R2R ENGINEERS

RIFFLES TO RIPPLES

MEMORANDUM

DATE:	November 1, 2022 (Revised to include TAC input on November 4, 2022)
TO:	Jacob James, P.E.; Cherry Creek Basin Water Quality Authority (CCBWQA) – Technical Advisory Committee (TAC) Chairman Jane Clary, Wright Water Engineers, CCBWQA Technical Manager
CC:	Jason Trujillo, Cherry Creek State Park (CCSP) Park Manager
FROM:	Richard G. Borchardt PE, CFM
SUBJECT:	2022 Annual Field Observation of Pollution Reduction Facilities (PRFs) at CCSP

Introduction

Annually, the CCBWQA performs Field Observation of the PRFs constructed by the CCBWQA at CCSP. The annual Field Observation is a requirement of the Operations and Maintenance Agreement between the CCBWQA and CCSP dated January 14, 2006 (Agreement). The West Boat Ramp PRF was excluded from the Agreement by the First Amendment dated April 18, 2013 (Amendment).

The purpose of the 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 budgeting of maintenance activities. Restorative and rehabilitative maintenance requirements are the responsibility of the CCBWQA. Routine maintenance is the responsibility of CCSP. Other items, such as educational/interpretive sign replacement and weed control, as outlined in the Agreement, are shared 50% by CCSP and 50% by CCBWQA. The West Boat Ramp PRF's routine, restorative, and rehabilitative maintenance responsibility is 100% 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 PRF's 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. The Field Observation frequency by PRF is shown in **Table 1**. The Cherry Creek at 12-mile Park (Phase III) PRF was substantially complete in 2022 and therefore was added to **Table 1**.

PRFs Field Observation Annually and After Significant Storm Events (Part of Stream and Drainage System)	**PRFs Field Observation As-Needed (Part of Shoreline Stabilization)**
Shop Creek	Tower Loop
Cherry Creek at 12-Mile Park (Phases I and II)	East Shade Shelters
Cherry Creek at 12-Mile Park (Phases III)	East Boat Ramp
Cottonwood Creek Stream Reclamation	Dixon Grove
Cottonwood Wetlands	Mountain and Lake Loop
Quincy Drainage	
West Boat Ramp	

Table 1 – Frequency of Field Observation by PRF

The CCSP brochure map (**Figure 1**) is included for reference and shows general vicinity of PRFs.

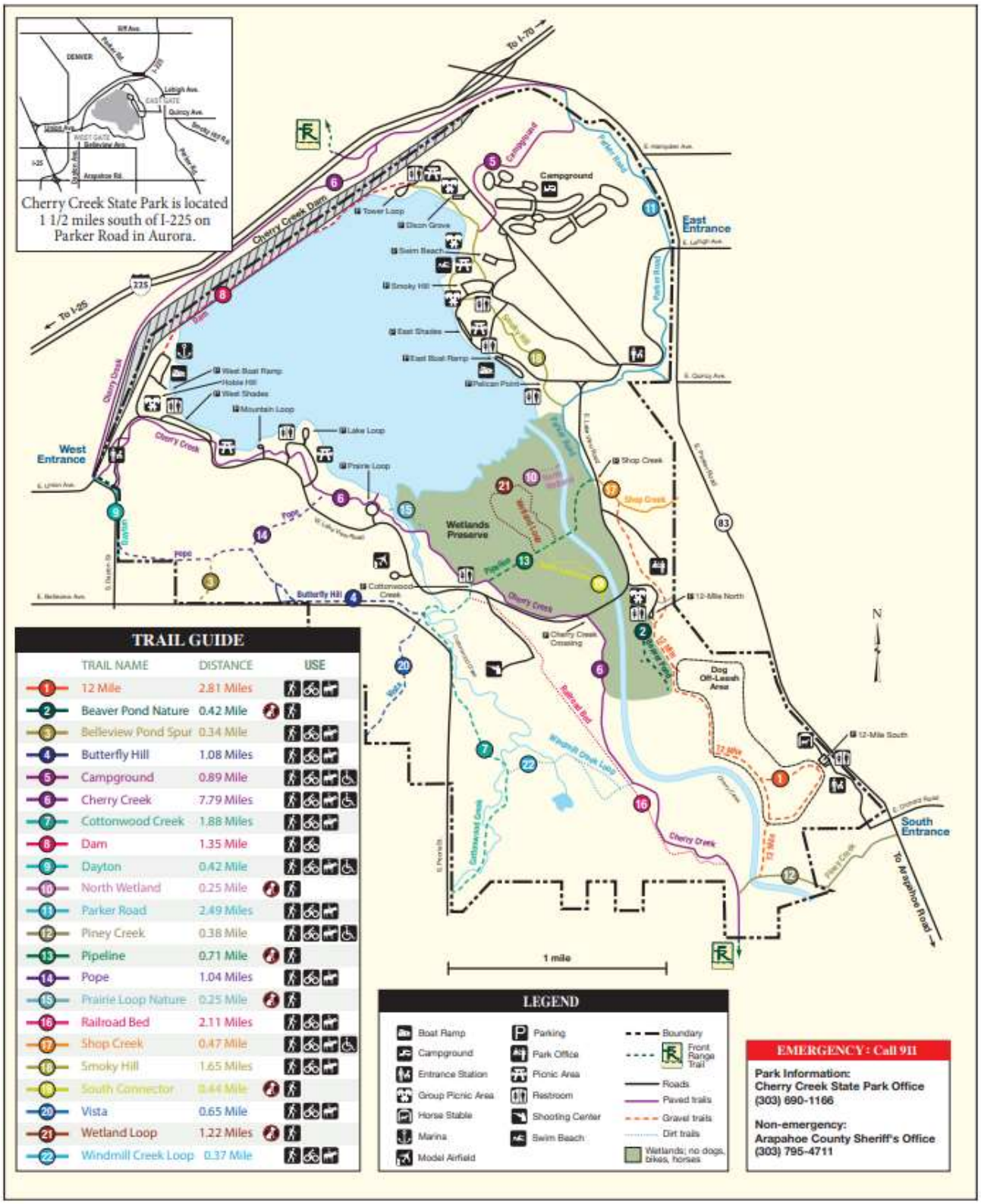
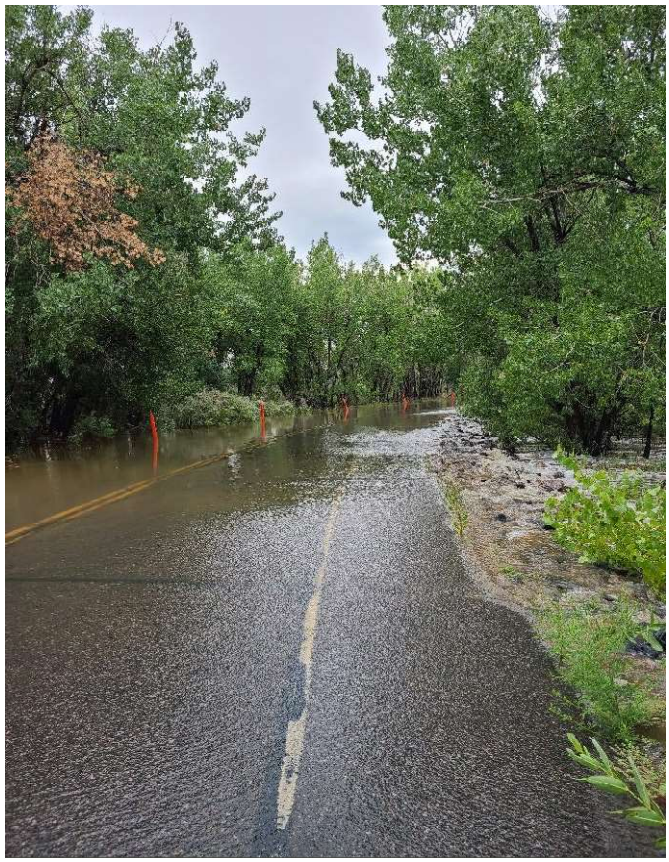


Figure 1 - CCSP brochure map

In 2022, all PRFs were observed. The Field Observation was performed in July and August. A coordination meeting with Colorado Parks and Wildlife (Claudia Mead and Jonathan Kingery) occurred on August 2, 2022.

On August 15-16, 2022, there was a significant storm event (see storm photos on right and following page courtesy of Erin Stewart with LRE Water). This storm event necessitated post-storm visits of the Cherry Creek 12-mile Park (Phases I, II, and III), the Cottonwood Creek Stream Reclamation, and Cottonwood Wetlands, as those were the primary PRFs that saw increased runoff from this storm event.



Storm Photo - Cherry Creek at Lake View Drive

Storm Photo - Cherry Creek at CC10

Storm Photo - Cottonwood Creek at CT-P1

General Assessments

The 2022 annual Field Observation general assessments and photos are provided on the following pages. The post-storm findings and photos have been included for the Cherry Creek 12-mile Park (Phases I, II, and III), the Cottonwood Creek Stream Reclamation, and Cottonwood Wetlands PRFs.

West Boat Ramp (Reservoir Water Surface Elevation = 5547.7 on 7/28/22): Construction of this PRF was completed in 2014. All maintenance for this PRF is the responsibility of CCSP. Routine maintenance is needed to clear woody vegetation (**Photo 1**). At the 8/2/22 meeting with CCSP, CCSP staff marked limits of the spillway with paint and will coordinate with Marina and associated groups to relocate items currently stored there to another location (**Photo 2**). Maintenance that was identified for CCSP is cutting and clearing of vegetation around outlet and relocating stored items outside of spillway.

Photo 1 - 7/28/22

Photo 2 - 7/28/22

Cottonwood Wetlands: Some woody vegetation was observed around outlet (**Photo 3**). This vegetation was subsequently cut and removed with the wetland harvesting effort. Some aquatic vegetation and algae were observed in water (**Photo 4**) and maintenance bench above outlet grate had cattail debris covering it (**Photo 5**); the outlet grate and bench were subsequently cleaned with the wetland harvesting. Several standing dead trees were noted around the PRF (**Photo 6**). The educational signs appear to be in functional shape (**Photos 7 and 8**). The post-storm visit was done on August 26, 2022; no damage was observed from the post-storm visit and a higher water surface was observed (**Photos 9 and 10**). Stressed vegetation and compaction of soils was observed on the access along the embankment (**Photos 11-14**); decompaction and reseeding will likely benefit the recovery of the native grasses and protection of embankment during overtopping events. The maintenance identified for CCBWQA's consideration is cleaning of the outlet grate and decompaction and revegetation of the access along the embankment.

Photo 3 – 8/1/22

Photo 4 – 8/1/22

Photo 5 – 8/1/22

Photo 6 – 8/1/22

Photo 7 – 8/1/22

Photo 8 – 8/1/22

Photo 9 (Post-storm visit on 8/26/22)

Photo 10 (Post-storm visit on 8/26/22)

Photo 11 – 8/1/22 (before heavy access use in 2022)

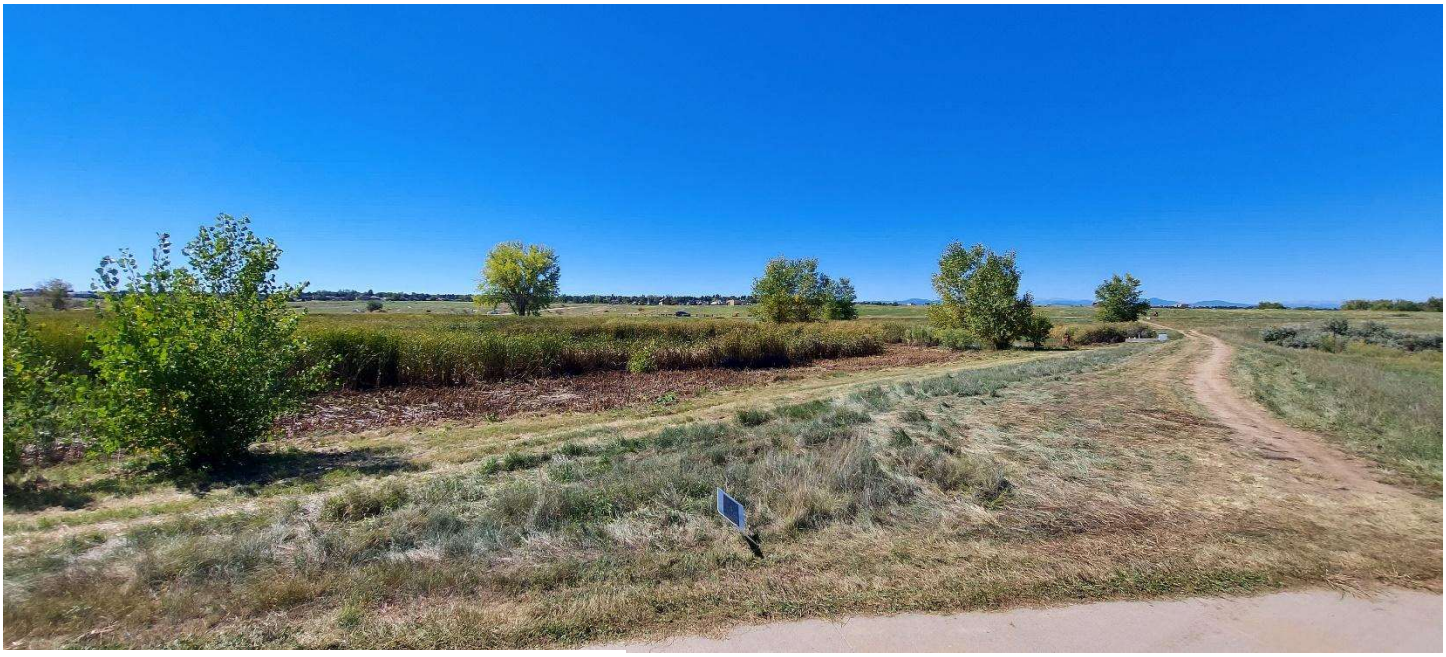


Photo 12 – 10/10/22 (after heavy use in 2022)

Photo 13 – 10/10/22 (Compaction test along access)

Photo 14 – 10/10/22 (Compaction test outside of access)

Cottonwood Creek Stream Reclamation: Riparian and wetland vegetation along stream banks is thriving (**Photo 15**). Riffle drops are functioning with some Russian olives, a Colorado noxious weed list B species, present (**Photo 16**). Common reed, a Colorado noxious weed watch-list species, was observed (**Photo 17**). Several downed trees were noted from beaver activity (**Photo 18**). The post-storm visit was done on August 26, 2022; no damage was observed from the post-storm visit and evidence of high-water debris was observed (**Photos 19 and 20**). No maintenance was specifically identified; however, continued monitoring and coordination with CCSP staff on noxious weeds is suggested.

Photo 15 – 8/1/22

Photo 16 – 8/1/22

Photo 17 – 8/1/22

Photo 18 – 8/1/22

Photo 19 (Post-storm visit on 8/26/22)

Photo 20 (Post-storm visit on 8/26/22)

Cherry Creek 12-mile Park Phase I: Phase I was completed in 2012. Bed erosion was noted in 2021 Annual Field Observation. A grade control structure was installed downstream with the Cherry Creek 12-mile Park Phase III project which appears to be helping (**Photos 21 and 22**). Additional bank erosion was observed (**Photo 23**) and the August storm event appears to have accelerated it (**Photo 24**). Bank and bed erosion appear to be active further upstream and away from the grade control structure installed with the Cherry Creek 12-mile Park Phase III project (**Photo 25**). No maintenance was identified; however, a capital project for stream reclamation may be needed. Continued planning is suggested to identify work needed, overall priorities, and costs for Cherry Creek between Lake View Drive and the CCSP Boundary.

Photo 21 – 7/28/22

Photo 22 – 7/28/22

Photo 23 (Bank Erosion on 7/28/22)

Photo 24 (Bank Erosion at post-storm visit on 8/23/22)

Photo 25 – 7/28/22

Cherry Creek 12-mile Park Phase II: Phase II was completed in 2014 and is experiencing high pedestrian and dog activity. Bed and bank erosion were observed near the boundary between Phase I and Phase II (**Photo 27**). Vegetation continues to be denuded by heavy park use (**Photo 28**). Additional bank erosion was observed (**Photo 29**) and the August storm event appears to have accelerated it (**Photo 30**). Bank erosion was observed on secondary channel, east of main stem (**Photo 31**). No maintenance was identified; however, a capital project for stream reclamation may be needed. Continued planning is suggested to identify work needed, overall priorities, and costs for Cherry Creek between Lake View Drive and the CCSP Boundary.

Photo 27 – 7/28/22

Photo 28 – 7/28/22

Photo 29 (Bank and Bed Erosion on 7/28/22)

Photo 30 (Bed and Bank Erosion at post-storm visit on 8/23/22)

Photo 31 – 7/28/22

Cherry Creek 12-mile Park Phase III: Phase III was substantially complete (**Photos 32 and 33**) ahead of the August storm event. There was some damage that resulted from the August storm event (**Photos 34 to 35**) and the construction Best Management Practices/Stormwater Control Measures greatly minimized the storm impact. Repairs are anticipated to be made in 2022 as the project is not fully closed out at the time of this report. Weed control is needed to help with vegetation re-establishment in project area; it will likely start with mechanical control and then move to herbicide once grasses start to mature. A capital project for stream reclamation may be needed, continued planning is suggested to identify work needed, overall priorities, and costs for Cherry Creek between Lake View Drive and the CCSP Boundary.

Photo 32 – 7/28/22

Photo 33 – 7/28/22

Photo 34 – 8/23/22

Photo 35 – 8/23/22

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. Drop 1 has spalling concrete along the crest (**Photos 36**). Drop 2 has spalling concrete along the crest, seepage between layers of roller-compacted concrete, and vegetation growing on downstream face (**Photo 37**). Drop 3 has spalling concrete along the crest, a tree growing next to drop with tree root intrusion in drop (**Photos 38 to 39**), and vegetation growing on downstream face of drop (**Photo 40**). Drop 4 has vegetation growing on downstream face and less severe spalling of concrete (**Photos 41 to 42**). Drop 5 has seepage between layers of roller-compacted concrete and less severe spalling of concrete (**Photo 43**). CCSP performs regular maintenance by cleaning the trash racks and mowing and removing vegetation around inlets (**Photo 44**). No deficiencies were observed with the educational signage. The maintenance identified for CCBWQA consideration is concrete repairs at crests of drops 1, 2, 3; removal of tree at drop 3; and vegetation control on face of drops 2, 3, and 4. Since seepage was noted on drops 2 and 5, it is recommended that seepage be monitored on all drops.

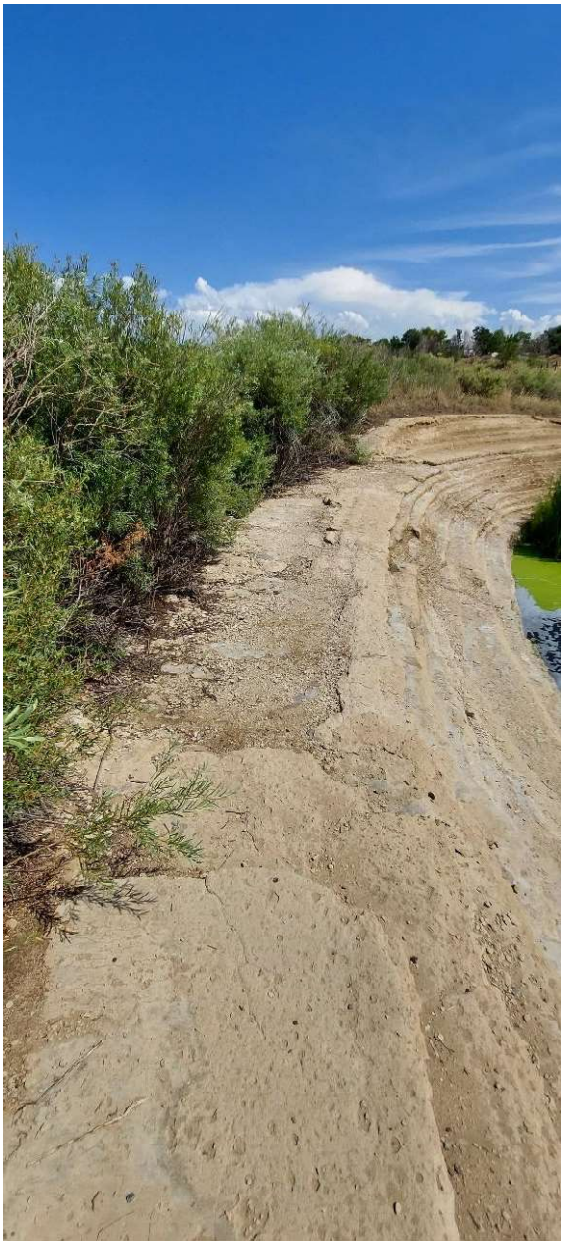


Photo 36 – Drop 1 – 7/27/22

Photo 37 – Drop 2 – 7/27/22

Photo 38 – Drop 3 – 7/27/22

Photo 39 – Drop 3 – 7/27/22

Photo 40 – Drop 3 – 7/27/22

Photo 41 – Drop 4 – 7/27/22

Photo 42 – Drop 4 – 7/27/22

Photo 43 – Drop 5 – 7/27/22

Photo 44 – Drop 5 – 7/27/22

Quincy Drainage: CCSP Staff cleans outlet structure (**Photo 45**). Some dead standing and fallen trees were observed (**Photo 46**). Bed and bank erosion observed in channel from Lake View Drive to PRF (**Photos 47 to 48**). No maintenance was identified. A capital project for stream reclamation may be needed from Lake View Drive to PRF. Planning is suggested to identify work needed, overall priorities, and costs.

Photo 45 – 7/27/22

Photo 46 – 7/27/22

Photo 47 – 7/27/22

Photo 48 – 7/27/22

Dixon Grove (Reservoir Water Surface Elevation = 5548.1 on 7/27/22): Boulders and riprap serve as protection of shoreline (**Photos 49 and 50**). Area includes a water quality capture area (**Photo 51)** that receives runoff from adjacent parking lot (**Photos 52 and 53**). Shoreline erosion was observed just south of Dixon Grove (**Photo 54**). No maintenance needs were identified. Shoreline stabilization may be needed for the erosion located to the south of the PRF, and a planning effort may be useful in identifying work needed, priority, and costs.

Photo 49 - 7/27/22

Photo 50 - 7/27/22

Photo 51 - 7/27/22

Photo 52 - 7/27/22

Photo 53 - 7/27/22

Photo 54 - 7/27/22

East Boat Ramp (Reservoir Water Surface Elevation = 5547.9 on 8/9/22, 5547.3 on 10/4/22): Boulders and riprap serve as protection of shoreline (**Photos 55 and 56**). Maintenance work was completed in October 2022 (**Photos 57 and 58**). Weed control is needed to help with vegetation re-establishment in the project area; it will likely start with mechanical control and then move to herbicide once grasses start to mature.

Photo 55 - 8/9/22

Photo 56 - 8/9/22

Photo 57 – 10/4/22

Photo 58 – 10/4/22

East Shade Shelters (Reservoir Water Surface Elevation = 5547.9 on 8/9/22):

South Section: Boulders and riprap have shifted, and erosion was observed (**Photos 59 to 60, 62**). Concrete walk and bench have been eroded and undermined (**Photo 61**). Social trail with erosion **(Photos 63, 66, 68 to 70)**. Shoreline bank erosion was observed (**Photos 64 to 65, 67**). No maintenance needs were identified. Shoreline stabilization may be needed for the erosion located in this section of this PRF, and a planning effort may be useful in identifying work needed, priority, and costs.

North Section: This area includes bank erosion (**Photo 71**) and social trails (**Photo72**). A capital project is currently being designed to stabilize the shoreline. No maintenance needs were identified as the capital project is expected to address the bank erosion and minimize impact of trails.

Photo 59 – 8/9/22

Photo 60 – 8/9/22

Photo 61 – 8/9/22

Photo 62 – 8/9/22

Photo 63 – 8/9/22

Photo 64 – 8/9/22

Photo 65 – 8/9/22

Photo 66 – 8/9/22

Photo 67 – 8/9/22

Photo 68 – 8/9/22

Photo 69 – 8/9/22

Photo 70 – 8/9/22

Photo 71 – 8/9/22

Photo 72 – 8/9/22

Mountain and Lake Loop (Reservoir Water Surface Elevation = 5548.1 on 7/28/22): Approximately 100 feet of shoreline is eroding (**Photo 73**) near the Lake Loop parking lot; there is a current maintenance design and permitting underway. Erosion was noted around a tree (**Photo 74**) near the rowing club storage buildings and the tree's roots seem to be providing some protection. No additional maintenance was identified beyond the current project. It suggested that erosion at tree near rowing club storage buildings be monitored.

Photo 73 – 7/28/22

Photo 74 – 7/28/22

Tower Loop (Reservoir Water Surface Elevation = 5548.2 on 7/12/22): This area includes boulders and riprap for shoreline protection (**Photo 75**). Bank erosion and social trails (**Photo 76**) are located to the south and east of the PRF; a capital project is currently being designed to stabilize the shoreline. No maintenance needs were identified as the capital project is expected to address the bank erosion and minimize impact of trails.

Photo 75 – 7/12/22

Photo 76

Conclusions

The conclusions from the 2022 Annual Field Observation of PRFs are:

1. All PRFs appear to be performing their functions. The Field Observation general assessments included thoughts on maintenance, monitoring, and planning efforts for future capital projects.
2. The maintenance identified for consideration by the TAC and Board includes a Summary of Operation & Maintenance costs and individual budget estimates for Restorative/Rehabilitation work included in **Appendix A**. The Operations and Maintenance cost as the result of this Field Observation for 2022 is $53,600 as compared to the 2021 budget of $204,850.
3. Concerns and issues that were located outside the limits of the original PRF or require additional analysis/study beyond the engineering already done for the original PRF were suggested as planning efforts. These planning efforts would identify the capital project needed, determine priority, identify the water quality benefit, and costs. These planning efforts include:
    a. Cherry Creek 12-mile Park Projects – continued planning on Cherry Creek from Lake View Drive to CCSP Boundary
    b. Quincy Drainage – planning for stream reclamation on Quincy Drainage to address bank and bed erosion from Lake View Drive to PRF
    c. Dixon Grove – planning for shoreline stabilization for Cherry Creek Reservoir to address erosion located to the south of the PRF
    d. East Shade Shelter – planning for shoreline stabilization for Cherry Creek Reservoir to address erosion located in the south section of the PRF

Appendix A

Cherry Creek Basin Water Quality Authority
Summary of Operation & Maintenance (O&M) Costs
Prepared / Updated: November 4, 2022

Project	Quantity			CCSP Work	CCBWQA Purchases Seed with CCSP Installation	CCBWQA Work					Comments	Total Cost
	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.	$ 13,000
	1									$ 10,000	Project carryover from 2022 to 2023, Concrete Repair at Crests of 3 drop structures.	
Cottonwood Wetlands	1									$ 3,600	PRF Routine, Decompaction and revegetation of access along embankment. Cleaning of outlet grate.	$ 3,600
Mountain/Lake Loop Shoreline	1									$ 30,000	Project carryover from 2022 to 2023, Restore shoreline area.	$ 30,000
East Boat Ramp	1					$ 3,000					Weed Control for noxious weeds at 100% CCBWQA, since within 5 years of PRF construction.	$ 3,000
Cherry Creek 12-mile Phase III	1					$ 4,000					Weed Control for noxious weeds at 100% CCBWQA, since within 5 years of PRF construction.	$ 4,000
Subtotal				$ -	$ -	$ 10,000	$ -	$ -	$ -	$ 43,600		

Totals

CCSP =	**$**	**-**
CCBWQA =	**$**	**53,600**
Combined =	**$**	**53,600**

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 = $800/acre. CCBWQA purchases seed CCSP installs it with their tractor and the seed attachment purchased by CCBWQA.
Note 3. Tree Replacement = $1,000/ea. Shrub Replacement =$50/ea.. CCBWQA Participation @ 100%.
Note 4. PRF Function Repair/Maintenace. Project Specific Estimate. CCBWQA Participation @ 100%.

2022 PRF Field Observation
Shop Creek 2023 Repair

Date: 10/31/2022

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No.	Item	Quantity	Unit	Unit Price	Extension
1	Mobilization	1	LS	$ 700.00	$ 700.00
2	Concrete Repair at Crests	1	LS	$ 5,000.00	$ 5,000.00
3	Water Control	1	LS	$ 1,000.00	$ 1,000.00
4	Concrete Washout	1	EA	$ 750.00	$ 750.00
5	Tree Removal	1	LS	$ 875.00	$ 875.00

Subtotal		$	8,325.00
Contingency	20%	$	1,665.00
Subtotal		$	9,990.00
Surveying			
Engineering, Permitting & Const Svs		$	-
Total Estimated Construction Cost		**$**	**9,990.00**

2022 PRF Field Observation
Cottonwood Wetlands 2023 Repair

Date: 10/31/2022

R2R ENGINEERS
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No.	Item	Quantity	Unit	Unit Price	Extension
1	Mobilization	1	LS	$ 500.00	$ 500.00
2	Decompaction	0.2	AC	$ 5,000.00	$ 1,000.00
3	Reseeding and Mulch	0.2	AC	$ 5,000.00	$ 1,000.00
4	Clean out Outlet Structure	1	LS	$ 500.00	$ 500.00

Subtotal		$	3,000.00
Contingency	20%	$	600.00
Subtotal		$	3,600.00
Surveying			
Engineering, Permitting & Const Svs		$	-
Total Estimated Construction Cost		**$**	**3,600.00**

2022 PRF Inspection
Mountain and Lake Loop 2023 Repair

Date: 10/31/2022

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RIFFLES TO RIPPLES

No.	Item	Quantity	Unit	Unit Price	Extension
1	Mobilization	1	EA	$ 1,200.00	$ 1,200.00
2	Construction Fence	800	LF	$ 4.50	$ 3,600.00
3	Erosion Control Log	80	LF	$ 3.00	$ 240.00
4	Type M Soil Riprap	85	CY	$ 185.00	$ 15,725.00
5	Seed	0.5	AC	$ 2,500.00	$ 1,250.00
6	Mulch	0.5	AC	$ 2,500.00	$ 1,250.00
7	Remove and Reset Fence for Access	50	LF	$ 32.00	$ 1,600.00

Subtotal		$	24,865.00
Contingency	20%	$	4,973.00
Subtotal		$	29,838.00
Surveying			
Engineering, Permitting & Const Svs	30%	$	-
Total Estimated Construction Cost		**$**	**29,838.00**