting, during drafting of IGA it was discovered that future maintenance of stream reclamation should be considered, project will be brought back to TAC at an upcoming meeting for maintenance discussion and recommendation (8/12/22). A stakeholder meeting was held on 9/29/22 to discuss maintenance. A stakeholder meeting was held on 11/2/22 to discuss findings from CCBWQA's site visit and findings included in Wright Water Engineers report. The Board supports CCBWQA's partnering with Centennial at their 11/17/22 meeting. A Memo of Understanding is under review by Colorado Parks and Wildlife (CPW) affirming maintenance responsibilities for the stream reclamation fit under the current agreement between CCBWQA and CPW (3/30/23). CCBWQA sent the Draft IGA to Centennial for review on 5/23/23.

6. Happy Canyon Creek – County Line to Confluence with Cherry Creek (aka Jordan Road, CCB-22.1)
    a. Description: The design and construction are in partnership with Southeast Metro Stormwater Authority and MHFD and includes 2,500 feet of stream reclamation. The Authority's water quality component share for design and construction is estimated to be $325,000. The total project cost is estimated at $1,300,000.
    b. Status: IGA is scheduled for June TAC and Board meetings (5/27/21). IGA has been approved and executed by all parties (7/29/21). Jacobs has been selected as design consultant and project scoping is underway; limits have been extended upstream to the County Line and sediment capture area and transport will be included with the project (10/15/21). Jacobs has submitted their scope of work and fee for design which is under review by project sponsors (11/11/21). Project sponsors have completed a review of Jacobs' fee and scope of work and the agreement is being routed for signatures (1/28/22). IGA Amendment to bring in 2022 funding is in process (3/10/22). A project kickoff meeting was held on 3/28/2022. A site visit was performed on 4/12/22 to document existing conditions and identify sediment source/transport/deposition areas. Project Team is preparing a sampling plan for bank and bed materials to determine phosphorous content (5/13/22). The project team met on 5/24/22 to discuss project goals and Jacobs is progressing through the study. Jacobs and ERC are working on sediment transport analysis and model (6/30/22). The results from the sediment transport model were presented at the 8/23/22 progress meeting and an upstream sediment capture area just south of the JWPP was included in the alternatives analysis (8/26/22). The alternative analysis report is expected to be completed before the end of 2022 (10/13/22). Lab results from stream soil samples were sent to Jacobs so that they include phosphorus reduction in the alternatives analysis report; a groundwater investigation is needed to inform sediment capture facility and stream reclamation alternatives, scoping and negotiations are in progress (11/11/22). Groundwater scope of work has been reviewed and approved by project sponsors (1/13/23). The IGA Amendment bringing in the 2023 funding was recommended by TAC and authorized by the Board in April (5/12/23).

7. Happy Canyon Creek - Upstream of I-25 (CCB-22.2)
    a. Description: The design and construction are in partnership with Douglas County, City of Lone Tree, and MHFD and includes 2,500 feet of stream reclamation. The Authority's water

quality component share for design and construction is estimated to be $500,000. The total project cost is estimated at $2,000,000.

b. Status: Douglas County, City of Lone Tree, and MHFD have initially funded and selected Muller Engineering as the design engineer. Design has started and a progress meeting was held on 1/27/21. Design is progressing (2/11/21). Muller has submitted 60% Design Deliverables (5/27/21). IGA for 2021 Funding is being brought to Board in September (9/9/21). 2021 IGA Amendment has been executed (11/11/21). Coordination with CDOT and easement acquisitions are on-going (1/13/22). Board authorized 2022 funding and IGA Amendment at their June 16th meeting (6/30/22). The project received environmental clearance from CDOT (8/12/22). The 90% design submittal is scheduled for delivery by end of September (8/26/22). The 90% design submittal is being reviewed (10/13/22). Comments were provided on 90% submittal (11/11/22). Muller completed the 100% design submittal on 11/22/22. CDOT permit was issued, and pre-construction meeting was held on 1/10/23; construction start is scheduled for 1/30/23 pending execution of easement documents from Surrey Ridge which has agreed to terms and easement language. Notice to Proceed on construction is pending execution of easement documents (1/27/23). Easements have been signed by property owners and Notice to Proceed has been issued to Naranjo Civil Constructors (2/8/23). Construction is underway with initial construction BMPs/stormwater controls in place; water diversion and control is being set up for the downstream section of the project (3/10/23). Water control is in place and construction of stream reclamation is underway for downstream sections of the project (3/30/23). Riffle and Boulder Cascade drop structures on downstream third of project are nearing completion (4/13/23). Construction is underway in the middle third of the project; efforts consist of stream grading and installation of Riffle and Boulder Cascade drop structures (5/12/23). The storm damage from May 11 to 13, 2023 event is being identified and repaired (5/25/23). Construction on the middle third is substantially complete and work has begun on the upstream third (7/27/23). The construction is nearly complete with the punch list walk on 9/13/23; contractor is working on completing plantings and resolving punch list items.

8. Dove Creek - Otero to Chambers Rd. (CCB-23.1)
    a. Description: The design and construction are in partnership with Southeast Metro Stormwater Authority (SEMSWA) and with Mile High Flood District (MHFD) being a key stakeholder; it includes 1,300 feet of stream reclamation. The Authority's water quality component share for design and construction is estimated to be $175,000. The total project cost is estimated at $700,000.
    b. Status: SEMSWA is drafting the Intergovernmental Agreement to bring in the 2021 funding for the project (3/12/21). RESPEC is the design consultant; two conceptual design alternatives have been prepared and reviewed during meeting on 3/15/21. IGA is scheduled for CCBWQA's May TAC and Board meetings (4/30/21). IGA has been approved and executed by all parties (7/29/21). 30% Design Review Meeting was held on 8/23/21. A Progress meeting is scheduled for 2/26/22 with 60% Plan submittal expected to follow (1/28/22). The 60% Design was submitted on 2/16/2022, comments were provided, and a design review meeting was held on 2/23/2022. IGA Amendment to bring in 2022 funding is in process (3/10/22). Construction costs were prepared by CEI based on 60% submittal (5/13/22). A design progress meeting was held 6/14/22 and 90% design submittal is being prepared (6/30/22). 90% design submittal is expected by the end of July (7/15/22). The 90% design submittal was reviewed, and comments were submitted on 8/22/22. *Construction is anticipated in 2023 (10/13/22).* A progress meeting was held on 11/8/22, project will likely be done in 2 phases, IGA Amendment will be needed early in 2023 so that construction can start ahead of storm season. Dove Creek IGA for construction of Phase 1 is scheduled for TAC and Board in January 2023, construction is expected to start shortly afterwards (12/30/22). Construction is scheduled to start mid-February; construction agreement and engineering construction services amendment are currently being reviewed (1/27/23). Construction and engineering construction services have been finalized and a preconstruction meeting was held on 2/2/23. Notice to Proceed has been issued to Concrete Express; construction is underway with initial construction BMPs/stormwater controls in place (3/10/23). Water control

is in place and construction of stream reclamation is on-going (3/30/23). Step pool drop structures have been constructed and work on soil wraps is underway (4/13/23). Low-flow or bank full channel work (soil wraps and erosion control blanket) and step-pool structures are complete, water diversion has been removed, and is active to storm flows; work continues in upland areas and higher elevations of stream reclamation (5/12/23). Storm damage from May 11 to 13, 2023 event is being repaired (5/25/23). Construction punch list is being completed (6/29/23). Construction is complete (7/27/23).

9. Piney Creek from Fraser Street to Confluence with Cherry Creek aka Reaches 1 and 2 (CCB-21.1)
    a. Description: This project includes 2900 liner feet of stream reclamation on Piney Creek. The project partners are SEMSWA and CCBWQA.
    b. Status: Project coordination meeting was held with SEMSWA on 6/29/22. IGA drafted and is being reviewed by SEMSWA (8/12/22). IGA was approved by CCBWQA at the 9/15/22 Board meeting. IGA Amendment to bring in 2023 funding was recommended by the TAC and authorized by the Board in May (5/25/23). CCBWQA sent the Draft IGA Amendment to SEMSWA for review on 6/29/23. SEMSWA has no comments on the IGA Amendment and plans to take it to their Board in October (8/11/23). The project site was walked with SEMSWA and Olsson and Associates on 8/30/23, Olsson is preparing their scope of work and fee for design.

10. Mountain and Lake Loop Shoreline Stabilization Phase II (OM 4.6)
    a. Description: This project was identified in through the 2020 annual inspection and design and permitting started in 2021. It adds about 40 feet of shoreline protection where it has eroded leaving a 1-2 foot tall vertical bank.
    b. Status: Construction Plans have been prepared and the GESC was submitted to Arapahoe County for review (1/13/22). Plans are being reviewed by US Army Corps of Engineers for 408 clearance (5/13/22). Comments were received from the US Army Corps of Engineers on 8/29/23.

11. Cherry Creek from Reservoir to Lake View Drive (OM 4.6)
    a. Description: This project is in follow up to CCBWQA's study of Cherry and Piney Creeks in Cherry Creek State Park (CCSP). Muller completed two reports on Cherry Creek from Reservoir to State Park Boundary, Stream and Water Quality Assessment and Baseline Channel Monitoring Report, in 2022. These reports highlight the need for this project.
    b. Status: A workshop is scheduled for the 3/16/23, to seek CCBWQA Board and TAC input on this project and Cherry and Piney Creeks in CCSP (3/10/23). *The follow up from workshop is underway – project overview and funding flyer has been created,* Muller is scoping the next step of design for Reach 1 and providing a fee, and multi-pronged approach is in development for workshop priority reaches that prioritizes Reach 1 and reduces risk from upstream reaches; these items will be brought to TAC and Board for discussion, direction, and/or action at upcoming meetings (3/30/23). A site visit for partner outreach and funding was held on 5/25/23 at 1-4 pm (6/8/23). A coordination meeting was held with Aurora on 6/23/23 and they showed interest in partnering on the project to protect their water lines. The Mile High Flood District has provided their budget/CIP schedule and Arapahoe County Open Space has been contacted to investigate potential partnering opportunities (7/13/23). The TAC created a subcommittee for this project on 8/3/23; which will attend progress meetings, provide timely feedback to Muller, and to coordinate with TAC as-needed. The alternatives analysis kickoff meeting was held on 8/29/23. *Site visit was held on 9/22/23 to look at multiple flow paths and potential risks for consideration in alternatives analysis.*

RG AND ASSOCIATES, LLC
4885 Ward Road, Suite 100 • Wheat Ridge, CO 80033
Del Norte • Gypsum • Wheat Ridge
303-293-8107 • www.rgengineers.com

30 Celebrating 30 Years of Excellence

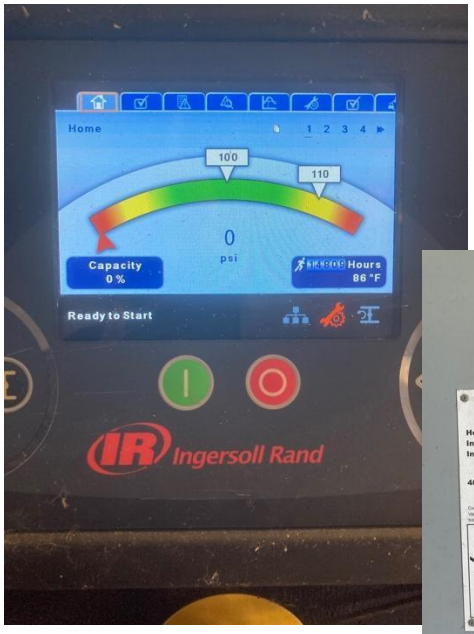
Task Memorandum

Task: RDS Operations Report October
Date: 10/13/23
To: Board and TAC
By: Ricardo Gonçalves, PE

Yearly Inspection and Maintenance- The yearly inspection and maintenance on the aeration system was done and completed on October 4, 2023, by Foster, Dirt and Construction. Foster Dirt has taken over the duties that Blair Wacha with B&RW had previously done for the last number of years. Blair chose to retire this year, and actually trained Justin Foster on the aeration system maintenance activities last year while he was a member of the work crew. Blair was on the work crew this year to aid in the transition. No major issues were encountered. A few of the cam lock levers and pins were replaced due to corrosion. Blair noted that over the years, he has replaced more pins and cams in the area of the reservoir where Cottonwood Creek drains into the reservoir than any other place in the reservoir. Given stainless steel can corrode (rust) in the presence of high acidity and anoxic water condition conditions, Blair and I wonder if those conditions could be caused by wastewater effluent presence in Cottonwood Creek drainage from the upstream wastewater treatment plants.

Compressor Shutdown-On October 5th, 2023 at 8:15 am, the compressor was shut down in accordance with Authority Policies and Procedures. The newly installed drip legs were released of accumulated water to prevent water freezing in the pressure reducers, and water was blown off from the compressor and the regulator tank. This year a new procedure was implemented whereby the air discharge valves downstream of the pressure reducers were shut down very slowly while the compressor was still running to shut off the air to the aeration system, gradually. This was to prevent a sudden back pressure on the aeration system heads that has caused some of the O-rings to blow out in the past.

After the valves were shut, the compressor was then shut down.



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Aditi Bhaskar, PhD

University of Colorado Boulder

4001 Discovery Drive #607 UCB

Boulder, Colorado 80303

Subject: 2023 Colorado Water Conservation Board Water Plan Grant Application

Dear Dr. Bhaskar:

The <Organization> is pleased to support the project proposed by University of Colorado Boulder for a Colorado Water Conservation Board Water Plan Grant in 2023. Data and analysis on the effects of landscape transformations on urban heat and water quality are important to develop scientifically sound and pragmatic guidance on landscape transformation programs and their effects across Colorado. As a participating partner, we anticipate providing in-kind staff time as outlined below.

Our involvement will consist principally of:

- Participating in and providing feedback to two half-day stakeholder engagement sessions, near the beginning and end of the project.

The approximate monetary value of this in-kind contribution is $1,500. <optional sentence>

We look forward to participating in this important project. If you have any questions regarding <*organization*>'s participation, please contact us.

Sincerely,

<*name*>
<*title*>
<*affiliation*>