Colorado Trout Unlimited and Boulder Flycasters
Lower South Boulder Creek
Stream Management Plan Phase II - Final Report
September 30, 2022

Colorado Trout Unlimited and Boulder Flycasters
Lower South Boulder Creek Stream Management Plan Phase II
Final Report

TABLE OF CONTENTS

[Please note that in this report there are a few terms that have specific or equivalent meaning.

- *"South Boulder Creek" or "SBC" refers to the entire watershed from the continental divide to the confluence with Boulder creek*
- *"lower South Boulder Creek" or "lower SBC" refers to the stretch of water included in the project study area*
- *"aquatic species passage" refers to the ability of all aquatic life such as fish, macroinvertebrates, aquatic plants, etc. to freely move / migrate within the creek channel*
- *"channel connectivity" refers to mechanisms to reconnect isolated sub-reaches (channels) and create the opportunity for aquatic species passage]*

1. REPORT SUMMARY

1.1. Project Background and Overview

The project location is the (approximately) 9-mile reach of South Boulder Creek at the Community Ditch (FRICO) diversion structure at the mouth of Eldorado Canyon to the confluence with Boulder Creek.

Please refer to Exhibit A – Lower South Boulder Creek Reach Map

Beginning in 2017, Colorado Trout Unlimited (CTU) and Boulder Flycasters chapter of Trout Unlimited (BFC) (collectively referred to as "TU") contacted key stakeholders to form a collaborative working group to address watershed improvement opportunities in lower SBC. The catalyst for bringing this group together was the (then) pending Gross Reservoir expansion project. The proposed (now approved) project included construction and implementation of an Environmental Pool (EP) within Gross Reservoir to provide for sustainable year-round, in-stream flows. This is described in an inter-governmental agreement (IGA) between Denver Water, and the cities of Boulder and Lafayette. The initial collaboration focused on how to implement the IGA, and what flow management / infrastructure changes might be required. As the collaboration matured, the working group expanded discussions to include opportunities for channel connectivity, aquatic species passage and habitat improvement to mitigate environmental degradation.

The Stream Management Plan (SMP) Phase I project began in April 2019. In 2020, Phase I work was completed (coalition building, planning, data collection), and final reports submitted (June 2020). SMP Phase II was funded in August of 2020 and focused primarily on sub-reach level improvement opportunities based on field assessment of biology, hydrology, geo-morphology, and recreational needs and impacts. Phase II (final phase) is the focus of this report. This work was accomplished in close consultation with City of Boulder Open Space & Mountain Parks, the majority public land management agency along lower SBC.

As a result of the SMP Phase I, recommendations for multiple ditch diversion structures' modifications were identified. These recommendations were to help improve ditch operations, address environmental impacts, and meet the EP IGA requirements. This work progressed to the point of justifying a separate project. For this "spin out" project, "Watershed Restoration Phase I (WSR PH I)", TU applied for, and was awarded, Colorado Water Conservation Board (CWCB) and US Fish & Wildlife Service (USFWS) grant funding in 2020. WSR PH I (structure modification conceptual designs for channel connectivity, aquatic species passage, flow management, associated operational improvement, and proximate habitat / environmental improvements) launched in August 2020, and completed in August 2022.

Stakeholders include:

- Steering Committee: City of Boulder – Public Works, Utilities Department, Water Resources; and Open Space & Mountain Parks; City of Lafayette – Public Works, Water; Denver Water; Trout Unlimited
- Core (Directly Effected) Stakeholders: Boulder County – Parks & Open Space; City of Louisville – Water Utility; 14 ditch ownership groups; Xcel Energy
- Additional Stakeholders: private landowners along lower SBC; Eldorado Artesian Water
- Advisors: Colorado Parks & Wildlife (CPW); Colorado Water Conservation Board; Division of Water Resources (DWR – District 6 Water Commissioner); US Fish & Wildlife Service – Fish Passage; Cities of Boulder / Lafayette and Denver Water professional staff

1.2. Goals and Objectives

The primary goals associated with completion of the SMP for lower SBC ties directly to the Colorado Water Plan goals for "Watershed Health, Environment, and Recreation." Overall health of this stretch of the creek corridor, and balancing health improvement with recreational use, is a primary goal of the lower SBC SMP and related projects.

The original "call to action" was to use the SMP results to help better define and enhance efforts to implement an Environmental Pool within Gross Reservoir to provide for sustainable year-round in-stream water flows. Hence a related primary goal is more efficient water management.

As the project progressed, expanded goals provide for improved lower SBC water quality and creek function through increases in flow, direct improvements to the channel geomorphology, and direct improvements to the riparian corridor biota.

The three supporting project objectives are:

- Objective 1: Develop working collaboration between key stakeholders committed to habitat quality, and water quantity and quality
- Objective 2: Improve understanding of the current state, challenges, and future opportunities for improvement to the overall lower SBC watershed
- Objective 3: Define and launch specific opportunities and projects for on-the-ground improvement, and leverage / pool resources across stakeholders

These objectives are interrelated and interdependent on achievement.

As stated above, the SMP Phase I was largely stakeholder engagement, methodology and data / information identification driven. SMP Phase II focused on: expanding stakeholder communications / involvement, completing the data set (fill in the gaps), performing data analysis, completing the River Heath Assessment (RHA), and identifying specific improvements and monitoring requirements / projects from the RHA results.

1.3. Current State

In SMP PH II, the project team conducted a sub-reach-level River Health Assessment (RHA) that included both office-based and in-the-field evaluation. The RHA considered flow, water quality, landscape context, riparian and geomorphologic characteristics, aquatic habitat, and recreation use. SMP PH I identified flow as the single most important factor contributing to deteriorating stream function and riparian conditions. However, flow records for lower SBC are incomplete, and frequently rely on inconsistently collected, manual measurements. Additionally, the 2013 flood destroyed all the instream gaging within the lower reach. The only gage to be replaced to-date is the one just upstream of South Boulder Road. This gage is prone to inaccurate measurement that requires additional processing to obtain meaningful data. Given the importance of flow data and lack of a strong, consistent historical record, the project team developed a Point Flow Model to simulate stream flow conditions.

The Point Flow Model (PFM) estimates a broad range of surface water inflows and outflows at ungauged stations, based on available stream and diversion flow records from 10/1/1997 to 10/31/2018, and estimated gains. It starts at the Eldorado Springs stream gauge (BOCELSCO – 0603610) and ends at the confluence of Boulder Creek. For comparison, it also estimates flows above Gross Reservoir with all water development inputs / outputs removed as a surrogate for natural flow conditions. The model calculates flows at a daily time step at 13 reach breakpoints along lower SBC. The result is a model that shows natural and artificially developed sources and uses. For more detail, please reference the two technical memorandums provided in the **3. Exhibits** section of this report. Since the flow data record is incomplete, particularly for downstream sub-reaches, the current model has limitations, but is very useful for under-standing the flow trends along the reach.

In summary, the project team observed that the lower ~9 miles of SBC is a highly disturbed ecological system. The assessment confirmed SMP PH I observations of environmental degradation from urban development, past mining, agriculture, water diversion activities, and flow regime management. There are also 17 channel-spanning diversion

structures in the 9-mile study reach. Eight (8) were identified as the primary sources of most flow management and channel connectivity / aquatic species passage issues, as well as stream function disruption.

During the field portion of the RHA, assessors made observations related to water quality but no direct measurements and statistical analysis. Historically, water quality data for lower SBC were not collected in a sufficiently comprehensive and consistent manner to perform a sub-reach by sub-reach water quality assessment.

A sub-reach level RHA score card was prepared across the study reach. A review of the sub-reach scores and consolidation to an overall score for the study reach was then performed. Based on the assessment, the overall Functional Score for lower SBC is 2.0 out of 4.0, described as "Partially Functioning."

Please refer to Exhibit B - River Health Assessment Methodology / Field Assessment Parameters / Score Guide, Exhibit C - Reach Descriptions, Exhibit D - RHA Field Assessment - Summary Assessment Table, and Exhibit F - Point Flow Model

According to the Colorado Department of Public Health and Environment (CDPHE) 2022 integrated report, the upper section (COSPBO04b-D) is classified as Category 5, indicating that there is water quality impairment. It is listed on the State's 303(d) List.

- Water Supply Use - dissolved arsenic
- Aquatic Life Use – dissolved silver
- Aquatic Life Use - macro-invertebrates

This section is also on the State's Monitoring and Evaluation (M&E) List.

- Recreation Use – e. Coli monitoring (there may be an impairment, but e. Coli data are insufficient)

The lower section (COSPBO05-A) is classified as Category 1a, indicating attainment for all water quality standards.

Additionally, the Boulder County Keep It Clean (BCKIC) Coalition reports on overall Boulder Creek and St Vrain watersheds' water quality. Again, there are limited data and testing sites related to lower SBC. The BCKIC report references the CDPHE impairments and highlights challenges specific to lower SBC.

To better understand water quality throughout lower SBC in the mid-to-long term, TU initiated a data collection program that currently focuses on measuring dissolved oxygen (monthly) and water / air temperature (hourly) at five stations distributed throughout lower SBC. This work is another "spin-out" project (self-funded to-date) that came out of the observed need for such data. Although still in the early stages of building an overall water quality / quantity database, and developing lower SBC water quality analysis results, the initial findings identified:

1. Earlier and more compact spring run-off timing, as well as decreased overall flow trends, and
2. Increasing seasonal instances of low dissolved oxygen levels

Please refer to Exhibit G - Data Analysis Graphs and Charts

Specific functional impairment include:

- Not surprisingly, flow is significantly impaired. As such, the level of stream function can dramatically change depending on water diversion demand. During winter months the creek experiences very-low-to-no-flow conditions
- Sediment disposition / movement is greatly impaired, and the channel substrate is embedded in many locations with a high silt percentage
- Access / connection to the floodplain is limited in part or whole in all but one (1) sub-reach (out of 19)
- Very few off-channel habitats exist (i.e., backwaters, oxbows, side channels, etc.)

- Pool habitat in general, and especially over-winter-depth pool habitat, is lacking and, where deeper pools are present, there is little protective cover / structure
- Riparian health varies along the sub-reaches, with property ownership and land use driving overall function, such as:
    - lack of woody vegetation
    - sparser than expected stands of cottonwood trees and woody riparian brush such as willows
    - very little wood in the channel and very little (dead or alive) in the riparian zone
    - a disconnected flood plain inhibits cottonwood propagation
- Conditions tend to worsen moving downstream

Please refer to Exhibit E - RHA Field Assessment - Reach Assessments and Project Recommendations

1.4. Conclusions and Path Forward

Flow (along with the direct disruption by water diversion infrastructure addressed in the WSR project) is the most significant limiting factor for lower SBC improvement. The major flow improvement opportunity is the Environmental Pool. This will allow for year-round storage and release of water in support of agreed-to targeted flow needs. The EP will be constructed as part of the Gross Reservoir expansion project currently underway (approximately 5 – 7 years to complete.) Targeted flows were developed through extensive work between CWCB, CPW and the Cities of Boulder and Lafayette. A Water Delivery Agreement with CWCB is in place. The water stored in the EP will be owned by the cities of Lafayette and Boulder, and will be filled through existing eastern-slope water rights.

There are also potential opportunities to improve flow by working with water rights' owners, water users and owners of infrastructure to keep more water in the creek for longer stretches through water management and operational changes. Achieving this objective would directly support the Colorado Water Plan goals stated above but will require more research and negotiation to achieve.

<u>Recommendations:</u>

Continue to emphasize the operational planning, administrative tools, and water management infrastructure modifications necessary to successfully operate the EP, especially at very low flow levels, i.e., 1.5 to 10 cfs. And work toward other outcomes such as:

- Keeping more water in lower SBC for longer stretches through more efficient water delivery infrastructure, as well as potential water management and use, and associated operational changes
- Some of the non-flow assessment categories could potentially improve through alternative flow regime management techniques to better mimic natural stream flow conditions
- Stream bank and floodplain improvement will benefit the public and help Boulder OSMP maintain these lands
- Recommended riparian, geo-morphology, and aquatic habitat actions and future projects include:
    - Education outreach regarding landscape and creek-side improvements with private landowners
    - Moving recreation trails away from the creek bank, changes in grazing protocols, and alternative stock-water sources
    - Increase streambank native plantings
    - Use fencing to protect new plantings from people and cattle
    - Enhance existing meanders and riffle / pool sequences, and stabilize eroding banks
    - Incorporate channel connectivity / aquatic life passage into applicable ditch diversion structures to help reconnect the creek channel, allow for more natural migration patterns and improve overall creek function. (See WSR PH I final report)

- Recommended updates to the Point Flow Model (as described in Section 2.4 of the Detail Report) as new data is available – likely 3 to 5 years from now

- Define and implement an overall watershed database and associated analytics for lower SBC

Please refer to Exhibit E - RHA Field Assessment - Reach Assessments and Project Recommendations

The immediate next phase of funded projects will continue developing engineering designs for structures. These new projects were approved for funding by CWCB at the March 2022, Board meeting, and contracting with the State of Colorado is complete (August 2022). USFWS approved funding and completed contracting in January 2022. The project team currently estimates that these projects will likely begin in September 2022.

1.5. Project Administration and Financial Management

The project tasks were completed successfully, and all described deliverables are complete, except for those few noted in the Detail Report section. The project was delivered within the budgets provided in grant documents. The project suffered several disruptions to the original timeline due primarily to the discovery of New Zealand Mud Snails in lower SBC, COVID project team illnesses, general COVID societal restrictions, and most recently the Marshall Fire. A project extension was requested and granted by the State of Colorado. These delays are reflected in the changed project schedule and the timing of project tasks described in the Detail Report section. However, there was no impact to the project financial budget.

Please refer to Exhibit J - Project Financial and In-Kind Detail Support, and Exhibit K - Project Funding Detail

*** * * * * * * * * END OF SUMMARY REPORT * * * * * * * * * ***

2. REPORT DETAIL

2.1. Project Background and Status

This report is the second of two Stream Management Plan (SMP) reports for lower South Boulder Creek. Much of the background and events leading up to and through SMP Phase I, and contained in that first report, will not be repeated in this second SMP Phase II report. The lower SBC SMP PH I report is available at the SMP sharing and learning website**: https://www.coloradosmp.org/**.

Beginning in 2017, Colorado Trout Unlimited (CTU) and Boulder Flycasters chapter of Trout Unlimited (BFC) (collectively referred to as "TU") contacted key stakeholders to form a collaborative working group to address watershed improvement opportunities in the lower SBC. The project location is the (approximately) 9-mile reach of SBC beginning at the Community Ditch (FRICO) diversion structure at the mouth of Eldorado Canyon (LAT: 39.932 / LONG: -105.281), to the confluence with Boulder Creek (LAT: 40.033 / LONG: -105.217).

Please refer to Exhibit A – Lower South Boulder Creek Reach Map

The catalyst for bringing this group together was the (then) pending Gross Reservoir expansion project. The proposed project (now approved) included implementation of an Environmental Pool (EP) within Gross Reservoir to provide for sustainable year-round, in-stream flows. This is described in an inter-governmental agreement (IGA) between Denver Water, and the cities of Boulder and Lafayette. The initial collaboration focused on how to implement the IGA, and what flow management / infrastructure changes might be required. As the collaboration matured, the working group expanded discussions to include opportunities for channel connectivity, aquatic species passage, and habitat improvement to mitigate environmental degradation.

In 2018, TU applied for, and was awarded, a Colorado Water Conservation Board (CWCB) grant to prepare a Stream Management Plan for lower SBC. The SMP Phase I project began in April 2019. In 2020, Phase I work was completed (coalition building, planning, data collection), and final reports submitted (June 2020). SMP PH II was funded in August 2020 and focused primarily on sub-reach level improvement opportunities based on field assessment of biology, hydrology, geomorphology, and recreational needs and impacts. SMP PH II (final phase) is the focus of this report. This work was accomplished in close consultation with City of Boulder Open Space & Mountain Parks, the majority land manager along lower SBC.

The project suffered several disruptions to the original timeline due to a sub-contractor conflict-of-interest resolution period, the discovery of New Zealand Mud Snails in lower SBC, COVID project team illnesses, general COVID societal restrictions, and, most recently, the Marshall Fire. A project extension was requested and granted by the State of Colorado. These delays are reflected in the changed project schedule and the timing of project tasks. However, there was no negative impact to the project financial budget or task level deliverables.

As a result of the SMP Phase I, recommendations for multiple ditch diversion structures' modifications were identified. These recommendations were to help improve ditch operations, address environmental impacts, and meet the EP IGA requirements. This work progressed to the point of justifying a separate project. For this "spin out" project, "Watershed Restoration Phase I (WSR PH I)", TU applied for, and was awarded, Colorado Water Conservation Board (CWCB) and US Fish & Wildlife Service (USFWS) grant funding in 2020.

WSR PH I (structure modification conceptual designs for channel connectivity / aquatic species passage, flow management, associated operational improvement, and proximate habitat / environmental improvements)

launched in August 2020. High level, diversion structure conceptual designs, and associated operational improvements, are described for eight (8) high priority structures. Preliminary engineering designs (~15-20%) are complete for three (3) of the eight (8) structures. The SBC WSR PH I Report is available at the SMP sharing and learning website: **https://www.coloradosmp.org/**

The next phase of funded projects will continue developing engineering designs for structures.

- Grants and matching funding were approved to take two (2) additional structures to the 100% design level (permit and construction phase ready), and two (2) structures to the preliminary design stage (~15-20%)
- Grants and matching funding were approved for a ditch automation project to demonstrate the integrated use of automated gates linked to flow gages and operated locally or remotely over a network.

These new projects were approved for funding by CWCB at the March 16, 2022, Board meeting. Contracting with the State of Colorado is complete (August 15, 2022). USFWS approved funding and completed contracting in January 2022. The project team currently estimates that these projects will likely begin in September 2022.

2.2. Key Participants: Stakeholders, Advisors, Funding Sources and Contractors

Stakeholders

Steering Committee
- **City of Boulder – Public Works, Utilities Department, Water Resources; and Open Space & Mountain Parks**
- **City of Lafayette – Public Works, Water**
- **Denver Water**
- **Trout Unlimited**

Advisors
- **Colorado Parks & Wildlife (CPW)**
- **Colorado Water Conservation Board**
- **Division of Water Resources (DWR – District 6 Water Commissioner)**
- **US Fish & Wildlife Service – Fish Passage**
- **Cities of Boulder and Lafayette professional staff**

Additional Stakeholders
- **Boulder County – Parks & Open Space**
- **City of Louisville – Water Utility**
- **Eight ditch ownership groups (one representing seven (7) ditch / reservoir companies)**
  - **Farmers Reservoir and Irrigation Company (Community Ditch)**
  - **Davidson Ditch and Reservoir Company**
  - **Goodhue Ditch and Reservoir Company**
  - **Marshallville Ditch Company**
  - **New Dry Creek Carrier Ditch (serving: Base Line Land and Reservoir Company, Enterprise Irrigating Ditch Company, Dry Creek Davidson Ditch Company, Andrews Farwell Ditch Company, LH Davidson Ditch Company, Leyner Cottonwood Ditch Company, and Cottonwood No. 2 Ditch)**
  - **Howard Ditch Company**
  - **East Boulder Ditch Company**
  - **Leggett Inlet Canal Complex**

Note: Xcel Energy, City of Boulder, City of Lafayette, City of Louisville, and Boulder County have various ownership stakes in these ditches and sit on the boards of many of the ditch companies.

Funding Sources

The SMP PH II project was funded by cash grants, direct cash matching contributions, and in-kind services matching contributions from the following organizations:

- **Colorado Water Conservation Board – Colorado Watershed Restoration Program (CWRP) – Stream Management Plan grant (cash)**
- **Metro Round Table – Water Supply Reserve Fund (WSRF) – cash match**
- **South Platte Basin Round Table – Water Supply Reserve Fund (WSRF) – cash match**
- **US Fish & Wildlife Service – Fish Passage Grant (cash)**
- **City of Boulder – Public Works, Utilities Department, Water Resources – in-kind services match**
- **City of Boulder – Open Space & Mountain Parks (OSMP) – in-kind services match**
- **City of Lafayette – Public Works, Water – in-kind services match**
- **Denver Water – cash and in-kind services match**
- **Trout Unlimited – cash and in-kind services match**

Contractors and Consultants

- **Biohabitats – prime contractor**
- **Wright Water Engineers – sub contractor**
- **GEI – sub contractor**
- **Wilson Water Group – sub contractor**

2.3. Goals and Objectives

The Colorado Water Plan goals led to the establishment of Stream Management Plans (administered by CWCB) for improvement of Colorado's watersheds The Colorado Water Plan states that: "The goals within Colorado's Water Plan are to meet the water supply and demand gaps; defend Colorado's compact entitlements; improve regulatory processes; and explore financial incentives—all while honoring Colorado's water values and ensuring that the state's most valuable resource is protected and available for generations to come." A more detailed, sub-goal directly applicable to the creation of SMPs, as well as to the lower SBC SMP, is to promote and protect:

"Watershed Health, Environment, and Recreation: Cover 80 percent of the locally prioritized lists of rivers with stream management plans, and 80 percent of critical watersheds with watershed protection plans, all by 2030."

- Overall health of this stretch of the creek corridor is a primary goal of the lower SBC SMP and related projects.

A related set of sub-goals that are most applicable to our municipal, industrial, and agricultural stakeholders include:

"Conservation: Achieve 400,000 acre-feet of municipal and industrial water conservation by 2050."

- Although not directly applicable as a goal for this project, the expansion of Gross Reservoir is a very important part of local efforts to improve lower SBC through the additional of an Environmental Pool. Integral to this and other projects is to prepare SBC water management infrastructure to be able to administer, protect and pass target flows.

"Land Use: By 2025, 75 percent of Coloradans will live in communities that have incorporated water-saving actions into land-use planning."

- This is directly related to the SMP objectives for leaving more water in the creek longer.

"Agriculture: Agricultural productivity will keep pace with growing state, national, and global needs, even if some acres go out of production."

- Although not a specific project goal, many of the owners within the ditch company stakeholders are providing water for agricultural use and need to improve their water delivery and infrastructure efficiency.

The primary goal associated with completion of the SMP for lower SBC ties directly to the Colorado Water Plan goals for watershed health, environment, and recreation, as well as more efficient water management. These goals remain largely the same for Phase II as stated in Phase I:

Original Call-to-Action Goal:

- Use the SMP results to help better define and enhance efforts to implement an Environmental Pool within Gross Reservoir to provide for sustainable, year-round, in-stream water flows, as described in the IGA between Denver Water, Boulder, and Lafayette

Expanded Goals include:

- Identify opportunities for habitat improvement, channel connectivity and low flow in-channel modifications to improve lower SBC water quality and creek function
- Support the recreational and environmental goals of local stakeholders based on target flows provided by the Environmental Pool, and investigate other opportunities to keep more water in the creek longer
- Work toward the longer-term potential for flows that can exceed current in-stream flow targets and provide a more natural hydrograph in the future

Three supporting objectives are:

- Objective 1: Develop working collaboration between key stakeholders committed to habitat quality, and water quantity and quality
- Objective 2: Improve understanding of the current state, challenges, and future opportunities for improvement to the lower SBC watershed
- Objective 3: Define and launch specific opportunities and projects for on-the-ground improvement, and leverage / pool resources across stakeholders

These objectives are interrelated and interdependent on achievement.

As stated above, the SMP Phase I was largely stakeholder engagement, methodology and data / information identification driven. The SMP PH II then focused on: expanding stakeholder communications / involvement, completing the data set (fill in the gaps), performing data analysis, completing the River Heath Assessment (RHA), and identifying specific improvements and monitoring requirements / projects from the RHA results.

2.4. Assessment, Findings and Recommendations

Approach and Observations:

In SMP PH II, evidence of environmental degradation from urban development, past mining, agriculture, water diversion activities and flow regime management were confirmed through a comprehensive River Health Assessment. The RHA considered flow, water quality, landscape, riparian and geomorphologic characteristics, aquatic habitat, and recreation use. The level of detail of the assessment varied depending on the nature of the parameter being assessed and available data. Eight (8) channel-spanning diversion structures were identified

as the primary sources of most flow management and channel connectivity / aquatic species passage issues, as well as stream function disruption.

In SMP PH II, our team conducted a sub-reach-level River Health Assessment (RHA) that included both office-based and in-the-field evaluation. The RHA considered flow, water quality, landscape context, riparian and geomorphologic characteristics, aquatic habitat, and recreation use. SMP PH I identified flow as the single most important factor contributing to deteriorating stream function and riparian conditions. However, flow records for lower SBC are incomplete, and frequently rely on inconsistently collected, manual measurements. Additionally, the 2013 flood destroyed all the instream gaging within the lower reach. The only gage to be replaced to-date is the one just upstream of South Boulder Road. This gage is prone to inaccurate measurement that requires additional processing to obtain meaningful data. Given the importance of flow data and lack of a strong, consistent historical record, the project team developed a Point Flow Model to simulate stream flow conditions.

The Point Flow Model (PFM) estimates a broad range of surface water inflows and outflows at ungauged stations, based on available stream and diversion flow records from 10/1/1997 to 10/31/2018, and estimated gains. It starts at the Eldorado Springs stream gauge (BOCELSCO – 0603610) and ends at the confluence of Boulder Creek. For comparison, it also estimates flows above Gross Reservoir with all water development inputs / outputs removed as a surrogate for natural flow conditions. The model calculates flows at a daily time step at 13 reach breakpoints along lower SBC. The result is a model that shows natural and artificially developed sources and uses. For more detail, please reference the two technical memorandums provided in the **3. Exhibits** section of this report.

The longer-term goal is to continue to update and make more useful the PFM, with the potential for its usefulness to extend beyond this project and to be a useful tool for future management of SBC. For example, it will allow water managers to better understand discrete flows in and around their diversions, assist land managers with restoration efforts, and could be used to help stakeholders manage the future Environmental Pool. As of this writing, the following data collection / measurement improvements will be needed if the PFM is to become a better operational tool.

1. The additional telemetry-based flow gages at 4 locations (Eldorado Springs (bridge #2), downstream of New Dry Creek Carrier ditch, downstream of East Boulder ditch and downstream of Leggett Inlet Canal Complex) on lower SBC, and the planned upgrade of the South Boulder Road gage (currently managed by Mile Hi Flood District / One Rain), will greatly improve data accuracy. It will likely require 3 to 5 years of continuous data to be meaningful within the context of the PFM
2. Additional electronic gaging should be installed at the outflow of both Anderson Extension Ditch and Viele Channel
3. Wellman ditch is owned by Xcel Energy, and currently only limited flow records are available. Future revision efforts should work with Xcel to obtain both diversion and outflow data. Wellman Ditch does have an outflow flume, but it is observed to be in poor condition and will likely need to be updated. Ideally electronic gaging would be installed and connected to the State flow data system (Colorado DSS)
4. In the future work with diverters downstream of Leggett Inlet Canal Complex to install accurate, electronic measurement devices and ensure that diversion records are maintained
5. The last two nodes in the PFM (KOA Lake, End of South Boulder Creek (confluence with Boulder Creek)) were flagged and a note was added explaining that the two nodes are not recommended for use until more data is available on water use downstream of the Leggett Inlet Canal Complex. This includes the KOA Lake, the Martin Marietta aggregate processing plant pipe below KOA lake outflow, the Butte Mill Ditch and at the confluence with mainstem Boulder Creek

The point flow model could be updated in the future if more data becomes available. It is important to keep in mind that even with additional data, the point flow model is still limited by the accuracy of the stream gage and diversion flumes. It is also limited by how often diversions are visited and recorded by the water commissioner for ditches that do not have telemetry or other forms of automated gaging.

Since the flow data record is incomplete, particularly for downstream sub-reaches, the current model has limitations, but is very useful for under-standing the flow trends along the reach. Overall, flow conditions worsen further downstream. Low-flow conditions that are critical to aquatic health drop too low, and annual peak flows that are critical to channel flushing and maintenance are not being sustained.

Please refer to Exhibit B - River Health Assessment Methodology / Field Assessment Parameters / Score Guide, and Exhibit F – Point Flow Model

Biohabitats and GEI, with assistance from TU, conducted desktop assessments in October and November 2020, and field assessments in March and April 2021. The following methods and measures were employed during the assessment tasks:

- The PFM was used to determine level of function for flow in each sub-reach. The PFM also supported conclusions on the impact of current flow management practices. Due to data limitations, the PFM results are approximate. Further refinement of the PFM is being considered and may be a useful tool in the future for key stakeholders (see above)
- Water quality was considered in a more general manner. *See Water Quality Assessment, below*
- Landscape parameters for each sub-reach consisted of landscape buffer and terrestrial connectivity. They were assessed mainly using aerial imagery with some field checking
- Riparian and geomorphology parameters for each sub-reach were determined mostly in the field with some preliminary remote analysis. Riparian assessment looked at extent of canopy, tree age classes, and number of structural classes. Geomorphology looked at cross-section, profile, resistance (or resiliency), and equilibrium (extent of entrenchment). Observational field notes were also recorded for both categories
- Aquatic habitat for each sub-reach consisted of a field assessment of applicable features (pool depth, cover, etc.) and channel connectivity / aquatic species passage
- Recreational use and its impact were noted for each sub-reach

The team also developed a reach numbering schema for the study area, working from the CPW Segments defined for SBC (three Segments defined from Gross Reservoir outlet to the confluence with Boulder Creek). This was done in consultation with stakeholders and is now used as a common descriptor when identifying activities and locations on lower South Boulder Creek.

Please refer to Exhibit C – Reach Descriptions, and Exhibit F – Point Flow Model

Assessments were conducted from sub-reach 2.1 (beginning below the Community Ditch (FRICO) diversion structure), to sub-reach 3.7 (Indian Road / confluence with Boulder Creek). In summary, the project team observed that the lower ~9 miles of SBC is a highly disturbed ecological system. Historically this stretch has been subject to:

- Quarry mining
- Grazing and associated bank degradation / reduction of woody structures
- Residential, industrial, and recreational development, and associated urban infrastructure
- Creekside residential and recreational development
- Channel straightening

- Modification for flood conveyance
- Armoring of banks, especially in residential areas
- Impoundment for pond creation
- High levels of water diversion for agriculture, municipal and commercial / industrial uses resulting in 17 channel spanning / blocking diversion structures

Water Quality Assessment:

During the field portion of the RHA, assessors made observations related to water quality but no direct measurements. Historically, water quality data for lower SBC were not collected in a sufficiently comprehensive and consistent manner to perform a sub-reach by sub-reach water quality assessment.

Colorado Department of Public Health and Environment (CDPHE) monitors water quality as part of its Clean Water Act requirements. CDPHE organizes this part of SBC into two sections (identified as COSPBO04b-D and COSPBO05-A) with South Boulder Road forming the dividing line between them. CDPHE's organization corresponds with this SMP's sub-reaches 2.x and 3.x, respectively, and with CPW Segments 2 and 3. The City of Boulder has a monitoring station in lower SBC located in sub-reach 2.7. The city collects various data, including water quality. This data is the basis for the CDPHE data reported within the Colorado DSS.

According to the CDPHE 2022 integrated report, the upper section (COSPBO04b-D) is classified as Category 5, indicating that there is water quality impairment. It is listed on the State's 303(d) List.

- Water Supply Use - dissolved arsenic
- Aquatic Life Use – dissolved silver
- Aquatic Life Use - macro-invertebrates

This section is also on the State's Monitoring and Evaluation (M&E) List.

- Recreation Use – e Coli monitoring (there may be an impairment, but E. coli data are insufficient)

The lower section (COSPBO05-A) is classified as Category 1a, indicating attainment for all water quality standards.

Additionally, the Boulder County Keep It Clean Coalition (BCKIC) reports on overall Boulder Creek and St Vrain watersheds' water quality. Again, there are limited data and testing sites related lower SBC. That report references the CDPHE impairments and highlights challenges (data collected 2015 through 2019).

- Water temperature, conductivity, total suspended solids, alkalinity, hardness, and pH generally increases from upstream to downstream
- Overall, pH is showing an increasing trend; nitrogen is a neutral trend; phosphates showing an increasing trend

However, due to limited data, the above observations are general trends. It is not possible to assess lower SBC at the major reach level, let alone the sub-reach level, to develop a better understanding of the proximate causes.

To better understand water quality throughout lower SBC, TU initiated a data collection program that currently focuses on dissolved oxygen (monthly) and water / air temperature (hourly) at five (5) stations distributed throughout lower SBC. This work is another "spin-out" project (self-funded to-date) that came out the SMP PH I observed need for such data.

The project team is building an integrated watershed database incorporating the TU collected data with City of Boulder, Denver Water, CDPHE and other data sources. The goal is to develop a more comprehensive lower SBC

water quality and quantity assessment capability. Although still in the early stages of this database, the initial findings identified:

1. Earlier and more compact spring run-off timing, as well as decreased overall flow trends, and
2. Increasing seasonal instances of low dissolved oxygen levels.

Please refer to Exhibit G – Data Analysis Graphs and Charts

River Health Assessment Results:

- Not surprisingly, flow is significantly impaired. As such, the level of stream function can dramatically change depending on water diversion demand (i.e., irrigation, municipal water use), time of year, and seasonal weather conditions. During winter months the creek experiences very-low-to-no-flow conditions

- Sediment disposition / movement is greatly impaired by the 21 channel spanning structures as well as the decrease in frequency and magnitude of adequate flushing flows. Consequently, the channel substrate is embedded in many locations with a high silt percentage
- Access / connection to the floodplain is limited in part or whole in all but one (1) sub-reach (2.2) out of 19
- We found very few off-channel habitats (i.e., backwaters, oxbows, side channels, etc.)
- Pool habitat in general, and especially over-winter-depth pool habitat, is lacking and, where deeper pools are present, there is little protective cover / structure
- Riparian health varies along the sub-reaches with property ownership and land use driving overall function
    - Historically cottonwood gallery forests in the west did not form a continuous canopy. Stands of trees were separated by open areas in the floodplain. However, private properties tend to lack woody vegetation except for larger trees that are part of a maintained and often non-native lawn-species landscape. OSMP lands are higher quality
    - Overall, stands of cottonwood trees and woody riparian brush like willows are sparser than expected. Some areas on OSMP land also lack woody species. Some of this is due to naturally occurring gaps. Other gaps are due to grazing impacts. OSMP is balancing management actions such as invasive species removal and protecting habitat for rare / threatened species, with canopy density. There are opportunities to revisit some of these gap areas for additional native shrub and tree plantings

    - Very little wood in the channel and very little (dead or alive) in the riparian zone. Active cattle grazing and private residential properties with lawns maintained to the stream bank are contributing factors
    - Disconnected flood plain also inhibits cottonwood propagation
- Conditions tend to worsen moving downstream. Flow impacts become more obvious beginning at South Boulder Road (Segment 2 to 3 transition). This is the location of the New Dry Creek Carrier Ditch that delivers water to six (6) other ditches and a storage reservoir. Operationally, this structure diverts significant amounts of water, has the right to sweep-the-creek, and is the most significant disruptor of creek function within the study stretch. The downstream-most reaches demonstrate the lowest function due to the compounding impacts of the stressors that were listed previously. On the upstream end, sub-reach 2.2 showed the highest function overall.

Please refer to Exhibit D – RHA Field Assessment – Summary Assessment Table, and Exhibit E – RHA Field Assessment – Reach Assessments and Project Recommendations

Recommendations:

Flow and Water Management Improvement:

- Continue to emphasize the water management infrastructure modifications necessary to successfully operate the EP, especially at very low flow levels, i.e., 1.5 to 10 cfs. Beyond the more obvious benefits to the watershed, the Cities of Boulder and Lafayette will benefit from support for the EP IGA implementation. The EP is specifically for maintaining target flows in lower SBC. This is especially needed during the non-irrigation / dry season. Improved water management infrastructure will benefit ditch companies by providing them with updated infrastructure that is more efficient with water delivery. Updated headgates and improved automation / gauging / telemetry are integral to attaining these benefits. Keeping more water in the creek for longer stretches through more efficient water delivery infrastructure, and potential water management and operational changes would improve stream function, and especially existing pool habitat
- Some of the non-flow assessment categories could potentially improve through alternative flow regime management techniques to better mimic natural stream flow conditions. There is a concern that the expansion of Gross Reservoir may dampen the annual peak flows that help maintain a better channel cross-section, and flush fine sediment, reducing embeddedness. Achieving these benefits will be directly related to how the EP is managed / operated
- Increase water movement at the Leggett Canal Complex backwater through flow and water management programs to help reduce algae blooms and invasive plant species, and decreased dissolved oxygen (DO) levels
- Implement recommended updates to the Point Flow Model (as described in Section 2.4) as new data is available – likely 3 to 5 years from now
- Define and implement an overall watershed database and associated analytics for lower SBC

The SBC WSR PH I Report is available at the SMP sharing and learning website**: https://www.coloradosmp.org/**

Riparian/Geomorphology/Aquatic Habitat resulting from the RHA field work:

Stream Bank and Floodplain Improvement will benefit the public and private lands adjacent to SBC, as well as help Boulder OSMP maintain these lands:

- Education outreach regarding landscape and creek-side improvements with private landowners to help improve bankside habitat and reduce disruptions to geomorphology
- Moving recreation trails away from the creek bank and changes in grazing protocols, in conjunction with alternative stock-water sources / modified stock access water gaps, to help protect banks and maintain a natural channel cross section
- Increase streambank native plantings for more structural variation and further improve riparian buffer
- Use fencing to protect new plantings from people and cattle, in an up to 200’ corridor along either side of the creek
- Enhance existing meanders and riffle / pool sequences and stabilize eroding banks to increase riparian buffer in appropriate locations. Protect and, where appropriate, increase the number of pools of one foot or greater for fish habitat, as well as natural structures (boulders, woody structures, undercut banks, canopy)
- Enhance existing meanders and riffle / pool sequences and stabilize eroding banks to increase riparian buffer in appropriate locations.
- Incorporate channel connectivity / aquatic species passage into applicable ditch diversion structures to help reconnect the creek channel, allow for more natural migration patterns and improve overall creek function

Please refer to Exhibit E – RHA Field Assessment – Reach Assessments and Project Recommendations

Overall RHA Functional Score for the Study Area and Sub-Reaches:

Summary Assessment Functional Scores for Lower SBC: *2.0 Partially Functioning*

FUNCTION SCORE				
HIGH	**MODERATE**	**PARTLY**	**POOR**	**NOT**
>3-4	>2-3	>1-2	>0-1	0

REACH		LOWER SOUTH BOULDER CREEK - STREAM FUNCTION ASSESSMENT							
Number	Description	Flow	Riparian		Landscape		Geomorphology	Aquatic Habitat	Overall Assessment
			River Left	River Right	River Left	River Right			
2.1	Eldorado Springs beginning at Farmers Reservoir and Irrigation Company ("FRICO") / Community Diversion and Ditch Structure to 3575 Eldorado Springs Road	2.8	1.0	1.0	1.5	2.0	1.8	1.0	**1.5**
2.2	3575 Eldorado Springs Road (downstream of property line) to Davidson Diversion and Ditch Structure	2.8	3.0	3.0	4.0	3.0	3.0	2.5	**3.1**
2.3	Davidson Diversion and Ditch Structure to Goodhue Diversion and Ditch Structure	2.3	2.3	1.3	3.0	2.0	2.5	1.0	**2.0**
2.4	Goodhue Diversion and Ditch Structure to Dry Creek #2 Ditch Structure	1.8	2.7	2.0	3.0	2.0	2.5	1.5	**2.5**
2.5.1	Dry Creek No. 2 Ditch Structure to Marshallville Diversion and Ditch Structure	1.8	3.0	1.3	2.5	1.0	2.3	2.0	**2.0**
2.5.2	Marshallville Diversion and Ditch Structure to City of Boulder Open Space & Mountain Parks Property Line	1.8	2.3	2.0	1.5	1.5	2.5	2.0	**2.0**
2.6	City of Boulder Open Space & Mountain Parks Property Line to Shearer Diversion and Ditch Structure	1.8	2.0	2.0	3.5	3.0	2.5	2.0	**2.5**
2.7	Shearer Diversion and Ditch Structure to South Boulder Canyon Diversion and Ditch Structure	1.7	1.7	1.7	3.0	3.0	2.3	2.5	**2.5**
2.8	South Boulder Canyon Diversion and Ditch Structure to McGinn Diversion and Ditch Structure	1.7	1.0	2.0	2.5	2.5	2.0	2.5	**2.0**
2.9	McGinn Diversion and Ditch Structure to New Dry Creek Carrier Diversion and Ditch Structure	1.2	1.3	2.3	1.5	1.0	1.8	2.0	**1.5**
3.1.1	New Dry Creek Carrier Diversion and Ditch Structure to Howard Diversion and Ditch Structure	1.2	1.3	2.3	2.0	2.5	1.5	1.0	**1.5**
3.1.2	Howard Diversion and Ditch Structure to Pedestrian Bridge	1.0	2.0	1.7	2.5	3.0	1.8	2.0	**2.0**
3.2.1	Pedestrian Bridge to East Boulder Diversion and Ditch Structure	1.0	2.3	2.3	3.0	3.0	1.8	1.5	**2.0**
3.2.2	East Boulder Ditch to Baseline Road	0.8	2.3	2.3	2.5	2.5	1.5	0.5	**2.0**
3.3	Baseline Road to Wellman Canal Outlet	0.8	2.0	1.0	2.5	1.0	1.8	1.0	**1.1**
3.4	Wellman Canal Outlet to Leggett/Jones-Donnelly Canal Control Structure	1.3	1.0	1.3	0.5	0.5	1.5	1.0	**1.1**
3.5	Leggett/Jones-Donnelly Canal Control Structure to KOA Lake Inlet Structure	1.0	2.3	1.7	1.0	1.0	1.0	0.5	**1.0**
3.6	KOA Lake to Butte Mill Ditch Structure	1.0	1.3	0.7	0.5	0.5	-	-	**0.5**
3.7	Butte Mill Ditch Structure to Boulder Creek Confluence	1.0	1.7	1.7	3.0	2.0	2.0	2.5	**2.0**

Detailed assessments, recommendations and associated future projects are part of this report.
Please refer to Exhibit E – RHA Field Assessment - Reach Assessments and Project Recommendations

Target Flows:

Flow (along with the direct disruption by water diversion infrastructure addressed in the WSR PH I project) is the most significant limiting factor for lower SBC improvement. Overall, 13 out of 19 sub-reaches fell within partly or poorly functioning categories; only sub-reach 2.2 was within the high functioning category. Also, flow conditions tend to worsen in the downstream direction, though there is some variation depending on the parameter being considered. This is especially apparent downstream of South Boulder Road, which is the transition from Segment 2

(the cold-water fishery) to Segment 3 (the warm water fishery). New Dry Creek Carrier ditch diversion structure (NDCC) is directly downstream of South Boulder Road. It diverts water to six (6) ditches and one (1) storage reservoir. These diversions represent some of the most senior rights on lower SBC. NDCC can also sweep-the-creek. Below NDCC is the East Boulder Ditch diversion structure (EBD), which can also sweep-the-creek.

The major flow improvement opportunity is the Environmental Pool for storage and release of water in support of agreed to targeted flow needs. The EP will be constructed as part of the Gross Reservoir expansion project currently underway (5-7 years to complete). The water stored in the EP will be owned by the cities of Lafayette and Boulder and will be filled through existing eastern slope water rights. A Water Delivery Agreement with CWCB is in place. The State Engineer's Office will shepherd these flows for downstream users.

In summary, the cities of Boulder and Lafayette and Denver Water will work together to make releases from Gross Reservoir based on current downstream flows in South Boulder Creek as compared to the IGA targeted flows. Releases will be protected from diversion in the identified Segments by the CWCB and the District 6 Water Commissioner.

There are other opportunities to improve flow, as stated above, by working with water rights' owners, water users and owners of infrastructure to keep more water in the creek for longer stretches through water management and operational changes. Pursing options such as swaps, leases and transfers are all possible routes. Achieving this objective would directly support the Colorado Water Plan goals stated above. Accumulating relatively small amounts of flow over time into this kind of program could add up to significant improvement opportunities. However, these opportunities are currently undefined and will likely take a relatively long period of time to achieve.

Stream Segment	IGA TARGETED FLOWS				CWCB/CPW FLOWS	
	Summer (May–Sept.)		Winter (Oct.–April)		Summer (May–Sept.)	Winter (Oct.–April)
	Average Year	Dry Year	Average Year	Dry Year	All Year Types	
Segment 1						
Gross Reservoir to USGS gauge 06729500	10 cfs	7 cfs	7 cfs	5 cfs	15 cfs (Preserve)	8 cfs (Preserve)
Segment 2						
USGS gage 06729500 to South Boulder Road	10 cfs	7 cfs	7 cfs	5 cfs	15 cfs (Preserve)	8 cfs (Preserve)
Segment 3						
South Boulder Road to confluence with Boulder Creek	4 cfs	2 cfs	2.5 cfs	1.5 cfs	5.8 cfs (Preserve)	2.5 cfs (Preserve)

Extensive work was performed by CWCB and the City of Boulder to establish the IGA target flows. The flows established (earlier in time than the IGA targets) by CWCB / CPW to reach a "preserve" level of environmental protection are higher but are difficult to achieve under the current water management operating regime. So, although targeted flows are currently the best opportunity, we will continue to work in future project phases to find other ways to keep more water in the creek longer, as described above. Even an addition 2 – 3 cfs throughout the dry season would improvement conditions significantly.

2.5. Communications and Outreach

Steering Committee:

The project team worked through the Steering Committee (SC) for most project task-level related communications. The Cities of Boulder and Lafayette are primarily responsible for implementing the IGA with Denver Water. Their presence on the SC, and the access this gave the project team to professional city staff resources, was critical to

success. Denver Water, also on the SC, was an important source of information, data, and assistance during the project.

After a project kick-off meeting on August 12, 2020, formal SC meetings were held every other month. However, it quickly became clear that interaction with the City of Boulder, and to a lesser degree the City of Lafayette, required meeting more often. Waiting two months for group discussions was too long, and too many activities were occurring in the interim. We agreed to hold bi-monthly "check in calls" with the Cities of Boulder and Lafayette to ensure alignment with activities (alternating months with SC meetings). These additional monthly meetings resulted in much closer interaction and reduction in misunderstandings and / or duplicate work.

Ditch / Diversion Structure Owners:

External communications with other stakeholder groups began with direct contact to six (6) of eight (8) high priority diversion structure / ditch owners – Davidson Ditch and Reservoir Company, Goodhue Ditch and Reservoir Company, Marshallville Ditch Company, New Dry Creek Carrier Ditch (serving: Base Line Land and Reservoir Company, Enterprise Irrigating Ditch Company, Dry Creek Davidson Ditch Company, Andrews Farwell Ditch Company, LH Davidson Ditch Company, Leyner Cottonwood Ditch Company, and Cottonwood No. 2 Ditch), Howard Ditch Company, and East Boulder Ditch Company. In all, the project team met on multiple occasions, in the field and / or via video conference, with representatives of all six (6) of the high priority structures. Initially these discussions centered on owner maintenance and operations issues, and then progressed to project objectives for low flow and channel connectivity / aquatic species passage. As work progressed, joint conversations were held to review conceptual design modifications to structures, and incorporation of owners' specific needs. Contact with the two (2) remaining structures (Farmers Reservoir and Irrigation Company (Community Ditch) and Leggett Inlet Canal Complex (XCEL Energy)) occurred later in the project. Discussions with the latter two ditch companies progressed to the point of agreement on high-level concepts and willingness to work together on engineering designs in the future. The lower SBC WSR PH I Report is available at the SMP sharing and learning website**: https://www.coloradosmp.org/**

Other Stakeholders:

The project team met with several other stakeholders from time-to-time, including:

- Worked with 3 different District 6 Water Commissioners over the course of the project. In general, with all of them, the project team walked the creek and discussed issues and diversion structure needs, described the project, and received input on objectives and priorities. The changes in commissioner resulted in repeated efforts to re-introduce each one to the SMP project and to incorporate differing points of view on how to manage in-stream flows from the Environmental Pool. However, there were few substantive changes to the project scope and direction.
- Successfully included Boulder County and City of Louisville to participate more directly in the SMP process
- Conducted a day-long field trip in July 2021 to update advisors and solicit expert input. Participants included: CWCB, CPW, USFWS, City of Boulder and TU.
- Continued dialog with XCEL Energy regarding modifications to their majority owned ditch structures – East Boulder Ditch, Enterprise Ditch, and the Leggett Inlet Canal Complex
- Sent out mailers to 34 proximate landowners along SBC, targeting those along the most important sub-reaches for RHA study. Resulted in direct contact with six landowners.
- Initiated project discussions with Farmers Reservoir and Irrigation Company (Community Ditch) and held on-site meetings.

2.6. Major Project Recommendations

The major projects recommended from SMP PH II are as follows:

Landowner outreach and education regarding landscaping, natural bank stabilization, and stream function disruptions from owner creek-scaping, at scale
- Eight-to-ten-year passive restoration program, primarily on OSMP lands, to include plantings up to 200 ft. of either side of the creek channel, fencing to allow new plantings to mature, and addition of woody structures - Redirection of recreational trails from the immediate creek bank - Modify grazing practices including more directive fencing, seasonal rotations, and other methods - Improve flood plain connectivity - Create more consistent over-wintering pools in the creek channel
Work with Denver Water and SBC water-rights holders to find ways to modify Gross Dam operating regime and various diversion operations to improve the overall flow regime, and leave as much water as legally possibly in the creek longer without jeopardizing water rights. Also investigate smaller water-rights holders to include in a program of transfers, swaps, leases, etc.
- Improve channel connectivity / aquatic species passage though modifications to diversion structures and proximate habitat improvement, which are important to the overall river health. **These assessments and recommendations can be found in the WSR PH I final report.**

Although many of these recommendations were implemented by OSMP on their managed lands in the past, the project team recommendations are at a higher level of scale, involve more sub-reach integration and hence encompass a larger scope.

Please refer to Exhibit E – RHA Field Assessment - Reach Assessments and Project Recommendations

2.7. Project Scope, Schedule, and Task Budget

The project was managed at the task / sub-task level against the budget and schedule estimated, and documented in the grant application Statement of Work (SOW.) This occurred at the beginning of the grant process and was then later adjusted during the State contracting process The project extension granted in February 2022 did not change the SOW. The "Scope of Work and Task Completion" section below uses the language / terms contained in the grant contract. Some terms, language and organization names may differ slightly from those in the body of this report.

<u>Scope of Work and Task Completion</u>

Task 1.0: Execute Stakeholder Communications Plan

- Overview: Stakeholder engagement / expansion accomplished through two sub-task areas: Steering Committee involvement and stakeholder outreach, as defined in the Communications Plan
- Method / Procedure:
    - Execute the Communications Plan:
        - Steering Committee (Direct Project Partners): Coordinated and regularly met with Steering Committee to provide project updates and solicit input and assistance from committee members, which include City of Boulder – Water Utilities Division, City of Boulder – Open Space & Mountain Parks, City of Lafayette – Public Works, Denver Water, TU / Boulder Flycasters, Biohabitats Consulting Team. Meetings were held every other month. Additional meetings were held every other month (when no SC meeting) with cities of Boulder and Lafayette to maintain project coordination

- Core (Directly Affected) Stakeholders: Directly communicated with High Priority Infrastructure Owners and High Priority Water Rights Owners as identified in Communication Plan to continue coordination that started in Phase I. This included 14 ditch companies, 1 reservoir storage company, the City of Louisville, and Xcel Energy
- Secondary (Indirectly Affected) Stakeholders: Initiated and carried out interaction with Other Infrastructure Owners (Ditch Companies and Commercial Entities), Other Water Rights Owners (Other Private, Industrial, Commercial and Municipal Entities), and Proximate Private Landowners as identified in Communication Plan. This included Eldorado Artesian Water, Valle Del Rio, and Arroyo Campo Subdivisions (Prado Drive / Senda Rocosa Street) residential landowners, and Canterbury Subdivision (Old Tale Road / Gaper Road / Cherryvale Road) residential landowners
- Other Related Stakeholders: Informed applicable Conservation / Advocacy / Recreational Groups with a Boulder Creek Watershed Mission and Other Adjacent Private Landowners about project. This included Boulder Watershed Collective, Lefthand Watershed Center, and Preble's Meadow Jumping Mouse Site Conservation Team (US Forest Service)
- ***General Public as Stakeholder: opted to not provide outreach regarding project to the general public at this time based on input from steering committee to not communicate until there would be concrete actions for discussion***
- The Communication Plan also identified an Advisors stakeholder group: the project team worked directly with Colorado Water Conservation Board, Colorado Parks & Wildlife, District Water Commissioner, Colorado TU, Other SMP Projects, and the Metro and South Platte Basin Roundtables. They were consulted throughout the project as needed

- Deliverables:
  - Stakeholder group specific messaging package
  - Stakeholder meetings and related schedules

Task 2.0: Close Data / Criteria Gaps to Support RHA, Flow, and Infrastructure Tasks

- Overview: Use the Gap Assessment from Phase I to gather or obtain the data and target criteria information needed to complete the Flow, RHA, and Infrastructure tasks described below.

- Method / Procedure:
  - Kicked off this task with a coordination meeting (August 2020) to discuss data sources and overall scope. Key participants included staff from municipal partners, CWCB, and CPW, as well as the district water commissioner, our consultants and TU personnel
    - Confirmed use of existing data, reports, and models
    - Developed a daily point-flow model, using the StateMod underlying data where appropriate, state water records and existing rough model from City of Boulder (2020) data sources
    - Developed spreadsheet tool for existing and natural flows on daily time-step.
  - Closed criteria gaps and finalized assessment procedure for River Health Assessment
    - Defined sub-reaches for assessment through collaboration with municipalities, CWCB, CPW, district water commissioner and others as identified. Result was based on CPW Segment schema, and then added reach and sub-reach naming standards
    - Reviewed draft assessment procedure and refined approach based on updated data sources and information.
    - Determined criteria necessary to evaluate remaining categories.
  - Developed "highest practical" scenario representing an undefined but reasonable (in the realm of possibility) future condition of higher in-stream flows than provided by the Environmental Pool IGA
    - Created and discussed potential scenario alternatives

        - Refined "highest practical" opportunities through further discussion with Steering Committee, CWCB, CPW, the district water commissioner and other experts as needed.
        - ***However, there is not enough high-quality data to develop this scenario. The RHA data cannot correlate flow to riparian health in a meaningful way (at the sub-reach and specific improvement level). There is limited data regarding actual flows and significant data from modeled flows, but the riparian channel is so degraded that ANY amount of additional flow would improve conditions. Hence, it is not within the realm of possibility to establish the highest practical scenario as the level of complexity and data to identify potential sources of "leaving more water in the creek longer" is beyond the scope and budget of this project***
        - ***Did not develop a backup plan in the event the Gross Reservoir Expansion project was significantly delayed or unable to obtain necessary permits to proceed, as this resolved in favor of the expansion during the project timeline***
    - Closed data gaps based on final criteria and as identified in Phase I.
        - Reviewed compiled data list and, with stakeholder's assistance, searched for information to fill existing data gaps and add to inventory.
        - In cases where data are not available, adjusted criteria or made assumptions to move forward with available and / or most relevant information.
    - Finalized Infrastructure Assessment
        - Reviewed compiled information on structures, in coordination with WSR PH I project team
        - Added missing information.
- Deliverables:
    - Spreadsheet flow tool (point flow model)
    - Finalized RHA criteria
    - Finalized data compilation / analysis tools
    - Final infrastructure assessment (handoff to the WSR PH I parallel project)

Task 3. 0: Conduct River Health and Environmental Goals Assessment

- Overview: Use the agreed-to methodology from Phase I combined with Phase II data / criteria gap collection in Task 2.0 above. Continue to analyze and update flow targets in conjunction with the RHA. Based on assessment results, complete analysis of restoration opportunities and constraints, and define opportunities / projects.

- Method / Procedure:
    - Performed desktop analysis of stream conditions to evaluate applicable categories and help prepare for field visits (below)
        - Completed Level 1 assessment of RHA categories
    - Conducted field work necessary to complete RHA
        - Prepared field forms for data collection
        - Completed Level 2 assessment for applicable categories that required field assessment and verification
    - Displayed baseline and increased flow target assessment results for river health (using CWCB / CPW derived targets)
        - Produced maps showing results for existing conditions suing ARCGIS
        - ***Were unable to quantify specific sub-reach level increased effects of Environmental Pool Scenario and "highest practical" scenario to river health (see above). However, we were able to identify study area-wide effects***
    - Integrated recreation component
        - Collected recreational use information from OSMP and other identified available sources

        - Included results in restoration analysis, below
    - Completed ecological restoration opportunities analysis
        - Evaluated restoration opportunities and constraints
        - Developed data to support analysis and results
        - Identified potential restoration projects and reviewed with OSMP (the major landowner)
- Deliverables:
    - River Health Assessment results
    - Ecological Restoration analysis results
    - Non-infrastructure project recommendations (see WSR PH I report for infrastructure projects)
    - Supporting statistical analysis

Task 4.0: Program Management and Administration

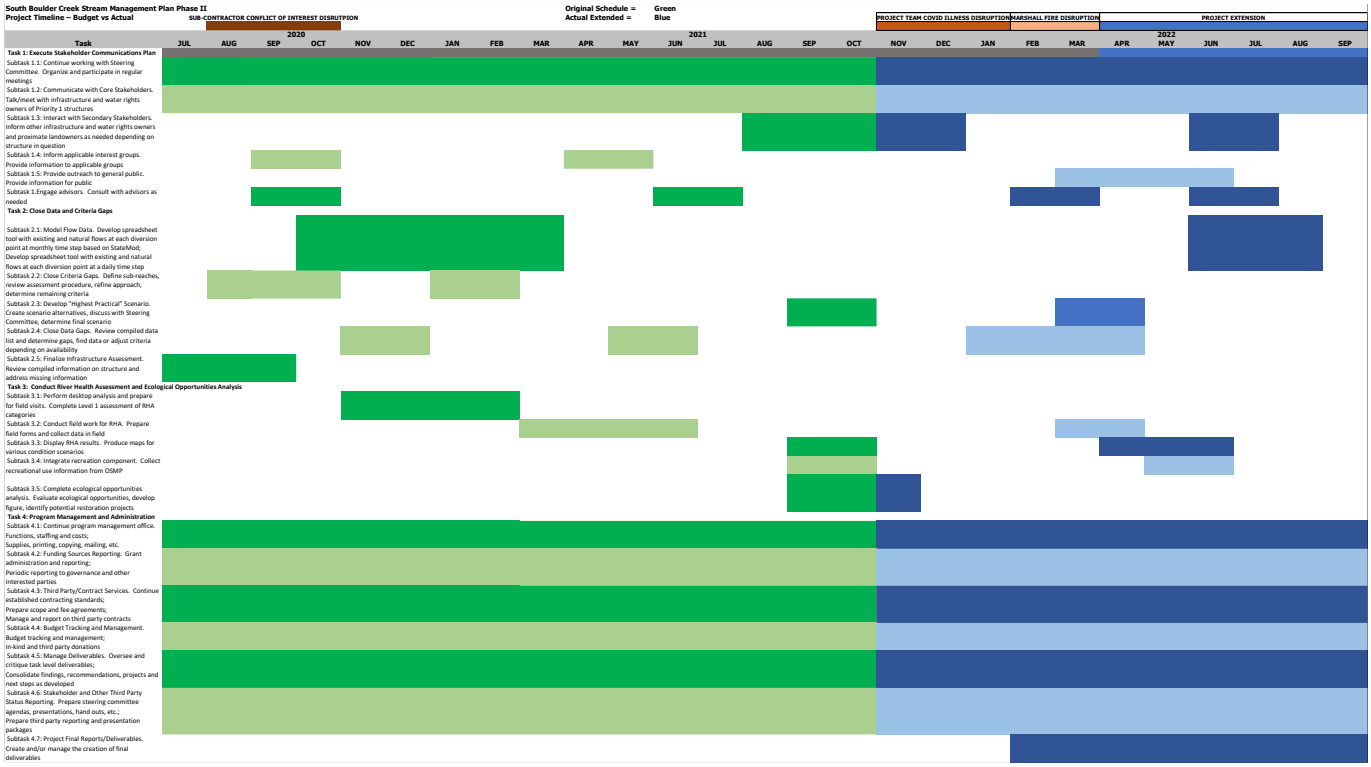
- Overview: Overall management of the project, including budget tracking, periodic reporting, task deliverable tracking, and final deliverables development.
- Method / Procedure:
    - Program Management Office – provided administrative and coordination
    - Funding Sources Reporting
        - Provided grant administration and reporting
        - Provided periodic reporting to governance and other interested parties
    - Third Party / Contract Services
        - Prepared scope and fees agreements / contracts
        - Managed and reported on third party contracts
    - Budget tracking and management
        - Provided budget tracking and management
        - Tracked in-kind and third-party donations (time sheets)
    - Managed Deliverables
        - Oversaw and critiqued task level deliverables
        - Consolidated findings, recommendations, projects, and next steps as developed
    - Stakeholder and Other Third-Party Status Reporting
        - Prepared Steering Committee agendas, presentations, handouts, etc.
        - Prepared third party reporting and presentation packages
    - Project Final Reports / Deliverables
        - Created and / or managed the creation of final deliverables
- Deliverables:
    - Grant Specific Reports
    - Budget Reporting
    - Deliverables Library
    - Final Report

These tasks were completed successfully, and all described deliverables are complete, except for those noted. The project was delivered within the budgets provided in grant documents. The timeline was lengthened by 6 months after setbacks due to COVID and wildfire extenuating circumstances (see below).

Timeline – Actual versus Estimated:

The project suffered several disruptions to the original timeline due primarily to the discovery of New Zealand Mud Snails in SBC, COVID project team illnesses, general COVID societal restrictions, and most recently the Marshall Fire. A project extension was requested and granted by the State of Colorado. These delays are reflected in the changed project schedule and the timing of project tasks.

The project took significantly longer to complete than the original estimated timeline. All tasks and deliverables were completed. However, there was no impact to the project financial budget.



Budget versus Actual – Dollars and Hours:

The project was delivered within the estimated budget. In-kind services match exceeded expectations for volunteer participation.

as of 11/18/2022

Task	Description	Budget		Actual		Variance	
		Cash	In-Kind	Cash	In-Kind	Cash	In-Kind
1	Execute Stakeholder Communications Plan	$ 10,798.17	$ 1,356	$ 8,003.36	$ 2,208	$ 2,795	$ 852
2	Close and Criteria Data Gaps	$ 50,812.75	$ 6,393	$ 69,916.27	$ 10,410	$ (19,104)	$ 4,017
3	Conduct River Health Assessment and Ecological Opportunities Analysis	$ 89,161.88	$ 11,237	$ 74,567.86	$ 18,297	$ 14,594	$ 7,060
4	Program Management and Administration	$ 10,172.19	$ 2,540	$ 16,675.42	$ 4,136	$ (6,503)	$ 1,596
	Project Team Expenses	$ 10,000.01	$ -	$ 1,782.09	$ -	$ 8,218	$ -
TOTALS		**$170,945**	**$ 21,526**	**$ 170,945**	**$ 35,051**	**$ -**	**$ 13,525**

Please refer to Exhibit J – Project Financial and In-Kind Detail Support

Project Funding Sources – Budget versus Actual:

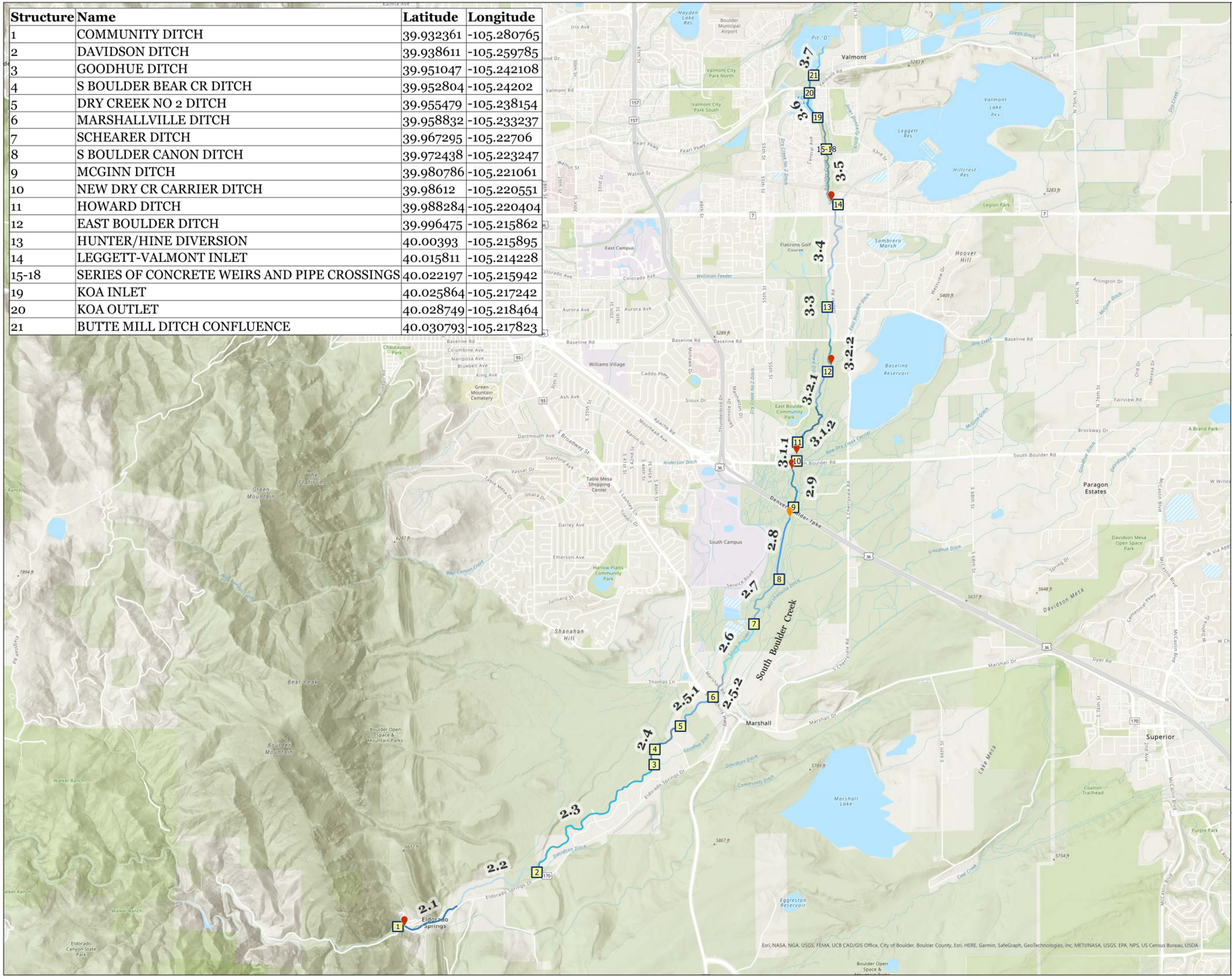
Project costs and in-kind services were allocated proportionately across funding sources.

As of 11/18/22							
SMP PH II FUNDING SOURCE	TYPE	CASH			IN-KIND		
		BUDGET	ACTUAL	VARIANCE	BUDGET	ACTUAL	VARIANCE
Colorado Water Conservation Board	Colorado Water Plan – WSRG/SMP	$95,500	$95,500	$0	$0	$0	$0
Metro Round Table	WSRF Account Grant	$23,875	$23,875	$0	$0	$0	$0
South Platte Basin Round Table	WSRF Account Grant	$23,875	$23,875	$0	$0	$0	$0
Colorado Trout Unlimited	Local Chapter Grants	$5,000	$5,000	$0	$3,976	$588	-$3,388
Boulder Flycasters	Local Chapter Cash Match	$11,461	$11,461	$0	$8,540	$18,788	$10,248
City of Boulder	Cash Match and Staff Support	$0	$0	$0	$6,000	$11,850	$5,850
City of Lafayette	Cash Match and Staff Support	$0	$0	$0	$0	$2,050	$2,050
Denver Water	Cash Match and Staff Support	$10,000	$10,000	$0	$3,000	$1,775	-$1,225
USF&WS	Cash (incremental to CWCB Grant)	$1,234	$1,234	$0	$0	$0	$0
TOTAL		**$170,945**	**$170,945**	**$0**	**$21,516**	**$35,051**	$13,535

3.0 . Exhibits

A. Reach / Sub-Reach Maps and Photos
B. River Health Assessment Methodology
C. Reach Descriptions
D. RHA Field Assessment - Summary Assessment Table
E. RHA Field Assessment - Reach Assessments and Project Recommendations
F. Point Flow Model
G. Data Analysis Graphs and Charts
J. Project Financial and In-Kind Detail Support
K. Project Funding Detail

Structure	Name	Latitude	Longitude
1	COMMUNITY DITCH	39.932361	-105.280765
2	DAVIDSON DITCH	39.938611	-105.259785
3	GOODHUE DITCH	39.951047	-105.242108
4	S BOULDER BEAR CR DITCH	39.952804	-105.24202
5	DRY CREEK NO 2 DITCH	39.955479	-105.238154
6	MARSHALLVILLE DITCH	39.958832	-105.233237
7	SCHEARER DITCH	39.967295	-105.22706
8	S BOULDER CANON DITCH	39.972438	-105.223247
9	MCGINN DITCH	39.980786	-105.221061
10	NEW DRY CR CARRIER DITCH	39.98612	-105.220551
11	HOWARD DITCH	39.988284	-105.220404
12	EAST BOULDER DITCH	39.996475	-105.215862
13	HUNTER/HINE DIVERSION	40.00393	-105.215895
14	LEGGETT-VALMONT INLET	40.015811	-105.214228
15-18	SERIES OF CONCRETE WEIRS AND PIPE CROSSINGS	40.022197	-105.215942
19	KOA INLET	40.025864	-105.217242
20	KOA OUTLET	40.028749	-105.218464
21	BUTTE MILL DITCH CONFLUENCE	40.030793	-105.217823



Lower South Boulder Creek

Stream Management Plan

Boulder, CO

EXHIBIT A

- Channel-spanning Structures
- X.X Subreaches

Water Quality Monitoring Stations

- Boulder Flycasters
- City of Boulder

0 2,500 5,000 Feet

N

Biohabitats

SOUTHERN ROCKY MOUNTAIN BIOREGION

September 2022

Colorado Trout Unlimited and Boulder Flycasters
South Boulder Creek Stream Management Plan Phase II

Exhibit B - River Health Assessment Methodology / Field Assessment Parameters / Score Guide

RHA Component	Measurement Type	Data Source & Notes	Uncertainty, Data & Information Gaps	Scoring Criteria
FLOW REGIME	Compare ratio of existing vs. baseline "no diversion" conditions for following items: -Mean Annual Q -Mean Aug Q -Mean Sept Q -Mean Jan Q -Mean Annual Peak Daily Q -7-Day Min.	SBC Point Flow model	Few gauges below Eldorado Springs with limited length of record. Due to lack of gauges, gains were approximated using results from Rozaklis. 7-day min. data was very spotty.	Grade function level based on percent change from baseline. For example: <10% high functioning 10-20% functioning 20-33% part functioning 33-50% low functioning >50% not functioning
FLOW REGIME	Using mean annual peak results from above, calculate existing peak flows for 1.01-, 1.5-, 2-, and 5-year flow events and compare to natural conditions	Same as above	Peak flows estimated from PFM results.	Grade function level based on percent change from baseline (see above).
BUFFER	System's ability to buffer stream and riparian zone (mainly laterally), measured by land use change	Available Land Use data, Aerial photography, Field observation	Set outer edge of buffer 600' from both sides of creek.	(4) No appreciable land use change (3) Changes have minimal impact on riparian and stream function, e.g., haying, light grazing, low-intensity silviculture, or intensive change in <10% of area (2) Moderate intensity land use e.g., dryland farming, urban green corridors, moderate grazing; not overt source of pollutants or sediment; capacity to support natural stream function largely retained; high-intensity uses 10-40% (1) Considerable urban or fertilizer-rich water runoff; intensive logging; low-density urban development; some urban parkland and ag; artificial or bare area 40-75%

Scores: 4 = High-functioning, 3 = Functioning, 2= Partially functioning, 1 = Poorly functioning, 0 = Not functioning

Exhibit B - River Health Assessment Methodology / Field Assessment Parameters / Score Guide

RHA Component	Measurement Type	Data Source & Notes	Uncertainty, Data & Information Gaps	Scoring Criteria
				(0) Essentially completely developed, severe ecological stress; commercial or highly urban; artificial or bare area >75%
TERRESTRIAL LONGITUDINAL CONNECTIVITY	UNDER REVISION Impairment to migration and dispersal of terrestrial organisms into, out of, and within the reach based on habitat loss and dispersal/migration barriers in the riparian zone	Aerial photos, Field observation, mapping	See criteria description for what constitutes a barrier.	4 - no barriers to up- or downstream movement within a reach or to adjacent reaches 3 - Barriers are easily passed, e.g., gravel roads, minor levees, minor ditches, barbed-wire fences 2 - Dispersal retarded, constrained, and/or hazardous. Busy 2-lane roads, railroads, low-density development 1 - Many species impeded, mortality likely 0 – Impermeable in at least one location
AQUATIC CONNECTIVITY	Impairment of migration/dispersal into, out of, and within the reach	Aerial photos/map with structures Field observations, mapping	Existence of barriers within and at reach endpoints	4 – no barriers 3 – minimal barrier such as natural-bed bridge road crossing 2 – low-flow barrier 1 – nearly impermeable barrier; impacted during both low and high flows 0 – completely isolated reach
WIDTH	Riparian width	Aerial imagery, GIS, field observation	Outer extent of riparian trees – average 8 measurements each subreach	4 – 180+ ft 3 – 80-180 ft 2 – 30-80 ft 1 – 10-30 ft 0 - <10 ft
VEGETATION	Age classes woody species	Mainly field observations Riparian Woodland includes willows		4 – 4 age classes 3 – mature + 2 other classes 2 – seedlings or saplings + mature or decadent 1 – mature or decadent only 0 – no woody species

Scores: 4 = High-functioning, 3 = Functioning, 2= Partially functioning, 1 = Poorly functioning, 0 = Not functioning

Exhibit B - River Health Assessment Methodology / Field Assessment Parameters / Score Guide

RHA Component	Measurement Type	Data Source & Notes	Uncertainty, Data & Information Gaps	Scoring Criteria
	Herbaceous Wetland Presence - **ANCILLARY**		Check box: yes or no. If yes, then enter approx size (and other notes, e.g., patchy)	Qualitative notes
	Number of structural layers		Canopy, sub canopy/shrub, herbaceous	(4) 3 layers well-represented throughout (3) 2-3 w/ uneven distribution (2) essentially 2 layers, woody species highly localized (1) 1-2 layers, woody species poorly distributed (0) 0-1 vegetative layers
MORPHOLOGY	Dimension – Width/Depth ratio S. Boulder Creek should be Rosgen B channel Low W/D-channelized High W/D-too wide	Mainly field observations Cross section data from various sources		Use different ranges of W/D (4) 15 – 20 (3) 12, 25 (2) 9, 30 (1) 7, 40 (0) 5, 50
	Profile Highly functioning B channel should have steep riffles and deep pools Impacted channels tend to have a simplified profile with low gradient riffles and shallow pools	Presence and extent of artificial features that influence stream profile Aerial photos, mapping, field observations	Use professional judgement Steep riffles will be cobble dominated with no embedded Pools should be around 3' deep	Negligible: no grade-impacting structures/features in sub reach Mild: 1 to 2 partially impacting structures Significant: >3 partial or 1 fully impacting structure Severe: Multiple full structures Profound: structure(s) causing permanent ponding
RESILIENCY	Resistance – extent of woody vegetation along bank	Field observations	Professional judgment	Rate based on percent of coverage High – willows thriving on shallow channel banks with willows & cottonwoods on low floodplain Functioning – No vegetation on banks but dense willow & cottonwood on floodplain

Scores: 4 = High-functioning, 3 = Functioning, 2= Partially functioning, 1 = Poorly functioning, 0 = Not functioning

Exhibit B - River Health Assessment Methodology / Field Assessment Parameters / Score Guide

RHA Component	Measurement Type	Data Source & Notes	Uncertainty, Data & Information Gaps	Scoring Criteria
				Partial – cottonwoods only on floodplain with roots holding banks Low – one row of cottonwoods or non-native trees holding banks Non-functioning – no woody species
	Equilibrium – floodplain connectivity	Frequency of overbank flow	Quick entrenchment observation in field	Negligible – overbank flow at or below 1.01-year flow Mild – overbank flow between 1.01- and 2-year flow Significant – overbank flow between 2- and 5-year flow Severe – overbank flow between 5- and 10-year flow Profound – overbank flow > 10-year flow
PHYSICAL STRUCTURE	Macro- and Micro-habitat	Field Assessment – method developed by Ashley	Professional judgment	Rating of 0-4 based on partitioning analysis

Scores: 4 = High-functioning, 3 = Functioning, 2= Partially functioning, 1 = Poorly functioning, 0 = Not functioning

Colorado Trout Unlimited / Boulder Flycasters
Lower South Boulder Creek
Stream Management Plan Phase II

EXHIBIT C - Reach Descriptions
Segment / Reach / Sub- Reach Designation Chart
20. Oct. 2020

SEGMENT PER CPW and IGAs		REACH NOMENCLATURE		Notes	SUBREACH (for flow)		CDPHE Designations	Ditches	Flow Analysis	Straight Line Distance (ft)		Phase I Initial
Name	Description	Number	Description		Number	Description						
SEGMENT 1	Outlet of Gross Reservoir to FRICo Structure	NA for this project		Gauge stations and reservoir release data in this Segment will be used for flow analysis (see point Flow Model).	NA for this project			Denver Water, L&L, Community Ditch	NA	NA		NA
SEGMENT 2	FRICo Structure to New Dry Creek Carrier Structure	2.1	Downstream of FRICo Structure through Eldorado Springs to where creek crosses into 3575 Eldorado Springs Road	Potential location of flow and temp gauges based on Sanitation District actions.	NA		Combined Segments 1 and 2 correspond with CDHPE COSPBO05b_B and Designated Cold Stream Habitat	None	2.1 + 2.3	2500		SBC-06
		2.2	From 3575 Eldorado Springs Road property line to Davidson Ditch Structure (near Mesa Trail Head)	Low flow channel connectivity impeded by weir at Davidson Ditch	NA			Davidson Ditch		3700		
		2.3	Downstream of Davidson Ditch Structure to Goodhue Ditch Structure	Low flow administration and channel connectivity impeded by Goodhue Ditch. Gauge near San Souci	NA			Goodhue Ditch	2.3	6600		SBC-05
		2.4	Downstream of Goodhue Ditch Structure to Dry Creek No. 2 Structure		NA			S. Boulder Bear, Dry Creek No. 2	2.4	2000		
		2.5	Downstream of Dry Creek No. 2 to City OSMP property line	Low flow administration and channel connectivity impeded by Marshallville Ditch.	2.51	DS of Dry Creek No. 2 to Marshallville		Marshallville	2.51	1800	2700	
					2.52	DS Marshallville to property line		None	2.52 + 2.6	900		SBC-04
		2.6	City property line to Schearer Structure		NA			Schearer		2600		
		2.7	Schearer to S. Boulder Canyon Structure		NA			S. Boulder Canyon	2.7	2100		
		2.8	Downstream of S. Boulder Canyon to McGinn Structure (just downstream of US HWY 36)		NA			McGinn	2.8	3100		SBC-03
		2.9	Downstream of McGinn to New Dry Creek Carrier Structure (just downstream of S. Boulder Rd)	Flow and water/air temperature gauges upstream of SBR. Low flow administration and channel connectivity impeded by New Dry Creek Carrier Ditch. In flow point upstream of NDCC.	NA			New Dry Creek Carrier	2.9	1900		
SEGMENT 3	Downstream of New Dry Creek Carrier Structure to Confluence with Boulder Creek	3.1	Downstream of New Dry Creek Carrier to Pedestrian Bridge	Staff Gauge and water/air temperature gauges downstream of NDCC. Low flow administration and channel connectivity impeded by Howard.	3.11	DS of NDCC to Howard Ditch	Segment 3 corresponds with CDHPE COSPBO05_A and Designated Warm Stream Habitat	Howard Ditch	3.11	700	2400	
					3.12	DS of Howard to Pedestrian Bridge		None	3.12 + 3.21	1700		
		3.2	Downstream of Pedestrian Bridge to Baseline Road	Low flow administration and channel connectivity impeded by East Boulder Ditch and aire and water temperature gauges downstream of EBD.	3.21	DS of Pedestrian Bridge to East Boulder Ditch		East Boulder Ditch		1600	2800	
					3.22	DS of EBD to Baseline Rd		None	3.22 + 3.3	1200		SBC-02
		3.3	Downstream of Baseline Road to Wellman Ditch	End this reach at Wellman Ditch to better account for extra water.	NA			Hunter/Hine		2700		
		3.4	From downstream of Wellman Ditch to Leggett Canal Complex	Low flow administration and channel connectivity impeded by Leggett Canal Complex	NA			Wellman Ditch input Leggett	3.4	2900		
		3.5	Downstream of Leggett Canal Complex to KOA Lake inlet	Staff gauge and air / water temperature gauges downstream of Leggett Canal Complex. Low flow administration and channel connectivity impeded by inlet.	NA			None	3.5 + 3.6 + 3.7	3800		SBC-01
		3.6	Downstream KOA Lake inlet to Butte Mill Ditch	Low flow administration and channel connectivity impeded by outlet and Butte Mill	NA			Martin Marietta		1800		
		3.7	Downstream of Butte Mill Ditch to confluence with Boulder Creek		NA			None		1100		

Colorado Trout Unlimited / Boulder Flycasters
Lower South Boulder Creek
Stream Management Plan Phase II

EXHIBIT D - RHA Field Assessment
Summary Assessment Table

9/30/2022

REACH		LOWER SOUTH BOULDER CREEK - STREAM FUNCTION ASSESSMENT							
Number	Description	Flow	Riparian		Landscape		Geomorphology	Aquatic Habitat	Overall Assessment
			River Left	River Right	River Left	River Right			
2.1	Eldorado Springs beginning at Farmers Reservoir and Irrigation Company ("FRICO") / Community Diversion and Ditch Structure to 3575 Eldorado Springs Road	2.8	1.0	1.0	1.5	2.0	1.8	1.0	**1.5**
2.2	3575 Eldorado Springs Road (downstream of property line) to Davidson Diversion and Ditch Structure	2.8	3.0	3.0	4.0	3.0	3.0	2.5	**3.1**
2.3	Davidson Diversion and Ditch Structure to Goodhue Diversion and Ditch Structure	2.3	2.3	1.3	3.0	2.0	2.5	1.0	**2.0**
2.4	Goodhue Diversion and Ditch Structure to Dry Creek #2 Ditch Structure	1.8	2.7	2.0	3.0	2.0	2.5	1.5	**2.5**
2.5.1	Dry Creek No. 2 Ditch Structure to Marshallville Diversion and Ditch Structure	1.8	3.0	1.3	2.5	1.0	2.3	2.0	**2.0**
2.5.2	Marshallville Diversion and Ditch Structure to City of Boulder Open Space & Mountain Parks Property Line	1.8	2.3	2.0	1.5	1.5	2.5	2.0	**2.0**
2.6	City of Boulder Open Space & Mountain Parks Property Line to Shearer Diversion and Ditch Structure	1.8	2.0	2.0	3.5	3.0	2.5	2.0	**2.5**
2.7	Shearer Diversion and Ditch Structure to South Boulder Canyon Diversion and Ditch Structure	1.7	1.7	1.7	3.0	3.0	2.3	2.5	**2.5**
2.8	South Boulder Canyon Diversion and Ditch Structure to McGinn Diversion and Ditch Structure	1.7	1.0	2.0	2.5	2.5	2.0	2.5	**2.0**
2.9	McGinn Diversion and Ditch Structure to New Dry Creek Carrier Diversion and Ditch Structure	1.2	1.3	2.3	1.5	1.0	1.8	2.0	**1.5**
3.1.1	New Dry Creek Carrier Diversion and Ditch Structure to Howard Diversion and Ditch Structure	1.2	1.3	2.3	2.0	2.5	1.5	1.0	**1.5**
3.1.2	Howard Diversion and Ditch Structure to Pedestrian Bridge	1.0	2.0	1.7	2.5	3.0	1.8	2.0	**2.0**
3.2.1	Pedestrian Bridge to East Boulder Diversion and Ditch Structure	1.0	2.3	2.3	3.0	3.0	1.8	1.5	**2.0**
3.2.2	East Boulder Ditch to Baseline Road	0.8	2.3	2.3	2.5	2.5	1.5	0.5	**2.0**
3.3	Baseline Road to Wellman Canal Outlet	0.8	2.0	1.0	2.5	1.0	1.8	1.0	**1.1**
3.4	Wellman Canal Outlet to Leggett/Jones-Donnelly Canal Control Structure	1.3	1.0	1.3	0.5	0.5	1.5	1.0	**1.1**
3.5	Leggett/Jones-Donnelly Canal Control Structure to KOA Lake Inlet Structure	1.0	2.3	1.7	1.0	1.0	1.0	0.5	**1.0**
3.6	KOA Lake to Butte Mill Ditch Structure	1.0	1.3	0.7	0.5	0.5	-	-	**0.5**
3.7	Butte Mill Ditch Structure to Boulder Creek Confluence	1.0	1.7	1.7	3.0	2.0	2.0	2.5	**2.0**

FUNCTION SCORE				
HIGH	MODERATE	PARTLY	POOR	NOT
>3-4	>2-3	>1-2	>0-1	0

Colorado Trout Unlimited and Boulder Flycasters
South Boulder Creek Stream Management Plan PH II
Final Report

Exhibit E - RHA Field Assessment - Reach Assessments and Project Recommendations

Attached are the sub-reach level River Health Assessment results and associated recommended projects for mitigation and improvement of the riparian channel.

A recommended landowner education project spans multiple sub-reaches. This project is described in the first page of this exhibit.

A map (Esri / Arc GIS) of the sub-reaches with pop-up windows containing the sub-reach assessment information is shown in the second page of this exhibit. A representative screenshot of the visualization tool is shown. Each pop-up window contains a summary assessment, and then specific assessment results for flow, geomorphology, landscape, riparian, aquatic habitat, and recreation components of the RHA. The full visualization tool will become available once licensing and model transfer from the project consultants is completed.

Sub-Reaches:

2.1 Downstream of FRICo Structure through Eldorado Springs to where creek crosses into 3575 Eldorado Springs Road

2.2 From 3575 Eldorado Springs Road property line to Davidson Ditch Structure (near Mesa Trail Head)

2.3 Downstream of Davidson Ditch Structure to Goodhue Ditch Structure

2.4 Downstream of Goodhue Ditch Structure to Dry Creek No. 2 Structure

2.5 Downstream of Dry Creek No. 2 to City OSMP property line

2.6 City property line to Schearer Structure

2.7 Schearer to S. Boulder Canyon Structure

2.8 Downstream of S. Boulder Canyon to McGinn Structure (just downstream of US HWY 36)

2.9 Downstream of McGinn to New Dry Creek Carrier Structure (just downstream of S. Boulder Rd)

3.1 Downstream of New Dry Creek Carrier to Pedestrian Bridge

3.2 Downstream of Pedestrian Bridge to Baseline Road

3.3 Downstream of Baseline Road to Wellman Ditch

3.4 From downstream of Wellman Ditch to Leggett Canal Complex

3.5 Downstream of Leggett Canal Complex to KOA Lake inlet

3.6 Downstream KOA Lake inlet to Butte Mill Ditch

3.7 Downstream of Butte Mill Ditch to confluence with Boulder Creek

South Boulder Creek SMP Phase II
River Health Assessment Field Assessment
Private Property Owner Education

Project Narrative

Candidate Reaches: 2.1, 2.3, 2.4, 3.3 and 3.4

Improvement Opportunities: water quality, aquatic habitat, and riparian vegetation could be improved with:

1. An education campaign focused on streamside property owners
    a. Strategies to educate property owners could include community meetings (potentially inviting residents from other reaches), workshops, and requests for property volunteers to host demonstration projects
    b. Education efforts would need to include queries or surveys to ascertain the interest and willingness of property owners to participate in creek improvements, whether passive or active, and other factors
2. And paired with partnering with the City of Boulder, such as:
    a. An OSMP habitat improvement to "match" private efforts
    b. OSMP provides technical support
    c. OSMP provided "group purchases" of plant and landscape materials

Targeted "neighborhoods" include:

- The town of Eldorado Springs creek-side property owners (sub-reach 2.1)
- Property owners along the south side of creek in the Marshall / Eldorado Springs (upstream of Valle Del Rio), Valle Del Rio (Prado Drive / La Mesa Drive), and Marshall / Eldorado Springs (Senda Rocosa Drive, Senda Rocosa Street, Saddleback Lane) sub-divisions up to US HWY 93 (sub-reaches 2.3 and 2.4)
- The creek-side properties along Gaptor Road (east side) and Old Tale Road (west side), and between Baseline Road (south) and Arapahoe Road (north) (sub-reaches 3.3 and 3.4)

Potential Partners: Left Hand Watershed Center may provide an effective model or lessons for outreach, and / or could be incorporated into the LHWC managed Adaptive Management at Scale initiative for the St. Vrain watershed (which includes the overall Boulder Creek watershed)

Targeted Improvements: water quality, aquatic habitat, riparian vegetation, community stewardship via engagement/investment. Additionally, stewardship can scale up with increasing individual participation.

Projected lead time (est.): an education campaign could be organized in 1-3 months. With follow on improvement projects over the next 2 – 3 (or more) years

Projected cost (est.): *TBD*

Challenges:

- Lack of a "critical mass" of private landowners to achieve meaningful watershed health improvements
- Conflicting goals and / or desires for Creekside landscaping
- Capacity of local organization to coordinate and create continuity over several years
- Funding

Potential Funding Sources: Colorado Watershed Assembly, CWCB, partnering with other environmental groups (Duck Unlimited, Audubon Society, Nature Conservatory, etc.)

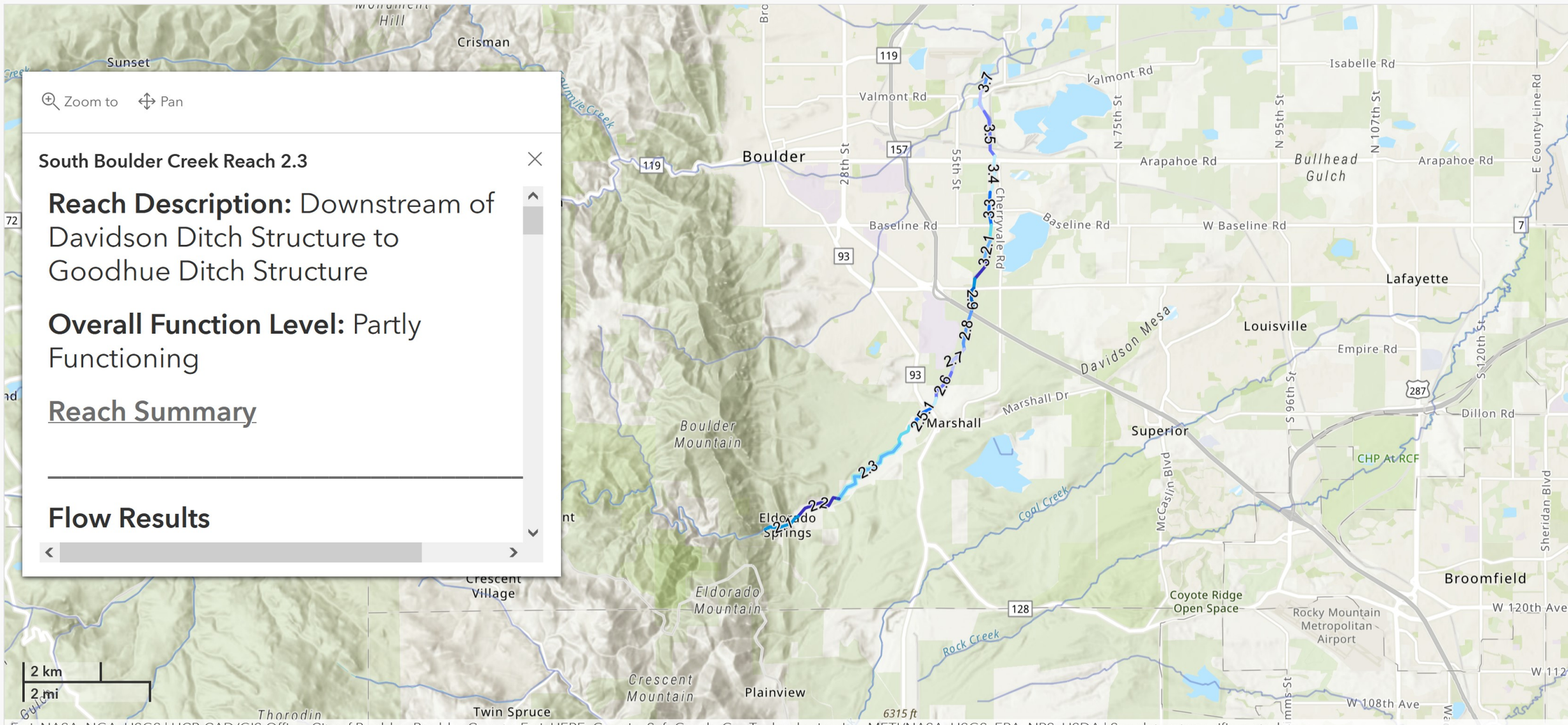
Lower South Boulder Creek RHA Results 2022 V02 — Mozilla Firefox

File Edit View History Bookmarks Tools Help

New Tab | Lower South Boulder Creek RHA

https://biohabitats.maps.arcgis.com/apps/dashboards/e00e9153eb794d428b3d6f4151cee3c4

Lower South Boulder Creek River Health Assessment Results



Reach 2.1 Eldorado Springs beginning at Farmers Reservoir and Irrigation Company ("FRICO") / Community Diversion and Ditch Structure to 3575 Eldorado Springs Road

Summary: Private (residential and commercial) properties line most of both sides of the creek, which is highly channelized and armored. Community Ditch diversion at upstream end is a 9'- high dam.

Overall Condition: Partly Functioning

Improvement Potential: Low

Preliminary Project Priority and Time Frame: Low (no time frame)

Ratings

Flow		2.8 functioning
Riparian	Left	1.0 poorly functioning
	Right	1.0 poorly functioning
Landscape	Left	1.5 partly functioning
	Right	2.0 partly functioning
Geomorphology		1.8 partly functioning
Aquatic Habitat		1.0 poorly functioning
Recreation		(No public access)

>3-4 = High-functioning, >2-3 = Functioning, >1-2 = Partly functioning, >0-1 = Poorly functioning, 0 = Not functioning

Improvement Opportunities: Education outreach regarding landscape and creek-side improvements with private landowners. None within the project planning (3 years) horizon of this assessment. Longer term potential for aquatic connectivity / fish passage and channel improvement at the FRICO structure (currently not considered practical given size of structure, complexity of geomorphology, and cost implications).

Recommended Project: None within the project planning (3 years) horizon of this assessment, although property owners should be included with community education efforts in other reaches. See Education Outreach Project Narrative.

Detailed Observations: Most of the reach is private property with numerous owners. Historic modifications are significant, the channel hardened by walls and debris, and resulting floodplain connectivity is poor. In-stream structures, many simply stacked rock to create drops and pools, but also some relatively permanent, restrict channel connectivity, and creek function. Riparian trees are all mature to decadent, with no apparent younger generations, and a sparse understory. Aquatic connectivity / fish passage is low with a 9'-high dam at the upstream end of the reach. Although Eldorado Springs is a small town, S. Boulder Creek collects all the runoff, compounding other water quality stressors.

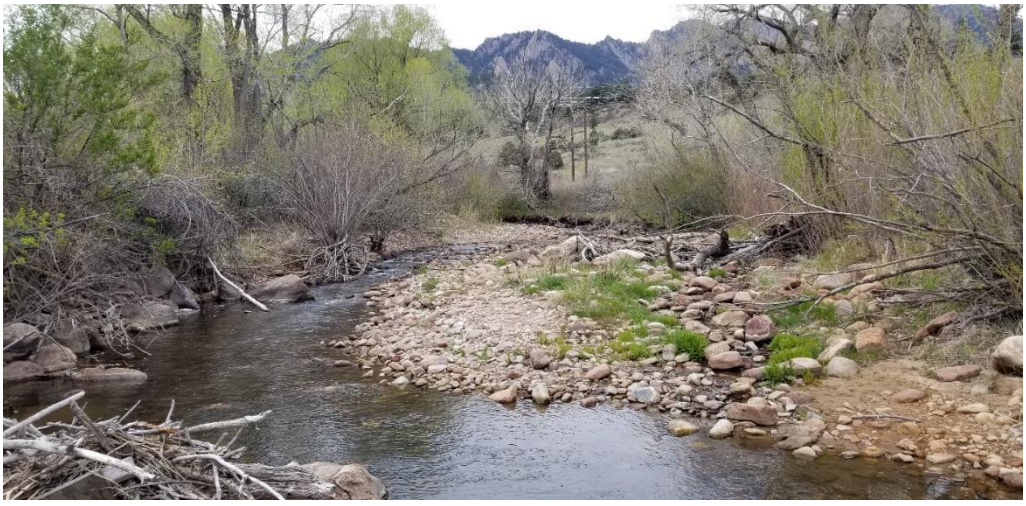
Reach 2.2 3575 Eldorado Springs Road (downstream of property line) to Davidson Diversion and Ditch Structure

Summary: Reach 2.2 is one of the highest-quality reaches within the study area stretch. Development to the north and the south is minimal, and floodplain connectivity is good. The Davidson diversion is at the downstream end.

Overall Condition: Functioning

Improvement Potential: Medium

Preliminary Project Priority and Time Frame: Low, 2025+



Ratings

Flow		2.8 functioning
Riparian	Left	3.0 functioning
	Right	3.0 functioning
Landscape	Left	4.0 high functioning
	Right	3.0 functioning
Geomorphology		3.0 functioning
Aquatic Habitat		2.5 functioning
Recreation		no impact / limited access

>3-4 = High-functioning, >2-3 = Functioning, >1-2 = Partly functioning, >0-1 = Poorly functioning, 0 = Not functioning

Improvement Opportunities: Increase streambank plantings for more structural variation and further improve floodplain connectivity. Removal of invasive species, especially crack willow (Salix Fragilis). Long-term / low priority compared to other reaches.

Recommended Project: None within the project planning (3 years) horizon of this assessment, although plant installation could be relatively low-cost, the benefits would not be as measurable without more expensive grading to optimize floodplain connectivity, possibly in conjunction with aquatic connectivity / fish passage efforts at the Davidson diversion and ditch structure (future engineering / construction project).

Detailed Observations: Although much of Reach 2.2 is privately owned, development is minimal, and this reach represents a very natural channel. Floodplain connectivity is good, and an adequate margin of thriving and regenerating riparian vegetation provides resistance to bank erosion. Upland connectivity within the reach is mostly unimpeded. Emergent wetlands are on an upland terrace on the south side. Water chemistry is likely compromised from upstream stressors. The Davidson diversion and ditch is a barrier to aquatic connectivity / fish passage at low flows. For potential improvements, plant installation could be relatively low-cost, but the benefits would not be as measurable without more expensive grading to optimize floodplain connectivity.

Reach 2.3 Davidson Diversion and Ditch Structure to Goodhue Diversion and Ditch Structure

Summary: Private residential property lines the right / south bank and occupies some parts of the left / north bank as well. City of Boulder Open Space & Mountain Parks (OSMP) property dominates the landscape on the north side and supports minor grazing. Davidson and Goodhue diversions are at upstream and downstream ends, respectively.

Overall Condition: Partly Functioning

Improvement Potential: Medium

Preliminary Project Priority and Time Frame: High, 2022 – 2023

Ratings

Flow		2.3 functioning
Riparian	Left	2.3 functioning
	Right	1.3 partly functioning
Landscape	Left	3.0 functioning
	Right	2.0 partly functioning
Geomorphology		2.5 functioning
Aquatic Habitat		1.0 poorly functioning
Recreation		No impact / few points of access

>3-4 = High-functioning, >2-3 = Functioning, >1-2 = Partly functioning, >0-1 = Poorly functioning, 0 = Not functioning

Improvement Opportunities: Water quality, aquatic habitat, and riparian vegetation; community stewardship

Recommended Project: An education campaign focused on streamside property owners, paired with a City of Boulder OSMP partnership. See Education Outreach Project Narrative.

Detailed Observations: Landscaping (mostly on the right / south bank) and lawn care are presumed to be conventional, and with negative impacts to water quality. Some properties have walls along the bank (see photo). In-stream structures, many simply stacked rock to create drops and pools, but also some relatively permanent, restrict channel connectivity and creek function. Water quality impacts on the north side from OSMP grazing are likely negligible due to fencing. Long, shallow pools and few riffles characterize aquatic habitat, and diversions at upstream and downstream ends impede aquatic connectivity / fish passage. Although floodplain connectivity is only mildly impaired, there is no vegetation on the lower banks, and riparian trees are all mature to decadent. Vegetation on the right (residential) bank is characterized by canopy species and an herbaceous understory with no subcanopy, while the left (open space) bank has several layers well-represented. There are some very limited occurrences of obligate wetland species (speedwell, *Veronica* sp.) on the left bank.

Reach 2.4 Goodhue Diversion and Ditch Structure to Dry Creek #2 Ditch Structure

Summary: This is a relatively short reached characterized by private residential property on the right/south bank, and OSMP property, or undeveloped private parcels, on the left/north bank. OSMP property supports minor grazing. The Goodhue and Dry Creek No. 2 diversions are at the upstream downstream ends, respectively.

Overall Condition: Functioning

Improvement Potential: Medium

Preliminary Project Priority and Time Frame: High, 2022 – 2023

Ratings

Flow		1.8 partly functioning
Riparian	Left	2.7 functioning
	Right	2.0 partly functioning
Landscape	Left	3.0 functioning
	Right	2.0 partly functioning
Geomorphology		2.5 functioning
Aquatic Habitat		1.5 partly functioning
Recreation		No impact / limited points of access

>3-4 = High-functioning, >2-3 = Functioning, >1-2 = Partly functioning, >0-1 = Poorly functioning, 0 = Not functioning

Improvement Opportunities: Water quality, aquatic habitat, and riparian vegetation; community stewardship

Recommended Project: An education campaign focused on streamside property owners, paired with a City of Boulder OSMP partnership. See Education Outreach Project Narrative.

Detailed Observations: Landscaping on the right/south bank and lawn care are presumed to be conventional and with negative impacts to water quality. Some properties have walls along the bank (see photo). In-stream structures, many simply stacked rock to create drops and pools, but also some relatively permanent, restrict channel connectivity and creek function. Water quality impacts on the north side from OSMP grazing are likely negligible due to fencing. Goodhue diversion at upstream end impedes aquatic connectivity / fish passage. Riparian vegetation on the left (open space) bank represents diverse structure while that on the right (residential / private) bank is more homogeneous. Floodplain connectivity is mildly impeded. Private property spans both sides of the creek in some areas.

Reach 2.5.1 Dry Creek No. 2 Ditch Structure to Marshallville Diversion and Ditch Structure

Summary: Landscape and riparian conditions with upstream OSMP parcels are relatively good due to low disturbance and development. The downstream portion of the reach has adjacent lawns. Dry Creek No. 2 ditch, and a 6-foot grade diversion control structure (Marshallville diversion and ditch), are at upstream and downstream ends, respectively.

Overall Condition: Partly Functioning

Improvement Potential: Medium

Preliminary Project Priority and Time Frame: High, 2022 – 2023

Ratings

Flow		1.8 partly functioning
Riparian	Left	3.0 functioning
	Right	1.3 partly functioning
Landscape	Left	2.5 functioning
	Right	1.0 poorly functioning
Geomorphology		2.3 functioning
Aquatic Habitat		2.0 partly functioning
Recreation		No impact / limited points of access

>3-4 = High-functioning, >2-3 = Functioning, >1-2 = Partly functioning, >0-1 = Poorly functioning, 0 = Not functioning

Improvement Opportunities: Water quality, aquatic habitat, and riparian vegetation; community stewardship

Recommended Project: An education campaign focused on streamside property owners, paired with a City of Boulder OSMP partnership. See Education Outreach Project Narrative.

Detailed Observations: Ownership is approximately evenly divided between City of Boulder and private property. Stressors to the creek are greater in the downstream portion where there is more development including lawns, road crossing, and paving in the surrounding landscape. In-stream structures built by property owners, many simply stacked rock to create drops and pools, but also some relatively permanent, restrict channel connectivity and creek function. There is grazing in the reach that causes localized degradation (see photo) but, in general, fencing keeps livestock out of the channel with ample buffer. Riparian vegetation is structurally diverse and landscape connectivity is fair. Marshallville diversions at downstream end impedes aquatic connectivity / fish passage, except at very high flows.

Reach 2.5.2 Marshallville Diversion and Ditch Structure to City of Boulder Open Space & Mountain Parks Property Line

Summary: Very narrow area hemmed in by Hwy 93 / Marshallville diversion structure to the west, private properties to the north and south, and Marshall Road / private lands to the east. The section downstream of Marshall Road runs entirely through private land and is in better overall condition than the upstream portion. Minimal opportunity for improvement (OSMP personnel state that large private landowner performed reasonable mitigation after the 2013 flood).

Overall Condition: Partly Functioning (Poorly Functioning, upstream; Functioning, downstream)

Improvement Potential: Low

Preliminary Project Priority and Time Frame: Low (no time frame)

Ratings

Flow		1.8 partly functioning
Riparian	Left	2.3 functioning
	Right	2.0 partly functioning
Landscape	Left	1.5 partly functioning
	Right	1.5 partly functioning
Geomorphology		2.5 functioning
Aquatic Habitat		2.0 partly functioning
Recreation		No impact / no access

>3-4 = High-functioning, >2-3 = Functioning, >1-2 = Partly functioning, >0-1 = Poorly functioning, 0 = Not functioning

Improvement Opportunities: No practical opportunities; private property owners reluctant to participate. Largest property owner (presenting 75%+ of this sub-reach) previously cooperated with City of Boulder OSMP but did not allow access for this assessment.

Recommended Project: None within the project planning (3 years) horizon of this assessment, although possible longer-term potential for stream bank and channel improvement.

Detailed Observations: Scoring reflects functional averages of up- and downstream reaches, which are lower and higher functioning, respectively. Hwy 93 and Marshall Road (see photos) impact aquatic and terrestrial connectivity, water quality, and related land use. The Marshallville diversion grade control structure at the upstream end is a barrier to aquatic connectivity / fish passage. Floodplain connectivity is fair, although banks appear artificially high. Upstream landscaping and lawn care are presumed to be conventional, and with negative impacts to water quality. Riparian trees are maturing to decadent. Low herbaceous understory is throughout, and a subcanopy layer is mostly restricted to the left (north) bank. Downstream private property was not accessible for direct assessment. However, past interactions between property owner and City of Boulder Open Space & Mountain Parks indicate that the channel morphology and stream bank vegetation are in good shape, relative to the reaches in this study, and might be rated as “functioning.”

Reach 2.6 City of Boulder Open Space & Mountain Parks Property Line to Shearer Diversion and Ditch Structure

Summary: There is variation between reaches 2.6 to 2.9, but, in general, these reaches are somewhat entrenched, relatively open with few woody areas and cattle grazing, but with potential for effective, short-term action. This reach runs entirely through City of Boulder Open Space & Mountain Parks (OSMP) land.

Overall Condition: Functioning

Improvement Potential: Medium

Preliminary Project Priority and Time Frame: Medium, 2022 – 2032

Ratings

Flow		1.8 partly functioning
Riparian	Left	2.0 partly functioning
	Right	2.0 partly functioning
Landscape	Left	3.5 high functioning
	Right	3.0 functioning
Geomorphology		2.5 functioning
Aquatic Habitat		2.0 partly functioning
Recreation		No impact / access restricted by fencing

>3-4 = High-functioning, >2-3 = Functioning, >1-2 = Partly functioning, >0-1 = Poorly functioning, 0 = Not functioning

Improvement Opportunities: Strategically fence out cattle and provide an alternative water source(s). Removal of invasive species, especially crack willow (Salix Fragilis). Plant native woody species along creek to provide bank protection, cover, and buffer.

Recommended Project: OSMP cattle grazing managed with fencing to protect new plantings, plantings up to 200' along creek, buried woody stabilization structures - "10-year passive restoration project"

Detailed Observations: Creek is moderately entrenched with moderate bank erosion due to lack of woody vegetation. Upper reach has some larger tree patches along creek. Lower reach has few trees and cattle have access to creek causing bank erosion and over-wide channel dimensions. Most trees are mature cottonwoods with little opportunity for seedling establishment. Shearer diversion at downstream end of reach supports aquatic connectivity / fish passage, although that passage may be difficult for some small, native fish species.

Project Narrative: Riparian vegetation, bank erosion, water quality, floodplain access, and aquatic habitat could be improved by installing fences to keep cattle out of the creek and the riparian buffer. Excluding cattle from the creek would entail installation of alternative watering methods. Long rooted nursery stock should be utilized, or regular nursery stock installed in extra deep planting pits to ensure roots reach groundwater. Plantings may require supplemental watering for the first few years. Some eroding banks should be graded / stabilized to ensure vegetation establishment. This may include the installation of toe wood to provide bank stabilization, provide aquatic habitat, and add large wood to the system. More frequent floodplain access could be achieved by installing large wood structures in the creek. These engineered log structures mimic woody debris jams – essentially raising the channel invert, creating deeper pools, and adding large wood into the system.

Projected lead time (est.):

Planting only: 6 – 12 months if plants are available; 24 months if grow-hold agreement with nursery
Planting/grading: 12 – 24 months to obtain permits (Army Corps, City of Boulder, Boulder County)

Projected cost (est.):

Fencing: 5000 LF barbed wire @ $4/LF = $20,000
Removal of invasive species, especially crack willow (Salix Fragilis) ($2,500 - $3,000 / tree)
Planting: 10 acres woody species (100' each side x 2200') @ $20,000/Ac = $200,000
Large wood structures and bank stabilization: $100,000

Challenges: Changes to grazing practices, including establishing alternative watering sources for cattle (versus "water gaps"), and managing grazing seasonality and stocking rates within grazing lease terms. These factors will need to be weighed against riparian health benefits. Installation of wood structures would require an involved permitting process.

Potential Funding Sources: CWCB (SMP Implementation)

Reach 2.7 Shearer Diversion and Ditch Structure to South Boulder Canyon Diversion and Ditch Structure

Summary: There is variation between reaches 2.6 to 2.9, but, in general, these reaches are somewhat entrenched, relatively open with few woody areas and cattle grazing, but with potential for effective short-term action. This reach runs entirely through City of Boulder Open Space & Mountain Parks (OSMP) land.

Overall Condition: Functioning

Improvement Potential: Medium

Preliminary Project Priority and Time Frame: Medium, 2022 – 2032

		Ratings
Flow		1.7 partly functioning
Riparian	Left	1.7 partly functioning
	Right	1.7 party functioning
Landscape	Left	3.0 functioning
	Right	3.0 functioning
Geomorphology		2.3 functioning
Aquatic Habitat		2.5 functioning
Recreation		No impact / access limited by fencing

>3-4 = High-functioning, >2-3 = Functioning, >1-2 = Partly functioning, >0-1 = Poorly functioning, 0 = Not functioning

Improvement Opportunities: Strategically fence out cattle and provide an alternative water source(s). Removal of invasive species, especially crack willow (Salix Fragilis). Plant native woody species along creek to provide bank protection, cover, and buffer.

Recommended Project: OSPM cattle grazing managed with fencing to protect new plantings, plantings up to 200' along creek, buried woody stabilization structures - "10-year passive restoration project"

Detailed Observations: Creek is moderately entrenched with moderate bank erosion due to lack of woody vegetation. Reach has few trees and cattle have access to creek causing bank erosion and over-wide channel dimensions. Most trees are mature cottonwoods with little opportunity for seedling establishment. South Boulder Canyon diversion at downstream end of Reach is a partial barrier to aquatic connectivity / fish passage during low flow conditions, and may be difficult to pass small, native fish species during optimal flow conditions.

Project Narrative: Riparian vegetation, bank erosion, water quality, floodplain access, and aquatic habitat could be improved by installing fences to keep cattle out of the creek and the riparian buffer. Excluding cattle from the creek would entail installation of alternative watering methods. Fencing should be placed to allow cattle access to some existing shade trees. Long rooted nursery stock should be utilized, or regular nursery stock installed in extra deep planting pits to ensure roots reach groundwater. Some eroding banks should be graded / stabilized to ensure vegetation establishment. This may include the installation of toe wood to provide toe stabilization, provide aquatic habitat, and add large wood to the system. More frequent floodplain access could be achieved by installing large wood structures in the creek. These engineered log structures mimic woody debris jams – essentially raising the channel invert, creating deeper pools, and adding large wood into the system.

Projected lead time (est.):

Planting only: 6 – 12 months if plants are available; 24 months if grow-hold agreement with nursery.
Planting/grading: 12 – 24 months to obtain permits (Army Corps, City of Boulder, Boulder County)

Projected cost (est.):

Fencing: 5000 LF barbed wire @ $4/LF = $20,000
Removal of invasive species, especially crack willow (Salix Fragilis) ($2,500-$3,000 / tree)
Planting: 10 acres woody species (100' each side x 2200') @ $20,000/Ac = $200,000
Large wood structures and bank stabilization: $100,000

Challenges: Changes to grazing practices, including establishing alternative watering methods for cattle (versus "water gaps") and managing grazing seasonality and stocking rates within grazing lease terms. These factors will need to be weighed against riparian health benefits.

Reducing the bank / berm would require extensive flood plain engineering work and a lengthy permitting process.

Potential Funding Sources: CWCB (SMP Implementation)

Reach 2.8 South Boulder Canyon Diversion and Ditch Structure to McGinn Diversion and Ditch Structure

Summary: There is variation between reaches 2.6 to 2.9, but, in general, these reaches are somewhat entrenched, relatively open with few woody areas and cattle grazing, but with potential for effective, short-term action. These reaches run entirely through City of Boulder Open Space & Mountain Parks (OSMP) land.

Overall Condition: Partly Functioning

Improvement Potential: Medium

Preliminary Project Priority and Time Frame: Medium, 2022 – 2032

Ratings

Flow		1.7 partly functioning
Riparian	Left	1.0 poorly functioning
	Right	2.0 partly functioning
Landscape	Left	2.5 functioning
	Right	2.5 functioning
Geomorphology		2.0 partly functioning
Aquatic Habitat		2.5 functioning
Recreation		No impact / access limited by fencing

>3-4 = High-functioning, >2-3 = Functioning, >1-2 = Partly functioning, >0-1 = Poorly functioning, 0 = Not functioning

Improvement Opportunities: Enhance riparian buffer and aquatic habitat.

Recommended Project: Removal of invasive species, especially crack willow (Salix Fragilis). Plant native vegetation to expand and diversify riparian buffer. Install boulder structures and large wood structures to enhance aquatic habitat.

Detailed Observations: This reach has been channelized. It is highly entrenched and very straight. It does have a narrow riparian buffer of mostly mature cottonwoods. Some willows growing at downstream end where sediment aggradation occurs due to over-wide opening at US 36. Little bank erosion due to trees stabilizing channel banks. McGinn diversion at downstream end of reach has a sculpted concrete fishway but it is a partial barrier to aquatic connectivity / fish passage during low flow conditions. Cattle do not have access to this reach. It is accessible to the public, but most people stay on the trail.

Project Narrative: The floodplain is 8' to 10' above channel due to past channelization. This severe entrenchment makes it difficult for any potential improvements to be successful. Establishing woody vegetation that high above groundwater would be difficult without several years of irrigation. In-channel structures would have to be hardened to withstand shear stresses during very high flows. A combination of raising the channel invert and grading to create floodplain benches in appropriate areas would decrease shear stress to allow for large wood structures and improved aquatic habitat.

Projected lead time (est.):

Planting/grading: 12 – 24 months to obtain permits (Army Corps, City of Boulder, Boulder County)

Projected cost (est.):

Removal of invasive species, especially crack willow (Salix Fragilis) ($2,500 – $3,000 / tree)
Planting: 14 acres woody species @ $20,000/Ac = $280,000
Large wood structures and bench grading: $200,000

Challenges: The entrenched condition of the channel creates very high shear stresses in channel during high flows. Combination of known threatened species such as Ute-ladies'-tresses orchid (*Spiranthes diluvialis*) and impacts to regulated floodplain significantly complicate potential restoration projects. Reducing the bank / berm would require extensive flood plain engineering work and a lengthy permitting process. Any bank / berm changes would need to be assessed against the potential impact on existing cottonwood tree population.

Potential Funding Sources: CWCB (SMP Implementation)

Reach 2.9 McGinn Diversion and Ditch Structure to New Dry Creek Carrier Diversion and Ditch Structure

Summary: There is variation between reaches 2.6 to 2.9, but, in general, these reaches are somewhat entrenched, relatively open with few woody areas and cattle grazing, but with potential for effective short-term action. This reach runs entirely through City of Boulder Open Space & Mountain Parks (OSMP) land.

Overall Condition: Partly Functioning

Improvement Potential: Medium

Preliminary Project Priority and Time Frame: Medium, 2022 – 2032

Ratings

Flow		1.2 partly functioning
Riparian	Left	1.3 partly functioning
	Right	2.3 functioning
Landscape	Left	1.5 partly functioning
	Right	1.0 poorly functioning
Geomorphology		1.8 partly functioning
Aquatic Habitat		2.0 partly functioning
Recreation		No impact / access limited by fencing

>3-4 = High-functioning, >2-3 = Functioning, >1-2 = Partly functioning, >0-1 = Poorly functioning, 0 = Not functioning

Improvement Opportunities: Strategically fence out cattle and provide alternative water source(s). Removal of invasive species, especially crack willow (Salix Fragilis). Plant native woody species along creek to provide bank protection, cover, and buffer.

Recommended Project: OSPM cattle grazing managed with fencing to protect new plantings, plantings up to 200' along creek, buried woody stabilization structures - "10-year passive restoration project"

Detailed Observations: The creek is moderately entrenched with moderate bank erosion due to lack of woody vegetation. This reach has few trees and cattle have access to creek causing bank erosion and over-wide channel dimensions. This reach is also accessible to the public, although most people stay on the trail. Most trees are mature cottonwoods with little opportunity for seedling establishment. There are some patches of willows in upstream reach. New Dry Creek Carrier diversion at downstream end of reach is a barrier to aquatic connectivity / fish passage and often sweeps the creek.

Project Narrative: Riparian vegetation, bank erosion, water quality, floodplain access, and aquatic habitat could be improved by installing fences to keep cattle out of the creek and the riparian buffer. Excluding cattle from the creek would entail installation of alternative watering methods. Fencing should be placed to allow cattle access to some existing shade trees. Long rooted nursery stock should be utilized, or regular nursery stock installed in extra deep planting pits to ensure roots reach groundwater. Some eroding banks should be graded / stabilized to ensure vegetation establishment. This may include the installation of toe wood to provide toe stabilization, provide aquatic habitat, and add large wood to the system. More frequent floodplain access could be achieved by installing large wood structures in the creek. These engineered log structures mimic woody debris jams – essentially raising the channel invert, creating deeper pools, and adding large wood into the system.

Projected lead time (est.):

Planting only: 6 – 12 months if plants are available; 24 months if grow-hold contract with nursery
Planting/grading: 12 – 24 months to obtain permits (Army Corps, City of Boulder)

Projected cost (est.):

Fencing: 2000 LF barbed wire @ $4/LF = $8,000
Removal of invasive species, especially crack willow (Salix Fragilis) ($2,500 - $3,000 / tree)
Planting: 10 acres woody species @ $20,000/Ac = $200,000

Large wood structures and bank stabilization: $100,000

Challenges: Changes to grazing practices, including establishing alternative watering sources for cattle (versus "water gaps"), and managing grazing seasonality and stocking rates within grazing lease terms. These factors will need to be weighed against riparian health benefits. Installation of wood structures would require an involved permitting process.

Potential Funding Sources: CWCB (SMP Implementation)

Reach 3.1.1 New Dry Creek Carrier Diversion and Ditch Structure to Howard Diversion and Ditch Structure

Summary: Significant disruption of flow at New Dry Creek Carrier (NDCC) diversion structure. 100% within City of Boulder Open Space & Mountain Parks (OSMP) land but interlaced with recreation trails that present opportunity for channel and habitat improvement.

Overall Condition: Partly Functioning

Improvement Potential: Medium

Preliminary Project Priority and Time Frame: High, 2022 – 2027

Ratings

Flow		1.2 partly functioning
Riparian	Left	1.3 partly functioning
	Right	2.3 functioning
Landscape	Left	2.0 partly functioning
	Right	2.5 functioning
Geomorphology		1.5 partly functioning
Aquatic Habitat		1.0 poorly functioning
Recreation		No impact

>3-4 = High-functioning, >2-3 = Functioning, >1-2 = Partly functioning, >0-1 = Poorly functioning, 0 = Not functioning

Improvement Opportunities: Enhance riparian buffer and aquatic habitat.

Recommended Project: In conjunction with downstream Reach 3.1.2, create floodplain benches and install large wood structures to enhance aquatic habitat.

Detailed Observations: This reach has been channelized. It is highly entrenched and very straight. It does have a narrow riparian buffer of mostly mature cottonwoods. Little bank erosion due to trees stabilizing channel banks. The Reach is isolated due to aquatic connectivity / fish passage barriers up-stream and downstream. Cattle do not have access to this reach. It is accessible to the public, but most people stay on the trail. The Green Belt Meadows housing sub-division is just to the west and abuts the OSMP lands. Impacts from rogue trails are more prevalent in the downstream reach. New Dry Creek Carrier diversion often sweeps the creek but there is usually an upstream flow. An additional source of water from the Viele Channel enters South Boulder Creek from the west during non-winter months. This reach (and the downstream reaches to the confluence with Boulder Creek) often has no-to-very-low flows from upstream water (less than 1 cfs) during the winter months. There is some runoff / return flow from storms and snow melt during the winter months.

Project Narrative: The floodplain is 5' to 7' above channel. This high entrenchment makes it difficult for any improvements to be successful. Establishing woody vegetation that high above groundwater would be difficult without several years of irrigation, and in-channel structures would have to be hardened to withstand shear stresses during very high flows. Raising the channel invert would help but may not be possible due to houses on west side of floodplain. Some grading to create floodplain benches may be possible. This would help reduce shear stress and allow for large wood installation and aquatic habitat enhancement. Work on this reach should occur concurrently with the project described for downstream Reach 3.1.2.

Projected lead time (est.):

Planting/grading: 12 – 24 months to obtain permits (Army Corps, City of Boulder, Boulder County)

Projected cost (est.):

Fencing: 1000 LF wire @ $4/LF = $4,000
Removal of invasive species, especially crack willow (Salix Fragilis) ($?)
Planting: 3 acres woody species @ $20,000/Ac = $60,000
Large wood structures and bench grading: $100,000

Challenges: Entrenchment, floodplain regulations. Raising the bank / berm would require extensive flood plain engineering work and a lengthy permitting process. The Greenbelt Meadows subdivision has "unlimited" access to OSMP lands along their neighborhood. Managing access and keeping people in designated trails will be a challenge. A pedestrian bridge over the creek to the main trails may be an option.

Potential Funding Sources: CWCB (SMP Implementation)

Reach 3.1.2 Howard Diversion and Ditch Structure to Pedestrian Bridge

Summary: Significant disruption due to flow reduction below New Dry Creek Carrier and Howard Ditch diversions. 100% within City of Boulder Open Space & Mountain Parks (OSMP) lands but interlaced with informal trails and unmanaged creek access that present opportunities for habitat improvement.

Overall Condition: Partly Functioning

Improvement Potential: Medium

Preliminary Project Priority and Time Frame: High, 2022 – 2027

Ratings

Flow		1.0 poorly functioning
Riparian	Left	2.0 partly functioning
	Right	1.7 partly functioning
Landscape	Left	2.5 functioning
	Right	3.0 functioning
Geomorphology		1.8 partly functioning
Aquatic Habitat		2.0 partly functioning
Recreation		High impact

>3-4 = High-functioning, >2-3 = Functioning, >1-2 = Partly functioning, >0-1 = Poorly functioning, 0 = Not functioning

Improvement Opportunities: Install fencing to eliminate public access to creek during vegetation establishment (8 – 10 years). Enhance existing meanders and riffle/pool sequences. Install wood toe and grade banks where necessary to establish woody vegetation. Install large wood channel structures to raise channel invert to reduce entrenchment and increase wood in system.

Recommended Project: Modify OSMP recreational trails to allow managed access to creek, plantings up to 200' along creek, buried woody stabilization structures

Detailed Observations: Creek is moderately entrenched with moderate to severe bank erosion in places due to visitor / dog access and lack of woody vegetation. Reach has few trees and allows unfettered public access to creek, causing bank erosion and over-wide channel. Most trees are mature cottonwoods with little opportunity for seedling establishment. There are small patches of willow on low benches. Howard diversion at the upstream end blocks aquatic connectivity / fish passage. While moderately entrenched, this reach has the lowest entrenchment of all the reaches on OSMP property. The creek was most likely channelized at some point in time, but due to the lack of woody bank stabilization it has created some small meander bends with moderate pool habitat. The upstream New Dry Creek Carrier diversion often sweeps the creek but there is usually an upstream flow. An additional source of water from the Viele Channel (a constructed flood control channel) enters South Boulder Creek from the west during non-winter months. This reach (and the downstream reaches to the confluence with Boulder Creek) often has no-to-very-low flows from upstream water (less than 1 cfs) during the winter months. There is some runoff / return flow from storms and snow melt during the winter months.

Project Narrative: Riparian vegetation, bank erosion, water quality, floodplain access, and aquatic habitat could be improved by installing fences to keep the public out of the creek and the riparian buffer. Public access to the creek could be provided at a few select locations to allow visitors to enjoy a creek-side experience. Long rooted nursery stock should be utilized, or regular nursery stock installed in extra deep planting pits to ensure roots reach groundwater. Plantings may require supplemental watering for the first few years. Some eroding banks should be graded / stabilized to ensure vegetation establishment, which may include the installation of toe wood to provide bank stabilization, aquatic habitat, and large wood to the system. Large wood structures in the creek could also be designed to allow the creek more frequent access to the floodplain. These engineered log structures mimic woody debris jams – essentially raising the channel invert, creating deeper pools, and adding large wood into the system. Project could also consider moving the existing concrete trail farther away from the

creek to provide larger vegetated buffer between creek and trail, but would need to consider existing tallgrass prairie and wet meadows.

Projected lead time (est.):

Planting only: 6 – 12 months if plants are available; 24 months if grow hold
Planting/grading: 12 – 24 months to obtain permits (Army Corps, City of Boulder)

Projected cost (est.):

Fencing: 4000 LF barbed wire @ $4/LF = $16,000
Removal of invasive species, especially crack willow (Salix Fragilis) ($2,500 - $3,000 / tree)
Planting: 8 acres woody species (100’ each side x 1800’) @ $20,000/Ac = $160,000
Large wood structures and bank stabilization: $100,000
Channel realignment: $150,000

Challenges: Keeping the public out of restoration areas. Will need stable access areas. Grading activities would require floodplain engineering analysis and a lengthy permitting process.

Potential Funding Sources: CWCB (SMP Implementation)

Reach 3.2.1 Pedestrian Bridge to East Boulder Diversion and Ditch Structure

Summary: Recreational impacts are moderate and riparian habitat is in good condition. No cattle access to creek.

Overall Condition: Partly Functioning

Improvement Potential: Low

Preliminary Project Priority and Time Frame: Low

Ratings

Flow		1.0 poorly functioning
Riparian	Left	2.3 functioning
	Right	2.3 functioning
Landscape	Left	3.0 functioning
	Right	3.0 functioning
Geomorphology		1.8 partly functioning
Aquatic Habitat		1.5 partly functioning
Recreation		moderate impact

>3-4 = High-functioning, >2-3 = Functioning, >1-2 = Partly functioning, >0-1 = Poorly functioning, 0 = Not functioning

Improvement Opportunities: Stabilize eroding banks and increase riparian buffer in appropriate locations.

Recommended Project: Plant native vegetation to expand and diversify riparian buffer. Stabilize eroding banks and create floodplain benches.

Detailed Observations: Creek is moderately entrenched and mostly straight except for a couple of meanders at the upstream end. Most of the reach has a woody riparian buffer and mature cottonwoods keep the banks from eroding. Existing fencing controls public assess. A few areas with no trees and breaks in the fencing allow public access, resulting in moderate to severe bank erosion. Most trees are mature cottonwoods with little opportunity for seedling establishment. East Boulder diversion is a barrier to aquatic connectivity / fish passage at downstream end. The next upstream blockage to aquatic connectivity / fish passage is Howard Ditch. The creek was most likely channelized at some point in time. While moderately entrenched, raising the creek bed would greatly reduce the entrenchment and the stresses associated with it.

Project Narrative: Stabilize eroding banks through grading and wood toe protection. Create floodplain benches to reduce shear stress. Plant native woody species in restoration areas and other areas with minimal woody vegetation. Install fencing to eliminate public access to restoration areas to allow vegetation to establish (8 – 10 years). Install wood and rock structures to raise channel invert and reduce entrenchment. Create stabilized public access points.

Projected lead time (est.):

Planting only: 6 – 12 months if plants are available; 24 months if grow hold
Planting/grading: 12 – 24 months to obtain permits (Army Corps, City of Boulder)

Projected cost (est.):

Removal of invasive species, especially crack willow (Salix Fragilis) ($?)
Planting: 2 acres woody species @ $20,000/Ac = $40,000
Large wood structures, bank stabilization, bench grading: $200,000

Challenges: Moderate to high entrenchment creates high shear stresses in channel during high flows; high public use area; floodplain regulations. Reducing the bank / berm would require extensive flood plain engineering work and a lengthy permitting process.

Potential Funding Sources: CWCB (SMP Implementation)

Reach 3.2.2 East Boulder Ditch to Baseline Road

Summary: Recreational impacts are moderate, riparian habitat is in good condition relative to adjacent reaches, but aquatic habitat is very poor. No cattle access to creek.

Overall Condition: Partly Functioning

Improvement Potential: Low

Preliminary Project Priority and Time Frame: Low

Ratings

Flow		0.8 poorly functioning
Riparian	Left	2.3 partly functioning
	Right	2.3 partly functioning
Landscape	Left	2.5 functioning
	Right	2.5 functioning
Geomorphology		1.5 poorly functioning
Aquatic Habitat		0.5 poorly functioning
Recreation		Moderate impact

>3-4 = High-functioning, >2-3 = Functioning, >1-2 = Partly functioning, >0-1 = Poorly functioning, 0 = Not functioning

Improvement Opportunities: Increase peak flows to scour pools; stabilize eroding banks and increase riparian buffer in appropriate locations.

Recommended Project: Plant native vegetation to expand and diversify riparian buffer. Stabilize eroding banks and create floodplain benches.

Detailed Observations: Creek is moderately to severely entrenched with some natural meandering. Good riffle/pool sequences but most pools are shallow. Most of the reach has a woody riparian buffer and mature cottonwoods keep banks from eroding. A few areas with no trees have allowed moderate to severe bank erosion. Most trees are mature cottonwoods with little opportunity for seedling establishment. Existing fencing controls public assess. A few areas with no trees and breaks in the fencing allow public access, resulting in moderate to severe bank erosion. East Boulder diversion is a barrier to aquatic connectivity / fish passage at upstream end, and a drop at Baseline Road culvert create an isolated reach. While moderately entrenched, raising the creek bed would greatly reduce the entrenchment and the stresses associated with it. This reach scores very low for aquatic habitat due to being isolated and lacking habitat features. Implementation of the East Boulder Ditch project (to include aquatic connectivity / fish passage) will improve connectivity. The upstream New Dry Creek Carrier diversion often sweeps creek but there is usually an upstream flow. An additional source of water from the Viele Channel (a constructed flood control channel) enters South Boulder Creek from the west during non-winter months. This reach (and the downstream reaches to the confluence with Boulder Creek) often has no-to-very-low flows from upstream water (less than 1 cfs) during the winter months. There is some runoff / return flow from storms and snow melt during the winter months.

Project Narrative: Stabilize eroding banks through grading and wood toe protection. Create floodplain benches to reduce shear stress. Plant native woody species in restoration areas and other areas with minimal woody vegetation. Install fencing to eliminate public access to restoration areas to allow vegetation to establish (8 – 10 years). Install wood and rock structures to raise channel invert and reduce entrenchment. Create stabilized public access points.

Projected lead time (est.):

Planting only: 6 – 12 months if plants are available; 24 months if nursery grow-hold agreement
Planting/grading: 12 – 24 months to obtain permits (Army Corps, City and County of Boulder)

Projected cost (est.):

Fencing: 1000 LF wire @ $4/LF = $4,000
Removal of invasive species, especially crack willow (Salix Fragilis) ($2,500 - $3,000 / tree)
Planting: 2 acres woody species @ $20,000/Ac = $40,000
Large wood structures, bank stabilization, bench grading: $150,000

Challenges: Moderate to high entrenchment creates high shear stresses in channel during high flows. Area receives high public use. Grading activities would require floodplain engineering analysis and a lengthy permitting process.

Potential Funding Sources: CWCB (SMP Implementation)

Reach 3.3 Baseline Road to Wellman Canal Outlet

Summary: Creek enters a more residential area. Overall corridor structure is simplified with confined and straight channel, poor riparian area, and lack of aquatic features.

Overall Condition: Partly Functioning

Improvement Potential: Medium

Preliminary Project Priority and Time Frame: Low, 2025+

Ratings

Flow		0.8 poorly functioning
Riparian	Left	2.0 partly functioning
	Right	1.0 poorly functioning
Landscape	Left	2.5 functioning
	Right	1.0 poorly functioning
Geomorphology		1.8 partly functioning
Aquatic Habitat		1.0 poorly functioning
Recreation		No impact

>3-4 = High-functioning, >2-3 = Functioning, >1-2 = Partly functioning, >0-1 = Poorly functioning, 0 = Not functioning

Improvement Opportunities: Establish riparian buffer of native plants and enhance herbaceous and shrub layers; refurbish Hunter-Hinde structure for aquatic connectivity / fish passage.

Recommended Project: Hunter-Hinde structure assessment and structure rehabilitation (including improved fish passage); public outreach on creek stewardship, including stream bank landscaping. See Educational Outreach Project description.

Detailed Observations: North of Baseline Road, the creek flows mostly along the back of a residential neighborhood with private properties to the east and City of Boulder OSMP land to the west. Near Baseline

Road, there is a short section where private property is on both sides of the creek. Overall, the creek is more channelized with relatively limited restoration opportunities due to private land. Some properties have rock-armored banks. Most of them maintain mowed lawn all the way to the creek edge.). In-stream structures, many simply stacked rock to create drops and pools, but also some relatively permanent, restrict channel connectivity and creek function. A paved path runs along half of this sub-reach on the OSMP land to the west and does not appear to limit creek function, nor provide public access. The private Hunter-Hinde structure is in the middle of the sub-reach; it does not function when water is low, appears to be undercut, and inhibits aquatic connectivity / fish passage. Upstream New Dry Creek Carrier and East Boulder diversions often sweep the creek but there is usually an upstream flow. An additional source of water from the Viele Channel enters South Boulder Creek from the west during non-winter months. This reach (and the downstream reaches to the confluence with Boulder Creek) often has no-to-very-low flows from upstream water (less than 1 cfs) during the winter months. There is some runoff / return flow from storms and snow melt during the winter months.

Reach 3.4 Wellman Canal Outlet to Leggett/Jones-Donnelly Canal Control Structure

Summary: Creek continues through residential area, now with private properties on both sides for the entire reach. Like Reach 3.3, overall corridor structure is simplified with poor riparian area and lack of aquatic features.

Overall Condition: Partly Functioning

Improvement Potential: Medium

Preliminary Project Priority and Time Frame: Low, 2025+

Ratings

Flow		1.3 partly functioning
Riparian	Left	1.0 poorly functioning
	Right	1.3 partly functioning
Landscape	Left	0.5 poorly functioning
	Right	0.5 poorly functioning
Geomorphology		1.5 partly functioning
Aquatic Habitat		1.0 poorly functioning
Recreation		No impact

>3-4 = High-functioning, >2-3 = Functioning, >1-2 = Partly functioning, >0-1 = Poorly functioning, 0 = Not functioning

Improvement Opportunities: Establish riparian buffer of native plants and enhance herbaceous and shrub layers; increase water movement through Leggett/Jones-Donnelly backwater.

Recommended Project: Public outreach on creek stewardship, including stream bank landscaping. See Educational Outreach project description.

Detailed Observations: Downstream of the Wellman Canal, the creek flows through a residential neighborhood with private properties on both sides. Overall, the creek is channelized with areas of steep banks and relatively limited opportunities due to private land. Some properties have rock-armored banks, and many of them maintain mowed lawn to the creek edge.). In-stream structures, many simply stacked rock to create drops and pools, but also some relatively permanent, restrict channel connectivity and creek function. Channel bed appears relatively homogenous. Compared to Reach 3.3, the channel is more sinuous.

Reach 3.4 includes a short section between Arapahoe Road and the Leggett Inlet Canal Complex diversion structure. Due to the control structure, this part of the creek is typically a stagnant pond that can become covered with algae and other aquatic plant growth. These conditions further degrade water quality and would be expected to contribute to higher temperature, lower dissolved oxygen, and higher nutrients and bacteria. The channel is confined by a levee/trail on the left (west) side and automobile dealership on the right (east) side. Upstream New Dry Creek Carrier and East Boulder diversions often sweep the creek but there is usually an upstream flow. An additional source of water from the Viele Channel enters South Boulder Creek from the west during non-winter months. This reach (and the downstream reaches to the confluence with Boulder Creek) often has no-to-very-low flows from upstream water (less than 1 cfs) during the winter months. There is some runoff / return flow from storms and snow melt during the winter months.

Reach 3.5 Leggett Inlet Canal Control Structure to KOA Lake Inlet Structure

Summary: Downstream of the Leggett Inlet Canal Control Structure, the creek passes through highly degraded sections, including a flood conveyance project managed by Mile High Flood District (MHFD), with a high level of commercial and light industrial activity adjacent to the corridor.

Overall Condition: Poorly Functioning

Improvement Potential: Low

Preliminary Project Priority and Time Frame: Low, 2025+

Ratings

Flow		1.0 poorly functioning
Riparian	Left	2.3 functioning
	Right	1.7 partly functioning
Landscape	Left	1.0 poorly functioning
	Right	1.0 poorly functioning
Geomorphology		1.0 poorly functioning
Aquatic Habitat		0.5 poorly functioning
Recreation		No impact

>3-4 = High-functioning, >2-3 = Functioning, >1-2 = Partly functioning, >0-1 = Poorly functioning, 0 = Not functioning

Improvement Opportunities: There are limited opportunities for improvement – approximately 75% of the reach is managed to provide flood conveyance and the other 25% is confined and hidden from access. A future development project in this area may provide an opportunity for improvement.

Recommended Project: Keep track of future development and potential improvement opportunities. One concept is to create a bypass channel to take KOA Lake offline of the stream channel.

Detailed Observations: In this lower stretch, the creek is highly degraded, braided in some areas, and hemmed in by commercial / industrial development. The upstream quarter of the reach, between the control structure and a railroad bridge, is often subject to illegal camping that inhibits establishment and growth of riparian vegetation and is a source of pollution, including waste such as syringes, human excrement, abandoned camp equipment, etc. A levee / trail on the left (west) side and backyard parking area of the neighboring automobile dealership to the right (east) confines the creek corridor.

Downstream of the railroad bridge, the remainder of the reach to KOA Lake is an MHFD flood conveyance channel. Levees on each side form an artificial valley with concrete weirs evenly spaced along the reach length and that extend across the entire floodplain. Woody vegetation appears to be limited as part of maintenance of flood capacity.

This reach is downstream of all major diversions. In addition to the Leggett control structure, upstream New Dry Creek Carrier and East Boulder diversions often sweep the creek but there is usually an upstream flow. An additional source of water from the Viele Channel enters South Boulder Creek from the west during non-winter months. This reach (and the downstream reaches to the confluence with Boulder Creek) often has no-to-very-low flows from upstream water (less than 1 cfs) during the winter months. There is some runoff / return flow from storms and snow melt during the winter months. The channel is smaller and aquatic habitat is limited.

Reach 3.6 KOA Lake to Butte Mill Ditch Structure

Summary: KOA Lake supports non-native, invasive fish population. Downstream exhibits mostly backwater conditions due to Butte Mill structure.

Overall Condition: Poorly Functioning

Improvement Potential: Low

Preliminary Project Priority and Time Frame: Low, 2030+

Ratings

Flow		1.0 poorly functioning
Riparian	Left	1.3 poorly functioning
	Right	0.7 not functioning
Landscape	Left	0.5 poorly functioning
	Right	0.5 poorly functioning
Geomorphology		not applicable
Aquatic Habitat		not applicable
Recreation		KOA Lake fishing / picnicking

>3-4 = High-functioning, >2-3 = Functioning, >1-2 = Partly functioning, >0-1 = Poorly functioning, 0 = Not functioning

Improvement Opportunities: There are very limited opportunities for improvement. Most of this reach is a pond that is maintained for recreational fishing. The Butte Mill structure appears very inefficient, effectively creating a large pool upstream except during the highest flow times of the year, and causes severe impact to the channel / stream function. Historically the previous landowner allowed slag from the nearby concrete plant to be dumped along and near the ditch structure causing additional bank armoring and degrading the local habitat.

Recommended Project: Functional improvements of the Butte Mill structure could be a future project but is outside the scope of this study and the project planning horizon (3 years).

Detailed Observations: Overall this Reach is isolated due to aquatic connectivity / fish passage barriers up-stream and downstream. Due to the presence of KOA Lake, this reach was not a focus of the study. While in-line ponds such as KOA Lake cause significant impacts to streams, it is an established recreational feature and anticipated to continue with its present use into the foreseeable future. Invasive warm water species are in the pond. A concrete structure at its upstream inlet helps keep the invasive pond species out of upstream reaches. Overall, the isolation is beneficial by limiting invasive species migration.

The Butte Mill structure allows water from (main stem) Boulder Creek to cross South Boulder Creek. It is a major disrupter to creek connectivity and function, and blocks aquatic connectivity / fish passage. It also appears inefficient and outdated. It also causes the short stretch of creek between KOA Lake and the structure to backwater. The reach is further degraded by the Valmont Road crossing between the pond and structure.

This reach (and the downstream reaches to the confluence with Boulder Creek) often has no to very low flows from upstream water (less than 1 cfs) during the winter months. There is some runoff / return flow from storms and snow melt during the winter months.

Reach 3.7 Butte Mill Ditch Structure to Boulder Creek Confluence

Summary: Private property isolated from upstream connectivity opportunities.

Overall Condition: Partly Functioning

Improvement Potential: Low

Preliminary Project Priority and Time Frame: Low, 2030+

Ratings

Flow		1.0 poorly functioning
Riparian	Left	1.7 poorly functioning
	Right	1.7 poorly functioning
Landscape	Left	3.0 functioning
	Right	2.0 partly functioning
Geomorphology		2.0 partly functioning
Aquatic Habitat		2.5 partly functioning
Recreation		No impact

>3-4 = High-functioning, >2-3 = Functioning, >1-2 = Partly functioning, >0-1 = Poorly functioning, 0 = Not functioning

Improvement Opportunities: There are limited opportunities for improvement. The owner of this property has been helpful to this study, allowing access to assess the creek.

Recommended Project: There may be an opportunity for this reach to be the location of a demonstration project for riparian stewardship as part of an outreach program for private landowners. See Educational Outreach project description.

Detailed Observations: Overall, conditions along this downstream-most reach are better than the proximate upstream reaches (3.4 - 3.6). While filling and some armoring along the west bank occurred due to the off-line pond embankment located there, the channel has a more accessible riparian zone on the east side and good connectivity to the mouth of the creek. Aquatic habitat conditions are also better.

Being located at the mouth of the creek, this reach provides additional habitat for Boulder Creek fish / aquatic species. However, the issues and poor conditions described for upstream Reaches 3.5 and 3.6 isolate Reach 3.7 from the rest of South Boulder Creek.

This reach often has no-to-very-low flows from upstream water (less than 1 cfs) during the winter months. There is some runoff / return flow from storms and snow melt during the winter months.

Colorado Trout Unlimited and Boulder Flycasters
South Boulder Creek Stream Management Plan PH II
Final Report

Exhibit F – Point Flow Model

Attached are the follow Point Flow Model components:

1. Exhibit F (1) - Point Flow Model – Capabilities and Limitations (memo)
2. Exhibit F (2) - Point Flow Model – Analysis (model – separate large Excel document file)
3. Exhibit F (3) - Point Flow Model – Overview (memo)
4. Exhibit F (4) - Point Flow Model – Data and Analysis (model – separate large Excel document file)

Memorandum

To: Mike Lighthiser
From: Brenna Mefford
Date: 9/13/2022
Re: Task 1 Summary: Meet with City of Boulder

This memo summarizes Wilson Water Groups (WWGs) efforts working with staff at City of Boulder to update the South Boulder Creek Point Flow Model with additional data and information from the City. City of Boulder staff's main concerns with the Point Flow Model are outlined below:

- Anderson Extension ditch carries stormwater, water from sump pumps, Anderson Ditch tail water, and Dry Creek # 2 water. Diversion records do not reflect the additional water picked up along the ditch; therefore, the point flow model is likely underestimating Anderson Extension Ditch flow.
- The current Point Flow Model gain/loss configuration sometimes results in negative flows below Dry Creek Carrier when Howard Ditch is diverting. The Viele Channel can also be used to meet Howard's demands but is not represented in the model.
- Wellman Ditch, similar to Anderson Extension Ditch, also carriers storm water and tail water from other ditches. Even if Wellman is not diverting, it is typically carrying water; therefore, the Wellman diversion records in the model are underestimated.
- A concrete plant that diverts water off KOA Lake is currently not included in the point flow model.

WWG met with City of Boulder staff, and Boulder Flycasters to walk through their concerns and see what additional information City of Boulder could provide to help improve the model. City of Boulder was not able to provide additional data for Anderson Extension, Wellman Ditch, or Viele Channel to include in the model. WWG explained that the methodology used to estimate gains attempts to account for the extra water in Anderson Extension, Wellman Ditch, and Viele Channel that eventually flows into South Boulder Creek. The model utilizes Lee Rozaklis's methodology to estimate gains to Boulder Creek and South Boulder Creek downstream of the Orodell and Eldorado Gages developed under a contract with the City of Boulder. Staff at City of Boulder asked WWG to set up a meeting with Lee to better understand the gains methodology and the process to account for the extra water that flows into South Boulder Creek through the three diversions. During the meeting, held on August 12, 2022, Lee confirmed that his method did include estimates for excess water in the ditches.

At the request of the City of Boulder WWG investigated the negative flows below Dry Creek Carrier when Howard was diverting and attempted to see if they corresponded with precipitation events. If negative flows were occurring during or closely after precipitation

events, this could indicate that the gains method was potentially underestimating the amount of water coming in from Anderson Extension. No correlation could be made between negative flows below Dry Creek Carrier while Howard was diverting and when precipitation events occurred. WWG did determine that 83 percent of the instances that negative flows occurred below Dry Creek Carrier while Howard was diverting were before telemetry was installed on Dry Creek Carrier in 2008. This indicates that negative flows may not be related to an underestimation of Anderson flows, but inaccurate diversion records on Dry Creek Carrier.

As a result of the meetings with City of Boulder, only minor changes were made to the point flow model:

- Per the City of Boulder, the last two nodes (KOA Lake, End of South Boulder Creek) were flagged in the point flow model and a note was added explaining that the two nodes are not recommended for use until more data is available on water use downstream of the Valmont Complex.
- A Future Recommendations tab was developed and added to the Point Flow Model based on conversations with City of Boulder staff and Boulder Flycasters. This tab documents where additional measurement devices should be installed and recommends future updates to the model.
- WWG also verified that the water class coding used to estimate the Anderson Extension flows in the model was accurate.

As stated in the updated model, WWG recommends additional measurement devices be installed on the outflow of Anderson Extension Ditch and Viele Channel. Wellman ditch is owned by Xcel Energy, and currently only limited records are available. WWG recommends working with Xcel to get both diversion and outflow data. Wellman Ditch does have an outflow flume, but it is believed to be in poor condition and will likely need to be updated. WWG also recommends working with diverters downstream of Valmont Complex to install accurate measurement devices and ensure that diversion records are maintained.

The point flow model could be updated in the future if and when more data is available. It is important to keep in mind that even with additional data, the point flow model is still limited by the accuracy of the streamgage and diversion flumes. It is also limited by how often diversions are visited and recorded by the water commissioner for ditches that do not have telemetry.

Transmittal Memorandum

To: Mike Lighthiser
From: Brenna Mefford
Date: Updated 2/23/2020
Re: Lower South Boulder Creek SMP – Point Flow Model

Wilson Water Group (WWG) developed a daily point flow model that estimates streamflow at critical ungaged locations on South Boulder Creek as part of the Lower South Boulder Creek Stream Management Plan – Phase II. Per the scope of work, WWG also estimated natural flow (i.e. streamflow absent the effect of man) on South Boulder Creek above Gross Reservoir, and developed metrics and graphical components to allow users to visually assess information about estimated streamflow at critical locations. Critical streamflow locations (i.e. reach breaks) were provided by Mike Lighthiser to WWG in an email on December 2, 2020. The reach breaks are described in Table 1 and shown in Figure 1.

Table 1. Reach Breaks

Model Name
Streamflow blw Community Ditch
Streamflow blw Davidson Ditch
Streamflow blw Goodhue Ditch
Streamflow blw Dry Creek No. 2 Ditch
Streamflow blw Marshallville Ditch
Streamflow blw Schearer Ditch
Streamflow blw S Boulder Canon Ditch
Streamflow blw McGinn Ditch
Streamflow blw New Dry Cr- Carrier Ditch
Streamflow blw Howard Ditch
Streamflow blw East Boulder Ditch
Streamflow blw Valmont Complex Diversion
End of South Boulder Creek

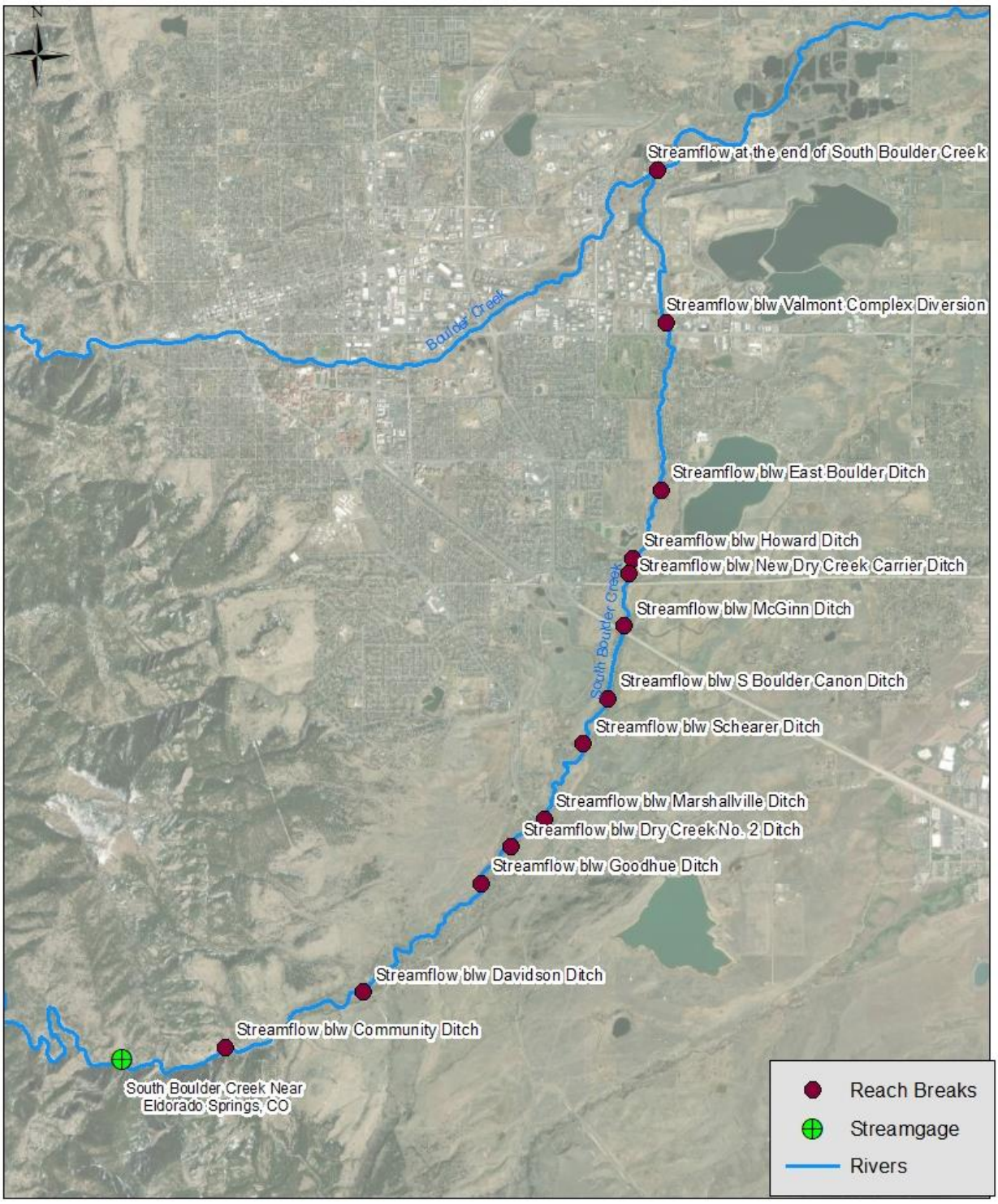


Figure 1. Reach Breaks along South Boulder Creek where Streamflow was Estimated

The daily point flow model uses gaged streamflow data, diversion records, and estimated gains in each reach to simulate daily historical streamflow conditions at the reach breaks shown in Table 1 and Figure 1. The South Boulder Creek reach modeled in the point flow begins at the South Boulder Creek near Eldorado Springs, CO streamgage (USGS ID 06729500) and ends at

the confluence of South Boulder Creek and Boulder Creek. Streamflow was estimated at all reach breaks using the closest gages, diversions, and accounting for gains and losses in that reach. The model was calibrated by comparing the simulated streamflow estimates from the point flow model to simulated streamflow produced by the South Platte Decision Support System StateMod model and a model developed by Lee Rozaklis. Anecdotal information from the Water Commissioner and other sources was also used to verify operations on South Boulder Creek and justify discrepancies between models.

In most point flow models a mass balance between a downstream and upstream gage is completed and any gains and losses are distributed throughout the model. On South Boulder Creek there is not a gage upstream of the confluence of South Boulder Creek and Boulder Creek, therefore the mass balance approach to distributing gains could not be used. Instead, the point flow model relies on gains distributed along the river based on a method developed by Lee Rozaklis for City of Boulder Utilities, as documented in an October 5th, 2020 memo to the City of Boulder[1]. This method estimates gains for both South Boulder Creek and Boulder Creek by looking at the two creeks as one system and breaking the combined drainage area into an upper and a lower basin. All of South Boulder Creek fell into the upper basin. Upper basin gains were determined using the following steps:

1. Total monthly upper basin gains were derived using the following linear regression:
   Total Monthly Upper Basin Gains (AF) = Max (0, $-192.25 + 0.126X_1 + 568X_2 + 154X_3$)
   X_1 = Monthly natural flow at South Boulder Creek near Eldorado gage (AF)
   X_2 = Monthly Boulder precipitation (inches)
   X_3 = Previous month Boulder precipitation (inches)

2. The resulting monthly time series of gains was split into quarter-monthly volumes using the cubic spline method.

3. Each quarter-month's total upper basin gain was allocated to a South Boulder Creek upper basin gain location based on the percentage shown in Table 2. Note that there are more upper basin gain locations that are not shown here as they were outside of the point flow models reach and that the locations and percentage of basin gain were obtained from the Rozaklis memo.

Table 2. South Boulder Creek Upper Basin Gains Locations and Percent of Total Basin Gains

South Boulder Creek Upper Basin Gain Location	Percent of Basin Gain
South Boulder Creek at Community Ditch	2%
South Boulder Creek at South Boulder Road	21%
South Boulder Creek at Arapahoe Road	6%

[1] Rozaklis, Lee. Memo to the City of Boulder Utilities. Boulder, CO. October 5, 2020. City of Boulder Utilities should be contacted to inquire about a copy of the memo.

4. Distribute the quarter-month's upper basin gain at each South Boulder Creek location to daily by distributing the gains equally across the number of days in each quarter of a month.

Note that the calculated natural flow on South Boulder Creek above Gross Reservoir in the point flow model was assumed to be equal to natural flow at the Eldorado Springs streamgage. For more information on how the regression equation shown in Step 1 was developed or for more background information on this method, refer to the October 2020 Rozaklis memo to City of Boulder.

The level of calibration completed on the model is directly tied to the accuracy of the diversion and streamflow data. Accuracy of data can be affected by the frequency of diversion measurements throughout the year, frozen streams, and streamgage calibrations. Inaccurate data can introduce uncertainty into the model. Examples of data inaccuracies include:

- During wet years or runoff, when daily administration was not needed, the same diversion record was often repeated for multiple days in a row. When the streamflow dropped during this period, the repeated diversion record was greater than the streamflow resulting in negative streamflow estimates.
- Gaged winter streamflow measurements are often affected by ice, which can then effect estimates of streamflow at ungaged locations.
- Reservoir storage content measurements can be affected by wind, incorrectly calibrated staff gages and measurement reading error. Reservoir storage content was used to estimate diversion records for ditches that supply reservoirs and had missing diversion records.
- Rocks, debris, or aquatic grasses near streamgages or diversion measurement devices can produce artificial increases in water level readings during low streamflow conditions.

To help calibrate the model, the following checks were made:

- Estimated flow at the end of South Boulder Creek was compared to the Boulder Creek at North 75th St. streamgage (USGS ID 06730200) to ensure that flows at the Boulder Creek streamgage were larger than flows at the end of South Boulder creek.
- Estimated flow at the end of South Boulder Creek was compared to estimated streamflow on South Boulder Creek below the Valmont Complex from a model developed by Lee Rozaklis. Rozalkis's model did not include gains, so the two models were compared to ensure that flow from the point flow model was always larger.
- Daily estimated flow at the end of South Boulder Creek was summed to monthly and compared to streamflow at the end of South Boulder Creek from the South Platte Decision Support System StateMod model. The models were compared to see how the flows differed. If the flows in the models did differ, the cause of the difference in flow was investigated and if needed adjustments were made to the point flow model.

- Estimated diversions at the New Dry Creek Carrier Ditch and the Valmont Complex Diversion were compared to estimated diversions at the same locations from a model developed by Lee Rozaklis to ensure that the two models estimated diversions similarly. Any discrepancies that were found were investigated, and if needed adjustments were made to the estimated diversions in the point flow model.
- Daily estimated diversions at the New Dry Creek Carrier Ditch and the Valmont Complex Diversion were summed to monthly and compared to diversions modeled in the South Platte Decision Support System StateMod model. Any discrepancies that were found were investigated, and if needed adjustments were made to the estimated diversions in the point flow model.
- Estimated daily natural flow above Gross Reservoir was summed to monthly and compared to natural flow in the South Platte Decision Support System StateMod model at the South Boulder Creek near Eldorado Springs streamgage to ensure that the two models reported similar natural flow values. Any discrepancies that were found were investigated, and adjustments were made to the natural flow in the point flow model to improve the correlation between the two data sets.
- South Platte Decision Support System StateMod model documentation that was specific to South Boulder Creek was reviewed and anecdotal information available in the documentation was used to help verify modeled operations on South Boulder Creek. The StateMod documentation was also used to help justify differences between the point flow model results and the StateMod model results.
- Water Commissioner notes and the final report from the City of Boulder Open Space Environmental Water Sharing Feasibility Analysis was reviewed and anecdotal information from the documentation was used to help verify modeled operations on South Boulder Creek.

The results from the point flow model were summarized graphically and tabularly. Specific summaries, including statistical analyses were not explicitly defined in the Scope of Work and were decided upon during discussions with Mike Lighthiser. Negative values caused by data discrepancies were left in the point flow model to help identify the time periods with data issues but were set to zero for the statistical analyses. Note that statistical analyses calculated during winter months can be affected by icing conditions on diversions and streamgages. The point flow model results are intended to be used for planning purposes only. They are not intended for litigation purpose and, as established by the data discrepancies, should not be used as such.

The deliverables for this project include two Excel spreadsheets and this memo; no formal report was scoped. The two deliverable spreadsheets are listed below, and descriptions follow:

1. SouthBoulderCreek_PFM_Dec292020.xlsx
2. PFM_Analysis_12292020.xlsx

SouthBoulderCreek_PFM_Dec292020.xlsx

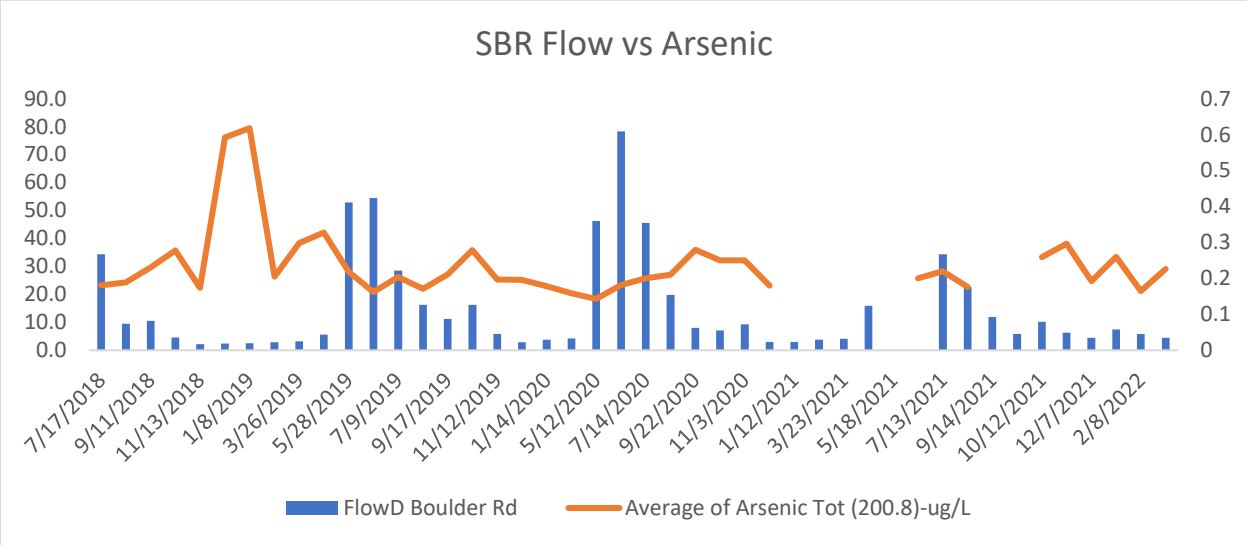
This spreadsheet contains the Lower South Boulder Creek point flow model. The point flow model estimates streamflow at 13 critical locations and estimates South Boulder Creek natural flow above Gross reservoir. The spreadsheet includes a *ReadMe* that explains the purpose of the different tabs in the workbook.

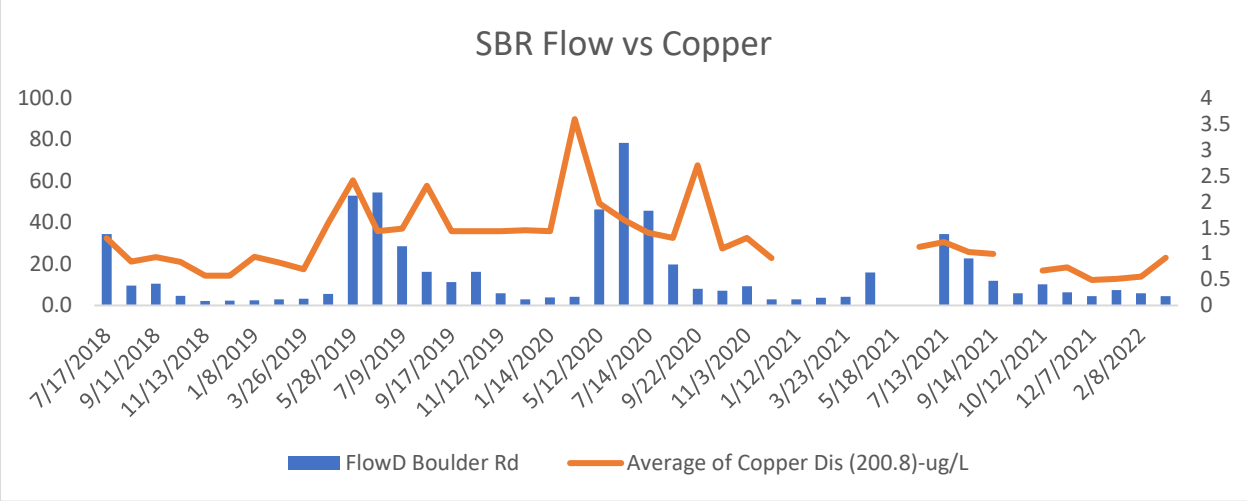
PFM_Analysis12232020.xlsx
This workbook contains the streamflow analyses that were developed as part of this project. The analyses were completed for the 13 reach breaks, the South Boulder Creek at Eldorado Springs streamgage and for the estimate of natural flow on South Boulder Creek above Gross Reservoir. The following analyses were completed and included in the workbook:

- Annual average daily flow and year type
- Monthly average daily flow and corresponding month/year type for all months
- Annual maximum daily average flow and date of occurrence
- Minimum 7-day average daily average flow

Colorado Trout Unlimited / Boulder Flycasters
Lower South Boulder Creek
Stream Management Plan Phase II

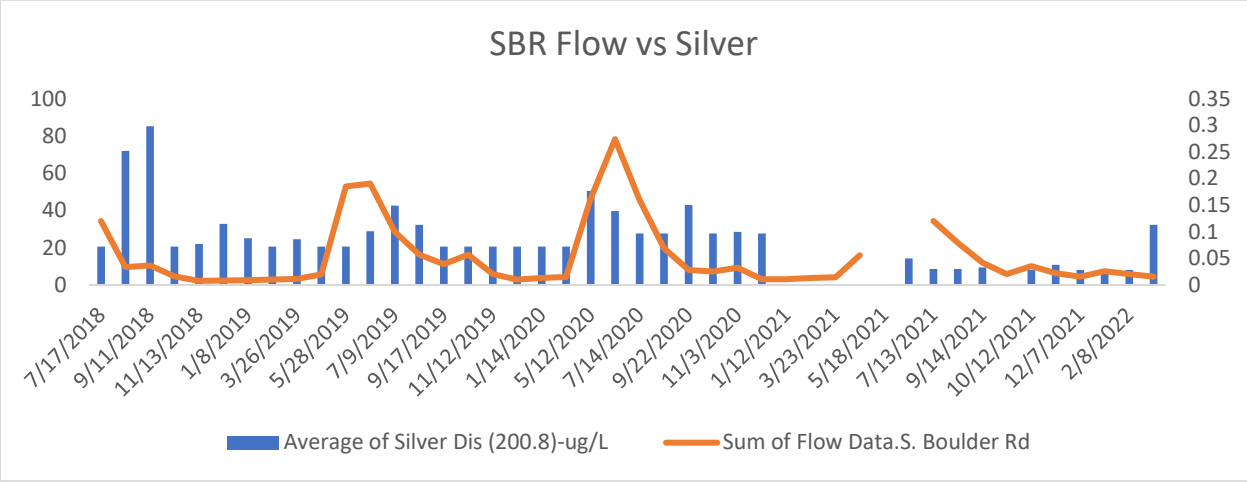
Exhibit G – Data Analysis Graphs and Charts
Representative of Preliminary Data Analysis

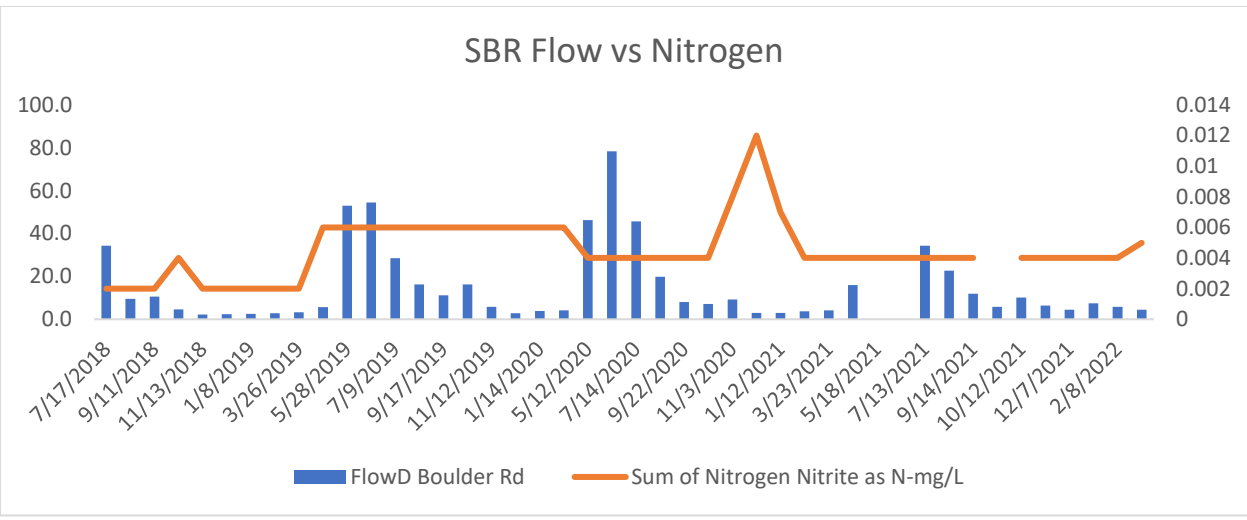


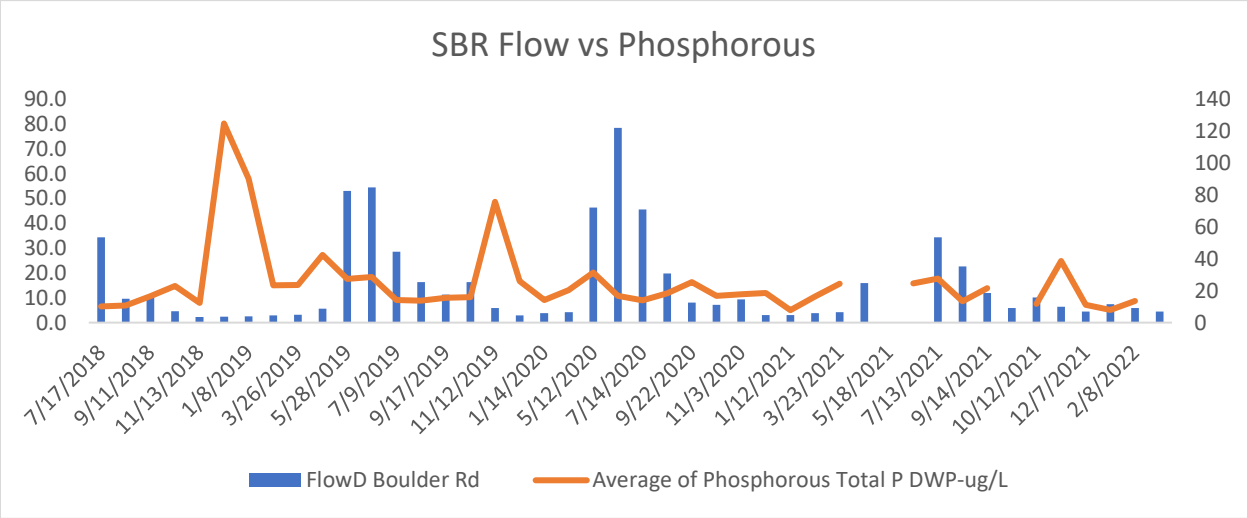


Colorado Trout Unlimited / Boulder Flycasters
Lower South Boulder Creek
Stream Management Plan Phase II

Exhibit G – Data Analysis Graphs and Charts
Representative of Preliminary Data Analysis

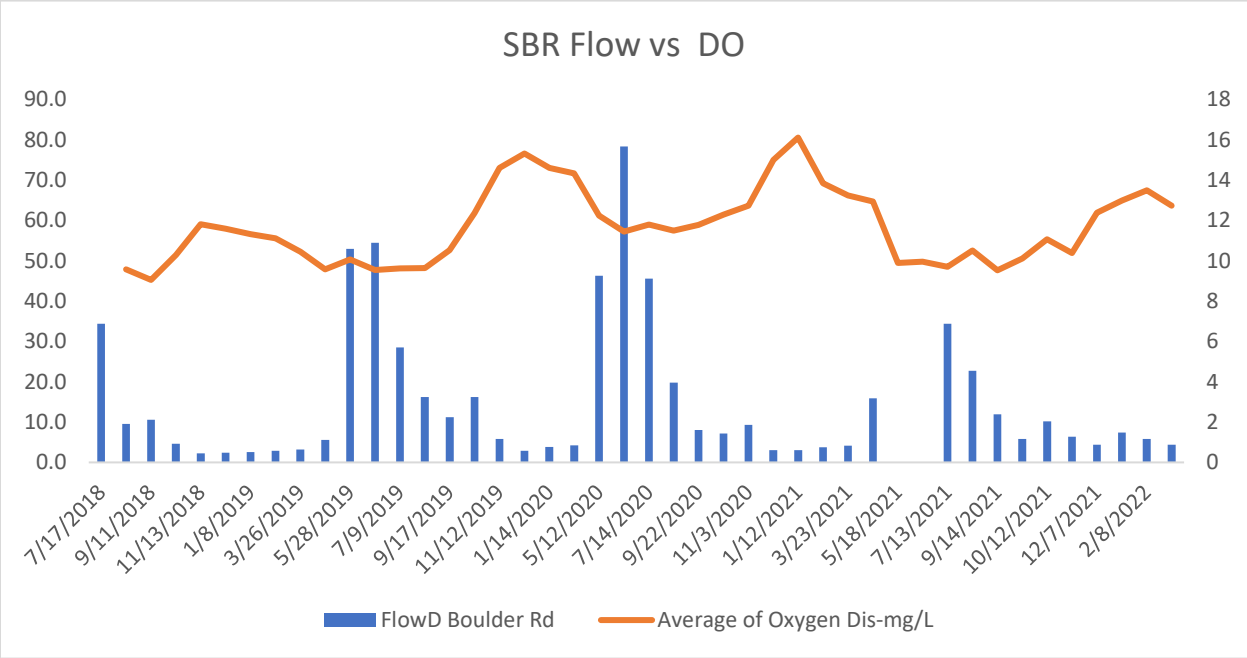






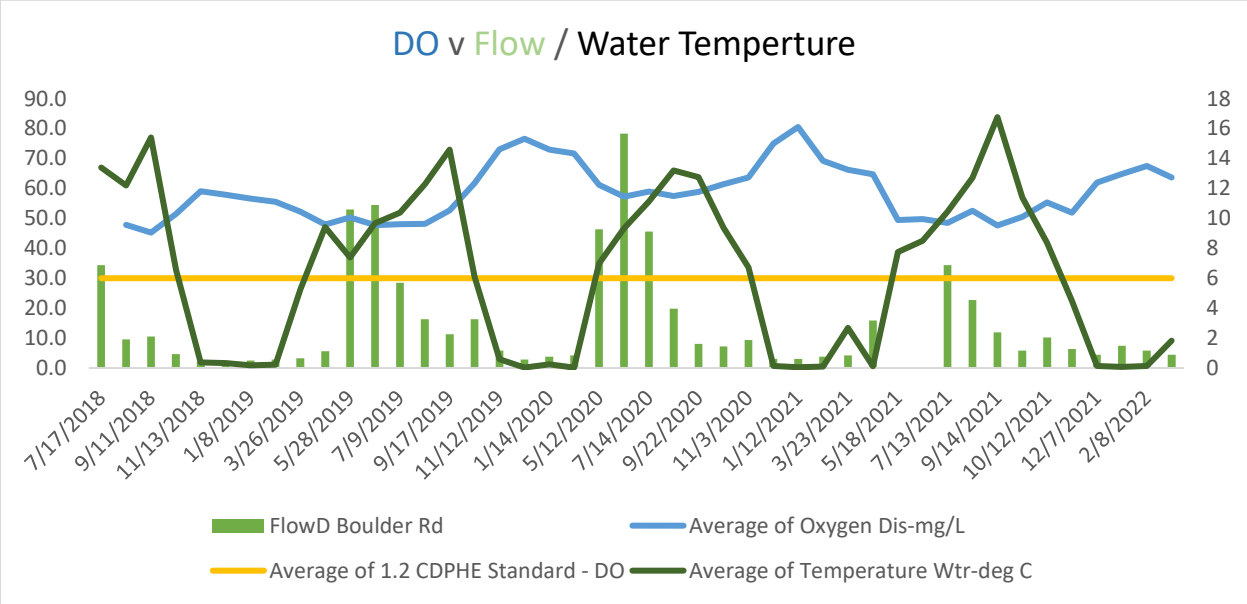
Colorado Trout Unlimited / Boulder Flycasters
Lower South Boulder Creek
Stream Management Plan Phase II

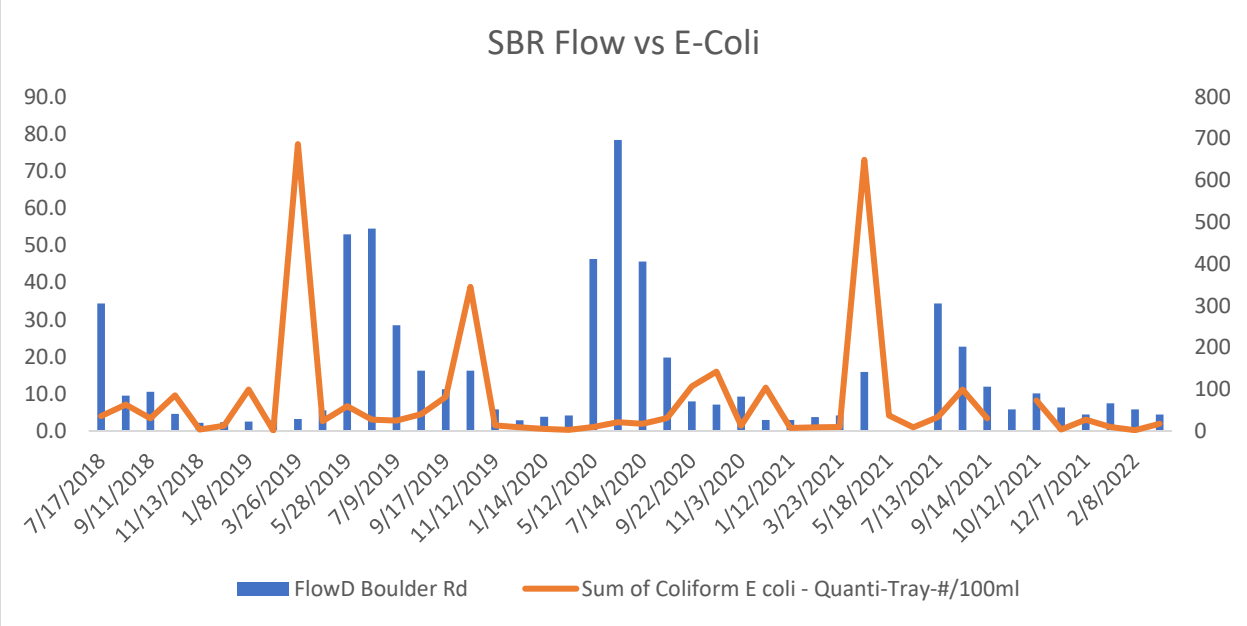
Exhibit G – Data Analysis Graphs and Charts
Representative of Preliminary Data Analysis



Colorado Trout Unlimited / Boulder Flycasters
Lower South Boulder Creek
Stream Management Plan Phase II

Exhibit G – Data Analysis Graphs and Charts
Representative of Preliminary Data Analysis





Colorado Trout Unlimited / Boulder Flycasters
Lower South Boulder Creek
Stream Management Plan Phase II

EXHIBIT K - Project Funding Detail Support

As of 11/18/22

SMP PH II FUNDING SOURCE	TYPE	CASH		
		BUDGET	ACTUAL	VARIANCE
Colorado Water Conservation Board	Colorado Water Plan – WSRG/SMP	$95,500	$95,500	$0
Metro Round Table	WSRF Account Grant	$23,875	$23,875	$0
South Platte Basin Round Table	WSRF Account Grant	$23,875	$23,875	$0
Colorado Trout Unlimited	Local Chapter Grants	$5,000	$5,000	$0
Boulder Flycasters	Local Chapter Cash Match	$11,461	$11,461	$0
City of Boulder	Cash Match and Staff Support	$0	$0	$0
City of Lafayette	Cash Match and Staff Support	$0	$0	$0
Denver Water	Cash Match and Staff Support	$10,000	$10,000	$0
USF&WS	Cash (incremental to CWCB Grant)	$1,234	$1,234	$0
TOTAL		**$170,945**	**$170,945**	**$0**

IN-KIND		
BUDGET	ACTUAL	VARIANCE
$0	$0	$0
$0	$0	$0
$0	$0	$0
$3,976	$588	-$3,388
$8,540	$18,788	$10,248
$6,000	$11,850	$5,850
$0	$2,050	$2,050
$3,000	$1,775	-$1,225
$0	$0	$0
$21,516	**$35,051**	$13,535