Crystal River Restoration and Weaver Ditch Efficiency Project



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Table of Contents

Executive Summary 3
Project Location 4
Technical Project Description: 4
Performance Measures 10
Evaluation Criteria 11
A. Project Benefits 11
B. Watershed Restoration Planning 20
C. Stakeholder Support 25
D. Readiness to Proceed 29
E. Performance Measures 31
F: Department of the Interior and Reclamation Priorities 32
Project Budget 36
Funding Plan and Letters of Commitment 36
Budget Proposal 37
Budget Narrative: 41
Environmental and Cultural Resource Considerations 46
Required Permits or Approvals 51
Documentation in Support of Applicant Eligibility 52

Executive Summary

Date: November 17, 2020

Applicant: Roaring Fork Conservancy

Project Location: Carbondale, Garfield County, Colorado

Project Summary: Roaring Fork Conservancy (RFC), with partners Town of Carbondale (TOC), Aspen Valley Land Trust (AVLT), and American Rivers (AR), will restore and enhance a one-half mile, 18-acre reach of the Crystal River as it flows through the town of Carbondale, and improve the efficiency of the town owned Weaver Ditch headgate and diversion. The project will: **restore** the ecological integrity of the riparian zone by stabilizing river banks, reestablishing native vegetation, and creating instream habitat; **develop** a long term, self-sustaining solution to improve river channel stability and habitat; **create** a self-sustaining diversion and head gate structure for the Weaver Ditch to improve delivery, function and efficiencies; and **enhance** passive user experiences of Riverfront Park through interpretive signs, accessible trails, gathering spaces, and educational programs. A collaborative team of experts has worked hand-in-hand with the Town of Carbondale to develop restoration strategies based on the Roaring Fork Watershed Plan (RFWP) and Crystal River Management Plan (CRMP) to address the habitat, hydrologic, agricultural and anthropogenic pressures within this reach. With measurable localized benefits, this project will serve as a model for other projects locally and regionally demonstrating how the RFWP and CRMP can be implemented. Watershed values guide the project, which will restore wetland, and riparian areas, preserve healthy habitat, enhance hydrologic connectivity and fisheries, prevent unnecessary dewatering, and provide passive recreation and interpretation for the local community.



Project Location: The Crystal River Restoration and Weaver Ditch Efficiency Project is located in the Town of Carbondale, Colorado. The project latitude is 39°22'57.1"N and longitude is107°12'14.8"W.

Technical Project Description:

The project team has developed a restoration plan that addresses the identified degradation and existing conditions[1] with four types of interventions by ecologic community type: Preserve; Enhance; Create; and Future Restoration Opportunities.

The Project Area restoration concept focuses on three main ecologic communities: riparian, wetland and in channel. The surveyed riparian and wetland communities are recommended for preservation, enhancement, or creation.

Preservation - The protection of intact and functioning wetland or riparian through ecologic and landscape planning and site development.

Enhancement - The restoration of partially functioning healthy wetlands and riparian areas. This can include noxious weed elimination, planting, seeding, and other restoration techniques.

Creation - Identifying and re-establishing areas that are heavily degraded but have the opportunity, due to location and surrounding vegetation, for full restoration activities resulting in the creation of a new wetland or riparian area.

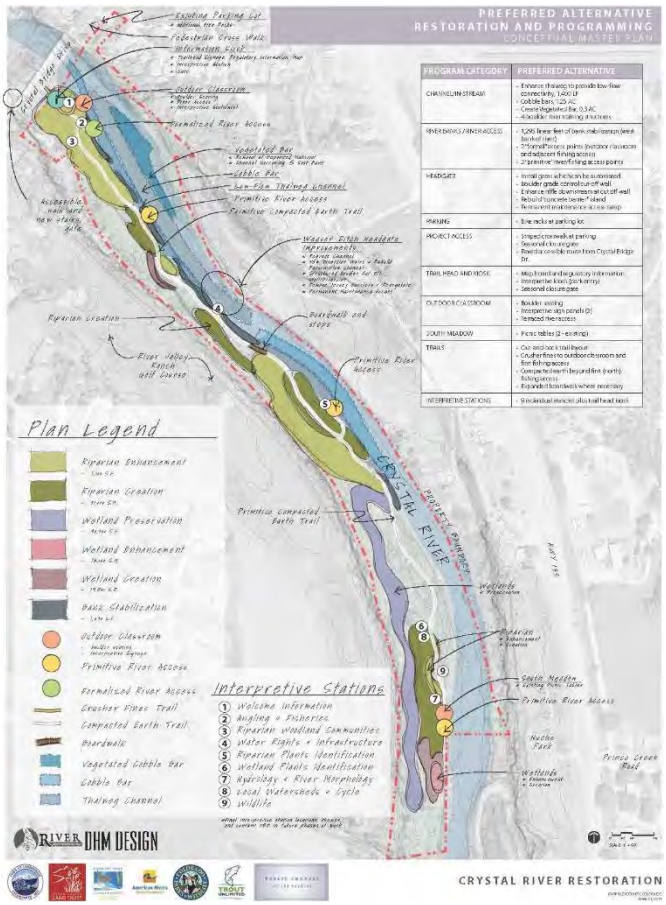
[1] See the 2016 *Crystal River Management Plan*, which is a comprehensive Stream Management Plan (SMP) study for identifying, prioritizing, and guiding management actions that honor local agricultural production, preserve existing water uses, and enhance the ecological integrity of the river. That study identified this project reach as severely to unsustainably degraded, and a priority for restoration.

The health and quality of the riparian environment within the Project Area is variable across the reach. The project includes 10.1 acres for preservation, 0.45 acres for enhancement, and 1.1 acres for creation.

Riparian preservation includes a regular monitoring and maintenance plan to preserve the high-quality riparian habitat. Monitoring noxious and native vegetation will preserve and sustain current riparian conditions. By limiting access to sensitive areas and minimizing disturbance by directing human traffic through wayfinding and the creation of designated, formalized paths, impacts will be reduced. The project will preserve approximately 10.4 acres of high-quality riparian habitat.

Riparian enhancement will improve existing conditions to increase habitat value. This will be done through the development and implementation of a weed management plan to control noxious vegetation, identification of arboricultural maintenance needs and expansion of plant diversity through planting and seeding. The resulting enhancement will provide increased habitat value for wildlife and improve overall ecological conditions. The project will enhance approximately .45 acres of riparian habitat.

Riparian creation is the most intensive of the three types of restoration. This involves grading the topography to create elevations with the appropriate available water to support native riparian vegetation plantings. Areas identified within the report and included in the restoration plans are immediately adjacent to the riverbank and are in close proximity to the river water table. Areas identified for bank stabilization as part of river improvements are ideal locations for this recommended intervention as bank stabilization and riparian creation are both interventions with overlapping goals. The project includes 1.1 acres of riparian creation.



The health and quality of the wetland environment within the Project Area is good to excellent. The project includes 1.6 acres for preservation, .076 acres for enhancement, and .17 acres for creation. Wetland preservation includes regular monitoring and maintenance of plant species, the percent cover of plants, and the hydrological conditions on site. Monitoring will assist with understanding overall wetland health, identify trends, and allow for short-term and long-term preservation planning. The construction of boardwalks in these areas will dramatically reduce human impacts and provide excellent learning and wildlife viewing opportunities. The project will preserve 1.6 acres of wetland.

Wetland enhancement, including noxious and invasive species control, selective planting and maintenance can enhance what is already considered a high-quality wetland within the Project Area. The project includes .076 acres for wetland enhancement.

Appropriate hydrological conditions to support wetland plant species will be created by grading the topography of appropriate sites within the Project Area. The location of the wetland creation sites allows for ease of colonization of adjacent wetland plant species. Minimal grading will be required to achieve successful wetland creation in this area. The project will include .17 acres (7,225 square feet) for wetland creation.

Several locations along the west bank of the river are identified as opportunities for restoration. This restoration will take several forms depending on the location and other project goals such as river access, angling locations, and educational opportunities. In higher traffic and access areas, the bank restoration will be comprised of boulders. Lower traffic area restoration activities will utilize vegetation and large wood logs, with boulders only used for toe reinforcement.

In-channel improvements timing will be coordinated with Colorado Fish and Wildlife to mitigate impacts to fish habitat and spawning.

Project objectives will be achieved by the following restoration actions:

- Instream work focused on the lower 1600 feet of the river channel through the project reach, including the Weaver Ditch diversion structure. The current diversion infrastructure will be modified to reduce in-channel maintenance needs and improve channel stability issues associated with semi-annual push up dam construction. Below the diversion, the thalweg will be re-established to provide low flow connectivity for fish and reduce an annual occurrence of channel bed and bank de-stabilization providing a more natural state with a deeper low flow channel and adjacent gravel bars. Habitat boulders will be placed in the channel and along the banks to create more structure and habitat variability. Healthier sections of the Crystal River upstream and downstream of the project reach, as indicated by the CRMP, were used as a reference. (this portion of the IS funded by this request)
- Approximately 900 feet of stream bank will be restored, primarily through regrading and planting. This work will reconnect the riparian edge to the hydrology, vegetation, and habitat matrix of the river. Increased species diversity, shade and structure will improve the overall resilience of the riparian corridor. Additionally, specific sections will be rebuilt with boulder steps to create durable access points for anglers and other river users. The access points will

connect with an interpretive/education focused trail system. (this portion of the Project IS funded by this request)

- Riparian improvements will focus on removing invasive species while retaining endemic vegetation in functional habitat areas. The project team has worked with the Roaring Fork Audubon Society to develop a riparian restoration plan that retains and enhances nesting and habitat for the various bird species that visit or reside in Riverfront Park. (this portion of the Project IS funded by this request)
- Additionally, the project will make improvements for accessibility to Riverfront Park, allowing visitors of every ability to access the Crystal River. The improvement will make Riverfront Park the only accessible Crystal River frontage within the Town of Carbondale. An accessible ramp off Crystal Bridge Drive will lead to a rustic gathering area with direct access to the Crystal River. This area is intended to also serve as an outdoor classroom for the five nearby schools, helping to create the community's future river stewards. (this portion of the Project is NOT funded by this request.)

Upon completion, the Weaver Ditch diversion structure will function as a stable part of the stream, requiring less in-channel maintenance. The project will add a land-based maintenance access point river right, to allow for direct access to the diversion structure rather than the current method of driving an excavator nearly a half mile up the streambed at low water. The channel downstream of the diversion is currently flat and over-widened due to increased sediment loading. During low flow periods this section becomes a barrier for fish passage. The project improvements will benefit the channel morphology and hydrologic conditions to reduce several local sediment sources and reestablish a thalweg, providing connectivity at lower flow. The in-channel improvements will also include several small fish habitat structures.

The outcomes of the project have been designed and planned by experts in the field with collaboration created through community buy-in and support, funding has been ongoing since 2018. This project is a collaborative effort, with the project team (RFC, TOC, AVLT, and AR) working closely with Colorado Parks and Wildlife, River Valley Ranch, Trout Unlimited, Roaring Fork Audubon Society, the angling community, and other stakeholders to ensure the project addresses both ecological and community needs and values. The planning documents, including CRMP and RFWP are currently serving as a guide to funding final designs and construction. Project partners have already secured the totality of funds for permit, planning and design and over $175,000 in funds committed to construction and implementation to date. Additionally, five grants are pending and several other public and private entities expressing interest in funding.

This multi-benefit project is one of the largest functional and demonstrative projects to be implemented from Crystal River Management Plan. As a pilot project, it will not only benefit Riverfront Park and the Weaver Ditch, but also serve as an example for future on-the-ground improvements and be a template for the project development process for other impaired reaches of the Crystal and other rivers. With increased interest in Crystal River health and restoration from both public and private entities, this project will be a noteworthy example to share and build upon as other reaches are assessed and prioritized for action. From engineers to watershed groups to CWCB staff, many in the water world are watching to see how the completed CRMP can put projects on the ground and begin to make a measurable difference for the environment. Additionally, the Town of Carbondale has expressed interest in similar projects on other properties, and there is interest in restoration and ditch efficiency projects among private property owners along the Crystal River as well. As implementation begins, we anticipate being

able to use the entire project or selected components as a replicable pilot for other properties in the Crystal River and greater Roaring Fork River Watersheds**.**

Performance Measures

The outcomes of this plan are achievable because they have been created with community buy-in and support, have been designed and planned by experts in the field, and funding of the project is well underway. This project is a collaborative effort, with the project team (RFC, TOC, AVLT, and AR) working closely with Colorado Parks and Wildlife, River Valley Ranch, Trout Unlimited, the angling community, and other stakeholders to ensure the project addresses both ecological and community needs and values. The planning documents (attached separately) are currently serving as a guide to funding final designs and construction.

Photographic Monitoring: Photographs taken at referenced locations that show changes over time; the impacts from recreational users, accumulation of sediment, and the stability and function of restoration treatments and structures.

Channel and Bank Surveys: Topographic surveys of the channel, banks and floodplain for pre-restoration conditions will be collected for baseline cross section and longitudinal profiles. As-built surveys shall be conducted to evaluate post project conditions. Channel surveys will determine the stability of in-channel structures, and the formation of a thalweg. Functional attributes of the channel will be monitored by the structures' ability to scour and deposit sediments and provide low-flow habitat for fish. Bank surveys will monitor the stability of the bank and how the newly excavated floodplains connect with the channel for overbank processes and convey flood flows.

Riparian Surveys: Vegetation transect surveys will validate whether restoration treatments were effective at diversifying the age and species in the riparian corridor. In addition, these surveys

will help determine if birding food sources and perching stands are maintained in the riparian corridor. Pedestrian patterns should also be inventoried for erosion and trampling.

Riparian Invasive Species Inventory: An annual inventory will be taken of the approximate cover and location of weed species and competitive non-native trees. This inventory will aid in determining control treatments and adaptive management of the riparian corridor.

Aquatic Surveys: The objective of restoring the physical changes to the channel is to create a positive biological response in the aquatic community. Monitoring the macroinvertebrate community composition and abundance is a good metric for stream health. Fish population surveys show the abundance, age, and type of fish present in the Crystal River. Fish passage inspection by a qualified biologist during storm flow, low-flow, and flood flow will help with management decisions and the assessment of the biotic integrity of the River.

Results may show trends toward continued improvement, or uncover recommendations for adaptive management including BMPs, operational practices, and other restoration needs.

The intent of the project is to have minimal maintenance. Once final plans are in place, maintenance and monitoring funds will be determined and allocated.

Evaluation Criteria

A. Project Benefits

o Will the project make more water available to meet water needs, or make water available at a more advantageous time or location? If so, how and to what extent?

A component of the project prepares the Weaver Ditch headgate for automation. Through the automation process, the Town of Carbondale will be able to modulate the flow according to residential demand on the ditch system. This could help keep more water in the dewatered stretch

immediately downstream of the ditch to the mouth of the Roaring Fork River. (Approximately 3 miles)

o Will the project result in long-term improvements to water quality? For example, will the project decrease sediment or nutrient pollution, improve water temperature, or mitigate impacts from floods or drought? If so, how and to what extent?

The Weaver diversion improvements and 900 feet of bank stabilization associated with the project will reduce sediment input into the river. The diversion improvements will reduce sediment input by minimizing the need for disturbing/destabilizing the channel bed and banks with heavy equipment to create push up dams for water delivery. This activity currently occurs almost annually. The bank stabilization will improve 900 feet of eroding cut banks in the project reach by reducing bank slope, adding toe protection and revegetation. The project will benefit water temperatures in two ways: (1) by creating a low flow channel for the thalweg downstream of the Weaver Ditch diversion a deeper channel will aid in reduced temperatures during dry years, where currently water is spread over an over-widened and shallow reach; and (2) by restoring riparian vegetation and canopy will increase stream shading and help to mitigate stream temperature. The revegetated banks will also provide additional shade, further reducing water temperatures. Water quality will likely be locally improved through the enhancement of riparian and wetland communities. In addition to providing aesthetic, social, and habitat values, healthy riparian ecosystems naturally provide key water quality treatment and protection services for surface waters due to their landscape location between developed environments and streams. Healthy functioning buffers reduce stormwater loads by promoting infiltration before runoff, removing or attenuating sediment and other contaminants, maintaining bank stability during high flows, and providing base food chain inputs to aquatic and terrestrial life. The project reach

modifications are projected to improve the hydraulics and morphology of the channel's ability to flush sediments through, instead of settling within the reach.

o Will the project benefit aquatic or riparian ecosystems within the watershed? For example, will the project reduce flood risk, reduce bank erosion, increase biodiversity, or preserve native species? If so, how and to what extent?

The project will benefit both the aquatic and riparian ecosystems of the one-half mile, 18-acre reach, and provide ancillary benefits downstream. One of the project goals is to restore the ecological integrity of the riparian zone through streambank stabilization, reconnection of the floodplain, and replace invasive weed communities and plant monocultures with healthy and diverse riparian plant regimes, while preserving healthy bird and wildlife habitat. This goal will be achieved through riparian and upland restoration planting which will enhance habitat, provide shelter and forage, increase shading, and improve riverine temperatures. Dedicated angler access points will allow anglers to fish while maintaining adjacent restored riparian areas. Similarly, carefully planned, and designed trail systems will mitigate social trails and protect habitat and wildlife values. Interpretive components will be incorporated into the park to educate students and the public about the ecosystem and restoration work, building community awareness and stewardship.

Development of a long term, self-sustaining solution to improve river channel stability, fish habitat and spawning areas will promote conditions that support and enhance instream biotic structure and diversity. Implemented bank improvements will increase bank stability, decrease erosion, reduce bank slopes, and re-establish riparian vegetation. These changes will provide shade and in-stream structural diversity for fish.

Creation of a self-sustaining diversion and head gate structure for the Weaver Ditch will make it function as part of the river system, improving the water delivery for the Town of Carbondale and render the ditch consistent with future improvements and efficiencies.

The completion of the Weaver Ditch diversion structure, which will function as a stable part of the stream, will result in less in-channel maintenance and sedimentation. The project will add a maintenance access point, so when work is needed, access adjacent to the head gate, eliminating the need for an excavator to drive nearly a half mile up the streambed at low water. The channel downstream of the diversion is currently flat and over-widened due to increased sediment deposition. During low flow periods this section becomes a barrier for fish passage. The project improvements will reduce several local sediment sources, improve sediment transport, and reestablish a thalweg, providing connectivity at lower flow. The in-channel improvements will also include several small fish habitat structures.

o Will the project benefit specific species and habitats? If so, describe the species and/or type of habitat that will benefit. How and to what extent will the project benefit the species or habitat? Please explain the status of species and habitat that will benefit (e.g., native species, game species, federally threatened or endangered, state listed, and whether critical habitat has been designated).

The Project Area provides habitat for a variety of wildlife species. The Project Area provides good quality habitat for various avian species, from waterfowl to raptors and a variety of other bird species in between. The many dead trees and snags throughout provide excellent hunting perches and cavity nesting opportunities for a variety of raptor species. An active osprey (*Pandion haliaetus*) nest is located approximately 900 feet to the south of the Project Area. The Crystal River Park is currently closed from December 15 to March 15, to allow for bald eagle

(*Haliaeetus leucocephalus*) winter foraging activities. Bird nesting boxes exist on the parcel. Additional nesting boxes for variety of species could increase nesting opportunities and provide additional birding opportunities for visitors. The Project Ecologist on site also noted a high incidence of great blue heron (*Ardea herodias*) within the Project Area.

Mammal habitat is limited due to the size and surrounding land use. Mapped habitat within the project area includes overall range and winter range for larger ungulates such as Mule deer (*Odocoileus hemionus*), Elk (*Cervus canadensis*), and Black bear (*Ursus americanus*). The project area is located within a black bear human conflict area.

Fish species likely to occur within the Project Area include Rainbow trout (*Oncorhynchus mykiss*), Brown trout (*Salmo trutta*), Brook trout (*Salvelinus fontinalis*), Colorado Cutthroat trout (*Oncorhynchus clarki pleuriticus*), and Mountain whitefish (*Prosopium williamsoni*). Fish habitat is currently limited throughout the reach, due to extremely low water conditions during certain times of the year which constrains fishing opportunities. The project will address these concerns through thalweg construction and Weaver diversion improvements. There is also a Colorado Parks and Wildlife (CPW) operated fish hatchery located immediately upstream of the project on the east bank. Per the CPW website, the hatchery raises rainbow trout and Snake River cutthroat trout (*Oncorhynchus clarkia bouvieri*) brood fish. The eggs generated by these brood fish are shipped to other hatcheries for hatching, raising, and stocking.

No Threatened or Endangered Species (T&E) were observed within the Project Area. State and federal T&E species likely to occur in the project area include: U.S. Fish and Wildlife (USFWS) threatened and endangered tiger salamander (A*mbystoma tigrinum stebbinsi*), state listed species of concern northern leopard frog (*Lithobates pipiens*) and the peregrine falcon (*Falco peregrinus*), which is also a state listed species of concern.

o Will the project benefit multiple water uses within the watershed (e.g., agricultural, municipal, tribal, environmental, recreation uses)? If so, how and to what extent?

The Crystal River Restoration and Weaver Ditch Efficiency project was created based on findings from the CRMP as a multi-benefit pilot project benefitting municipal (town ditch) water, environmental, and recreational users. The stated goal to enhance passive user experiences of Riverfront Park through interpretive signs, trails, gathering spaces, and educational programs directly addresses recreational use. Currently the Project Area supports many passive recreation activities such as angling, walking, hiking, bird watching, picnicking, and nature play. All these activities will be enhanced by improving, updating, and programing the Project Area. A dual benefit of the enhancements is their ability to protect the restored ecology by directing people into areas specifically designed for recreation and intentionally directing people away from ecologically sensitive areas.

Angling opportunities will be improved by the completed riverbank restorations and instream restorations. Fishing and fishing access will also be significantly enhanced by formalizing river access points to places along the bank which are safe, stable and offer unique opportunities to interact with the river.

Through site visits and a discussion with stakeholders, two locations have been identified for outdoor classroom and public gathering spaces, one at the north end of the park near Crystal Bridge Drive and one at the south end of the park. The classroom and accessible ramp will allow community and school groups the opportunity to access the river and interpretive trails.

North end near Crystal Bridge Drive: The area along the riverbank is degraded, reducing impacts to healthy riparian areas elsewhere. Optimally, gathering space will be placed along the bank with multiple access points down to the river to provide visitors with an opportunity to access the

river and bank. This access will serve as an educational opportunity and for recreational opportunities such as angling. This gathering space will also serve as an area to inform the public about regulations or special information about the park, and function as a universally accessible gathering space.

South End: The second public gathering space will be near the existing cottonwood grove at the south end of the park. This space will be more focused on the wetland and upland areas of the park. This location also has the potential to serve as a smaller outdoor classroom with seating, shade, and interactive interpretive elements. Walking and hiking through the site will be enhanced by trail improvements and upgraded access. Hiking and walking offer low impact exercise to many people. The gentle grade of the Project Area makes this site ideal for people of many ability levels and provides access to a wide range of ages, interests, abilities, and fitness levels.

The existing bird watching opportunities on the site will be expanded. Wetland and riparian areas host some of the greatest bird life of any ecosystem type. The ecological restorations will improve the habitat for bird populations and provide birding enthusiasts with an incredible in-town amenity. Focusing on bird watching as a major element of recreation on the site will encourage users to protect the ecosystem and respect the Project Area.

The other notable ecological objective is to develop a long term, self-sustaining solution that improves river channel stability as well as fish habitat and spawning areas by promoting conditions that support and enhance instream biotic structure and diversity. To benefit municipal uses, this project will improve the efficiency and operation of the Weaver Ditch diversion and headgate. Restructuring this diversion will be done in a way that improves the diversion itself while improving habitat conditions for this reach of the Crystal River. In many cases the State's

In-Stream Flow (ISF) right is rarely met. Improvements to the river channel and diversion structure may help realign flows, and most definitely the overall goals of the ISF program to preserve the natural environment. Restructuring this diversion will be done in a way that both improves the efficiency of the diversion while improving in-stream habitat conditions near the diversion.

Opportunities for new recreational, educational, and interpretive amenities have been identified. There are many unique features of the site that have the potential to serve as the basis for recreational, interpretive, and educational programming elements for diverse audiences. The project will build on interactive, recreational, and interpretive experiences, while simultaneously improving, restoring, and protecting the health and ecology of the Crystal River and its riparian corridor. This multifaceted approach will create recreational amenities and municipal enhancements that also provide ecological benefits to bring cultural and ecological value to the site simultaneously.

Will the project benefit watershed stakeholders in ways not addressed in the preceding questions? If so, how? Will the project reduce water conflicts within the watershed? Will the project increase resiliency to drought? Will the project provide benefits to other water uses not mentioned above? If so, how and to what extent?

This multi-benefit project is the largest functional and demonstrative project to be implemented from Crystal River Management Plan. As a pilot project, it will not only benefit Riverfront Park and the Weaver Ditch, but also serve as an example for future on-the-ground improvements and be a template for the project development process for other impaired reaches of the Crystal River. With increased interest in Crystal River health and restoration from both public and private entities, this project will be a noteworthy example to share and build upon as other

reaches are assessed and prioritized for action. From engineers to watershed groups, many in the water world are watching to see how a completed plan can put projects on the ground and begin to make a measurable difference for water rights holders, recreationalists, and the environment. The Town of Carbondale has expressed interest in similar projects on other properties, and there is interest in restoration and ditch efficiency projects among private property owners along the Crystal as well. As implementation begins, we anticipate being able to use the entire project or selected components as a replicable pilot for other properties in the Crystal River and greater Roaring Fork River Watersheds.

The project will make improvements for accessibility to Riverfront Park, allowing visitors of every ability to access the Crystal River. The improvements will make Riverfront Park the only accessible Crystal River frontage within the Town of Carbondale. The accessible ramp off Crystal Bridge Drive will lead to a rustic gathering area with direct access to the Crystal River. This area is intended to also serve as an outdoor classroom for the five nearby schools, helping to create the community's future river stewards. Additional hard and soft-scape trails will be formalized within the park providing passive recreational opportunism such as wildlife viewing while preserving important habitat and sensitive areas by deterring off trail use.

Existing amenities such as the trail, river access, interpretive and regulatory information and gathering places have become degraded and weathered over time. These spaces are generally in disrepair and are no longer as effective as they once were. The main trail along the site is heavily overgrown and can be difficult to locate and navigate. Areas of the trail have eroded into the river and navigation through the overgrowth is difficult in sections. This trail overgrowth and degradation has resulted in informal "social trails" winding through the site and degraded riverbanks from informal access points contributing to erosion and bank destabilization.

The Project Area contains several interpretive signs; however, these signs have become worn over time and are dated. Many signs are no longer visible due to vegetation overgrowth and do not describe the ecologies of the locations where they stand. Instructional and regulatory signs are not concentrated or clearly placed near the main access point near the bridge. There are no formal gathering places except for two picnic tables near the south end of the site. The area is both hard to locate and in disrepair due to age and lack of maintenance. Several informal gathering spaces exist and are evident in areas where the vegetation has been disturbed. In addition, the access point beneath the bridge is difficult to find, is steep and the stairs are in disrepair. Currently, the site is not universally accessible.

• Will the project address multiple issues of concern within the watershed?

Yes, the project will address multiple issues of concerns as identified in the CRMP, Section 5.4. These include riparian restoration, bank stability, fish habitat, water temperatures and low flow connectivity. This project will address ecological concerns along with diversion efficiency and recreational/educational benefits. Each component of the project is designed with all of these in mind.

B. Watershed Restoration Planning

o When was the restoration plan prepared and for what purpose?

The Roaring Fork Watershed Plan[2] (RFWP), originally published in 2012, is the product of over four years of collaboration and effort by more than a hundred people, representing dozens of agencies, governments, and interests throughout the Roaring Fork Valley. It is a compendium of proposals and recommendations developed by both experts and interested citizens, meant to be implemented by a variety of agencies, governments, and other entities, as resources allow. It

[2] http://www.roaringfork.org/media/1171/20120412-roaring-fork-watershed-plan-final.pdf

details more than 250 action items, ranging from identifying and protecting major wetlands to pursuing opportunities for improving natural and artificial water storage as well as improving low stream flows and supporting state and federal tax credits for donations of conservation easements. Action items are intended to provide guidance and direction on how best to cooperatively improve and protect the water resources of the Roaring Fork Valley. Throughout 2017 and 2018, with funding from Pitkin County Healthy Rivers Board, RFC met with and interviewed numerous coordinating entities to determine and document projects or actions completed by those organizations that accomplished Plan goals. Significant accomplishments in the past six years show measurable benefits to the watershed, valuable collaboration, and widespread dedication to the resource.

The CRMP[3] was published in 2016. The Crystal River watershed provides critical habitat for fish and wildlife, as well as water essential for both local agricultural and municipal uses. The river system is home to cutthroat trout, Bald Eagles, Lewis's Woodpeckers and rare plant species, and draws anglers, kayakers and sightseers from around the world. Because of the free-flowing river's scenic, historic, and recreational values, the U.S. Forest Service has found the upper Crystal River eligible for federal Wild and Scenic River designation. Interest in protecting the watershed and its consumptive and non-consumptive water uses has recently grown due to a variety of factors, including the addition of the Crystal River to America's 'Most Endangered Rivers' list in 2012, work being conducted on the Colorado Water Plan, and recent drought conditions. The CRMP utilizes a science-based and stakeholder-centered approach to consider complex interactions between the physical components driving watershed structure; the biological components of riverine ecosystems; the social context of competing perspectives,

[3] http://www.roaringfork.org/media/1352/crmp_noappendix_bleeds.pdf

needs, and values; and the existing legal and administrative frameworks governing water use in an effort to identify and evaluate management and structural alternatives that honor local agricultural heritage, preserve existing water uses, and enhance the ecological integrity of the river. A series of stakeholder meetings held throughout the planning process served to clarify outstanding questions, summarize results from previous studies, refine planning goals and objectives, and evaluate the feasibility of various management alternatives.

o What types of watershed management issues are addressed in the plan? For example, does the restoration plan address water quantity issues, water quality issues, and/or issues related to ecosystem health or the health of species and habitat within the watershed?

Both the RFWP and the CRMP address water quality, water quantity, ecosystem health, habitat health/function, and climate change impacts.

o Who was involved in preparing the plan? Was the plan prepared with input from stakeholders with diverse interests? What was the process used for interested stakeholders to provide input during the planning process?

The RFWP engaged hundreds of stakeholders in its original 2012 publication from all facets of the watershed: municipal, agricultural, recreational, and environmental. This was done through the creation of an ad hoc group called the "Roaring Fork Watershed Collaborative," which consisted of representatives from local government and jurisdictions, Federal organizations, local and regional nonprofits, and interested citizens. Stakeholders were engaged through a series of meetings from 2009 through publication in 2012. The watershed planning process was, by design, very broad and deliberate. The overriding concerns were to be inclusive, transparent, thorough and detailed in the effort, which has led down many pathways that were not anticipated when this process was started. The result is a highly detailed Plan which is daunting in its scope

and ambition, but which sets lofty goals, and which challenges the community to take on a vast responsibility for critical resources. In 2018, RFC re-engaged the original stakeholders to update successful actionable items, remove action items that had become obsolete, and add items based on changes in the watershed, region, and state since 2012. This effort resulted in streamlined action lists for each entity and the publication of an updated Executive Summary.

As a strategic planning document for local communities, the CRMP strives to integrate sound scientific and engineering evaluations, competing local value systems and resource use priorities, and feasibility constraints imposed on identified management alternatives. Human values largely shape the way these concerns are measured in cost-benefit analyses that guide local planning priorities. Therefore, development of the CRMP relied heavily on stakeholder input. Stakeholder groups involved in the process include: agricultural producers, State water administrators, local municipalities, natural resource agencies, local and national environmental organizations, recreational advocates, and other water rights holders. A series of group and individual meetings held throughout the planning process served to clarify outstanding questions, summarize results from previous studies, refine planning goals and objectives, and evaluate the feasibility of various management alternatives. The pursuit of actionable project recommendations required understanding the multiple dimensions of decision-making criteria. Therefore, answering the questions of "Socioeconomic Context" required characterizing the condition of riverine resources in the Crystal River watershed and the physical processes that govern the movement of water, its interaction with local channel forms, and its impacts on aquatic biota.

o If the restoration plan was prepared by an entity other than the watershed group, explain why the watershed group did not prepare its own plan.

The RFWP was prepared by RFC in partnership with Ruedi Water and Power Authority (RWAPA). The CRMP was prepared by Lotic Hydrological, LLC for RFC and Public Counsel of the Rockies. A consultant was used to author the report due to the technical nature of research and in-depth hydrological engineering knowledge necessary. RFC is listed as the project sponsor on the report and was highly involved throughout the process.

• Describe how the existing restoration plan provides support for your proposed watershed management project.

The RFWP recognized the impact significantly altered flow regimes, wetland degradation, and sediment issues on various reaches of the Crystal River. The RFWP identified the Crystal as a location for opportunities to improve fish passage, improve ecological health through land-use change, and explore grazing impact mitigation. The project also meets the following designated plan goals:

GWB1a. &b. Identify, protect, and restore **major wetlands** areas in the watershed.

RIB1a., RIB2a., & SWE2b. Working with landowners, resource experts, and other interested parties, plan and implement **riparian/ instream protection and restoration projects**. Use these projects to restore the natural function of floodplains and improve bird habitat.

RIC1h. Minimize instream impacts and improve fish habitat by **reengineering instream structures** intended to move water into headgates.

NEW2018. Investigate or support investigation of improved headgate designs.

The CRMP is one of the first SMPs to be completed, and states that "The reaches of the Crystal River between Thompson Creek and the confluence with the Roaring Fork exhibit the most degraded overall functional condition" (5.4, CRMP). This project will work to reverse some of that degradation. This project is a coordinated effort to implement two of the key

recommendations from the CRMP. From an ecological standpoint, the first objective of this project is to restore the integrity of the riparian zone through streambank stabilization, reconnection of the floodplain, and replacement of invasive weed communities and plant monocultures with healthy and diverse native riparian plant regimes, while preserving existing bird and wildlife habitat.

The second ecological objective is to develop a long term, self-sustaining solution that improves river channel stability as well as fish habitat and spawning areas by promoting conditions that support and enhance instream biotic structure and diversity (5.4, CRMP). This project will improve the efficiency and operation of the Weaver Ditch diversion and headgate. Restructuring this diversion will be done in a way that both improves the diversion itself while improving habitat conditions for this reach of the Crystal River. In many cases the State's ISF right is rarely met. Improvements to the river channel and diversion structure may help with flows, and most definitely the overall goals of the ISF program to preserve the natural environment. Restructuring this diversion will be done in a way that both improves the efficiency of the diversion while improving in-stream habitat conditions near the diversion.

o Does the proposed project implement a goal or need identified in the restoration plan?

Yes. Please see description in previous section.

o Describe how the proposed project is prioritized in the referenced restoration plan.

In addition to the goals listed previously, the project addresses RFWP Urgent Action Item "Plan and Implement Key Riparian and Instream Protection and Restoration Projects," and "Increase Awareness of the Importance of Riparian Areas." The CRMP goals are characterized as "Management Priorities," and "Future Considerations."

C. Stakeholder Support

• Please describe the level of stakeholder support for the proposed project. Are letters of support from stakeholders provided (see Section D.2.2.9. Letters of Support)? Are any stakeholders providing support for the project through cost-share contributions, or through other types of contributions to the project?

Stakeholder input and support have been an integral part of the project from the onset. Stakeholder input was gathered through a series of community meetings and through the website www.yourcrystalriver.com. The project has garnered support from the Town of Carbondale (letter included, over $50,000 committed in planning and construction funds), Colorado Parks and Wildlife (letter included, $50,000 support through two grants), River Valley Ranch Homeowners Association, Aspen Valley Land Trust ($20,000 from the Hause Family R3 Fund), American Rivers, Trout Unlimited, and several Crystal Valley residents.

• Please explain whether the project is supported by a diverse set of stakeholders (appropriate given the types of interested stakeholders within the watershed and the scale, type and complexity of the proposed project). For example, is the project supported by entities representing agricultural, municipal, tribal, environmental, or recreation uses?

The project has garnered support from a diverse network of stakeholders because the project worked to engage these groups from the onset. Letters of support from Town of Carbondale, American Rivers, CPW, Pitkin County Commissioner, the Roaring Fork Fly Fishing Guide Alliance, and local ranchers involved in the CRMP are included. The outreach process included the creation of two restoration alternatives that were brought before the community. Based on feedback, these plans were modified to create the final design. Because we involved the community stakeholders and their feedback in the design process, we have been able to garner greater support.

• Is the project supported by entities responsible for the management of land, water, recreation, or forestry within the watershed? Is the project consistent with the policies of those agencies?

Yes, the project has support of the Colorado Department of Parks and Wildlife. (Letter attached)

• Will the proposed project complement other ongoing watershed management activities by state, Federal, or local government entities, non-profits or individual landowners within the watershed? Please describe other relevant efforts, including who is undertaking these efforts and whether they support the proposed project. Explain how the proposed project will avoid duplication or complication of other ongoing efforts.

The Crystal River Restoration and Weaver Ditch Efficiency project complements several other projects that are completed, planned, and proposed in the Crystal Watershed. The Town of Carbondale is working on increasing ditch efficiency and has completed a survey of the Weaver Ditch to understand how water moves through the ditch to understand placements of weirs and telemetry devices that complement the headgate improvements and eventual automation planned here. In addition, several riparian initiatives to benefit the river complement the current proposal by creating additional quality riparian areas. The Colorado Rocky Mountain School owns property downstream of the project area and has undertaken a Russian Olive removal plan as well as cattle exclusion and riparian planting. In addition, Pitkin County Open Space and Trails has several riparian projects completed or underway, including a cottonwood restoration at the confluence of Thompson Creek (upstream), erosion control on Thompson Open Space, and vegetative restoration and fencing at Filoha Meadows (upstream). Furthermore, RFC continues to work with a citizen's group, "Crystal River Restoration Working Group" to identify and

pursue priority restoration projects. The culmination of all these projects and the current proposal create a greater quantity and quality of riparian areas to benefit overall Crystal River health.

In 2015, the Town of Carbondale developed and adopted the Great Outdoors Colorado (GOCO) funded Carbondale Parks, Recreation & Trails Master Plan to address services, management, maintenance, facilities and policies regarding its parks, recreation and trails over the next ten years. The master plan states that "The Roaring Fork and the Crystal River are two unique assets to Carbondale that can be better highlighted and connected to in years to come and promoted as community assets and recreational amenities." The plan goes on to recommend, "better visual and physical accessibility, increased river trail opportunities for everyone and encouraging conservation and restoration projects within the riparian corridors." A survey administered as part of the master planning process indicates that Carbondale citizen's support "improving the Crystal River corridor for trail users and fishing access" as well as "creating places for nature observation and exploration" and a desire to "create a native birding trail and preserve….along the Crystal River and Riverfront Park." The project responds directly to the goals outlined in the above plan through improved access and community amenities, and restoration.

The Town of Carbondale has expressed interest in similar projects on other properties, and there is interest in restoration and ditch efficiency projects among private property owners along the Crystal as well. As implementation begins, we anticipate being able to use the entire project or selected components as a replicable pilot for other properties in the Crystal River and greater Roaring Fork River Watersheds.

• Is the project completely or partially located on Federal land or a Federal facility? If so, explain whether the agency supports the project, whether the agency will contribute toward the project, and why the Federal agency is not completing the project?

No, the project is not located on Federal Land or near a Federal facility.

• Is there opposition to the proposed project? If so, describe the opposition and explain how it will be addressed. Opposition will not necessarily result in fewer points.

One homeowner at River Valley Ranch has expressed opposition to the project does not believe the restoration project is worthwhile due to cost and believes the project will not be effective as a solution for the reach. Project team members have reached out to him to discuss and listened to his concerns and opposition. Otherwise, the project enjoys a broad coalition of support.

D. Readiness to Proceed

• Describe the implementation plan for the proposed project. Please include an estimated project schedule that shows the stages and duration of the proposed work, including major tasks, milestones, and dates.

The project has completed 60% design plans, with 90% design scheduled for completion by 12/20. Project stakeholders are working on an intensive fundraising plan to allow the project to work on the following schedule:

Task	Description	Target Start Date	Target Completion Date
1	Construction Bidding and Services Acquisition	April 2021	May 2021
2	Contract Negotiation and Finalization	May 2021	June 2021
3	Public outreach and Coordination	June 2021	November 2021
4	In-Channel Improvements	September 2021	October 2021
5	Upland Improvements	September 2021	November 2021
6	Construction Administration	June 2021	November 2021
7	United States Army Corps Reporting	October 2021	November 2021

• Describe any permits and agency approvals that will be required, along with the process and timeframe for obtaining such permits or approvals.

In accordance with the Clean Water Act, the project requires Section 404 authorization from the US Army Corps of Engineers (USACE). The project team has coordinated with the local USACE district staff and has developed a plan to permit the project through the programmatic

Nationwide Permit (NWP) program. The project team is currently preparing the required supporting documentation for this process with anticipated submittal by November 30, 2020. The USACE has 30 days to review and comment on the package once submitted. It is anticipated that the project will have USACE authorization by early January 2021.

The project also requires a floodplain development permit, which is administered by the local floodplain administrator, the Town of Carbondale. The floodplain development requires a 1-dimensional hydraulic model and a technical memorandum documenting impacts to the floodplain. This process is in work and will be complete as part of the 90% plans submittal.

• Identify and describe any engineering or design work performed specifically in support of the proposed project, or that will be performed as part of the project. Priority will be given to project that are further along in the design process and ready for implementation.

The planning and design work required for the projects is completely funded through stakeholder contributions and prior grant awards and is currently in work. The engineering and design documents are currently at the 60% level suitable for permit submittal (attached separately). The engineering team is currently working on the 90% plan, which will be reviewed by the project stakeholders in late December/early January. Review comments will be incorporated into a final set of bid documents, including plans, specifications and bid tabulation to be used for bidding the project in late winter/early spring 2021.

• Does the applicant have access to the land or water source where the project is located? Has the applicant obtained any easements that are required for the project? If so, please provide documentation. If the applicant does not yet have permission to access the project location, please describe the process and timeframe for obtaining such permission.

Yes, the Town of Carbondale owns both the property and the ditch headgate associated with the project.

• Has the applicant included an amount equal to 5 percent of the total project costs in their project budget to cover costs associated with environmental and cultural resource compliance (see Section 2.2.5. Project Budget for additional information)? Yes.

E. Performance Measures

Please describe the performance measures that will be used to quantify actual project benefits upon completion of the project. Include support for why the specific performance measures were chosen.

Photographic Monitoring: Photographs taken at referenced locations that show changes over time; the impacts from recreation users, accumulation of sediment, and the stability and function of restoration treatments and structures.

Channel and Bank Surveys: Topographic surveys of the channel, banks and floodplain for pre-restoration conditions will be collected for baseline cross section and longitudinal profiles. As-built surveys shall be conducted to evaluate post project conditions. Channel surveys will determine the stability of in-channel structures, and the formation of a thalweg. Functional attributes of the channel will be monitored by the structures' ability to scour and deposit sediments, provide low-flow habitat for fish. Bank surveys will monitor the stability of the bank and how the newly excavated floodplains connect with the channel for overbank processes and convey flood flows.

Riparian Surveys: Vegetation transect surveys will validate whether restoration treatments were effective at diversifying the age and species in the riparian corridor. In addition, these surveys will help determine if birding food sources and perching stands are maintained in the riparian corridor. Pedestrian patterns should also be inventoried for erosion and trampling.

Riparian Invasive Species Inventory: An annual inventory of the approximate cover and location of weed species and competitive non-native trees. This inventory will aid in determining control treatments and adaptive management of the riparian corridor.

Aquatic Surveys: The objective of restoring the physical changes to the channel is to create a positive biological response in the aquatic community. Monitoring the macroinvertebrate community composition and abundance is a good metric for stream health. Fish population surveys show the abundance, age, and type of fish present in the Crystal River. Fish passage inspection by a qualified biologist during storm flow, low-flow, and flood flow will help with management decisions and the assessment of the biotic integrity of the River.

Results may show trends toward continued improvement, or uncover recommendations for adaptive management including BMPs, operational practices, and other restoration needs. The intent of the project is to have minimal maintenance. Once final plans are in place, maintenance and monitoring funds will be determined and allocated.

F: Department of the Interior and Reclamation Priorities[4]

Department of the Interior Priorities

1. Creating a conservation stewardship legacy second only to Teddy Roosevelt

a. Utilize science to identify best practices to manage land and water resources and adapt to changes in the environment

This project has used best available science, planning and engineering. The work in the planning process is based on the following prior studies/plans: Roaring Fork Watershed Plan 2018/2012; Crystal River Management Plan 2016; Carbondale Water Wastewater Master Plan 2016; Regional Water Efficiency Plan, Roaring Fork Watershed Colorado 2015; Municipal Water

[4] Priorities that are not applicable to the project have been omitted

Efficiency Plan, Town Carbondale Colorado 2015; Opportunities for Water Conservation, RFC 2012; Town of Carbondale Source Water Protection Plan 2015; Wildland Hydrology Crystal River Restoration Scoping 2014; Crystal River and Coal Basin Aquatic Life Use Assessment , 2012; State of the Roaring Fork Watershed, 2008. In addition, the project consultant team has decades of experience planning and implementing collaborative river restoration projects throughout Colorado and the Rocky Mountain West. Locally speaking, River Restoration recently completed the Pitkin County Whitewater Park in Basalt, DHM Design executed the design and planning behind the Basalt River Restoration Project.

The project partner/stakeholder group often works together as part of the Roaring Fork Valley's Watershed Collaborative and has completed several management plans and other initiatives within the watershed.

b. Examine land use planning processes and land use designations that govern public use and access.

In 2015, the Town of Carbondale developed and adopted the Great Outdoors Colorado (GOCO) funded Carbondale Parks, Recreation & Trails Master Plan to address services, management, maintenance, facilities and policies regarding its parks, recreation and trails over the next ten years. The master plan states that "The Roaring Fork and the Crystal River are two unique assets to Carbondale that can be better highlighted and connected to in years to come and promoted as community assets and recreational amenities." The plan goes on to recommend, "better visual and physical accessibility, increased river trail opportunities for everyone and encouraging conservation and restoration projects within the riparian corridors." A survey administered as part of the master planning process indicates that Carbondale citizen's support "improving the Crystal River corridor for trail users and fishing access" as well as "creating places for nature

observation and exploration" and a desire to "create a native birding trail and preserve….along the Crystal River and Riverfront Park."

e. Foster relationships with conservation organizations advocating for balanced stewardship and use of public lands

This multi-beneficial project partners with local government, federal agencies, and nonprofit organizations to demonstrate balanced stewardship and many uses on public land.

g. Shift the balance towards providing greater public access to public lands over restrictions to access

Access to the site will be improved to allow for individuals with limited impairment to access this site.

3. Restoring trust with local communities

a. Be a better neighbor with those closest to our resources by improving dialogue and relationships with persons and entities bordering our lands

This project provides the opportunity to be recognized on interpretive materials that help improve the relationship both the land and the associated organizations.

b. Expand the lines of communication with governors, state natural resource offices, Fish and Wildlife offices, water authorities, county commissioners, tribes, and local communities

Participation in this project will open communication with a diverse group of stakeholders and help build relationships with the Roaring Fork and Crystal Valleys.

4. Striking a regulatory balance

b. Ensure that ESA decisions are based on strong science and thorough analysis.

The project has been based on developed utilizing metric-based design concepts for the enhancement of riverine environment. The consultant team has experience in similar projects in the Rocky Mountain region.

5. Modernizing our infrastructure

a. Support the White House Public/Private Partnership Initiative to modernize U.S. infrastructure

This project includes the modernization of the Weaver Ditch Headgate, which is currently nearly 100 years old. This will not only benefit the Weaver Ditch and citizens of Carbondale, but also serve as a model for other town and privately owned ditch infrastructure.

b. Remove impediments to infrastructure development and facilitate private sector efforts to construct infrastructure projects serving American needs

Successful implementation of the Weaver ditch improvements will serve as a model for other town and privately owned ditch infrastructure to provide water conservation measures and reduce impacts of diversion intake structures on river diversion systems.

Bureau of Reclamation Priorities

1. Increase Water Supplies, Storage, and Reliability under WIIN and other Authorities

The restructuring of the Weaver Ditch diversion will help the town more efficiently receive their allocated water right based on flow in the river and priority, as well as minimize annual maintenance.

3. Leverage Science and Technology to Improve Water Supply Reliability to Communities

The design of the ditch headgate and diversion structure will be state of the art. Enabling the ditch to be automated will help ensure a reliable supply to the Weaver Ditch, and create the

ability to take only what is needed when it is needed, thus making water available for environmental needs or downstream junior users.

4. Address Ongoing Drought

By reconfiguring the Weaver diversion and creating a thalweg for low flow times, this project creates and models opportunities for drought resiliency.

Project Budget

Funding Plan and Letters of Commitment

Project partners have already secured the totality of funds for permit, planning and design and over $175,000 in funds committed to construction and implementation to date. Additionally, five grants are pending, and several other public and private entities have expressed interest. Commitments letters are not available at the time of this application submission. RFC anticipates having all letters in hand by June of 2021. Cost-share funding from sources outside of our organization will be secured and available prior to award.

Project Phase	Grant/Funding Source	Amount	Dedicated Funds/Project Component
Construction	Colorado Parks and Wildlife	$20,000.00	Plants and Trees
Construction	Fishing is Fun	$30,000.00	Access Ramp and Classroom
Construction	GOCO Restore 2020*	$249,947.00	Restoration and Trails
Construction	Pitkin County Healthy Rivers***	$65,000.00	Weaver Ditch Headgate Improvements
Construction	Black Hills Energy*	$20,000.00	
Construction	Martin Foundation*	$30,000.00	
Construction	Aspen Valley Land Trust R3	$10,000.00	
Construction	GOCO Resilient Communities*	$55,000.00	$25k ADA Access Construction, $30k outdoor classroom
Construction	Wetlands Project Funding - Colorado Parks & Wildlife*	$300,000.00	Riparian Restoration
Construction	CWCB - Colorado Watershed Restoration Grants*	$225,000.00	In Channel Improvements, Riparian restoration
Construction	2020 Town of Carbondale Funding	$20,000.00	
Construction	2021 Town of Carbondale Funding***	$40,000.00	**$40 K earmarked for match in 2021 draft budget**
	TOTAL FUNDING Secured to Date:	**$80,000.00**	
	TOTAL FUNDING Pending*:**	**$105,000.00**	
	TOTAL FUNDING Applied For*:	**$879,947.00**	
	GRAND TOTAL	**$1,064,947.00**	

Budget Proposal

This grant seeks **$252,091.08** (18% of anticipated construction costs) for the implementation and construction of the Crystal River Restoration and Weaver Ditch Efficiency project. Funds will be used directly for the implantation of efficiency improvements and the restoration and enhancement of the adjacent landscape. Specifically, monies gained through the WaterSMART program will be employed in the: in-channel improvements, west bank improvements; and restoration planting and seeding. The anticipated benefits of these activities are discussed in detail in the proposal and attached planning documents.

The budget proposal does not include any project costs that have been incurred prior to application. Planning and design of this project were fully funded through a diverse group of supporters and the Town of Carbondale as noted below.

Project Phase	Grant/Funding Source	Amount
Planning and Design	Colorado Water Conservation Board - Water Plan Grant	$100,000.00
Planning and Design	Aspen Valley Land Trust R3	$10,000.00
Planning and Design	Colorado Healthy Rivers Fund	$25,000.00
Planning and Design	Colorado Water Conservation Board - Water Supply Reserve Fund	$20,363.00
Planning and Design	Aspen Ski Co Environmental Foundation	$9,300.00
Planning and Design	Town of Carbondale Funding	$20,000.00
	TOTAL FUNDING Planning and Design:	**$184,663.00**

Below is a detailed engineer's opinion of construction and implementation costs:

PROJECT: Crystal River Restoration Project - Crystal River, Carbondale, CO
Ver 5 -Date: ***February 6, 2020***
Preliminary Cost Opinion

IN-CHANNEL IMPROVEMENTS

Item #	Description	Quantity	Unit	Unit Cost	Total Cost	Totals	*Notes / Assumptions*
	Site Preparation						
1	Erosion and Sediment Control	1	LS	$15,000	$15,000		
2	Site Access	1	LS	$25,000	$25,000		Assume access road will be regraded and ditch can be blocked during construction
3	Care of water	1	LS	$125,000	$125,000		Assume river will need to be diverted to left then right
4	Site Restoration	1	LS	$15,000	$15,000		Regrade and replant bank access points, restore ditch, refurbish curb at start of access
					Sub Total:	**$180,000**	

	Weaver Ditch Headgate Structure and "Island" Rebuild						
5	Removal, Haul and Disposal of Old Gates	1	LS	$2,500	$2,500		
6	Furnish and Install Sluice Gate	1	LS	$25,000	$25,000		
7	Furnish and Install Diversion Gate	1	LS	$25,000	$25,000		
8	Reinforced Concrete Wall and Concrete Access Steps	6	CY	$1,500	$9,000		
9	Aggregate Base	4	CY	$100	$400		
10	Channel Excavation	37	CY	$17	$632		
11	Removal, Haul and Disposal of Existing Concrete Barriers	1	LS	$1,000	$1,000		
12	Furnish and Install Filter Fabric	90	SY	$8	$720		
13	Furnish, Deliver and Place "Island" Boulders	126	TON	$125	$15,810		
14	Erosion Control Matting	60	SY	$8	$480		
15	Import and Install Topsoil	10	CY	$70	$700		
16	Access Ramp Restoration Seed Mix	60	SY	$5	$300		
17	Furnish, Deliver and Place Inlet "Filter" Boulders	10	TON	$120	$1,161		
					Sub Total:	**$82,703**	
	Maintenance Access Ramp						
18	Access Ramp Excavation	179	CY	$17	$3,035		
19	Haul and Disposal of Alluvial Bank Material offsite	179	CY	$52	$9,285		
20	Furnish, Deliver and Place Access Ramp Surface Material	31	CY	$60	$1,833		6"-0 minimum 1' thickness
21	Furnish, Deliver and Place Access Ramp Boulder	35	TON	$120	$4,200		
22	Furnish and Install Filter Fabric	101	SY	$8	$807		
23	Import and Install Topsoil	15	CY	$70	$1,050		
24	Access Ramp Restoration Seed Mix	90	SY	$5	$450		
					Sub Total:	**$20,660**	
	In-channel Improvements						
25	Channel Excavation	2,299	CY	$17	$39,082		
26	Cutoff Wall	1	LS	$80,000	$80,000		rough estimate from Structures, Inc. Denver
27	Regrade Riffle	2,384	CY	$12	$28,608		
28	Furnish, Deliver and Place Boulder	93	TON	$120	$11,150		
29	Furnish, Deliver and Place Select Boulder	113	TON	$160	$18,053		assume 1/3 total structure boulder
30	Rework Existing Boulder	68	TON	$69	$4,671		assume 1/5 structure will be reworked existing boulder
31	Riffle Boulder Clusters	41	TON	$120	$4,896		
32	Alluvial Backfill	0	CY	$12	$0		
33	Haul and Disposal of Alluvial Material offsite	610	CY	$50	$30,517		
34	Furnish and Install Filter Fabric	227	SY	$8	$1,816		
					Sub Total:	**$218,793**	
	West Bank Improvements						
35	Haul and Disposal of Alluvial Bank Material offsite	422	CY	$52	$21,944		
36	Channel Excavation	163	CY	$17	$2,769		

37	Furnish Deliver and Place) Boulder - Type C Bank (625' total length		142	TON	$120	$17,000		
38	Furnish Deliver and Place) Boulder - Type D Bank (205' total length		310	TON	$130	$40,271		
39	Furnish, Deliver and Place Jetty Boulder @ Outdoor Classroom		39	TON	$130	$5,108		
40	Furnish, Deliver and Place Boulder Clusters		78	TON	$120	$9,302		
41	Furnish and Install Erosion Control Matting		1,500	SY	$8	$11,250		
42	Furnish and Install Filter Fabric		1020	SY	$8	$8,160		
						Sub Total:	**$115,804**	
	INCHANNEL IMPROVEMENTS - TOTAL COST OPINION						**$617,960**	

UPLAND IMPROVEMENTS							
	Description	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Totals**	***Notes / Assumptions***
	Site Improvements Paving						
43	Road Base	2,293	SF	$4	$9,172		*Includes roadbase under concrete*
44	Concrete Path	1,137	SF	$12	$13,644		
45	Compacted Earth Trail	2,231	LF	$1	$2,231		
					Sub Total:	**$25,047**	
	Site Walls & Other Features						
46	Timber Walls	210	LF	$50	$10,500		
47	Concrete Stairs	35	LF	$36	$1,260		
48	Steel Handrail	1	LS	$3,000	$3,000		
49	Beamstone Walls	300	LF	$190	$57,000		*At outdoor classroom and beamstone fishing access*
50	Boulder Seats	10	EA	$500	$5,000		
51	Boardwalk	97	LF	$125	$12,125		
52	Timber Stairs	1	EA	$1,000	$1,000		
53	Boulder Fishing Access Type A	3	EA	$1,000	$3,000		
54	Boulder Fishing Access Type B	1	EA	$2,500	$2,500		
					Sub Total:	**$95,385**	
	Landscape						
55	Import Topsoil	494	CY	$70	$34,580		
56	Supply Mulch (10 sf per planting	21,770	SF	$0.33	$7,184		
57	*Acer Glabrum / Rocky Mountain Maple (5 Gal)*	6	EA	$80	$480		
58	*Alnus Tenuifolia / Thinleaf Alder (5 Gal)*	175	EA	$80	$14,000		
59	*Artemisia Tridentata / Big Sagebrush (5 Gal)*	6	EA	$80	$480		
60	*Betula Occidentalis / Water Birch (5 Gal)*	175	EA	$80	$14,000		
61	*Chrysothamnus Nauseosus / Rubber Rabbitbrush (5 Gal)*	6	EA	$80	$480		
62	*Cornus Sericea / Red Twig Dogwood (5 Gal)*	175	EA	$80	$14,000		
63	*Populus Angustifolia / Narrowleaf Poplar (5 Gal)*	181	EA	$80	$14,480		
64	*Prunus Virginiana Melanocarpa / Western Chokeberry (5 Gal)*	6	EA	$80	$480		
65	*Salix Bebbiana / Bebb`S Willow (5 Gal)*	314	EA	$80	$25,120		
66	*Salix Drummondiana / Drummond`S Willow (5 Gal)*	314	EA	$80	$25,120		

67	*Salix Lasiandra / Whiplash Willow (5 Gal)*	314	EA	$80	$25,120		
68	*Salix Monticola / Rocky Mountain Willow (5 Gal)*	314	EA	$80	$25,120		
69	*Shepherdia Argentea / Silver Buffaloberry (5 Gal)*	191	EA	$80	$15,280		
70	10 Cl Wetlands Plug Grass	2137	EA	$2	$4,274		
71	Willow and Cottonwood Cuttings	1149	EA	$2	$2,298		
72	Seeding & Revegetation	30240	SF	$0.35	$10,584		
					Sub Total:	**$233,080**	
	Site Furnishings						
73	Closure Gates	3	EA	$300	$900		
74	Closure Gate Posts & Bases	3	EA	$800	$2,400		
75	Gate Installation	1	LS	$1,500	$1,500		
76	Kiosk Signs	2	EA	$5,000	$10,000		
77	Interpretive Signs	1	LS	$20,000	$20,000		
					Sub Total:	**$34,800**	
	UPLAND IMPROVEMENTS - TOTAL COST OPINION					**$388,312**	
	ITEMIZED CONSTRUCTION SUBTOTAL					**$1,006,273**	
	Contingency (15%)					**$150,941**	
A1	Land Survey (LS)				*$1,600*		
A2	Geotechnical Engineering						*N/A*
A3	Structural Engineering				*$9,000*		
A4	Utility Relocations						*N/A*
A5	Traffic Control				$5,000		
A6	Hydrographic Survey						*Included in current or future contracts*
A7	Cultural Resource Survey and Report						*n/a*
A8	Full Wetland Delineation						*Included in current or future contracts*
A9	Lands and Easements (Permanent)						*n/a*
A10	Lands and Easements (Construction)						*Stakeholders to lead*
A11	Lands and Easements Processing						*n/a*
A12	Construction Bonding/Ins (5%)				$50,314		5% construction
A13	Mob and Demob (5%)				$50,314		5% construction
A14	Environmental Assessment Recovery Prgm						n/a
A15	Public Outreach and Coordination				*$1,280*		*Fundraising*
A16	Engineering Design				*$43,326*		
A17	Hydraulic Modeling				*$8,724*		
A18	Permitting 404, 401						*Included in current or future contracts*
A19	CDOT ROW License						*n/a*
A20	Permitting Floodplain				*$6,880*		
A21	Plans and Specifications for bid				*$19,148*		
A22	Construction Stakeout				$8,000		
A23	Construction Review Observations				$25,000		
A24	Vegetation Replacement YR 2						*Stakeholders to lead*
A24	Grant Writing Assistance				*$12,000*		
A25	Interpretive Design Programming/Details				*$14,707*		
	TOTAL PROJECT COST OPINION				**$1,412,506**		

Budget Narrative[5]:

The project budget has been developed to implement the tasks and activities that are necessary to achieve the goals of the project. The Crystal River Restoration Project has numerous project elements to achieve the project's objectives. Heavy overhead costs have been minimized to the greatest extent possible.

The project construction/implementation activities are:

A. Construction Bidding and Services Acquisition: Following construction documentation and permit acquirement completion, the Town of Carbondale will release a request for bids for the construction of the project. The bid process will be competitive and detailed project requirements will be provided to the applicants. Priority will be given to contractors with track records of success implementing similar restoration projects, demonstrated ability to perform services in a timely and efficient manner, and with competitive costs. The goal is to implement all the project components in a single coordinated effort as opposed to a phased approach to maximize project impact and limit long term disturbance and activity within the reach. **(This portion of the Project is NOT funded by this request)**

B. Contract Negotiation and Finalization: The selected contractor and subcontractor will finalize contract agreements with the Town of Carbondale. A detailed work plan and schedule will be established for implementation. **(This portion of the Project is NOT funded by this request)**

C. Public outreach and Coordination: Throughout the construction phase, public outreach and coordination will continue. Dedicated efforts will be made to provide the public and stakeholder

[5] Finalized costs as they pertain to salaries and wages, estimated hours or percent of time, and rate of compensation will not be able to be determined in totality until construction documentation is finalized and the bidding process is underway.

with information about the work occurring at River Front Park and in the Crystal River and why the restoration and park improvements are vital to ecosystem and community. **(This portion of the Project is NOT funded by this request)**

D. In-Channel Improvements: In-channel improvements timing will be coordinated with Colorado Fish and Wildlife to mitigate impacts to fish habitat and spawning. Work is to include:

a. The Weaver Ditch Headgate Structure and "Island" Rebuild – Instream work is focused on the lower 1600 feet of the river channel through the project reach. This stretch includes the Weaver Ditch diversion structure, which will be modified to reduce in-channel maintenance needs and improve channel stability issues associated with semi-annual push up dam construction. **(This portion of the Project is NOT funded by this request)**

b. Maintenance Access Ramp Installation – the maintenance access ramp will provide a dedicated and durable access point to service and maintain the Weaver Ditch. **(This portion of the Project is NOT funded by this request)**

c. In-Channel Improvements – Below the diversion the thalweg will be re-established to provide low flow connectivity for fish. Re-establishing a thalweg and reducing an annual occurrence of channel bed and bank de-stabilization will return the river to a more natural state with a deeper low flow channel and adjacent gravel bar. Habitat boulders will be placed in the channel and along the banks to create more structure and variability.

More healthy sections of the Crystal River upstream and downstream of the project reach were used as a reference. **(This portion of the Project IS funded by this request)**

d. West Bank Improvements – Approximately 900 feet of stream bank will be restored, primarily through regrading and planting. Specific sections will be rebuilt with boulder steps to create access points for anglers and other river users. The access points will connect with an

interpretive/education focused trail system. **(This portion of the Project IS funded by this request)**

E. Upland Improvements: Upland improvements include riparian restoration, habitat enhancement and preservation, and creation/formalization of cultural and recreational amenities.

a. Paving and Trail Network - The project will make improvements for accessibility to Riverfront Park, allowing visitors of every ability to access the Crystal River. The improvement will make Riverfront Park the only accessible Crystal River frontage within the Town of Carbondale. The accessible ramp off Crystal Bridge Drive will lead to a rustic gathering area with direct access to the Crystal River. This area is intended to also serve as an outdoor classroom for the five nearby schools, helping to create the community's future river stewards. Additional hard and soft-scape trails will be formalized within the park providing passive recreational opportunism such as wildlife viewing while preserving important habitat and sensitive areas by deterring off trail use. **(This portion of the Project is NOT funded by this request)**

b. Site Features and Furnishing- Two locations will become outdoor classroom and public gathering spaces (see attached "Preferred Alternative" map), one at the north end of the park near Crystal Bridge Drive and one at the south end of the park. The north end location near Crystal Bridge Drive will be along the bank with multiple access points down to the river to provide visitors with an opportunity to access the river and bank.

This access will be a universally accessible gathering space, serving as an educational opportunity and for recreational opportunities such as angling. This gathering space will also serve as an area to inform the public about regulations or special information about the park. The second public gathering space will be near the existing cottonwood grove at the south end of the

park. This space will be focused on the wetland and upland areas of the park. Interpretive elements will be updated throughout the park expanding and updating the current interpretive materials to make them more accessible and interactive. Site furnishings providing areas for picnicking, nature play, shade, respite, and exploration will be included in the formalizing public gathering areas. **(This portion of the Project is NOT funded by this request)**

c. Restoration Planting and Seeding - Riparian improvements will focus on removing invasive species while retaining vegetation in functional habitat areas. The project team has worked with the Roaring Fork Audubon Society to develop a riparian restoration plan that provided nesting and habitat for the various bird species that visit or reside in Riverfront Park including waterfowl. **(This portion of the Project IS funded by this request)**

F. Construction Administration: Construction will be monitored and assessed by the project team to ensure that standards for safety, restoration and mitigation meet best practices and project objectives. **(This portion of the Project is NOT funded by this request)**

G. United States Army Corps Reporting: All activities regulated by the Army Corps of Engineers will be documented and reporting will be delivered to the channels specified by the permit process. **(This portion of the Project is NOT funded by this request)**

H. Grant Reporting: All grant reporting will be conducted by RFC. **(This portion of the Project is NOT funded by this request)**

Salaries and Wages

Project Manager: Heather Tattersall Lewin

Salary: Undisclosed

Percent of time: 10%

Rate of compensation: $75/hr (no compensation is included in this request)

Lead Consultant: Quinn Donnelly, River Restoration

Salary: Undisclosed

Percent of time: 10%

Rate of Compensation: $160/hr

Town Liaison: Mark O'Meara, Utilities Director

Salary: Undisclosed

Percent of time: 5%

Rate of Compensation: $68.31/hour (no compensation is included in this request)

Fringe Benefits N/A

Travel N/A. The project team is local to the project site and travel costs are nominal.

Equipment

Equipment will be provided by the contractor and is included in the construction cost estimate.

Materials and Supplies

An engineer's estimate of costs with material costs (priced at furnished and installed) is provided in the previous section. Materials and supplies will be furnished and installed under a contract, and the equipment is included in the construction cost estimate.

Contractual

Following construction documentation and permit acquirement completion, the Town of Carbondale will release a request for bids for the construction of the project. The bid process will be competitive and detailed project requirements will be provided to the applicants. Priority will

be given to contractors with track records of success implementing similar restoration projects, demonstrated ability to perform services in a timely and efficient manner, and with competitive costs. The goal is to implement all the project components in a single coordinated effort as opposed to a phased approach to maximize project impact and limit longterm disturbance and activity within the reach. The selected contractor and subcontractor will finalize contract agreements with the Town of Carbondale. A detailed work plan and schedule will be established for implementation.

Third-Party In-Kind Contributions N/A

Environmental and Regulatory Compliance Costs

The project team does not anticipate extensive additional costs due to environmental or cultural resource impacts.

Indirect Costs

The applicant has never received a federally approved indirect cost rate agreement and is not proposing a rate greater than the de minimis 10 percent rate. Indirect costs are not anticipated to be incurred.

Environmental and Cultural Resource Considerations

To allow Reclamation to assess the probable environmental and cultural resources impacts and costs associated with each application, all applicants should consider the following list of questions focusing on the NEPA, ESA, and NHPA requirements. Please answer the following questions to the best of your knowledge. If any question is not applicable to the project, please explain why. The application should include the answers to:

• Will the proposed project impact the surrounding environment (e.g., soil [dust], air, water [quality and quantity], animal habitat)? Please briefly describe all earth-disturbing

work and any work that will affect the air, water, or animal habitat in the project area. Please also explain the impacts of such work on the surrounding environment and any steps that could be taken to minimize the impacts.

Once completed, the project is anticipated to improve the ecological value of the project site compared to existing conditions. The proposed project does require the use of heavy equipment to regrade the river bottom, stabilize riverbanks, make trail improvements, construct educational and interactive amenities, and establish native vegetation. During construction, the project area will be disturbed through the use of this construction equipment, particularly along the riverbanks and within the river in the areas designated for regrading. Wildlife present in the project area will likely temporarily relocate upstream or downstream during construction to avoid the noise and disturbance associated with construction activities. Long term, the project is not anticipated to result in more than minimal adverse environmental effects or substantially disrupt the necessary life cycle movements of species of aquatic life indigenous to the river and the riparian corridor, including those species that normally migrate through the area.

The proposed fill in the project area is expected to be native alluvium and imported boulder, which meets the definition of non-toxic, suitable fill. Material shall not be placed in any location or manner that may impair surface water flows into or out of any special aquatic sites. Precautions shall be taken to avoid and minimize temporary impacts and protect wetlands and riffle-pool complexes from damage during access and construction. All affected areas shall be returned to pre-construction conditions or better, including revegetation. Care will be taken to avoid destruction of riparian and riverine vegetation, especially mature cottonwoods, to the maximum extent possible. Any damage to riparian vegetation that is not directly covered by a permanent feature will be replanted with a mixture of native trees, shrubs, forbs, and grasses.

Best management practices (BMPs) will be implemented and maintained in effective operating condition throughout construction. All exposed soil and other fills, as well as any work below the ordinary high water mark (OHWM), shall be permanently stabilized at the earliest practicable date. Coffer dams, turbidity curtains and oil booms will be used to minimize risk of spills and contamination. Aquatic species will be recovered within the construction and relocated upstream or downstream. All disturbed areas, including the riparian and upland buffer zones, shall be revegetated with native species to prevent erosion. All construction debris (including excess dredged or fill materials, work, cleared vegetation, concrete shall be disposed of in an upland area in such a manner that it cannot enter a waterway or wetland.

• Are you aware of any species listed or proposed to be listed as a Federal threatened or endangered species, or designated critical habitat in the project area? If so, would they be affected by any activities associated with the proposed project?

The Project Area provides habitat for a variety of wildlife species. The Project Area provides good quality habitat for various avian species, from waterfowl to raptors and a variety of other bird species in between. The many dead trees and snags throughout provide excellent hunting perches and cavity nesting opportunities for a variety of raptor species. An active osprey (*Pandion haliaetus*) nest is located approximately 900 feet to the south of the Project Area. The Crystal River Park is currently closed from December 15 to March 15, to allow for bald eagle (*Haliaeetus leucocephalus*) winter foraging activities. Bird nesting boxes exist on the parcel. Additional nesting boxes for variety of species could increase nesting opportunities and provide additional birding opportunities for visitors. The Project Ecologist on site also noted a high incidence of great blue heron (*Ardea herodias*) within the Project Area.

No Threatened or Endangered Species (T&E) were observed within the Project Area. State and federal T&E species likely to occur in the project area include: U.S. Fish and Wildlife (USFWS) threatened and endangered tiger salamander (A*mbystoma tigrinum stebbinsi*), state listed species of concern northern leopard frog (*Lithobates pipiens*) and the peregrine falcon (*Falco peregrinus*), which is also a state listed species of concern.

Work on this project is not expected to negatively impact any wildlife species or habitat.

• Are there wetlands or other surface waters inside the project boundaries that potentially fall under CWA jurisdiction as "Waters of the United States?" If so, please describe and estimate any impacts the proposed project may have.

Yes, there are wetland and surface waters inside the project boundary. These include 1,776 feet of the Crystal River, 0.27 acres of palustrine persistent emergent wetland and 0.59 acres of palustrine scrub-shrub wetland. Any temporary or permanent impact to Waters of the United States will be reviewed by the US Army Corps of Engineers as part of the Section 404 permit process. In general, the riparian and upland project elements were placed to minimize impacts to existing wetlands in project area, which were identified and delineated at the start of the planning process. The project proposes to preserve all existing wetlands found onsite and create an additional 0.17 acres of additional wetlands. Impacts to surface waters will only be temporary during construction. The focus of the in-channel work will be to improve aquatic habitat, reduce sediment input and strengthen low flow connectivity. 900 linear feet of bank stabilization will reduce fine sediment input to the river, provide additional shade along the banks and improve 0.25 acres of aquatic habitat. The reconfiguration of the Weaver diversion structure will reduce sediment input and reduce maintenance activities in the river. The channel regrading will

improve 800 feet of thalweg, providing low flow connectivity through the project site for aquatic species.

• When was the water delivery system constructed?

The Weaver Ditch System was originally constructed in 1885, the first appropriation date. The water right was initially adjudicated in 1889 with additional rights adjudication in 1924 and 1936.

• Will the proposed project result in any modification of or effects to, individual features of an irrigation system (e.g., headgates, canals, or flumes)? If so, state when those features were constructed and describe the nature and timing of any extensive alterations or modifications to those features completed previously.

The proposal will upgrade the diversion structure and replace headgate of the Weaver Ditch as detailed in the project proposal. The system has been updated as needed to ensure function and increase efficiency over the past one hundred plus years. This was historically an agricultural property which has since be converted to residential use. Sections of the ditch have been lined on an ad hoc basis determined by adjacent construction requiring modification or system failure. The timing for the modifications will be in the late fall or early spring to alleviate disruption of ditch operation during the irrigation season.

• Are any buildings, structures, or features in the irrigation district listed or eligible for listing on the National Register of Historic Places? A cultural resources specialist at your local Reclamation office or the State Historic Preservation Office can assist in answering this question.

No.

• Are there any known archeological sites in the proposed project area?

No

• Will the proposed project have a disproportionately high and adverse effect on low income or minority populations?

No

• Will the proposed project limit access to and ceremonial use of Indian sacred sites or result in other impacts on tribal lands?

No

• Will the proposed project contribute to the introduction, continued existence, or spread of noxious weeds or non-native invasive species known to occur in the area?

No. The project will work to mitigate and remove noxious weeds currently present on the property.

Required Permits or Approvals

United States Army Corps: USACE's Regulatory Program involves the regulating of discharges of dredged or fill material into waters of the United States and structures or work in navigable waters of the United States, under section 404 of the Clean Water Act and section 10 of the Rivers and Harbors Act of 1899. Project intent is to utilize a programmatic permit within the 404-permitting process. 401 permit is included in our 404 permit if a programmatic national or regional permit is authorized.

Permits/Approvals Status: Intend to Apply.

Permits/Approvals Agency-Contact Person: United States Army Corps of Engineering (USACE).

Permits/Approvals Submittal-Approval Date: 05/15/2021

Clean Water Act 401 Certification: Clean Water Act 401 Certification will be included as a part of the 404-permit application process.

Permits/Approvals Status: Intend to Apply

Permits/Approvals Agency-Contact Person: Environmental Protection Agency.

Permits/Approvals Submittal-Approval Date: 05/15/2021

National Flood Insurance Program compliance, compliance will be through the Town, which is the floodplain administrator who will coordinate with FEMA.

Permits/Approvals Status: Intend to Apply.

Permits/Approvals Agency-Contact Person: Federal Emergency Management Agency (FEMA)

Permits/Approvals Submittal-Approval Date: 05/15/2021

Construction Dewatering permit, to be applied for and held by contractor. Contractor to develop necessary dewatering plan as needed.

Permits/Approvals Status: Intend to Apply.

Permits/Approvals Agency-Contact Person: State of Colorado.

Permits/Approvals Submittal-Approval Date: 09/15/2021

Stormwater Discharge During Construction, to be applied for and held by contractor. Contractor to develop necessary stormwater management plan as needed. Permits/Approvals Status: Intend to Apply. Permits/Approvals Agency-Contact Person: State of Colorado.

Permits/Approvals Submittal-Approval Date: 09/15/2021

Documentation in Support of Applicant Eligibility

Please see Attachment 2.

Roaring Fork Conservancy UEI: 009818183

ROARING FORK CONSERVANCY
Bringing People Together to Protect Our Rivers

BOARD OF DIRECTORS

Pat McMahon
President
George Kelly
Vice President
Michelle Schindler
Secretary
Jennifer Sauer
Treasurer
Ted Borchelt
Jeff Conklin
Jim Light
Rick Lofaro
Executive Director
Diane Schwener
Larry Yaw

STAFF

Rick Lofaro
Executive Director
Heather Lewin
Director of Science & Policy
Christina Medved
Director of Community Outreach
Megan Dean
Education Programs Director
Chad Rudow
Water Quality Program Manager
Sheryl Sabandal
Development Director

Roaring Fork Conservancy

MISSION:
Roaring Fork Conservancy inspires people to explore, value, and protect the Roaring Fork Watershed.

Since 1996, Roaring Fork Conservancy has inspired people to explore, value, and protect the Roaring Fork Watershed. We bring people together to protect our rivers and work hard to keep water in local streams, monitor water quality, and preserve riparian habitat. As one of the largest watershed organizations in Colorado, Roaring Fork Conservancy serves residents and visitors throughout the Roaring Fork Valley through school and community-based Watershed Education programs and Watershed Science and Policy Projects including regional watershed planning, water resource policy initiatives, stream management, and restoration.

P.O. Box 3349 Basalt, Colorado 81621 | 970.927.1290 | www.roaringfork.org

ARTICLES OF INCORPORATION
OF
ROARING FORK CONSERVANCY

The undersigned person, acting as the incorporator of a corporation pursuant to the Colorado Non-Profit Corporation Act and being 21 years of age or older, hereby signs and acknowledges the following Articles of Incorporation:

ARTICLE I
Name

The name of the corporation is Roaring Fork Conservancy.

ARTICLE II
Duration

The period of duration of the corporation is perpetual.

ARTICLE III
Charitable Purposes, Objectives and Powers

1. This corporation is organized exclusively for charitable purposes within the meaning of Section 501(c)(3) of the Internal Revenue Code. The corporation shall be operated exclusively as a non-profit, tax-exempt organization dedicated:

(a) To promote for the benefit of the general public the conservation, preservation and restoration of the natural riparian corridors of the Roaring Fork and Frying Pan Rivers in the Roaring Fork Valley of Colorado, including land and water resources, wildlife habitat, fishing and recreational access, and the unique scenic, natural and historic features of these river corridors;

(b) To provide educational and artistic opportunities for children and adults relating to the preservation and restoration of these river corridors including the identification and use of suitable sites for environmental education;

(c) To work with individual landowners to further their conservation, preservation and restoration goals when those goals are consistent with the charitable purposes and functions of the corporation; and

(d) To receive and accept property, including but not limited to real property and conservation easements, by way of gift, bequest, devise or purchase, from any person, firm, trust, corporation or other entity, to be held and administered in accordance with the goals of the corporation.

2. In furtherance of the foregoing purposes and objectives and subject to the restrictions set forth in Article IV, the corporation shall have and may exercise all of the powers now or hereafter conferred upon non-profit corporations organized under the Colorado Non-Profit Corporation Act.

ARTICLE IV
Tax-Exempt Nonprofit Corporation

The corporation shall be a tax-exempt non-profit public benefit corporation and shall neither be organized nor operated for private pecuniary gain or profit. In addition to any other restrictions provided by Colorado law or by the Internal Revenue Code applicable to non- profit and tax-exempt corporations, the following provisions shall in all events apply:

(a) No part of the net earnings of the corporation shall inure to the benefit of, or be distributable to, any member, director, trustee or officer of the corporation, or any other private individual (except that reasonable compensation may be paid for services rendered to or for the benefit of the corporation affecting one or more of its charitable purposes) and no member, director, trustee or officer of the corporation, or any other private individual, shall be entitled to share in any distribution of any of the corporation's assets on dissolution of the corporation or otherwise;

(b) No substantial part of the activities of the corporation shall consist of carrying on propaganda or otherwise attempting to influence legislation, and the corporation shall not participate or intervene in any political campaign on behalf of any candidate for public office;

(c) No part of the assets of the corporation shall be contributed to any organization whose net earnings or any part thereof inure to the benefit of any private shareholder or individual or any substantial part of the activities of which consists of carrying on propaganda or otherwise attempting to influence legislation;

(d) The corporation shall not conduct or carry on any activities not permitted to be conducted or carried on by an organization which is qualified as a tax-exempt organization under Section 501(c)(3) of the Internal Revenue Code of 1954 and its regulations, as the same now exist or may hereafter be amended;

(e) The corporation shall distribute its income for each taxable year at such time and in such manner as not to subject the corporation to tax under Section 4942 of the Internal Revenue Code of 1954 and its regulations; shall not engage in any act of self-dealing, as defined in Section 4941(d) of the Internal Revenue Code of 1954 and its regulations; shall not retain any excess business holdings, as defined in Section 4943(c) of the Internal Revenue Code of 1954 and its regulations; shall not make any investments in such manner as to subject the corporation to tax under Section 4944 of the Internal Revenue Code of 1954 and its regulations; and shall not make any taxable expenditures, as defined in Section 4945(d) of the Internal Revenue Code of 1954 and its regulations, all as said Internal Revenue Code and the regulations thereunder now exist or may hereafter be amended.

(f) Upon dissolution of the corporation, all of the corporation's assets remaining after payment of or provision for all of its liabilities shall be paid over and distributed only for the purposes set forth in Article III to one or more organizations qualified as tax-exempt under Section 501(c)(3) of the Internal Revenue Code of 1954 and its regulations. The organizations to receive such assets and property shall be designated by the Board of Directors.

ARTICLE V
Registered Office and Agent

The address of the initial registered office of the corporation is 320 W. Main Street, Aspen, CO 81611. The name of its initial registered agent at such address is Timothy McFlynn.

ARTICLE VI
Members

The corporation shall have no members with voting and other rights and powers under the provisions of the Colorado Non-Profit Corporation Act. The Board of Directors may establish honorary non-voting classes of "members" for fundraising purposes as it deems appropriate from time to time. The corporation shall have no capital stock.

ARTICLE VII
Board of Directors

The management of the affairs of the corporation shall be vested in a Board of Directors, except as otherwise provided in the Colorado Non-Profit Corporation Act, these articles of incorporation, or the bylaws of the corporation. The Board of Directors shall consist of not less than three (3) nor more than twenty-one (21) directors, the number of directors, their classification, if any, their terms of office, and the manner of their election or appointment to be determined according to the Bylaws of the corporation then in force.

The number of Directors constituting the initial Board of Directors is five (5). The names and addresses of the persons who shall serve as the initial Board of Directors are as follows:

James W. Light
Box 5000
Snowmass Village, CO 81615

Christopher R. Myers
Rising Sun Enterprises
0040 Sunset Dr., #1
Basalt, CO 81621

David A. Wilhelm
Roaring Fork Club
PO Box 1669
Basalt, CO 81621

Shane J. Harvey
P.O. Box 677
Aspen, CO 81612

William D. Browning
Rocky Mountain Institute
1739 Snowmass Creek Road
Snowmass, CO 81654

The number of Incorporators shall be one, and the name and address of the person who shall serve as the incorporator is as follows:

Timothy McFlynn, Esq.
McFlynn Pickett Doremus & Whitsitt, P.C.
320 West Main Street
Aspen, Colorado 81611

ARTICLE VIII
Indemnity and Insurance

The corporation shall indemnify any director or former director of the corporation against any claim by the corporation or its members for any monetary damages for breach of fiduciary duty as a director. Such limit of personal liability shall not extend to a director for monetary damages for any breach of the director's duty of loyalty to the corporation or its members; acts or omissions not in good faith or which involve intentional misconduct or a knowing violation of law; acts specified in Section 7-24-111, CRS; or any transaction from which the director derived an improper personal benefit. The corporation shall maintain such officers' and director's liability insurance as may from time to time be required in the bylaws of the corporation or by resolution of its Board of Directors.

ARTICLE IX
Distribution of Assets Upon Dissolution

In the event of dissolution, the assets of the corporation shall be distributed as follows:

(a) All liabilities and obligations of the corporation shall be paid and discharged, or adequate provisions shall be made therefor;

(b) Assets held by the corporation on condition requiring return, transfer or conveyance, which condition occurs by reason of the dissolution, shall be returned, transferred or conveyed in accordance with such requirement.

(c) Assets received and held by the corporation, subject to limitations permitting their use only for specified purposes, but not held upon a condition requiring return, transfer or conveyance by reason of the dissolution shall be transferred or conveyed to one or more domestic or foreign corporations, societies, or organizations engaged in activities similar to those of the corporation, pursuant to a plan of distribution adopted as provided in Section 77-26-104, CRS.

(d) Remaining assets, if any, shall be distributed to another non-profit tax-exempt organization with conservation and education goals similar to the Roaring Fork Conservancy.

IN WITNESS WHEREOF, the undersigned incorporator of the corporation as designated in Article VII has executed these Articles of Incorporation this 25th day of November, 1996.

Timothy McFlynn, Incorporator

STATE OF COLORADO)
) ss.
COUNTY OF PITKIN)

Subscribed and sworn to before me this 25th day of November, 1996, by Timothy McFlynn, as the Incorporator of Roaring Fork Conservancy.

Witness my hand and official seal.
My Commission expires:
10-6-98

Notary Public

rft\articles.inc

BY-LAWS

OF THE

ROARING FORK CONSERVANCY

ARTICLE I

Offices

1. Business Office. The principal office of the corporation shall be in Basalt, Colorado. The corporation may also have one or more offices at such other places or places within or without the State of Colorado as the Board of Directors may from time to time determine or as the business of the corporation may require.

2. Registered Office. The registered office of the corporation shall be as set forth in the Articles of Incorporation, unless changed as provided by the Colorado Non-Profit Corporation Act.

ARTICLE II

Members

The corporation shall have no members with voting or other rights and powers under the provisions of the Colorado Non-Profit Corporation Act. The corporation may have non-

voting associate memberships for general public support and other fund-raising purposes, in such categories and with such a fee schedule as the Board may from time to time adopt by Resolution.

ARTICLE III

Board of Directors

1. Management. The affairs of the corporation shall be managed by the Board of Directors.

2. Number and Qualification. The Board of Directors shall consist of not less than three (3) nor more than (15) Directors, as shall be determined from time to time by Resolution of the Board of Directors. Directors need not be residents of the State of Colorado.

3. Election and Tenure. The Directors constituting the first Board of Directors as named in the Articles of Incorporation shall hold office until the dates set forth below or until their successors are elected and shall qualify:

Name and address	**Expiration of Term**
James W. Light	2 years

June 22, 2007

Box 5000 Snowmass Village, CO 81615	(December 31, 1998)
David A. Wilhelm Roaring Fork Club PO Box 1669 Basalt, CO 81621	2 years (December 31, 1998)
William D. Browning Rocky Mountain Institute 1739 Snowmass Creek Road Snowmass, CO 81654	2 years (December 31, 1998)
Shane J. Harvey PO Box 677 Aspen, CO 81612	2 years (December 31, 1998)
Christopher R. Meyers Rising Sun Enterprises 0040 Sunset Drive, #1 Basalt, CO 81621	2 years (December 31, 1998)

Each new Director shall thereafter be elected to three (3) year terms by the vote of the existing Directors at the annual meeting of Directors or at a special meeting called and notices for this purpose. Each Director so elected shall serve until his or her successor shall be elected and shall qualify, except that any Director may resign by tendering written notice of resignation to the President at least thirty (30) days prior to the effective date of such resignation.

4. Annual Meeting of the Board of Directors. The annual meeting of the Board of Directors for the election of new Directors and for the transaction of such other business as may come before the meeting shall be held during the third month after the close of each fiscal year of the corporation.

5. Regular Meetings of Directors. The first regular meeting of the Board of Directors shall be as soon as practical following the date of incorporation at such time and place as may be mutually agreed upon by the first Board of Directors. Other regular meetings of the Board of Directors may be held at such regular intervals (e.g., quarterly, monthly, etc.) and at such times and places as shall be determined from time to time by the Board of Directors.

6. Special Meeting of Directors. Special meetings of the Board of Directors may be called by the President or by any two (2) Directors.

7. **Place of Meetings**. Meetings of the Board of Directors, whether annual, regular or special, shall be held at the principal office of the corporation or at such other place, within or outside the State of Colorado, as may from time to time be determined by the Board of Directors and specified in the notice of the meeting.

8. **Quorum**. Fifty (50%) percent or more of the Directors then in office shall constitute a quorum for the transaction of business at any meeting of the Board of Directors which has been duly called and notices or as to which notice has been waived. The act of a majority of the Directors present at such a meeting shall constitute the act of the Board of Directors.

9. **Vacancies**. Any vacancy occurring in the Board of Directors may be filled by the affirmative vote of a majority of the remaining Directors. A Director elected to fill a vacancy shall be elected for the unexpired term of his predecessor in office. Any Directorship to be filled by reason of an increase in the number of Directors shall be filled by the affirmative vote of a majority of the Directors then in office. A Director chosen to fill a position resulting from an increase in the number of Directors shall hold office until the next annual meeting of Directors.

10. **Executive Committee**. The Board of Directors, by resolution adopted by a majority of the Directors, may designate three (3) or more Directors to constitute an executive committee, which committee, to the extent provided in such resolution and subject to the limitations of the Colorado Nonprofit Corporation Act, shall have and may

exercise all of the authority of the Board of Directors in the management of the corporation.

11. Compensation. The Directors may be paid their out-of-pocket expenses, if any, of attendance at each meeting of the Board of Directors and shall not otherwise be compensated for attendance of meetings of the Board of Directors or of its Committees or for other activities as a Director. No such payment shall preclude any Director from serving the Corporation in any other capacity and receiving compensation therefor.

12. Conflict of Interest. When a real or seeming incompatibility between a Director's private or professional interests and the interests of the Conservancy exists, Director is disqualified from representing both interests if the dual representation adversely affects either interest or if interest does not consent.

ARTICLE IV

Notices, Waiver and Action Without Meeting

1. Annual Meeting of Directors. Notice of each annual meeting of Directors shall be given not less than ten (10) nor more than fifty (50) days prior thereto to each Director by delivering written notice thereof to such Director personally or by mailing the same to such Director at his or her address as shown on the books of the corporation.

2. Regular Meeting of Directors. Notice of regular meeting of Directors shall be given not less than ten (10) nor more than thirty (30) days prior thereto to each Director by delivering written notice thereof to such Director personally or by mailing the same to such Director at his or her address as shown on the books of the corporation.

3. Special Meeting of Directors. Notice of such special meeting of Directors shall be given to each Director by delivering written notice thereof to such Director personally, or by verbal telephonic communication to such Director personally, not less than two (2) days prior to the date of such meting, or by mailing or telefaxing such written notice thereof to such Director at his or her address as shown on the books of the corporation, not less than seven (7) days prior to the date of such meeting.

4. Time of Notice. Any notice given by personal delivery or personal telephonic communication shall be deemed given at the time of such personal delivery or personal telephonic communication. Any notice given by mail shall be deemed given at the time the same is deposited in the mail; and any notice given by telefax shall be deemed given at the time when the telefax is transmitted.

5. Contents of Notice. The notice required for any meeting of Directors shall state the place, date and hour thereof. Neither the business to be transacted at, nor the purpose of, any meeting of Directors need be specified in the notice of the meeting,

except, in the case of the election of Directors, and/or officers and in the case of any amendment of these By-Laws which shall be set forth in the notice and except as may be otherwise provided for by law.

6. Waiver of Notice. Whenever any notice of a meeting of Directors is required to be given by these By-Laws or by law, a Waiver thereof in writing, signed by the person entitled to said notice, whether signed before, at, or after the time of such meeting, shall be deemed equivalent to the proper giving of such notice. The attendance of a Director at a meeting shall constitute a Waiver of notice of such meeting, except where a Director attends a meeting for the express purpose of objecting to the transaction of any business because of the meeting has not been lawfully called on convened.

7. Action Without Meeting. Any action of the Board of Directors or Members of the Executive Committee of the corporation may be taken without a meeting if a consent in writing, setting forth the action so taken, shall be signed by all of the Directors or members of the executive committee, as the case may be, entitled to vote with respect to the subject matter thereof.

8. Voting. Members of the Board of Directors may cast a vote on any action of the Board of Directors or Members of the Executive Committee via writing, email, or telephone, when entitled to vote with respect to the subject matter thereof.

ARTICLE V

Officers

1. Appointment. The officers shall be a President, one or more Vice-Presidents, a Secretary and a Treasurer, and such other officers as the Directors may deem necessary who shall each be elected by the Board of Directors at its annual or any regular meeting. Each officer shall hold office at the pleasure of the Board. Any two (2) of the above offices, except those of President and Secretary, may be held by the same person. The President, and Vice-President(s), the Secretary and the Treasurer shall be known as executive officers and shall constitute the Executive Committee. A board member may be allowed to leave the Board of Directors for a period of no less than one year unless by the unanimous vote of the Board their continuance is critical to the operation of the Conservancy, in which case they may be elected to an additional term. Up to two (2) Board members may be appointed to the Conservancy's Board of Directors by the Town of Basalt Trustees with the consent and approval of the Conservancy Board.

2. President. The President shall be the chief executive officer of the corporation; shall have general and active management of the business of the corporation; shall see that all orders and resolutions of the Board of Directors are carried into effect; and shall, in the absence of the Chairman of the Board or if there be no Chairman, preside at all meetings of the Board of Directors. The President shall have authority to employ and dismiss such employees and agents (other than officers to be appointed by the Board) as the business of the corporation may require and to fix their compensation, duties and responsibilities.

3. **Vice-President**. The Vice-President shall, in the absence of disability of the President, perform the duties and exercise the powers of the President and shall perform such other duties and have such other powers as the President or the Board of Directors may prescribe from time to time. If there shall be more than one Vice-President, then the Vice-Presidents shall act in the order in which they are elected.

4. **Secretary**. The Secretary shall keep the minutes of all Executive Committee meetings in one or more books prescribed for tat purpose and, in general, shall perform all duties incidental to the office of Secretary and such other duties as may be assigned by the President of the Board of Directors from time to time. The Secretary shall keep the seal of the corporation in safe custody and, when authorized by the Board of Directors, shall affix the same to any instrument requiring it and, when so affixed, it shall be attested by his or her signature. The Conservancy staff shall keep the minutes of regular Board of Directors' meetings.

5. **Treasurer**. The Treasurer shall have the responsibility for the funds of the corporation, shall keep full and accurate accounts of receipts and disbursements in books belonging to the corporation, and shall deposit al monies and other valuable effects n the name and to the credit of the corporation in such depositaries as may be designated by the Board of Directors from time to time. The Treasurer shall perform such other duties and have such other powers as the President or the Board of Directors may prescribe from time to time.

ARTICLE VI

Execution of Instruments

1. Execution of Instruments. The President and Executive Director shall have power, upon authorization by the Board, to execute on behalf and in the name of the corporation any deed, contract, bond, debenture, note or other instrument requiring the signature of an officer of the corporation, except when the signing and execution thereof shall be expressly delegated by the Board of Directors to some other officer or agent of the corporation. Unless so authorized, no other officer, agent or employee shall have any power or authority to bind the corporation in any way, to pledge its credit, or to render it liable pecuniarily for any purpose or in any amount, except as provided in Section 2 of this Article VI.

2. Checks and Endorsements. All checks and drafts upon the funds of the corporation in any of its depositories shall be signed by such of its officers, employees or agents as shall from time to time be determined by resolution of the Board of Directors and all notes, bills, receivables, trade acceptances, drafts and other evidences of indebtedness payable to the corporation shall for the purpose of the deposit, discount or collection be endorsed by such officers, employees or agents of the corporation as shall from time to time be determined by resolution of the Board of Directors.

3. Conservation Easements. The President and Executive Director shall have the power to execute in the name of the corporation any conservation easement with approval by a quorum vote of the Board of Directors.

ARTICLE VII

Corporate Seal

The corporate seal shall be in such form as shall be approved by resolution of the Board of Directors. Said seal may be used by causing it or a facsimile thereof to be impressed on or affixed to any document.

ARTICLE VIII

Fiscal Year

The fiscal year of the corporation shall be January 1 through December 31 unless and until a different fiscal year shall be adopted by the Board of Directors.

ARTICLE IX

Corporate Books and Records

Except as otherwise required by statute, the books and records of the corporation may be kept at such place or places as may be from time to time designated by the Board of Directors.

ARTICLE XI

Sexual Harassment Policy

It is not the Roaring Fork Conservancy's intention to regulate social relationships among employees. The Conservancy will, however, take disciplinary action if warranted and necessary, against any employee who engages in conduct that constitutes sexual harassment or physical, emotional, or verbal abuse.

Complaints should be reported immediately to the Executive Director or our supervisor and will remain confidential.

ARTICLE X

Amendment

The By-Laws of the corporation shall be subject to amendment or repeal, and new By-Laws may be added, by an affirmative quorum vote of the members of the Board of Directors at any annual, regular or special meeting duly noticed for purposes of consideration of said amendment.

CERTIFICATE

June 22, 2007

The undersigned hereby certifies that she is the duly elected, qualified and acting Secretary of the aforesaid corporation and that the foregoing By-Laws constitute a true and complete copy of the By-Laws of said corporation presently in force and effect.

June 22, 2007

ROARING FORK CONSERVANCY
Bringing People Together to Protect Our Rivers

ROARING FORK CONSERVANCY CURRENT BOARD MEMBERS

Pat McMahon, President

George Kelly, Vice President

Michelle Schindler, Secretary

Jennifer Sauer, Treasurer

Jeff Conklin

David Knight

Jim Light

Rick Lofaro, Executive Director

Rana Dershowitz

Diane Schwener

Larry Yaw

ROARING FORK CONSERVANCY

Bringing People Together to Protect Our Rivers

BOARD OF DIRECTORS

Pat McMahon
President
George Kelly
Vice President
Michelle Schindler
Secretary
Jennifer Sauer
Treasurer
Ted Borchelt
Jeff Conklin
Jim Light
Rick Lofaro
Executive Director
Diane Schwener
Larry Yaw

STAFF

Rick Lofaro
Executive Director
Heather Lewin
Director of Science & Policy
Christina Medved
Director of Community Outreach
Megan Dean
Education Programs Director
Chad Rudow
Water Quality Program Manager
Sheryl Sabandal
Development Director

November 15, 2020

To whom it may concern:

Roaring Fork Conservancy holds monthly board meetings on the third Wednesday of each month. We also host regular public meetings and provide input to public and private organizations upon request.

Sincerely,

Rick Lofaro, Executive Director

P.O. Box 3349 Basalt, Colorado 81621 | 970.927.1290 | www.roaringfork.org

November 11, 2020

To whom it may concern:

I am writing to you in support of the Roaring Fork Conservancy's request to the WaterSMART Watershed Restoration Grant program entitled "Crystal River Restoration and Weaver Ditch Efficiency Project."

Having been a Roaring Fork Conservancy backer and stakeholder throughout an extended and detailed Crystal River Management Plan process I believe partnering with them to implement its significant goals including riparian restoration and ditch efficiency improvements would be highly beneficial to the severely compromised lower Crystal River.

As the owner of a Flyfishing company, board member of the Roaring Fork Fishing Guide Alliance, Town of Carbondale Trustee, and former general manager of the River Valley Ranch Homeowners Association, I have discussed Crystal River Management Plan implementation objectives on numerous occasions with the Roaring Fork Conservancy and enthusiastically endorse this project as both a stakeholder and twenty-two year resident of the Crystal River Watershed.

Efficient use of our water resources is essential to ensure that we maintain adequate consumptive water supplies and strive toward the protection and enhancement of stream flows in our local rivers. Equally important to our community and its visitors is the effective rehabilitation of the ever important riparian habitat. An improved Crystal River will provide sustainable recreational opportunities, as well as critical instream and enriched riparian habitat for resident and migrating wildlife.

I support the RFC and the Town of Carbondale's combined efforts to enhance the Riverfront Park area that borders the Crystal River which will result in a valuable demonstration of beneficial projects to many other water users throughout this region and beyond. I look forward to continuing to provide technical advice, community input and a recreational user perspective to the implementation team.

Sincerely,

Lani R. Kitching

Town of Carbondale, elected official
Proudline Guided Fly Fishing, owner/operator
Roaring Fork Fishing Guide Alliance, board member
Ruedi Water and Power, board member
River Valley Ranch HOA, former general manager

COLORADO
Parks and Wildlife
Department of Natural Resources

Glenwood Springs Wildlife Service Center
88 Wildlife Way
Glenwood Springs, CO 81601
P 970.947.2924 | F 970.947.2936

November 16, 2020

RE: Crystal River Restoration: Riverfront Park Project

To Whom It May Concern,

Colorado Parks and Wildlife (CPW) is writing in support of Roaring Fork Conservancy's (RFC) request for funding of the Crystal River Restoration: Riverfront Park project. CPW's statutory mission to perpetuate the wildlife resources of the State, to provide a quality State parks system, and to provide enjoyable and sustainable outdoor recreation opportunities that educate and inspire current and future generations to serve as strategic stewards of Colorado's natural resources. CPW is a stakeholder in the 2016 Crystal River Management Plan (CRMP) and has recently provided funding for a portion of this project through our Fishing Is Fun grant.

The Crystal River Restoration: Riverfront Park project aligns with CPW's mission, as it will perpetuate the wildlife resources that use the Crystal River corridor and provide an example of natural resource stewardship that will inspire others. The project goals intends to restore the ecological integrity of the reach, improving water efficiency at the Town of Carbondale's Weaver Ditch, mitigate seasonal dewatering of the river channel by upstream diversions, and enhance recreational and interpretive opportunities.

CPW greatly values the collaborative project approach, holistic goals and dedication to wildlife habitat and recreation. The proposed restoration and efficiency project reflects an integrated and collaborative approach to river restoration; building on multiple recommendations of the CRMP and CPW, Roaring Fork Conservancy, American Rivers and the Town of Carbondale. We applaud the substantial planning, public outreach, and consensus building that has culminated in the pending implementation of a highly supported restoration project.

CPW is optimistic that this pioneer project of the CRMP will lay the groundwork for future restoration and improvement in the ecological health of the Roaring Fork Valley and Colorado River Watershed. Indeed, CPW is planning to incorporate river improvements at our local fish hatchery to amplify the ecosystem benefits upstream along the Crystal River and further increase opportunities for anglers.

Local CPW staff have served as resource advisors for this project and we look forward to our continued involvement in project development around the Riverfront Park as it balances community needs while providing meaningful protections to the important ecological functions inherent to the area. The Crystal River Restoration and Weaver Ditch Efficiency Project will have measurable, long-lasting benefits to this reach of the Crystal River and for future projects. We strongly encourage your support. If there are any questions or needs for additional information, please contact Aquatic Biologist Kendall Bakich at 970.947.2924 or District Wildlife Manager John Groves at 970.947.2920.

Sincerely,

Kendall Bakich, Aquatic Biologist

Cc: Matt Yamashita, Area Wildlife Manager; John Groves, District Wildlife Manager; Lori Martin, Senior Aquatic Biologist; File

Dan Prenzlow, Director, Colorado Parks and Wildlife • Parks and Wildlife Commission: Marvin McDaniel, Chair • Carrie Besnette Hauser, Vice-Chair
Marie Haskett, Secretary • Taishya Adams • Betsy Blecha • Charles Garcia • Dallas May • Duke Phillips, IV • Luke B. Schafer • James Jay Tutchton • Eden Vardy

November 11, 2020

RE: Support for the Crystal River Restoration and Weaver Ditch Efficiency Project.

To whom it may concern;

American Rivers strongly supports the Crystal River Restoration and Weaver Ditch Efficiency Project. American Rivers has been engaged in efforts to improve conditions of the Crystal River for several years. Part of this work also means improving irrigation efficiencies for the many ditches that divert water from the Crystal. The Crystal River Management Plan provides a sound framework from which projects such as this can be accomplished.

We also are very excited about the proposed improvements to the Town of Carbondale's Riverside Park. Restoring the river, improving the ditch headgate, reconnecting the flood plane and riparian with the river gain added value with the ability of people and educational groups to access the site.

We urge the you to support this project with the requested funding.

Thank you!

Ken Neubecker

Ken Neubecker, Colorado Projects Director
American Rivers Upper Colorado Basin Program within Colorado
24 S Meadow View Ct.
Glenwood Springs, CO 81601
(970) 230-9300
Kneubecker@americanrivers.org

ASPEN VALLEY
LAND TRUST

November 9, 2020

To whom it may concern,

Aspen Valley Land Trust (AVLT) is proud to support the Crystal River Restoration and Weaver Ditch Efficiency Project. AVLT has been a partner on the project since its inception in 2013 and has invested over $40,000 and countless hours in previous planning efforts that have moved the project to this critical juncture. We are happy to say that the project partners have raised all necessary funding for planning and design, and we are excited to be raising funds now for implementation of the plan, toward which AVLT has committed an additional $10,000.

This is an opportunity for the Town of Carbondale to act on the recommendations of the 2015 Carbondale Parks, Recreation, and Trails Master Plan (CPRT) and the stakeholder-driven 2016 Crystal River Management Plan (CRMP). The CPRT recommended, *"increased river trail opportunities for everyone and encouraging conservation and restoration projects within Carbondale's riparian corridors."* The CRMP classified the project reach's ecological health as "severely to unsustainably impaired."

Our goal is to restore this reach to a healthy native condition. Furthermore, the site's proximity to several Carbondale schools offers our community an incredible opportunity to serve our citizens as an engaging "wildland park" that educates visitors and serves as a model for future river restoration projects in the watershed. This project will realize that vision.

The strength of this community proposal lies in the collaboration that was necessary to create it. The Town of Carbondale and its partners have worked tirelessly to arrive at a consensus approach to the project. We have that consensus now and have done our planning. Our opportunity to act is now.

This implementation project is an opportunity for Roaring Fork Conservancy, the Town of Carbondale, and the project team to leverage previous master planning investments and bring identified community priorities to life. The Crystal River Restoration and Weaver Ditch Enhancement Project is an ambitious but well thought out proposal, and we are grateful to you for your consideration of this important project.

Sincerely,

Suzanne Stephens
Executive Director

RUEDI WATER & POWER AUTHORITY
0238 Fawn Drive
Carbondale, Co 81623
970.963.4959
www.rwapa.org

To Whom It May Concern,

I write to express Ruedi Water and Power Authority's (RWAPA) support for Roaring Fork Conservancy's (RFC) request for funding of the "Crystal River Restoration: Riverfront Park" project. RWAPA is a regional water agency in the Roaring Fork Watershed, directed by a Board with an elected official from each local government within the watershed – Aspen, Snowmass Village, Basalt, Carbondale, Glenwood Springs, Pitkin and Eagle Counties. Our mission is to mobilize resources and influence to protect and enhance the waters and communities of the Roaring Fork Watershed.

The Crystal River is one of the world's most beautiful rivers and is an extremely valuable resource for our communities because of its natural beauty, rich environment, and recreational opportunities. Unfortunately, it suffers severe impairments and is in dire need of restoration and improvement. The Riverfront Park project will improve the Crystal through restoration and creation of a significant stretch of riparian area along the river, which will in turn improve the water quality and habitat within that stretch. It will additionally improve a significant diversion structure of the town of Carbondale and provide education for the Carbondale community about the value of rivers and riparian areas.

RWAPA and RFC have partnered for many years to create and foster implementation of watershed plans and projects throughout the Roaring Fork watershed. We are excited to see this project come to fruition as it is not only a high priority project identified in the Crystal River Management, but also addresses many of the action items identified in the more broad Roaring Fork Watershed Plan. It is an outstanding example of a project that brings together many partners and provides multiple benefits for the Crystal River and the Carbondale community. It is easily supported by RWAPA's member jurisdictions and we encourage your full support of this valuable project as well.

Sincerely,

April Long, Director
Ruedi Water and Power Authority

November 13, 2020

To whom it may concern:

I am writing this letter in support of Roaring Fork Conservancy's request to the BOR WaterSMART Grant program entitled "Crystal River Management Plan Implementation." Having been involved with the preceding Coal Basin project, and present as a stakeholder throughout the Crystal River Management Plan process, I believe partnering with them to implement plan goals- including increasing flows and riparian restoration would be highly beneficial to the lower Crystal.

I have discussed Crystal River Management Plan Implementation with Roaring Fork Conservancy, and strongly support the project as a stakeholder and long-standing resident of the Crystal River Watershed.

After experiencing another drought year in 2020, we are reminded that the efficient use of water resources is essential to ensure that we maintain adequate consumptive water supplies and strive toward the protection and enhancement of stream flows in our local rivers. Restoring riparian and instream habitat benefits all aspects of our community- from agriculture, to recreation, to environment. Improving this reach of the Crystal River will provide enhanced recreational opportunities, as well as critical instream and riparian habitat for resident and migrating wildlife, and serve as an example for what other riverfront property owners may accomplish.

I appreciate the work RFC and the Town have done to move this project forward, and will continue to provide technical advice, agricultural perspective, and other assistance whenever possible.

Sincerely,

Bill Fales
Cold Mountain Ranch

November 12, 2020 Snowmass, Colorado

To whom it may concern:

I would like to express my endorsement of the proposed Crystal River Restoration and Weaver Ditch Efficiency project by Roaring Fork Conservancy (RFC) as a key implementation of the Crystal River Management Plan and Roaring Fork Watershed Plan.

I have followed this project from my position as a Pitkin County Commissioner, through my participation in the Colorado River Basin Roundtable, and as a water rights owner and irrigator on Capitol Creek. This creek has very similar issues to the Crystal River, with very low water flow levels in the lower stretches of the creek late in the irrigating season. I have thought a lot for many years about how to help solve this problem and leave more water in the creek in order to improve the stream health, so I fully understand the issues involved on the Crystal River.

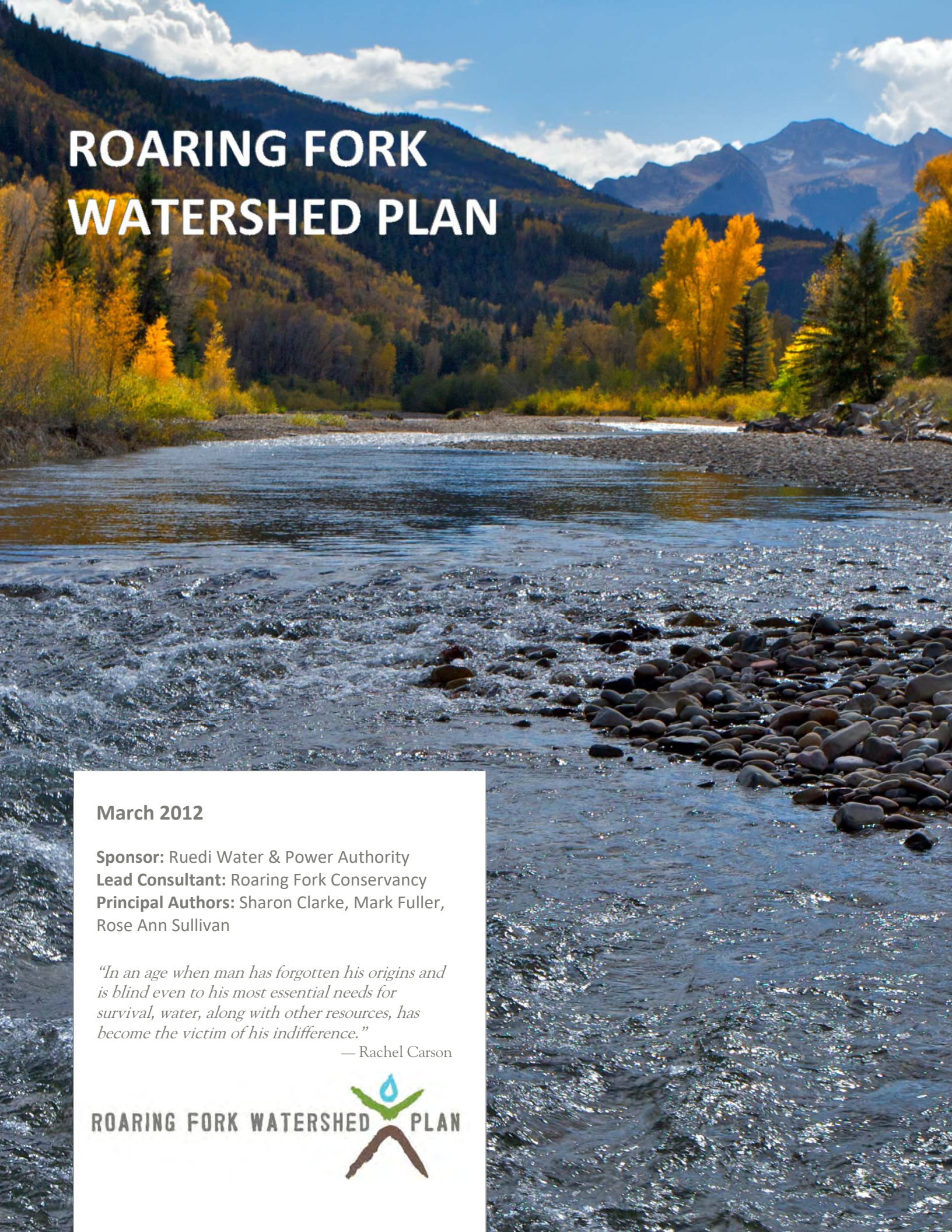
Many people in Colorado are working hard to find solutions to our water problems. This project is worthy of funding because it seeks to address many of the constraints surrounding improved environmental conditions while taking into account the concerns and needs of municipal water rights holders along with recreational and educational components.

Efficient use of our water resources is essential to ensure that we maintain adequate consumptive water supplies and strive toward the protection and enhancement of stream flows in our local rivers. Equally important to our community and its visitors is rehabilitating the ever important riparian habitat. An improved Crystal River will provide enhanced recreational opportunities, as well as critical instream and riparian habitat for resident and migrating wildlife.

I look forward to seeing the benefits of plan implementation in this watershed.

Sincerely, Steve Child

Rancher, irrigator, and Pitkin County Commissioner



ROARING FORK WATERSHED PLAN

March 2012

Sponsor: Ruedi Water & Power Authority
Lead Consultant: Roaring Fork Conservancy
Principal Authors: Sharon Clarke, Mark Fuller, Rose Ann Sullivan

"In an age when man has forgotten his origins and is blind even to his most essential needs for survival, water, along with other resources, has become the victim of his indifference."

— Rachel Carson

ROARING FORK WATERSHED PLAN

This document is formatted to print double-sided to save paper. Some pages are left blank so that sections begin on odd numbered pages. When placed in a three-ring binder, each section can be divided by a tab for easy reference. When the plan is updated, sections, rather than the whole document can be replaced. Cover photo of Crystal River by Greg Watts.

Acknowledgements

The Ruedi Water and Power Authority, an intergovernmental agency made up of the towns and counties in the Roaring Fork Valley, has sponsored the Watershed Plan process. All of the members of the Authority support the concept of comprehensive water planning for the Roaring Fork Watershed and have contributed to the Plan. Roaring Fork Conservancy served as the lead consultant on the Plan. Kootenay Resources, LLC also assisted with work on all aspects of the Plan.

The following additional people and organizations provided input to the Plan:

David Brown; U.S. Geological Survey
Andreas Holland-Sears, Mark Lacy and Scott Snelson; U.S. Forest Service, White River National Forest
Travis Morse; U.S. Army Corps of Engineers
Sharie Prow; Mount Sopris Conservation District
Bill Blakeslee; Colorado Division of Water Resources
Kendall Bakich, Jenn Logan, and Kevin Wright; Colorado Parks & Wildlife
Don Meyer; Colorado River Water Conservation District
Ray Merry; Eagle County
Tamra Allen, Fred Jarman, and Jim Rada; Garfield County
Catherine Berg, Ruthie Brown, John Ely, Cindy Houben, Steve Hunter, Bill Jochems, Greg Poschman, Rick Neiley, Susan Pearson, Carla Ostberg, Michael Owsley, Ellen Sassano, Lisa Tasker, and Andre Wille; Pitkin County/Pitkin County Healthy Rivers and Streams Board
April Long; City of Aspen
Robi Darcy, Bentley Henderson, and Susan Philp; Town of Basalt
A'Lyssa Gerum; City of Glenwood Springs
Kevin Lusk; Colorado Springs Utilities
Amanda Barker, Angela Michalek, Anne Kohl, Bethany Hellman, Kathleen McIntyre, and Julia Wondolleck; School of Natural Resources and Environment, University of Michigan
John Emerick; Colorado School of Mines (retired)
Shanna Koenig Camuso and Lane Wyatt; Northwest Colorado Council of Governments
Dee Malone; Colorado Natural Heritage Program
John Katzenberger; Aspen Global Change Institute
Claire Britt, Sarah Johnson, Rick Lofaro, Tim O'Keefe, Chad Rudow, and Sarah Woods; Roaring Fork Conservancy
G. Moss Driscoll; Elk Mountain Consulting, LLC
Tom Kinney; Western Slope Water Rights, LLC
Ken Kolm; Hydrologic Systems Analysis, LLC
Bill Miller; Miller Ecological Consultants, Inc.
Bob Schultz; Robert Schultz Consulting, LLC
Paul K.M. van der Heijde; Health Hydrology, Inc.
Jonathan Waterman
Dale Ratliff
Jane Clancy

Many additional members of the public also contributed to the Plan at five public meetings hosted throughout the Roaring Fork Valley during the fall of 2009, and during interviews conducted by students from the University of Michigan's School of Natural Resources and Environment during the spring of 2010.

Grants & Other Funding Support

City of Aspen
Town of Snowmass Village
Town of Basalt
Town of Carbondale
City of Glenwood Springs
Pitkin County
Pitkin County Healthy Rivers and Streams Fund
Eagle County
Garfield County
Colorado Water Conservation Board Water Reserve Fund Grant
Ruedi Water & Power Authority Reserve Fund
Gunnison County
Snowmass Water & Sanitation District
Colorado River Water Conservation District
White River National Forest
Environmental Systems Research Institute, Inc.
Kootenay Resources, LLC
Colorado Healthy Rivers Fund
Environment Foundation (Aspen Community Foundation and the Aspen Skiing Company Family Fund)

Dedication



Randy Russell

September 11, 1948 - November 21, 2009

The seeds for this plan began nearly a decade ago when Randy Russell, a long-range planner for Garfield County, assembled a diverse group of people to discuss water issues within the Roaring Fork Watershed. We were planners, biologists, hydrologists, and land and water managers from local, state, and federal agencies. We were directors of water-related non-profits, ranchers, and interested citizens. From that meeting began a collaborative effort between government agencies, watershed organizations, and local landowners. With the help of Randy's enthusiasm, we convened regularly, sharing water related information and seeking collective solutions to the challenges facing the Roaring Fork River system.

Randy had a keen understanding of the value of comprehensive watershed planning. An example of his foresight was his efforts to secure financial support from Garfield County Commissioners for three distinct and concurrent investigations: stream health, water quality, and water quantity. To avoid competition for funding between the studies he created a "water study" line item to support each analysis equally. Together with funds from agencies and organizations throughout the valley, each of these studies was completed and, together, established the foundation of the Roaring Fork Watershed Plan.

Randy possessed an acerbic wit and sharp intellect that demanded pragmatism. Yet he had a generous and playful side that netted him life-long friends from all walks of life. His passion, however, was collaboration, its potential to stimulate a broad exchange of ideas and its promise to transcend jurisdictional boundaries that inspired true community. He freely shared his wealth of knowledge and expertise in what he often called "brain dumps," and we in the Roaring Fork watershed benefitted greatly from them. It is fitting that this Plan be dedicated to the memory of Randy's vision, passion, and commitment towards protecting and improving the health of the Roaring Fork Watershed.

Contents

1. Introduction/Overview 9

2. Urgent Actions 13

3. Watershed Management Topics 15

I. Recommended Actions to Achieve Regional Water Management (RWM) Goals and Objectives 17

RWM A. Objective: Improve public education and understanding concerning complex federal and state water policies/programs affecting management of our rivers and streams. 18

RWM B. Objective: Ensure that Roaring Fork Valley decision makers consistently evaluate and pursue strategic opportunities for obtaining environmentally and economically beneficial stream flows in the Roaring Fork Watershed, striving to achieve a unified watershed approach whenever possible. 20

RWM C. Objective: Ensure coordination of local land use actions to prevent or mitigate water resource impacts throughout the watershed. 24

RWM D. Objective: Ensure that the potential effects of climate change are considered as an element in future water management decision-making. 26

II. Recommended Actions to Achieve Surface Water (SW) Management Goals and Objectives 29

SW A. Objective: Identify flows needed to meet non-consumptive needs. 29

SW B. Objective: Ensure that Colorado Water Conservation Board instream flow rights are adequate to preserve or improve the natural environment to a reasonable degree and are consistently being met. 32

SW C. Objective: Identify stream reaches that are vulnerable to increased flow alteration and pursue opportunities to prevent additional impacts on flows. 33

SW D. Objective: Improve our community's understanding of the importance of maintaining adequate stream flows for the environment. 35

SW E. Objective: Reduce the negative impacts of drought and floods. 36

III. Recommended Actions to Achieve Groundwater (GW) Management Goals and Objectives 39

GW A. Objective: Obtain, compile and utilize information on groundwater availability and sustainability in local land use and development decisions. 39

GW B. Objective: Sustain and improve groundwater recharge in the watershed 40

GW C. Objective: Improve our community's understanding and enforcement of federal, state, and local regulations designed to protect groundwater availability and sustainability. 42

GW D. Objective: Improve our community's understanding of groundwater. 43

IV. Recommended Actions to Achieve Water Quality (WQ) Goals and Objectives 45

WQ A. Objective: Obtain water quality data to adequately assess status and trends. 45

WQ B. Objective: Meet state water quality standards in all of our rivers and streams. 47

WQ C. Objective: Minimize nonpoint source pollution of surface waters and groundwater. 48

WQ D. Objective: Improve our local ability to address point source water quality issues. 53

WQ E. Objective: Improve public awareness and support of water quality protection and improve public engagement in water quality protection activities. 54

WQ F. Objective: Develop a strategic plan for dealing with potential future water quality threats. 55

V. Recommended Actions to Achieve Riparian and Instream (RI) Goals and Objectives 57

RI A. Objective: Assess the condition of riparian and instream habitat for all major streams in the watershed. 57

RI B. Objective: Enhance and preserve native riparian and instream flora and fauna including wild, naturally reproducing fish communities. 58

RI C. Objective: Minimize the impact of development and other activities in riparian and instream areas. 63

RI D. Objective: Improve understanding of the importance of riparian and instream areas. 66

RI E. Objective: Eradicate/control invasive species in riparian and instream areas. 67

5. Matrices 73

6. Implementation 109

I. Potential Implementation Strategies 109

II. Potential Grant and Other Opportunities for Funding Implementation of the Roaring Fork Watershed Plan's Recommended Actions 111

7. Acronyms, Abbreviations, and Glossary 129

8. References 135

Appendices 139

Appendix 1. Natural Communities and Species of Concern *. 139

Appendix 2. Noxious Weeds or Undesirable Disturbance-Induced Plant Species..... 142

Roaring Fork Watershed Plan Purpose: To plan for and work toward an environmentally and economically healthy watershed that benefits all who have a stake in it.

1. Introduction/Overview

> *"The Collaborative started several years ago to bring municipalities and counties together to try to think as a watershed. All decisions were being made with local communities here and counties over there. We made an effort to start thinking as a watershed instead of our own unique municipality or county."*
> — Andrea Holland-Sears, USFS, White River National Forest

The Roaring Fork Watershed Plan is the product of over four years of effort by more than a hundred people, representing dozens of agencies, governments, and interests throughout the Roaring Fork Valley and beyond. The Plan is the culmination of countless meetings, conversations, debates, and iterations, all of them aimed at creating a document that will be meaningful and useful to both water managers and the general public.

The Plan had its origins in the work of the Roaring Fork Watershed Collaborative, an informal gathering of local officials, planners, resource managers, and interested citizens, which began meeting on an irregular basis in 2002. Collaborative members concluded that water, as one of the critical resources common to the entire valley, deserved special attention. This led to the formation of a Water Committee in 2005. The Water Committee, in turn, began formulating the outline of a Watershed Plan aimed at surveying and assessing the condition of our local water resources and recommending actions to preserve those resources.

Why do we need a Watershed Plan? Water is one of our most precious natural resources and one which can readily be physically removed from the watershed by transmountain diversions. Local water resources are also threatened by global climate change, pollution from both natural and man-made sources, and overuse. Specifically:

- The state's population of 5 million is expected to increase to almost 8 million by 2030. Eighty percent of the state's population lives in the half of the state that receives about 20 percent of the precipitation. Recent studies identify a need for another 600,000 to one million acre-feet of raw water by 2030. Those figures do not include water needs that might be generated by the effects of climate change, environmental and recreational uses, and energy development. By 2050 climate change could cause Colorado River flows to decline by 18 percent. Average Colorado Basin water storage could decline by 32 percent. Energy development could consume up to 200,000 acre-feet of water.

- On average, 37 percent of the Upper Roaring Fork Watershed (40,600 acre-feet) and 41 percent of the Upper Fryingpan Watershed (61,500 acre-feet) is already diverted annually to the Front Range. These are the 5th and 3rd largest transmountain diversions in the state.

- Almost 140 of 185 miles of streams surveyed in the Roaring Fork Watershed have moderately modified to severely degraded riparian habitat. In Colorado, riparian habitat represents less than three percent of the landmass but has the highest species richness with 75 - 80 percent of wildlife species using riparian habitat during some part of their life cycles. Functioning riparian areas reduce the risk of flooding and increase stream base flows.

If our water resources are damaged or reduced, impacts will be felt by instream and riparian habitats, the wildlife and recreation that depends on those resources, and by the local agricultural operations that rely on irrigation. Lower water levels in local streams and rivers will increase water treatment costs as the benefits of dilution are lost. Changes in the management of Ruedi Reservoir could impact the Fryingpan and Roaring Fork Rivers' world class fishery and reduce the availability of flat water recreation. All of these factors, plus the importance of water to our overall quality of life, led to the decision to create a Plan aimed at safeguarding the valley's precious water resources.

In late 2006 the Ruedi Water and Power Authority (RWAPA), a consortium of local governments, became involved as the official sponsor of the Plan. RWAPA engaged Roaring Fork Conservancy as the lead consultant on the project and secured funding for Phase I, the *State of the Roaring Fork Watershed Report 2008*. That report was widely recognized as a comprehensive, accessible, and valuable compendium of watershed conditions. It was supplemented by two guidance documents: (i) *Why the Roaring Fork Watershed Plan Matters* (October 15, 2008), and (ii) *Illuminating the Way Ahead* (February 12, 2010). The findings of the *State of the Roaring Fork Watershed Report 2008* and the guidance documents became the basis for a series of meetings with the public and technical advisors aimed at translating the Phase I findings into a series of goals, objectives, and actionable recommendations which would make up Phase II of the Plan. This document is the result of that process and, in tandem with the *State of the Roaring Fork Watershed Report 2008* and the two guidance documents, represents the final product of the watershed planning process that began with those Watershed Collaborative discussions of several years ago.

BENEFITS OF A WATERSHED PLAN:

- Provides a structure for continued input from and dialogue between all stakeholders.
- Improves community understanding, interest, and leadership in watershed issues.
- Encourages partnerships to identify and fund mutually beneficial projects, allowing project prioritization and collaboration on major grant applications.
- Provides a framework for efficient use of financial resources and effective use of agency and organizational personnel.
- Provides guidance on means for protection of riparian and aquatic resources, while providing for a viable economic community.
- Provides available watershed information and data to all stakeholders, thereby precluding duplicative work efforts.
- Facilitates collaboration on public outreach and education efforts on water resource issues within the watershed.

The watershed planning process has, by design, been very broad and deliberate. Our overriding concerns have been to be inclusive, transparent, thorough and detailed in our effort, which has led us down many pathways that were not anticipated when this process was started. The result is a highly detailed Plan which is daunting in its scope and ambition, but which sets lofty goals, and which challenges the community to take on a vast responsibility for critical resources.

One way to describe this Plan is to note the things that it is not. It is not a political document which lays blame or points fingers at any entity. It is not a technical document meant to be used as a work plan by engineers, hydrologists, or biologists. It is not a survey that represents a statistically valid sampling of public opinion. It is, rather, a compendium of proposals and recommendations developed by both

experts and interested citizens, meant to be implemented by a variety of agencies, governments, and other entities, as resources allow.

One of this Plan's key objectives is to provide a reference to enable laymen, students, activists, and recreationists to get involved in watershed management. With this in mind, we have made a special effort to use non-technical language, to limit the use of academic jargon, and to address a wide range of topics and issues. One of our most important goals is to engage the broadest possible constituency in the work of watershed management.

To that end, the Plan provides more than one avenue for accessing its goals, objectives, and recommendations. The Narrative section describes the various goals, objectives, and recommended actions according to five broad topic areas: Regional Water Management, Surface Water, Groundwater, Water Quality, and Riparian and Instream Habitat. This extensive overview of goals, objectives, and recommended actions is the basis for the matrices that follow. The Matrix section takes the recommendations of the five narratives and reformats them to provide a variety of perspectives. The recommended actions are broken out according to topic area and then further organized by geographic area and priority, coordinating entities/key participants, and action type (*i.e.*, project or program/legislation or regulation/further study required). These matrices are intended to shed light on the findings of the Plan by organizing those findings according to a variety of distinguishing characteristics and to assist in determining implementation strategies, timetables, and partnerships. Finally, the Implementation section of the Plan offers a framework for moving forward and catalogs a variety of resources that can be called upon to assist with implementation in both the short and long term.

We recognize that in order for this Plan to have long-term meaning and impact, those of us who have worked on the Plan in the past will need to continue our efforts towards implementation. Our presentations of the Plan to local and regional leaders and to the public at large will be the beginning of this process as we discuss alternative implementation strategies with water managers, government officials, and citizen activists. Although this is the end of a long process, it is the beginning of another one that will have no end. The implementation, follow-up, and future revision of this Plan will be the ultimate measure of its worth and will be a process that we hope will become an ingrained part of the community.

> *"After experiencing three of these input sessions and listening to the dialogue, I have come to understand that we are really talking about changing the culture of our relationship to water in the region. We can propose some regulatory changes that could have some impact, but the real change will be based on people having a different relationship with water and a culture of water responsibility becoming part of our regional ethic. That cannot be mandated."*
>
> — Bob Schultz, Roaring Fork Watershed Plan public meeting facilitator, 2009

2. Urgent Actions

A handful of actions from each of the five broad water topics are suggested for immediate implementation. These actions were selected based on a combination of factors, including the environmental and economic value of the resource to be protected or restored, the threat of future adverse impacts, and the likelihood that the actions can be successfully completed in the near term. Also, most of these actions provide benefits throughout the watershed and offer significant opportunities for collaboration and education. Some of these actions are opportunistic, in that they build upon ongoing work and take advantage of current political will and public enthusiasm. Successful implementation of these actions will provide momentum for accomplishing the 200+ recommended actions identified in this Plan.

Regional Water Management

❖ **Create a Unified Voice for Regional Water Management**

RWM B2a. Appoint a Working Group to identify mechanisms for consolidating and coordinating the Roaring Fork Valley's involvement in regional water management and to advise local governments on participation in regional water management planning.

❖ **Assess the Impacts of Climate Change on the Watershed**

RWM D1g. Assess the vulnerability of the Roaring Fork Watershed to climate change. Develop an adaptive management strategy that integrates findings from the vulnerability assessment with watershed planning priorities and decision support.

Surface Water

❖ **Ensure that Water Availability Studies Include Environmental and Recreational Water Needs**

SW A1c. Ensure that the Colorado River Basin Water Availability Phase II Study adequately assesses and addresses the Roaring Fork Watershed's non-consumptive needs, including projected needs with climate alteration.

❖ **Quantify Non-consumptive Flow Needs**

SW A1f. Conduct site-specific studies of environmental and recreational flows needed for stream reaches that are currently significantly flow-altered or threatened by significant flow alteration. Include an analysis of how often these flows are not met.

❖ **Pursue a Water Conservation Campaign that Benefits Rivers**

SW B1f. Investigate if water conservation translates to environmental benefits under Colorado water law. Pursue opportunities for water conservation, if appropriate.

- Complete the report, *Opportunities for Water Conservation – Options and Recommendations for the Roaring Fork Watershed* and pursue a water conservation campaign utilizing the report's analysis.

Groundwater

❖ **Ensure an Adequate Groundwater Supply for New Land Uses and Developments**

GW A2a. Adopt local regulations, policies, and procedures to ensure that there is a sufficient technical and legal demonstration of the availability and sustainability of an adequate water supply for any new land use or development reliant upon groundwater.

Water Quality

❖ **Onsite Wastewater Treatment System Education Campaign**

WQ E1h. Improve public education regarding individual onsite wastewater treatment systems, particularly the need for regular system inspections – not just pumping.

Riparian and Instream Areas

❖ **Plan and Implement Key Riparian and Instream Protection and Restoration Projects**

RI B1a. Working with landowners, resource experts, and other interested parties, plan and implement riparian/ instream protection and restoration projects.

> *Fostering Implementation of the Roaring Fork Watershed Plan*. (December, 2010).
> Recommendation #3: Pursue an initial voluntary project.

- Four areas have been identified that have high visibility and are ecologically significant. To varying degrees they provide opportunities for collaboration/partnerships, take advantage of ongoing projects/program support, and offer relatively uncomplicated access to the riparian and instream area. The four areas are: Upstream and downstream of the Town of Basalt, the Northstar area of the Roaring Fork River, the Cattle Creek confluence with the Roaring Fork River, and the Coal and East Creeks confluence with the Crystal River.

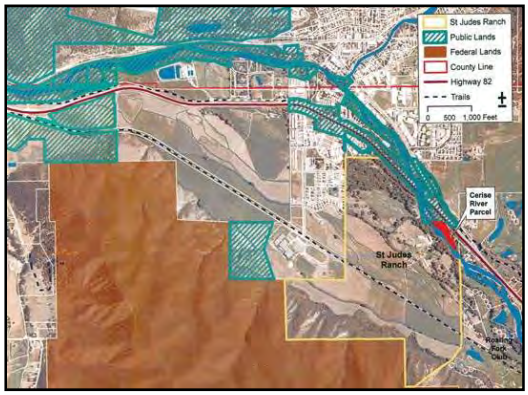


Figure 1. The Roaring Fork River near Basalt is ecologically significant and much of the riparian area is in public ownership (Map: Pitkin County Open Space and Trails)**.**

❖ **Provide Adequate Stream Setbacks Throughout the Watershed**

RI C1c. Develop and enforce stream setbacks that protect riparian areas throughout the watershed.

❖ **Increase Awareness of the Importance of Riparian Areas**

RI D1a. Provide education to the public about the important functions of riparian areas, of development and other threats to riparian areas, what can be done to protect and restore riparian areas, and potential sources of funding for riparian projects.

- Roaring Fork Conservancy's *"Citizen's Guide to Riverfront Property"* provides information on the benefits of riparian areas and what people can do to protect these areas.

3. Watershed Management Topics

> *"All the water that will ever be is, right now."*
> — National Geographic, October 1993

The Narrative section of the Plan is divided into five water-topic sections mirroring the organization of the *State of the Roaring Fork Watershed Report 2008.* These include **Regional Water Management**, **Surface Water Management**, **Ground Water Management**, **Water Quality**, and **Riparian and Instream Areas.** Under each of these headings is a topic goal addressing what the Plan hopes to achieve. For instance, the goal for Groundwater Management is ***"To protect the availability and sustainability of our groundwater."*** Each topic's goal is accompanied by brief explanatory text. This is followed by four to six objectives which speak to the various aspects of achieving the goal. Each objective is described in more detail and has an associated Summary Statement of action required. Each Summary Statement identifies the most likely Coordinating Entities and other Key Participants. The companion matrices (Section 5) also identify the Coordinating Entities and Key Participants for each individual action. The Summary Statements and connected Recommended Actions are where the Plan addresses the practical realities associated with implementation. At the end of each action are letters signifying the type of action: (P) "Project or Program," (S) "Study," or (L) "Legislative and Regulatory" or any combination of the three. "Projects" are activities which require physical alterations to the landscape, such as revegetation of a riparian area or the construction of a kayak park, while "Programs" require an active effort using legislative, educational, legal, regulatory or other tools to carry out a recommendation. A "Study" is just what its name implies - an effort to learn more through research, inquiry, and analysis about a given topic. The "Study" designation often indicates a knowledge gap - an aspect of the watershed which is poorly understood or documented. "Studies" are often paired with one of the other categories because they are a necessary precursor to more direct action. "Legislative and Regulatory" recommendations refer to those actions which will require a governing body to take official action, including adopting standards, imposing penalties, and providing resources. The category distinctions in this narrative are somewhat subjective and are not intended to exclude other approaches to implementation nor to value one type of implementation action over another. They are intended to act as a starting point for further discussion and as an aid in assigning responsibility for actions.

Each Goal, Objective, Summary of Action Required, and Recommended Action is coded with an alpha-numeric identifier to clarify relationships to each other. The following Recommended Action to achieve the Surface Water Goal is an example:

SW C3a. *Complete a comprehensive climate impacts assessment on stream flows for the Roaring Fork Watershed. (S)*

This Recommended Action is associated with the Surface Water (SW) section and is designated *"a"* under Summary of Action Required #3 under Objective C. The (S) indicates it is a Study. Some elements of this outline format require further explanation, including:

Coordinating Entity or Entities: This sub-head identifies that agency or agencies which have immediate jurisdiction over the subject of the recommendation or have the most readily-identified responsibility

for that subject. This is not to suggest that Coordinating Entities have sole responsibility or a legal obligation to implement a given recommendation. It is instead a guide as to what entities would need to be closely involved if the recommendation were to be implemented.

Key Participants: This sub-head identifies the other participants that would be potential partners or referral agencies to the Coordinating Entities. As noted above, partnerships and sharing of resources will be a key factor in determining the success of this Plan.

The listing of Coordinating Entities and Key Participants recognizes existing relationships and also provides a starting place for establishing partnerships around one implementation action or another. The critical involvement and participation of amorphous groups, such as landowners and schools, while recognized for many of the Plan's action items, has not been explicitly called out.

Section 4 of the Narrative is a Key which lists and defines all of the acronyms used to identify Coordinating Entities and Key Participants.

Sidebars: Sidebars are presented in boxes interspersed throughout the Narrative and provide further explanation or background on the various actions. These additions to the Narrative generally include details, resources, examples or definitions which shed further light on the actions with which they are associated.

I. Recommended Actions to Achieve Regional Water Management (RWM) Goals and Objectives

<u>RWM Goal</u>: To ensure that solutions to water management issues meet both our consumptive needs for water and the need to keep water in our rivers and streams for instream uses.

During the last decade, Colorado has seen rapidly increasing demands on water by both traditional consumptive uses and, more recently, by non-consumptive recreational and environmental uses. By the year 2030, Colorado's population is expected to grow to about 7.1 million people from the current estimate of 4.5 million. This population growth, together with the recent drought (1999-2004) and the threat of global climate change, raises serious concerns about the ability of Colorado's water supplies to meet the needs of its citizens and the environment.

Water use and stream flows in the Roaring Fork Watershed are affected by transmountain diversions, water rights within the Roaring Fork Watershed and the broader Upper Colorado River Basin, multi-state river compacts, and pressure by many interests to develop water supplies for future growth and development. What happens in the Roaring Fork Watershed has a significant impact on water management in the region and in the state, and vice versa.

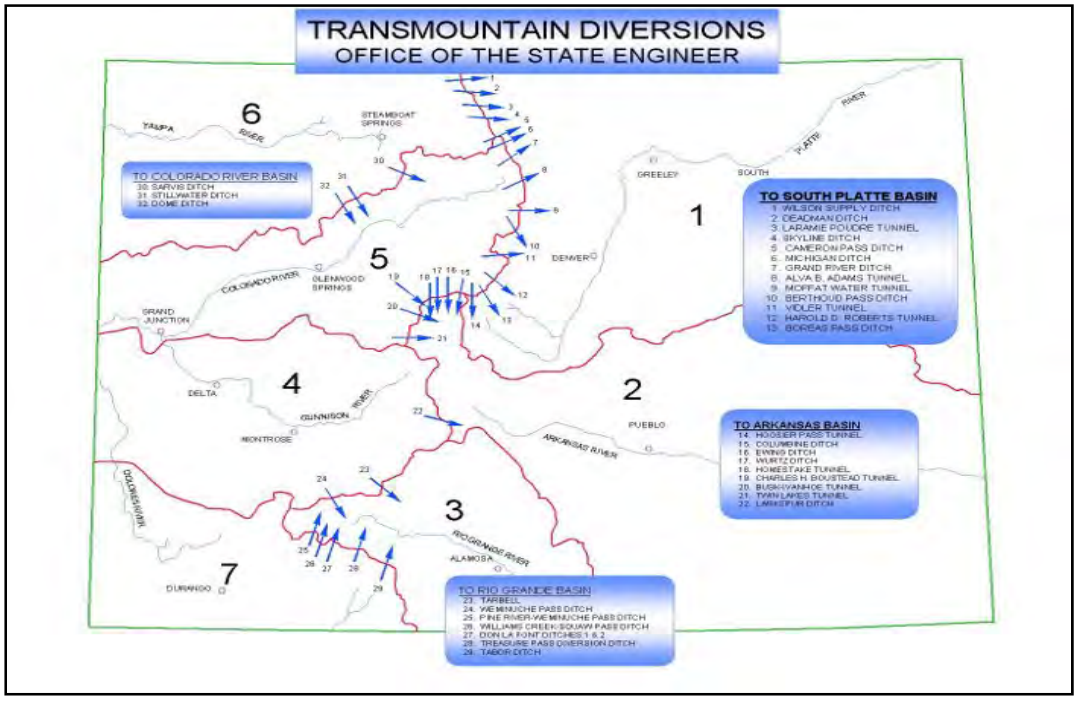


Figure 2. Transmountain diversions in the State of Colorado.

Water distribution and management in the watershed is influenced primarily by Colorado's Prior Appropriation Doctrine, which determines timing and allocations of water rights. Other important factors include water management agreements like the Colorado River Compact, and planning initiatives and policies, including the Colorado Interbasin Compact negotiation process, Endangered Species Act and Wild and Scenic Rivers Act. Finally, structural projects play a key role in the watershed, with the Fryingpan-Arkansas Project and Independence Pass Transmountain Diversion System directly affecting water availability and stream flows. Looking to the future, the development of conditional water rights,

uncertainty surrounding the Colorado River Compact, additional water demands, and structural project proposals, such as the Ruedi Pumpback, Colorado River Return Project, and Preferred Storage Options Plan, are some of the issues with potential implications for water availability and management in the Roaring Fork Watershed.

RWM A. Objective: Improve public education and understanding concerning complex federal and state water policies/programs affecting management of our rivers and streams.

The *State of the Roaring Fork Watershed Report 2008* summarizes the most important federal and state laws, regulations, and policies influencing water use in the Roaring Fork Watershed. The programs and structural projects implementing these laws, regulations, and policies tend to be complex and can be hard to understand unless significant time is devoted to their study. Yet, some level of understanding is important for the community to be able to knowledgeably engage in water management planning. Enhanced media coverage of federal and state initiatives affecting our watershed is needed and ways must be found to improve public education and outreach on the issues so our community is better prepared to influence water management policy.

The Roaring Fork Watershed Plan's Phase II Guidance Documents (*Why the Roaring Fork Watershed Plan Matters* and *Illuminating the Way Ahead*) discuss the state's Interbasin Compact Process. The Roaring Fork Watershed participates in the Interbasin Compact Process through its representatives on the Colorado Basin Roundtable (CBRT) which meets monthly in Glenwood Springs. CBRT representatives include appointees from local municipalities and counties, representatives from water supply agencies, and from the public at large.

To date, there has been little public attendance at the CBRT meetings and limited public participation on the CBRT's working groups, Most members of the community are not aware of the work being done by the CBRT and the other basin roundtables. The discussions, studies and projects being conducted by these basin roundtables will influence the long-term management of the Roaring Fork Watershed's water resources. The CBRT's interface with its constituents needs to be improved. Otherwise, the decisions being made on behalf of the watershed in the Interbasin Compact Process may not be supported by the community.

The CWCB's website (cwcb.state.co.us) has information on the Roaring Fork Watershed's **CBRT representatives**, upcoming **CBRT meetings**, as well as **minutes** from past meetings. The website also includes **reports** generated by the CBRT and other basin roundtables.

RWM A1. *Summary of Action Required*: Improve media coverage of federal and state water policies/programs affecting management of our rivers and streams.

- ***Coordinating Entity*: CRWCD**
- ***Key Participants*: CBRT, CFWE, CTU, CWCB, local jurisdictions, NWCCOG Q/Q, RFC, RWAPA**

RWM A1a. Regularly broadcast, via webcast, local cable TV, and other outlets, educational presentations on federal and state water policies/programs affecting management of our rivers and streams. Presentations given at basin roundtable and other meetings can be recorded and rebroadcast in edited form for easy consumption. (P)

RWM A1b. Issue regular press releases from the CBRT, CRWCD, and RWAPA. Include "tie-ins" to the Roaring Fork Watershed whenever possible in press communications. (P)

RWM A1c. Use social networking opportunities (*e.g.*, Facebook, Twitter) to improve communication with respect to meetings, workshops, and other educational opportunities concerning water issues. (P)

RWM A2. *Summary of Action Required*: Develop and implement outreach and education programs that translate and convey consistent information on complex water policies/programs affecting management of our rivers and streams.

- ***Coordinating Entities*: CRWCD, RFC**
- ***Key Participants*: CBRT, CFWE, CTU, CWCB, local jurisdictions, NWCCOG Q/Q, RWAPA**

RWM A2a. Fund and distribute videos (*e.g.*, the Roaring Fork Watershed video by Greg Poschman), PowerPoint presentations, brochures, and other media that tell the story of the Roaring Fork Watershed. Exhibit and promote these products as widely as possible. (P)

RWM A2b. Create a graphical tool or an educational game (like "Risk") illustrating the relationship between downstream calls, transmountain diversions, in-basin diversions (*e.g.*, ditches), and flows in the Roaring Fork Watershed. Include an illustration of how transmountain and local diversions and downstream calls may support or harm instream values (*e.g.*, kayaking, fishing, rafting). Make this tool available for schools and for presentations on water issues. (P)

When a **"call"** is placed on a river by a water rights holder it means that the water rights holder is requesting the CDWR to shut down (curtail) all upstream junior water rights until their senior water rights downstream are satisfied. The primary "call" on the Roaring Fork Watershed is the "Cameo Call," a group of senior irrigation rights near Grand Junction, which can curtail even transmountain diversions.

RWM A2c. Support projects such as the CRWCD/NWCCOG Q/Q's "It's the Same Water Campaign" and the RFC's River Center, including exhibits to enhance public awareness of complex regional water management issues. (P)

RWM A2d. Create a portable plumbing model of the Roaring Fork Watershed similar to the NRCS stream trailer. (P)

RWM A2e. Publish and distribute the RWAPA document, *Front Range Water Supply Planning Update: Increased Storage, Increased Demands, Increased Transmountain Diversions*. Translate and graphically represent key findings from this document. (P)

RWM A2f. Support projects such as the Univ. of Michigan Master's Project, *Fostering Implementation of the Roaring Fork Watershed Plan*. Evaluate and utilize recommendations for improving public education and outreach from the Univ. of Michigan Master's Project, as appropriate. Seek out opportunities to engage academia in research and implementation projects. (P)

RWM A3. *Summary of Action Required*: Improve communication between the Colorado Basin Roundtable and the public on Roundtable activities, projects, and policies.

- ***Coordinating Entity*: CBRT**
- ***Key Participants*: CRWCD, CWCB, local jurisdictions, RFC, RWAPA**

RWM A3a. Advertise the CBRT meetings and their agendas. Include information on subcommittee/working group meetings that are open for public participation. (P)

RWM A3b. Broadcast CBRT meetings and publicize the broadcasts. (P)

OPPORTUNITIES TO IMPROVE COMMUNICATION BETWEEN THE CBRT & ITS CONSTITUENTS INCLUDE:

- Local cable TV and webcast coverage of CBRT meetings.
- Announcements of CBRT meetings and agendas in local newspapers, on local radio and cable TV and through social networking channels.
- A monthly Q&A with CBRT representatives published in local newspapers and on the RFC website.
- Interviews with CBRT representatives on local cable TV and radio.
- A Facebook page for CBRT representatives.

RWM A3c. Institute regular reporting to constituents by the Roaring Fork Watershed CBRT representatives in "user friendly" formats including social media, e-mail mailing lists, and bulk mailings. (P)

RWM A3d. Create a mechanism to capture and relay public comment to the CBRT on issues affecting the Roaring Fork Watershed. (P)

RWM A3e. Support/fund a touring educational program on regional water management issues (*e.g.*, "Flowing Uphill -Diversions, Rivers and Water in Colorado" by Ken Neubecker of the Western Rivers Institute). (P)

RWM B. Objective: Ensure that Roaring Fork Valley decision makers consistently evaluate and pursue strategic opportunities for obtaining environmentally and economically beneficial stream flows in the Roaring Fork Watershed, striving to achieve a unified watershed approach whenever possible.

Both the *State of the Roaring Fork Watershed Report 2008* and the Phase II Guidance Document, *Illuminating the Way Ahead*, discuss the legal framework under which our water resources are managed. Many different federal, state and local entities monitor and enforce a complicated array of statutes, regulations, and agreements. Inadequate resources (*e.g.*, insufficient field staff, lack of gaging stations, inadequate funding for data analysis) will almost certainly continue to be a problem for all of these entities individually. Collaborative efforts, utilizing all of the technical and legal resources at hand, represent our best opportunity for vigilant protection of our water resources.

Currently, local governments in the watershed vary widely in the resources they devote to federal and state water policies and programs. Few, if any, of the local governments have the technical and legal staff available to consistently analyze federal and state initiatives and recommend positions to be taken by elected officials. Multi-jurisdictional entities, such as the CRWCD, RWAPA and NWCCOG Q/Q, provide additional resources for local governments. However, the positions they advocate on behalf of their membership may not reflect the views of all of the decision makers in the Roaring Fork Watershed.

The Roaring Fork Watershed lacks a unified local voice able to draw from technical and legal resources from across the watershed. Establishing mechanisms and institutions to promote cooperation among decision makers will be critical for implementation of the Roaring Fork Watershed Plan and for effective management of our water resources in the future.

The 2002 drought that affected streams throughout the region was a reminder that water supplies are a function of climate more than any other single factor. Climate change will continue to impact water availability in the Roaring Fork Valley. Energy development and future transmountain diversions may further impact local water resources. Our community should not wait for the next crisis before taking action to address current and potential stream flow issues in the Roaring Fork Valley. Increased demands and unpredictable supplies create a fragile system where even a temporary deviation from normal flow regimes can have instantaneous and lasting impacts.

The Phase II Guidance Document, *Illuminating the Way Ahead*, discusses the CWCB's instream flow lease and loan program and other tools available for local governments to protect stream flows. Regional collaboration aimed at maintaining or increasing stream flows should be a priority for our watershed.

As discussed in the *State of the Roaring Fork Watershed Report 2008* and the Phase II Guidance Document, *Illuminating the Way Ahead*, augmentation plans and temporary substitute supply plans are important water management tools for dealing with changing land use in Colorado. However, in their current form, these plans are primarily concerned with satisfying the requirements of other water *users*. There are few protections in place for non-consumptive water needs. A plan which adversely impacts streamflow amounts or timing can still be approved if it protects other water users.

As part of the Interbasin Compact Process, the CBRT and the other basin roundtables are responsible for conducting non-consumptive needs assessments in their respective watersheds. Through this process, Colorado has already taken a significant step towards recognizing the standing of its non-consumptive water needs. Augmentation and substitute supply plan requirements that recognize the importance of non-consumptive water uses in Colorado should be the next step towards assuring that those needs are met in the future.

RWM B1. *Summary of Action Required*: Ensure that decision makers consistently review and take positions on federal and state water policies/programs affecting management of the Roaring Fork Watershed.

- ***Coordinating Entities*: CRWCD, local jurisdictions, RWAPA**
- ***Key Participants*: BLM, BOR, CBRT, CDWR, CPW, CTU, CVEPA, CWCB, DOI, NWCCOG Q/Q, River Board, transmountain diverters, USFS, USFWS, USGS**

RWM B1a. Appoint a Working Group to study and make recommendations on how the CRWCD can better foster collaboration among its Roaring Fork Watershed Board members. Evaluate and utilize the recommendations of projects such as the Univ. of Michigan Master's Project, *Fostering Implementation of the Roaring Fork Watershed Plan*, as appropriate. (S)

RWM B1b. Cultivate collaborative relationships with state and federal water resource experts and decision makers. Look for opportunities for agencies to partner on multi-jurisdictional projects. (P)

RWM B1c. Hold public meetings on significant water issues affecting the Roaring Fork Watershed with CBRT and RWAPA representatives, CRWCD Directors, and local elected officials. Publicize these meetings through various means. (P)

RWM B1d. Identify streams in the watershed that may be candidates for federal wild, scenic, and recreational status. Determine community support for a designation and work to meet community goals. (S&L)

RWM B1e. Encourage Pitkin County's River Board to publicize its priorities and activities and to take steps to coordinate those activities with local water managers and interest groups. (P)

In the Roaring Fork Watershed**, the BLM found Thompson Creek to be eligible for scenic designation**. Public participation in the BLM's resource management planning process will help determine suitability for inclusion within the Wild and Scenic Federal System. **Most of the National Forest lands adjacent to the Crystal River are also eligible for inclusion in the Wild and Scenic Rivers System.** The White River National Forest's *2002 Revised Forest Plan* established Scenic and Recreation River management prescriptions for the land adjacent to the Crystal River and its tributaries.

RWM B1f. Cultivate collaborative relationships with the entities diverting water from the Roaring Fork Watershed to the East Slope. Look for opportunities to partner on creative solutions to meet both East and West Slope water supply requirements. (P)

RWM B1g. Revitalize the Roaring Fork Watershed Collaborative Water Committee as a focal point for regional cooperation and communication. (P)

RWM B2. *Summary of Action Required*: Investigate mechanisms for consolidating and coordinating the Roaring Fork Valley's involvement in regional water management and to advise local governments on participation in regional water management planning.

- ***Coordinating Entities*: CRWCD, local jurisdictions, RWAPA**
- ***Key Participants*: CBRT, local fishing industry, NWCCOG Q/Q, RFC**

RWM B2a. Appoint a Working Group to identify mechanisms for consolidating and coordinating the Roaring Fork Valley's involvement in regional water management and to advise local governments on participation in regional water management planning. Evaluate and utilize the results of projects such as the Univ. of Michigan Master's Project, *Fostering Implementation of the Roaring Fork Watershed Plan*, as appropriate. (S)

RWM B3. *Summary of Action Required*: Evaluate and recommend changes in regulations to require implementation of augmentation and substitute supply plans which meet both consumptive and non-consumptive water needs within the context of Colorado water law.

- ***Coordinating Entities*: CDWR, NWCCOG Q/Q**
- ***Key Participants*: CRWCD, CWCB, local jurisdictions, RWAPA**

RWM B3a. Create a Working Group (with both technical and legal representatives) to investigate and recommend changes to regulations governing augmentation and substitute supply plans that reflect the importance of maintaining natural hydrology in the development of these plans. Evaluate the scope of local jurisdictions' legal authority in this area as part of this process, as well as the economic (*e.g.*, restricted development) and environmental consequences (*e.g.*, increased storage requirements) associated with any recommended changes to existing regulations. Strive to develop recommendations

which work within existing legal boundaries and which do not trade off one environmental value against another. Pursue regulatory amendments, as necessary, through all appropriate channels. (S&L)

The basic principles of **augmentation plans** and **substitute supply plans** are described in the Colorado Foundation for Water Education's *Citizen's Guide to Colorado Water Law*.

RWM B4. *Summary of Action Required*: Affirmatively use environmental laws and regulations (*e.g.*, local 1041 powers, NEPA, and the Fry-Ark Operating Principles), as necessary to protect the watershed and enforce existing agreements (*e.g.*, the Twin Lakes exchange) designed to protect the watershed. Seek out opportunities to use regulatory authority to encourage cooperative rather than punitive or compulsory solutions.

- ***Coordinating Entities*: CRWCD, local jurisdictions, RWAPA**
- ***Key Participants*: BLM, BOR, CBRT, CTU, CWCB, transmountain diverters, USEPA, USFS, USGS**

RWM B4a. Formalize the existing *ad hoc* arrangement among the CRWCD, USFS, Pitkin County, City of Aspen and CPW for establishing the annual flow regime for the Twin Lakes exchange and identify the entity (ies) in the watershed responsible for monitoring implementation of the Twin Lakes exchange on behalf of the Western Slope. Foster communications with managers and clients of the Twin Lakes diversions and seek out cooperative solutions which do not threaten their water supplies. (P)

RWM B4b. Maintain active participation by Roaring Fork Watershed decision makers in the 10,825 Working Group to ensure that watershed interests are protected and obligations under existing agreements (*e.g.*, the Fry-Ark Operating Principles) are met. (P)

RWM B4c. Cultivate collaborative relationships with those entities responsible for ensuring an adequate and sustainable water supply for the East Slope. Seek mutually-agreeable solutions to East and West Slope water supply requirements whenever possible. (P)

RWM B5. *Summary of Action Required*: Investigate the potential impacts of the perfection of conditional water rights on stream flows.

- ***Coordinating Entities*: CDWR, RWAPA**
- ***Key Participants*: Local jurisdictions**

RWM B5a. Investigate existing conditional water rights and determine if the exercise of these water rights would pose a threat to stream flows. Assess and pursue opportunities for securing or modifying the exercise of such rights within the confines of Colorado water law. (S&P)

A **conditional water right** is a water right obtained through water court proceedings where the right is given a priority date, even though actual water appropriation has not occurred. The holder of the conditional water right is given time to complete the appropriation, but every 6 years the water court reviews the progress made by the rights holder to ensure "diligence." Once the right has been perfected by use, the holder of the conditional water right must still request the water court to convert the conditional right to an absolute right in further proceedings.

RWM C. Objective: Ensure coordination of local land use actions to prevent or mitigate water resource impacts throughout the watershed.

Land use planning and development in the Roaring Fork Valley should adopt a "watershed perspective" whenever possible. For example, approval of a development in the headwaters that is reliant upon a nonexempt groundwater well may result in an augmentation plan that is satisfied by a release miles downstream on the Roaring Fork River. Absent a "watershed perspective," the land use approval may ignore potential impacts on stream flows between the point of withdrawal and the augmentation plan's point of release downstream. Individually, the impact from a single headwaters development approval may be small. Cumulatively, the impact from multiple development approvals with similar augmentation plans may be significant.

Any development in the Roaring Fork Valley involving water resources typically impacts other local water users and will draw the attention of more than just the local planning department. For example, an ornamental pond may divert and store water that needs to be released to senior water rights holders during dry summer months. The proper maintenance and accessibility of the head gate on the pond will be of interest to the local water commissioner, who is responsible for administering water rights. During the dry summer months the same pond may be viewed as a critical water storage facility for fire protection in a remote area. The local fire protection district may want the pond to remain full, or be replaced with a storage tank. If the interested parties are not talking to each other early in the planning process, a property owner may be left to deal with conflicting directives after a project has been engineered and completed.

The Roaring Fork Watershed Plan provides an ideal opportunity to improve cooperation and information sharing among local planning and engineering departments, state water commissioners, local fire protection districts, and other interested entities.

RWM C1. *Summary of Action Required:* Improve collaboration among Roaring Fork Watershed decision makers on local land use and development issues.

- ***Coordinating Entities*: RWAPA**
- ***Key Participants*: BOR, CDWR, CFWE, CRWCD, local jurisdictions NWCCOG Q/Q, RFC, SI, USFS**

RWM C1a. Periodically conduct watershed explorations for local decision makers (*e.g.*, the RFC's Floating Summit). (P)



Figure 3. Roaring Fork Watershed Summit, June 10, 2010. Planned as a "Floating Summit," dangerously high flows resulted in a "Dry Land Summit" for the nearly 80 elected officials, agency staff, and water experts who came together to discuss critical water issues in the Roaring Fork Watershed (Photo credit: Greg Poschman).

RWM C1b. Conduct a periodic retreat for Roaring Fork Watershed decision makers on specific land use and water issues of common interest/concern. (P)

RWM C1c. Identify and collect all IGAs, MOUs, etc. between/among Roaring Fork Valley jurisdictions with applicability to water issues. Make all such agreements easily accessible to the public online. Analyze those agreements and look for opportunities to consolidate, clarify, or revise those documents to improve interagency collaboration. (P, S & L)

RWM C1d. Identify jurisdictional and substantive gaps on water issues in existing IGAs, MOUs, etc. between/among local jurisdictions in the Roaring Fork Watershed. Recommend and pursue modifications to existing agreements, as well as new agreements, to close identified gaps. (S&L)

RWM C2. *Summary of Action Required*: Improve communication between local entities and state water commissioners on projects of common interest (*e.g.*, local land use and development approvals for micro-hydro facilities and ornamental ponds).

The Roaring Fork Watershed (Division 5, District 38) has only **two water commissioners** assigned to cover the entire watershed.

- ***Coordinating Entities*: Local jurisdictions**
- ***Key Participants*: CDWR, fire protection districts**

RWM C2a. Modify local land use regulations to require referrals to state water commissioners and local fire protection districts during the land use application review phase. (L)

RWM C2b. Request that local land use planning departments adopt a policy of offering state water commissioners and local fire protection districts an opportunity to participate on any technical advisory/working groups developing amendments to land use regulations and/or forms addressing water resource matters of common interest. (L)

RWM C2c. Conduct a bi-annual meeting of local land use planners, local fire protection district personnel, and state water commissioners to provide a forum for discussing land use and water resource matters of common interest. (P)

RWM D. Objective: Ensure that the potential effects of climate change are considered as an element in future water management decision-making.

Many studies have focused on how climate change can affect the Upper Colorado River Basin over the course of this century. One of them, the *Colorado River Water Availability Study – Phase I Report (Draft)*, issued March 22, 2010, has projected some dramatic changes to hydrologic conditions in the Colorado River Basin based on anticipated 2040 climate conditions. Among the report's findings:

- Temperature will increase basin-wide by 3.3 to 3.7 degrees Fahrenheit, with lower elevations showing the largest increase and temperature increases occurring each month of the year.
- Winter precipitation (November-March) will increase basin-wide by 6 to 13 percent.
- Summer precipitation (April-October) will decrease basin-wide by 4 to 10 percent.
- Annual streamflow will shift toward an earlier peak runoff and streamflow will decrease in late summer and early fall.
- Higher elevations will generally have less annual streamflow available to meet future demands, as a percent of modeled streamflow.

As discussed in the *State of the Roaring Fork Watershed Report 2008*, physical climate changes will impact the ecosystems and socioeconomics of the watershed. Climate change must be considered in all aspects of our water management planning.

RWM D1. *Summary of Action Required:* Ensure that provisions for climate change-driven impacts, as well as adaptations necessary to account for climate change, are integrated into all regional water management planning.

- ***Coordinating Entities*: AGCI, local jurisdictions**
- ***Key Participants*: Aspen SkiCo, CBRT, CDWR, CPW, CRWCD, CWCB, local fishing industry, major water diverters, NWCCOG Q/Q, Public Safety Council, RFC, RWAPA, Sunlight Mt. Resort, USEPA, USFS, water conservancy districts, water and sanitation districts**

RWM D1a. Improve collaboration among local jurisdictions and key stakeholders (*e.g.*, Aspen Skiing Company) in the watershed to ensure that adequate physical, chemical, and biological data are collected to monitor local climate change and assess its impacts. (P)

RWM D1b. Improve our decision makers' understanding of the potential impacts of climate change on our water resources. (P)

RWM D1c. Conduct site-specific research and modeling within the Roaring Fork Watershed to improve projections of the impacts of climate change on the watershed. (S)

RWM D1d. Review existing master plans in the watershed to identify changes necessary to account for the impact of climate change on the timing and magnitude of stream flows and water usage. (S)

RWM D1e. Review the existing water-related infrastructure and operational procedures in the Roaring Fork Watershed to identify changes necessary to account for the impact of climate change on the timing and magnitude of stream flows and water usage. (S)

RWM D1f. Research the impact that climate change may have on the water resource-related economy in the Roaring Fork Watershed (*e.g.*, skiing, fishing, rafting, etc.). (S)

RWM D1g. Assess the vulnerability of the Roaring Fork Watershed to climate change. Develop an adaptive management strategy that integrates findings from the vulnerability assessment with watershed planning priorities and decision support. (S)

A 3D hydrologic study, using for example the University of Washington's Variable Infiltration Capacity Macroscale Hydrologic Model of the Roaring Fork combined with climate change models could provide a more complete picture of projected water availability to improve planning efforts.

II. Recommended Actions to Achieve Surface Water (SW) Management Goals and Objectives

***SW Goal*: To protect the availability and sustainability of surface waters.**

> *Any river is really the summation of the whole valley. To think of it as nothing but water is to ignore the greater part.*
>
> — Hal Borland, *This Hill, This Valley*

Healthy rivers are defined by adequate and consistent flows which follow the natural hydrograph. The consequences of inadequate flows are often highly visible, such as unmet calls, a dewatered stream reach, or, in extreme cases, dying fish. Flood flows that exceed streambed capacity can also have serious consequences, such as threatening human safety and causing property damage. However, these high flows also have benefits. They maintain healthy streams and riparian areas and recharge the groundwater that contributes to stream base flow and well production.

Snowpack in Colorado provides approximately 75 percent of streamflow, with most of Colorado's snow falling on its western mountain ranges. Snowmelt-driven systems, including the upper basin tributaries of the Colorado River such as the Roaring Fork River and its tributaries, are particularly prone to disruption in the historical pattern of spring runoff. One of the consequences of the increasing temperatures associated with climate change is change to historic runoff timing and amounts.

Changes in historic patterns of snowmelt and runoff will influence local and regional surface water supply and demand. Although most of Colorado's water supply is on the West Slope, most of the state's population and agricultural production occurs on the East Slope, where low precipitation results in semi-arid climate conditions. Many headwater streams on the west side of the Continental Divide, including the Roaring Fork and Fryingpan Rivers, have been partially diverted to the East Slope to support Front Range agriculture and development, impacting the ability of West Slope streams to sustain aquatic wildlife and provide other benefits.

SW A. Objective: Identify flows needed to meet non-consumptive needs.

The Colorado Water for the 21st Century Act (*see* C.R.S. §§ 37-75-101 through 37-75-106) was passed to facilitate discussions and negotiations among the various river basins within Colorado. The Act created nine basin roundtables, including the CBRT. The basin roundtables are required to complete basin-wide needs assessments, including an assessment of non-consumptive water needs (environmental and recreational) and based on this work identify projects or methods to meet any identified water needs.

Examples of important non-consumptive water uses and values include:

- Sufficient flows for channel and riparian area maintenance,
- Seasonal flushing flows to remove sediment deposition that may smother fish spawning beds and benthic organisms,
- Maintenance or restoration of high quality habitat for fish and aquatic life,
- Groundwater recharge,
- Adequate flows to maintain high water quality,
- Support of popular water-based recreation, including rafting, kayaking, and angling, and
- Adequate flows to support hydropower generation.

Understanding and defining the non-consumptive uses of water in the watershed is a complicated endeavor. It requires evaluation of a broad set of hydrologic parameters influencing biological and

geomorphological processes, including the magnitude, timing, and duration of flows, the rate of change in flows, and the frequency of flow events. However, environmental flow needs must consistently be met for other non-consumptive uses to be accommodated in the Roaring Fork Watershed.

Assessment of environmental flow needs requires good, hard science – not guesswork. However, scientific analysis is often hampered by spatially and temporally limited stream gage and flow data, a lack of adequate ecological and geomorphical data, and a limited understanding of the specific relationships among biological and geomorphological processes and flows. For example, what are the relationships between sediment, flows, fish, and macroinvertebrates? Similarly, flow needs for rafting and kayaking activities are based on judgments from the recreational community about the level of flows necessary to sustain a quality recreational experience. Adequate flows for angling need to correlate with levels needed to maintain a healthy fishery and, in the case of fly fishing, flow levels suitable for angler access to the stream (sometimes called "wadeability"). Sometimes the needs of one group conflict with those of another (*e.g.*, the high waters sought by rafters and the calmer waters sought by anglers).

SW A1. *Summary of Action Required*: Identify environmental flow needs, including an assessment of historical flow alterations and their ecological consequences.

- ***Coordinating Entities*: CBRT, local jurisdictions**
- ***Key Participants*: AGCI, BOR, CDWR, CPW, CRWCD, CSU, CTU, CWCB, FERC, local utilities, NWCCOG Q/Q, RFC, RWAPA, TNC, USFS, USGS, WRI**

SW A1a. At the state and local level, support the funding of research projects designed to address the non-consumptive needs knowledge gap. (L&S)

SW A1b. Work with the CBRT Non-Consumptive Needs Assessment (NCNA) Working Group and the designated NCNA contractors to assess the utility and limitations of the Watershed Flow Evaluation Tool. Evaluate the suitability of other tools/methods developed to provide a regional assessment of ecological risk conditions related to flow and, if warranted, revise the regional assessment using the most suitable approach. (S)

EXAMPLES OF TOOLS/METHODS TO QUANTIFY ENVIRONMENTAL FLOWS:

- Clipperton *et al.* *Instream Flow Needs Determinations for the South Saskatchewan River Basin, Alberta, Canada.* (2003).
- Richter *et al.* *Ecologically Sustainable Water Management (ESWM) Methodology.* (2003).
- Poff *et al.* *The Ecological Limits of Hydrologic Alteration (ELOHA): a New Framework for Developing Regional Environmental Flow Standards.* (2010).

SW A1c. Ensure that the Colorado River Basin Water Availability Study adequately assesses and addresses the Roaring Fork Watershed's non-consumptive needs, including projected needs with climate alteration. (S)

SW A1d. Create and maintain an adequate network of stream gages in the watershed. (P)

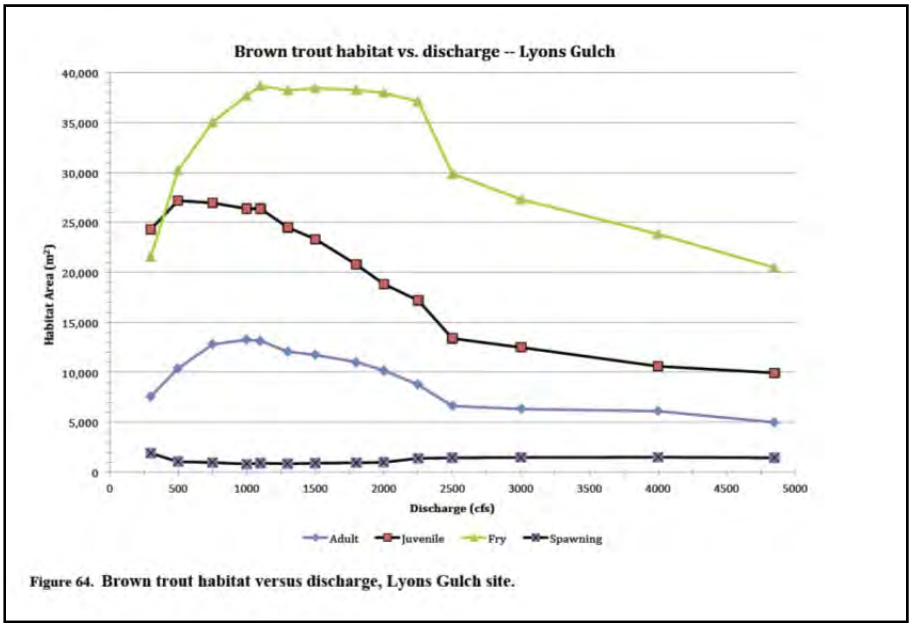


Figure 4. CDWR Roaring Fork above Lost Man Creek near Aspen stream flow gage, July 8, 2005. Ice and snow in the winter and the rocky substrate hinder accurate, year-round stream flow readings.

Highest priorities for stream gages in the watershed are: (1) Castle and Maroon creeks, (2) the Lower Crystal River (year-round), (3) the Upper Roaring Fork, and (4) tributaries in the Upper Fryingpan. Second order and higher streams in the watershed with significant diversions and no active stream gage or no gage located below the major diversion structures include: Brush, Fourmile, Threemile, Cattle, Woody, Sopris, Capitol, Maroon, Owl, Landis and Thompson creeks. Several creeks with by-pass flows associated with the Fry-Ark Project are not gaged. Gages at Cattle, Fourmile, Maroon, Thompson, Castle Lime, Cunningham, Middle Cunningham, Mormon, Carter, Granite, Sawyer, and Lily Pad creeks are no longer operating.

SW A1e. Assess flow alteration in stream reaches where stream gage or modeled data are lacking. (S)

SW A1f. Conduct site-specific studies of environmental and recreational flows needed for stream reaches that are currently significantly flow-altered or threatened by significant flow alteration. Include an analysis of how often these flows are not met. (S)



Two-dimensional (2D) depth averaged models are useful to understand local details of velocity and depth distributions. Miller and Swaim's *Instream Flow Report for the Colorado River from Kremmling, Colorado Downstream to Dotsero, Colorado* (2010) used the Rivers 2D model to quantify non-consumptive needs.

Figure 5. Example graph of brown trout habitat for all life stages versus discharge (Miller and Swaim, 2010).



Figure 6. Rafters on the Roaring Fork River.

SW A1g. Assess the direct and indirect economic consequences associated with non-optimal flows. (S)

SW A1h. Ensure that local land use policies and regulations adequately assess all of the costs and benefits associated with hydropower development and mitigate the impact of hydropower development on other non-consumptive water uses. Ensure that hydropower development is considered and addressed in local Master Plans. (L)

SW A1i. Assess potential local and regional recreational and environmental advantages and disadvantages associated with Recreational In-Channel Diversions (RICDs) in the watershed. As appropriate, obtain RICDs and ensure that they do not impact riparian and aquatic habitat. (S&P)

Recreational in-channel diversions sites are **under consideration** on the Roaring Fork River in Basalt and Carbondale

SW B. Objective: Ensure that Colorado Water Conservation Board instream flow rights are adequate to preserve or improve the natural environment to a reasonable degree and are consistently being met.

The Colorado Water Conservation Board (CWCB) Instream Flow Program is designed to address environmental non-consumptive needs. Generally, these needs are based on biological recommendations provided to the CWCB by various state and federal agencies and follow the premise that the amount of water necessary to preserve an aquatic indicator species (*e.g.*, a trout species) is also adequate to preserve the entire natural environment. The program has several limitations: (i) instream flow rights are not always met because all new appropriations are dated post-1973 and administered within the state's prior appropriation system, (ii) the ability of the Colorado Division of Water Resources to place calls to meet instream flows is hampered where stream gages are not present to provide an accurate real-time measurement of flow conditions, and (iii) instream flow amounts do not address the entire annual hydrograph (including peak flows) and all components of the stream environment, such as riparian flora and fauna. Completion of the Recommended Actions under Objective A will help determine the flows needed to meet non-consumptive needs, where additional CWCB instream flow rights are needed, and where existing rights are inadequate.

SW B1. *Summary of Action Required*: Identify the cause(s) of flow alterations and potential solutions.

- ***Coordinating Entities*: CWCB, local jurisdictions**
- ***Key Participants*: Aspen SkiCo, CDWR, CPW, CRWCD, CSU, CTU, CWT, major water diverters, MSCD, NWCCOG Q/Q, RFC, RWAPA, Sunlight Mt. Resort, TNC, USFS**

SW B1a. Based on assessments of flow alteration and ecological consequences, quantify instream flow needs in streams with and without instream flow rights. Pursue instream flow rights for streams with inadequate or no instream flow rights. (S&P)

SW B1b. Investigate why CWCB instream flows are not being met (*e.g.*, junior water rights, inadequate flow monitoring) and institute appropriate projects to remedy the problems identified (*e.g.*, acquire water rights, enhance stream gage network). (S&P)

TOOLS AVAILABLE TO IMPROVE INSTREAM FLOWS INCLUDE:
- Short-term loan program,
- Longer-term lease or loan arrangements, and
- Tax credits for donating water.

SW B1c. Increase the utilization of tools and funding available to improve instream flows. (P)

SW B1d. Identify stream reaches where irrigation return flows and groundwater recharge provide late summer and fall flows and investigate opportunities to maintain these important sources of supplemental stream flows whenever possible. (S&L)

OPPORTUNITIES TO IMPROVE WATER STORAGE INCLUDE:
- Introduction of beavers,
- Constructed wetlands,
- Healthy forest coverage, and
- Private ponds.

SW B1e. Identify and pursue opportunities for improving natural and artificial water storage to improve low stream flows. (S&P)

SW B1f. Investigate if water conservation translates to environmental benefits under Colorado water law. Pursue opportunities for water conservation, if appropriate. (S& L)

SW B1g. Quantify the role of snow making in flow alteration and, where warranted, pursue opportunities for decreasing the environmental impact of snowmaking. (S&P)

SW C. Objective: Identify stream reaches that are vulnerable to increased flow alteration and pursue opportunities to prevent additional impacts on flows.

Flow-altered stream reaches include the Roaring Fork, Fryingpan, and Crystal Rivers, as well as Hunter, Lincoln, Maroon, Castle, West Willow, Woody, Snowmass, Capitol, Collins, Sopris, Nettle, Thompson, Cattle, Fourmile, and Threemile creeks.

As discussed in the *State of the Roaring Fork Watershed Report 2008*, changes in water policy and management, the creation of new water rights, more calls on rivers and streams to meet the demands of existing water rights, new or enlarged structural storage and diversion projects, additional out-of-basin water demands, and climate change all have the potential to affect the quantity of water in the Roaring Fork Watershed's rivers and streams. Additionally, local land use changes will continue to affect water quantity. Throughout the watershed, the flow regime is being altered by urbanization, road development, and developed recreation activities. The replacement of soil and vegetation with impervious (*i. e.,* paved) surfaces changes stream dynamics and the hydrologic cycle.

SW C1. *Summary of Action Required*: Factor in water quantity needs when making land use decisions.

- ***Coordinating Entities*: Local jurisdictions**

- ***Key Participants*: CDWR, fire protection districts, water conservancy districts, water and sanitation districts**

SW C1a. Ensure that local land use planning requires an adequate technical assessment and legal review of the availability, sustainability, and (as applicable) potability of an adequate water supply for a proposed use prior to the grant of a development approval. (L)

HB 08-1141 requires that an **adequate supply of water** must be demonstrated before a local government can issue a development permit for projects that include new water use in an amount greater than that used by 50 single-family equivalents, or fewer, as determined by the local government.

SW C1b. Quantify the direct and cumulative effects of changes in land use (*e.g.*, increases in impervious surfaces, changes from agricultural to developed land uses) on surface flows (both increases and decreases to flows). Incorporate the results in the review of local land use applications and investigate opportunities for mitigation. (S&L)

Impervious surfaces contribute to flood risk and lower baseflows. **Opportunities for mitigation** include reducing density, use of porous surfaces, and water detention features such as ponds, wetlands, and swales. These opportunities can be encouraged through education and incentives, and required through regulations and fees.

SW C1c. Enhance communication and collaboration between local land use planners and water commissioners (*e.g.*, reduce the number of illegal ponds/diversions by having land use planners notify and seek the input of CDWR water commissioners when ponds are being permitted/approved and to discuss the appropriate conditions of approval to ensure adequate and timely diversion headgate repairs). (P&L)

SW C1d. Quantify expected proximal stream flow changes associated with a planned development's augmentation plan. Investigate and pursue opportunities for mitigating the impact to these streams within the confines of Colorado water law. (S&L)

SW C1e. Evaluate the need for ponds designed for fire mitigation and, where necessary, require that steps be taken to minimize their evaporative losses. (S& L)

SW C2. *Summary of Action Required*: Investigate the potential impacts of the perfection of conditional water rights on stream flows.

- ***Coordinating Entities*: Local jurisdictions, RWAPA**
- ***Key Participants*: CDWR, CDWCD, major water diverters**

Streams with significant direct flow or storage flow conditional water rights in the watershed (not associated with transmountain diversions) include: the Roaring Fork, Fryingpan, and Crystal Rivers, as well as Maroon, Sopris, Snowmass, Brush, Threemile, and Thompson creeks.

SW C2a. Investigate existing conditional water rights and determine if the exercise of these water rights would pose a threat to stream flows. Assess and pursue opportunities for securing or modifying the exercise of such rights within the confines of Colorado water law. (S&P)

SW C3. *Summary of Action Required*: Investigate the potential impacts of climate change.

- ***Coordinating Entity*: AGCI**
- ***Key Participants*: Aspen SkiCo, BLM, CRWCD, CSU, CTU, CWCB, local jurisdictions, RFC, RMI, RWAPA, TNC, USFS**

SW C3a. Complete a comprehensive climate impacts assessment on stream flows for the Roaring Fork Watershed. (S)

SW D. Objective: Improve our community's understanding of the importance of maintaining adequate stream flows for the environment.

The *State of the Roaring Fork Watershed Report 2008* summarizes the primary issues related to depletions in water quantity, including the prospect of insufficient water for consumptive uses (including high quality drinking water), and alteration to the timing, frequency, duration, magnitude, and rate of change of flows, which can harm stream ecosystems, affect water-based recreation activities, and/or decrease the supply of water for hydropower generation. The major factors that lead to reduced water availability and flow alteration in the watershed are: (i) transmountain and in-basin diversions, (ii) downstream water calls, (iii) reservoir operations, (iv) changes in land use, and (v) anticipated reductions in streamflow and timing from climate change. Improved public education and outreach on these matters will allow our community to be better prepared to prevent or mitigate their impacts on stream flows.

SW D1. *Summary of Action Required*: Implement outreach and education programs that address the importance of streams flows, the causes of flow alterations, and encourage citizen/stakeholder involvement.

- ***Coordinating Entity*: local jurisdictions, RFC, RWAPA**
- ***Key Participants*: ACES, CDWR, CBRT, CFWE, CPW, CRWCD, CTU, CWCB, major water diverters, NWCCOG Q/Q, SI, USFWS, water conservancy districts, water and sanitation districts, WRI**

SW D1a. Support and distribute films, videos, PowerPoint presentations, etc. illustrating local water conditions and issues. (P)

SW D1b. Develop projects such as the RFC's River Center, with exhibits to enhance public awareness of the importance of maintaining adequate streams flows in the watershed and the consequences of drought. (P)

SW D1c. Support projects such as the Univ. of Michigan Master's Project, *Fostering Implementation of the Roaring Fork Watershed Plan*. Utilize the Univ. of Michigan Master's Project's recommendations for improving public education and outreach, as appropriate. (P)

SW D1d. Improve education/outreach on the connection between water availability and sustainability and land use planning and design strategies. (P)

SW D1e. Improve education/outreach and opportunities for involvement in mitigating the effects of drought. (P)

SW D1f. Improve education/outreach on the connection between high flows and healthy riparian and instream areas. (P)

SW D1g. Increase awareness of water conservation techniques and the importance of conservation. Identify and implement the most strategic water conservation measures. (S&P)

SW D1h. Improve education on the basis for obtaining and perfecting conditional water rights under Colorado water law. (P)

SAMPLE WATER CONSERVATION MEASURES:

- Lawn and garden watering restrictions,
- Fines and tiered rates for high water use,
- Metering of water usage,
- Distribution/transmission system leak detection,
- Water conservation cooperative agreements/operating agreements,
- Alternative irrigation practices,
- Xeric landscaping,
- Lining of ditches and canals,
- Conjunctive use of surface and groundwater, and
- Use of recycled water.

SW E. Objective: Reduce the negative impacts of drought and floods.

Water conservation and drought are topics of continuing interest, given the arid climate and landscapes of the Roaring Fork Watershed and the Upper Colorado River Basin. In 2004, the CWCB's Office of Water Conservation and Drought Planning produced a statewide *Drought and Water Supply Assessment* based on results of an opinion survey administered to water managers and planners. Major needs identified for future water supply planning and potential drought mitigation projects included:

- Funding to support water development and infrastructure projects (including capital, repair and maintenance).
- Development of new water supplies.
- Improvement of the ability to predict the weather (as it relates to predicting drought).
- Development of new infrastructure (including surface water and groundwater storage, transmission and distribution systems, large-scale multi-basin projects, and water reuse projects).
- Repair and rehabilitation of existing infrastructure (including lining ditches and canals, dredging and repairing existing reservoirs and dams, repairing existing diversion structures, and upgrading water transmission and distribution systems).
- Improvement of water conservation measures and programs, as well as measurement techniques.
- Additional public education and involvement programs.
- Provision of technical assistance in water supply, water conservation, and drought planning.

High flows are desirable to support numerous ecosystem services within river systems. A functioning flood plain attenuates flood flows and contributes to base flows. However, development in flood plains and controlled flows related to operation of dams and diversions, in combination with large storm events, can lead to flooding issues. Climate-driven changes to the hydrological system will likely increase the frequency, magnitude, and financial costs of extreme weather events. Snowmelt-driven basins like the Roaring Fork Watershed are at especially high risk. High flows associated with spring melt of the snowpack, particularly if it is above average, is tied to spring temperature fluctuations. A rapid spring warm-up and sustained high temperatures pose a serious risk of flooding. Other important considerations are dust and rain on snow events that may contribute to flooding by accelerating snowpack melting.

SW E1. *Summary of Action Required*: Plan for drought to reduce its impacts.

- ***Coordinating Entities*: CWCB, local jurisdictions**
- ***Key Participants*: CDWR, CPW, CRWCD, CWT, major water diverters, MSCD, RFC, RWAPA, TNC, USFS, water conservancy districts, and water and sanitation districts**

AREAS PRONE TO FLOODING INCLUDE:
- Pan-Fork Mobile Home Park,
- Roaring Fork Mobile Home Park,
- Redstone,
- Lazy Glen, and
- Lower Roaring Fork.

SW E1a. Utilize the CWCB's 2010 Drought Mitigation and Response Plan and Drought Planning Toolbox. (P)

SW E1b. Work with the CWCB's Office of Water Conservation and Drought Planning to obtain technical assistance and grants to help develop local drought mitigation plans. Evaluate opportunities to use groundwater to augment flows. (P)

The *Big Hole Drought Management Plan* provides an example of a drought management plan. The plan identifies reach-specific flow triggers and associated escalating actions ranging from raising awareness to fishing closure.

SW E1c. Create "shovel-ready" drought-mitigation projects that can be quickly implemented. (P)

SW E1d. Investigate the potential benefits and disadvantages of acquiring small storage water rights that can be delivered for municipal uses in times of need and used to mitigate low stream flows. Pursue a streamlined approval process for landowners, if warranted. (S&L)

SW E1e. Investigate opportunities to temporarily loan water to streams using C.R.S. § 37-83-105. Discuss triggering criteria, such as low snowpack levels on specific spring dates, and draft agreements with critical water rights holders, the CDWR Division Engineer, and CWCB that can be quickly implemented when needed. (S&P)

While **small storage ponds** may be useful for **drought mitigation** they could provide a breeding opportunity for whirling disease and a home for mosquitoes that carry West Nile Virus.

SW E1f. Identify flow and temperature triggers and draft emergency drought fishing regulations. (S&L)

SW E2. *Summary of Action Required*: Develop plans that address the public health and safety issues associated with high flows while recognizing and retaining their environmental benefits.

- **Coordinating Entities: Local jurisdictions**
- **Key Participants: AVLT, BLM, BOR, CDOT, CPW, CTU, CWCB, FERC, MSCD, Public Safety Council, RFAS, RFC, RWAPA, TNC, USFS**

SW E2a. Ensure that county and municipal emergency management plans minimize the potential for harmful flooding in developed floodplains. (S&P)

SW E2b. Where feasible, restore the natural function of floodplains. (S&P)

SW E2c. Ensure that the Federal Emergency Management Agency (FEMA) floodplain maps for the watershed used by local jurisdictions are up to date and available digitally for public access. (P)

SW E2d. Develop and enforce local regulations that minimize development in the flood plain. (L)

SW E2e. Identify and pursue opportunities to maintain decision makers' and the public's interest in flooding issues after flood events have passed, like creating "shovel-ready" flood mitigation projects that can be quickly implemented. (S&P)



Figure 7. Eroded riverbank and road damage caused by high water near Basalt, 1995.

III. Recommended Actions to Achieve Groundwater (GW) Management Goals and Objectives

***GW Goal*: To protect the availability and sustainability of our groundwater**

> *We forget that the water cycle and the life cycle are one.*
> — Jacques Cousteau, Oceanographer

Understanding the connection between surface water and groundwater is vitally important as our water resources continue to be developed. Withdrawing water from streams may affect groundwater and pumping water from groundwater may affect streams. The dynamic interaction between groundwater and surface water influences water supply, water quality, and aquatic ecosystems.

The *State of the Roaring Fork Watershed Report 2008* identified the lack of comprehensive groundwater information as an issue. Little specific reference was made to groundwater in the report because of the lack of information available about groundwater tables, aquifers and connections between groundwater and surface water in the Roaring Fork Watershed. Lack of groundwater information was called out as a data gap for each of the nine sub-watersheds.

GW A. Objective: Obtain, compile and utilize information on groundwater availability and sustainability in local land use and development decisions.

Generally, the process of modeling a groundwater system requires identifying and quantifying inputs and outputs from multiple variables, including geology, soils and geomorphology, climatic factors (*e.g.*, precipitation and snowmelt), stream functions (*e.g.*, water gains and losses), vegetation (*e.g.*, loss to evapotranspiration), topography (*e.g.*, slope steepness and aspect), and human activity (*e.g.*, wells and irrigation). Any modeling effort in the Roaring Fork Watershed can be a frustrating exercise. The Valley continues to experience periods of drought, water rights transfers, and land uses change, all of which affect groundwater resources.

Where groundwater information is available, such as the "high-level" GIS-based groundwater resources studies completed for Pitkin County by Hydrologic Systems Analysis, LLC, we know that the availability of some local groundwater supplies is inconsistent and that sustainable groundwater supplies are unavailable in many locations. In some areas of the watershed leakage from unlined ditches and ponds is likely recharging local groundwater systems and influencing groundwater flow direction. Similarly, irrigation return flows may be recharging the groundwater supply in certain locales. Taking irrigated land out of production could have an impact on local groundwater supplies. Even onsite wastewater treatment systems are recharging the groundwater systems in some portions of the watershed.

Groundwater availability and sustainability is not just an issue for rural areas in the Roaring Fork Watershed. Groundwater well pumping can deplete the amount of water available to replenish surface waterways used for cities' and towns' public water supplies. Much of the surface water in local rivers and streams was once groundwater, and what affects surface water will inevitably affect groundwater as well, and vice versa.

There is a need to better understand the groundwater systems on which so many people rely for their water supply in the Roaring Fork Watershed. The land use and development decisions made must use this information to protect the availability and sustainability of these supplies for the future.

GW A1. *Summary of Action Required*: Conduct hydrogeological assessments of all sub-watersheds lacking detailed hydrogeologic information.

- ***Coordinating Entities*: Local jurisdictions**
- ***Key Participants*: CDWR, CWCB, major water diverters, USGS, water conservancy districts, water and sanitation districts**

HIGH-LEVEL HYDROGEOLOGICAL ASSESSMENTS WHICH HAVE BEEN COMPLETED:

- The Upper & Middle Roaring Fork Valley,
- Central Roaring Fork Tributaries,
- The Capitol & Snowmass Creek watersheds,
- The East Sopris Creek watershed,
- The West Sopris Creek watershed,
- The Sopris Creek watershed below the confluence of East & West Sopris Creeks, and
- The Crystal River.

GW A1a. Identify all sub-watersheds lacking detailed hydrogeologic information and prioritize the sub-watersheds for study on the basis of threats posed to the groundwater supply. Conduct hydrogeological assessments of all sub-watersheds lacking detailed hydrogeologic information, working collaboratively across sub-watershed jurisdictional boundaries. (S&P)

The Colorado Division of Water Resources' ***WellView Web* search tool** provides access to detailed information about well applications and issued permits, including permitting details and location information.

GW A1b. Ensure that local governments obtain, utilize, and regularly update information from: (i) state well databases, and (ii) onsite wastewater treatment system permitting in their hydrogeological assessments. (P)

GW A1c. Delineate areas of interaction between groundwater and surface water, including quantification and assessment of interaction type. For aquifers that are currently used or have the potential to be used: (i) quantify the water budget, (ii) rate the importance of the aquifers, and (iii) prioritize the need for additional detailed studies that include assessments of water budgets, flows, and water table interactions. (S)

GW A2. *Summary of Action Required*: Ensure that local land use planning requires a sufficient technical and legal demonstration of the availability and sustainability of an adequate groundwater supply for any new land use or development.

- ***Coordinating Entities*: Local jurisdictions, CDWR**
- ***Key Participants*: Water conservancy districts, water and sanitation districts**

GW A2a. Adopt local regulations, policies, and procedures to ensure that there is a sufficient technical and legal demonstration of the availability and sustainability of an adequate water supply for any new land use or development reliant upon groundwater. (L)

GW B. Objective: Sustain and improve groundwater recharge in the watershed.

The adverse impacts of land development on groundwater recharge have long been recognized. Development activities that either cover permeable soils with impervious surfaces or reduce the soil's permeability as a result of disturbance and compaction will reduce the rate of groundwater recharge that occurred under pre-developed site conditions. Loss of groundwater recharge areas can adversely impact the groundwater supply as well as the health of streams and riparian areas. Groundwater

recharge is an important part of the hydrologic cycle and needs to be an element of a comprehensive Roaring Fork Watershed Plan.

GW B1. *Summary of Action Required*: Provide and improve opportunities for groundwater recharge through such methods as maintaining and restoring wetlands and, where possible, restoring overbanking flows.

- ***Coordinating Entities*: Local jurisdictions**
- ***Key Participants*: AVLT, BLM, CDWR, CFWE, CPW, CRWCD, CTU, RFAS, RFC, SI, USFS, water conservancy districts, and water and sanitation districts**

MAJOR WETLAND AREAS REQUIRING RESTORATION INCLUDE:

- The Northstar area on the Roaring Fork River east of Aspen,
- The Roaring Fork River near Emma,
- The Roaring Fork River between Carbondale and Basalt,
- The Roaring Fork River near Cattle Creek,
- The Placita area on the Crystal River south of Redstone,
- The Coal Creek confluence with the Crystal River, and
- The Thompson Creek confluence with the Crystal River.

GW B1a. Restore major wetlands areas in the watershed. (P)

GW B1b. Identify and protect major wetlands areas in the watershed (*e.g.*, the lower Woody Creek area). (P&L)

GW B1c. Institute programs to promote water reuse, particularly in areas that are using groundwater beyond its ability to recharge. (P)

GW B1d. Study and pursue opportunities, as appropriate to enhance natural recharge by slowing down sheet runoff and runoff in creeks and recharging potentially good aquifers such as terraces and fans. (S&P)

GW B1e. Quantify the effect of changes in land use and development (*e.g.*, increases in impervious surfaces, changes from agricultural to residential land uses) on groundwater recharge in both rural and urbanized areas of the watershed and disseminate the information to decision makers. (S)

GW B1f. Adopt local regulations, policies and procedures to ensure that the impacts on groundwater recharge are understood and taken into consideration by decision makers in the review and approval of land use applications (*e.g.*, encouraging dense, vertical development within urban growth boundaries to minimize sprawl). (L)

Utilize past modeling studies of groundwater and surface water interaction at Northstar (Kolm *et al.* 2000) and Warren Lakes (Kolm and Glover, 1999).

GW B1g. Develop and implement a prioritized well-monitoring program for local jurisdictions to allow them to determine trends in groundwater levels, in coordination with ongoing studies (*e.g.*, the Basalt Water Conservancy District study on Missouri Heights, monitoring being conducted in the Woody Creek area). (S&P)

GW B1h. Create and maintain an inventory of groundwater monitoring data and results. (P)

GW B1i. Conduct detailed monitoring of groundwater levels and fluctuations in important wetland and groundwater discharge zones, including collection of information on aquifer thickness and development of parameters and information for development of detailed water budgets and modeling. (S)

GW C. Objective: Improve our community's understanding and enforcement of federal, state, and local regulations designed to protect groundwater availability and sustainability.

The Colorado Division of Water Resources has published a ***Guide to Well Permits, Water Rights, and Water Administration***.

Groundwater wells provide the water supply for hundreds of parcels of land in the watershed. Many of these wells are for single residences and are "exempt" from the state's water rights priority system. These wells are generally limited to 15 gallons per minute and require non-evaporative onsite wastewater treatment systems, so that the bulk of the wastewater is returned to the land on which the water is used. Wells for other uses, such as large-scale irrigation and multi-home subdivisions, are "non-exempt" and administered within the priority system. Non-exempt wells require augmentation plans to prevent injury to senior water rights.

In the Roaring Fork Watershed there are hundreds of exempt and non-exempt wells and not all of these wells are compliant with the terms of their permits. Wells permitted for use by a single household may be drawing water to service multiple residences. Wells that have only been permitted for indoor, household use may be used to irrigate large outdoor landscaped areas. These non-permitted uses of water may be injuring the availability and sustainability of the groundwater supply for legally permitted uses, but may continue unabated for years. Many landowners are unaware of the terms and conditions of their well permit. With only two CDWR water commissioners assigned to the Roaring Fork Watershed, it is imperative that local jurisdictions start to play a more active role in monitoring compliance with well permit conditions.

GW C1. *Summary of Action Required*: Improve enforcement of exempt and non-exempt well permit conditions.

- ***Coordinating Entities*: Local jurisdictions, CDWR**
- ***Key Participants*: CRWCD, NWCCOG Q/Q, water and sanitation districts**

GW C1a. Adopt local regulations requiring confirmation of compliance with well permit conditions in connection with land use approvals and building permits. (L)

GW C1b. Adopt local policies and procedures for notifying CDWR of any noncompliance with well permit conditions observed in connection with land use approvals and building permits. (L)

GW C1c. Assess the need for additional resources in the administration of water rights. (S)

GW C1d. Create maps of the watershed showing the location of exempt and non-exempt wells. (P)

GW D. Objective: Improve our community's understanding of groundwater.

Groundwater plays an essential role in the hydrologic cycle. Groundwater provides much of the water that flows in streams, especially during periods of low precipitation and when cold temperatures prevent snow from melting. Along rivers and streams, groundwater flows into surface water in some areas, while in other areas, surface water flows into groundwater. Unfortunately, the watershed's residents and decision makers are largely unaware of the significant relationship between groundwater and surface water availability. Many also share a misconception that large aquifers underlie the Roaring Fork Valley and that our groundwater resources will always be available to support existing and future development. As a result, we have been slow to undertake and fund programs and initiatives to better understand and protect our groundwater resources.

Overuse of groundwater to meet the demands of development in the Roaring Fork Watershed can have far-reaching environmental and economic consequences that cross jurisdictional boundaries. It will take a coordinated, collaborative education/outreach campaign to raise awareness and heighten involvement in groundwater issues in the Roaring Fork Watershed. Multi-jurisdictional initiatives are necessary to reach all of our watershed's citizens and ensure groundwater availability and sustainability for the future.

GW D1. *Summary of Action Required*: Improve our community's understanding of the connection between land use and groundwater recharge.

- ***Coordinating Entities*: Local jurisdictions**
- ***Key Participants*: CDWR, CFWE, CRWCD, CTU, NWCCOG Q/Q, RFC, USGS**

GW D1a. Create and disseminate educational materials on the impact of land use on groundwater resources, including: (i) a graphic representation of groundwater recharge pathways and the influence of land use, (ii) why people should care about groundwater issues, and (iii) what people can do to protect groundwater resources. (P)

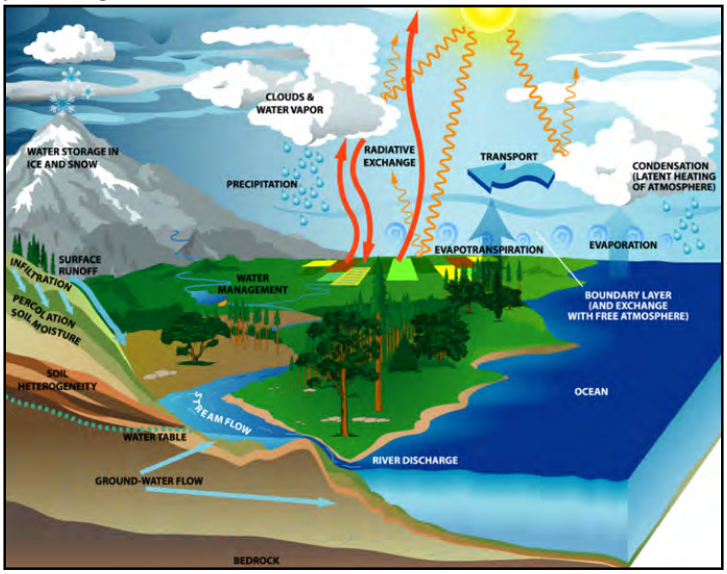


Figure 8. The hydrologic cycle showing groundwater recharge.

GW D1b. Create maps of groundwater availability in the watershed. (P)

GW D1c. Create and disseminate educational materials on the purpose of augmentation plans associated with new non-exempt wells and the potential for detrimental effects on local streams. (P)

Pitkin County has defined and mapped groundwater availability, sustainability, and vulnerability for non-federal lands. Van der Heijde and Kolm. (2011) *Development of County-wide Hydrogeological and Hydrological GIS Maps for Pitkin County, Colorado*.

GW D2. *Summary of Action Required*: Improve our community's understanding of hydrogeology and its relationship to the groundwater supply.

- ***Coordinating Entities*: Local jurisdictions**
- ***Key Participants*: CDWR, CFWE, CRWCD, RFC, water conservancy districts, water and sanitation districts**

GW D2a. Create summaries of all sub-watershed hydrogeological assessments targeted at the layperson, using a consistent format for all sub-watersheds. Make all summaries available online and publicize their availability. (P)

COMPLETED HYDROGEOLOGICAL ASSESSMENT SUMMARIES:

- Upper and Middle Roaring Fork Valley,
- Capitol and Snowmass Creek Areas, and
- Crystal River and West Sopris Creek Areas.

GW D2b. Create and periodically broadcast local cable television programs discussing the hydrogeological assessments and explaining their importance for understanding groundwater supplies in the Roaring Fork Watershed. (P)

GW D2c. Implement pricing mechanisms that better reflect the true value of a local groundwater supply and that encourage a decrease in usage (*e.g.*, increased fees associated with obtaining and maintaining well permits in "water-short" areas). (P&L)

GW D2d. Develop projects such as the RFC's River Center, with exhibits to enhance public understanding of hydrogeology in the watershed and its relationship to the groundwater supply. (P)

IV. Recommended Actions to Achieve Water Quality (WQ) Goals and Objectives

***WQ Goal*: To protect our groundwater, rivers and streams from degradation, and to restore water quality when and where necessary.**

> *Water is the most critical resource issue of our lifetime and our children's lifetime. The health of our waters is the principal measure of how we live on the land.*
> — Luna Leopold, Hydrologist

Water quality is one of the most important elements in maintaining adequate water resources. If quality is compromised, water quantity, riparian habitat, recreation, wildlife, health and safety, and all other water-dependent ecosystems and activities are threatened. Maintenance of water quality has a spillover effect on other elements of the environment because it requires that streamside habitats, man-made environments and disruptions from development be managed responsibly.

Water quality in the Roaring Fork Watershed is generally good, but is subject to constant threat from both natural and man-made events - ranging from mud slides to mine drainage, to polluted runoff, to dysfunctional wastewater treatment systems. It is vital that activities and events that might impact water quality be managed in a way that preserves or enhances natural water quality and does not export water quality problems downstream. Consistent regulations, regular communication between jurisdictions, coordinated responses to events, and ongoing monitoring of water quality conditions will be vital to reaching water quality goals and objectives.

WQ A. Objective: Obtain water quality data to adequately assess status and trends.

Water quality data is currently collected in the watershed by the U. S. Geological Survey (USGS), the U. S. Forest Service (USFS), Roaring Fork Conservancy (RFC) (in collaboration with River Watch), municipal utilities, high school students, and many other entities and individuals. While a considerable amount of time and resources are being devoted to water quality monitoring in the Roaring Fork Watershed, collection techniques vary, and a "clearinghouse" that is consistently utilized for reporting and analyzing datasets has not been fully realized, although the USGS has developed the Roaring Fork Water Quality Data Repository.

The *State of the Roaring Fork Watershed Report 2008* compiled and summarized readily available water quality data. Unfortunately, surface water quality data was limited or entirely absent in certain areas. Water quality data for groundwater was consistently identified as a data gap. The reliability of some of the data was questionable, and the general lack of adequate time-series data prohibited the detection of trends.

Common indicators for gauging water quality include nitrogen, phosphorus, sediment, turbidity and dissolved/suspended solids, conductivity, dissolved oxygen, temperature, and pH. However, other parameters might need to be regularly measured in all or portions of the watershed to secure adequate baseline data and data necessary to assess current status and trends. For example:

- Endocrine disrupting compounds (EDCs) (*e. g.*, birth control pills, steroids, and pesticides) and other emerging contaminants deserve attention.
- In areas with near-term potential for oil and gas development (*e. g.*, the Thompson, Fourmile, and Coal Creek drainages), comprehensive baseline water quality testing is needed.

- The water quality impacts associated with magnesium chloride, a salt used for de-icing and dust suppression on roadways, and for weed prevention and control, should be assessed. Salts are highly soluble and easily wash off pavement into surface waters and leach into soil and groundwater.
- Regular monitoring going into and out of storm drain catchments, such as the City of Aspen's Jenny Adair Park artificial wetlands system, is needed to help determine their efficacy and identify problem areas for mitigation. Monitoring should include suspended solids, hydrocarbons, pesticides, fertilizers, and heavy metals – for example copper from brake-lining dust. A related issue is the fate of extracted sediments and vegetation from catchments like Jenny Adair -- where does it go and how secure is the extracted material deposits from possible stream or groundwater contamination?
- The presence of fecal coliforms (*e. g.*, *E. coli*), bacteria found in the digestive tract of warm-blooded animals, indicates that pollution from sewage may have occurred and that other harmful microorganisms may be present. *E. coli* testing should be routinely conducted in the watershed, given the proliferation of onsite wastewater treatment systems (OWTSs) (a/k/a septic systems).
- Benthic macroinvertebrate species (*i.e.,* aquatic insects, mollusks, and crustaceans) have a broad range of trophic levels and pollution tolerances, providing good information on both short-term and cumulative effects of environmental variations. A consistent, coordinated collection and interpretation effort for macroinvertebrates should be initiated.
- Groundwater quality issues caused by natural sources, such as radioactive water in granites and tertiary sandstones, hard water in Leadville limestone, and sulfides in tertiary intrusions and altered sedimentary rock, need to be understood.

It is critical that water quality monitoring programs include consistent and long-term flow data, since low flow is a major physical constraint affecting water quality in many areas of the watershed.

Currently only a snapshot of water quality exists in the watershed. Integrated and coordinated water quality monitoring needs to be established to generate complete datasets that can be used as a basis for watershed decisions. Communication and collaboration/coordination among regulatory agencies and others currently engaged in water quality monitoring must be improved to enhance data collection and sharing, data analysis and reporting, as well as funding opportunities.

***WQ A1. Summary of Action Required*: Develop and implement integrated and coordinated water quality monitoring programs for groundwater and surface waters.**

- ***Coordinating Entities*: local jurisdictions, RFC, USGS**
- ***Key Participants*: CPW, CDPHE, CRWCD, RWAPA, USFS, water and sanitation districts**

WQ A1a. Convene a Water Quality Working Group to identify monitoring objectives, parameters, and protocols. Charge the Working Group with the following tasks:

- Gather and collate baseline data to assess water quality status and trends;
- Provide recommendations for new, consolidated, or modified water quality data collection efforts, taking into account the need to coordinate with existing data collection efforts and databases;
- Identify and prioritize locations to be studied to fill data gaps; and
- Identify funding sources and recommend strategies for securing funding for water quality monitoring. (S&P)

WQ A1b. Develop and implement a consistent process for analyzing and reporting on water quality monitoring results; build on the RFC's 5-year Water Quality Reports. (S&P)

WQ A1c. Undertake targeted water quality monitoring studies to investigate water quality issues identified through routine water quality monitoring, and to capture the impacts or benefits of developments, projects, or other activities. (P)

WQ A1d. Promote/support a sampling program for groundwater aimed at testing the integrity and water quality impacts of individual onsite wastewater treatment systems. (P)

WQ A1e. Promote/support a sampling program for groundwater and surface waters aimed at testing the water quality impacts of snow dump facilities. (P)

WQ B. Objective: Meet state water quality standards in all of our rivers and streams.

Surface water quality classifications and standards applicable to the watershed are available on the CDPHE Water Quality Control Commission's website.

Meeting state water quality standards throughout the watershed is a long-term objective. The first step should be identification of naturally-occurring versus human-caused exceedances in water quality standards. Second, the contamination source(s) should be identified. Finally, mitigation measures to address the source(s) of contamination should be developed and implemented, where possible.

The water quality overview provided in the *State of the Roaring Fork Watershed Report 2008* identified a number of problematic stream reaches and attempted to highlight the most probable causes for observed exceedances. For example, elevated levels of selenium can cause reproductive failure and deformities in fish and aquatic birds. Selenium concentrations were observed to exceed the chronic water quality standard in numerous locations. However, the likely source of this contaminant is the Mancos shale which is prevalent throughout the watershed. Total recoverable iron exceedances, such as those observed in Coal Creek, are more likely to be attributable to mining activities. In such areas, better land reclamation and incorporating the natural filtration function of wetlands may improve water quality.

Salinity (a measure of the total amount of dissolved salts in water) has been a concern throughout Western Colorado for years. High salinity levels are often observed at the same locations as elevated levels of selenium, due to leaching from shale-derived soils. High salinity can significantly reduce crop production and damage water-exposed equipment. Glenwood Springs is currently investigating geothermal opportunities. This might provide a good opportunity for a demonstration project to address naturally-occurring salinity in the watershed (*e. g.*, desalination as heat is extracted). Regional funding is needed to further explore this opportunity.

Review and revision of water quality standards is an ongoing process. State and federal law require this review at least once every three years (the "triennial review process"). Our watershed needs to be fully engaged in this process.

WQ B1. *Summary of Action Required*: Take action to meet state water quality standards in all streams and rivers within the Roaring Fork Watershed.

- ***Coordinating Entities*: Local jurisdictions**
- ***Key Participants*: BLM, CDOT, CDPHE, CDRM&S, CWCB, major water diverters, MSCD, RFC, USFS, water and sanitation districts**

WQ B1a. Investigate and pursue opportunities for reducing water quality impacts from natural salinity (*e.g.*, selenium loading). (S&P)

WQ B1b. Identify human-based sediment sources; develop and implement strategies for reducing sediment from those sources. (S&P)

WQ B1c. Incorporate water quality goals into local land use plans and regulations. Treat the maintenance and improvement of water quality as a priority in Master Plans and development approvals. (L)

PROGRAMS/PRACTICES TO REDUCE SELENIUM LOADING INCLUDE:

- Lining irrigation ditches in areas where selenium rich soils (*e.g.*, Mancos shale) are prevalent;
- Discouraging the use of unlined ponds and/or water features in pervious selenium rich soils; and
- Encouraging native landscaping, limiting irrigated landscape areas, and requiring efficient irrigation systems on selenium rich lands.

WQ B2. *Summary of Action Required*: Work to assure that water quality standards are adequate to protect local waterways.

- ***Coordinating Entity*: CDPHE, NWCCOG Q/Q, USEPA**
- ***Key Participants*: CRWCD, CTU, CWQF, local jurisdictions, major water diverters, USFS, water conservancy districts, water and sanitation districts**

WQ B2a. Assess the adequacy of current water quality standards and recommend modifications. Specifically consider (i) the need for water quality standards for contaminants that are not currently monitored or controlled (*e.g.*, emerging contaminants), and (ii) the adequacy of proposed water quality standards to limit nutrients (total nitrogen and total phosphorus) in water bodies. (S)

WQ B2b. Consider the need/process for developing standards for private drinking water supplies. (S)

WQ B2c. Evaluate the implications of securing "outstanding waters" designations for local waterways. (S)

An **"outstanding waters" designation** may be applied by the state CDPHE's WQCD, to certain high quality surface waters that constitute outstanding natural resources. No degradation of such waters by regulated activities is permitted.

WQ C. Objective: Minimize nonpoint source pollution of surface waters and groundwater.

Nonpoint source pollution is the largest source of water quality problems in Colorado and the rest of the nation. The identification of nonpoint source pollutants, their sources and impacts, as well as implementation of best management practices (BMPs) to address identified sources of nonpoint source pollution should be a significant part of our watershed protection planning effort.

Sources of nonpoint source pollution in the watershed encompass both natural and anthropogenic sources. Examples include:

- Nutrient loading from fertilizers, failing or improperly maintained onsite wastewater treatment systems, sediment and eroded soils, and pet wastes;
- Soil erosion and sedimentation of surface waters due to runoff from construction sites, roadways, buildings, and other hard surfaces;
- Elevated levels of pathogens, like *E. coli,* from pet, livestock, wildlife, and human waste washed into surface waters from fields and parks, from holding tank waste (from a boat, RV, or mobile home) dumped into a storm drain or roadside swale, and from failing or improperly maintained onsite wastewater treatment systems;
- Debris and litter that has been dropped, washed, or dumped into gutters, roadside swales, and surface waters;
- Organic compounds (*e. g.* , PCBs) and heavy metals (*e. g.* , lead, mercury) introduced into surface waters or groundwater due to accidental spills, illicit discharges, improper disposal of gasoline, used motor oil, pesticides and herbicides, leaching from mine tailings, or washed into surface waters in agricultural, lawn, golf course, and road runoff;
- Pharmaceuticals and personal care products (PPCPs) and endocrine disrupting compounds (EDCs) entering the water from onsite wastewater treatment systems and runoff from confined animal feeding operations and other areas with animal waste; and
- High levels of salts from road de-icing operations or from water softener backwash discharge.

In the Roaring Fork Watershed, stormwater runoff and improperly functioning, privately-owned onsite wastewater treatment systems can have a profound and ongoing impact on water quality.

Onsite wastewater treatment systems (OWTSs) can fail for many reasons, including inappropriate design for the soil conditions or water table, faulty construction or installation, extended use beyond service life expectancy, and lack of proper maintenance or use. By carrying nutrients (phosphorus and nitrogen), bacteria, pharmaceutical agents, and other pollutants to surface waters and groundwater, with little or no treatment, onsite wastewater treatment systems can create public health risks (*e. g.* , bacterial contamination of drinking water supplies) and impair the aquatic environment (*e. g.* , reduction of dissolved oxygen from plant growth). The glacial and alluvial geomorphology which exists in much of our watershed increases the risk of contamination in areas with high concentrations of these systems due to the high permeability of the underlying geologic strata.

In undisturbed areas, stormwater is able to infiltrate through the soil, allowing most pollutants to be removed by filtration. When land is disturbed and the natural filtration functions are not replaced (with infiltration, detention, or restoration measures), nearby water resources can be harmed by increased flows and pollutant loading. Increased stormwater flows are problematic for a number of reasons. Soil, litter and other pollutants (*e. g.*, motor oil, de-icing chemicals and pet waste) are picked up by stormwater as it flows over impervious surfaces, such as roads and buildings, into surface waters. The impact from agricultural lands can be either positive or negative depending on the management practices used. Agricultural practices that minimize the amount of pollutants and promote infiltration can help filter non-point source pollutants from other sources, such as roads. High flows from stormwater runoff can also have enough energy to scour soils and destabilize stream banks, carrying sediments downstream and changing the natural contour of the stream. In addition to the deleterious effects of chemical pollutants, excessive deposits of fine sediment fill in spawning beds and impair macroinvertebrate communities, an important food source for fish.



Figure 9. Urban runoff is concentrated in storm drains.

The Roaring Fork Watershed is comprised of diverse communities and includes both rural areas and urban centers. A variety of structural and non-structural management practices need to be evaluated throughout the watershed, considering factors such as cost, drainage area served, available land, pollutant loading and removal efficiency, as well as a variety of site specific factors such as soil types, slopes, and depth to groundwater. Opportunities to improve the natural functions of wetland and riparian areas should be sought, and areas which are still fairly intact should be prioritized for preservation, given their critical importance for filtering pollutants and stabilizing stream banks.

WQ C1. *Summary of Action Required*: Institute and enforce best management practices necessary to minimize nonpoint source pollution.

- ***Coordinating Entities*: local jurisdictions, NWCCOG Q/Q**
- ***Key Participants*: BLM, CDOT, CDPHE, CDRM&S, COGCC, CWQF, DOLA, Industry Associations, IPF, major water diverters, MSCD, NNI, Public Safety Council, RFOV, SI, USACE, USEPA, USFS, water and sanitation districts, WRFC, WW**

WQ C1a. Provide incentives for the implementation of BMPs (*e.g.*, higher scoring on land use approvals) in connection with the control of nonpoint source pollution from development sites and activities. (L)

THE 3 GENERAL CATEGORIES OF BEST MANAGEMENT PRACTICES (BMPS):

- ***Structural BMPs*** – site-specific engineered and constructed systems that improve the quality and/or control the quantity of runoff (*e.g.*, detention ponds, constructed wetlands). *Example*: City of Aspen's Jenny Adair project.
- ***Vegetative BMPs*** – preservation of natural features and processes, such as existing vegetative buffers along water bodies and established ground cover, which reduce soil erosion and naturally filter pollutants carried in runoff. *Example*: wetlands at the Aspen Glen golf course, the use of swales instead of gutters.
- ***Managerial BMPs (Non-Structural)*** - institutional, educational, or regulatory nonpoint source pollution prevention practices designed to reduce stormwater runoff, or reduce the level of pollutants contained in the runoff. *Example*: proper application of limited amounts of fertilizers.

WQ C1b. Develop a training program to help communities assess the adequacy of local regulations and land use policies regarding water quality, and the impacts of development on water quality. (P)
hh

WQ C1c. Assess the impacts of agricultural and commercial (*i. e.*, golf courses) irrigation on water quality. Mandate/recommend mitigation strategies through local regulation, as warranted. (S&L)

WQ C1d. Ensure that local regulations addressing stormwater impact mitigation and BMPs for stormwater management are effective, stringent, and enforced. (L)

WQ C1e. Identify and prioritize stormwater mitigation improvement projects in each jurisdiction (including programs specifically designed to reduce the sediment impacts from hard surfaces, such as roadways) and plan for implementing such projects. (S&P)

Information on CDPHE's **Water Quality Control Division's Stormwater Program** (including permit requirements) is available on the agency's website.

WQ C1f. Support state funding to inspect sites and enforce relevant regulations where stormwater management plans are required under WQCD Stormwater Construction General Permits. (L)

WQ C1g. Assess current regulation of onsite wastewater treatment systems. Impose more stringent regulations, as warranted. Coordinate with the State of Colorado's plans to revise its regulatory framework. (S&L)

WQ C1h. Require training and licensing of onsite wastewater treatment system installers, cleaners/pumpers, and inspectors. (L)

Performance-based OWTS regulations would require that OWTSs meet specific performance standards, but would not prescribe the methods or site conditions for meeting those standards. The goal of a performance-based approach is to promote a desired level of wastewater treatment in a manner that protects both public health and water quality.

WQ C1i. Support development of state and local financing mechanisms to provide incentives/assistance to individuals and subdivisions to upgrade or consolidate onsite wastewater treatment systems. (L)

Inspection of an OWTS may reveal that pumping is unnecessary – eliminating the need for expensive sludge disposal.

WQ C1j. Maintain and publicize information on financial assistance available for upgrades to onsite wastewater treatment systems. (P)

WQ C1k. Investigate the feasibility of creating regional wastewater treatment facilities that would consolidate or incorporate existing scattered onsite wastewater treatment systems and package plants. Pursue opportunities, as appropriate. (S&P)

WQ C1l. Improve opportunities for the use of constructed wetlands as an element of onsite wastewater or stormwater treatment, including the development of performance-based state regulations addressing constructed wetlands for onsite wastewater treatment and mirroring those regulations at the local level. (L)

WQ C1m. Assess surface water and groundwater quality impacts associated with snow dump sites. Ensure that local regulations addressing the location and impacts of snow dumping and runoff from snow dumps are effective, stringent, and enforced. (S&L)

WQ C1n. Assess the impacts of magnesium chloride on water quality. Mandate/recommend alternatives/mitigation, as necessary, through local regulation. (S&L)

WQ C1o. Support the enforcement of federal and state regulations addressing oil and gas development. (L)

WQ C1p. Support disclosure of chemicals used in drilling and fracking and mandatory frack fluid tagging. Encourage owners and operators to use environmentally friendly alternatives. Support scientific studies of fracking impacts on the environment and public health. (S&L)

MAJOR MINING SITES REQUIRING SUSTAINED RECLAMATION INCLUDE:

- Coal Creek,
- Ruby Mine,
- Thompson Creek, and
- Smuggler Mountain.

WQ C1q. Ensure that local land use policies and regulations limiting and mitigating the impacts of mining and oil and gas development on water quality are stringent and enforced. (L)

WQ C1r. Address and regulate runoff from hazardous sites, including mines, landfills, junkyards, and similar locations. Address and regulate the disposal/use of materials from sites potentially contaminated by hazardous materials (*e. g.,* use of soil from abandoned mine sites as fill dirt in other locations). (L)

WQ C1s. Work with the State of Colorado to identify reclamation sites and work with responsible parties to assure that reclamation of mining sites is adequate and sustainable to mitigate impacts on water quality. Perform additional reclamation work as necessary. (P)

WQ C1t. Work with local emergency and public safety agencies to assure that they are adequately trained and equipped to respond to releases of hazardous materials and spills. (P)

KNOWN USFS DISPERSED RECREATION IMPACTED AREAS:

- Cunningham Creek,
- Lime Creek/Lime Park, and
- North Thompson Creek.

WQ C1u. Support enforcement of streamside camping restrictions and development/enforcement of other recreational use restrictions by the USFS necessary to protect waterways. Work with the USFS to remove/reclaim campsites near rivers and streams. (L&P)

USFS CAMPGROUNDS NEAR WATER BODIES:

- Chapman,
- Ruedi Reservoir Complex,
- Elk Wallow,
- Bogan Flats,
- Avalanche,
- Difficult,
- Lincoln,
- Silver Bar,
- Silver Bell, and
- Silver Queen.

WQ C1v. Inventory and protect areas around natural springs. (P)

WQ C1w. Support new and additional funding mechanisms for water technology research and development. (L)

WQ C2. *Summary of Action Required*: Institute and enforce best management practices necessary to protect our drinking water sources from nonpoint sources of pollutants.

- ***Coordinating Entities*: CDPHE, CRWA, local jurisdictions**
- ***Key Participants*: BLM, CDWR, CPW, MSCD, RFC, USFS, USGS, water and sanitation districts**

WQ C2a. Support the completion of the State Source Water Assessments for the watershed. (P)

WQ C2b. Develop Source Water Protection Plans for all of the major water supply systems in the watershed. (P)

WQ C2c. Implement a private wellhead protection program. (P)

CDPHE's Water Quality Control Division and the Colorado Rural Water Association have developed a **source water protection planning DVD/CD toolkit.** The toolkit is free and available from CDPHE.

WQ D. Objective: Improve our local ability to address point source water quality issues.

Colorado Discharge Permit System (CDPS) permits, issued as part of the U.S. EPA's National Pollution Discharge Elimination System (NPDES) program, regulate point source discharges of wastewater in the watershed.

WQ D1. *Summary of Action Required:* Institute actions necessary to improve our community's ability to address point source water quality issues.

- ***Coordinating Entities*: Water and sanitation districts**
- ***Key Participants*: CDPHE, Industry Associations, local jurisdictions, NNI, USEPA**

WQ D1a. Upgrade technology and treatment methods at local wastewater treatment facilities as funding and infrastructure allow. (P)

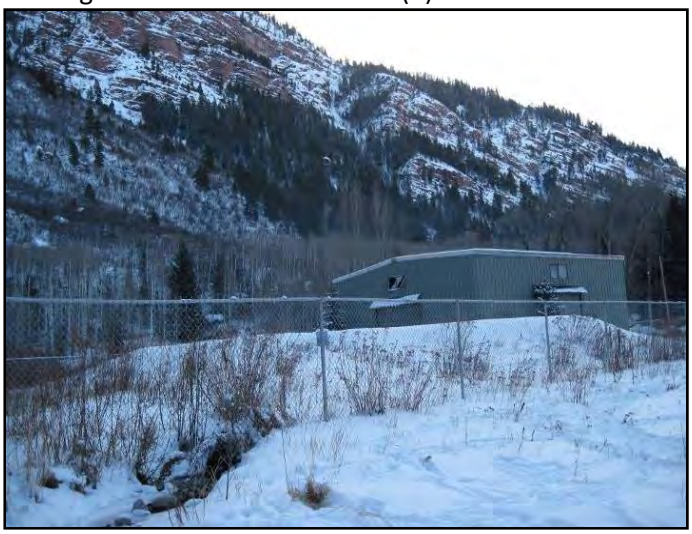


Figure 10. Redstone wastewater treatment plant, January 13, 2011. The Redstone treatment plant recently received a grant to assist with financing the upgrades necessary to remedy the treatment issues which have existed at the facility for several years.

WQ D1b. Investigate the potential for reusing waste products from landfills, wastewater treatment plants, and commercial activities (*e. g.,* the use of sludge as fertilizer) in order to reduce the need for increased treatment capacity at concentrated waste disposal sites. (S)

WQ D1c. Support new and additional funding mechanisms for water technology research and development. (L)

WQ E. Objective: Improve public awareness and support of water quality protection and improve public engagement in water quality protection activities.

The watershed's growing population is still largely unaware of the wide range of human behavior that affects water quality and the primary sources of pollution in the watershed. The significant relationship between water quantity and water quality is not commonly understood. Lack of public awareness of the water quality problems that already exist in the watershed and a failure to appreciate the magnitude of the additional threats leads to complacency and a lack of personal responsibility. This in turn translates into a lack of community-based action to protect and restore local surface water and groundwater resources. Absent public awareness and support, local decision makers are less likely to undertake or fund new programs and initiatives to either protect or restore water resources.

It is also important that the education/outreach campaigns conducted in the watershed strive for a unified and consistent message across jurisdictional boundaries. Water issues are complex enough without the additional task of sorting through multiple program initiatives independently instituted by local jurisdictions, nonprofits and other stakeholders throughout the Valley. A coordinated effort is required for efficiency and success.

WQ E1. *Summary of Action Required*: Undertake action to improve public support for water quality protection and improvement, as well as public engagement in water quality protection/improvement activities.

- ***Coordinating Entities*: CFWE, RFC**
- ***Key Participants*: ACES, CDPHE, Colo Prof in Onsite Wastewater, CPW, CRWCD, CTU, Industry Associations, local jurisdictions, NNI, NWCCOG Q/Q, RWAPA, USEPA, USFS, water and sanitation districts**

WQ E1a. Improve local understanding of the importance of water quality and the relationship between water quality and quantity. Install signs and notices in appropriate areas (*e. g.*, campgrounds, high-use recreation areas adjacent to rivers and streams) noting the importance of maintaining water quality. (P)

WQ E1b. Improve the public's understanding of the importance of water quality to public health and safety and to the local lifestyle, economy, and environment, and of the consequences of a degraded or contaminated water supply. (P)

WQ E1c. Educate the public about daily activities that impact water quality and how individuals can modify their behavior and reduce water quality impacts on the watershed. Include education about the hazards associated with emerging contaminants and implementation of programs to halt their improper disposal and foster alternative disposal methods. (P)

WQ E1d. Improve local decision makers' understanding of federal, state, and local regulations addressing water quality by creating an illustration of the hierarchy of water quality agencies and regulations in a manner aimed at a lay audience. (P)

CANDIDATES FOR EMERGING CONTAMINANT DISPOSAL PROGRAMS INCLUDE:

- Local hospitals,
- Local medical offices,
- Pharmacies, and
- Retail outlets.

WQ E1e. Educate the public about issues surrounding

the development of new water technologies, such as nanotechnology-based systems. (P)

WQ E1f. Improve public understanding of the risk of groundwater pollution by creating maps showing areas vulnerable (based on natural underlying geologic conditions) and susceptible (based on land use, concentrations of onsite wastewater treatment systems, agricultural practices, etc.) to groundwater contamination. (P)

WQ E1g. Implement a stream segment adoption program (*i. e.,* the "Adopt a Stream" program) to facilitate cleanup and monitoring activities. Incorporate the program in school curriculums where possible. Create and publicize a map of "Adopted Streams". (P)

WQ E1h. Improve public education regarding individual onsite wastewater treatment systems, particularly the need for regular system inspections – not just pumping. (P)

WQ E1i. Educate the public on the benefits of BMPs and encourage public implementation of structural, vegetative, and non-structural BMPs whenever possible. Create incentive programs for voluntary retrofits of residential sites (*e.g.*, removal of lawns and establishment of streamside buffers, removal of non-native plants and incorporation of native landscaping, installation of on-site water quality treatment areas). (P&L)

EDUCATE THE PUBLIC ABOUT OWTSs BY:

- Conducting seminars to teach local realtors, engineers, homeowners, HOAs, caucuses, and planners the basics of OWTS planning, design, construction, and maintenance,
- Incorporating educational opportunities into real estate closings,
- Providing information on OWTSs in property information, and
- Creating educational materials for local TV and other media outlets.

WQ F. Objective: Develop a strategic plan for dealing with potential future water quality threats.

The *State of the Roaring Fork Watershed Report 2008* highlighted some of the changes that can be expected to occur to the watershed's environmental resources as a result of population growth and new development (*e. g.*, as a result of a shift in water usage patterns, increases in impervious surfaces). These changes will impact water quality in ways that are already familiar today. However, there are other reasonably foreseeable events (including some potentially catastrophic events) that warrant attention as part of the watershed's longer-term planning process. For example:

- How will escalating oil and gas drilling affect the quality of our Valley's water supply?
- How will beetle kill impact the quantity and quality of runoff from our watershed?
- Where are the high fire danger areas and what would be the impact of a catastrophic fire on our water supplies?
- What are the water quality impacts associated with additional transmountain diversions, or changes in the timing of existing diversions?
- How will climate change impact our watershed?

Our planning process should always be looking 5 to 10 years ahead in order to ensure that the capability to develop strategic plans exists to address changing circumstances.

***WQ F1. Summary of Action Required*: Develop a strategic plan for dealing with potential future water quality threats.**

- ***Coordinating Entities*: local jurisdictions, NWCCOG Q/Q,**
- ***Key Participants*: AGCI, ACES, Aspen Skico, BLM, CBRT, CDPHE, CPW, CRWCD, CSU, CWCB, RFC, USEPA, USFS, water and sanitation districts, WRFC, WW**

WQ F1a. Quantify the needs of our watershed as they relate to water quality (*e. g.*, maintenance of adequate stream flows for dilution of contaminants). Support and participate in the Non-Consumptive Needs Assessment being carried out by the Colorado Basin Roundtable. (S)

WQ F1b. Ensure that local land use policies and regulations adequately address the water quality impacts of development, and that requisite mitigation measures imposed as conditions of land use approvals are both implemented and enforced (*e.g.*, construction and ongoing maintenance of stormwater retention ponds designed to capture pollutant loading associated with an increase in impervious surfaces). (L)

SIGNIFICANT PROPOSED DEVELOPMENTS THAT MAY IMPACT WATER QUALITY INCLUDE:

- Spring Valley Ranch,
- Snowmass Base Village,
- Cattle Creek, and
- Sunlight.

WQ F1c. Monitor and address the impacts of high-use, paved trails on water quality. (S&L)

High use paved trails which may be impacting water quality include the Crystal River Trail and the Rio Grande Trail.

WQ F1d. Ensure that activities aimed at mitigating or responding to pine beetle and other insect infestations and diseases do not generate detrimental water quality impacts. (S&L)

WQ F1e. Monitor and address the impacts of climate change on water quality (*e. g.*, higher water temperatures reducing dissolved oxygen levels, changes in the timing, intensity, and duration of precipitation producing more sedimentation from runoff, etc.). (S&P)

V. Recommended Actions to Achieve Riparian and Instream (RI) Goals and Objectives

> *"Rivers are places that renew our spirit, connect us with our past, and link us directly with the flow and rhythm of the natural world."*
> — Ted Turner, The Rivers of South Carolina

***RI Goal:** To protect and restore the functions of riparian and instream areas.*

Riparian areas have the highest species richness of all major ecosystems in Colorado, but they cover only one to two percent of the land area. In addition to providing high quality wildlife habitat and supporting biological diversity, these ecosystems perform numerous other critical natural functions. Riparian areas remove nutrients and other constituents that can impair water quality, enhance the structural diversity of aquatic habitat, and support hydrologic processes. Riparian vegetation stabilizes stream channels and maintains sustainable instream flows by facilitating the infiltration of flooding flows. Riparian areas are critical to fisheries in that they provide shelter, shade, and food along streambanks. Finally, riparian areas provide aesthetically and naturally rich places for human use.

The Roaring Fork Watershed is dominated by montane headwater streams that provide high quality water for downstream habitats supporting a wide array of aquatic and terrestrial species. Streams serve as important conduits for natural materials - transporting water, nutrients, sediments, and other substances. They provide recreational opportunities, such as boating, fishing, and wildlife viewing, and support hydropower production and consumptive water uses like agricultural irrigation and the provision of municipal drinking water



Figure 11. A healthy riparian area, Cattle Creek (Photo credit: Dee Malone).

RI A. Objective: Assess the condition of riparian and instream habitat for all major streams in the watershed.

A monitoring program is needed to determine the status of riparian and instream areas (including associated wildlife populations), as well as trends impacting their overall condition. Ongoing monitoring would allow identification of areas where conditions are improving (including assessment of the effectiveness of protection and restoration activities), as well as areas where protection and restoration efforts should be focused.

RI A1. *Summary of Action Required*: Develop and implement a riparian and instream monitoring program.

- ***Coordinating Entities*: BLM, CPW, RFC, USFS**
- ***Key Participants*: CNHP, CTU, local jurisdictions, MSCD, NWCCOG Q/Q, RFAS, USEPA**

RI A1a. Convene a Riparian and Instream Areas Working Group to develop a riparian and instream monitoring program for the watershed. Charge the Working Group with the following tasks:

- Identify parameters (indicators), sampling locations, sampling protocols, and monitoring intervals to adequately assess riparian and instream area status and trends.

  - Ensure compatibility with existing riparian and instream assessments (*e.g.,* the Stream Health Initiative's use of the U.S. Environmental Protection Agency's Rapid bioassessment protocol for use in wadeable streams and rivers and the Natural Resource Conservation Service's Riparian Assessment Method).
  - Include species distribution information and population status and trends for breeding, resident, and wintering birds; amphibians; and small, medium, and large mammals. Identify important migratory stopover sites. Develop a Bird Index of Biotic Integrity specifically tailored to the watershed.
  - Identify desirable fish (including non-game fish), fish habitat, and macroinvertebrates. Work with the Water Quality Working Group to ensure that adequate stream temperature and dissolved oxygen data are collected across the watershed to monitor impacts on aquatic wildlife from changes in land use, etc., and to help inform studies on the impact of climate change on aquatic organisms.
  - Include an assessment of upland habitat conditions (including soil disturbance/erosion, vegetative ground cover/deforestation, browse level), that influence stream health. (S &P)

- Collect and analyze riparian and instream data on stream reaches where assessments have not been completed. (P)
- Review and provide recommendations for the modification/consolidation of existing riparian and instream data collection programs. (S)
- Identify sources of ongoing funding for the riparian and instream monitoring program and make strategic recommendations for securing funding. (S&P)
- Develop a mechanism to analyze and report the results of the riparian and instream monitoring program and to address areas of concern. (P)
- Design a companion monitoring strategy for more intensive, site-specific assessments of riparian and instream management impacts, restoration efforts, and adaptive management actions. (P)

Riparian and Instream habitat assessments are needed in Hunter, Woody, Lincoln, Capitol, Sopris, Coal, Prince, Thompson, and Threemile Creeks, as well as the upper Fryingpan River watershed.

RI B. Objective: Enhance and preserve native riparian and instream flora and fauna including wild, naturally reproducing fish communities.

As discussed in the *State of the Roaring Fork Watershed Report 2008,* healthy riparian areas provide the diverse natural resources necessary to support a rich community of wildlife. The functions and values of riparian areas fall into five categories: protecting water quality, maintaining sustainable instream flows, maintaining the natural shape of the stream channel, maintaining biodiversity, and providing sustainable wildlife habitat.

Sustainable and functional riparian ecosystems require native vegetation with high quality, vigor, good cover, even distribution of all age-classes of woody plant species, and no noxious weeds. Where woody species are an important component of the historic plant community, an even distribution of all age-classes of woody plant species provides ecosystem resilience and is essential to site maintenance and recovery from disturbance.

Wildlife species can be used to indicate habitat condition and to monitor and assess the effects of land uses and management strategies. They respond to environmental characteristics, selecting preferred habitat based on the presence and quality of those characteristics. Mammal species whose presence indicates good quality riparian habitat include mink, western jumping mouse, and water shrew. In the Roaring Fork Watershed the presence of disturbance-intolerant, riparian-dependent songbirds such as Lincoln's Sparrow, Wilson's Warbler, Willow Flycatcher, MacGillivray's Warbler, Red-Naped Sapsucker, Swainson's Thrush, and Lewis's Woodpecker are good indicators of intact riparian habitat. The American Dipper is a good indicator of the quality of stream habitat.

Today, the decline of native Colorado River cutthroat trout (CRCT) and boreal toad populations are of particular concern in the watershed. In addition to the economic benefit derived from the Roaring Fork Watershed's thriving trout populations in its Gold Medal streams, trout are an important aquatic species in mountain stream ecosystems and an important indicator species whose decline signals environmental imbalance or disturbance. CRCT historically occupied 34,500 km of Colorado's streams. Today, unhybridized populations of CRCT, or those of particular ecological significance, occupy less than 10 percent of their historical range. As discussed in the *State of the Roaring Fork Watershed Report 2008,* hybridization with rainbow trout, competition with non-native trout, and whirling disease have all impacted CRCT populations. Additionally, trout are dependent on clear and cold water, both of which are at risk from global warming. The cumulative effects of alterations to streams' thermal regimes and flow patterns will likely affect trout spawning in the future. The USFS has designated the CRCT a sensitive species, the BLM has provided the CRCT with a similar status and in the State of Colorado they have been designated a Species of Special Concern by Colorado Parks and Wildlife.

Since 1970, there has been a dramatic decline in boreal toad and other amphibian populations. Reasons for the decline have not been definitively identified, but may include the presence of toxins or a habitat disturbance that suppresses the immune system, making the toad more susceptible to a fungus - *Chytridiomycosis* (which also kills chorus frogs). Already, one breeding population of boreal toads in the Roaring Fork Watershed is believed to have been extirpated by *Chytridiomycosis* and the fungus has been documented in another population. The boreal toad is listed by the State of Colorado as an endangered species.

RI B1. *Summary of Action Required*: Maintain/increase the extent and continuity of native riparian plant communities so that riparian and aquatic systems are functionally connected.

- ***Coordinating Entities*: Local jurisdictions**

- ***Key Participants*: AVLT, BLM, CNHP, CPW, CWT, CTU, MSCD, NRCS, NWCCOG Q/Q, RFAS, RFC, RMI, TNC, USACE, USEPA, USFS, USFWS, USGS, WW**

RI B1a. Working with landowners, resource experts, and other interested parties, plan and implement riparian and instream protection and restoration projects, including:

- Working with landowners on conservation easements or acquisitions;
- Identifying and revitalizing historic wetlands and reconnecting stream channels to the historic floodplain;
- Working with the USFS and BLM to protect or restore high quality and priority riparian areas;
- Introducing beavers to create dams and wetland areas in appropriate stream reaches; and
- Working on ways to manage the timing of available streamflows (high and low), their duration, rise and fall rate, and inter-annual variation to maintain or restore riparian and instream health.

Example locations where significant ecological benefit may be derived from changes in land management or a project include large alluvial areas such as Northstar area on the Roaring Fork River, Cattle Creek confluence with the Roaring Fork River, the Roaring Fork River near Emma, the USFS Tree Farm, Thompson Creek confluence with the Crystal River, Coal Creek confluence with the Crystal River, and the Crystal River at Placita.

Pursue opportunities for riparian and instream protection and restoration where:

- Small changes in land management or small projects will yield significant riparian and instream improvements;
- Significant ecological benefit will be derived from changes in land management or a project;
- Program support exists and access to the riparian and instream area is relatively uncomplicated;
- Partnerships can be developed (*e.g.*, using the Wyden Amendment for USFS involvement); and
- An in-lieu-fee program can be developed with a regulatory agency (S&P).

Under an **in-lieu-fee agreement**, the mitigation sponsor collects funds from an individual or a number of individuals who are required to conduct compensatory mitigation required under the federal USACE Section 404 program, or another state or local wetland regulatory program. The sponsor may use the funds pooled from multiple permittees to create one or more sites under the authority of the agreement to satisfy the permittees' required mitigation.

RI B1b. On an ongoing basis, reassess the Colorado Natural Heritage Program's Potential Conservation Areas for changes in resource conditions or management needs. (S)

RI B1c. Assess greenbelts/greenways as effective tools for protecting riparian areas in the watershed and pursue, as appropriate. (S&P)

A **green belt** is an invisible line encircling a certain area, preventing development of the area and allowing wildlife to return and be established.

RI B1d. Research wetland mitigation banks and work to expand such a program, if warranted. (S&P)

A **mitigation bank** is a wetland, stream, or other aquatic resource area that has been restored, established, enhanced, or preserved for the purpose of providing compensation for unavoidable impacts to aquatic resources permitted under Section 404 or a similar state or local wetland regulation. Rocky Mountain Institute has a **wetlands mitigation bank** in Snowmass with a service area covering the Roaring Fork drainage.

RI B1e. Investigate regional planning mechanisms available for protection of riparian areas (*e.g.,* a special district crossing local governments'

jurisdictional boundaries) and funding available to support such a regional effort. Pursue suitable opportunities, if warranted. (S,P&L)

RI B1f. Support state and federal tax credits for donations of conservation easements. Investigate additional tax incentives for such donations; work with interested parties on adoption of new incentives. (S,P&L)

RI B2. *Summary of Action Required*: Maintain or increase the population size and distribution of all riparian-dependent wildlife species, particularly indicator species.

- ***Coordinating Entity*: BLM, local jurisdictions, USFS,**
- ***Key Participants*: AGCI, CPW, CNHP, CSU, CTU, CU, MSCD, NWCCOG Q/Q, RFAS, RFC, TNC**

RI B2a. Using the results of the watershed-specific Bird Index of Biotic Integrity, implement habitat improvement projects. (P)

RI B2b. Determine the potential impact of climate change on riparian-dependent wildlife. (S)

RI B2c. Proactively develop the NEPA documentation necessary to relocate beavers to federal lands. Implement projects that promote beaver activity. (P)

RI B2d. In conjunction with local land use approvals, require the design and execution of site-specific adaptive management plans to evaluate and minimize the impacts of development on riparian areas. (L)

RI B2e. Inventory and maintain or increase the population size and range of plant species and communities of concern, as appropriate. (S&P)



Figure 12. Ute Ladies' Tresses August 25, 2010. This species is listed as *Threatened* by the US Fish and Wildlife Service

PLANT SPECIES AND COMMUNITIES OF CONCERN INCLUDE:

- All federally and state listed threatened and endangered species;
- USFS and BLM sensitive species;
- State species of special concern; and
- Colorado Natural Heritage Program's globally and state 1-3 (1: critically imperiled, 2: imperiled, and 3: vulnerable) ranked species and communities. (*See* Appendix 1 for list).

RI B3. *Summary of Action Required*: Maintain or increase the population size, range, and purity of all existing Colorado River cutthroat trout populations.

- ***Coordinating Entity*: BLM, CPW, USFS**
- ***Key Participants*: AGCI, CSU, CTU, CU, USEPA, USFWS, USGS**

RI B3a. Determine the optimum number and distribution of CRCT populations and implement projects that work toward achieving this goal, including projects that:

- Reduce whirling disease transmission to CRCT populations;
- Protect CRCT spawning areas;
- Create barriers for non-native fish;
- Improve CRCT passage by replacing culverts;
- Reduce land use impacts (*e.g.*, sedimentation, chemicals in stormwater runoff from roads, grazing, oil and gas development activities, low flows, and stream channelization) affecting CRCT populations;
- Encourage the propagation of recreational CRCT populations, increasing public awareness of our native trout ; and
- Reflect the 2006 *Conservation Strategy for Colorado River Cutthroat Trout*, the revised 2011 strategy, and any subsequent agreements. (P,S &L)

RI B3b. Conduct fish surveys above natural and man-made barriers to determine if there are additional populations of CRCT in the watershed. Increase/institute monitoring of all identified CRCT populations. (S&P)

RI B3c. Study the potential effects of climate change on CRCT populations (*e.g.*, Dr. Kurt Fausch's research, CSU). (S)

RI B4. *Summary of Action Required*: Assess the current condition of wild, naturally-reproducing fish communities; undertake actions to improve existing communities, and monitor their effectiveness.

- ***Coordinating Entity*: CPW**
- ***Key Participants*: AGCI, BLM, CDOT, CDPHE, CSU, CTU, CU, local jurisdictions, RFC, USFS, USFWS, Whirling Disease Foundation**

RI B4a. Monitor wild, naturally-reproducing fish populations (including non-game fish) and conduct spawning surveys. (S&P)

RI B4b. Identify, protect, and restore important trout spawning habitat. In areas of high spawning importance, evaluate seasonal closures and, if warranted, implement closures. (S&P)

RI B4c. Follow the *Range-wide Conservation Agreement and Strategy for Bluehead Sucker and Flannelmouth Sucker*. (S&P)

RI B4d. Determine the effect of stream temperature on wild, naturally-reproducing fish species distribution and initiate actions to ensure that threshold temperatures are not exceeded. (S&P)

RI B4e. Inventory road/stream crossings and improve fish passage, as needed. (P)

Opportunities to improve fish passage exist in the Fryingpan River and Crystal River, and the Cattle Creek and East and West Sopris Creek watersheds.



Figure 13. Before photo –These culverts were complete barriers to fish due to high velocity, no natural substrate, and location above the stream channel creating a jump barrier. After photo – This elliptical pipe dissipates stream velocity reducing the velocity barrier; pipe is embedded into the stream bottom at same grade as stream; and the bottom of the pipe is covered with gravels and cobbles creating a more natural substrate (Photo credit: Mark Weinhold, USFS).

RI B4f. Improve education regarding methods to reduce whirling disease transmission, including installing education stations in areas of high fishing use. (P)

RI B4g. Address the problem of illegal introduction of fish in the watershed (increasing disease potential, causing increased predation, and posing hybridization issues), through education and regulatory initiatives. (P&L)

RI B5. *Summary of Action Required*: Assess key amphibian populations (boreal toads, chorus frogs, tiger salamanders, and Northern leopard frogs); undertake actions to restore or increase key amphibian populations and assess their effectiveness.

- ***Coordinating Entity*: BLM, CPW, USFS**
- ***Key Participants*: AGCI, CNHP, CSU, CU, USFWS, USGS**

RI B5a. Monitor key amphibian populations to determine their status. (S)

RI B5b. Restore important amphibian habitats and, if appropriate, pursue opportunities for the reintroduction of species. (P)

RI B5c. Study the potential impact of climate change on amphibian populations. (S)

RI B5d. Survey potential boreal toad habitats to determine if additional populations exist in the watershed. (S)

RI B5e. Increase awareness of the dangers to toad populations associated with *Chytridiomycosis* fungus transmission and provide education about proper equipment/gear disinfection. (P)

RI B5f. Follow the ***Conservation Plan and Agreement for the Management and Recovery of the Southern Rocky Mountain Population of the Boreal Toad***. (P&L)

RI C. Objective: Minimize the impact of development and other activities in riparian and instream areas.

As discussed in the *State of the Roaring Fork Watershed Report 2008*, development, including roads, recreational trails and campsites, agriculture and mining can have severe and enduring impacts on riparian and instream areas. The impacts from some of these activities, such as agriculture, are often easier and less expensive to reverse - with dedicated funding sources available for protection and restoration activities. The juxtaposition of high-quality riparian areas with the open space provided by agricultural lands is valuable for many wildlife species and the large acreages often provide opportunities for protection or restoration of contiguous riparian areas. For these reasons, our agricultural lands provide excellent opportunities for protecting and restoring riparian areas.

Beaver populations in the watershed are much diminished from historic levels due to loss of riparian habitat and trapping. Reductions in beaver populations results in a loss of the benefits to riparian and instream habitat that result from beaver activity. Beavers modify stream channels, thereby slowing flooding flows and increasing out-of-bank flows, water storage, and groundwater recharge. Beaver activity results in the entrapment of sediment and nutrients - improving water quality and nutrient cycling. By enhancing the environmental conditions necessary for the establishment and maintenance of riparian vegetation, beavers create the habitat necessary for numerous aquatic and semi-aquatic species to thrive. Beavers can cause impacts to necessary infrastructure due to flooding and vegetation removal. Critical infrastructure can be protected from beaver damage by careful location of roads and trails and through a variety of structural techniques.



Figure 14. Left photo, Castor Master - A PVC pipe is inserted through a beaver dam extending both upstream and downstream. The upstream end of the pipe in the pond has a grate or the pipe is perforated. The beaver pond will be lowered to the level of the grate or the perforated pipe. Right photo, Beaver Deceiver- A perforated pipe is placed on the upstream side of a culvert and extends into the pond. A fence is constructed at the culvert inlet which the beavers plug, but they cannot plug the perforated pipe that runs into the culvert and extends into the upstream side of the pool (Photo credit: Skip Lisle).

RI C1. *Summary of Action Required*: Address the impacts of development and other activities on riparian and instream areas.

- ***Coordinating Entities*: BLM, local jurisdictions, USFS**
- ***Key Participants*: ACES, ACOE, CDOT, CDWR, CPW, CDRM&S, CNHP, COGCC, CSU, CTU, Ditch Companies, MSCD, NWCCOG Q/Q, RFAS, RFC, RWAPA, TDC, TNC, USACE**

RI C1a. Evaluate and address the impacts of riparian alteration/disturbance on native riparian-dependent wildlife and plant species and communities of concern (*see* Appendix 1 for list) and native wildlife species. (S&P)

RI C1b. Investigate the effects of acute and chronic sediment pulses on aquatic ecosystems, differentiating between natural and human-influenced sources of sediment. (S)

RI C1c. Develop and implement Best Management Practices (BMPs) for instream projects that minimize sedimentation and turbidity to reduce impacts to spawning fish movement, incubating eggs and fry, and spawning habitat. (P)

RI C1d. Implement the Travel Management Plan for the White River National Forest, including closing, obliterating, and signing select roads. (P)

RI C1e. Develop and enforce stream setbacks that protect riparian areas throughout the watershed. (L)

Coal, Thompson, and Brush Creeks, as well as the Lower Fryingpan and Crystal Rivers all **have significant sediment issues**.

Castle Creek, Lime Creek/Lime Park, the North Fork of the Crystal River, Middle Thompson Creek, and Coal Creek all **have significant sediment issues resulting from roads**.

RI C1f. Inventory developed and dispersed recreation sites, trails, and access points and assess their impacts on riparian and instream areas; work to reduce impacts through relocation, removal, or mitigation. Minimize the impact of new recreational sites, access points, and trails on riparian and instream areas. (S&P)

RI C1g. Prevent or mitigate riparian and instream impacts associated with agricultural activities. For example, work with willing landowners on riparian planting projects, managing cattle, and, where appropriate, fencing riparian areas and providing stock water. (P)



Good opportunities to explore mitigation of grazing impacts exist on the Roaring Fork and Crystal Rivers, and on Sopris, Lower North Thompson, Middle Thompson, Coal, and Cattle Creeks.

Figure 15. Fencing to exclude cattle on Middle Thompson Creek, September, 2010 (Photo credit: Mark Lacy, USFS). For more information on fencing see the CPW's brochure, *Fencing with Wildlife in Mind*.

RI C1h. Minimize instream impacts and improve fish habitat by reengineering instream structures intended to move water into head gates. (P)

RI C1i. Restore riparian and instream areas impacted by historical mining activities. (P)

RI C1j. Ensure that future oil and gas development does not adversely impact riparian and instream areas. (L)

RI C1k. Work to minimize/mitigate the effects of bridges on riparian and instream habitat. (P)

RI D. Objective: Improve understanding of the importance of riparian and instream areas.

RI D1. *Summary of Action Required*: Increase education/outreach programs on the importance of riparian and instream areas.

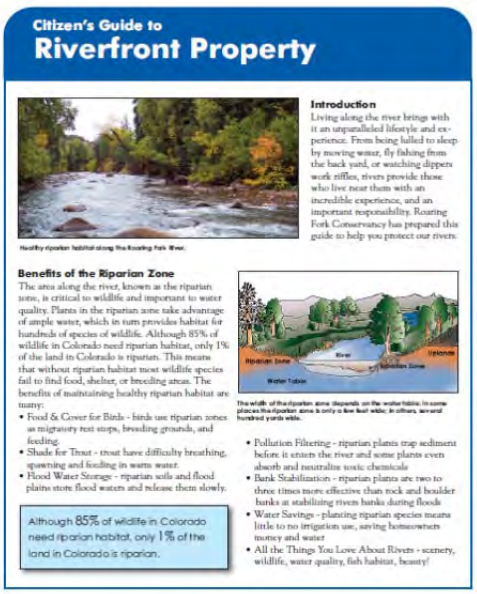
- ***Coordinating Entity*: RFC**
- ***Key Participants*: ACES, AVLT, BLM, CNHP, CPW, CRWCD, CSU, CTU, local jurisdictions, MSCD, NWCCOG Q/Q, RFAS, RFOV, RWAPA, USFS**

RI D1a. Provide education to the public (particularly streamside landowners, local decision makers, realtors, and developers) about the important functions of riparian areas, development and other threats to riparian areas, what can be done to protect and restore riparian areas, and potential sources of funding for riparian projects. Incorporate site-specific information from the Stream Health Initiative's riparian and instream assessments in educational initiatives. Educational opportunities include:

- Institution of a volunteer program partnering streamside property owners and birders to identify bird species occurring on properties;
- Site visits with streamside property owners to discuss current conditions and ideas for improvements;
- A brochure for new streamside property owners, providing guidance on the "dos" and "don'ts" of living near rivers, costs of mitigation, and ideas for landscaping;
- Increasing realtor involvement (*e.g.*, a "Realtors for Rivers" organization);
- Increasing opportunities for watershed explorations and programs; and
- Education materials, such as newspaper inserts illustrating the impact of invasive species in riparian and instream areas. (P)

EDUCATION MESSAGES SHOULD INCLUDE:

- The important functions of riparian areas,
- Impacts of development and other threats to riparian areas,
- What can be done to protect and restore riparian areas,
- Local regulations protecting riparian areas,
- Fines and cost associated with required riparian mitigation, and
- Potential sources of funding for riparian projects.


Citizen's Guide to
Riverfront Property

Introduction
Living along the river brings with it an unparalleled lifestyle and experience. From being lulled to sleep by moving water, fly fishing from the back yard, or watching dippers work riffles, rivers provide those who live near them with an incredible experience, and an important responsibility. Roaring Fork Conservancy has prepared this guide to help you protect our rivers.

Benefits of the Riparian Zone
The area along the river, known as the riparian zone, is critical to wildlife and important to water quality. Plants in the riparian zone take advantage of ample water, which in turn provides habitat for hundreds of species of wildlife. Although 85% of wildlife in Colorado need riparian habitat, only 1% of the land in Colorado is riparian. This means that without riparian habitat most wildlife species fail to find food, shelter, or breeding areas. The benefits of maintaining healthy riparian habitat are many:
- Food & Cover for Birds - birds use riparian zones as migratory rest stops, breeding grounds, and feeding.
- Shade for Trout - trout have difficulty breathing, spawning and feeding in warm water.
- Flood Water Storage - riparian soils and flood plains store flood waters and release them slowly.
- Pollution Filtering - riparian plants trap sediment before it enters the river and some plants even absorb and neutralize toxic chemicals
- Bank Stabilization - riparian plants are two to three times more effective than rock and boulder banks at stabilizing rivers banks during floods
- Water Savings - planting riparian species means little to no irrigation use, saving homeowners money and water
- All the Things You Love About Rivers - scenery, wildlife, water quality, fish habitat, beauty!

Although 85% of wildlife in Colorado need riparian habitat, only 1% of the land in Colorado is riparian.

Figure 16. Roaring Fork Conservancy's *Citizen's Guide to Riverfront Property* provides information on the benefits of riparian areas and what people can do to protect these areas.

RI D1b. Develop the RFC's River Center, with its exhibits on the importance of riparian and instream areas to the watershed. (P)

RI D1c. Provide publicity, tours, and interpretation of riparian and instream restoration projects. (P)

RI D1d. Involve the public in restoration projects (*e.g.*, weed pulls, plantings). (P)

RI E. Objective: Eradicate/control invasive species in riparian and instream areas.

Noxious weeds are non-native invasive plants that displace desirable vegetation and degrade natural and agricultural lands. They threaten our drinking water supply, agricultural crops, pasture lands, and native habitats.
State of Colorado Noxious Weed List.

Noxious weeds, zebra and quagga mussels, New Zealand mud snails, and other invasive species threaten the health of riparian and instream areas, and climate change threatens to increase the likelihood of invasions. Some invasive species, like New Zealand mud snails, are almost impossible to contain once they have entered an area. Even native species can take on "invasive" aspects and become problematic. For example, the *Didymosphenia geminata* (*Didymo*) algae forms extensive masses that can cover almost all of the organisms that live on or in the bottom of a stream, preventing the growth of other algae that are an important food for aquatic invertebrates. Some species also have the potential to do substantial economic damage when they appear (*e.g.*, zebra and quagga mussels can fasten themselves to almost any surface - coating and damaging docks, boats and structures).

RI E1. *Summary of Action Required*: Create an invasive species task force for the watershed to coordinate efforts to control riparian weeds, reestablish native species, and provide education about invasive species.

- ***Coordinating Entities*: BLM, local jurisdictions, MSCD, USFS**
- ***Key Participants*: Ditch companies, NWCCOG Q/Q, RFOV, WRFC**



Figure 17. Canada thistle.

EXAMPLE INVASIVE PLANT SPECIES OF CONCERN IN RIPARIAN AREAS
(*See* Appendix 2 for list):

- *Listed Noxious Weeds:*
  Canada, Russian, and Plumeless thistle; tamarisk; leafy spurge; oxeye daisy; purple loosestrife; common mullein; scentless chamomile; and butter and eggs.
- *Other Problem Weeds:*
  Reed canary grass and pasture grasses.

RI E1a. Convene an Invasive Species Task Force to:

- Identify the invasive species of greatest concern in riparian areas in the Roaring Fork Watershed, including vegetation not designated as "noxious" that is a problem in riparian zones because it prohibits cottonwood and willow seedlings from becoming established on bare soils;
- Identify and prioritize locations to address invasive species in the watershed;
- Identify and disseminate information on the least harmful method(s) of eradication/control;
- Develop a plan to eradicate/control invasive species in the Roaring Fork Watershed (including an education component and the organization of community events to remove invasive species); and
- Study the potential impact of climate change on invasive species. (P&S)

RI E1b. Work with local jurisdictions' weed boards (or other appropriate contact(s)), the USFS, BLM, MSCD, and private land owners to eradicate/control invasive plant species that are a significant concern, particularly adjacent to riparian areas and along roads. Eradicate tamarisk in the watershed and ensure that any new infestations are removed (*e.g.*, Threemile Creek). Where possible, revive more natural flow regimes (small and large floods) to help control weeds. (P)

RI E2. *Summary of Action Required*: Prevent Aquatic Nuisance Species (ANS), such as the New Zealand mud snail, *Didymo* algae, quagga and zebra mussels, and rusty crayfish, from establishing in the watershed.

- ***Coordinating Entities*: CPW, RWAPA, USFS**
- ***Key Participants*: BLM, BOR, CSU, CTU, local jurisdictions, RFC, USEPA, USGS**

RI E2a. Research and survey the *Didymo* algae to determine the cause of its rapid spread, the ecological implications, and possible methods of control. (S)

RI E2b. Improve our understanding of the economic and ecological consequences of ANS invasion and the methods for preventing the spread of such species. Provide education on the spread of ANS. (S&P)

RI E2c. Implement invasive species inspection/monitoring programs. Require proper cleaning and disinfection of boats and construction equipment used in watercourses. (P&L)

RI E2d. Institute new regulations, as necessary, to address the movement of aquatic species within and between drainages to prevent the movement of ANS. (S&L)



Figure 18. Boat inspection for invasive species at Ruedi Reservoir.

EXAMPLES OF INSPECTION/ MONITORING PROGRAMS INCLUDE:

- Funding/staffing boat cleaning for non-native mussels, and
- Participating in the USGS's efforts to create a *Didymo* algae monitoring program.

4. Key

Project Type

S Study
P Project or program
L Legislative or regulatory

Key Participants and Coordinating Entities (Listed alphabetically under summary statements)

Local

Conservancy Districts	Basalt Water, West Divide
Fire protection districts	Aspen - Pitkin County, Aspen Park - Elk Creek Fire Department, Basalt Fire & Rescue, Carbondale & Rural Fire Protection District, Glenwood Springs Fire Department, and Snowmass Wildcat Fire Protection District
Local jurisdictions	Counties (Eagle, Garfield, Gunnison, and Pitkin) and Municipalities (Aspen, Basalt, Carbondale, Glenwood Springs, and Snowmass Village)
River Board	Pitkin County River Board
Local utilities	
Major water diverters	Large inbasin and transmountain diverters
MSCD	Mount Sopris Conservation District
Public Safety Council	
RWAPA	Ruedi Water and Power Authority
Water and Sanitation Districts	

Regional

CBRT	Colorado Basin Roundtable
CFWE	Colorado Foundation for Water Education
CRWCD	Colorado River Water Conservation District
NWCCOG Q/Q	Northwest Colorado Council of Governments Quality/Quantity

State

CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and the Environment
CDRM&S	Colorado Division of Reclamation, Mining, and Safety
CDWR	Colorado Division of Water Resources
COGCC	Colorado Oil and Gas Conservation Commission
CPW	Colorado Park & Wildlife
CRWA	Colorado Rural Water Association
CSU	Colorado State University
CNHP	Colorado Natural Heritage Program
CU	University of Colorado
CWCB	Colorado Water Conservation Board
CWQF	Colorado Water Quality Forum
DOLA	Colorado Department of Local Affairs

Federal

BLM	Bureau of Land Management
BOR	Bureau of Reclamation
DOI	US Department of Interior
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
NNI	National Nanotechnology Initiative
NRCS	National Resource Conservation Service
USACE	Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service - White River National Forest
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

Nonprofits

ACES	Aspen Center for Environmental Studies/ For the Forest
AGCI	Aspen Global Change Institute
AVLT	Aspen Valley Land Trust
CRWA	Colorado Rural Water Association
CTU	Colorado Trout Unlimited
CVEPA	Crystal Valley Environmental Protection Association
CWT	Colorado Water Trust
IPF	Independence Pass Foundation
RFAS	Roaring Fork Audubon Society
RFC	Roaring Fork Conservancy
RFOV	Roaring Fork Outdoor Volunteers
RMI	Rocky Mountain Institute
SHI	Stream Health Initiative
SI	Sonoran Institute
TDC	Thompson Divide Coalition
TNC	The Nature Conservancy
WRFC	White River Forest Conservancy
WRI	Western Rivers Institute
WW	Wilderness Workshop

Other

Aspen SkiCo	Aspen Skiing Company
CPOW	Colorado Professionals in Onsite Wastewater
Industry Associations	
Local Schools	
Major Water Diversions	
Transmountain Diversions	Independence Pass Transmountain Diversion System, Fryingpan-Arkansas Project and Busk-Ivanhoe System

5. Matrices

The following matrices provide a direct entry point to the Plan's recommendations. They are intended to give another perspective on the Plan's recommendations by tying them to a number of important parameters.

- One matrix presents prioritized Recommended Actions in terms of the geographic areas to which they apply (*i.e.*, the major segments of the Roaring Fork, Fryingpan and Crystal Rivers).
- A second prioritized matrix breaks down the Recommended Actions according to the Coordinating Entities and Key Participants in the implementation of the Recommended Actions. This matrix is intended to identify those organizations, governments, or agencies whose participation in one action or another will be key to the successful accomplishment of that action. The list is long but not exhaustive. It is intended to be a starting point for discussions, acknowledging that other important parties will be identified as Plan implementation moves forward.
- In the third matrix the Recommended Actions are designated as a Study, a Project/Program, or a Legislative/Regulatory action. This division makes it possible to distinguish easily between the action-oriented recommendations, the political elements of implementation, and the recommendations that are attached to areas of continued uncertainty and knowledge gaps.

It is important to note that the matrices were subject to the same input and review process that was applied to the Plan as a whole, but that to some extent the final product was developed according to the subjective judgment of the Plan's principal authors. Although the authors of this Plan have many years of experience with both the general and specific issues affecting the Roaring Fork Watershed, one of the lessons of this planning process has been that many perspectives and interests have influenced water management in the past and will continue to do so in the future. The matrices are intended to provide guidance, food for thought, and a starting place for more focused discussion, rather than a set of strict prescriptions. We encourage the users of this Plan to bring their own perspectives to bear on the recommendations and not to get caught up in the minutiae of the matrix designations.

These matrices are also available as a companion Excel Workbook to allow users to sort them for their particular uses. The coding used in these matrices mirrors the codes in the Plan Narrative, allowing the user to refer back to the Narrative for more detail and context.

The following describes each of the matrix categories in more detail:

1. Geographic Area Matrix. In Phase I of the Watershed Plan, the *State of the Roaring Fork Watershed Report 2008*, the Roaring Fork Watershed was broken down into nine areas corresponding with the four main sections of the Roaring Fork River and five major tributaries. The Geographic Area Matrix takes this breakdown a step further and divides the watershed into nineteen subareas corresponding to reaches of the main streams in the watershed or their major tributaries, plus a column for "Watershed-Wide" recommendations. Clearly some recommendations of the Plan are applicable in one part of the

watershed but not another, while others apply to the entire watershed. The purpose of this matrix is to illustrate those physical distinctions, while also noting that some recommendations of the Plan fall into both categories. That is, they are applicable watershed-wide but are more urgent or farther along in one or more areas of the watershed. To make this distinction, recommendations are color-coded to indicate "Urgent," "High," or "Medium" priorities by geographic area or on a watershed-wide basis, and are also assigned an overall implementation priority. A key is included to interpret the various priority designations.

2. Coordinating Entities and Key Participants Matrix. As noted above, this listing of public agencies, organizations, and governments is intended to identify those entities whose participation and support (as either a "Coordinating Entity" or a "Key Participant") will be vital to successful implementation of this Plan. To add to the utility of this matrix, the overall priority of a Recommended Action is also shown. The "Coordinating Entity" has a direct interest or jurisdiction, or a strong influence relative to a given recommendation. "Key Participants" are those entities whose participation or support would be instrumental in implementation of a Recommended Action. This does not always imply that an identified entity has the current capacity or direction to accomplish the action. In some cases selection is simply intended to identify the most likely entity that could accomplish a Recommended Action if funding or staffing changes or priorities shift. Most of the parties identified have been active participants in the planning process or are aware that the Plan is underway. Moreover, most of these entities have participated at one time or another in the discussions of the Roaring Fork Watershed Collaborative Water Committee relative to implementation of the Plan and have expressed their support for both the planning process and the Plan's recommendations. As the implementation process moves forward, it will be incumbent on these organizations to act as custodians and investors in the Plan through their support for implementation as either a Key Participant or a Coordinating Entity. As previously noted, this list is not exhaustive and will no doubt be expanded as implementation moves forward.

3. Type of Recommendation Matrix. The Recommended Actions fall into three general categories: (i) "Project or Program," (ii) "Study," and (iii) "Legislative and Regulatory." "Projects" are activities which require physical alterations to the landscape, such as a riparian area revegetation effort or the construction of a kayak park, while "Programs" require an active effort using legislative, educational, legal, regulatory, or other tools to carry out a recommendation. A "Study" is just what its name implies - an effort to learn more through research, inquiry, and analysis about a given topic. The Study designation often indicates a knowledge gap - an aspect of the watershed which is poorly understood or documented. Studies are often paired with one of the other categories because they are a necessary precursor to more direct action. "Legislative and Regulatory" recommendations refer to those Recommended Actions which will require a governing body to take official action, including adopting standards, imposing penalties, and providing resources. The category distinctions in this matrix are somewhat subjective and are not intended to exclude other approaches to implementation, or to value one type of implementation action over another. They are intended to act as a starting point for further discussion and as an aid in assigning responsibility for one action or another. For instance, it would be counterproductive to assign a complex water quality study to a fishing club, and it would be equally inappropriate to assign a river clean-up project to a Front Range university.

Recommended Action CE = Coordinating Entity X = Key Participant Yellow 3 = Priority, Orange 2 = High Priority, Red 1 = Urgent	Overall Priority	Aspen Ctr for Envi Studies	Aspen Global Change Inst	Aspen Valley Land Trust	Bureau of Land Management	Colo Basin Roundtable	Colo Dept Transportation	Colo Div of Parks & Wildlife	Colo Dept Pub Health & Envi	Colo Dept Water Resources	Colo Found Water Education	Colo Natural Heritage Prog	Colo River Water Cons Dist	Colo State University	Colo Trout Unlimited	Colo Water Cons Board	Local Jurisdictions	Major Water Diverters	Mt. Sopris Conservation Dist	NW Colo Council Govts QQ	Roaring Fork Audubon Society	Roaring Fork Conservancy	Ruedi Water & Power Authority	The Nature Conservancy	US Envr Protection Agency	US Fish & Wildlife Service	US Forest Service	US Geological Survey	Water Conservancy Districts	Water and San Districts	Other
RWM A1a. Regularly broadcast educational presentations on federal and state water policies/programs.	3					X					X		CE		X	X				X		CE	X								
RWM A1b. Issue regular press releases from the CBRT, CRWCD, and RWAPA. Include "tie-ins" to the Roaring Fork Watershed whenever possible in press communications.	3					CE							CE										X								
RWM A1c. Use social networking opportunities to improve communication with respect to meetings, workshops, and other educational opportunities concerning water issues.	3					X					X		CE									CE	X								
RWM A2a. Fund and distribute videos, PowerPoint presentations, brochures, and other media that tell the story of the Roaring Fork Watershed. Exhibit and promote these products as widely as possible.	3										X		CE			X	X					CE	X								
RWM A2b. Create a graphical tool, or an educational game illustrating the relationship between downstream calls, transmountain diversions, in-basin diversions and flows in the Roaring Fork Watershed. Make this tool available for schools and for presentations on water issues.	3										X		X									CE									
RWM A2c. Support projects such as the CRWCD/NWCCOG Q/Q's "It's the Same Water Campaign" and the RFC's River Center, including exhibits to enhance public awareness of complex regional water management issues.	2												X				X			X		CE	X								
RWM A2d. Create a portable plumbing model of the Roaring Fork Watershed similar to the NRCS stream trailer.	3										X		X			X						CE									
RWM A2e. Publish and distribute the RWAPA document, "Front Range Water Supply Planning Update: Increased Storage, Increased Demands, Increased Diversions." Translate and graphically represent key findings from this document.	2																						CE								
RWM A2f. Support projects such as the Univ. of Michigan Master's Project, "Fostering Implementation of the Roaring Fork Watershed Plan." Evaluate and utilize recommendations for improving public education and outreach from the Univ. of Michigan Master's Project, as appropriate. Seek opportunities to engage academia in research and implementation projects.	2												X		X		X					CE	CE				X	X			
RWM A3a. Advertise the CBRT meetings and their agendas Include information on subcommittee/working group meetings that are open for public participation.	3					CE							X			X							X								
RWM A3b. Broadcast CBRT meetings and publicize the broadcasts.	3					CE							X			X															
RWM A3c. Institute regular reporting to constituents by the Roaring Fork Watershed CBRT representatives in "user friendly" formats.	2					CE							X				X														
RWM A3d. Create a mechanism to capture and relay public comment to the CBRT on issues affecting the Roaring Fork Watershed.	3					CE							X																		
RWM A3e. Support/fund a touring educational program on regional watershed management issues.	2												X				X					CE	X								
RWM B1a. Appoint a Working Group to study and make recommendations on how the CRWCD can better foster collaboration among its Roaring Fork Watershed Board members.	3												CE				X						X								

Recommended Action CE = Coordinating Entity X = Key Participant Yellow 3 = Priority, Orange 2 = High Priority, Red 1 = Urgent	Overall Priority	Aspen Ctr for Envi Studies	Aspen Global Change Inst	Aspen Valley Land Trust	Bureau of Land Management	Colo Basin Roundtable	Colo Dept Transportation	Colo Div of Parks & Wildlife	Colo Dept Pub Health & Envi	Colo Dept Water Resources	Colo Found Water Education	Colo Natural Heritage Prog	Colo River Water Cons Dist	Colo State University	Colo Trout Unlimited	Colo Water Cons Board	Local Jurisdictions	Major Water Diverters	Mt. Sopris Conservation Dist	NW Colo Council Govts QQ	Roaring Fork Audubon Society	Roaring Fork Conservancy	Ruedi Water & Power Authority	The Nature Conservancy	US Envr Protection Agency	US Fish & Wildlife Service	US Forest Service	US Geological Survey	Water Conservancy Districts	Water and San Districts	Other
RWM B1b. Cultivate collaborative relationships with state and federal water resource experts and decision makers. Look for opportunities for agencies to partner on multi-jurisdictional projects.	2				X	X				X			X			X	X			X			CE			X	X	X			BOR
RWM B1c. Hold public meetings on significant water issues affecting the Roaring Fork Watershed with CBRT and RWAPA representatives, CRWCD Directors, and local elected officials. Publicize these meetings through various means.	3					CE							CE				X							CE							
RWM B1d. Identify streams in the watershed that may be candidates for federal wild, scenic, and recreational status. Determine community support for a designation and work to meet community goals.	3												X				X							X				CE				DOI, CVEPA
RWM B1e. Encourage Pitkin County's River Board to publicize its priorities and activities and to take steps to coordinate those activities with local water managers and interest groups.	3																X															River Board
RWM B1f. Cultivate collaborative relationships with the entities diverting water from Roaring Fork Watershed to the East Slope. Look for opportunities to partner on creative solutions to meet both East and West Slope water supply requirements.	2												CE				X					X	CE									Transmountain Diverters
RWM B1g. Revitalize the Roaring Fork Watershed Collaborative Water Committee as a focal point for regional cooperation and communication.	2				X			X		X			X				CE					CE	X				X	X				
RWM B2a. Appoint a Working Group to identify mechanisms for consolidating and coordinating the Roaring Fork Valley's involvement in regional water management and to advise local governments on participation in regional water management planning.	1					X							CE				CE			X		X	CE									Local fishing industry
RWM B3a. Create a Working Group to investigate and recommend changes to regulations governing augmentation and substitute supply plans that reflect the importance of maintaining natural hydrology in the development of these plans. Pursue regulatory amendments, as necessary, through all appropriate channels.	3									CE			X			X	X			CE			X									
RWM B4a. Formalize the existing ad hoc arrangement among the CRWCD, USFS, Pitkin County, City of Aspen and CPW for establishing the annual flow regime for the Twin Lakes exchange and identify the entity(ies) in the watershed responsible for monitoring implementation of the Twin Lakes exchange on behalf of the Western Slope.	2							X		X			CE				CE					X					X					Transmountain Diverters
RWM B4b. Maintain active participation by Roaring Fork Watershed decision makers in the 10,825 Working Group to ensure that watershed interests are protected and obligations under existing agreements are met.	2					X		X					X				X						CE									BOR
RWM B4c. Cultivate collaborative relationships with those entities responsible for ensuring an adequate and sustainable water supply for the East Slope. Seek mutually-agreeable solutions to water supply issues whenever possible.	2					CE							X			X	X						CE									Transmountain Diverters

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RWM B5a. Investigate existing conditional water rights and determine if the exercise of these water rights would pose a threat to stream flows. Assess and pursue opportunities for securing or modifying the exercise of such rights within the confines of Colorado water law.	2									CE							X						CE								
RWM C1a. Periodically conduct watershed explorations for local decision makers.	3										X		X									CE	X								
RWM C1b. Conduct a periodic retreat for Roaring Fork Watershed decision makers on specific land use and water issues of common interest/concern.	3				X					X			CE				X					X	CE				X				SI
RWM C1c. Identify and collect all IGAs, MOUs, etc. between/among Roaring Fork Valley jurisdictions with applicability to water issues. Make all such agreements easily accessible to the public online. Analyze those agreements and look for opportunities to consolidate, clarify, or revise those documents to improve interagency collaboration.	2				X								X				X			X		X	CE				X				
RWM C1d. Identify jurisdictional and substantive gaps on water issues in existing IGAs, MOUs, etc. between/among local jurisdictions in the Roaring Fork Watershed. Recommend and pursue modifications to existing agreements, as well as new agreements, to close identified gaps.	2				X								X				X			X		X	CE				X				
RWM C2a. Modify local land use regulations to require referrals to state water commissioners and local fire protection districts during the land use application review phase.	2									X							CE														Fire Protection Districts
RWM C2b. Request that local land use planning departments adopt a policy of offering state water commissioners and local fire protection districts an opportunity to participate on any technical advisory/working groups developing amendments to land use regulations and/or forms addressing water resource matters of common interest.	3									X							CE														Fire Protection Districts
RWM C2c. Conduct a bi-annual meeting of local land use planners, local fire protection district personnel, and state water commissioners to provide a forum for discussing land use and water resource matters of common interest.	3									X							CE														Fire Protection Districts
RWM D1a. Improve collaboration among local jurisdictions and key stakeholders to ensure that adequate physical, chemical, and biological data are collected to monitor local climate change and assess its impacts.	2		X										X				CE					X			X		X				Aspen SkiCo
RWM D1b. Improve our decision makers' understanding of the potential impacts of climate change on our water resources.	2		X										X				CE					X			X		X				
RWM D1c. Conduct site-specific research and modeling within the Roaring Fork Watershed to improve projections of the impacts of climate change on the watershed.	2		CE										X				X					X	X		X						
RWM D1d. Review existing master plans in the watershed to identify changes necessary to account for the impact of climate change on the timing and magnitude of stream flows and water usage.	2		X														CE						X								

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RWM D1e. Review the existing water-related infrastructure and operational procedures in the Roaring Fork Watershed to identify changes necessary to account for the impact of climate change on the timing and magnitude of stream flows and water usage.	2		X							X			X				X	X					CE				X		X	X	Public Safety Council
RWM D1f. Research the impact that climate change may have on the water resource-related economy in the Roaring Fork Watershed.	2		CE					X					X				CE					CE					X				Aspen SkiCo; Sunlight Mt. Resort; local fishing industry
RWM D1g. Assess the vulnerability of the Roaring Fork Watershed to climate change. Develop an adaptive management strategy that integrates findings from the vulnerability assessment with watershed planning priorities and decision support.	2		CE														X														
SW A1a. At the state and local level, support the funding of research projects designed to address the non-consumptive needs knowledge gap.	3					X		X								CE	CE										X				
SW A1b. Work with the CBRT Non-Consumptive Needs Assessment (NCNA) Working Group and the designated NCNA contractors to assess the utility and limitations of the Watershed Flow Evaluation Tool. Evaluate the suitability of other tools/methods developed to provide a regional assessment of ecological risk conditions related to flow and if warranted, revise the regional assessment using the most suitable approach.	3					CE		X						X	X	X				CE		X		X							WRI
SW A1c. Ensure that the Colorado River Basin Water Availability Study adequately assesses and addresses the Roaring Fork Watershed's non-consumptive needs, including projected needs with climate alteration.	1		X			CE										CE	X			X		X	X	X							WRI
SW A1d. Create and maintain an adequate network of stream gages in the watershed.	2									CE			X				X					X						CE			
SW A1e. Assess flow alteration in stream reaches where stream gage or modeled data are lacking.	2													X	CE	X	CE			X		X	X	X			X	X			
SW A1f. Conduct site-specific studies of environmental and recreational flows needed for stream reaches that are currently significantly flow-altered or threatened by significant flow alteration. Include an analysis of how often these flows are not met.	1					CE		X						X	X	X	CE			X		X	X	X			CE				
SW A1g. Assess the direct and indirect economic consequences associated with non-optimal flows.	3																CE					X	X								
SW A1h. Ensure that local land use policies and regulations adequately assess all of the costs and benefits associated with hydropower development and mitigate the impact of hydropower development on other non-consumptive water uses. Ensure that hydropower development is considered and addressed in local Master Plans.	2																CE														FERC, Local Utilities
SW A1i. Assess potential local and regional recreational and environmental advantages and disadvantages associated with Recreational In-Channel Diversions (RICDs) in the watershed. As appropriate, obtain RICDs and ensure that they do not impact riparian and aquatic habitat.	2							CE		X							CE					X	X								

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SW B1a. Based on assessments of flow alteration and ecological consequences, quantify instream flow needs in streams with and without instream flow rights. Pursue instream flow rights for streams with inadequate or no instream flow rights.	2							X		X						CE	CE					X	X								
SW B1b. Investigate why CWCB instream flows are not being met and institute appropriate projects to remedy the problems identified.	2							X		CE							CE	X				X	X	X							
SW B1c. Increase the utilization of tools and funding available to improve instream flows.	2							X		X					X	CE	CE					X	X	X							CWT
SW B1d. Identify stream reaches where irrigation return flows and groundwater recharge provide late summer and fall flows and investigate opportunities to maintain these important sources of supplemental stream flows whenever possible.	3									X							CE	X	X												
SW B1e. Identify and pursue opportunities for improving natural and artificial water storage to improve low stream flows.	3							X		CE							CE		X			X	X				X				
SW B1f. Investigate if water conservation translates to environmental benefits under Colorado water law. Pursue opportunities for water conservation, if appropriate.	1												X				CE	X		X		CE	X							X	
SW B1g. Quantify the role of snow making in flow alteration and, where warranted, pursue opportunities for decreasing the environmental impact of snowmaking.	3									X							CE										CE				Aspen SkiCo; Sunlight Mt. Resort
SW C1a. Ensure that local land use planning requires an adequate technical assessment and legal review of the availability, sustainability, and (as applicable) potability of an adequate water supply for a proposed use prior to the grant of a development approval.	2																CE														
SW C1b. Quantify the direct and cumulative effects of changes in land use on surface flows. Incorporate the results in the review of local land use applications and investigate opportunities for mitigation.	3																CE														
SW C1c. Enhance communication and collaboration between local land use planners and water commissioners.	3									CE							CE														
SW C1d. Quantify expected proximal stream flow changes associated with a planned development's augmentation plan. Investigate and pursue opportunities for mitigating the impact to these streams within the confines of Colorado water law.	2									CE							CE												CE	CE	
SW C1e. Evaluate the need for ponds designed for fire mitigation and, where necessary, require that steps be taken to minimize their evaporative losses.	3									X							CE														Fire Protection Districts
SW C2a. Investigate existing conditional water rights and determine if the exercise of these water rights would pose a threat to stream flows. Assess and pursue opportunities for securing or modifying the exercise of such rights within the confines of Colorado water law.	2									X			X				CE	X					CE								
SW C3a. Complete a comprehensive climate impacts assessment on stream flows for the Roaring Fork Watershed.	3		CE		X								X	X	X	X	X					X	X	X			X				Aspen SkiCo; RMI

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SW D1a. Support and distribute films, videos, PowerPoint presentations, etc. illustrating local water conditions and issues.	3					X							X				X					CE	X								
SW D1b. Develop projects such as RFC's River Center, with exhibits to enhance public awareness of the importance of maintaining adequate streams flows in the watershed and the consequences of drought.	3	X															X					CE									
SW D1c. Support projects such as the Univ. of Michigan Master's Project Fostering Implementation of the Roaring Fork Watershed Plan. Utilize the Univ. of Michigan Master's Project's recommendations for improving public education and outreach, as appropriate.	3	X																				CE	CE								
SW D1d. Improve education/outreach on the connection between water availability and sustainability and land use planning and design strategies.	2										X						CE					X	X								SI
SW D1e. Improve education/outreach and opportunities for involvement in mitigating the effects of drought.	3										X		X			X	CE	X				X	X								
SW D1f. Improve education/outreach on the connection between high flows and healthy riparian and instream areas.	3	X						X			X				X							CE	X			X					WRI
SW D1g. Increase awareness of water conservation techniques and the importance of conservation. Identify and implement the most strategic water conservation measures.	2										X		CE				CE	X		X		CE	X						X	CE	
SW D1h. Improve education on the basis for obtaining and perfecting conditional water rights under Colorado water law.	3									X	X		X									X	CE								
SW E1a. Utilize the CWCB's 2010 Drought Mitigation and Response Plan and Drought Planning Toolbox.	3												X			CE	CE	X												X	X	
SW E1b. Work with the CWCB's Office of Water Conservation and Drought Planning to obtain technical assistance and grants to help develop local drought mitigation plans.	2												X			CE	CE	X												X	X	
SW E1c. Create "shovel-ready" drought-mitigation projects that can be quickly implemented.	3									X			X				CE	X				X					CE			X	X	
SW E1d. Investigate the potential benefits and disadvantages of acquiring small storage water rights that can be delivered for municipal uses in times of need and used to mitigate low stream flows. Pursue a streamlined approval process for landowners, if warranted.	3									X			X				CE	X	X											X	CE	
SW E1e. Investigate opportunities to temporarily loan water to streams using C.R.S. § 37-83-105. Discuss triggering criteria such as low snowpack levels on specific spring dates and draft agreements with critical water rights holders, CDWR Division Engineer, and CWCB that can be quickly implemented when needed.	3							X		X			X			CE	CE	X				X	X	X						X		CWT
SW E1f. Identify flow and temperature triggers and draft emergency drought fishing regulations.	3							CE																								
SW E2a. Ensure that county and municipal emergency management plans minimize the potential for harmful flooding in developed floodplains.	3																CE															FEMA
SW E2b. Where feasible, restore the natural function of floodplains.	3			X	CE			X							X	X	CE		X		X	X		X			CE					

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SW E2c. Ensure that the Federal Emergency Management Agency (FEMA) floodplain maps for the watershed used by local jurisdictions are up to date and available digitally for public access.	3																CE														FEMA
SW E2d. Develop and enforce local regulations that minimize development in the flood plain.	2																CE														
SW E2e. Identify and pursue opportunities to maintain decision makers' and the public's interest in flooding issues after flood events have passed, such as by creating "shovel-ready" flood mitigation projects that can be quickly implemented.	3				X		X	X							X	X	CE					X	X	X			X				Public Safety Council, BOR
GW A1a. Identify all sub-watersheds lacking detailed hydrogeologic information and prioritize the sub-watersheds for study on the basis of threats posed to the groundwater supply. Conduct hydrogeological assessments of all sub-watersheds lacking detailed hydrogeologic information, working collaboratively across sub-watershed jurisdictional boundaries.	2									X						X	CE	X											X	X	X	
GW A1b. Ensure that local governments obtain, utilize, and regularly update information from: (i) state well databases, and (ii) onsite wastewater treatment system permitting in their hydrogeological assessments.	3									X						X	CE														X	
GW A1c. Delineate areas of interaction between groundwater and surface water, including quantification and assessment of interaction type. For aquifers that are currently used or have the potential to be used: (i) quantify the water budget, (ii) rate the importance of the aquifers, and (iii) prioritize the need for additional detailed studies that include assessments of water budgets, flows, and water table interactions.	3									X							CE													X	X	
GW A2a. Adopt local regulations, policies, and procedures to ensure that there is a sufficient technical and legal demonstration of the availability and sustainability of an adequate water supply for any new land use or development reliant upon groundwater.	1									CE							CE													X	X	
GW B1a. Restore major wetlands areas in the watershed.	3			X	CE			X							X		CE				X	X					CE					
GW B1b. Identify and protect major wetlands areas in the watershed.	3			X	CE			X							X		CE				X	X					CE					
GW B1c. Institute programs to promote water reuse, particularly in areas that are using groundwater beyond its ability to recharge.	3										X		X				CE					X								X	CE	
GW B1d. Study and pursue opportunities, as appropriate to enhance natural recharge by slowing down sheet runoff and runoff in creeks and recharging potentially good aquifers such as terraces and fans.	3				CE												CE					X									CE	
GW B1e. Quantify the effect of changes in land use and development on groundwater recharge in both rural and urbanized areas of the watershed and disseminate the information to decision makers.	3									X							CE					X										SI

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GW B1f. Adopt local regulations, policies and procedures to ensure that the impacts on groundwater recharge are understood and taken into consideration by decision makers in the review and approval of land use applications.	3																CE													X	
GW B1g. Develop and implement a prioritized well-monitoring program for local jurisdictions to allow them to determine trends in groundwater levels, in coordination with ongoing studies.	3									X							CE												X	X	
GW B1h. Create and maintain an inventory of groundwater monitoring data and results.	3									X							CE														
GW B1i. Conduct detailed monitoring of groundwater levels and fluctuations in important wetland and groundwater discharge zones, including collection of information on aquifer thickness and development of parameters and information for development of detailed water budgets and modeling.	3																CE														
GW C1a. Adopt local regulations requiring confirmation of compliance with well permit conditions in connection with land use approvals and building permits.	2																CE													X	
GW C1b. Adopt local policies and procedures for notifying CDWR of any noncompliance with well permit conditions observed in connection with land use approvals and building permits.	2									X							CE													X	
GW C1c. Assess the need for additional resources in the administration of water rights.	3									CE			X				X			X											
GW C1d. Create maps of the watershed showing the location of exempt and non-exempt wells.	3									X			X				CE														
GW D1a. Create and disseminate educational materials on the impact of land use on groundwater resources.	3										X						CE					X									
GW D1b. Create maps of groundwater availability in the watershed.	3									X			X				CE			X		X						X			
GW D1c. Create and disseminate educational materials on the purpose of augmentation plans associated with new non-exempt wells and the potential for detrimental effects on local streams.	3										X		X		X		X					X									
GW D2a. Create summaries of all sub-watershed hydrogeological assessments targeted at the layperson, using a consistent format for all sub-watersheds. Make all summaries available online and publicize their availability.	3												X				CE					X									
GW D2b. Create and periodically broadcast local cable television programs discussing the hydrogeological assessments and explaining their importance for understanding groundwater supplies in the Roaring Fork Watershed.	3												X				CE					X									
GW D2c. Implement pricing mechanisms that better reflect the true value of a local groundwater supply and that encourage a decrease in usage.	3									CE							CE												X	X	
GW D2d. Develop projects such as the RFC's River Center, with exhibits to enhance public understanding of hydrogeology in the watershed and its relationship to the groundwater supply.	3										X											CE									

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WQ A1a. Convene a Water Quality Working Group to identify monitoring objectives, parameters, and protocols.	3							X	X				X				CE					CE	X				X	CE		X	
WQ A1b. Develop and implement a consistent process for analyzing and reporting on water quality monitoring results; build on the RFC's 5-year Water Quality Reports.	3																CE					CE						CE		X	
WQ A1c. Undertake targeted water quality monitoring studies to investigate water quality issues identified through routine water quality monitoring, and to capture the impacts or benefits of developments, projects, or other activities.	3							X									CE					X					X	X			
WQ A1d. Promote/support a sampling program for groundwater aimed at testing the integrity and water quality impacts of individual onsite wastewater treatment systems.	3								X								CE														
WQ A1e. Promote/support a sampling program for groundwater and surface waters aimed at testing the water quality impacts of snow dump facilities.	3								X								CE														
WQ B1a. Investigate and pursue opportunities for reducing water quality impacts from natural salinity.	3																CE	X	X			X									
WQ B1b. Identify human-based sediment sources and develop and implement strategies for reducing sediment from those sources.	3				X		X		X								CE		X			X					X				CDRM&S
WQ B1c. Incorporate water quality goals into local land use plans and regulations. Treat the maintenance and improvement of water quality as a priority in Master Plans and development approvals.	3																CE													X	
WQ B2a. Assess the adequacy of current water quality standards and recommend modifications.	2								X								X			CE					X						CWQF
WQ B2b. Consider the need/process for developing standards for private drinking water supplies.	3								CE								X			X					CE						CWQF
WQ B2c. Evaluate the implications of securing "outstanding waters" designations for local waterways.	3					X							CE		X		X	X		X							X		X	X	
WQ C1a. Provide incentives for the implementation of BMPs in connection with the control of nonpoint source pollution from development sites and activities.	3																CE														
WQ C1b. Develop a training program to help communities assess the adequacy of local regulations and land use policies regarding water quality, and the impacts of development on water quality.	3																			CE											DOLA, SI
WQ C1c. Assess the impacts of agricultural and commercial irrigation on water quality. Mandate/recommend mitigation strategies through local regulation, as warranted.	3								X								CE	X	X												
WQ C1d. Ensure that local regulations addressing stormwater impact mitigation and BMPs for stormwater management are effective, stringent, and enforced.	3																CE														
WQ C1e. Identify and prioritize stormwater mitigation improvement projects in each jurisdiction in each jurisdiction and plan for implementing such projects.	3																CE														
WQ C1f. Support state funding to inspect sites and enforce relevant regulations where stormwater management plans are required under WQCD Stormwater Construction General Permits.	3																CE			CE											

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WQ C1g. Assess current regulation of onsite wastewater treatment systems. Impose more stringent regulations, as warranted. Coordinate with the State of Colorado's plans to revise its regulatory framework.	3								X								CE														
WQ C1h. Require training and licensing of onsite wastewater treatment system installers, cleaners/pumpers, and inspectors.	3								X								CE														
WQ C1i. Support development of state and local financing mechanisms to provide incentives/assistance to individuals and subdivisions to upgrade or consolidate onsite wastewater treatment systems.	3								X								CE			CE											
WQ C1j. Maintain and publicize information on financial assistance available for upgrades to onsite wastewater treatment systems.	3								X								CE			X											DOLA
WQ C1k. Investigate the feasibility of creating regional wastewater treatment facilities that would consolidate or incorporate existing scattered onsite wastewater treatment systems and package plants. Pursue opportunities, as appropriate.	3																CE								X					CE	
WQ C1l. Improve opportunities for the use of constructed wetlands as an element of onsite wastewater or stormwater treatment, including the development of performance-based state regulations addressing constructed wetlands for onsite wastewater treatment, and mirroring those regulations at the local level.	3								CE								CE														USACE
WQ C1m. Assess surface water and groundwater quality impacts associated with snow dump sites. Ensure that local regulations addressing the location and impacts of snow dumping and runoff from snow dumps are effective, stringent, and enforced.	3																CE														
WQ C1n. Assess the impacts of magnesium chloride on water quality. Mandate/recommend alternatives/mitigation, as necessary, through local regulation.	2						CE										CE														
WQ C1o. Support the enforcement of federal and state regulations addressing oil and gas development.	2																CE			CE											COGCC
WQ C1p. Support disclosure of chemicals used in drilling and fracking and mandatory frack fluid tagging. Encourage owners and operators to use environmentally friendly alternatives. Support scientific studies of fracking impacts on the environment and public health.	2																CE			CE											COGCC
WQ C1q. Ensure that local land use policies and regulations limiting and mitigating the impacts of mining and oil and gas development on water quality are stringent and enforced.	2																CE														
WQ C1r. Address and regulate runoff from hazardous sites including mines, landfills, junkyards, and similar locations. Address and regulate the disposal/use of materials from sites potentially contaminated by hazardous materials.	3																CE								X						CDRM&S

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WQ C1s. Work with the State of Colorado to identify reclamation sites and work with responsible parties to assure that reclamation of mining sites is adequate and sustainable to mitigate impacts on water quality. Perform additional reclamation work as necessary.	3																CE										X				CDRM&S
WQ C1t. Work with local emergency and public safety agencies to assure that they are adequately trained and equipped to respond to releases of hazardous materials and spills.	3								X								X														Public Safety Council
WQ C1u. Support enforcement of streamside camping restrictions and development/enforcement of other recreational use restrictions by the USFS necessary to protect waterways. Work with the USFS to remove/reclaim campsites near rivers and streams.	3																										CE				IPF, RFOV, WW, WRFC
WQ C1v. Inventory and protect areas around natural springs.	3				X												CE										X			CE	
WQ C1w. Support new and additional funding mechanisms for water technology research and development.	3																								CE						NNI, Industry Associations
WQ C2a. Support the completion of the State Source Water Assessments for the watershed.	3								CE								X													X	CRWA
WQ C2b. Develop Source Water Protection Plans for all of the major water supply systems in the watershed.	3				X			X	X	X							X		X			X					X	X		X	CRWA
WQ C2c. Implement a private wellhead protection program.	3																CE														CRWA
WQ D1a. Upgrade technology and treatment methods at local wastewater treatment facilities as funding and infrastructure allow.	3								X																X					CE	
WQ D1b. Investigate the potential for reusing waste products from landfills, wastewater treatment plants, and commercial activities in order to reduce the need for increased treatment capacity at concentrated waste disposal sites.	3								CE								CE													CE	
WQ D1c. Support new and additional funding mechanisms for water technology research and development.	3																								CE						NNI, Industry Associations
WQ E1a. Improve local understanding of the importance of water quality and the relationship between water quality and quantity. Install signs and notices in appropriate areas noting the importance of maintaining water quality.	3										CE		X		X		X					CE	X				X			X	
WQ E1b. Improve the public's understanding of the importance of water quality to public health and safety and to the local lifestyle, economy, and environment, and of the consequences of a degraded or contaminated water supply.	3								CE		X		X				CE			X		X									
WQ E1c. Educate the public about daily activities that impact water quality and how individuals can modify their behavior and reduce water quality impacts on the watershed.	3								X		CE						X					CE									
WQ E1d. Improve local decision makers' understanding of federal, state, and local regulations addressing water quality by creating an illustration of the hierarchy of water quality agencies and regulations in a manner aimed at a lay audience.	3										CE		X										X								

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WQ E1e. Educate the public about issues surrounding the development of new water technologies, such as nanotechnology-based systems.	3																								CE						NNI, Industry Associations
WQ E1f. Improve public understanding of the risk of groundwater pollution by creating maps showing areas vulnerable and susceptible to groundwater contamination.	3																CE					CE									SI
WQ E1g. Implement a stream segment adoption program to facilitate cleanup and monitoring activities. Incorporate the program in school curriculums where possible. Create and publicize a map of "Adopted Streams".	3	X						X			X						X					CE									
WQ E1h. Improve public education regarding individual onsite wastewater treatment systems, particularly the need for regular system inspections – not just pumping.	1								X								CE								X						Colo Prof in Onsite Wastewater
WQ E1i. Educate the public on the benefits of BMPs and encourage public implementation of structural, vegetative, and non-structural BMPs whenever possible. Create incentive programs for voluntary retrofits of residential sites.	2								X		X						CE					X									
WQ F1a. Quantify the needs of our watershed as they relate to water quality. Support and participate in the Non-Consumptive Needs Assessment being carried out by the Colorado Basin Roundtable.	2					CE		X					X			X				CE		X									
WQ F1b. Ensure that local land use policies and regulations adequately address the water quality impacts of development, and that requisite mitigation measures imposed as conditions of land use approvals are both implemented and enforced.	2							X									CE														
WQ F1c. Monitor and address the impacts of high-use trails on water quality.	3				CE			X									CE										CE				WW
WQ F1d. Ensure that activities aimed at mitigating or responding to pine beetle and other insect infestations and diseases do not generate detrimental water quality impacts.	3	X			X				CE								X			X							X				Aspen SkiCo, WRFC
WQ F1e. Monitor and address the impacts of climate change on water quality.	3		CE						X				X	X		X	X														
RI A1a. Convene a Riparian/Instream Working Group to develop a riparian/instream monitoring program.	3				CE			CE				X			X		X		X	X	X	CE			X		CE				
RI B1a. Working with landowners, resource experts, and other interested parties, plan and implement riparian/ instream protection and restoration projects.	1			X	CE			X							X		CE		CE	X		X					CE				
RI B1b. On an ongoing basis, reassess the Colorado Natural Heritage Program's Potential Conservation Areas for changes in resource conditions or management needs.	3				X			X				CE				X	X				X						X				WW
RI B1c. Assess greenbelts/greenways as effective tools for protecting riparian areas in the watershed and pursue, as appropriate.	3			X											X		CE					X									
RI B1d. Research wetland mitigation banks and work to expand such a program, if warranted.	3			X													CE							X							RMI, USACE
RI B1e. Investigate regional planning mechanisms available for protection of riparian areas and funding available to support such a regional effort.	3																CE			X					X	X		X			NRCS

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RI B1f. Support state and federal tax credits for donations of conservation easements. Investigate additional tax incentives for such donations; work with interested parties on adoption of new incentives.	3			CE													CE					X									CWT
RI B2a. Using the results of the watershed-specific Bird Index of Biotic Integrity, implement habitat improvement projects.	3				CE			X				X			X		CE		X	X	X	X		X			CE				
RI B2b. Determine the potential impact of climate change on riparian-dependent wildlife.	3		CE					X						X													X				CU
RI B2c. Proactively develop the NEPA documentation necessary to relocate beavers to federal lands. Implement projects that promote beaver activity.	3				CE			X									CE					X		X			CE				
RI B2d. In conjunction with local land use approvals, require the design and execution of site-specific adaptive management plans to evaluate and minimize the impacts of development on riparian areas.	2							X									CE														
RI B2e. Inventory and maintain or increase the population size and range of plant species and communities of concern, as appropriate.	3				X							X															X				
RI B3a. Determine the optimum number and distribution of CRCT populations and implement projects that work toward achieving this goal.	2				CE			CE							X												CE				
RI B3b. Conduct fish surveys above natural and man-made barriers to determine if there are additional populations of CRCT in the watershed. Increase/institute monitoring of all identified CRCT populations.	3				CE			CE																			CE				
RI B3c. Study the potential effects of climate change on CRCT populations.	3		CE		CE			X						CE											CE	CE	CE	CE			CU
RI B4a. Monitor wild, naturally-reproducing fish populations (including non-game fish) and conduct spawning surveys.	3				X			CE																			X				
RI B4b. Identify, protect, and restore important trout spawning habitat. In areas of high spawning importance, evaluate seasonal closures and, if warranted, implement closures.	3				X			CE																			X				
RI B4c. Follow the "Range-wide Conservation Agreement and Strategy for Bluehead Sucker and Flannelmouth Sucker".	3				X			CE																		CE	X				
RI B4d. Determine the effect of stream temperature on wild, naturally-reproducing fish species distribution and initiate actions to ensure that threshold temperatures are not exceeded.	3		X		X			CE	CE					X												X	X				
RI B4e. Inventory road/stream crossings and improve fish passage, as needed.	3				CE		X	CE							X		X										CE				
RI B4f. Improve education regarding methods to reduce whirling disease transmission.	3				CE			CE						X	CE		X					X					CE				Whirling Disease Foundation
RI B4g. Address the problem of illegal introduction of fish in the watershed through education and regulatory initiatives.	3				X			CE							X												X				CU
RI B5a. Monitor key amphibian populations to determine their status.	3				CE			CE				X														X	CE	X			

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RI B5b. Restore important amphibian habitats and, if appropriate, pursue opportunities for the reintroduction of species.	3				CE			CE				X														X	CE	X			
RI B5c. Study the potential impact of climate change on amphibian populations.	3		X		CE			CE				X		X												X	CE	X			CU
RI B5d. Survey potential boreal toad habitats to determine if additional populations exist in the watershed.	3				CE			CE				X														X	CE	X			
RI B5e. Increase awareness of the dangers to toad populations associated with Chytridiomycosis fungus transmission.	3				X			CE				X														X	X	CE			CU
RI B5f. Follow the Conservation Plan and Agreement for the Management and Recovery of the Southern Rocky Mountain Population of the Boreal Toad.	3				X			CE																			X	CE			
RI C1a. Evaluate and address the impacts of riparian alteration/disturbance on native riparian-dependent wildlife and plant species and communities of concern and native wildlife species.	3				CE			X				X		CE	X		X				X	X		X			CE				
RI C1b. Investigate the effects of acute and chronic sediment pulses on aquatic ecosystems, differentiating between natural and human-influenced sources of sediment.	3				CE			X						CE			X										CE				
RI C1c. Develop and implement Best Management Practices (BMPs) for instream projects that minimize sedimentation and turbidity to reduce impacts to spawning fish movement, incubating eggs and fry, and spawning habitat.	3				CE			CE							X		X					X					CE				USACE
RI C1d. Implement Travel Management Plan for the White River National Forest, including closing, obliterating, and signing select roads.	3																										CE				
RI C1e. Develop and enforce stream setbacks that protect riparian areas throughout the watershed.	1				X												CE										X				
RI C1f. Inventory developed and dispersed recreation sites, trails, and access points, and assess their impacts on riparian and instream areas; work to reduce impacts. Minimize the impact of new recreational sites, access points, and trails on riparian and instream areas.	3				CE			X									CE										CE				
RI C1g. Prevent or mitigate riparian and instream impacts associated with agricultural activities.	3				CE														CE								CE				
RI C1h. Minimize instream impacts and improve fish habitat by reengineering instream structures intended to move water into headgates.	3				CE			CE		X				CE	CE		CE		CE	X		X					CE				Ditch companies
RI C1i. Restore riparian and instream areas impacted by historical mining activities.	3				CE										X		CE										CE				CDRM&S
RI C1j. Ensure that oil and gas development does not adversely impact riparian and instream areas.	3				CE			CE									CE										CE				TDC, COGCC
RI C1k. Work to minimize/mitigate the effects of bridges on riparian and instream habitat.	3				CE		CE	CE									CE										CE				
RI D1a. Provide education to the public about the important functions of riparian areas, development and other threats to riparian areas, what can be done to protect and restore riparian areas, and potential sources of funding for riparian projects.	1	X		X	CE			X				CE		CE	CE		CE		CE	X		CE	X				CE				

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RI D1b. Develop the RFC's River Center, with its exhibits on the importance of riparian and instream areas to the watershed.	2																					CE									
RI D1c. Provide publicity, tours, and interpretation of riparian and instream restoration projects.	3	X			CE												X		CE	X		CE	X				X				
RI D1d. Involve the public in restoration projects.	3	CE			CE			CE					X		X		X		CE	X		X					CE				RFOV
RI E1a. Convene an Invasive Species Task Force.	2				CE		X										CE		CE	X							CE				
RI E1b. Work with local jurisdictions' weed boards, the USFS, BLM, MSCD, and private land owners to eradicate/control invasive plant species that are a significant concern, particularly adjacent to riparian areas and along roads.	3				CE		CE										CE		CE	X							CE				WRFC, RFOV, ditch companies
RI E2a. Research and survey the Didymo algae to determine the cause of its rapid spread, the ecological implications, and possible methods of control.	3				X			X	X					CE	X										CE		X	CE			
RI E2b. Improve our understanding of the economic and ecological consequences of ANS invasion and the methods for preventing the spread of such species. Provide education on the spread of ANS.	2				X			CE						CE	X		CE					CE	CE				CE	X			BOR
RI E2c. Implement invasive species inspection/monitoring programs. Require proper cleaning and disinfection of boats and construction equipment used in watercourses.	2							CE															CE				CE				
RI E2d. Institute new regulations, as necessary, to address the movement of aquatic species within and between drainages to prevent the movement of ANS.	3							CE															CE				CE				
TOTALS		8	14	8	55	19	7	62	25	40	21	11	61	16	31	26	164	16	18	37	7	84	56	14	16	11	77	21	15	30	69

Recommended Action	Project/ Program	Study	Legislative/ Regulatory
RWM A1a. Regularly broadcast educational presentations on federal and state water policies/programs.	X		
RWM A1b. Issue regular press releases from the CBRT, CRWCD, and RWAPA. Include "tie-ins" to the Roaring Fork Watershed whenever possible in press communications.	X		
RWM A1c. Use social networking opportunities to improve communication with respect to meetings, workshops, and other educational opportunities concerning water issues.	X		
RWM A2a. Fund and distribute videos, PowerPoint presentations, brochures, and other media that tell the story of the Roaring Fork Watershed. Exhibit and promote these products as widely as possible.	X		
RWM A2b. Create a graphical tool, or an educational game illustrating the relationship between downstream calls, transmountain diversions, in-basin diversions and flows in the Roaring Fork Watershed. Make this tool available for schools and for presentations on water issues.	X		
RWM A2c. Support projects such as the CRWCD/NWCCOG Q/Q's "It's the Same Water Campaign" and the RFC's River Center, including exhibits to enhance public awareness of complex regional water management issues.	X		
RWM A2d. Create a portable plumbing model of the Roaring Fork Watershed similar to the NRCS stream trailer.	X		
RWM A2e. Publish and distribute the RWAPA document, "Front Range Water Supply Planning Update: Increased Storage, Increased Demands, Increased Diversions." Translate and graphically represent key findings from this document.	X		
RWM A2f. Support projects such as the Univ. of Michigan Master's Project, "Fostering Implementation of the Roaring Fork Watershed Plan." Evaluate and utilize recommendations for improving public education and outreach from the Univ. of Michigan Master's Project, as appropriate. Seek opportunities to engage academia in research and implementation projects.	X		
RWM A3a. Advertise the CBRT meetings and their agendas Include information on subcommittee/working group meetings that are open for public participation.	X		
RWM A3b. Broadcast CBRT meetings and publicize the broadcasts.	X		
RWM A3c. Institute regular reporting to constituents by the Roaring Fork Watershed CBRT representatives in "user friendly" formats.	X		
RWM A3d. Create a mechanism to capture and relay public comment to the CBRT on issues affecting the Roaring Fork Watershed.	X		
RWM A3e. Support/fund a touring educational program on regional watershed management issues.	X		
RWM B1a. Appoint a Working Group to study and make recommendations on how the CRWCD can better foster collaboration among its Roaring Fork Watershed Board members.		X	
RWM B1b. Cultivate collaborative relationships with state and federal water resource experts and decision makers. Look for opportunities for agencies to partner on multi-jurisdictional projects.	X		
RWM B1c. Hold public meetings on significant water issues affecting the Roaring Fork Watershed with CBRT and RWAPA representatives, CRWCD Directors, and local elected officials. Publicize these meetings through various means.	X		
RWM B1d. Identify streams in the watershed that may be candidates for federal wild, scenic, and recreational status. Determine community support for a designation and work to meet community goals.		X	X
RWM B1e. Encourage Pitkin County's River Board to publicize its priorities and activities and to take steps to coordinate those activities with local water managers and interest groups.	X		
RWM B1f. Cultivate collaborative relationships with the entities diverting water from Roaring Fork Watershed to the East Slope. Look for opportunities to partner on creative solutions to meet both East and West Slope water supply requirements.	X		
RWM B1g. Revitalize the Roaring Fork Watershed Collaborative Water Committee as a focal point for regional cooperation and communication.	X		
RWM B2a. Appoint a Working Group to identify mechanisms for consolidating and coordinating the Roaring Fork Valley's involvement in regional water management and to advise local governments on participation in regional water management planning.		X	
RWM B3a. Create a Working Group to investigate and recommend changes to regulations governing augmentation and substitute supply plans that reflect the importance of maintaining natural hydrology in the development of these plans. Pursue regulatory amendments, as necessary, through all appropriate channels.		X	X
RWM B4a. Formalize the existing ad hoc arrangement among the CRWCD, USFS, Pitkin County, City of Aspen and CPW for establishing the annual flow regime for the Twin Lakes exchange and identify the entity(ies) in the watershed responsible for monitoring implementation of the Twin Lakes exchange on behalf of the Western Slope.	X		
RWM B4b. Maintain active participation by Roaring Fork Watershed decision makers in the 10,825 Working Group to ensure that watershed interests are protected and obligations under existing agreements are met.	X		
RWM B4c. Cultivate collaborative relationships with those entities responsible for ensuring an adequate and sustainable water supply for the East Slope. Seek mutually-agreeable solutions to water supply issues whenever possible.	X		
RWM B5a. Investigate existing conditional water rights and determine if the exercise of these water rights would pose a threat to stream flows. Assess and pursue opportunities for securing or modifying the exercise of such rights within the confines of Colorado water law.	X	X	
RWM C1a. Periodically conduct watershed explorations for local decision makers.	X		
RWM C1b. Conduct a periodic retreat for Roaring Fork Watershed decision makers on specific land use and water issues of common interest/concern.	X		

Recommended Action	Project/ Program	Study	Legislative/ Regulatory
RWM C1c. Identify and collect all IGAs, MOUs, etc. between/among Roaring Fork Valley jurisdictions with applicability to water issues. Make all such agreements easily accessible to the public online. Analyze those agreements and look for opportunities to consolidate, clarify, or revise those documents to improve interagency collaboration.	X	X	X
RWM C1d. Identify jurisdictional and substantive gaps on water issues in existing IGAs, MOUs, etc. between/among local jurisdictions in the Roaring Fork Watershed. Recommend and pursue modifications to existing agreements, as well as new agreements, to close identified gaps.		X	X
RWM C2a. Modify local land use regulations to require referrals to state water commissioners and local fire protection districts during the land use application review phase.			X
RWM C2b. Request that local land use planning departments adopt a policy of offering state water commissioners and local fire protection districts an opportunity to participate on any technical advisory/working groups developing amendments to land use regulations and/or forms addressing water resource matters of common interest.			X
RWM C2c. Conduct a bi-annual meeting of local land use planners, local fire protection district personnel, and state water commissioners to provide a forum for discussing land use and water resource matters of common interest.	X		
RWM D1a. Improve collaboration among local jurisdictions and key stakeholders to ensure that adequate physical, chemical, and biological data are collected to monitor local climate change and assess its impacts.	X		
RWM D1b. Improve our decision makers' understanding of the potential impacts of climate change on our water resources.	X		
RWM D1c. Conduct site-specific research and modeling within the Roaring Fork Watershed to improve projections of the impacts of climate change on the watershed.		X	
RWM D1d. Review existing master plans in the watershed to identify changes necessary to account for the impact of climate change on the timing and magnitude of stream flows and water usage.		X	
RWM D1e. Review the existing water-related infrastructure and operational procedures in the Roaring Fork Watershed to identify changes necessary to account for the impact of climate change on the timing and magnitude of stream flows and water usage.		X	
RWM D1f. Research the impact that climate change may have on the water resource-related economy in the Roaring Fork Watershed.		X	
RWM D1g. Assess the vulnerability of the Roaring Fork Watershed to climate change. Develop an adaptive management strategy that integrates findings from the vulnerability assessment with watershed planning priorities and decision support.		X	
SW A1a. At the state and local level, support the funding of research projects designed to address the non-consumptive needs knowledge gap.		X	X
SW A1b. Work with the CBRT Non-Consumptive Needs Assessment (NCNA) Working Group and the designated NCNA contractors to assess the utility and limitations of the Watershed Flow Evaluation Tool. Evaluate the suitability of other tools/methods developed to provide a regional assessment of ecological risk conditions related to flow and if warranted, revise the regional assessment using the most suitable approach.		X	
SW A1c. Ensure that the Colorado River Basin Water Availability Study adequately assesses and addresses the Roaring Fork Watershed's non-consumptive needs, including projected needs with climate alteration.		X	
SW A1d. Create and maintain an adequate network of stream gages in the watershed.	X		
SW A1e. Assess flow alteration in stream reaches where stream gage or modeled data are lacking.		X	
SW A1f. Conduct site-specific studies of environmental and recreational flows needed for stream reaches that are currently significantly flow-altered or threatened by significant flow alteration. Include an analysis of how often these flows are not met.		X	
SW A1g. Assess the direct and indirect economic consequences associated with non-optimal flows.		X	
SW A1h. Ensure that local land use policies and regulations adequately assess all of the costs and benefits associated with hydropower development and mitigate the impact of hydropower development on other non-consumptive water uses. Ensure that hydropower development is considered and addressed in local Master Plans.			X
SW A1i. Assess potential local and regional recreational and environmental advantages and disadvantages associated with Recreational In-Channel Diversions (RICDs) in the watershed. As appropriate, obtain RICDs and ensure that they do not impact riparian and aquatic habitat.	X	X	
SW B1a. Based on assessments of flow alteration and ecological consequences, quantify instream flow needs in streams with and without instream flow rights. Pursue instream flow rights for streams with inadequate or no instream flow rights.	X	X	
SW B1b. Investigate why CWCB instream flows are not being met and institute appropriate projects to remedy the problems identified.	X	X	
SW B1c. Increase the utilization of tools and funding available to improve instream flows.	X		
SW B1d. Identify stream reaches where irrigation return flows and groundwater recharge provide late summer and fall flows and investigate opportunities to maintain these important sources of supplemental stream flows whenever possible.		X	X
SW B1e. Identify and pursue opportunities for improving natural and artificial water storage to improve low stream flows.	X	X	
SW B1f. Investigate if water conservation translates to environmental benefits under Colorado water law. Pursue opportunities for water conservation, if appropriate.		X	X
SW B1g. Quantify the role of snow making in flow alteration and, where warranted, pursue opportunities for decreasing the environmental impact of snowmaking.	X	X	

Recommended Action	Project/ Program	Study	Legislative/ Regulatory
SW C1a. Ensure that local land use planning requires an adequate technical assessment and legal review of the availability, sustainability, and (as applicable) potability of an adequate water supply for a proposed use prior to the grant of a development approval.			X
SW C1b. Quantify the direct and cumulative effects of changes in land use on surface flows. Incorporate the results in the review of local land use applications and investigate opportunities for mitigation.		X	X
SW C1c. Enhance communication and collaboration between local land use planners and water commissioners.	X		X
SW C1d. Quantify expected proximal stream flow changes associated with a planned development's augmentation plan. Investigate and pursue opportunities for mitigating the impact to these streams within the confines of Colorado water law.		X	X
SW C1e. Evaluate the need for ponds designed for fire mitigation and, where necessary, require that steps be taken to minimize their evaporative losses.		X	X
SW C2a. Investigate existing conditional water rights and determine if the exercise of these water rights would pose a threat to stream flows. Assess and pursue opportunities for securing or modifying the exercise of such rights within the confines of Colorado water law.	X	X	
SW C3a. Complete a comprehensive climate impacts assessment on stream flows for the Roaring Fork Watershed.		X	
SW D1a. Support and distribute films, videos, PowerPoint presentations, etc. illustrating local water conditions and issues.	X		
SW D1b. Develop projects such as RFC's River Center, with exhibits to enhance public awareness of the importance of maintaining adequate streams flows in the watershed and the consequences of drought.	X		
SW D1c. Support projects such as the Univ. of Michigan Master's Project Fostering Implementation of the Roaring Fork Watershed Plan. Utilize the Univ. of Michigan Master's Project's recommendations for improving public education and outreach, as appropriate.	X		
SW D1d. Improve education/outreach on the connection between water availability and sustainability and land use planning and design strategies.	X		
SW D1e. Improve education/outreach and opportunities for involvement in mitigating the effects of drought.	X		
SW D1f. Improve education/outreach on the connection between high flows and healthy riparian and instream areas.	X		
SW D1g. Increase awareness of water conservation techniques and the importance of conservation. Identify and implement the most strategic water conservation measures.	X	X	
SW D1h. Improve education on the basis for obtaining and perfecting conditional water rights under Colorado water law.	X		
SW E1a. Utilize the CWCB's 2010 Drought Mitigation and Response Plan and Drought Planning Toolbox.	X		
SW E1b. Work with the CWCB's Office of Water Conservation and Drought Planning to obtain technical assistance and grants to help develop local drought mitigation plans.	X		
SW E1c. Create "shovel-ready" drought-mitigation projects that can be quickly implemented.	X		
SW E1d. Investigate the potential benefits and disadvantages of acquiring small storage water rights that can be delivered for municipal uses in times of need and used to mitigate low stream flows. Pursue a streamlined approval process for landowners, if warranted.		X	X
SW E1e. Investigate opportunities to temporarily loan water to streams using C.R.S. § 37-83-105. Discuss triggering criteria such as low snowpack levels on specific spring dates and draft agreements with critical water rights holders, CDWR Division Engineer, and CWCB that can be quickly implemented when needed.	X	X	
SW E1f. Identify flow and temperature triggers and draft emergency drought fishing regulations.		X	X
SW E2a. Ensure that county and municipal emergency management plans minimize the potential for harmful flooding in developed floodplains.	X	X	
SW E2b. Where feasible, restore the natural function of floodplains.	X	X	
SW E2c. Ensure that the Federal Emergency Management Agency (FEMA) floodplain maps for the watershed used by local jurisdictions are up to date and available digitally for public access.	X		
SW E2d. Develop and enforce local regulations that minimize development in the flood plain.			X
SW E2e. Identify and pursue opportunities to maintain decision makers' and the public's interest in flooding issues after flood events have passed, such as by creating "shovel-ready" flood mitigation projects that can be quickly implemented.	X	X	
GW A1a. Identify all sub-watersheds lacking detailed hydrogeologic information and prioritize the sub-watersheds for study on the basis of threats posed to the groundwater supply. Conduct hydrogeological assessments of all sub-watersheds lacking detailed hydrogeologic information, working collaboratively across sub-watershed jurisdictional boundaries.	X	X	
GW A1b. Ensure that local governments obtain, utilize, and regularly update information from: (i) state well databases, and (ii) onsite wastewater treatment system permitting in their hydrogeological assessments.	X		
GW A1c. Delineate areas of interaction between groundwater and surface water, including quantification and assessment of interaction type. For aquifers that are currently used or have the potential to be used: (i) quantify the water budget, (ii) rate the importance of the aquifers, and (iii) prioritize the need for additional detailed studies that include assessments of water budgets, flows, and water table interactions.		X	
GW A2a. Adopt local regulations, policies, and procedures to ensure that there is a sufficient technical and legal demonstration of the availability and sustainability of an adequate water supply for any new land use or development reliant upon groundwater.			X
GW B1a. Restore major wetlands areas in the watershed.	X		
GW B1b. Identify and protect major wetlands areas in the watershed.	X		X

Recommended Action	Project/ Program	Study	Legislative/ Regulatory
GW B1c. Institute programs to promote water reuse, particularly in areas that are using groundwater beyond its ability to recharge.	X		
GW B1d. Study and pursue opportunities, as appropriate to enhance natural recharge by slowing down sheet runoff and runoff in creeks and recharging potentially good aquifers such as terraces and fans.	X	X	
GW B1e. Quantify the effect of changes in land use and development on groundwater recharge in both rural and urbanized areas of the watershed and disseminate the information to decision makers.		X	
GW B1f. Adopt local regulations, policies and procedures to ensure that the impacts on groundwater recharge are understood and taken into consideration by decision makers in the review and approval of land use applications.			X
GW B1g. Develop and implement a prioritized well-monitoring program for local jurisdictions to allow them to determine trends in groundwater levels, in coordination with ongoing studies.	X	X	
GW B1h. Create and maintain an inventory of groundwater monitoring data and results.	X		
GW B1i. Conduct detailed monitoring of groundwater levels and fluctuations in important wetland and groundwater discharge zones, including collection of information on aquifer thickness and development of parameters and information for development of detailed water budgets and modeling.		X	
GW C1a. Adopt local regulations requiring confirmation of compliance with well permit conditions in connection with land use approvals and building permits.			X
GW C1b. Adopt local policies and procedures for notifying CDWR of any noncompliance with well permit conditions observed in connection with land use approvals and building permits.			X
GW C1c. Assess the need for additional resources in the administration of water rights.		X	
GW C1d. Create maps of the watershed showing the location of exempt and non-exempt wells.	X		
GW D1a. Create and disseminate educational materials on the impact of land use on groundwater resources.	X		
GW D1b. Create maps of groundwater availability in the watershed.	X		
GW D1c. Create and disseminate educational materials on the purpose of augmentation plans associated with new non-exempt wells and the potential for detrimental effects on local streams.	X		
GW D2a. Create summaries of all sub-watershed hydrogeological assessments targeted at the layperson, using a consistent format for all sub-watersheds. Make all summaries available online and publicize their availability.	X		
GW D2b. Create and periodically broadcast local cable television programs discussing the hydrogeological assessments and explaining their importance for understanding groundwater supplies in the Roaring Fork Watershed.	X		
GW D2c. Implement pricing mechanisms that better reflect the true value of a local groundwater supply and that encourage a decrease in usage.	X		X
GW D2d. Develop projects such as the RFC's River Center, with exhibits to enhance public understanding of hydrogeology in the watershed and its relationship to the groundwater supply.	X		
WQ A1a. Convene a Water Quality Working Group to identify monitoring objectives, parameters, and protocols.	X	X	
WQ A1b. Develop and implement a consistent process for analyzing and reporting on water quality monitoring results; build on the RFC's 5-year Water Quality Reports.	X	X	
WQ A1c. Undertake targeted water quality monitoring studies to investigate water quality issues identified through routine water quality monitoring, and to capture the impacts or benefits of developments, projects, or other activities.	X		
WQ A1d. Promote/support a sampling program for groundwater aimed at testing the integrity and water quality impacts of individual onsite wastewater treatment systems.	X		
WQ A1e. Promote/support a sampling program for groundwater and surface waters aimed at testing the water quality impacts of snow dump facilities.	X		
WQ B1a. Investigate and pursue opportunities for reducing water quality impacts from natural salinity.	X	X	
WQ B1b. Identify human-based sediment sources and develop and implement strategies for reducing sediment from those sources.	X	X	
WQ B1c. Incorporate water quality goals into local land use plans and regulations. Treat the maintenance and improvement of water quality as a priority in Master Plans and development approvals.			X
WQ B2a. Assess the adequacy of current water quality standards and recommend modifications.		X	
WQ B2b. Consider the need/process for developing standards for private drinking water supplies.		X	
WQ B2c. Evaluate the implications of securing "outstanding waters" designations for local waterways.		X	
WQ C1a. Provide incentives for the implementation of BMPs in connection with the control of nonpoint source pollution from development sites and activities.			X
WQ C1b. Develop a training program to help communities assess the adequacy of local regulations and land use policies regarding water quality, and the impacts of development on water quality.	X		
WQ C1c. Assess the impacts of agricultural and commercial irrigation on water quality. Mandate/recommend mitigation strategies through local regulation, as warranted.		X	X
WQ C1d. Ensure that local regulations addressing stormwater impact mitigation and BMPs for stormwater management are effective, stringent, and enforced.			X
WQ C1e. Identify and prioritize stormwater mitigation improvement projects in each jurisdiction in each jurisdiction and plan for implementing such projects.	X	X	
WQ C1f. Support state funding to inspect sites and enforce relevant regulations where stormwater management plans are required under WQCD Stormwater Construction General Permits.			X
WQ C1g. Assess current regulation of onsite wastewater treatment systems. Impose more stringent regulations, as warranted. Coordinate with the State of Colorado's plans to revise its regulatory framework.		X	X

Recommended Action	Project/ Program	Study	Legislative/ Regulatory
WQ C1h. Require training and licensing of onsite wastewater treatment system installers, cleaners/pumpers, and inspectors.			X
WQ C1i. Support development of state and local financing mechanisms to provide incentives/assistance to individuals and subdivisions to upgrade or consolidate onsite wastewater treatment systems.			X
WQ C1j. Maintain and publicize information on financial assistance available for upgrades to onsite wastewater treatment systems.	X		
WQ C1k. Investigate the feasibility of creating regional wastewater treatment facilities that would consolidate or incorporate existing scattered onsite wastewater treatment systems and package plants. Pursue opportunities, as appropriate.	X	X	
WQ C1l. Improve opportunities for the use of constructed wetlands as an element of onsite wastewater or stormwater treatment, including the development of performance-based state regulations addressing constructed wetlands for onsite wastewater treatment, and mirroring those regulations at the local level.			X
WQ C1m. Assess surface water and groundwater quality impacts associated with snow dump sites. Ensure that local regulations addressing the location and impacts of snow dumping and runoff from snow dumps are effective, stringent, and enforced.		X	X
WQ C1n. Assess the impacts of magnesium chloride on water quality. Mandate/recommend alternatives/mitigation, as necessary, through local regulation.		X	X
WQ C1o. Support the enforcement of federal and state regulations addressing oil and gas development.			X
WQ C1p. Support disclosure of chemicals used in drilling and fracking and mandatory frack fluid tagging. Encourage owners and operators to use environmentally friendly alternatives. Support scientific studies of fracking impacts on the environment and public health.		X	X
WQ C1q. Ensure that local land use policies and regulations limiting and mitigating the impacts of mining and oil and gas development on water quality are stringent and enforced.			X
WQ C1r. Address and regulate runoff from hazardous sites including mines, landfills, junkyards, and similar locations. Address and regulate the disposal/use of materials from sites potentially contaminated by hazardous materials.			X
WQ C1s. Work with the State of Colorado to identify reclamation sites and work with responsible parties to assure that reclamation of mining sites is adequate and sustainable to mitigate impacts on water quality. Perform additional reclamation work as necessary.	X		
WQ C1t. Work with local emergency and public safety agencies to assure that they are adequately trained and equipped to respond to releases of hazardous materials and spills.	X		
WQ C1u. Support enforcement of streamside camping restrictions and development/enforcement of other recreational use restrictions by the USFS necessary to protect waterways. Work with the USFS to remove/reclaim campsites near rivers and streams.	X		X
WQ C1v. Inventory and protect areas around natural springs.	X		
WQ C1w. Support new and additional funding mechanisms for water technology research and development.			X
WQ C2a. Support the completion of the State Source Water Assessments for the watershed.	X		
WQ C2b. Develop Source Water Protection Plans for all of the major water supply systems in the watershed.	X		
WQ C2c. Implement a private wellhead protection program.	X		
WQ D1a. Upgrade technology and treatment methods at local wastewater treatment facilities as funding and infrastructure allow.	X		
WQ D1b. Investigate the potential for reusing waste products from landfills, wastewater treatment plants, and commercial activities in order to reduce the need for increased treatment capacity at concentrated waste disposal sites.		X	
WQ D1c. Support new and additional funding mechanisms for water technology research and development.			X
WQ E1a. Improve local understanding of the importance of water quality and the relationship between water quality and quantity. Install signs and notices in appropriate areas noting the importance of maintaining water quality.	X		
WQ E1b. Improve the public's understanding of the importance of water quality to public health and safety and to the local lifestyle, economy, and environment, and of the consequences of a degraded or contaminated water supply.	X		
WQ E1c. Educate the public about daily activities that impact water quality and how individuals can modify their behavior and reduce water quality impacts on the watershed.	X		
WQ E1d. Improve local decision makers' understanding of federal, state, and local regulations addressing water quality by creating an illustration of the hierarchy of water quality agencies and regulations in a manner aimed at a lay audience.	X		
WQ E1e. Educate the public about issues surrounding the development of new water technologies, such as nanotechnology-based systems.	X		
WQ E1f. Improve public understanding of the risk of groundwater pollution by creating maps showing areas vulnerable and susceptible to groundwater contamination.	X		
WQ E1g. Implement a stream segment adoption program to facilitate cleanup and monitoring activities. Incorporate the program in school curriculums where possible. Create and publicize a map of “Adopted Streams”.	X		
WQ E1h. Improve public education regarding individual onsite wastewater treatment systems, particularly the need for regular system inspections – not just pumping.	X		
WQ E1i. Educate the public on the benefits of BMPs and encourage public implementation of structural, vegetative, and non-structural BMPs whenever possible. Create incentive programs for voluntary retrofits of residential sites.	X		X

Recommended Action	Project/ Program	Study	Legislative/ Regulatory
WQ F1a. Quantify the needs of our watershed as they relate to water quality. Support and participate in the Non-Consumptive Needs Assessment being carried out by the Colorado Basin Roundtable.		X	
WQ F1b. Ensure that local land use policies and regulations adequately address the water quality impacts of development, and that requisite mitigation measures imposed as conditions of land use approvals are both implemented and enforced.			X
WQ F1c. Monitor and address the impacts of high-use trails on water quality.		X	X
WQ F1d. Ensure that activities aimed at mitigating or responding to pine beetle and other insect infestations and diseases do not generate detrimental water quality impacts.		X	X
WQ F1e. Monitor and address the impacts of climate change on water quality.	X	X	

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RWM A1a. Regularly broadcast educational presentations on federal and state water policies/programs.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RWM A1b. Issue regular press releases from the CBRT, CRWCD, and RWAPA. Include "tie-ins" to the Roaring Fork Watershed whenever possible in press communications.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RWM A1c. Use social networking opportunities to improve communication with respect to meetings, workshops, and other educational opportunities concerning water issues.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RWM A2a. Fund and distribute videos, PowerPoint presentations, brochures, and other media that tell the story of the Roaring Fork Watershed. Exhibit and promote these products as widely as possible.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RWM A2b. Create a graphical tool, or an educational game illustrating the relationship between downstream calls, transmountain diversions, in-basin diversions and flows in the Roaring Fork Watershed. Make this tool available for schools and for presentations on water issues.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RWM A2c. Support projects such as the CRWCD/NWCCOG Q/Q's "It's the Same Water Campaign" and the RFC's River Center, including exhibits to enhance public awareness of complex regional water management issues.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RWM A2d. Create a portable plumbing model of the Roaring Fork Watershed similar to the NRCS stream trailer.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RWM A2e. Publish and distribute the RWAPA document, "Front Range Water Supply Planning Update: Increased Storage, Increased Demands, Increased Diversions." Translate and graphically represent key findings from this document.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RWM A2f. Support projects such as the Univ. of Michigan Master's Project, "Fostering Implementation of the Roaring Fork Watershed Plan." Evaluate and utilize recommendations for improving public education and outreach from the Univ. of Michigan Master's Project, as appropriate. Seek opportunities to engage academia in research and implementation projects.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RWM A3a. Advertise the CBRT meetings and their agendas Include information on subcommittee/working group meetings that are open for public participation.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RWM A3b. Broadcast CBRT meetings and publicize the broadcasts.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RWM A3c. Institute regular reporting to constituents by the Roaring Fork Watershed CBRT representatives in "user friendly" formats.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RWM A3d. Create a mechanism to capture and relay public comment to the CBRT on issues affecting the Roaring Fork Watershed.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RWM A3e. Support/fund a touring educational program on regional watershed management issues.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RWM B1a. Appoint a Working Group to study and make recommendations on how the CRWCD can better foster collaboration among its Roaring Fork Watershed Board members.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RWM B1b. Cultivate collaborative relationships with state and federal water resource experts and decision makers. Look for opportunities for agencies to partner on multi-jurisdictional projects.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RWM B1c. Hold public meetings on significant water issues affecting the Roaring Fork Watershed with CBRT and RWAPA representatives, CRWCD Directors, and local elected officials. Publicize these meetings through various means.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	

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RWM B1d. Identify streams in the watershed that may be candidates for federal wild, scenic, and recreational status. Determine community support for a designation and work to meet community goals.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RWM B1e. Encourage Pitkin County's River Board to publicize its priorities and activities and to take steps to coordinate those activities with local water managers and interest groups.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RWM B1f. Cultivate collaborative relationships with the entities diverting water from Roaring Fork Watershed to the East Slope. Look for opportunities to partner on creative solutions to meet both East and West Slope water supply requirements.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RWM B1g. Revitalize the Roaring Fork Watershed Collaborative Water Committee as a focal point for regional cooperation and communication.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RWM B2a. Appoint a Working Group to identify mechanisms for consolidating and coordinating the Roaring Fork Valley's involvement in regional water management and to advise local governments on participation in regional water management planning.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
RWM B3a. Create a Working Group to investigate and recommend changes to regulations governing augmentation and substitute supply plans that reflect the importance of maintaining natural hydrology in the development of these plans. Pursue regulatory amendments, as necessary, through all appropriate channels.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RWM B4a. Formalize the existing ad hoc arrangement among the CRWCD, USFS, Pitkin County, City of Aspen and CPW for establishing the annual flow regime for the Twin Lakes exchange and identify the entity(ies) in the watershed responsible for monitoring implementation of the Twin Lakes exchange on behalf of the Western Slope.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RWM B4b. Maintain active participation by Roaring Fork Watershed decision makers in the 10,825 Working Group to ensure that watershed interests are protected and obligations under existing agreements are met.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RWM B4c. Cultivate collaborative relationships with those entities responsible for ensuring an adequate and sustainable water supply for the East Slope. Seek mutually-agreeable solutions to water supply issues whenever possible.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RWM B5a. Investigate existing conditional water rights and determine if the exercise of these water rights would pose a threat to stream flows. Assess and pursue opportunities for securing or modifying the exercise of such rights within the confines of Colorado water law.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RWM C1a. Periodically conduct watershed explorations for local decision makers.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RWM C1b. Conduct a periodic retreat for Roaring Fork Watershed decision makers on specific land use and water issues of common interest/concern.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RWM C1c. Identify and collect all IGAs, MOUs, etc. between/among Roaring Fork Valley jurisdictions with applicability to water issues. Make all such agreements easily accessible to the public online. Analyze those agreements and look for opportunities to consolidate, clarify, or revise those documents to improve interagency collaboration.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RWM C1d. Identify jurisdictional and substantive gaps on water issues in existing IGAs, MOUs, etc. between/among local jurisdictions in the Roaring Fork Watershed. Recommend and pursue modifications to existing agreements, as well as new agreements, to close identified gaps.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	

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RWM C2a. Modify local land use regulations to require referrals to state water commissioners and local fire protection districts during the land use application review phase.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RWM C2b. Request that local land use planning departments adopt a policy of offering state water commissioners and local fire protection districts an opportunity to participate on any technical advisory/working groups developing amendments to land use regulations and/or forms addressing water resource matters of common interest.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RWM C2c. Conduct a bi-annual meeting of local land use planners, local fire protection district personnel, and state water commissioners to provide a forum for discussing land use and water resource matters of common interest.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RWM D1a. Improve collaboration among local jurisdictions and key stakeholders to ensure that adequate physical, chemical, and biological data are collected to monitor local climate change and assess its impacts.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RWM D1b. Improve our decision makers' understanding of the potential impacts of climate change on our water resources.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RWM D1c. Conduct site-specific research and modeling within the Roaring Fork Watershed to improve projections of the impacts of climate change on the watershed.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RWM D1d. Review existing master plans in the watershed to identify changes necessary to account for the impact of climate change on the timing and magnitude of stream flows and water usage.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RWM D1e. Review the existing water-related infrastructure and operational procedures in the Roaring Fork Watershed to identify changes necessary to account for the impact of climate change on the timing and magnitude of stream flows and water usage.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RWM D1f. Research the impact that climate change may have on the water resource-related economy in the Roaring Fork Watershed.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RWM D1g. Assess the vulnerability of the Roaring Fork Watershed to climate change. Develop an adaptive management strategy that integrates findings from the vulnerability assessment with watershed planning priorities and decision support.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
SW A1a. At the state and local level, support the funding of research projects designed to address the non-consumptive needs knowledge gap.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
SW A1b. Work with the CBRT Non-Consumptive Needs Assessment (NCNA) Working Group and the designated NCNA contractors to assess the utility and limitations of the Watershed Flow Evaluation Tool. Evaluate the suitability of other tools/methods developed to provide a regional assessment of ecological risk conditions related to flow and if warranted, revise the regional assessment using the most suitable approach.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
SW A1c. Ensure that the Colorado River Basin Water Availability Study adequately assesses and addresses the Roaring Fork Watershed's non-consumptive needs, including projected needs with climate alteration.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
SW A1d. Create and maintain an adequate network of stream gages in the watershed.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
SW A1e. Assess flow alteration in stream reaches where stream gage or modeled data are lacking.	2		2	2	2	3	3		3			3	2	2	2	3	3						

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SW A1f. Conduct site-specific studies of environmental and recreational flows needed for stream reaches that are currently significantly flow-altered or threatened by significant flow alteration. Include an analysis of how often these flows are not met.	1		2	2	2		3	3	3	3	2	3	2	2	2	3	2	3		2	3	2	
SW A1g. Assess the direct and indirect economic consequences associated with non-optimal flows.	3		3		2			2		3								2		3			
SW A1h. Ensure that local land use policies and regulations adequately assess all of the costs and benefits associated with hydropower development and mitigate the impact of hydropower development on other non-consumptive water uses. Ensure that hydropower development is considered and addressed in local Master Plans.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
SW A1i. Assess potential local and regional recreational and environmental advantages and disadvantages associated with Recreational In-Channel Diversions (RICDs) in the watershed. As appropriate, obtain RICDs and ensure that they do not impact riparian and aquatic habitat.	2				2			2															
SW B1a. Based on assessments of flow alteration and ecological consequences, quantify instream flow needs in streams with and without instream flow rights. Pursue instream flow rights for streams with inadequate or no instream flow rights.	2		2	2	2	3	3		3	3	2	3	2	2	3	3	3	3		2	3	2	
SW B1b. Investigate why CWCB instream flows are not being met and institute appropriate projects to remedy the problems identified.	2		2	2	2															2			
SW B1c. Increase the utilization of tools and funding available to improve instream flows.	2		2	2	2								2	2						2	3	2	
SW B1d. Identify stream reaches where irrigation return flows and groundwater recharge provide late summer and fall flows and investigate opportunities to maintain these important sources of supplemental stream flows whenever possible.	3				3		2	3	3	3	3	3			3	3				2	3	2	
SW B1e. Identify and pursue opportunities for improving natural and artificial water storage to improve low stream flows.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
SW B1f. Investigate if water conservation translates to environmental benefits under Colorado water law. Pursue opportunities for water conservation, if appropriate.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
SW B1g. Quantify the role of snow making in flow alteration and, where warranted, pursue opportunities for decreasing the environmental impact of snowmaking.	3				3						3				3								
SW C1a. Ensure that local land use planning requires an adequate technical assessment and legal review of the availability, sustainability, and (as applicable) potability of an adequate water supply for a proposed use prior to the grant of a development approval.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
SW C1b. Quantify the direct and cumulative effects of changes in land use on surface flows. Incorporate the results in the review of local land use applications and investigate opportunities for mitigation.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
SW C1c. Enhance communication and collaboration between local land use planners and water commissioners.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
SW C1d. Quantify expected proximal stream flow changes associated with a planned development's augmentation plan. Investigate and pursue opportunities for mitigating the impact to these streams within the confines of Colorado water law.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
SW C1e. Evaluate the need for ponds designed for fire mitigation and, where necessary, require that steps be taken to minimize their evaporative losses.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	

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SW C2a. Investigate existing conditional water rights and determine if the exercise of these water rights would pose a threat to stream flows. Assess and pursue opportunities for securing or modifying the exercise of such rights within the confines of Colorado water law.	2	3	2		3	3		3	3	3		3	3	3	3		2		2	3	3		
SW C3a. Complete a comprehensive climate impacts assessment on stream flows for the Roaring Fork Watershed.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
SW D1a. Support and distribute films, videos, PowerPoint presentations, etc. illustrating local water conditions and issues.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
SW D1b. Develop projects such as RFC's River Center, with exhibits to enhance public awareness of the importance of maintaining adequate streams flows in the watershed and the consequences of drought.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
SW D1c. Support projects such as the Univ. of Michigan Master's Project Fostering Implementation of the Roaring Fork Watershed Plan. Utilize the Univ. of Michigan Master's Project's recommendations for improving public education and outreach, as appropriate.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
SW D1d. Improve education/outreach on the connection between water availability and sustainability and land use planning and design strategies.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
SW D1e. Improve education/outreach and opportunities for involvement in mitigating the effects of drought.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
SW D1f. Improve education/outreach on the connection between high flows and healthy riparian and instream areas.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
SW D1g. Increase awareness of water conservation techniques and the importance of conservation. Identify and implement the most strategic water conservation measures.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
SW D1h. Improve education on the basis for obtaining and perfecting conditional water rights under Colorado water law.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
SW E1a. Utilize the CWCB's 2010 Drought Mitigation and Response Plan and Drought Planning Toolbox.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
SW E1b. Work with the CWCB's Office of Water Conservation and Drought Planning to obtain technical assistance and grants to help develop local drought mitigation plans.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
SW E1c. Create "shovel-ready" drought-mitigation projects that can be quickly implemented.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
SW E1d. Investigate the potential benefits and disadvantages of acquiring small storage water rights that can be delivered for municipal uses in times of need and used to mitigate low stream flows. Pursue a streamlined approval process for landowners, if warranted.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
SW E1e. Investigate opportunities to temporarily loan water to streams using C.R.S. § 37-83-105. Discuss triggering criteria such as low snowpack levels on specific spring dates and draft agreements with critical water rights holders, CDWR Division Engineer, and CWCB that can be quickly implemented when needed.	3	3	2	3	3															2			
SW E1f. Identify flow and temperature triggers and draft emergency drought fishing regulations.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
SW E2a. Ensure that county and municipal emergency management plans minimize the potential for harmful flooding in developed floodplains.	3				3			2		3									3				
SW E2b. Where feasible, restore the natural function of floodplains.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
SW E2c. Ensure that the Federal Emergency Management Agency (FEMA) floodplain maps for the watershed used by local jurisdictions are up to date and available digitally for public access.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
SW E2d. Develop and enforce local regulations that minimize development in the flood plain.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	

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SW E2e. Identify and pursue opportunities to maintain decision makers' and the public's interest in flooding issues after flood events have passed, such as by creating "shovel-ready" flood mitigation projects that can be quickly implemented.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
GW A1a. Identify all sub-watersheds lacking detailed hydrogeologic information and prioritize the sub-watersheds for study on the basis of threats posed to the groundwater supply. Conduct hydrogeological assessments of all sub-watersheds lacking detailed hydrogeologic information, working collaboratively across sub-watershed jurisdictional boundaries.	2	3	3	3	3		3	3		2	2	2	3	3			3	3		2		2	
GW A1b. Ensure that local governments obtain, utilize, and regularly update information from: (i) state well databases, and (ii) onsite wastewater treatment system permitting in their hydrogeological assessments.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
GW A1c. Delineate areas of interaction between groundwater and surface water, including quantification and assessment of interaction type. For aquifers that are currently used or have the potential to be used: (i) quantify the water budget, (ii) rate the importance of the aquifers, and (iii) prioritize the need for additional detailed studies that include assessments of water budgets, flows, and water table interactions.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
GW A2a. Adopt local regulations, policies, and procedures to ensure that there is a sufficient technical and legal demonstration of the availability and sustainability of an adequate water supply for any new land use or development reliant upon groundwater.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
GW B1a. Restore major wetlands areas in the watershed.	3	3	3					3															
GW B1b. Identify and protect major wetlands areas in the watershed.	3	3	3					3															
GW B1c. Institute programs to promote water reuse, particularly in areas that are using groundwater beyond its ability to recharge.	3	3				3																	
GW B1d. Study and pursue opportunities, as appropriate to enhance natural recharge by slowing down sheet runoff and runoff in creeks and recharging potentially good aquifers such as terraces and fans.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
GW B1e. Quantify the effect of changes in land use and development on groundwater recharge in both rural and urbanized areas of the watershed and disseminate the information to decision makers.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
GW B1f. Adopt local regulations, policies and procedures to ensure that the impacts on groundwater recharge are understood and taken into consideration by decision makers in the review and approval of land use applications.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
GW B1g. Develop and implement a prioritized well-monitoring program for local jurisdictions to allow them to determine trends in groundwater levels, in coordination with ongoing studies.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
GW B1h. Create and maintain an inventory of groundwater monitoring data and results.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
GW B1i. Conduct detailed monitoring of groundwater levels and fluctuations in important wetland and groundwater discharge zones, including collection of information on aquifer thickness and development of parameters and information for development of detailed water budgets and modeling.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
GW C1a. Adopt local regulations requiring confirmation of compliance with well permit conditions in connection with land use approvals and building permits.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	

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GW C1b. Adopt local policies and procedures for notifying CDWR of any noncompliance with well permit conditions observed in connection with land use approvals and building permits.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
GW C1c. Assess the need for additional resources in the administration of water rights.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
GW C1d. Create maps of the watershed showing the location of exempt and non-exempt wells.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
GW D1a. Create and disseminate educational materials on the impact of land use on groundwater resources.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
GW D1b. Create maps of groundwater availability in the watershed.	3	3	3		3	3	3	3	3	3	3	3			3	3			3	3		3	
GW D1c. Create and disseminate educational materials on the purpose of augmentation plans associated with new non-exempt wells and the potential for detrimental effects on local streams.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
GW D2a. Create summaries of all sub-watershed hydrogeological assessments targeted at the layperson, using a consistent format for all sub-watersheds. Make all summaries available online and publicize their availability.	3	3	3		3	3	3	3	3	3	3	3			3	3			3	3		3	
GW D2b. Create and periodically broadcast local cable television programs discussing the hydrogeological assessments and explaining their importance for understanding groundwater supplies in the Roaring Fork Watershed.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
GW D2c. Implement pricing mechanisms that better reflect the true value of a local groundwater supply and that encourage a decrease in usage.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
GW D2d. Develop projects such as the RFC's River Center, with exhibits to enhance public understanding of hydrogeology in the watershed and its relationship to the groundwater supply.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ A1a. Convene a Water Quality Working Group to identify monitoring objectives, parameters, and protocols.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ A1b. Develop and implement a consistent process for analyzing and reporting on water quality monitoring results; build on the RFC's 5-year Water Quality Reports.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ A1c. Undertake targeted water quality monitoring studies to investigate water quality issues identified through routine water quality monitoring, and to capture the impacts or benefits of developments, projects, or other activities.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ A1d. Promote/support a sampling program for groundwater aimed at testing the integrity and water quality impacts of individual onsite wastewater treatment systems.	3		3		3	3	2	3	3	1	3	3	3	3	3	3	3	3	3	3		2	
WQ A1e. Promote/support a sampling program for groundwater and surface waters aimed at testing the water quality impacts of snow dump facilities.	3		3		3		3						3										
WQ B1a. Investigate and pursue opportunities for reducing water quality impacts from natural salinity.	3		3		3	3				3									3	3		3	
WQ B1b. Identify human-based sediment sources and develop and implement strategies for reducing sediment from those sources.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ B1c. Incorporate water quality goals into local land use plans and regulations. Treat the maintenance and improvement of water quality as a priority in Master Plans and development approvals.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ B2a. Assess the adequacy of current water quality standards and recommend modifications.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
WQ B2b. Consider the need/process for developing standards for private drinking water supplies.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	

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WQ B2c. Evaluate the implications of securing "outstanding waters" designations for local waterways.	3		3	3									3	3			3		3				
WQ C1a. Provide incentives for the implementation of BMPs in connection with the control of nonpoint source pollution from development sites and activities.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ C1b. Develop a training program to help communities assess the adequacy of local regulations and land use policies regarding water quality, and the impacts of development on water quality.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ C1c. Assess the impacts of agricultural and commercial irrigation on water quality. Mandate/recommend mitigation strategies through local regulation, as warranted.	3				3	3	3	3	3	3	3	3			3	3				3	3	3	
WQ C1d. Ensure that local regulations addressing stormwater impact mitigation and BMPs for stormwater management are effective, stringent, and enforced.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	urban areas, post construction
WQ C1e. Identify and prioritize stormwater mitigation improvement projects in each jurisdiction in each jurisdiction and plan for implementing such projects.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ C1f. Support state funding to inspect sites and enforce relevant regulations where stormwater management plans are required under WQCD Stormwater Construction General Permits.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ C1g. Assess current regulation of onsite wastewater treatment systems. Impose more stringent regulations, as warranted. Coordinate with the State of Colorado's plans to revise its regulatory framework.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ C1h. Require training and licensing of onsite wastewater treatment system installers, cleaners/pumpers, and inspectors.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ C1i. Support development of state and local financing mechanisms to provide incentives/assistance to individuals and subdivisions to upgrade or consolidate onsite wastewater treatment systems.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ C1j. Maintain and publicize information on financial assistance available for upgrades to onsite wastewater treatment systems.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ C1k. Investigate the feasibility of creating regional wastewater treatment facilities that would consolidate or incorporate existing scattered onsite wastewater treatment systems and package plants. Pursue opportunities, as appropriate.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ C1l. Improve opportunities for the use of constructed wetlands as an element of onsite wastewater or stormwater treatment, including the development of performance-based state regulations addressing constructed wetlands for onsite wastewater treatment, and mirroring those regulations at the local level.	3		3		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ C1m. Assess surface water and groundwater quality impacts associated with snow dump sites. Ensure that local regulations addressing the location and impacts of snow dumping and runoff from snow dumps are effective, stringent, and enforced.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ C1n. Assess the impacts of magnesium chloride on water quality. Mandate/recommend alternatives/mitigation, as necessary, through local regulation.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
WQ C1o. Support the enforcement of federal and state regulations addressing oil and gas development.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	

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WQ C1p. Support disclosure of chemicals used in drilling and fracking and mandatory frack fluid tagging. Encourage owners and operators to use environmentally friendly alternatives. Support scientific studies of fracking impacts on the environment and public health.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
WQ C1q. Ensure that local land use policies and regulations limiting and mitigating the impacts of mining and oil and gas development on water quality are stringent and enforced.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
WQ C1r. Address and regulate runoff from hazardous sites including mines, landfills, junkyards, and similar locations. Address and regulate the disposal/use of materials from sites potentially contaminated by hazardous materials.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ C1s. Work with the State of Colorado to identify reclamation sites and work with responsible parties to assure that reclamation of mining sites is adequate and sustainable to mitigate impacts on water quality. Perform additional reclamation work as necessary.	3		3										3						3		3		
WQ C1t. Work with local emergency and public safety agencies to assure that they are adequately trained and equipped to respond to releases of hazardous materials and spills.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ C1u. Support enforcement of streamside camping restrictions and development/enforcement of other recreational use restrictions by the USFS necessary to protect waterways. Work with the USFS to remove/reclaim campsites near rivers and streams.	3		3											3	3		3		3				
WQ C1v. Inventory and protect areas around natural springs.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ C1w. Support new and additional funding mechanisms for water technology research and development.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ C2a. Support the completion of the State Source Water Assessments for the watershed.	3		3	3	3	3	3	3	3	3	3		3	3	3			3	3	3	3	3	
WQ C2b. Develop Source Water Protection Plans for all of the major water supply systems in the watershed.	3		3	3	3	3	3	3	3	3	3		3	3	3			3	3	3	3	3	
WQ C2c. Implement a private wellhead protection program.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ D1a. Upgrade technology and treatment methods at local wastewater treatment facilities as funding and infrastructure allow.	3		3		3	3		3		3									3	3			
WQ D1b. Investigate the potential for reusing waste products from landfills, wastewater treatment plants, and commercial activities in order to reduce the need for increased treatment capacity at concentrated waste disposal sites.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ D1c. Support new and additional funding mechanisms for water technology research and development.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ E1a. Improve local understanding of the importance of water quality and the relationship between water quality and quantity. Install signs and notices in appropriate areas noting the importance of maintaining water quality.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ E1b. Improve the public's understanding of the importance of water quality to public health and safety and to the local lifestyle, economy, and environment, and of the consequences of a degraded or contaminated water supply.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ E1c. Educate the public about daily activities that impact water quality and how individuals can modify their behavior and reduce water quality impacts on the watershed.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	

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WQ E1d. Improve local decision makers' understanding of federal, state, and local regulations addressing water quality by creating an illustration of the hierarchy of water quality agencies and regulations in a manner aimed at a lay audience.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ E1e. Educate the public about issues surrounding the development of new water technologies, such as nanotechnology-based systems.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ E1f. Improve public understanding of the risk of groundwater pollution by creating maps showing areas vulnerable and susceptible to groundwater contamination.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ E1g. Implement a stream segment adoption program to facilitate cleanup and monitoring activities. Incorporate the program in school curriculums where possible. Create and publicize a map of "Adopted Streams".	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ E1h. Improve public education regarding individual onsite wastewater treatment systems, particularly the need for regular system inspections – not just pumping.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
WQ E1i. Educate the public on the benefits of BMPs and encourage public implementation of structural, vegetative, and non-structural BMPs whenever possible. Create incentive programs for voluntary retrofits of residential sites.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
WQ F1a. Quantify the needs of our watershed as they relate to water quality. Support and participate in the Non-Consumptive Needs Assessment being carried out by the Colorado Basin Roundtable.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
WQ F1b. Ensure that local land use policies and regulations adequately address the water quality impacts of development, and that requisite mitigation measures imposed as conditions of land use approvals are both implemented and enforced.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
WQ F1c. Monitor and address the impacts of high-use trails on water quality.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
WQ F1d. Ensure that activities aimed at mitigating or responding to pine beetle and other insect infestations and diseases do not generate detrimental water quality impacts.	3		3	3	3				3								3						
WQ F1e. Monitor and address the impacts of climate change on water quality.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI A1a. Convene a Riparian/Instream Working Group to develop a riparian/instream monitoring program.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI B1a. Working with landowners, resource experts, and other interested parties, plan and implement riparian/ instream protection and restoration projects.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
RI B1b. On an ongoing basis, reassess the Colorado Natural Heritage Program's Potential Conservation Areas for changes in resource conditions or management needs.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI B1c. Assess greenbelts/greenways as effective tools for protecting riparian areas in the watershed and pursue, as appropriate.	3		3		3	3		3		3			3					3	3	3			
RI B1d. Research wetland mitigation banks and work to expand such a program, if warranted.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI B1e. Investigate regional planning mechanisms available for protection of riparian areas and funding available to support such a regional effort.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI B1f. Support state and federal tax credits for donations of conservation easements. Investigate additional tax incentives for such donations; work with interested parties on adoption of new incentives.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI B2a. Using the results of the watershed-specific Bird Index of Biotic Integrity, implement habitat improvement projects.	3		3			3		3		3				3				3	3	3		3	

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RI B2b. Determine the potential impact of climate change on riparian-dependent wildlife.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI B2c. Proactively develop the NEPA documentation necessary to relocate beavers to federal lands. Implement projects that promote beaver activity.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI B2d. In conjunction with local land use approvals, require the design and execution of site-specific adaptive management plans to evaluate and minimize the impacts of development on riparian areas.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RI B2e. Inventory and maintain or increase the population size and range of plant species and communities of concern, as appropriate.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI B3a. Determine the optimum number and distribution of CRCT populations and implement projects that work toward achieving this goal.	2		2	2					2		2		2	2	2	2	2		2		2	2	
RI B3b. Conduct fish surveys above natural and man-made barriers to determine if there are additional populations of CRCT in the watershed. Increase/institute monitoring of all identified CRCT populations.	3		3	3					3		3		3	3	3	3	3		3		3	3	
RI B3c. Study the potential effects of climate change on CRCT populations.	3		3	3					3						3	3	3		3		3	3	
RI B4a. Monitor wild, naturally-reproducing fish populations (including non-game fish) and conduct spawning surveys.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI B4b. Identify, protect, and restore important trout spawning habitat. In areas of high spawning importance, evaluate seasonal closures and, if warranted, implement closures.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI B4c. Follow the "Range-wide Conservation Agreement and Strategy for Bluehead Sucker and Flannelmouth Sucker".	3							3		3										3			
RI B4d. Determine the effect of stream temperature on wild, naturally-reproducing fish species distribution and initiate actions to ensure that threshold temperatures are not exceeded.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI B4e. Inventory road/stream crossings and improve fish passage, as needed.	3		3	3	3	3	3	3	3	3	2	3	3	3	3	3	2	2	3	3	2	3	
RI B4f. Improve education regarding methods to reduce whirling disease transmission.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI B4g. Address the problem of illegal introduction of fish in the watershed through education and regulatory initiatives.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI B5a. Monitor key amphibian populations to determine their status.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI B5b. Restore important amphibian habitats and, if appropriate, pursue opportunities for the reintroduction of species.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI B5c. Study the potential impact of climate change on amphibian populations.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI B5d. Survey potential boreal toad habitats to determine if additional populations exist in the watershed.	3		3	3									3	3	3	3	3		3		3		
RI B5e. Increase awareness of the dangers to toad populations associated with Chytridiomycosis fungus transmission.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI B5f. Follow the Conservation Plan and Agreement for the Management and Recovery of the Southern Rocky Mountain Population of the Boreal Toad.	3		3	3									3	3	3		3		3		3		
RI C1a. Evaluate and address the impacts of riparian alteration/disturbance on native riparian-dependent wildlife and plant species and communities of concern and native wildlife species.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI C1b. Investigate the effects of acute and chronic sediment pulses on aquatic ecosystems, differentiating between natural and human-influenced sources of sediment.	3					3												3	3	3	3		

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RI C1c. Develop and implement Best Management Practices (BMPs) for instream projects that minimize sedimentation and turbidity to reduce impacts to spawning fish movement, incubating eggs and fry, and spawning habitat.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI C1d. Implement Travel Management Plan for the White River National Forest, including closing, obliterating, and signing select roads.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI C1e. Develop and enforce stream setbacks that protect riparian areas throughout the watershed.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
RI C1f. Inventory developed and dispersed recreation sites, trails, and access points and assess their impacts on riparian and instream areas; work to reduce impacts. Minimize the impact of new recreational sites, access points, and trails on riparian and instream areas.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI C1g. Prevent or mitigate riparian and instream impacts associated with agricultural activities.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI C1h. Minimize instream impacts and improve fish habitat by reengineering instream structures intended to move water into headgates.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI C1i. Restore riparian and instream areas impacted by historical mining activities.	3		3								3								3	3	3		
RI C1j. Ensure that oil and gas development does not adversely impact riparian and instream areas.	3										3								3	3	3		
RI C1k. Work to minimize/mitigate the effects of bridges on riparian and instream habitat.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI D1a. Provide education to the public about the important functions of riparian areas, development and other threats to riparian areas, what can be done to protect and restore riparian areas, and potential sources of funding for riparian projects.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
RI D1b. Develop the RFC's River Center, with its exhibits on the importance of riparian and instream areas to the watershed.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RI D1c. Provide publicity, tours, and interpretation of riparian and instream restoration projects.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI D1d. Involve the public in restoration projects.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI E1a. Convene an Invasive Species Task Force.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RI E1b. Work with local jurisdictions' weed boards, the USFS, BLM, MSCD, and private land owners to eradicate/control invasive plant species that are a significant concern, particularly adjacent to riparian areas and along roads.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
RI E2a. Research and survey the Didymo algae to determine the cause of its rapid spread, the ecological implications, and possible methods of control.	3									3	3							3		3			
RI E2b. Improve our understanding of the economic and ecological consequences of ANS invasion and the methods for preventing the spread of such species. Provide education on the spread of ANS.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
RI E2c. Implement invasive species inspection/monitoring programs. Require proper cleaning and disinfection of boats and construction equipment used in watercourses.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	

6. Implementation

I. Potential Implementation Strategies

Implementation of an ambitious and far-reaching plan such as this one is a long-term enterprise, one that must rely on partnership and persistence by those who are committed to a healthier watershed. Many agencies, governments, nonprofit organizations, private entities, and individuals will have a role to play in implementation, and the ability to carry out their implementation responsibilities will vary according to their resources, their priorities, and the individuals involved. Implementation is not going to be a perfectly coordinated, predictable, and orderly process. It will be intermittent, opportunistic, and sometimes messy. The key to successful implementation is going to be a willingness to push forward with implementation measures as opportunities arise, in spite of the unknowns, unintended consequences, and inevitable setbacks that will arise.

The sponsors of this Plan were fortunate to have the assistance of a team of graduate students from the University of Michigan who chose a study of the Roaring Fork Watershed's implementation options as a project .The study was extensive and included local interviews and documentation of 20 different watershed plans elsewhere in the Western United States. The study, *Fostering Implementation of the Roaring Fork Watershed Plan*, provides a wealth of examples, resources, and insight and provides an invaluable starting point for discussing the practical aspects of implementation. The study found the following values and characteristics to be common among successful watershed plans:

Diverse representation
Information sharing
Joint fact finding
Building partnerships and inter-jurisdictional relationships
Buy-in from the watershed and participants
Educational initiatives
Tailored roles for partners

The University of Michigan study also made the following specific recommendations, related to the above values, for local application:

Recommendation #1: Establish a Memorandum of Understanding between partner organizations
Recommendation #2: Trust and relationship-building
Recommendation #3: Pursue an initial voluntary project
Recommendation #4: Think creatively about solutions
Recommendation #5: Pursue varied funding opportunities
Recommendation #6: Continue and expand upon existing education programs
Recommendation #7: Research and evaluate education efforts
Recommendation #8: Consider a broad spectrum of education techniques

Those involved with implementation should keep these recommendations in mind as they move ahead with various aspects of the Plan.

Responsibility for implementation of the Watershed Plan will necessarily fall to a variety of organizations and government agencies. Coordinating Entities and Key Participants in the implementation of the recommendations are shown in the matrices and could change in the future. To recognize the benefits of a watershed plan these designations assume an increased focus on coordination and collaboration.

There has been extensive discussion between the authors of this Plan and other interested parties about whether or not a new entity should be created and charged with overall responsibility for Plan implementation. There has been a general reluctance to create yet another multi-jurisdictional entity in the Valley (the Roaring Fork Transportation Authority, the Northwest Colorado Council of Governments, and various special districts have been identified as examples) because it would take resources that could be put towards projects and use them to establish yet another bureaucratic entity. That entity, even if built on an established *ad hoc* group, such as the Watershed Collaborative Water Committee, would take resources to set up and run and would then need to establish itself as a representative of the Plan and a participant in local water management decision making. There has also been a recognition that the Valley-wide water management and advocacy agencies currently in place, such as the Ruedi Water and Power Authority, the Colorado River Water Conservation District, and Roaring Fork Conservancy, do not currently have the resources, geographic focus, buy-in of all stakeholders, nor organizational direction that would position them individually as ideal custodians of the Plan.

Despite the uncertainty about the specific mechanisms that will drive implementation, the Plan is being introduced to local governments and other agencies on the premise that much can be done to effect implementation by the stakeholders already in place. As implementation by various entities goes forward, the need for a long-term implementation structure and the ideal form of that structure will be clarified.

II. Potential Grant and Other Opportunities for Funding Implementation of the Roaring Fork Watershed Plan's Recommended Actions

Funding for project implementation was the most often cited challenge of watershed groups in *Fostering Implementation of the Roaring Fork Watershed Plan*. Although grant writing and administration can be daunting tasks, these funding sources provide the best opportunity to bring new resources to bear on local projects. One of the impediments to some grant funding in the past has been the absence of a comprehensive watershed plan in the Roaring Fork Valley. This Plan will provide an avenue to those previously unavailable funding sources.

SPECIFIC GRANT, FELLOWSHIP & OTHER PROGRAMS[1]

- **Adolph Coors Foundation.** The Adolph Coors Foundation.
  - Eligible Applicants: 501(c)(3) organizations. Organization must be in operation for at least one year.
  - Deadlines/Grant Cycle: Grant request deadlines are March 1, July 1, and November 1.
  - $$ Range: No minimum/maximum grant amounts specified.
  - Application Process: Submit a proposal in accordance with the guidelines available online.
  - Projects/Programs of Interest: Areas of interest include science education.

- **Ben & Jerry's Foundation (National Grassroots Grant Program).** http://www.benandjerrysfoundation.org/what-we-do.html.
  - Eligible Applicants: Grassroots, constituent-led, 501(c)(3) organizations using community-organizing strategies to accomplish their goals, or organizations providing technical support/resources to such entities. The Foundation generally funds organizations with budgets of $500,000 or less.
  - Deadlines/Grant Cycle: Grant requests can be submitted at any time. Letters of Interest/Inquiry ("LOIs") are considered on a rolling basis and reviewed within thirty days of submission. Full grant reviews occur nine times per year.
  - $$ Range: Up to $15,000 for a one-year period.
  - Application Process: Submit a one-page LOI in accordance with the guidelines available online. Organizations selected for further consideration will be requested to submit a full proposal within one year.
  - Projects/Programs of Interest: The Program funds environmental protection, among other activities. General operating support and project support grants are available. Grants are *not* available for research projects, among other specified activities.

- **Captain Planet Foundation.** Apply for Grants | Captain Planet Foundation.
  - Eligible Applicants: Tax exempt organizations.

[1] This summary was prepared in December of 2010. Due to changing program priorities and economic conditions, as well as the lack of currency of some program websites, all information should be verified at the time a decision is made to pursue any of the identified grant opportunities. Additionally, many grants require an applicant to provide some level of matching funds and/or in-kind contribution. The accounting requirements for acceptable matching funds and value-in-kind can be complex, and therefore typically have not been covered in this summary of programs and other opportunities.

- Deadlines/Grant Cycle: Deadlines are March 31, June 30, September 30, and December 31. Proposals are reviewed over a three-month period from the submission deadline. Applicants are notified of decisions within four months of proposal submission.
- $$ Range: Generally $250 - $2,500. "Adopt-a-stream" grants cannot exceed $400.
- Application Process: Online application.
- Projects/Programs of Interest: The Foundation funds projects that:
  - Promote understanding of environmental issues,
  - Focus on hands-on involvement,
  - Involve children and young adults, ages 6-18,
  - Promote interaction and cooperation within the group,
  - Help young people develop planning and problem solving skills, and
  - Include adult supervision.

❖ **Colorado Conservation Trust (Future Conservation Leaders Fellowships).** http://coloradoconservationtrust.org/programs/future-conservation-leaders-fellowship/. The Future Conservation Leaders Fellowship program places emerging conservation professionals with qualified conservation organizations for a two-year term. The program matches individuals with leading organizations that can meaningfully advance their work with the addition of a highly qualified staff member.

❖ **Colorado River Water Conservation District**. http://www.crwcd.org/page_193.
- Eligible Applicants: Guidelines available after December 1, 2010.
- Deadlines/Grant Cycle: Applications for the 2011 Grant Program must be submitted between December 1, 2010 and January 31, 2011.
- $$ Range: Grant program has $250,000 of funding available. A maximum of $150,000 (or 25% of the total project cost, whichever is less) can be awarded for a water supply project.
- Application Process: Online application packet.
- Projects/Programs of Interest: Guidelines available after December 1, 2010. Program focuses on:
  - Developing new water supplies,
  - Improving existing water supply projects,
  - Improving water use efficiency,
  - Improving water quality,
  - Improving sediment control,
  - Undertaking a watershed action,
  - Implementing tamarisk control, and
  - Protecting pre-1922 Colorado River Compact water rights.

❖ **Community Office for Resource Efficiency (CORE)**. Grants.
- Eligible Applicants: Private and nonprofit organizations, governmental entities, and individuals residing or working in the Roaring Fork Valley.
- Deadlines/Grant Cycle: Green Key Grants are awarded annually. Other grants are awarded on a rolling basis.
- $$ Range: Series of grants available for projects of local or regional significance in the Roaring Fork Valley: (i) Green Key Grants ($5,000-$250,000), (ii) Community Grants ($2,500-$10,000), (iii) Mini-Grants (<$2,500), (iv) Design Assistance Grants, and (v) Microhydro Feasibility Grants.

- Application Process: Applicants are encouraged to contact CORE to discuss their project prior to submitting an application. Applications and guidelines available online for all but the Microhydro Feasibility Grant.
- Projects/Programs of Interest: Varies by type of grant. Projects generally should promote research efficiency and sustainability. Green Key Grants may specifically be awarded for water conservation projects. Priority may be given to projects which benefit residents of Pitkin County.

❖ **El Pomar Foundation.** http://elpomar.org/what-we-do/grants.
- Eligible Applicants: Colorado nonprofit organizations and activities taking place in Colorado.
- Deadlines/Grant Cycle: Grant requests can be submitted at any time. The Foundation's Board of Trustees meets at regular intervals throughout the year to review grant requests.
- $$ Range: Capital grant requests cannot exceed $50,000. No maximum/minimum dollar amounts set for other types of grants.
- Application Process: No set form. Guidelines for grant applications are available online. Additionally, in 2011, each of the Foundation's nine Regional Councils can provide up to $200,000 in grant recommendations to the Board of Trustees.
- Projects/Programs of Interest: This is a general purpose foundation. Grants are available across a broad spectrum of areas, including education and community initiatives. Grants are *not* available for research projects/studies, media projects, conferences/meetings/seminars, among other activities.

❖ **The Environment Foundation.** (Aspen Skiing Company employee organization, in collaboration with the Aspen Skiing Company Family Fund and the Aspen Community Foundation). http://www.aspensnowmass.com/environment/foundation/foundation.cfm.
- Eligible Applicants: Private or nonprofit organizations, government agencies, or individuals. The Foundation is most interested in funding organizations that identify and work on root causes of problems, with a commitment to long-term change.
- Deadlines/Grant Cycle: Application deadlines for grant cycles post 2010 are not available. The Foundation's website should be consulted.
- $$ Range: It is suggested that grant requests not exceed $15,000. Requests for < $8,000 are more likely to be funded.
- Application Process: Email the Executive Director of the Foundation for an application, Grantmaking Guidelines and Selection Criteria.
- Projects/Programs of Interest: Funding is available for projects that improve or protect the Roaring Fork Valley environment. Support is available for environmental education, and projects that seek to reduce the impacts of climate change, foster responsible stewardship of natural resources, protect mountain ecosystems, or preserve and create unique opportunities for outdoor recreation. Projects must be innovative, have measurable results, and reflect a community or regional need.

❖ **The Harris Foundation.** http://www.harrisfoundation-nevada.com/index.htm.
- Eligible Applicants: 501(c)(3) organizations.
- Deadlines/Grant Cycle: Contact the Foundation for the next annual deadline for submission of an LOI and any subsequent grant application.
- $$ Range: $6,000 or less.
- Application Process: Submit an LOI in accordance with the guidelines available online prior to submission of any proposal.

- Projects/Programs of Interest: Environmental conservation and educational programs, among other activities. Areas of support include: environmental educational camps, animal field research, protection of natural resources and wildlife sanctuaries, and documentaries/videos/community outreach in the area of conservation education. Operational support is *not* available.

❖ **Laura Jane Musser Fund (Environmental Initiative Program – Environmental Stewardship).** http://www.musserfund.org/index.asp?page_seq=11.
- Eligible Applicants: 501(c)(3) organizations, organizations that are forming (if sponsored by a 501(c)(3) organization), local governments, organizations in the U.S. serving the U.S. population.
- Deadlines/Grant Cycle: Applications under the Environmental Initiative Program are due March 23, 2011. Funding decisions will be announced in June 2011.
- $$ Range: Up to $35,000.
- Application Process: Guidelines for grant applications are available online.
- Projects/Programs of Interest: Consensus-based environmental stewardship projects/programs in rural areas in their first three years (may be in the planning or implementation phase).

❖ **Liz Claiborne – Art Ortenberg Foundation.** http://lcaof.org/.
- Eligible Applicants: The Foundation's Program Director or Coordinator should be consulted.
- Deadlines/Grant Cycle: No submittal deadlines indicated. The Foundation's Program Director or Coordinator should be consulted.
- $$ Range: Historically, most grants have exceeded $10,000. The Foundation's Program Director or Coordinator should be consulted.
- Application Process: General guidelines for grant applications are available online. The Foundation's Program Director or Coordinator should be consulted for further details.
- Projects/Programs of Interest: Grants are available for western conservation.

❖ **Lorrie Otto Seeds for Education Grant Program.** http://www.for-wild.org/seedmony.html.
- Eligible Applicants: Schools, nature centers, and other non-profits that are learning centers and that have a site available for a stewardship project. Entities such as libraries, churches, and government agencies are eligible, subject to youth participation. Successful non-school applicants are typically a partnership between a site owner and a youth group.
- Deadlines/Grant Cycle: Applications are due October 15. Notification of grant awards will be made by February 15 of the subsequent year.
- $$ Range: $100 - $500. Successful projects are also eligible for discounts on seeds and plants from nursery partners.
- Application Process: Grant application available online.
- Projects/Programs of Interest: Grants are available for enhancement and development of an appreciation for native plants and native plant communities. Projects must emphasize student and volunteer involvement and increase the educational value of the project site. Examples of appropriate projects include development of a wetland area to study the effect of native vegetation on water quality, and planting native shrubs and trees that support birds and other wildlife.

❖ **Maki Foundation.** http://makifoundation.org/index.html.
- Eligible Applicants: 501(c)(3) organizations. The Foundation generally looks for small organizations. Many of its grantees are grassroots groups with a focus on activism and policy

change, particularly in the area of public lands management. Groups with annual budgets > $1 million are rarely funded.

- Deadlines/Grant Cycle: Proposals must be received by May 1 to be considered at the Board of Directors' annual meeting. Awards are announced by September 15.
- $$ Range: Typically grants range from $1,000 - $10,000.
- Application Process: New applicants need to contact Maki Foundation staff to discuss their organization and proposal before submitting a full application; alternatively, a one-page LOI may be submitted. The full grant application packet is available online.
- Projects/Programs of Interest: The Foundation is concerned with protection and preservation of the Rocky Mountain West's remaining wild lands, rivers, and wilderness, as well as the wildlife dependent on these lands. Its priorities are:
  - Wilderness and wild lands protection,
  - River and wetlands conservation,
  - Biological diversity conservation, and
  - Public lands management.

  Grants for general support will be considered, in addition to grants for specific projects.

❖ **National Fish and Wildlife Foundation.** A series of initiatives/programs are available, including the **Keystone Initiatives Program** (http://www.nfwf.org/Content/NavigationMenu/GrantPrograms/ProgramsOverview/Keystones/default.htm), and the two Programs described in more detail below.

- **Five Star Restoration Grant Program (2011).** http://www.nfwf.org/AM/Template.cfm?Section=Charter_Programs_List&Template=/TaggedPage/TaggedPageDisplay.cfm&TPLID=60&ContentID=17901.
  - Eligible Applicants: Open to any public or private entity that can receive grants. Projects must include at least five organizations. Although partnerships are encouraged to include state and federal agencies, those entities may not serve as the grantee unless the community partners demonstrate that the state or federal agency is best suited to coordinate the community-based project.
  - Deadlines/Grant Cycle: February 14, 2011.
  - $$ Range: In general, smaller-scale, one-year projects will be eligible for grants $10,000 – $25,000. Two-year, larger-scale projects will be eligible for grants $10,000 – $40,000. The average grant award anticipated is $20,000 – $25,000. Limited funding available for rural Colorado.
  - Application Process: Application and guidelines are available online.
  - Projects/Programs of Interest: Projects must (i) include on-the-ground wetland, riparian, in stream and/ or coastal habitat restoration, (ii) integrate meaningful education into the restoration project either through community outreach, participation and/or integration with K-12 environmental curriculum, and (iii) result in measurable ecological, educational and community benefits.
- **Private Landowner Technical Assistance Program.** http://www.nfwf.org/AM/Template.cfm?Section=Charter_Programs_List&Template=/TaggedPage/TaggedPageDisplay.cfm&TPLID=60&ContentID=18515.
  - Eligible Applicants: Non-profit 501(c) (3) organizations, educational institutions, tribes, and state or local units of governments (*e.g.*, state conservation agencies, counties, townships, cities, conservation districts, utility districts, drainage districts, etc.). Individuals, federal government agencies, and for-profit firms are not eligible.

- Deadlines/Grant Cycle: February 15, 2011.
- $$ Range: Typically grants range from $40,000 - $300,000.
- Application Process: Application and guidelines are available online.
- Projects/Programs of Interest: The program is a partnership with the NRCS to support field biologists and other habitat professionals (botanists, ecologists, foresters, etc.) working with NRCS field offices in providing technical assistance to farmers, ranchers, foresters, and other private landowners to optimize wildlife conservation on private lands.

❖ **National Forest Foundation.** http://nationalforests.org/conserve/grantprograms/whichprogram.

- Eligible Applicants: Varies, depending upon the type of funding sought. Includes collaborative community-based organizations and nonprofits.
- Deadlines/Grant Cycle: Varies by type of grant. Not all categories of grants are currently being funded.
- $$ Range: Varies by type of grant. Awards may be a few thousand dollars to >$100,000.
- Application Process: Varies by type of grant. Grant application packets available online.
- Projects/Programs of Interest: Grants can be awarded for a range of "On the Ground Programs" (*e.g.*, Matching Awards Program, Ski Conservation Fund) and "Capacity Building Programs" (*e.g.*, Collaboration Support Program). For example, the Matching Awards Program makes funding available for conservation/restoration projects on or adjacent to National Forest lands (including watershed health and restoration).

❖ **New Belgium Brewing Company**. http://www.newbelgium.com/Community/local-grants.aspx.

- Eligible Applicants: 501(c)(3) organizations.
- Deadlines/Grant Cycle: Information is not available post 2010. The company's website should be consulted.
- $$ Range: Small grants range from $500 - $5,000. The company will also partner with select nonprofits for capacity building and program support.
- Application Process: Online application form. Most applications are processed within three months.
- Projects/Programs of Interest: Areas of interest include both water stewardship and youth environmental education. Both project and program support is available.

❖ **Patagonia**. http://www.patagonia.com/us/patagonia.go?assetid=2942.

- Eligible Applicants: 501(c)(3) organizations. The company is interested in small, grassroots activist organizations with provocative direct-action agendas, working on multi-pronged campaigns that produce measurable results.
- Deadlines/Grant Cycle: Environmental Grants - applications to a retail store may be submitted at any time. Applications at the corporate level must be submitted by April 30 or August 31 to be considered. Applications received in April will be responded to in August. Applications received in August will receive a response in January of the following year. World Trout Initiative – no deadlines specified.
- $$ Range: Environmental Grants - most grants are in the range of $3,000 - $8,000. World Trout Initiative – typically grants range from $5,000 - $15,000.
- Application Process: Applicants should complete the online eligibility quiz for the grant program they are interested in. Qualifying applicants will be directed to an online grant application form.
- Projects/Programs of Interest: There are two grant programs:

- Environmental Grants – Funding is available for projects/programs to preserve and protect the environment, including projects/programs to protect local habitat. The company does *not* fund general environmental education or research that is not in direct support of a developed plan for specific action to alleviate an environmental problem, among other activities.
- World Trout Initiative – funding is available for work to protect various species of fish and their habitats, particularly projects/programs designed to work on the root causes of a problem and that approach the issues with a commitment to long-term change.

The company likes to support projects that force the government to abide by the law.

❖ **Pitkin County Healthy Rivers and Stream Fund.** Healthy Rivers and Streams | Pitkin County, Colorado.

- Eligible Applicants: No guidelines available. Contact the Pitkin County Attorney's Office for information.
- Deadlines/Grant Cycle: No guidelines available. Contact the Pitkin County Attorney's Office for information.
- $$ Range: No guidelines available. Contact the Pitkin County Attorney's Office for information.
- Application Process: No guidelines available. Contact the Pitkin County Attorney's Office for information.
- Projects/Programs of Interest: No guidelines available. Contact the Pitkin County Attorney's Office for information. Objectives of the Fund are:
  - Maintaining and improving water quality and quantity within the Roaring Fork watershed;
  - Purchasing, adjudicating changes of, leasing, using, banking, selling, and protecting water rights for the benefit of the Roaring Fork watershed;
  - Working to secure, create, and augment minimum stream flows in conjunction with non-profits, grant agencies, and appropriate State and Federal agencies to ensure ecological health, recreational opportunities, and wildlife and riparian habitat;
  - Promoting water conservation; and
  - Improving and constructing capital facilities that contribute to the objectives listed above.

❖ **Save the Colorado River Campaign.** http://www.savethecolorado.org/grants.php#apply.

- Eligible Applicants: 501(c)(3) environmental organizations working in the Colorado River basin and areas using Colorado River water.
- Deadlines/Grant Cycle: Annual grant cycle. Grant applications should be submitted between June 1, 2011 and June 30, 2011 for 2011. Decisions for 2011 will be made in August 2011.
- $$ Range: $2,500 - $25,000.
- Application Process: Online application.
- Projects/Programs of Interest:
  - Efforts that raise public awareness about the threats to the Colorado River and its water supplies;
  - Efforts that promote water conservation, or change public policy about water conservation in cities that receive Colorado River water; and
  - Efforts that protect and enhance the ecological health and biodiversity of the Colorado River and its tributaries, including but not limited to addressing the threats of new diversions and dams, mitigating past diversions and dams, and securing instream flows.

❖ **Smart Wool Advocacy Fund.** https://www.smartwool.com/default.cfm#/Smartprint/Advocacy/.

- Eligible Applicants: 501(c)(3) organizations.
- Deadlines/Grant Cycle: Applications must be submitted by March 1 for consideration at the April 1 meeting. Notification of decisions is made approximately six weeks after review.
- $$ Range: $500 -$5,000.
- Application Process: Submit a proposal in accordance with the guidelines available online.
- Projects/Programs of Interest: Funding is available for special programs/projects as well as general operating expenses of organizations that encourage responsible outdoor activity participation for youths age 18 and under, while promoting environmental stewardship. Strong grassroots characteristics (including volunteer and citizen involvement) to create long-term social change are important considerations for funding.

❖ **State of Colorado.**

- **Colorado Fish and Wildlife Resources Fund.** http://cwcb.state.co.us/LoansGrants/fish-and-wildlife-resources-fund-grants/Pages/main.aspx.
  - Eligible Applicants: Operators of existing water diversion, delivery, or storage facility projects and the CWCB. Entities that do not operate such facilities (e.g., certain municipalities, watershed groups) can explore opportunities for a joint application with the CWCB.
  - Deadlines/Grant Cycle: Applications accepted throughout the year.
  - $$ Range: Program is managed on an annual cycle beginning July 1, consistent with the state fiscal year. Annual funding amounts available and limitations should be discussed with CWCB staff.
  - Application Process: Potential applications should be discussed with CWCB staff and a pre-application submitted to the CWCB to determine whether a particular proposal is appropriate for funding. Grant application packet is available online.
  - Projects/Programs of Interest: Grants can be awarded for:
    - The appropriation of water rights to preserve, or the acquisition of water rights to preserve or improve the natural environment to a reasonable degree to mitigate the impact of an existing water facility. All acquisitions or appropriations must be in compliance with Instream Flow Rules and state water laws.
    - River restoration feasibility studies and construction projects designed to directly mitigate or significantly improve the environmental impacts of existing water facilities.
    - An appropriate combination of river restoration and water right acquisition or appropriation.

- **Colorado Fishing is Fun Program.** http://wildlife.state.co.us/Fishing/ResourcesTips/FishingIsFunProgram/.
  - Eligible Applicants: Local governments, park and recreation departments, water districts, individuals, conservation groups, and other non-profit organizations. Applicants may not participate in more than two projects annually. Separate chapters or units of statewide organizations are considered as separate applicants. Two or more local agencies may form a partnership to conduct a project.
  - Deadlines/Grant Cycle: Applications due March 1, 2011 to local regional or area Division of Wildlife office. Multiple deadlines for follow-up presentations, discussions, etc.
  - $$ Range: No dollar amount specified; awards can exceed $25,000. Federal matching funds available to reimburse project sponsors for up to 75% of approved expenses. Federal dollars cannot be used as the source for the local match, nor can donated labor from a federal agency be used for the match.

- Application Process: Applicants should contact their local Division of Wildlife Office early in the process and should address questions to the Program Coordinator. Application and instructions available online.
- Projects/Programs of Interest: The program has historically supported four categories of projects: (i) angler access, (ii) habitat development and site improvements, (iii) fishing site improvements, and (iv) motorboat access. Grants are not available for overhead, program administration, planning, or research.

- **Colorado Healthy Rivers Fund.** http://cwcb.state.co.us/LoansGrants/colorado-healthy-rivers-fund-grants/Pages/main.aspx.
  - Eligible Applicants: Locally-based collaborative watershed protection groups.
  - Deadlines/Grant Cycle: Application due by April 30. Grants awarded by September 30.
  - $$ Range: Project grants - suggested maximum is $50,000. Planning grants - suggested maximum is $25,000.
  - Application Process: Online application packet.
  - Projects/Programs of Interest: Locally-based, collaborative watershed protection efforts. Both planning (*e.g.*, data collection and assessment, analysis of project alternatives, project permitting, acquisition of funding, outreach efforts) and project grants (*e.g.*, water quantity and/or water quality monitoring, flood protection, channel stability, riparian, stream bank, and habitat restoration efforts) are available.

- **Colorado Nonpoint Source Management Program (FY2011).** http://npscolorado.com/index.html
  - Eligible Applicants: No restrictions identified.
  - Deadlines/Grant Cycle: Proposals due by December 15, 2010. Funding notification will occur by March 31, 2011. Funds will be available in the fall of 2011.
  - $$ Range: TBD. Program anticipates approximately $2 million to be available from the U.S. EPA.
  - Application Process: Online application packet.
  - Projects/Programs of Interest: Funding is available for projects that:
    - Address water quality impairments due to nonpoint source pollution,
    - Develop or update watershed plans ("extra consideration" will be given to such proposals), or
    - Provide education and outreach activities that help maintain or restore water quality impacted by nonpoint source pollution.

    "Priority watersheds" will be promoted in the evaluation process for FY2011 (this does not include the Roaring Fork Watershed).

- **Colorado Nonpoint Source Outreach Grants.** http://npscolorado.com/outreachgrant.htm.
  - Eligible Applicants: No restrictions identified.
  - Deadlines/Grant Cycle: Proposals accepted on a year-round basis.
  - $$ Range: $1,000-$5,000 (typically $1,000-$2,500 is awarded). Grants are provided on a cost-reimbursement basis and require a 40% match.
  - Application Process: Proposal guidelines available online.
  - Projects/Programs of Interest: The program's goal is to support information exchange, education, and hands-on efforts to provide information and alternative actions to citizens related to nonpoint source water pollution.

- **Colorado Source Water Assessment and Protection Program (Protection Planning Grants) .** http://www.cdphe.state.co.us/wq/sw/swaphom.html.
  - Eligible Applicants: - Active public water systems (excluding non-community private for profit water systems) and governmental entities.
  - Deadlines/Grant Cycle: Proposals are accepted throughout the year and reviewed on a first-come-first-served basis. Grants are awarded based on available funding.
  - $$ Range: Source Water Assessment and Protection Pilot Planning Project Grants ("PPP Grants") – maximum of $50,000 ($25,000 - $35,000 is the typical range). Protection Plan Development and Implementation Grants ("D&I Grants") - awards can range up to $5,000 per grant application. Applicants can apply for a second grant (up to $5,000) if a cost analysis supports additional funding and the initial grant has been expended.
  - Application Process: Online application packet.
  - Projects/Programs of Interest: PPP Grants are awarded to develop exemplary and comprehensive source water protection plans; projects should assist and promote source water protection planning efforts across Colorado. D&I Grants are awarded to prioritize potential contamination sources for raw drinking water supplies in a specific source area, and to identify and implement BMPs to minimize contamination threats to public water supplies.

- **Colorado Water Efficiency Grants.** http://cwcb.state.co.us/LoansGrants/water-efficiency-grants/Pages/main.aspx.
  - Eligible Applicants: Varies by type of grant. Includes water providers, state and local governmental entities, and public or private agencies whose primary purpose includes promotion of water conservation.
  - Deadlines/Grant Cycle: Varies by type of grant and the dollar amount sought. Some types of applications are accepted throughout the year. Others must be submitted by specific deadlines.
  - $$ Range: Program is managed on an annual cycle beginning July 1, consistent with the state fiscal year. Annual funding amounts available and limitations should be discussed with CWCB staff.
  - Application Process: Grant application packets available online for the different categories of grants.
  - Projects/Programs of Interest: Grants can be awarded for:
    - Water conservation planning;
    - Water conservation implementation;
    - Drought mitigation planning; and
    - Water resource conservation public education and outreach.

- **Colorado Watershed Restoration Grants.** http://cwcb.state.co.us/LoansGrants/colorado-watershed-restoration-grants/Pages/main.aspx.
  - Eligible Applicants: Organizations interested in developing watershed/stream restoration and flood mitigation studies and projects.
  - Deadlines/Grant Cycle: Applications due by January 31. Decision on awards made by April 15 and grants awarded July 1.
  - $$ Range: Program is managed on an annual cycle beginning July 1, consistent with the state fiscal year. Annual funding amounts available and limitations should be discussed with CWCB staff.

- Application Process: Potential applications should be discussed with CWCB staff prior to submittal. Grant application packet available online.
- Projects/Programs of Interest: Grants can be awarded for planning and engineering studies, including implementation measures, to address technical needs for watershed/stream restoration and flood mitigation. Special consideration is reserved for planning and project efforts that integrate multi-objectives in restoration and flood mitigation. This may include projects and studies designed to restore stream channels, provide habitat for aquatic and terrestrial species, restore riparian areas, reduce erosion, reduce flood hazards, and increase the capacity to utilize water.

- **Colorado Water Supply Reserve Account Grants.** http://cwcb.state.co.us/LoansGrants/water-supply-reserve-account-grants/Pages/main.aspx.
  - Eligible Applicants: Public and private entities (both for profit and nonprofit) and individuals are eligible for Basin Roundtable Account Funds. Public entities and private incorporated entities (both for profit and nonprofit) are eligible for Statewide Account Funds; individuals, partnerships, and sole proprietors are not eligible.
  - Deadlines/Grant Cycle: Applications are accepted throughout the year for Basin Roundtable Account Funds. Deadlines are available online and are sixty days in advance of the next CWCB bimonthly meeting. Monies from the Statewide Account are allocated in September of each year, and applications must be received by the CWCB no later than sixty days prior to the date of the CWCB's September meeting. Applicants are provided with a decision on their application within thirty days of CWCB review.
  - $$ Range: Grants vary in dollar amount, depending upon availability of funds and the merits of a proposal. No maximum/minimum dollar amount is specified under either fund.
  - Application Process: Funding requests must be approved by at least one of the Colorado Basin Roundtables before submission to the CWCB. Application packets, as well as Basin Roundtable contact information and meeting dates, are available online for each of the funding programs.
  - Projects/Programs of Interest: Funding is available from two separate accounts (a Basin Roundtable Account – which funds water activities from a Basin Roundtable, and the Statewide Account – which funds activities from a Basin Roundtable on a competitive basis). Eligible water projects/activities include:
    - Technical assistance regarding permitting, feasibility studies, and environmental compliance;
    - Studies/analysis of structural, non-structural, consumptive and non-consumptive water needs, projects, or activities; and
    - Structural and non-structural water projects or activities.

- **Colorado Wildlife Habitat Protection Program.** http://wildlife.state.co.us/LandWater/COwildlifehabitatprotectionprogram.
  - Eligible Applicants: Property owners, local government open space programs, land trusts, or other conservation organizations.
  - Deadlines/Grant Cycle: Information not available post-2010.
  - $$ Range: Funding availability not available post-2010.
  - Application Process: Specific proposal information not available post-2010. A Proposal Form is expected to be available online in the future.

- Projects/Programs of Interest: Proposals should address one or more of the following priorities:
  - Winter range for big game species,
  - Migration corridors for big game,
  - Important access for hunting and/or fishing opportunities,
  - Important habitat for Threatened or Endangered Species or Species of Concern,
  - Wetlands and/or riparian corridors, and
  - Property acquisitions that would enhance the management of a Colorado Division of Wildlife (DOW) State Wildlife Area (*i.e.*, provide a more manageable boundary, fill in an in-holding, improve public access, or enhance management of habitat or wildlife-related recreation on DOW property).

  Emphasis is on the purchase of permanent conservation easements. Additional financial consideration will be given to projects that separately convey to the DOW restricted or year-round public access for wildlife-related recreation, in addition to placing a conservation easement on the project property. Property owners may also submit proposals for projects whose sole purpose is to provide hunting or fishing access through an access easement or agreement, or conveyance of fee title.

- **Great Outdoors Colorado ("GOCO") Grants**. http://goco.org.s57353.gridserver.com/?page_id=5.
  - Eligible Applicants: Varies, depending upon grant program.
  - Deadlines/Grant Cycle: Trail grants offered once a year. Other grants offered twice each year, with spring and fall grant cycles.
  - $$ Range: Grants vary in dollar amount, depending upon the program.
  - Application Process: Online application packets are available for each of the grant programs.
  - Projects/Programs of Interest: GOCO grants are available for multiple programs:
    - Local Government Park and Outdoor Recreation ("LPOR") Grants & Mini-Grants – awarded to help acquire, expand and improve local parks and outdoor recreation and environmental education facilities;
    - Open Space Grants – awarded to help preserve natural areas, agricultural land, important wildlife habitat, park buffers, wildlife corridors, and scenic areas;
    - Planning Grants – awarded to help planning to protect and enhance open space, wildlife habitat and parks, while anticipating future outdoor needs;
    - Trails – awarded through the Colorado State Trails Program (http://parks.state.co.us/Trails/Grants/Pages/Grants.aspx) for trail planning, design, construction, maintenance, special projects, and equipment; and
    - Conservation Excellence Grants - awarded to existing organizations for conservation planning, staff training, open space assessment, expansion of services in underserved regions, planning for public access and education, and other activities which improve and expand the capacity of the organization to achieve quality land conservation.

- **Temper of the Times Foundation, Inc.** http://www.temperfund.org/index.html.
  - Eligible Applicants: 501(c)(3) organizations.
  - Deadlines/Grant Cycle: Information is not currently available for 2011. The organization's website should be consulted.
  - $$ Range: Grants are typically $5,000-$15,000.

- Application Process: Application information available online. LOI may be submitted prior to application, but is not required.
- Projects/Programs of Interest: Supports projects related to increasing awareness about wildland ecosystem conservation and restoration. Grants may be used to fund the production of print, radio, or TV ads, to pay for ad space or airtime, or to produce or distribute pamphlets, books, videos, or press packets. Funding may not be used for organizational newsletters.

❖ **The Tiffany & Co. Foundation.** http://www.tiffanyandcofoundation.org/default.aspx.
- Eligible Applicants: 501(c)(3) organizations.
- Deadlines/Grant Cycle: Applications may be submitted at any time. Grants are awarded by the Foundation's Board of Directors who meet twice annually.
- $$ Range: Grants vary in dollar amount. Most are several thousands of dollars.
- Application Process: Online application, beginning with submission of an LOI.
- Projects/Programs of Interest: Must be carefully tailored to meet the Foundation's program goals/strategies, which include restoration of environmentally significant sites and remediation of areas where mining has occurred.

❖ ***Together Green* Grants Program**. (National Audubon Society Program funded by Toyota). http://www.togethergreen.org/Grants/Default.aspx.
- Eligible Applicants: 501(c)(3) organizations in the Audubon network collaborating with at least one partner organization outside the Audubon network in their community.
- Deadlines/Grant Cycle: Deadline for applications post 2010 TBD in early 2011.
- $$ Range: Average Innovation Grant awarded in 2010 was $25,000 (with a range from $5,000 - $80,000). 2010 Planning Grants were $5,000 or less.
- Application Process: Grant application packets available online for both types of grants.
- Projects/Programs of Interest: There are two types of grants available. Innovation Grants are available for projects that: (i) conserve or restore habitat and protect species, improve water quality or quantity, and reduce the threat of global warming, (ii) engage new and diverse audiences in conservation, and (iii) inspire and use innovative approaches and technologies to engage people and achieve conservation results. Planning Grants are available to conduct preliminary work for a potential Innovation Grant project (e.g., monitoring or mapping of priority conservation areas, developing credibility with or researching a new audience, developing a relationship with a potential partner).

❖ **U.S. Government**

- **U.S. Dept. of Agriculture – Natural Resources Conservation Service (NRCS).** NRCS's natural resources conservation programs help reduce soil erosion, enhance water supplies, improve water quality, increase wildlife habitat, and reduce damages caused by floods and other natural disasters. The programs enhance natural resources that help sustain agricultural productivity and environmental quality while supporting continued economic development, recreation, and scenic beauty. A series of programs and funding opportunities are available (*see* http://www.co.nrcs.usda.gov/programs/index.html), including the **Wetlands Reserve Program (WRP)**, the **Wildlife Habitat Incentive Program (WHIP)**, the **Small Watershed Program (SWP), Conservation Innovation Grants (CIG)**, and the Environmental Quality Incentives Program (EQIP), described below.

- **Environmental Quality Incentives Program (EQIP).** http://www.co.nrcs.usda.gov/programs/eqip/eqip.html; http://www.co.nrcs.usda.gov/programs/eqip/2011EQIP/2011ColoradoRiver.html.
  - Eligible Applicants: Owners of land in agricultural production or persons engaged in livestock or agricultural production that meet detailed program requirements ("producers"). The USDA NRCS Field Service Center should be contacted as a "first step" in the application process.
  - Deadlines/Grant Cycle: Information not currently available for FY 2012.
  - $$ Range: Information is not currently available for FY 2012.
  - Application Process: Online application packet.
  - Projects/Programs of Interest: Financial assistance available to help develop conservation plans and implement conservation practices on eligible agricultural land. Program practices and activities are carried out according to an EQIP plan of operation; practices are subject to NRCS technical standards adapted for local conditions. There are five EQIP national priorities:
    - Reduction of nonpoint source pollution in impaired watersheds consistent with Total Daily Maximum Loads, where available; reduction of surface and groundwater contamination; reduction of contamination from agricultural point sources;
    - Conservation of ground and surface water resources;
    - Reduction of emissions ;
    - Reduction in soil erosion and sedimentation; and
    - Promotion of at-risk species habitat conservation.

    EQIP programs include the Agricultural Water Enhancement Program (AWEP), which is specifically directed at implementing water enhancement activities on agricultural land.

- **U.S. EPA (Environmental Education Grants)**. http://www.epa.gov/enviroed/grants.html.
  - Eligible Applicants: Local education agency, state education or environmental agency, college or university, 501(c)(3) organization, noncommercial educational broadcasting entity, tribal education agency .
  - Deadlines/Grant Cycle: Annual program. Deadline for FY2011 grant proposals TBD.
  - $$ Range: Annual funding for the program is $2 - $3 million. Regional grants are awarded for $50,000 or less (they are typically in the range of $15,000 - $20,000). U.S. EPA headquarters grants range from $50,001 - $200,000.
  - Application Process: Application packet available online. Approximately six months after receipt of applications, finalists are requested to submit additional documentation.
  - Projects/Programs of Interest: Supports environmental education projects that enhance the public's awareness, knowledge, and skills to help people make informed decisions that affect environmental quality. RFP under development for the next funding cycle.

- **U.S. Fish & Wildlife Service – Division of Bird Habitat Conservation – North American Wetlands Act.** http://www.fws.gov/birdhabitat/Grants/NAWCA/index.shtm.
  - Eligible Applicants: Public-private partnerships.
  - Deadlines/Grant Cycle: Annual program. In 2010 the Standard Grants Program deadline was July 30, 2010, and the Small Grants Program deadline was October 28, 2010.
  - $$ Range: Small Grants Program - up to $75,000. Standard Grants Program – No maximum/minimum dollar amount specified.

- Application Process: The Intermountain West Joint Venture Coordinator should be contacted for Small Grants Program projects in Colorado (http://iwjv.org/index.php). U.S. Fish & Wildlife staff should be contacted for direction with respect to the Standard Grants Program.
- Projects/Programs of Interest: A Small Grants Program (smaller scope projects) and a Standard Grants Program (larger projects) exist for the protection, restoration, and/or enhancement of wetlands and associated wetlands habitats for the benefit of wetlands-associated migratory birds. In the Small Grants Program funding priority is given to grantees or partners new to the program.

- **U.S. Fish & Wildlife Service – Partners for Fish and Wildlife (PFW).** http://www.fws.gov/mountain-prairie/pfw/colorado/co2.htm. The PFW Program works with owners of private lands for the benefit of wildlife, and the habitats in which they reside. Most habitat projects are for waterbirds, migratory song birds, boreal toads, leopard frogs, or cutthroat trout. Assistance is provided from both a technical and financial perspective with up to 75% of a project's cost being paid for by the Program. There is no public access requirement or landowner income thresholds. PFW prefers to match funds with other funding entities when possible. Projects need to be approved prior to any work being done and if a contractor needs to be hired he would work for the landowner.
  - Eligible Applicants: Private Landowners. Anyone is eligible, but larger ranches and properties are preferred.
  - Deadlines/Grant Cycle: No deadlines or cycles, call anytime and talk about your project idea.
  - $$ Range: $2,000-$50,000.
  - Application Process: Schedule an on-site visit by calling Bob Timberman 970-723-4926.
  - Projects/Programs of Interest: Depending upon the habitat project, private land benefits can include: Stream Fencing, livestock water, aspen regeneration, beaver dam control, spring improvements, riparian grazing plans, wetland restorations, shallow water projects, water level management, native plant restorations, native vegetation plantings, cutthroat trout stream restorations, head gate protections from beaver, and grazing plans to benefit livestock and wildlife.

❖ **Waste Management.** http://www.wm.com/wm/community/giving.asp.
- Eligible Applicants: 501(c)(3) organizations and public organizations where funding will be used exclusively for public purposes.
- Deadlines/Grant Cycle: Applications for funding are accepted year-round and reviewed on a continuous basis.
- $$ Range: No minimum/maximum dollar amount specified. In-kind or product donations can also be sought.
- Application Process: Proposal must be submitted containing all of the information specified online.
- Projects/Programs of Interest: Organizations and/or programs that preserve and/or enhance natural resources. Environmental education programs targeted at middle and high school students.

❖ **Wick Kenney Fund.** http://www.kenneybrosfdn.org/wickFund/grants.html.
- Eligible Applicants: 501(c)(3) organizations.

- Deadlines/Grant Cycle: LOIs may be submitted at any time. Grants are typically made only twice a year, in June and December.
- $$ Range: No minimum/maximum dollar amount specified. Grants in 2008 ranged from $5,000 - $15,000.
- Application Process: The Foundation makes only discretionary grants. A one-page LOI addressing the specifics outlined on the Fund's website must be submitted via email. Additional information may be requested by the Fund if the project has funding potential.
- Projects/Programs of Interest: Grants are available to protect and restore watersheds in the western U.S. Funding is available for projects that:
  - Provide a real opportunity to change western water policy on a local, state, or national level; or
  - Defend environmental laws critical for the protection of all western rivers; or
  - Focus on a specific strategy for protection of a biologically important western watershed; or Research and analyze issues that affect western water (e.g., alternatives for managing water demand, mechanisms for transferring water to environmental and recreational use).

  Grants may be used for arranging meetings. Preference will be given to projects that will be disseminated to reach advocates for the West's rivers.

❖ **The William and Flora Hewlett Foundation.**
http://www.hewlett.org/grants/grantseekers/environment-program

- Eligible Applicants: The Foundation does not fund individuals and generally does not fund unincorporated associations/groups or for-profit organizations.
- Deadlines/Grant Cycle: LOIs in open program areas may be submitted at any time.
- $$ Range: No minimum/maximum dollar amount specified. Recent grants have ranged from a few thousand dollars to millions of dollars.
- Application Process: Almost all grants are awarded to entities identified by the Foundation. However, unsolicited LOIs may be submitted (via an online application) in connection with certain programs. (The Foundation's Western Conservation Program was accepting LOIs as of October 2010). Unsolicited proposals are not accepted.
- Projects/Programs of Interest: In connection with its Western Conservation Program, grants are available for the restoration of river flows and conservation of riparian areas in Colorado and other western states. The Foundation will support organizations working to accomplish the following objectives:
  - Achieve West-wide policy changes that improve river flows and protect riparian areas;
  - Increase river flows and improve riparian land conservation through federal dam relicensing processes;
  - Improve state instream flow water policies and funding to increase river flows and riparian land conservation; and
  - Link surface and groundwater regulations to reduce aquifer depletion.

  Grants are also available for building broad-based support for land, water, and energy goals among key stakeholders. The Foundation will support organizations working to accomplish the following objectives:
  - Mobilize key constituencies to support land, water, energy, and climate outcomes;
  - Provide public feedback to decision makers on land, water, energy, and climate issues; and
  - Distribute analysis and research to educate decision makers on land, water, energy, and climate issues.

Activities the Foundation does *not* fund include: environmental education, habitat restoration, watershed restoration, stream and riverbank restoration, films and videos, conservation easements, land acquisition, and forest monitoring. The Foundation occasionally makes operating grants to organizations.

- **Wolcott Family Foundation.** http://www.dreamthefuture.org/forward/wolff/Downloads/WOLFF%20guidelines.pdf.
  - Eligible Applicants: 501(c)(3) organizations. The Foundation does not fund entities with annual budgets over $350,000.
  - Deadlines/Grant Cycle: Grant proposals must be submitted by the first Friday of September to be considered. Notification of grant awards generally occurs in December.
  - $$ Range: Generally grants range from $1,000 - $5,000.
  - Application Process: Submit a proposal following the guidelines available online.
  - Projects/Programs of Interest: Both general support and project support grants are available. The Foundation is interested in projects that emphasize environmental preservation, advocacy, and community involvement aimed at root causes of societal problems. The Foundation is also interested in funding organizations that demonstrate linkages and interdependence of ecosystems and economics with win-win solutions and collaborative approaches.

- **The Wyss Foundation (Wyss Fellows).** http://www.wyssfoundation.org/fellows/orgapply. Nonprofit, local, regional, and national conservation organizations that work on western public lands policy issues are eligible to apply to host 2-year, grant-funded, Wyss Fellow positions. Sponsoring organizations contribute staff time to mentor and monitor the Fellow's work, overhead expenses, and 20% of the Fellow's salary and benefits (the stipend must be between $35,000-$45,000). The Wyss Foundation provides host organizations a grant for programmatic support (project expenses and travel), and 80% of the Fellow's salary and benefits. Host organizations are responsible for the selection and hiring of the Fellow, in consultation with the Foundation. The next chance to apply to host a Wyss Fellow will be in the winter of 2011.

USEFUL WEB LINKS FOR IDENTIFYING ADDITIONAL GRANT OPPORTUNITIES

- Center for Invasive Plant Management- Resource Directory – Funding Opportunities: http://www.weedcenter.org/funding/funding.html.
- Colorado Outdoor Recreation Grants Summary List: http://parks.state.co.us/Trails/Grants/Other%20Outdoor%20Recreation%20Grants/Pages/Other%20Outdoor%20Recreation%20Grants.aspx.
- Colorado Watershed Assembly – Funding Opportunities List: Colorado Watershed Assembly - Funding Opportunities List.
- Environmental Grantmakers Association: Welcome | EGA.
- Federal Grants: http://www.grants.gov/.
- Multicultural Environmental Leadership Development Initiative – Environmental Grantmakers: http://meldi.snre.umich.edu/fellowships_and_funding/Environmental+Grantmaking.
- National Council for Science & the Environment Support/Funding Sources: Support & Funding | NCSE.
- NWCCOG List of Foundations in Colorado: http://www.nwccog.org/index.php/resources/grant-opportunities/.

- Sonoran Joint Venture List of Funding Sources: http://www.sonoranjv.org/funding/funding02.html.
- U.S. EPA - Catalog of Federal Funding Sources for Watershed Protection: http://cfpub.epa.gov/fedfund/.

7. Acronyms, Abbreviations, and Glossary

ACOE	Army Corps of Engineers
AGCI	Aspen Global Change Institute
AVLT	Aspen Valley Land Trust
BLM	Bureau of Land Management
BMP	Best Management Practices
BOR	U.S. Bureau of Reclamation
BWCD	Basalt Water Conservancy District
CBRT	Colorado Basin Roundtable
CDPHE	Colorado Department of Public Health and Environment
CDRM&S	Colorado Division of Reclamation, Mining, and Safety
CDWR	Colorado Division of Water Resources
CNHP	Colorado Natural Heritage Program
Collaborative	Roaring Fork Watershed Collaborative Water Committee
Conservancy	Roaring Fork Conservancy
CPW	Colorado Park & Wildlife
CRCT	Colorado River cutthroat trout
CRWCD	Colorado River Water Conservation District
CU	University of Colorado
CWCB	Colorado Water Conservation Board
CWT	Colorado Water Trust
DOI	US Department of Interior
EDCs	Endocrine disrupting compounds
ELOHA	Ecological Limits of Hydrologic Alteration
EPA	U.S. Environmental Protection Agency
ESWM	Ecologically Sustainable Water Management
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
Forest Plan	2002 White River Land and Resource Management Plan
Fry-Ark	Fryingpan-Arkansas Project
GIS	Geographic Information System
ISF	Water Conservation Board (CWCB) Instream Flow Program appropriations
MSCD	Mount Sopris Conservation District
NRCS	National Resource Conservation Service
NWCCOG	Northwest Colorado Council of Governments
OWTS	Onsite Wastewater Treatment Systems
PPCPs	Pharmaceuticals and personal care products
RICD	Recreational In-channel Diversion
RWAPA	Ruedi Water and Power Authority
SI	Sonoran Institute

TNC	The Nature Conservancy
Twin Lakes	Twin Lakes Reservoir and Canal Company
USFWS	U.S. Fish and Wildlife Service
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
West Divide	West Divide Water Conservancy District
WQCC	Water Quality Control Commission
WQCD	Water Quality Control Division

Glossary

Benthic – Of, relating to, or occurring at the bottom of a body of water.

Call – Demand for administration of water rights. In times of water shortages, the owner of a decreed water right will make a "call" for water. The call results in shut down orders against decreed water uses and decreed junior water rights as necessary to fill the beneficial use needs of the decreed senior calling rights.

Channel alteration – A measure of anthropogenic changes to the shape of the stream channel; includes channelization, clearing and snagging, selective snagging, riprapping, bank stabilization, realignment, lining, and dredge and fill activities. Channel alteration is present when artificial embankments, riprap, and other forms of artificial bank stabilization or structures are present; when the stream is very straight for significant distances; when dams and bridges are present; and when other such changes have occurred.

Channelization – Artificial straightening, stabilizing, or diverting of stream channels, resulting in a straighter and deeper channel.

Chitrid fungus – A fungus (*Batrachochytrium dendrobatidis*) that causes chytridiomycosis, a highly infectious disease of amphibians.

Confined channel – A stream channel which is in continuous or repeated contact with the outside of major meander bends.

Conservation population – Reference to Colorado River Cutthroat Trout. If a population is greater than 90 percent genetically pure, it is considered a "Conservation Population" according to the Colorado River Cutthroat Trout Conservation Team.

Consumptive use – The part of water withdrawn that is evaporated, transpired, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment.

Critical habitat – According to federal law, the ecosystem upon which endangered and threatened species depend.

Drought – A period of abnormally dry weather sufficiently long enough to cause a serious hydrological imbalance.

Duration – The length of time that a specific flow condition lasts, such as the duration of extremely low flow conditions.

Ecosystem – The biotic community and its abiotic environment functioning as a system.

Effluent – An outward movement of water, as a stream from a lake or wastewater from a treatment plant.

Floodplain – Lowlands bordering a stream which are subject to recurrent flooding. Floodplains are composed of sediments carried by rivers and deposited on land during flooding.

Flow status – The degree to which the channel is filled with water.

Frequency – How often a particular condition, such as high pulse or flood, has occurred.

Gradient – The degree of inclination, ascent or descent.

Groundwater – That portion of the water below the ground surface that is under greater pressure than atmospheric pressure; that part of the subsurface that is in the zone of saturation.

Groundwater recharge – The movement, usually downward, of surface water or precipitation into the groundwater system.

Hydrology – The properties, distribution, and circulation of water.
Hydrologic alteration or flow alteration – Change in stream flow.
Macroinvertebrate - An animal lacking a backbone and generally visible to the unaided eye or generally larger than 0.5 mm at its greatest dimension.
Magnitude – The amount of water passing a fixed point in the river at a specific point in time (*e.g.*, how big is the high flow pulse or flood?).
Meander – A stream reach that includes one complete bend, curve, or loop.
Municipal and Industrial – Defined by SWSI as all publicly-supplied and self-supplied residential, commercial, institutional, and industrial water uses.
Neotropical migrant – Bird species that nest and reproduce in North America and then migrate to Mexico, Central or South America to overwinter.
Non-Conservation population – Reference to Colorado River Cutthroat Trout.
Nonpoint source (NPS) pollution – Pollution that is not discharged through pipes or a point source but rather originates from a multitude of sources over a large area. Common sources of non-point source pollution include failing onsite wastewater treatment systems, improper animal-keeping practices, forest cultivation practices, and urban and rural runoff.
Overbanking – Streamflow that moves out of the channel and onto the floodplain or into the riparian habitat.
Point source – A pipe, channel, conduit, or other discrete conveyance from which pollutants are discharged.
Potential - The highest ecologically stable state possible for a stream reach, without significant human interference. Potential is influenced by the natural interactions of hydrology, soils, and climate affecting the reach.
R2Cross – A method to determine streamflow requirements for habitat protection. R2Cross is used by the CWCB in the development of instream flow recommendations for Colorado's Instream Flow Program.
Rate of change – How quickly the stream flow changes, as flows rise or fall from day-to-day.
Redd – The nest that trout use to both reproduce and incubate the young.
Return flow – Water that reaches a groundwater or surface water source after release from the point of use and thus becomes available for further use.
Riffle – Shallow water area with rapid current and with flow broken by a substrate of gravel or rubble.
Riparian areas – Ecosystems that occur along watercourses and water bodies. These areas have high water tables and support plants that require saturated soils during all or part of the year. Riparian areas include both wetland and upland zones.
Riparian vegetation – Any extra-aquatic vegetation that directly or indirectly influences the stream environment.
Salmonid – Belonging to the family *Salmonidae*, which includes salmon, trout, and whitefish.
Sediment – Fragmented material that originates from weathering and erosion of rocks or unconsolidated deposits and is transported by, suspended in, or deposited by water. Certain contaminants, including bacteria, tend to collect on and adhere to sediment particles.
Sediment deposition – A measurement of the amount of sediment that has accumulated in pools and the changes that have occurred to the stream bottom as a result of deposition. High levels of sediment

deposition are symptoms of an unstable and continually changing environment that is unsuitable for many organisms.

Stormwater runoff – Rainfall or snowmelt that runs off over the land surface, potentially carrying pollutants to streams, lakes, or reservoirs.

Stream – All sizes of flowing water channels and longitudinally linked drainage systems extending from the most meager headwater beginnings to an arbitrarily identified end, mouth, or estuary.

Substrate – The physical properties components and particles of materials within the stream channel.

Timing – The time of year at which particular flow events occur, such as the timing of annual floods or low flow conditions.

Turbidity – A measure of the amount of material suspended in the water. High levels of turbidity over extended periods are harmful to aquatic life.

Water quality – The biological, chemical, and physical conditions of a water body; a measure of a water body's ability to support life.

Watershed – The geographic region within which water drains into a particular river, stream or body of water. A watershed includes hills, lowlands, and the body of water into which the land drains.

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Appendices

Appendix 1. Natural Communities and Species of Concern *.

Riparian and Wetland Natural Communities (CNHP).

SCIENTIFIC NAME	COMMON NAME	CNHP GLOBAL RANK*	CNHP STATE RANK*
Eleocharis quinqueflora Herbaceous Vegetation	Alpine Wetlands	G4	S3S4
Salix brachycarpa / Deschampsia caespitosa - Geum rossii Shrubland	Alpine Willow Scrub	G4	S3S4
Populus tremuloides / Pteridium aquilinum Forest	Aspen Wetland Forests	G4	S3S4
Salix boothii / Carex utriculata Shrubland	Booth's Willow/Beaked Sedge	G4	S3
Salix boothii / Mesic Forbs Shrubland	Booth's Willow/Mesic Forb	G3	S3
Abies lasiocarpa / Ribes (montigenum, lacustre, inerme) Forest	Coniferous Wetland Forests	G5	S3
Populus angustifolia / Cornus sericea Woodland	Cottonwood Riparian Forest	G4	S3
Eleocharis rostellata Herbaceous Vegetation	Emergent Wetland	G3	S2
Kobresia myosuroides - Thalictrum alpinum Herbaceous Vegetation	Extreme Rich Fens	G2	S1
Crataegus rivularis Shrubland	Foothills Riparian Shrubland	G2Q	S2
Shepherdia argentea Shrubland	Foothills Riparian Shrubland	G3G4	S1
Betula occidentalis / Maianthemum stellatum Shrubland	Foothills Riparian Shrubland	G4?	S2
Cornus sericea Shrubland	Foothills Riparian Shrubland	G4Q	S3
Populus deltoides ssp. wislizeni / Rhus trilobata Woodland	Fremont's Cottonwood Riparian Forests	G2	S2
Salix geyeriana / Carex utriculata Shrubland	Geyer's Willow/Beaked Sedge	G5	S3
(Picea engelmannii) / Betula nana / Carex aquatilis - Sphagnum angustifolium Woodland	Iron Fen	G2	S2
Pseudotsuga menziesii / Cornus sericea Woodland	Lower Montane Riparian Forests	G4	S2
Betula occidentalis / Mesic Graminoids Shrubland	Lower Montane Riparian Shrublands	G3	S2
Salix drummondiana / Calamagrostis canadensis Shrubland	Lower Montane Willow Carrs	G3	S3
Deschampsia caespitosa - Ligusticum tenuifolium Herbaceous Vegetation	Mesic Alpine Meadows	GU	SU
Glyceria borealis Herbaceous Vegetation	Montane Emergent Wetland	G4	S3
Sparganium angustifolium Herbaceous Vegetation	Montane Floating/submergent Palustrine Wetlands	G4	SU
Acer negundo / Prunus virginiana Forest	Montane Riparian Deciduous Forest	G3	S2
Acer negundo / Cornus sericea Forest	Montane Riparian Deciduous Forest	G3?	S2
Populus angustifolia - Juniperus scopulorum Woodland	Montane Riparian Forest	G2G3	S2S3
Populus angustifolia - Pseudotsuga menziesii Woodland	Montane Riparian Forest	G3	S2
Populus angustifolia / Alnus incana Woodland	Montane Riparian Forest	G3	S3
Populus angustifolia / Betula occidentalis Woodland	Montane Riparian Forest	G3	S3
Picea pungens / Cornus sericea Woodland	Montane Riparian Forest	G4	S2
Abies lasiocarpa - Picea engelmannii - Populus angustifolia / Lonicera involucrata Forest	Montane Riparian Forest	G4	S3
Populus tremuloides / Acer glabrum Forest	Montane Riparian Forests	G2	S2
Picea pungens / Alnus incana Woodland	Montane Riparian Forests	G3	S3
Populus angustifolia - Picea pungens / Alnus incana Woodland	Montane Riparian Forests	G3	S3

Populus tremuloides / Alnus incana Forest	Montane Riparian Forests	G3	S3
Picea engelmannii / Cornus sericea Woodland	Montane Riparian Forests	G3	SU
Alnus incana - Salix drummondiana Shrubland	Montane Riparian Shrubland	G3	S3
Salix lucida ssp. caudata Shrubland [Provisional]	Montane Riparian Shrubland	G3Q	S2S3
Salix monticola / Carex utriculata Shrubland	Montane Riparian Willow Carr	G3	S3
Salix monticola / Mesic Graminoids Shrubland	Montane Riparian Willow Carr	G3	S3
Salix monticola / Mesic Forbs Shrubland	Montane Riparian Willow Carr	G4	S3
Picea pungens / Betula occidentalis Woodland	Montane Riparian Woodland	G2	S2
Populus balsamifera Woodland	Montane Riparian Woodland	GU	S2
Carex vesicaria Herbaceous Vegetation	Montane Wetland	G4Q	S1
Salix geyeriana / Carex aquatilis Shrubland	Montane Willow Carr	G3	S3
Salix monticola / Calamagrostis canadensis Shrubland	Montane Willow Carr	G3	S3
Salix drummondiana / Carex utriculata Shrubland	Montane Willow Carr	G4	S3
Acer negundo - Populus angustifolia / Cornus sericea Forest	Narrowleaf Cottonwood Riparian Forests	G2	S2
Populus angustifolia / Crataegus rivularis Woodland	Narrowleaf Cottonwood Riparian Forests	G2?	S2
Populus angustifolia / Salix ligulifolia - Shepherdia argentea Woodland	Narrowleaf Cottonwood Riparian Forests	G3	S3
Populus angustifolia / Salix (monticola, drummondiana, lucida) Woodland	Narrowleaf Cottonwood/Mixed Willows Montane Riparian Forest	G3	S3
Populus angustifolia / Rhus trilobata Woodland	Narrowleaf Cottonwood/Skunkbrush	G3	S3
Salix boothii / Mesic Graminoids Shrubland	Riparian Willow Carr	G3?	S3
Juniperus scopulorum / Cornus sericea Woodland	Riparian Woodland	G4	S2
Catabrosa aquatica - Mimulus ssp. Spring Wetland	Spring Wetland	GU	S3
Betula nana / Mesic Forbs - Mesic Graminoids Shrubland	Subalpine Riparian Shrubland	G3G4	S3
Salix planifolia / Deschampsia caespitosa Shrubland	Subalpine Riparian Willow Carr	G2G3	S2S3
Salix wolfii /Calamagrostis canadensis Shrubland	Subalpine Riparian Willow Carr	G3	S2S3
Salix wolfii / Mesic Forbs Shrubland	Subalpine Riparian Willow Carr	G3	S3
Salix planifolia / Calamagrostis canadensis Shrubland	Subalpine Riparian Willow Carr	G4	S2S3
Salix wolfii / Carex aquatilis Shrubland	Subalpine Riparian Willow Carr	G4	S3
Salix wolfii / Carex utriculata Shrubland	Subalpine Riparian Willow Carr	G4	S3
Sullivantia hapemanii - (Aquilegia barnebyi) Herbaceous Vegetation	Sullivantia Hanging Gardens	G2	S2
Alnus incana - Salix (monticola, lucida, ligulifolia) Shrubland	Thinleaf Alder-Mixed Willow Species	G3	S3
Alnus incana / Cornus sericea Shrubland	Thinleaf Alder-Red-osier Dogwood Riparian Shrubland	G3G4	S3
Nuphar lutea ssp. polysepala Herbaceous Vegetation	Western Slope Floating/Submergent Palustrine Wetlands	G5	S3
Phragmites australis Western North America Temperate Semi-natural Herbaceous Vegetation	Western Slope Marsh	G5	S3
Carex nebrascensis Herbaceous Vegetation	Wet Meadows	G4	S3

Riparian and Wetland Plants (Source: Dee Malone, CNHP).

SCIENTIFIC NAME	COMMON NAME	GLOBAL RANK*	STATE RANK*	US ESA*	FEDERAL AGENCY SENSITIVE LIST
Eriophorum altaicum var. neogaeum	Altai cottongrass	G4?T3T4	S3	-	USFS
Cypripedium calceolus ssp. parviflorum	American yellow lady's-slipper	G5	S2	-	USFS
Luzula subcapitata	Colorado wood-rush	G3?	S3?	-	-
Carex viridula	green sedge	G5	S1	-	-
Sullivantia hapemanii var. purpusii	Hanging Garden sullivantia	G3T3	S3	-	-
Parnassia kotzebuei	Kotzebue's grass-of-parnassus	G5	S2	-	USFS
Carex diandra	lesser panicled sedge	G5	S1	-	USFS
Salix lanata ssp. calcicola	lime-loving willow	G4G5T4	S1	-	-
Trichophorum pumilum	little bulrush	G5	S2	-	BLM
Cystopteris montana	mountain bladder fern	G5	S1	-	-
Listera borealis	northern twayblade	G4	S2	-	-
Drosera rotundifolia	roundleaf sundew	G5	S2	-	USFS
Eriophorum gracile	slender cottongrass	G5	S2	-	USFS
Carex stenoptila	small-winged sedge	G2	S2	-	-
Ranunculus gelidus ssp. grayi	tundra buttercup	G4G5	S2	-	USFS
Spiranthes diluvialis	Ute ladies' tresses	G2G3	S2	LT	-
Hippochaete variegata	variegated scouringrush	G5	S1	-	-
Eriophorum chamissonis	Chamisso’s cottongrass	G5	S1	-	USFS

*** Colorado Natural Heritage Program Global and State Ranked 1-3 natural communities and plants.**
1 - Critically imperiled; typically 5 or fewer occurrences
2 - Imperiled; typically 6 to 20 occurrences
3 - Vulnerable; typically 21 to 100 occurrences
- A range between two of the numeric ranks; indicates uncertainty about the rarity of the element
? - Unranked; element is not yet ranked
U - Unrankable; not enough information is known
Q - Taxonomic status is questionable

US ESA Endangered Species List
LT-Listed Threatened
C-Concern

Appendix 2. Noxious Weeds or Undesirable Disturbance-Induced Plant Species.

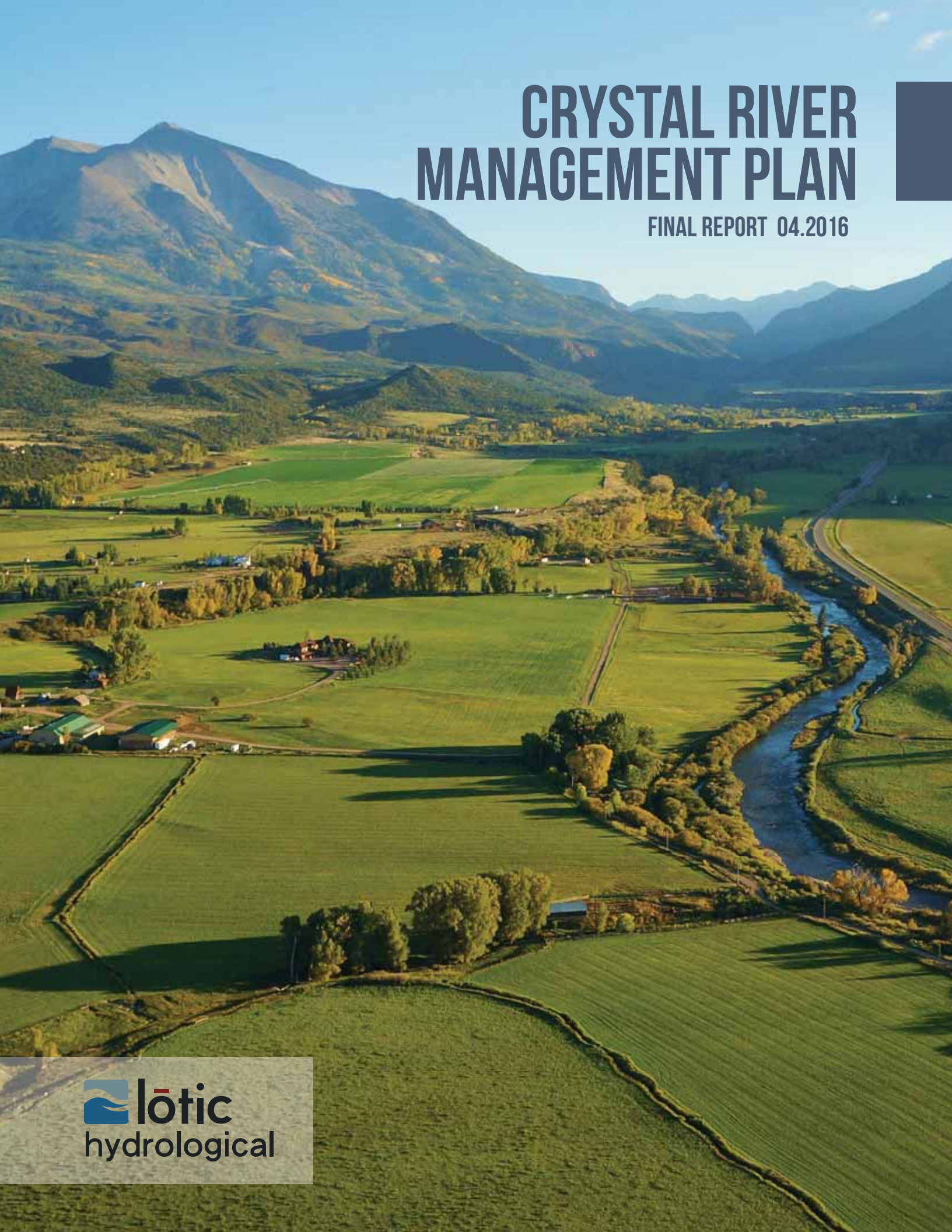
Associated with riparian and wetland areas found in the Roaring Fork Watershed (Source: Dee Malone).

SCIENTIFIC NAME	COMMON NAME
Agrostis gigantea*	Redtop
Agrostis stolonifera	Creeping Bentgrass
Alisma triaviale	Water Plantain
Amaranth spp.	Amaranth
Arctium minus*	Common Burdock
Asperugo procumbens	Catchweed
Brassica nigra*	Black Mustard
Bromus inermis*	Smooth Brome
Capsella bursa-pastoris*	Shepherd's Purse
Carduus acanthoides*	Plumeless Thistle
Carduuus nutans*	Musk Thistle
Centaurea pratensis	Meadow Knapweed
Centaurea repens	Russian Knapweed
Chenopodium spp.*	Goosefoot
Chrysanthemum leucanthemum*	Oxeye Daisy
Cichorium intybus*	Chicory
Cicuta douglasii	Water Hemlock
Cirsium arvense*	Canada Thistle
Cirsium vulgare*	Bull Thistle
Clematis orientalis	Chinese Clematis
Conium maculatum*	Poison Hemlock
Conoselinium scopulorum	Hemlock Parsley
Convolvulus arvensis*	Field Bindweed
Cynoglossum officianale*	Houndstongue
Dactylis glomerata	Orchard Grass
Descurainia incisa*	Tansy Mustard
Descurainia pinnata*	Western Tansy Mustard
Descurainia sophia*	Flixweed
Eleagnus angustifolia*	Russian-Olive
Euphorbia esula*	Leafy Spurge
Hesperis matrionalis*	Dame's Rocket
Lactuca serriola	Prickly Lettuce
Lepidium campestre	Field Pepperweed
Lepidium perfoliatum	Clasping Peppergrass
Linaria vulgaris	Butter and Eggs
Matricaria perforata	Scentless Chamomile
Medicago sativa	Alfalfa
Melilotus officinale*	Yellow Sweet Clover
Myriophyllum spicahim*	Eurasian Watermilfoil
Onopordum acanthium*	Scotch Thistle
Persicaria lepathifolia	Smartweed

Phalaris arundinaceae*	Reed Canarygrass
Phleum pratense	Common Timothy
Plantago lanceolata*	Lanceleaf Plantain
Plantago major*	Common Plantain
Planted Grasses	Planted Grasses
Poa pratense*	Kentucky Bluegrass
Rumex crispus	Curly Dock
Rumex densiflorus	Dense-flowered Dock
Rumex salicifolius	Willowleaf Dock
Salsola australis	Russian Thistle
Silene vulgaris	Bladder Campion
Sisymbrium altissimum*	Tumble Mustard
Solanum dulcamara*	Bittersweet Nightshade
Sonchus arvensis*	Sow-Thistle
Sonchus sp.*	Sow-Thistle
Tamarix ramosissima*	Tamarisk, Salt-Cedar
Tanacetum vulgare*	Common Tansy
Thlapsi arvense	Pennycress
Tragopogon pratensis	Salsify
Trifolium hybridium	Alsike Clover
Trifolium pratense	Red Clover
Trifolium repens	White Dutch Clover
Ulmus*	Siberian Elm
Verbascum thapsus	Common Mullein
Xanthium strumarium	Common Cocklebur

CRYSTAL RIVER MANAGEMENT PLAN

FINAL REPORT 04.2016



lōtic hydrological

ROARING FORK WATERSHED PLAN at work

PREPARED FOR

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CRYSTAL RIVER MANAGEMENT PLAN 2016

Identifying, prioritizing and guiding management actions that honor local agricultural production, preserve existing water uses, and enhance the ecological integrity of the river.

EXECUTIVE SUMMARY

Changing demographics and local economies place increasing value on the Crystal River's aesthetic, environmental and recreational attributes. At the same time, the community retains important cultural and economic ties to a strong agricultural heritage and ongoing agricultural production. Residents in the Town of Carbondale enjoy large shade trees, verdant gardens, and green parks and open spaces supported by a free raw-water supply sourced from the River. Agricultural producers, in turn, depend on use of the Crystal River to support their livelihoods and maintain vast open spaces terraced along the flanks of Mount Sopris and across the valley floor. The convergence of these diverse and sometimes competing demands with water scarcity on the Crystal River during periods of drought leads to demand shortages for some agricultural producers and impairment of various measures of ecosystem function.

Despite the challenges involved in managing water for multiple uses when resources are limited, diverse stakeholders continue to recognize the importance of balancing agricultural production and ecosystem function on the Crystal River. However, without comprehensive quantitative and social frameworks for understanding the costs and benefits associated with any proposed management alternative, uncertainty prevails and stakeholders default to the status quo. Planning around water needs on the Crystal River required development of a scientifically rigorous and consensus-based framework for predicting the ecological and social consequences of proposed projects or management strategies. The Crystal River Management Plan (the "Plan") utilized a science-based and stakeholder-centered approach to consider complex interactions between the physical components driving watershed structure; the biological components of riverine ecosystems; the social context of competing perspectives, needs, and values; and the existing legal and administrative frameworks governing water use in an effort to identify and evaluate management and structural alternatives that honor local agricultural heritage, preserve existing water uses, and enhance the ecological integrity of the river. A series of stakeholder meetings held throughout the planning process served to clarify outstanding questions, summarize results from previous studies, refine planning goals and objectives, and evaluate the feasibility of various management alternatives.

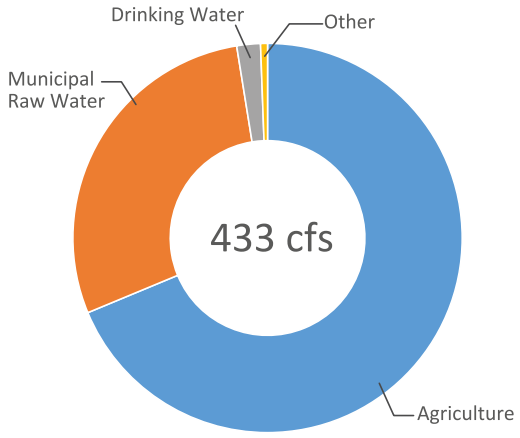
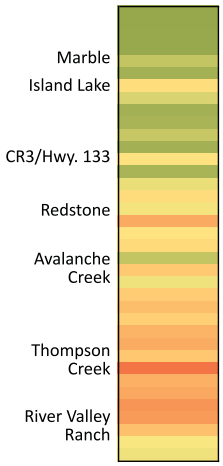


Figure ES-1: Agricultural and non-potable municipal water uses represent the dominant surface water diversions on the Crystal River

The functional assessments detailed in Section 2 conclude that few external stressors exist in the headwaters of the Crystal contributing to a generally healthy ecosystem above Redstone. Constraints on function increase in the downstream direction due to the cumulative effects of floodplain development and surface water diversions (Figure ES-1). The reaches of Crystal River between Thompson Creek and the confluence with the Roaring Fork exhibit the most degraded overall functional condition. This pattern most strongly reflects late summer modifications to the hydrological regime and cascading impacts on channel hydraulics, water temperature, habitat quality and availability, and biotic structure. The dominant nature of the impacts to streamflow and habitat suggest that management strategies that focus on these two variables will yield the greatest overall environmental benefit.

Characterizations of water management and use presented in Section 3 identified the prominent limiting circumstances for management of consumptive and non-consumptive use needs on the Crystal River. Legal and administrative frameworks governing the use of water on the Crystal River allocate water among multiple uses—agricultural production, municipal water use, operation of a fish hatchery, and a minimum instream flow right (Figure ES-2)—according to a seniority system that places the oldest existing uses ('senior rights') in priority over newer uses ('junior rights'). The convergence of water availability and water administration under the Prior Appropriation System creates both chronic and transient water shortages. Agricultural use shortages impact users on tributaries more significantly than on the mainstem of the Crystal River. The most persistent shortages on the Crystal River mainstem are the CWCB ISF right, and the junior water rights on the East Mesa Ditch, Sweet Jessup Canal, Helms Ditch, and Kaiser & Sievers Ditch. The presence of agricultural shortages highlights the difficulties associated with managing water to satisfy ecosystem needs without burdening existing water users.

The alternative management strategies detailed in Section 4 respond to the overlapping themes and management prospects that emerged from reviews of water use patterns, legal and administrative considerations, and evaluations of ecosystem function. The Plan considered the relative effectiveness of a wide array of market-based programs, efficiency measures, water supply projects, and channel modifications for meeting planning goals and



Grade	Score	Level of Impairment
A	90-100	Negligable
B	80-90	Mild
C	70-80	Significant
D	60-70	Severe
F	50-60	Profound/Unsustainable

Figure ES-2: Constraints on ecosystem function are greatest on the lower Crystal River where surface water diversions modify the hydrological regime and limit the quality and availability of aquatic habitat

objectives. Unfortunately, no single management option represented a panacea for meeting existing needs and addressing observed ecosystem impairments. Rather, each alternative was associated with a unique set of environmental, capital, and social costs and benefits. Section 5 presents the results of consideration of these factors by local stakeholders and a prioritization of management actions over the short and long-term. Stakeholders groups involved in the cost-benefit analysis process included: agricultural producers, State water administrators, local municipalities, natural resource agencies, local and national environmental organizations, recreational advocates, and other water rights holders.

The findings and recommendations presented in the various sections of the Plan are summarized below:

- Few external stressors exist in the headwaters of the Crystal contributing to a generally healthy ecosystem above Redstone.
- Constraints on ecosystem function slowly increase in the downstream direction due to the cumulative effects of floodplain development and surface water diversions.
- The reaches of the Crystal River between Thompson Creek and the confluence with the Roaring Fork exhibit the most degraded overall functional condition.
- Reductions in late summer baseflows produce cascading impacts on channel hydraulics, water temperature, and physical habitat quality and availability.
- Supply shortages on water-limited tributaries are common. Demand shortages on the Crystal River exist for the junior rights on the East Mesa Ditch, Sweet Jessup Canal, Helms Ditch, and Kaiser & Sievers Ditch. The CWCB ISF right is frequently short in late summer.
- Water efficiency upgrades (e.g. sprinkler irrigation and ditch lining) can significantly reduce the frequency and magnitude of demand shortages experienced by agricultural producers.
- The most feasible and effective management options for meeting planning goals include 1) Non-Diversion Agreements between the Sweet Jessup Canal and Carbondale Ditch, and 2) ditch lining and short term water leasing by the Town of Carbondale on the Carbondale Ditch and Weaver and Leonhardy Ditch.
- Non-Diversion Agreements of approximately 25 cfs in severe drought and 10-15 cfs during moderate drought will meet management goals for maintaining moderate risk to ecosystem function. Current conditions place the ecosystem at high risk for unfavorable change.
- Reaching management targets will require diversion reductions between 5-18% (depending on drought severity) between the Sweet Jessup Canal and the Carbondale Ditch.
- Stakeholders should continue to investigate the feasibility of stand-alone water efficiency infrastructure projects, off-channel reservoir development, and channel modifications to simultaneously promote ecosystem function and the long-term sustainability of local agricultural production.

Population growth trends indicate that the Town of Carbondale will experience a doubling in size in the coming decades. Projections from climate data indicate that climbing temperatures will shift the timing of snowmelt runoff and increase the frequency and severity of hot and dry summer conditions. These changes will place increasing strain on the riverine environment at the same time that demand shortages for existing uses become more common. Without tools and structured plans for responding to these challenges, tensions between stakeholders in the Crystal River watershed will continue to mount. This Plan recommends several high-priority actions for balancing water use needs. Implementation of these actions will equip the community with flexible tools to deal with shifting community values, economic diversification, and climate change in a manner that minimizes conflict between user groups and achieves high levels of environmental resiliency.

ACKNOWLEDGEMENTS

The Crystal River Management Plan (CRMP) evolved from years of planning, studies and assessments that underscored the need for further investigation into water use patterns, ecological health and associated impacts in order to justify and produce on-the-ground improvements. In 2013, equipped with knowledge of successes and shortcomings of prior efforts, Roaring Fork Conservancy, Public Counsel of the Rockies, and Lotic Hydrological, LLC (the "Project Team") met with water rights holders and water users, listening to concerns and soliciting ideas to enhance riparian and instream conditions in and along the Crystal River. Combining prior knowledge with community input created a strong foundation for the CRMP and brought together river science and community values. The long-term efficacy of the CRMP depends on continued participation and input by stakeholders whose knowledge and values inform the options for water management and river stewardship now and in the future.

The CRMP benefitted from the expertise and guidance of a diverse and passionate group of experts, stakeholders, and community members. CDR Associates worked closely with the team through the final stages of planning and stakeholder engagement. Colorado Water Trust provided invaluable expertise, thoughtful insights and creative water management ideas. A long list of individuals and organizations informed and advised the Project Team throughout the planning process:

Crystal River water rights holders and agricultural producers, including representatives from the Sweet Jessup Canal, East Mesa Ditch, Lowline Ditch, Ella Ditch, Helms Ditch, Pioneer Ditch, Bowles and Holland Ditch, Rockford Ditch, Carbondale Ditch, Weaver and Leonhardy Ditch, Kaiser and Sievers Ditch, and Southard and Cavanaugh Ditch; the Town of Carbondale; Trout Unlimited; Western Resource Advocates; Crystal Valley Environmental Protection Association; Pitkin County Open Space and Trails; American Rivers; United States Forest Services, Natural Resources Conservation Service, Colorado Parks and Wildlife, Jake DeWolfe and Kevin Rein (Colorado Division of Water Resources); Kara Steeland (University of Michigan); Sandra Ryan-Burkett (Rocky Mountain Research Station); Chris Treese (Colorado River District); Peter Nichols (Berg Hill Greenleaf & Ruscitti LLP); Mark Beardsley (EcoMetrics); Karin Boyd (Applied Geomorphology, Inc.); Scott Gillilan (Gillilan Associates); and the outstanding engineering staff at RiverRestoraton. Any omissions are regretted.

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TABLE OF CONTENTS

1. INTRODUCTION 1-1

1.1 PLANNING CHALLENGES 1-1
1.2 THE LOCAL CONTEXT 1-2
1.3 STAKEHOLDER PROCESS 1-4
1.4 REGIONAL AND STATE LEVEL PLANNING CONTEXT 1-5

2. ECOSYSTEM FUNCTIONAL ASSESSMENT 2-1

2.1 ASSESSMENT CRITERIA 2-5
2.2 WATERSHED SCALE ASSESSMENTS 2-7
2.2.1 Flow Regime 2-7
2.2.2 Sediment Regime 2-9
2.2.3 Water Quality 2-10
2.3 REACH SCALE ASSESSMENTS 2-11
2.3.1 Floodplain Connectivity 2-11
2.3.2 Riparian Vegetation 2-11
2.3.3 Debris Supply 2-12
2.4 CHANNEL SCALE ASSESSMENTS 2-13
2.4.1 Stream Morphology 2-13
2.4.2 Channel Stability 2-13
2.4.3 Physical Structure 2-14
2.4.4 Biotic Structure 2-15
2.5 AGGREGATED FUNCTIONAL CONDITION 2-17

3. EXISTING WATER USES 3-1

3.1 WATER RIGHTS OVERVIEW 3-1
3.1.1 Municipal Use Rights 3-1
3.1.2 Agricultural Use Rights 3-2
3.1.3 CWCB Instream Flow Rights 3-3
3.1.4 Trans-basin Diversions 3-3
3.2 WATER USE ASSESSMENT 3-3
3.2.1 Hydrological Simulation Modeling 3-4
3.2.2 System Efficiencies 3-4
3.2.3 Demand Shortages 3-6
3.3 OVERALL PATTERNS OF WATER USE 3-7

4. ALTERNATIVE MANAGEMENT STRATEGY EFFECTIVENESS 4-1

4.1 MARKET BASED STRATEGIES 4-2
4.1.1 Non-Diversion Agreements 4-2
4.1.2 Short-Term Water Leasing 4-2

4.2 CONSERVATION BASED STRATEGIES 4-3
4.2.1 Ditch Lining 4-3
4.2.2 Sprinkler Irrigation 4-3
4.2.3 Irrigation Scheduling 4-4

4.3 SUPPLY BASED STRATEGIES 4-5
4.3.1 Off-Channel Reservoir 4-5

4.4 CHANNEL MODIFICATION STRATEGIES 4-5
4.4.1 Grade Control Structures 4-5
4.4.2 Inset Channel 4-5
4.4.3 Fish Habitat Enhancements 4-5

5. IDENTIFIED MANAGEMENT PRIORITIES 5-1

5.1 NON-DIVERSION AGREEMENTS FOR AGRICULTURAL USERS 5-2
5.1.1 Examples of Similar Programs 5-2
5.1.2 Feasibility and Next Steps 5-3

5.2 TOWN OF CARBONDALE CONSERVATION AND EFFICIENCY PLANNING 5-3
5.2.1 Feasibility and Next Steps 5-4

5.3 FUTURE CONSIDERATIONS 5-4
5.3.1 Channel Modification Projects 5-4
5.3.2 Off-Channel Reservoir 5-5
5.3.3 Ditch Lining and Sprinkler Irrigation 5-5

5.4 MOVING FORWARD 5-6

APPENDIX A: AN ECODSS FOR BALANCING CONSUMPTIVE AND NON-CONSUMPTIVE WATER USES ON THE CRYSTAL RIVER, COLORADO
APPENDIX B: EROSION, SEDIMENT SOURCES, AND CHANNEL ANALYSIS IN THE CRYSTAL RIVER WATERSHED, COLORADO
APPENDIX C: CRYSTAL RIVER WATER QUALITY SUMMARY, 2004-2014
APPENDIX D: FACSTREAM RESULTS FOR THE CRYSTAL RIVER
APPENDIX E: CRYSTAL RIVER HYDRAULIC MODELING REPORT
APPENDIX F: 2012 CRYSTAL RIVER AND COAL BASIN AQUATIC LIFE USE ASSESSMENT
APPENDIX G: WATER QUALITY IN THE CRYSTAL RIVER AND COAL CREEK BASIN

INTRODUCTION

Predicted ongoing population growth, shifts in the local economy, and changes in climate portend future conflicts over water resource management for the satisfaction of multiple and diverse user groups. Management of water on the Crystal River will continue to support the livelihoods of many local families and will impact the high quality of life enjoyed broadly by local residents over the coming years. Ensuring continued support for historical uses and optimizing management to reflect changing local expectations and values requires careful and focused planning. The Crystal River Management Plan (CRMP) expresses the results of a collaborative community process that endeavors to alleviate constraints on important ecosystem functions on the Crystal River without injuring local agricultural producers.

1.1 PLANNING CHALLENGES

The nexus of growing populations, recurring droughts, and limited water supply in basins across Colorado leaves many streams and rivers with substantially modified flow regimes. Where these conditions occur frequently or with great enough magnitude, some corresponding shift in functionality of the riverine ecosystem likely results. Altered ecological functionality impacts streams' and rivers' ability to provide important ecosystem services critical for protecting native species, supporting local tourism and recreation-based economies, and improving or maintaining local residents' high quality of life. Conversely, many of the resource management decisions that impact ecosystem function support the development of municipal water supplies, local industries, and maintain the livelihoods of local families. In short, some degree of hydrological modification is inevitable where humans inhabit semi-arid ecosystems in the Colorado Rockies. Management of scarce water resources at local, regional, and State levels must, therefore, strive to balance consumptive and non-consumptive water uses in a way that optimizes multiple use needs without compromising the ecological, social, or economic stability of local communities.

Ongoing community dialogue and patterns of water use in the Crystal River (the "River") watershed reflect this resource management paradigm. Changes in the local economy and demographics drive changing expectations for resource use and the delivery of ecosystem goods and services by the River and its tributaries. Historically, the use of irrigation water to support farming and cattle ranching and to supply raw water and drinking water to the Town of Carbondale constituted a primary local management objective. In recent years, a growing chorus of stakeholders expressed concerns about historical patterns of agricultural use and its impact on aesthetic values, ecosystem resiliency and function. While these stakeholders express concerns about the impacts of water diversions, all parties recognize the value of continued agricultural production as an important cornerstone of a vibrant community culture that places significant value on the aesthetic of vast, open, green spaces and economic and social ties to the history of agricultural production in the valley.

Despite the challenges involved in managing water for multiple uses during times of resource constraint, diverse stakeholders representing multiple water uses continue to recognize the importance of balancing consumptive and non-consumptive water uses of the Crystal River. However, without comprehensive quantitative and social frameworks for understanding the costs and benefits associated with any proposed management alternative, uncertainty reigns and stakeholders default to the status quo. Consumptive and non-consumptive water use planning therefore benefits from a scientifically rigorous and consensus-based framework for predicting the ecological and social consequences of proposed projects or management strategies.

The Crystal River Management Plan (CRMP, or the "Plan") addresses this situation. The Plan utilizes a science-based and stakeholder-centered approach to consider complex interactions between the physical components driving watershed structure; the biological components of riverine ecosystems; the social context of competing perspectives, needs, and values; and the existing legal and administrative frameworks governing water use in an effort to identify and evaluate management and structural alternatives that support the overall project goal (the "Goal"):

> **"IDENTIFY, PRIORITIZE AND GUIDE MANAGEMENT ACTIONS THAT HONOR LOCAL AGRICULTURAL PRODUCTION, PRESERVE EXISTING WATER USES, AND ENHANCE THE ECOLOGICAL INTEGRITY OF THE RIVER."**

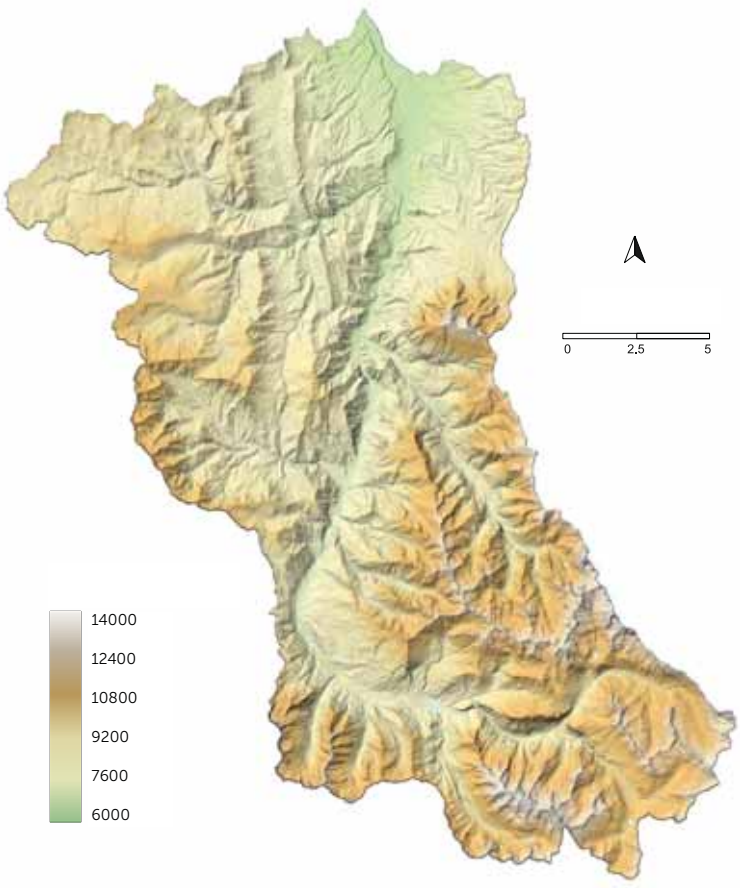


Figure 1-1: Crystal River Watershed

1.2 THE LOCAL CONTEXT

The Crystal River flows 35 miles from its headwaters in the Elk Mountains to its confluence with the Roaring Fork River. It is one of the longest remaining undammed rivers in the state of Colorado, and its biologically diverse ecosystem is home to mammals, birds, and aquatic organisms. The river corridor provides critical summer and winter habitat to elk, deer, coyotes, and red fox. Grouse, band-tailed pigeon, water fowl, prairie falcon, warblers, golden eagles, bald eagles, and western grebe depend on the Crystal's lush riparian vegetation. The river channel provides crucial habitat to native cutthroat trout, rainbow and brown trout, whitefish, and sculpin.[15]

Residents, conservation groups, environmental advocates, and government agencies recognize the unique virtue of the Crystal River. Starting in the 1980's, valley residents sought protection of the river corridor under the Wild and Scenic Rivers Act. Since then, the United States Forest Service (USFS) deemed Thompson Creek and most of the National Forest land bordering the Crystal River eligible for inclusion in the Federal Wild and Scenic Rivers System. In response to proposed dams and trans-basin water supply projects, American Rivers included the Crystal River on its "America's Most Endangered Rivers" list in 2012.1 Although the conditional water rights supporting the proposed reservoirs were recently abandoned, the administration of water rights in other parts of the River continue to pose challenges to concurrent management of consumptive and non-consumptive water uses.

An in-stream flow (ISF) water right held by The Colorado Water Conservation Board (CWCB) represents the only administrative mechanism in place to accommodate management for the environmental needs in the lower Crystal River. The right (100 cfs summer / 60 cfs winter) extends from Avalanche Creek to the Roaring Fork River. As a tool for meeting local ecosystem management objectives, the CWCB ISF on the Crystal is problematic in two respects. First, the summer ISF right is often not met from August-October[7] in moderate and severe drought conditions because of its junior priority under Colorado water law. Second, maintaining a flow of 100 cfs in the lower Crystal River during moderate or severe drought would require the dry-up of significant tracts of existing irrigated agricultural land. The latter scenario is largely unacceptable to the agricultural community and highlights the tension that exists between multiple competing value systems and different priorities for use and management of water in the Crystal.

Agricultural production represents a critical cornerstone of the Crystal River Valley culture and economy. Early settlers to the valley subsisted on sheep and cattle operations. Development of an extensive irrigation water conveyance system buttressed the growth of potato farming and, later, widespread production of hay and alfalfa. As the ski industry transformed the Western Slope, the Town of Carbondale expanded, incorporating historical ranchland into the municipal boundary. Several ranches and farms subsequently converted to subdivisions. However, numerous hay and cattle operations totaling approximately 4,800 acres remain, contributing to the sublime vistas appreciated equally by residents and visitors to the valley.

In addition to agricultural production, Crystal River water also supports drinking water supply needs of three small municipalities. In the upper Crystal, Marble and Redstone maintain small year-round populations. The Town of Carbondale, near the Crystal River's confluence with the Roaring Fork River, saw steady growth over recent decades and now is home to more than 6,000 people. Carbondale's projected population growth trajectory coincides with increased demand for drinking water and raw water for irrigating residential lawns and municipal open spaces. The Town's drinking water needs are supported by surface water diversions on Nettle Creek, a tributary to the lower Crystal, and well fields in the alluvial aquifers along the Crystal and Roaring Fork rivers. A network of surface water diversions and ditch systems provide irrigation water for lawns and gardens. An expected near doubling of population in Carbondale by 2035 portends steady increases in municipal water demands in the coming decades.

Growing populations and changing demographics in Carbondale bring new focus to the aesthetic and recreational values of the Crystal River. High spring flows attract whitewater enthusiasts to boat sections of the Crystal from Marble to the Roaring Fork. Anglers frequent many of the publically owned

sections of the river throughout the summer and fall. The Crystal River is also a main focal point of the West Elk Loop, one of Colorado's Scenic and Historic Byways. Additionally, multiple outdoor education organizations use the valley as venue for programs that engender increased environmental awareness and stewardship among participants. Each of these activities place an aesthetic and/or recreational use value on Crystal River water that does not always align with the existing patterns of water use within the watershed.

Over the last decade, growing concern over water resources in the greater Roaring Fork watershed led to numerous efforts by public, private and government stakeholders to explore the effects of land and water resource development and management decisions on watershed health. The following reports comprise the foundational body of literature supporting the development of the Plan:

State of the Roaring Fork Watershed Report[8]

Documents the water quality, water quantity, and water-dependent ecosystem status of the Roaring Fork Watershed, and points out areas where insufficient data prevent an accurate assessment of that status. The late summer/fallow flow issues on the Lower Crystal River were documented in this report.

Watershed Flow Evaluation Tool Pilot Study for Roaring Fork[3]

Pilot study in the Roaring Fork basin to support use of the Watershed Flow Evaluation Tool (WFET) as a coarse-scale method of assessing non-consumptive water needs in the Colorado River Basin. Colorado's StateMod for the Upper Colorado River simulated water allocation and accounting in the Roaring Fork. WFET evaluated important ecosystem health indicators using flow-ecology relationships based on scientific literature review. Site-specific data results collected at sites within the watershed generally validated WFET results.

Crystal River Snapshot Assessment[45]

Synoptic streamflow assessment that demonstrated the spatial and temporal variability of flow associated with water depletions from diversion on the Lower Crystal. The study suggested that several miles of the lower Crystal River are vulnerable to stream health degradation during times of low streamflow. Study illuminates the ancillary environmental, economic, and cultural impacts of poor river health and encourages proactive management to address potential issues.

Roaring Fork Watershed Plan[9]

Watershed planning document that recognized the impact significantly altered flow regimes, wetland degradation, and sediment issues on various reaches of the Crystal River. Identified the Crystal as a location for opportunities to improve fish passage, improve ecological health through land-use change, and explore grazing impact mitigation.

Crystal River Water Leasing Threshold Study[43, 44]

Study to identify water leasing threshold to support and protect aquatic habitat in the Crystal River near Carbondale. Interim target management flows estimated using the R2CROSS and Wetted-Perimeter Methods. Study indicated a water leasing threshold of 40-60 cfs could be appropriate to protect aquatic life. Effort endeavored to support future potential water leasing programs on the Crystal River.

Stream Conditions Assessment: Crystal River[29]

Assessment built upon previous local efforts and intended to provide information on streamflows, water quality, and aquatic life in the lower Crystal River (Avalanche Creek to the Roaring Fork confluence). Indicates the ways that diversions, return flows, and tributaries affect the discharge of the stream on a longitudinal (upstream-to-downstream) profile. Clarifies understanding of the magnitude and location of flow stress and dewatering along the lower Crystal River. Stream reaches to the south of the Town of Carbondale consistently experienced very low flows and near dewatering from the cumulative effect of upstream diversions. Temperature observations approached, but did not exceed, state standards. Macroinvertebrate sampling indicated the presence of healthy insect communities that met state standards for aquatic life use.

Water Rights Allocation and Accounting Model Development for the Lower Crystal River[28]

Study simulated streamflow conditions in the Lower Crystal based on Prior Appropriation water allocation and accounting principles. Changes in spatial and temporal streamflow patterns were characterized in existing and three potential municipal water conservation management plans in order to inform development and evaluation of water conservation measures by the Town of Carbondale. Results indicate that the most effective TOC conservation measures exist at the Carbondale Ditch and Weaver and Leonhardy Ditch, but none generate enough streamflow to meet existing instream-flow rights. TOC water savings is an important part of watershed-wide efforts to address lower Crystal streamflow depletions, but efforts focused on enhancing ecological and functional conditions should continue considering options for either increasing flows above the Carbondale Ditch or make available flows more supportive of ecosystem services most highly valued by stakeholders.

Rushing Rivers-Ag Project: Town of Carbondale[48]

Spearheaded by Western Resource Advocates, the Rushing Rivers project investigated opportunities for improving municipal water efficiency by demonstrating conservation savings by West Slope municipalities with extensive agricultural water rights. The project promoted efficiency gains through the use of "smart" irrigation infrastructure. The Town of Carbondale qualified as one of the West

Slope municipalities with the greatest opportunity to improve local streamflow through improved efficiency. Carbondale resource managers and local irrigators attended presentations about automated headgates and similar technology for improving agricultural water management

Roaring Fork Watershed Regional Water Efficiency Plan[16]

Effort aims to build on municipal Water Efficiency Plans in the watershed by providing a platform to coordinate efforts and identify opportunities that would benefit from resource sharing or a watershed-wide effort.

Carbondale Municipal Water Efficiency Plan[17]

Following Colorado's statutory water conservation planning requirements, Carbondale developed a Water Efficiency Program as part of the Roaring Fork Watershed Regional Water Efficiency Plan. This effort forecasted three water demand scenarios, inventoried current supply, and investigated several tiers of conservation to meet demand in a cost-effective way. Carbondale established a 24 AF savings per year efficiency goal (2%). Metering, water loss control, conservation-oriented water rate structure, development codes and ordinances, and raw water system mapping, inventory and management were selected as the most reasonable efficiency measures to pursue. Although water savings would be consistent with Carbondale's leadership as a conservation-minded community, Carbondale's water rights are sufficient to meet all foreseeable growth projections.

These assessments and planning efforts laid the groundwork for development of the CRMP by illuminating certain patterns of water use, impacts to the River's ecological health, and the need for further investigation. Furthermore, questions raised by these studies provided important context for identifying initial planning goals and objectives.

1.3 STAKEHOLDER PROCESS

As a strategic planning document for local communities, the CRMP strives to integrate sound scientific and engineering evaluations, competing local value systems and resource use priorities, and feasibility constraints imposed on identified management alternatives. Human values largely shape the way these concerns are measured in cost-benefit analyses that guide local planning priorities. Therefore, development of the CRMP relied heavily on stakeholder input. Stakeholder groups involved in the process include: agricultural producers, State water administrators, local municipalities, natural resource agencies, local and national environmental organizations, recreational advocates, and other water rights holders. A series of group and individual meetings held throughout the planning process served to clarify outstanding questions, summarize results from previous studies, refine planning goals and objectives, and evaluate the feasibility of various management alternatives. The stakeholder group contemplated a wide array of questions during these meetings, including:

- How are longitudinal patterns in flow affected by agricultural and municipal diversions between Thompson and Prince Creeks during dry, average, and wet years?
- How much water is needed to make a difference for the ecological health of the Crystal River?
- How do observed high sediment loads impact aquatic life? Are these loads natural or human caused?
- If shortages exist for the support of environmental function, where and when is water needed most? At what frequency?
- To what extent can local management 'solve' low streamflow issues on the Crystal?
- Are there practical engineering solutions to reaching planning goals?
- What is the potential for water leasing as a solution?
- How do conservation savings vary spatially and temporally for potential alternative management strategies?
- What is the most effective conservation strategy for each water rights holder to contribute to increased stream health?

The pursuit of actionable project recommendations required understanding the multiple dimensions of decision-making criteria. Therefore, answering the above questions (the "Socio-Economic Context") required characterizing the condition of riverine resources in the Crystal River watershed (the "Resource Condition") and the physical processes that govern the movement of water, its interaction with local channel forms, and its impacts on aquatic biota (the "Physical Processes").

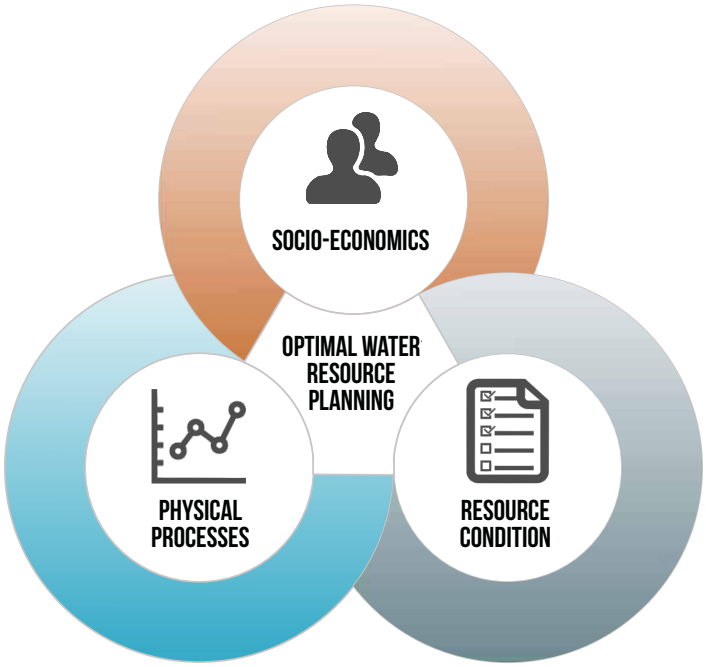


Figure 1-2: The CRMP planning framework

1.4 REGIONAL AND STATE LEVEL PLANNING CONTEXT

The general paucity of non-consumptive water use planning across the State emerged as a prominent issue during the recent development of the Colorado Water Plan (CWP). Focused efforts by the Colorado Basin Roundtable and others led to the inclusion of stream management planning in the CWP as a concept for resolving conflict and realizing optimized management of water for the benefit of both consumptive and non-consumptive uses. The CWP identifies stream management planning as a priority for streams with significant environmental or recreational value. The CWCB describes stream management plans as follows:

> *Well-developed stream management plans should be grounded in the complex interplay of biology, hydrology, channel morphology, and alternative water use and management strategies. They should also consider the flow and other structural or management conditions needed to support both recreational uses and ecosystem function. A stream management plan should: 1) involve stakeholders to ensure their acceptance of the plan; 2) assess existing biological, hydrological, and geomorphological conditions at a reach scale; 3) identify flows and other physical conditions needed to support environmental and recreational water uses; 4) incorporate environmental and recreational values and goals identified both locally and in a basin roundtable's BIP; and 5) identify and prioritize alternative management actions to achieve measurable progress toward maintaining or improving flow regimes and other physical conditions.*[14]

Stream management planning presents a unique pathway towards collaborative integrated watershed planning and management rooted in robust understanding of local physical processes. Ideally, SMPs provide a comprehensive review of stream characteristics using available data and facilitate stakeholder input to identify a set of alternative management strategies or projects for a given section of river. SMPs can address a multitude of water-related issues, including: sedimentation and erosion, flooding risk and mitigation, drinking water quality and supply, agricultural and industrial water supply, water storage, urban runoff, and habitat for aquatic life. Such planning exercises are well suited to decision-making and project identification in situations where competing water use needs produce potential for conflict. Once completed, these plans are meant to assist water users in planning for a sustainable future with the underlying assumption that a healthy watershed will support vibrant local economies and the high quality of life enjoyed by local residents.

Colorado's Western Slope is especially disadvantaged by the lack of non-consumptive use planning due to the geographic density of streams with high environmental or recreational value, widespread economic dependence on recreation and tourism, and the value local residents place on a healthy ecosystem. As a result, the Colorado River Basin Roundtable recently identified establishment of a basin-wide stream management planning effort as a high-priority action.[11] This Crystal River Management Plan (CRMP) was developed with consideration of the CWP and the Roundtable's water planning goals.



2 ECOSYSTEM FUNCTIONAL ASSESSMENT

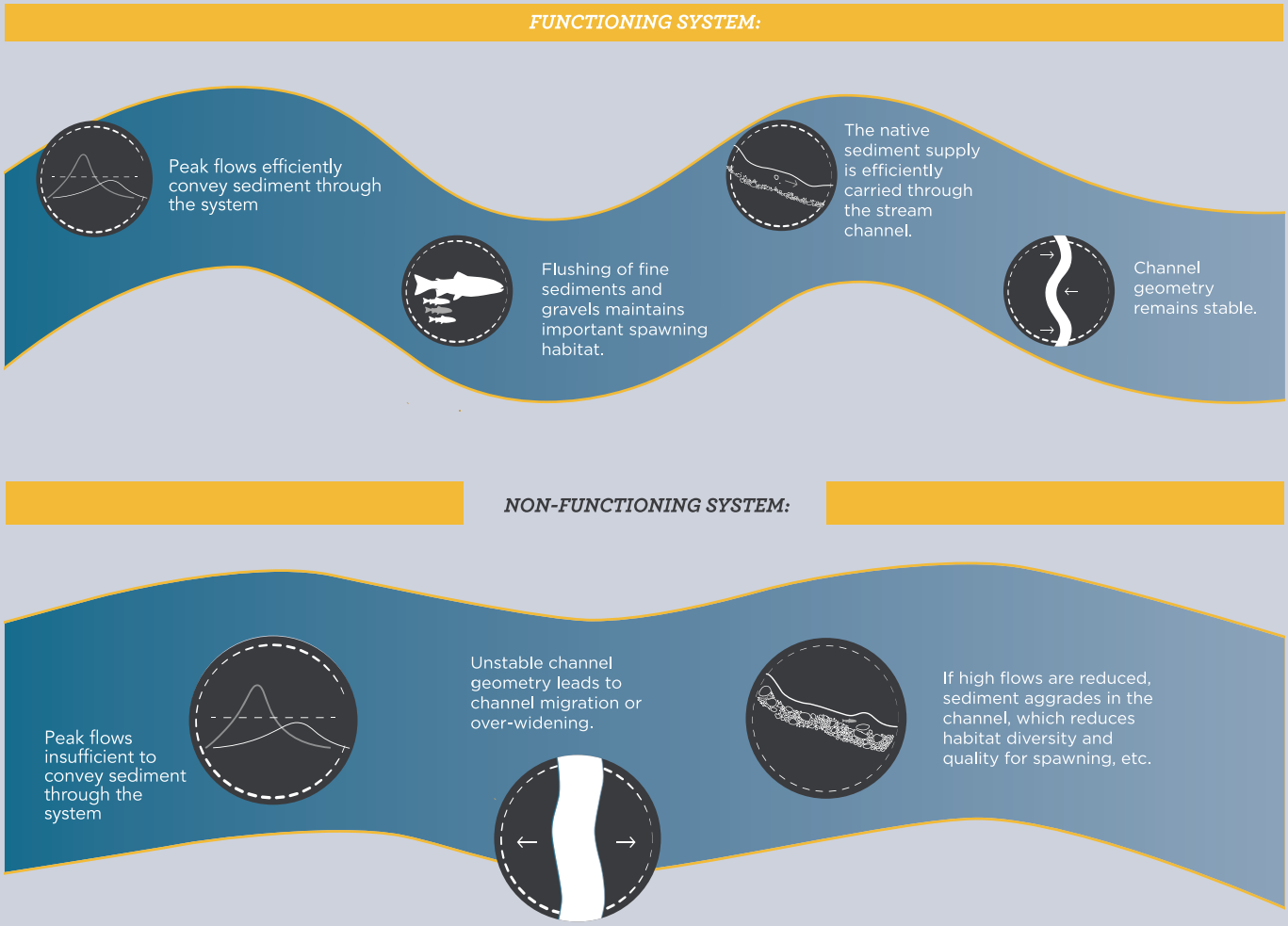
The CRMP provides recommendations for optimizing water management decisions to support existing uses while, simultaneously, alleviating constraints on the delivery of important ecosystem goods and services (EGS). It is often difficult to quantify EGS value given their nature as non-market common public amenities. Clean water, healthy fisheries, or stunning viewscapes provide intangible benefits that do not easily fit within the economic valuation and cost-benefit frameworks that typically drive resource management decisions. However, when delivery of EGS is acutely constrained, some corresponding impact—direct or indirect—to local economies, livelihoods, or quality-of-life frequently arises, driving the need to identify alternative resource management strategies. The CRMP considers three primary attributes (the "Attributes") commonly associated with EGS and frequently affected by water resource management activities: channel dynamics, riparian health, and aquatic habitat.



CHANNEL DYNAMICS

Channel dynamics encompass the fluvial and geomorphological processes that interact to control channel form and evolution across a range of spatial and temporal scales. Channel dynamics respond to interactions between patterns of rainfall and runoff, catchment-scale physical attributes (e.g. surficial geology, topography), riparian community structure, and local use practices (e.g. transportation corridor alignment, grazing practices). As a result, human management activities that modify the hydrological regime, alter patterns of erosion, adjust the structure of the channel bed, or modify riparian vegetation may yield fundamental shifts in the geometry and behavior of the stream at the channel (tens of yards) or reach (hundreds of yards) scale.

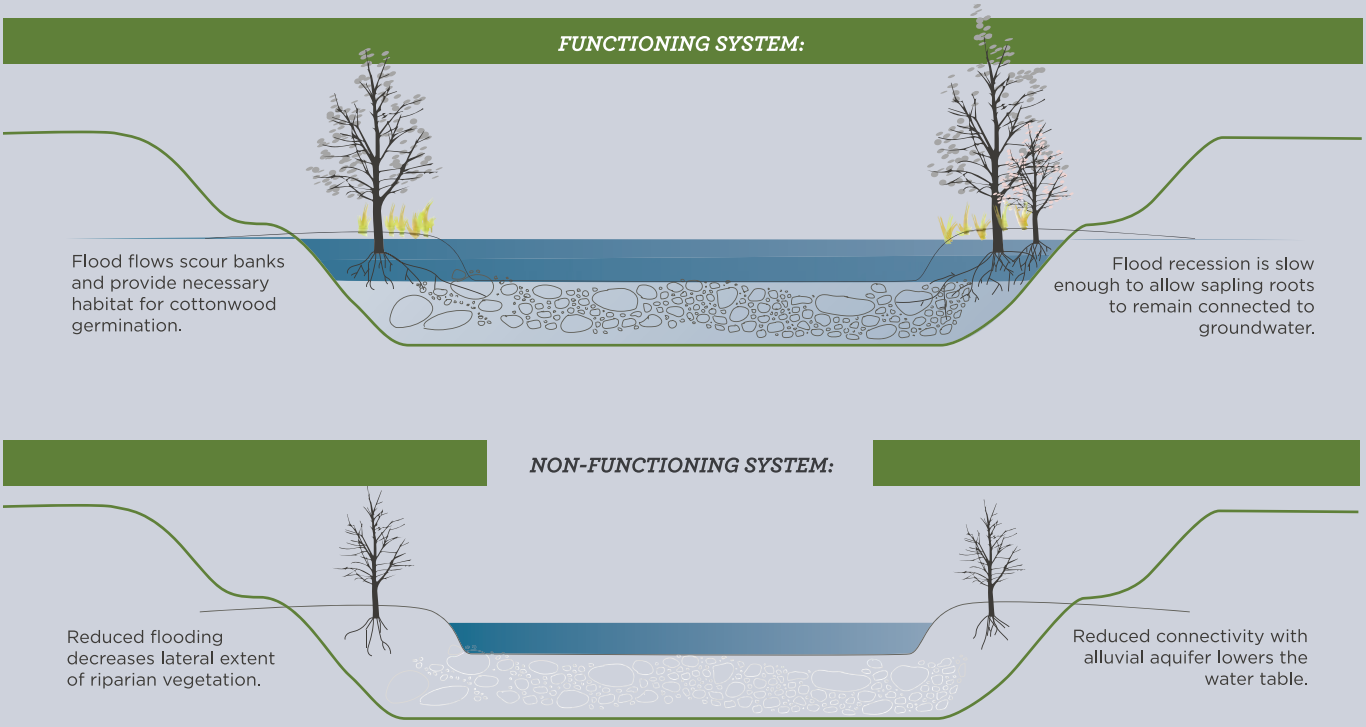
Alteration of sediment supply, channel forming flows, or streambank vegetation may lead to complex interactive effects that result in reduced resiliency of local channel forms. For example, in unconfined alluvial streams, degradation of riparian forests frequently results in diminished bank cohesion, an increased rate of channel avulsion, and a progressive widening and filling of the stream channel itself. These high-dynamic channel states generally provide poor aquatic habitat and present a risk to streamside property and infrastructure.



RIPARIAN HEALTH

Riparian areas support a wide variety of physical, biological, and ecological processes. Riparian zones generate important organic inputs for stream ecosystems, support streambank cohesion, perform vital nutrient cycling roles, and lend to the quality of aquatic habitat by providing shade and buffering against temperature extremes. The hydrological regime, sediment and channel dynamics, invasive vegetation, and near-stream land uses frequently impact the functionality of riparian areas.

Riparian areas exist in a complex equilibrium state governed by the local geometry of the channel/floodplain system and the inter-annual pattern of flood flows and baseflows. Occasional scouring of overbank areas provides the necessary habitat for germination of many riparian plant species. Following germination, seedlings require a relatively slow reduction in water table height over the progression of the growing year. Rapid water table reduction or late season water table heights that drop below the rooting depth of cottonwoods and other riparian plants stresses vegetation and can lead to mortality. Management activities that alter the magnitude, timing, or frequency of peak flows and baseflows, therefore, may limit riparian recruitment leading to decadent stands with little or no regeneration.



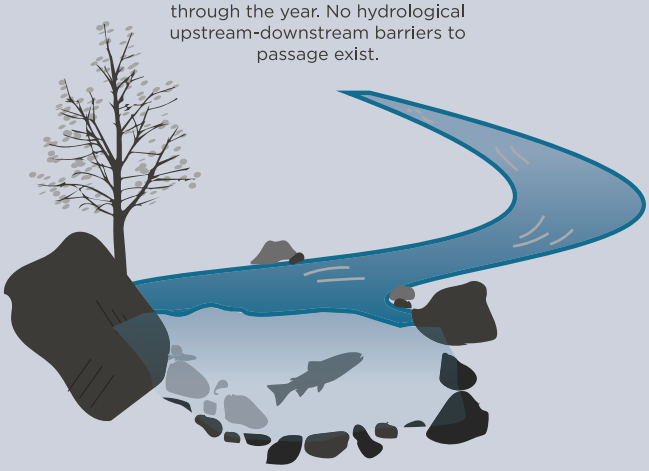
AQUATIC HABITAT

Interactions between streambed structure, channel hydraulics, water chemistry, vegetative shading, and organic matter inputs dictate the quality of habitat available for fish, macroinvertebrates, and macrophytes. In alluvial stream systems, high quality habitat typically supports vibrant and productive aquatic ecosystems—the kind of ecosystems that sustain robust trout fisheries. Habitat quality shares a directly proportional relationship to food-chain length in many systems. Ecosystems supporting long food chains tend to display greater resilience to changing external forcing variables like climate. Land and water management activities that affect sediment transport dynamics, streambed complexity, riparian shading, and local hydraulics comprise important primary controls on aquatic habitat quality.

Many aquatic species rely on specific and relatively narrow ranges of water depth, velocity and substrate types to perform various feeding/resting behaviors or complete different life stages. Fragmentation or degradation of habitat for aquatic species may, therefore, arise from modification of the hydrological regime, which alters local channel hydraulics and the spatial distribution of water depths and velocities. In a similar fashion, activities that physically alter the structure of the streambed may impact habitat quality by transforming the local hydraulic channel response to a given streamflow. The critical interaction between local structure and hydraulics gives credence to restoration approaches that aim to improve ecosystem function by reconfiguring channel cross-sectional geometry or planform patterns.

FUNCTIONING SYSTEM:

A variety of habitat types remain connected and available to organisms through the year. No hydrological upstream-downstream barriers to passage exist.



NON-FUNCTIONING SYSTEM:

High quality or critical habitats are isolated and unavailable to organisms in times of high stress. Hydrological barriers preclude organisms from utilizing the entirety of a stream network to complete important parts of their life cycle.



2.1 ASSESSMENT CRITERIA

The complex interplay between the human, physical, chemical, and biological components of the Crystal River, and of riverine systems in general, complicates the task of identifying appropriate management strategies that respond to local concerns about one or more of the Attributes (Figure 2-1). Each Attribute aggregates a suite of connected processes or characteristics. Therefore, evaluating the functional condition of multiple components of the system represents the first step towards developing a management plan that focuses actions on those components of the system constraining the delivery of highly valued EGS.

The existence of complex interactions between Attributes makes it necessary to disaggregate them into a collection of state variables. These variables describe more fundamental ecosystem processes and provide a more straightforward basis for measurement and evaluation. The CRMP assessed functional condition and identified constraints on the delivery of EGS based on a suite of physiochemical, biologic, geomorphic, hydrologic and hydraulic state variables. These include: flow regime, sediment regime, water quality, floodplain connectivity, riparian vegetation, debris supply, morphology, stability, physical structure, and biotic structure. Comprehensive evaluation of each variable through application of the Functional Assessment of Colorado Streams (FACStream) framework enabled a robust characterization of existing conditions and supported predictive assessments of changes in future state across a range of spatial scales.

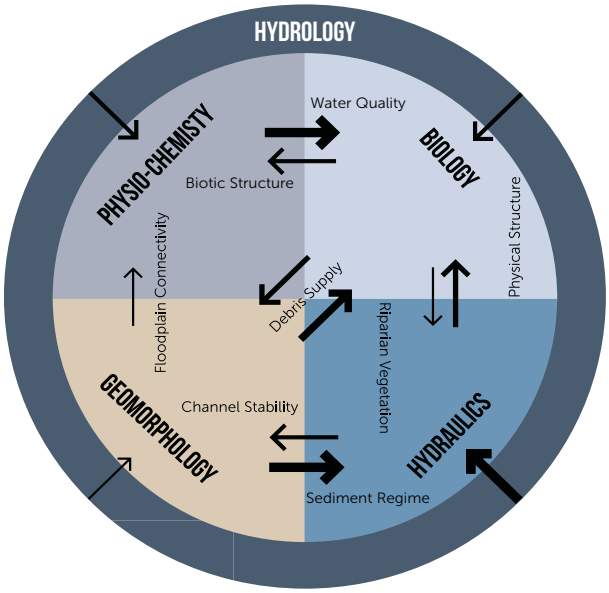


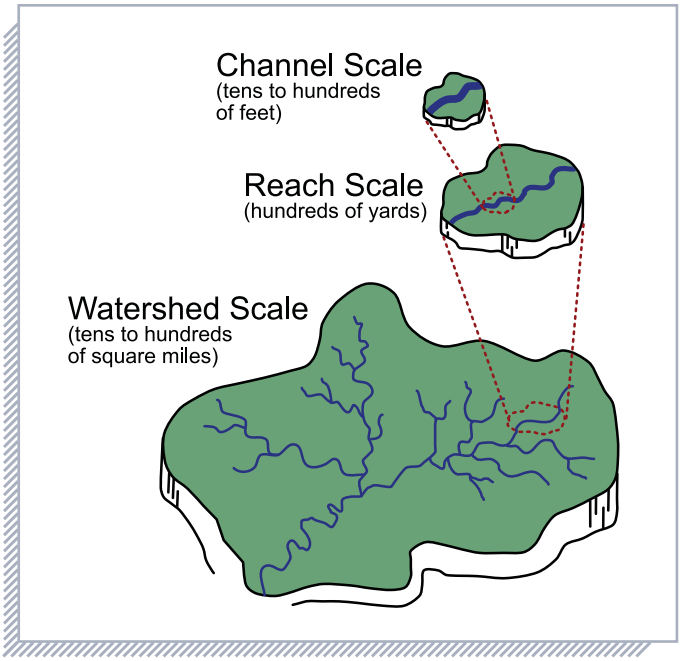
Figure 2-1: Complex relationships exist between hydrological, physiochemical, biological, geomorphological, and hydraulic river processes

Experts in geomorphology, riparian ecology, fisheries, and hydrology completed focused evaluations of the ten state variables and associated sub-variables (Table 2-1). State variable assessments evaluated current conditions and characterized the degree of departure from an unimpacted reference state using a forensic, weight-of-evidence approach.[24] A variety of assessment methodologies—some rapid and coarse, some focused and intensive—produced evidence that reflects ecosystem processes across a range of spatial scales with varying degrees of objectivity. The coarsest approaches (Level 1) produced qualitative, reconnaissance-level variable assessments that guided more targeted investigations. Rapid assessments (Level 2) focused on specific areas of concern and involved more field-intensive surveys to identify opportunities for ecological lift and reinforced expert opinions regarding the presence and magnitude of functional impairment. Where evidence of impairment persisted, intensive quantitative (Level 3) evaluations sought to explicitly account for the complex interactions between state variables and management activities. (Table 2-1). Utilization of this tiered evaluation structure facilitated a "drill-down" investigative approach that focused functional performance evaluations on the most degraded components of the river system.

SCALE	VARIABLES	SUB-VARIABLES
Watershed	Flow Regime	Total Volume, Peak Flows, Base Flows, Flow Variability
	Sediment Regime	Land Erosion, Channel Erosion, Transport
	Water Quality	Temperature Regime, Organics/Nutrients, Inorganics/Toxins
Channel	Floodplain Connectivity	Saturation Frequency, Floodplain Width, Saturation Duration
	Riparian Vegetation	Woody Vegetative Structure, Herbaceous Vegetative Structure, Species Diversity
	Debris Supply	Large Woody Debris, Detritus
Reach	Morphology	Evolutionary Stage, Planform, Dimension Profile
	Stability	Dynamic Equilibrium, Resilience
	Physical Structure	Hydraulic Structure, Coarse Scale Bedforms, Fine Scale Bedforms
	Biotic Structure	Macrophytes, Macroinvertabrates, Fish

Table 2-1: Hierarchical arrangement of state variables and sub-variables

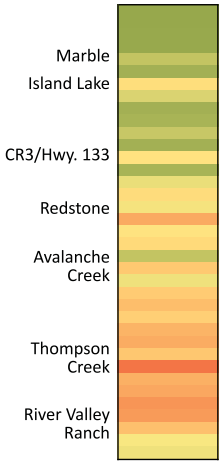
Assignment of functional condition scores for each state variable generally followed FACStream scoring criteria (Table 2-3) where a score of 100 indicated pristine conditions and a score of 50 indicated severe impairment. The overall size of the CRMP focus area necessitated delineation of the Crystal River into 36 separate assessment reaches to provide the appropriate spatial resolution for assessment activities focused on reach or channel-scale conditions. Local channel form and the degree of valley confinement informed the upstream and downstream boundaries of each reach. Individual reaches received a score for each of the ten state variables and associated sub-variables, as well as a composited score based on scoring for all state variables (Appendix D).



State variables assessed for the CRMP represent important ecosystem processes that occur at cascading hierarchical scales. Processes occurring at the contributing watershed scale (tens to hundreds of square miles) exert varying degrees of influence on reach scale (hundreds of yards) and channel scale (tens to hundreds of feet) processes. The inverse is generally not true. In a similar manner, reach scale processes generally influence channel scale characteristics and dynamics. The strength of the directional impact is limited in this case. Under some conditions, channel scale processes may alter those occurring at the reach scale. Nonetheless, it is often useful to conceptualize a hierarchical arrangement for state variables when identifying the primary stressors propagating through the ecosystem that constrain a given process or diminish some EGS of interest. The scale of the limiting process is generally commensurate with the scale of the effort required to address it. Thus, the consideration of scale is not only critical for ensuring the correct identification of stressors, but also for identifying a suite of appropriate management response opportunities.

ASSESSMENT LEVEL	DESCRIPTION	EXAMPLE METHODOLOGIES
Level 1 *remote assessment*	Coarsest level of investigation designed to provide a general estimation of functional condition and document obvious clues of impairment	• Collection of anecdotal evidence from local residents • Review of published literature and reports focused on streamflow, erosion, water quality, and aquatic life. • Aerial imagery assessments • "Windshield" surveys
Level 2 *rapid assessment*	Domain scientists and other experts use best professional judgement to score variables based on qualitative observations and data gathered during field visits.	• Rapid (1-2 day) functional condition assessments of stream reaches conducted by teams of geomorphologists, hydrologists, engineers and riparian ecologists
Level 3 *intensive assessment*	Predictive models generate quantitative parameters to validate and refine Level 1/2 assessment results.	• Indicators of Hydrological Alteration analysis • 1D/2D hydraulic modeling • Recruitment Box modeling • Aquatic habitat modeling

Table 2-2: Assessment methodologies employed during development of the CRMP



Grade	Score	Level of Impairment
A	90-100	Negligable
B	80-90	Mild
C	70-80	Significant
D	60-70	Severe
F	50-60	Profound/Unsustainable

Table 2-3: FACStream scoring criteria and associated color maps describing longitudinal patterns in functional condition for each state variable discussed in subsequent sections

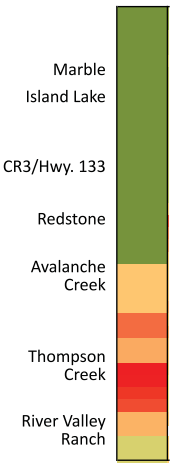
2.2 WATERSHED SCALE ASSESSMENTS

2.2.1 Flow Regime

Broad patterns of precipitation and topography largely determine a river's flow regime. In turn, fluvial ecologists generally treat flow regime as the "master variable" exerting the largest influence on riverine ecosystem form and function.[33] Activities that deplete or augment streamflow have the potential to impact important regime characteristics, including: total annual volume, magnitude and duration of peak and low flows, and variability in timing and rate of change. Changes to total annual volume and peak flows may impact channel stability, riparian vegetation, and floodplain functions. Impacts to base flows frequently alter water quality and the quality and availability of stream habitat. Alterations to natural patterns of flow variability, including the frequency and timing of floods, impact fish, aquatic insects and other biota with life history strategies tied to predictable rates of occurrence or change.[24]

information regarding flow conditions at multiple locations and across a range of flood/drought conditions produced the need for a more robust assessment approach.

Unfortunately, the arrangement of stream gauges, tributary inflows, and surface water diversion infrastructure on the Crystal River presents significant challenges to a data-driven understanding of historical and current flow regime characteristics at all locations along the stream channel. Development of an Ecological Decision Support System (EcoDSS) for the Crystal River watershed responded to this need (Appendix A). The EcoDSS is a collection of loosely coupled hydrological, hydraulic, and ecosystem-response models that jointly simulate and predict the impact



Flow Regime

IHA Metric	Location Along the Crystal River													
	Avalanche Creek Confluence	Sweet Jessup Canal	Nettle Creek Confluence	Lowline Ditch	Ella Ditch	Thompson Creek Confluence	Prince Creek Confluence	Rockford Ditch	Carbondale Ditch	Fish Hatchery	Weaver & Leonhardy Ditch	Kaiser & Sievers Ditch	Southard & Cavanaugh Ditch	Roaring Fork Confluence
Median Annual Flow (cfs)	0%	5%	9%	6%	10%	11%	11%	11%	14%	12%	10%	9%	10%	3%
Median August Flow (cfs)	0%	23%	41%	24%	48%	52%	51%	44%	59%	49%	37%	25%	27%	5%
Median September Flow (cfs)	0%	22%	41%	14%	42%	44%	44%	40%	52%	41%	33%	20%	22%	3%
Median 3-day Maximum Flow (cfs)	0%	0%	0%	0%	2%	3%	3%	3%	4%	4%	4%	3%	3%	3%
Julian Date of Maximum Flow	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Median January Flow (cfs)	0%	0%	0%	0%	0%	0%	0%	3%	3%	5%	7%	7%	7%	10%
Base Flow Index (cfs)	0%	6%	28%	15%	85%	81%	80%	60%	95%	528%	2%	1%	2%	9%
Julian Date of Minimum Flow	0.00	10.00	243.00	237.00	236.00	244.00	244.00	251.00	234.00	249.00	239.00	33.00	36.00	33.00
Median Positive Rate Change (cfs)	0%	0%	2%	9%	12%	13%	13%	13%	8%	3%	8%	6%	3%	2%
Median Negative Rate of Change (cfs)	0%	2%	1%	7%	10%	5%	2%	0%	5%	3%	2%	5%	2%	3%

Table 2-4: IHA analysis results indicating the absolute percent change in various metrics of hydrological behavior due to existing patterns of water use and management

Assessment Methodology

Assessment of flow regime alteration initially relied on literature reviews and interviews with local residents. These yielded some sparse quantitative observations, but generally produced anecdotal evidence of the location and timing of patterns of flow depletion by surface water diversions during severe drought. Conflicting evidence and a dearth of comprehensive

of water use and channel structure on stream hydrology and ecology. The hydrological modeling component of the EcoDSS provided 30 years of daily hydrological simulation results for reaches of the Crystal River below Avalanche Creek—reaches where management activities impact the flow regime. Results encompassed a range of drought and flood conditions and mimicked patterns of flow withdrawal for municipal and agricultural uses. Running the EcoDSS with all

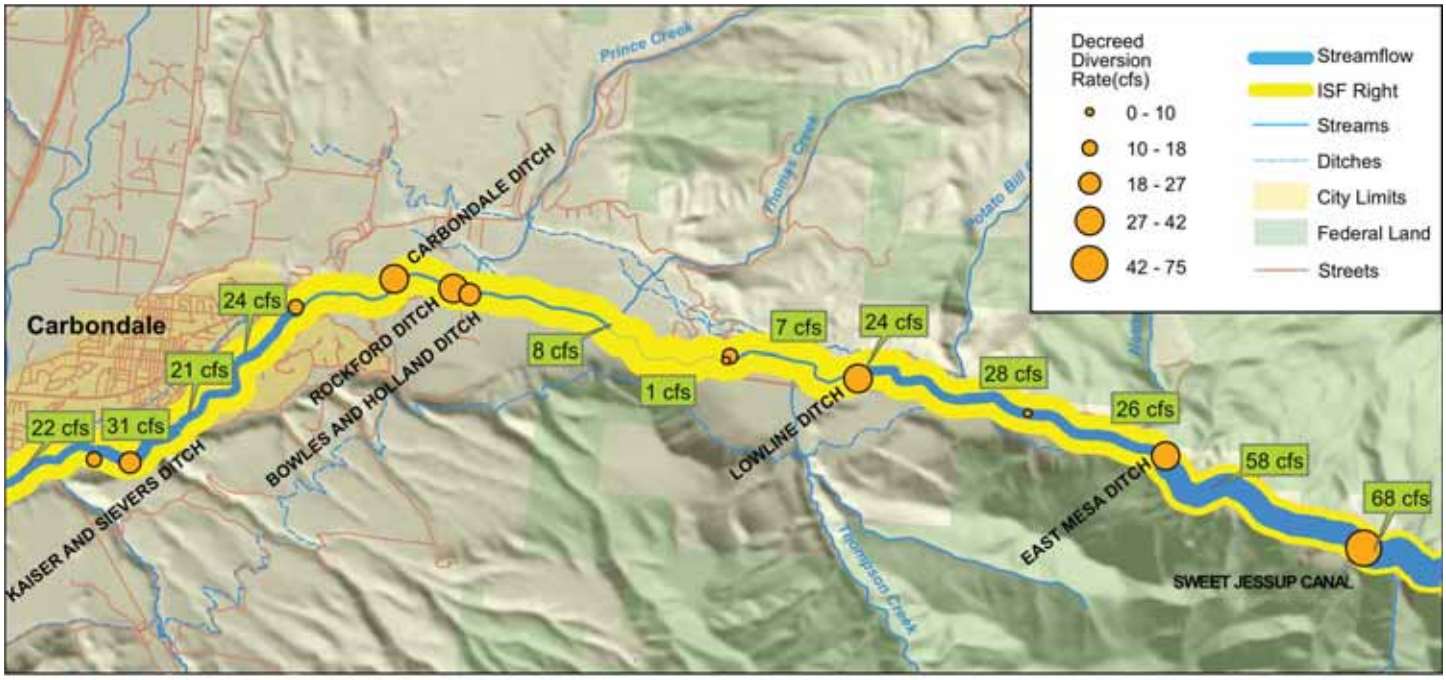


Figure 2-2: Late season streamflows observed on the Crystal River in the late summer of 2012. Green call-outs indicate measured flows. The thickness of the blue and yellow lines indicate the relative magnitudes of observed flows and the CWCB Instream Flow Right

surface water diversions switched "off" provided a simulation data set approximating natural or reference conditions on the Crystal. The EcoDSS quantitatively assessed the impact of resource management practices on total annual water yield, the magnitude and duration of peak and base flows, variability of peak flow frequency and timing, and rates of hydrograph recession. Management induced changes to the following metrics determined the functional condition of the flow regime:

- Mean Annual Flow
- Mean August Flow
- Mean September Flow
- 3-day Mean Annual Maximum Flow
- 7-day Mean Annual Minimum Flow
- Julian Date, 1-day Minimum Flow
- Julian Date, 1-day Maximum Flow

Functional Assessment

Flow regime is the most significantly constrained state variable on the Crystal River. Impairment is concentrated in the thirteen miles of the river upstream of the confluence with the Roaring Fork River. Moderate impairment beginning below Sweet Jessup Canal becomes increasingly severe downstream of Thomas Creek. Functional impairment begins to rebound somewhat below the Town of Carbondale (Figure 2-2).

Several major surface water diversions in the lower watershed support agricultural production, drinking water supply, and non-potable irrigation water for the Town of Carbondale. Cumulatively, these withdrawals impact the flow regime most significantly during moderate (1 in 5 year) to severe drought (1 in 20 year) during late-summer low flow periods.

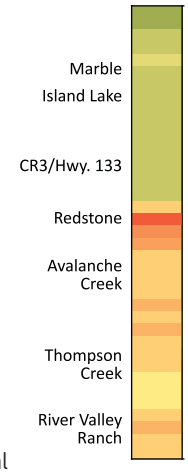
Field data collection campaigns executed in the summer of 2012 identified complete dewatering of Crystal River near the Thomas Road Bridge (Figure 2-3).[45] Quantitative metrics produced by the IHA assessment verify that mean August and September flows exhibit the greatest degree of departure from natural conditions (Table 2-4). Mean annual flow and variability in peak flow timing and magnitude appear less impacted; however, the onset of low flow conditions occurs somewhat earlier in the year under current management practices. Changes in flow regime frequently impact several other state variables. For example, total annual volume and peak flow characteristics influence channel stability, riparian vegetation, and floodplain connectivity. Base flow characteristics, in turn, influence patterns in water chemistry, physical and biological structure.

Management Response Opportunities

- Water conservation programs for treated and raw municipal water supply
- Irrigation application method and conveyance system efficiency upgrades
- Market-based streamflow bypass agreements
- Water leasing programs
- Off-channel reservoir construction

2.2.2 Sediment Regime

The production and transport of sediment within a stream system is a crucial determinant of stream form, habitat quality and general long-term stability. Functional condition considers the amount and timing of sediment production from the contributing watershed via surface and channel erosion, and sediment transport to and through the stream channel. Watershed-scale disruptions, such as deforestation, fire or dam construction, can alter sediment regime characteristics.



Sediment Regime

<u>Assessment Methodology</u>

Stakeholder conversations held during the initial scoping phases of the Plan indicated concerns about sediment dynamics among the highest concerns for diminished ecosystem function. The focus on sediment dynamics arose from extremely high sediment load observed on the Crystal River, Coal Creek, and other tributaries during late-summer precipitation events. Common knowledge held that historical road development and mining operations in Coal Basin contributed heavily to those sediment loads. Assessment of watershed-wide erosion and sediment supply dynamics relied initially on assessments of aerial imagery. Evidence of a highly dynamic system prompted reach-specific rapid assessments and, finally, a comprehensive modeling effort that quantified relative sediment yields throughout the watershed. Modeling characterized the impacts of surficial geology, topography, vegetative cover, road development, and other land-use disturbances on hillslope surface erosion, gullying, landslide activity, and road surface erosion (Appendix B). Both the timing and amount of sediment production via land and channel erosion, and sediment transport were considered in sediment regime evaluations.

<u>Functional Assessment</u>

The Crystal River's sediment regime appears relatively functional. The most significant impairments exist between Redstone and Avalanche Creek due to erosion from Coal Basin associated with road development and mining activity. Most sediment delivered to the Crystal from Coal Basin sources from highly erosive surficial geology, but past landslides and channel incision on Coal and Dutch Creeks evidences altered sediment yields in the past from historic Coal Basin mining practices. The bulk of these anthropogenic impacts in the Crystal River watershed is evidenced in Coal Basin itself (Figure 2-3). The Crystal River appears to transport elevated sediment loads from Coal Creek without the telltale signs of sediment transport functional degradation. Furthermore, bridge constrictions, levee construction and bank armoring near Redstone appear relatively innocuous in their impact on the continuity of sediment transport dynamics. A natural geological grade control north of Redstone causes the greatest disruption in transport dynamics in that part of the watershed. Impairments to sediment regime largely abate below Avalanche Creek where the influence of Coal Basin diminishes.

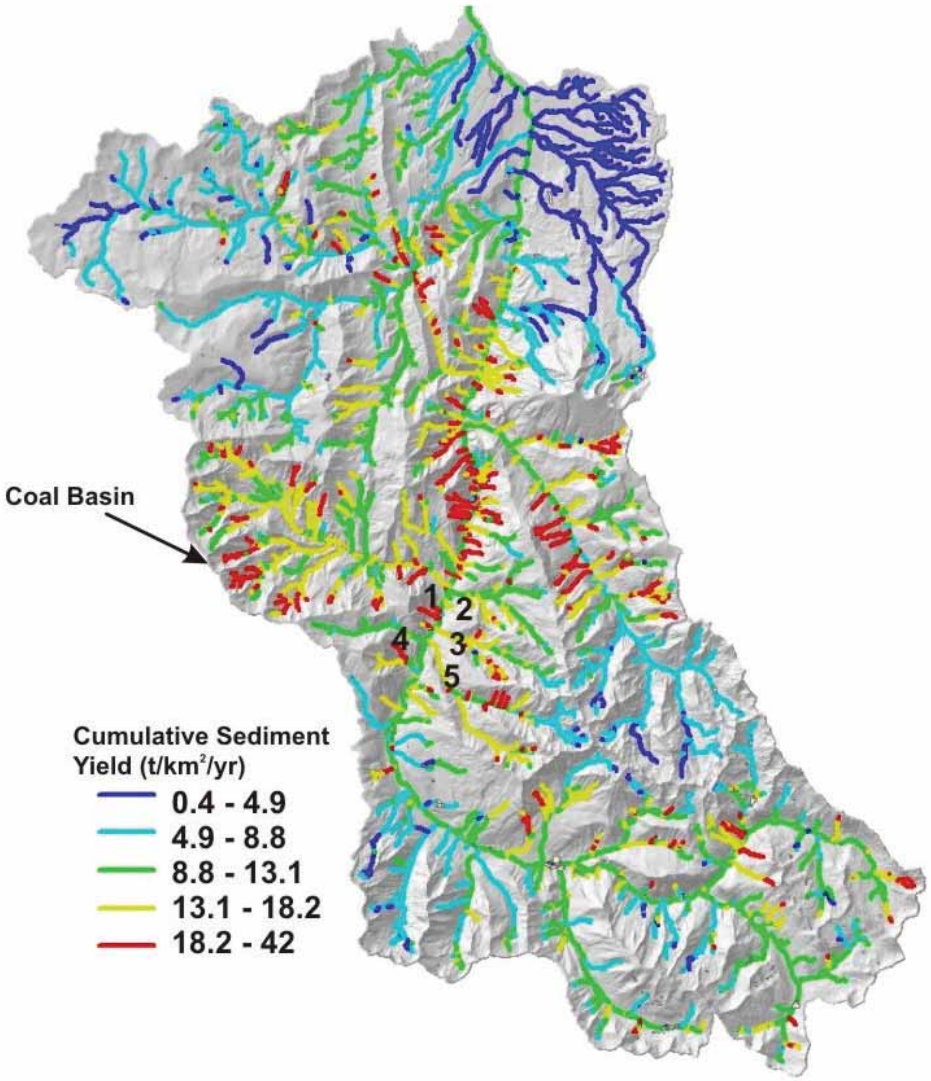


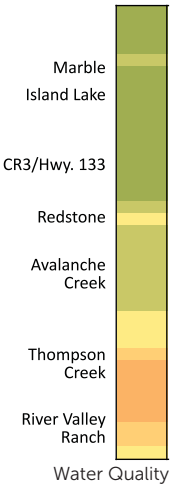
Figure 2-3: Shallow landslide and hillslope erosion modeling revealed that Coal Basin and the surrounding areas generate elevated sediment yields

<u>Management Response Opportunities</u>

❖ Limited erosion control projects on historical mining and roadway surfaces in Coal Basin

2.2.3 Water Quality

Natural geological weathering and human activities occurring at the scale of the contributing watershed largely dictate the physicochemical properties apparent on a stream reach. Biogeochemical processing by stream organisms may alter local water quality conditions to a small degree.[24] Physical water quality conditions (e.g. water temperature), while somewhat influenced by local patterns of channel form and streamside vegetation, remain fundamentally rooted in upstream conditions.



Assessment Methodology

Assessment of water quality conditions relied on a review of relevant literature[28, 30, 45, 47] and on a statistical data analysis. To capture potential impacts associated with these practices, assessment of water quality conditions relied on comparison of available water quality data to Colorado Department of Health and Environment (CDPHE) WQCD standards (Appendix C). Limited data availability restricted assessments to 23 locations across the watershed for the following water quality parameter types:

- Metals
- Nutrients
- Physical Characteristics
- Inorganic Compounds

Functional Assessment

A wide variety of land uses expected to impact water quality occur in the Crystal River watershed. Activities in the upper watershed include road development, forestry, legacy hardrock mining, and limited underground quarrying. Activities in the lower watershed include riparian alteration, livestock production, roads and urbanization. Nonetheless, the mainstem Crystal River generally exhibits high levels of water quality (Table 2-4). When evaluated against Water Quality Control Division (WQCD) standards for aquatic life use protection, water chemistry data indicate no impairments exist. A relatively small number of parameters present as potential areas of concern when compared against standards for drinking water. However, natural geological processes likely contribute to observed elevated arsenic levels and the single elevated lead value may be an outlier produced by a contaminated sample or poor data collection practices.

Flow depletion from the cumulative surface water diversions on the lower Crystal contributes to elevated temperatures during drought conditions. Previous studies indicate exceedances of the daily maximum stream temperature standard for protection of fisheries on the Crystal River below Thomas Road Bridge. Although limited data is available to assess temperature patterns across a range of streamflows, these transient conditions likely exist between July and October in moderate to severe drought conditions at locations along the river where flow depletions are most pronounced. Data collected in 2012 and 2013 indicates a strong inverse relationship between water temperatures and discharge between Thompson Creek and the Roaring Fork River. Elevated water temperatures in the lower Crystal River contribute to limited habitat quality and availability during drought conditions.

Management Response Opportunities

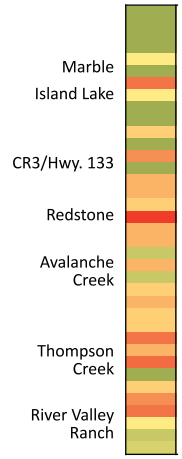
- Water conservation programs for treated and raw municipal water supply
- Irrigation application method and conveyance system efficiency upgrades
- Market-based streamflow bypass agreements
- Water leasing programs
- Off-channel reservoir construction

USE PROTECTION ASSESSMENT RANKINGS	Aquatic Life Use Protection Water Quality Standards																																
	Biology					Physical					Nutrients			Inorganics					Metals															
	Algae	Dead Fish	Fish	Invertebrates	Macrophyton	Dissolved Oxygen	Specific Conductance	Suspended Solids	Temperature	pH	Chlorophyll	Total Nitrogen	Total Phosphorous	Ammonia	Chlorine	Cyanide	Nitrite	Sulfide	Aluminum	Arsenic	Cadmium	Chromium (III)	Chromium (VI)	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	Uranium	Zinc
GOOD																																	
ACCEPTABLE																																	
CONCERN																																	
POOR																																	
LOW RESOLUTION																																	
DATA GAP																																	
Crystal River																																	
Coal Creek																																	
Thompson Creek																																	
North Thompson Creek																																	

Figure 2-4: Assessment of water quality data against WQCD standards for aquatic life use protection

2.3 REACH SCALE ASSESSMENTS

2.3.1 Floodplain Connectivity



Floodplain Connectivity

The frequency, lateral extent, and duration of interactions between the channel and 5-year floodplain create a characteristic pattern of floodplain connectivity that determines the extent to which the river accesses and hydrates overbank areas. Overbank flows elevate the water table in the alluvial aquifer and produce favorable conditions for riparian vegetation. Typical floodplain connectivity impairments result from watershed-scale impacts to the flow regime or localized geomorphic impacts from artificial levees, ditches, channelization, or channel enlargement.[24]

Assessment Methodology

Evaluations on the Crystal River relied on reviews of aerial imagery, rapid field assessments, and hydrological and hydraulic simulation modeling. Reviews of aerial imagery revealed locations of limited floodplain development along the river corridor. Rapid assessments utilized expert knowledge of geomorphological processes and riparian ecology to determine the extent to which modification of the flow regime or structural impediments limited connections between the channel and overbank areas. The EcoDSS supported a more quantitative assessment of connectivity by relating patterns in stream hydrology, channel hydraulics, and floodplain inundation by simulating two dimensional channel flow along the lower Crystal River on a daily timestep across a range of hydrological conditions (e.g. average flow, moderate flood, extreme flood). The degree of departure from reference conditions was evaluated by comparing the total inundated floodplain area for each reach under existing conditions and natural conditions (i.e. no surface water diversions) as simulated by the hydrological model in the EcoDSS (Appendix A).

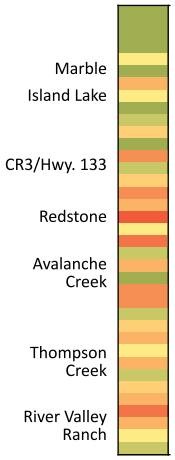
Functional Assessment

Widespread floodplain connectivity issues do not exist on the Crystal River. However, small pockets of considerable impairment occur at a few locations in the watershed. Pockets are concentrated around Island Lake, in the Redstone area, and near bridges in the lower Crystal. Observed impairment is generally attributable to roads, railroad grades, and bridges. Existing and abandoned transportation corridors bisect historical floodplains, diminishing the ability for bankfull flows to inundate the full lateral extent of the historical floodplain, fragmenting important off-channel habitat and reducing the extent of riparian zones. Roadfill and bridges impose artificial constriction in unconfined reaches, cutting off the stream's access to floodplain. Levees and berms protecting developments from floodwater, particularly around Redstone, limit access to undeveloped floodplain. These impairments limit effective floodplain width, and reduce the floodplain's ability to buffer against extreme changes in streamflow. Reduction in effective floodplain width further limits the quality and extent of important terrestrial and aquatic habitat.

Management Response Opportunities

- Culvert and or bridge installation through historical railroad grade at Red Wind Point
- Conservation and protection of limited high-quality floodplain habitats

2.3.2 Riparian Vegetation



Riparian Vegetation

Riparian vegetation performs several important functional roles for stream ecosystems. Root systems increase bank stabilization and the vegetative overstory provides detrital input and shading for aquatic species. Riparian forests supply the channel with woody debris, an important determinant in local physical structure. The functional condition of riparian vegetation considers species diversity and the structure of both the woody and herbaceous vegetation communities.[24] Impacts to riparian vegetation include deforestation or habitat degradation resulting from an altered hydrological regime or floodplain disconnections.

Assessment Methodology

Assessments of riparian condition consider the age class distributions and overall diversity of riparian species, total vegetative cover, root strength and depth, and above and belowground density of woody and herbaceous vegetation. Characterization of vegetative condition on the Crystal River relied primarily on literature reviews[9, 3, 19, 20] and rapid field assessments. Field assessments considered dominant valley form (e.g. confined vs. unconfined) and local floodplain size when assessing the degree of departure from reference conditions. In areas affected by hydrological impairment, the EcoDSS implemented the Recruitment Box methodology[31] to provide a quantitative understanding of constraints on cottonwood recruitment success (Figure 2-5). Simulation of one-dimensional channel hydraulics at representative cross sections throughout the lower Crystal River replicated rates of hydrograph recession and falling water surface elevations. Cottonwood saplings require a limited rate of water table decline to ensure that growing roots maintain contact with the free water surface. Comparing the number of days exhibiting optimal recruitment conditions under natural vs. existing conditions assessed the degree of departure from reference conditions.

Functional Assessment

Riparian areas exhibit high functional capacity in the upper Crystal River watershed. Pockets of moderate impairments exist around Marble, Redstone and below Avalanche Creek. Observed patterns of impairment on the mainstem of the Crystal River generally correspond to upland land use practices, rather than water resource management activities.

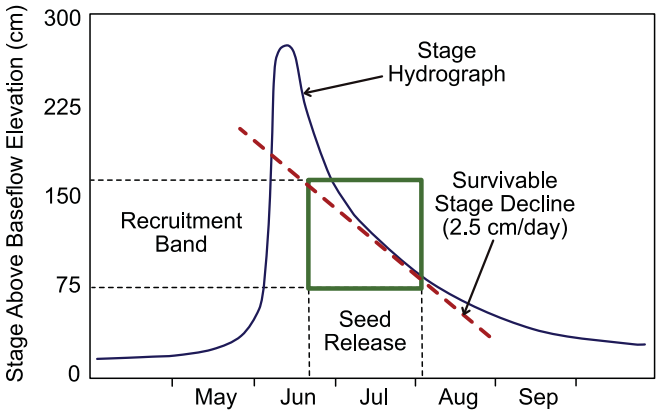


Figure 2-5: The Recruitment Box methodology compares rates of water table decline to average root growth rates for woody riparian vegetation to identify optimal and sub-optimal conditions for sapling growth

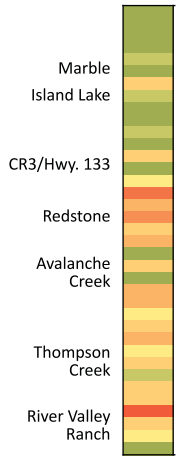
Floodplain development in the area around Redstone limits the extent of the riparian zone, impacting species diversity and wood vegetation structure. Riparian forest removal in several locations along the river corridor, particularly in the lower Crystal where grazing and haying production is more intensive, similarly limit the functionality of these zones. The most significant riparian forest degradation exists between the Bowles and Holland Ditch headgate and the River Valley Ranch (RVR) golf course. Limited invasion of Russian olive trees and tamarisk near the confluence with the Roaring Fork River likely produce limited effects on overall riparian function but could indicate a significant pathway for future degradation.

Management Response Opportunities

- Targeted removal of invasive species near the Roaring Fork River
- Moratorium on riparian forest removal practices
- Enhanced grazing enclosure buffer widths above the Carbondale Ditch headgate.
- Small-scale riparian restoration on Town of Carbondale stream tract.

2.3.3 Debris Supply

Debris supply encompasses the amount, timing, and type of large woody debris and small organic detritus reaching a stream channel from near stream areas. Large woody debris performs an important function as a component of structural heterogeneity on the streambed, altering channel hydraulics, patterns sediment transport, and habitat quality. Detritus represents a critical carbon and energy input to aquatic food webs. Impairment of debris supply typically follows degradation of riparian forests in response to active removal of vegetation, hydrological modification or floodplain dissection.



Assessment Methodology

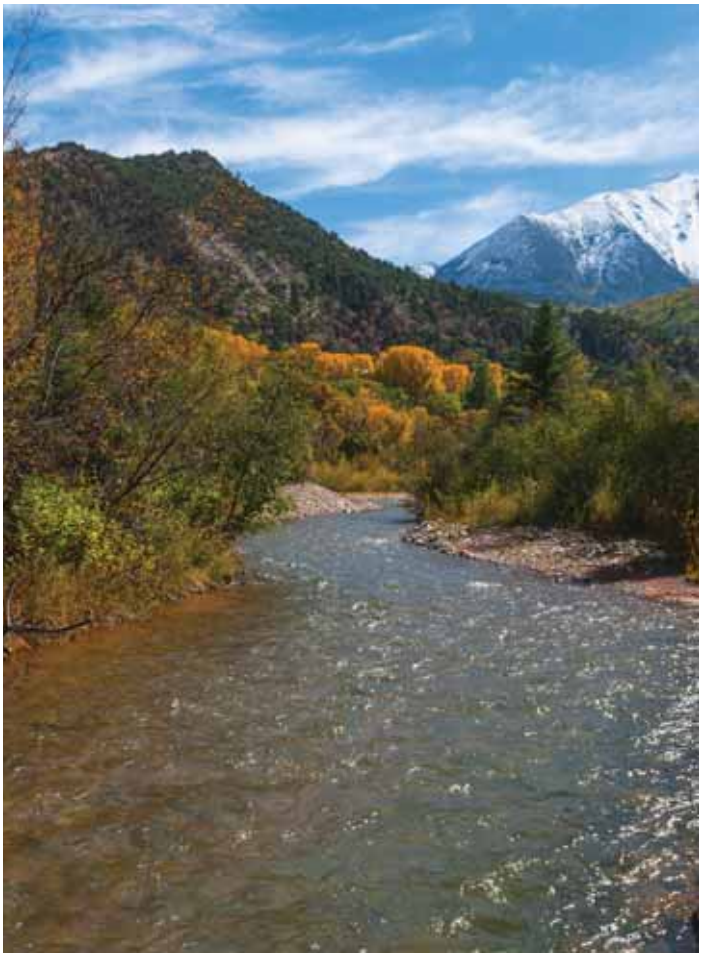
Assessment of debris supply relied exclusively on rapid field assessments that examined the types of debris present in the channel and the presence or absence of source areas supplying similar material throughout the river corridor.

Functional Assessment

Organic debris is a structural building block and important energy source in stream ecosystems. Patterns of impaired debris supply mirrored that of riparian vegetation. Small isolated pockets of minor impairment exist near Redstone and between the Bowles and Holland Ditch headgate and the RVR golf course. Valley floor development activities affecting riparian vegetation represent the primary stressors on debris supply. Given the relatively high functionality of this variable, response opportunities are somewhat limited.

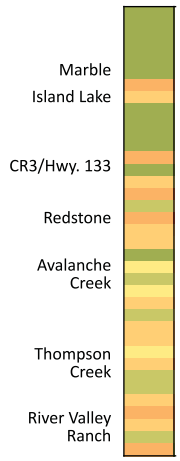
Management Response Opportunities

- Moratorium on riparian forest removal practices
- Enhanced grazing exclosure buffer widths above the Carbondale Ditch headgate.
- Small-scale riparian restoration on Town of Carbondale stream tract.



2.4 CHANNEL SCALE ASSESSMENTS

2.4.1 Stream Morphology



Morphology

A stream's morphological patterns reflect the interplay between hydrology, channel hydraulics, sediment supply, beaver activity, and streamside vegetation. Assessments of stream morphology consider the patterns of channel evolution, planform, cross-sectional dimensions, and channel profile. Impacts to stream morphology may arise from construction of roads and levees, extirpation of beavers, reduction of the active floodplain width, and disruption of sediment supplies due to dam construction. Stream's exhibiting morphological characteristics inappropriate for local valley forms and sediment regime may display elevated channel instability or a reduction in physical heterogeneity of the streambed.

Assessment Methodology

Evaluation of channel morphology began with windshield surveys and assessments of aerial imagery to determine the Rosgen stream classification of each reach. Subsequently, rapid field assessments investigated states of dynamic equilibrium and identified local impacts on cross-sectional geometry and planform structure.

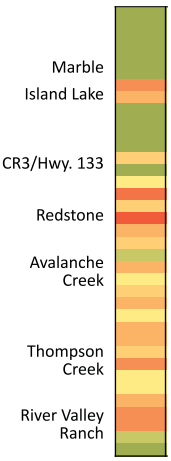
Functional Assessment

The majority of the Crystal River transports sediment effectively and exhibits very similar and stable channel types, planforms and dimensions. Minor morphological impairment results from local, structural instabilities due to development in near-stream areas. Levee construction and bank armoring near Redstone and Marble affect patterns of sediment scour and deposition, destabilizing natural morphology. Floodplain development in these areas also diminishes the extent and quality of riparian vegetation. Riparian forests help maintain stable channel forms by strengthening streambanks and contributing large woody debris to the stream channel. Impairments observed on the Crystal near Carbondale are mostly due to the interactive effects of water withdrawals and diversion infrastructure. Push-up dam creation near headgates somewhat disrupt sediment transport dynamics, contributing to aggrading bedforms, braiding, and increased rates channel avulsion. These effects are most pronounced near the headgates for the Carbondale, and Kaiser and Sievers ditches. Similar morphological patterns exist near the Lowline Ditch headgate. However, field assessment results suggest that aggradation at the terminus of the Crystal River Canyon is primarily due to a natural geological transition. A reduction in channel confinement and bed slope at this location diminish the River's ability to affectively convey the high bedloads common to the Crystal.

Management Response Opportunities

- ❖ Replacement of push-up dams with permanent grade control structures

2.4.2 Channel Stability



Channel Stability

Channel stability reflects the river's ability to balance sediment supply and transport in dynamic equilibrium. High channel stability typically equates to resiliency and the ability of the stream to recover after large disturbances. Morphological impairment on alluvial streams often emerges in the form of local channel instability. Stressors at the channel scale (e.g. bank hardening at a bridge crossing), reach-scale (e.g. bank failure due to riparian vegetation removal), or watershed-scale (e.g. sediment supply disruption due to dam construction) may, in turn, cause this instability.

Assessment Methodology

Characterization of channel stability relied heavily on prior assessments of flow regime, sediment regime, stream morphology, floodplain connectivity, and riparian vegetation. Process-based evaluations of fluvial geomorphic processes permitted prediction of unstable positions along the stream corridor. Follow-up field assessments at these locations verified the presence or absence of expected conditions. Where previous assessments indicated impacts to the hydrological regime, the EcoDSS employed two-dimensional hydraulic modeling and critical shear stress analysis to evaluate local sediment transport dynamics and the impacts of water management on channel maintenance flows (Appendix A). This approach assessed the degree of departure from natural conditions by comparing the fractional area of mobilized bed material for each reach under existing conditions and natural conditions (i.e. no surface water diversions) as simulated by the hydrological model in the EcoDSS (Figure 2-6).

Functional Assessment

Longitudinal patterns of channel stability on the Crystal River closely follow the functional condition of flow regime, sediment regime, floodplain connectivity, riparian vegetation, and channel morphology. Isolated pockets of minor to moderate impairment exist near Marble, Redstone, and in the vicinity of diversion infrastructure near Carbondale. Constrictions in the floodplain caused by push-up dams, levees, roads and bridges alter local patterns of sediment scour and deposition. These hardened structures are among the most stable channel forms in the river corridor, but may increase risk for chronic or catastrophic instabilities in the upstream and downstream direction. Little evidence of chronic instabilities exists; however, conditions may rapidly change following large magnitude flood or sediment mobilization events. Reconnection of disconnected floodplains and future realignment of levees and roadways can help mitigate for these risks. While impairments to channel stability are relatively minor on the Crystal, they are most pronounced near the headgates for the Carbondale, and Kaiser and Sievers ditches. Push-up dams created in the late summer at these locations frequently persist throughout the winter and spring months

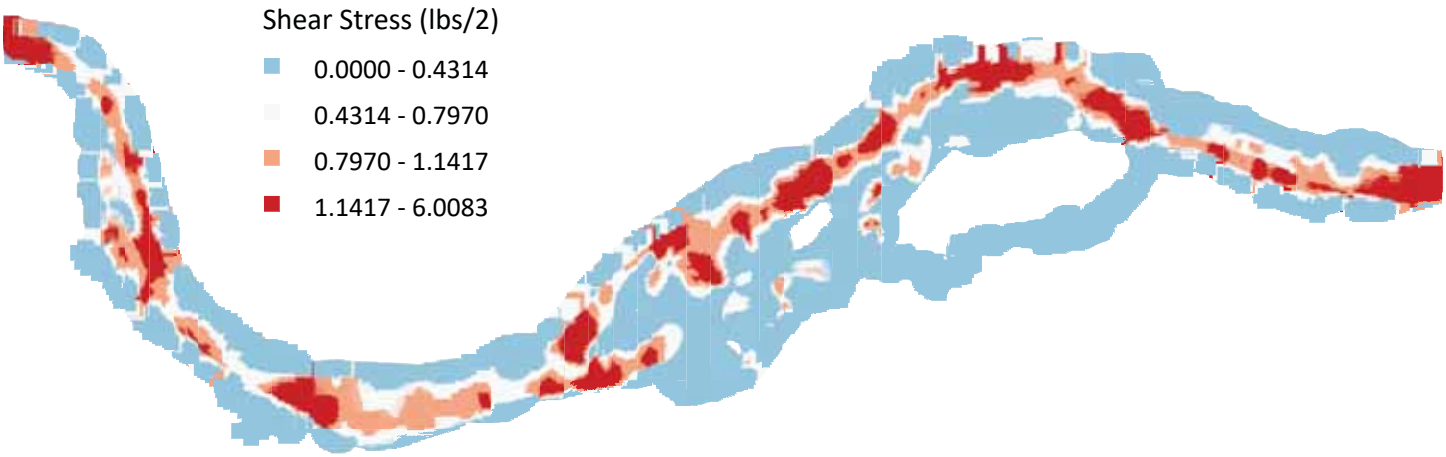


Figure 2-6: 2-dimensional hydraulic modeling simulated streambed shear stress conditions across a range of streamflows and allowed for assessment of sediment mobilization potential

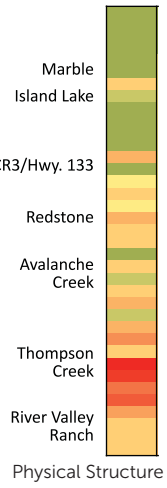
altering sediment dynamics and, where dams are large enough, contributing to elevated rates streambank avulsion and channel widening during peak flows. Similar instabilities noted near the Lowline Ditch headgate likely result from natural patterns in valley-scale landscape form.

Management Response Opportunities

- Replacement of push-up dams with permanent grade control structures
- Bridge span widening during future infrastructure replacement projects
- Culvert and or bridge installation through historical railroad grade during regional trail development at Red Wind Point

2.4.3 Physical Structure

Physical heterogeneity in the streambed and water column results from the complex interplay between the patterns of erosion, scour, and deposition that shape the streambed.24 As is the case for stream morphology, biological drivers, such as riparian vegetation, wood, and beavers, may also exert significant control over physical structure. Assessments of physical structure consider the hydraulic structure (water depth and velocity distributions), bed and bank features, and substrate material. Heterogeneity is a critical determinant of habitat quality for many aquatic organisms including macroinvertebrates and fish. Activities that physically alter the structure of the streambed, disrupt the sediment regime, or reduce large woody debris supplies to a reach frequently impact the physical structure and degree of heterogeneity present in the stream channel.



Assessment Methodology

Characterization of the physical structure of stream habitat aggregated results from prior assessments of flow regime, stream morphology, debris supply, and biotic structure to identify positions throughout the river corridor expected to exhibit significant departure from natural conditions. Visual indication of stress to the hydraulic structure was observed during rapid field assessments. Where field assessments and results considering other state variables identified impairment, the EcoDSS employed two-dimensional modeling of channel hydraulics and habitat quality and availability (Figure: Habitat suitability curves) to assess management impacts on fine scale (feet to tens of feet) physical structure (Appendix A). This EcoDSS assessed the degree of departure from natural conditions by comparing the weighted usable area (WUA)[32] of critical fish habitat on each reach under existing conditions and natural conditions (i.e. no surface water diversions).

Functional Assessment

Physical Structure is not significantly impacted in the Crystal River headwaters. Pockets of mild to moderate impairments become increasingly concentrated in the lower part of the Crystal where water resource management activities alter patterns of streamflow. Relatively homogenous bed structures in reaches on the lower Crystal generally limit habitat quality and availability and makes them more vulnerable to physical impacts produced by modifications of the hydrological regime. Water depletions supporting agricultural and municipal uses diminish spatial heterogeneity in water velocity and depth, fragmenting high quality habitat. Impairments are most pronounced between the headgates for the Lowline Ditch and Carbondale Town ditch in moderate (1 in 5 year) to severe (1 in 20 year) drought conditions (Figure 2-7). Conditions abate somewhat in the downstream direction as surface and groundwater return flows contribute to increased flows (Appendix A).

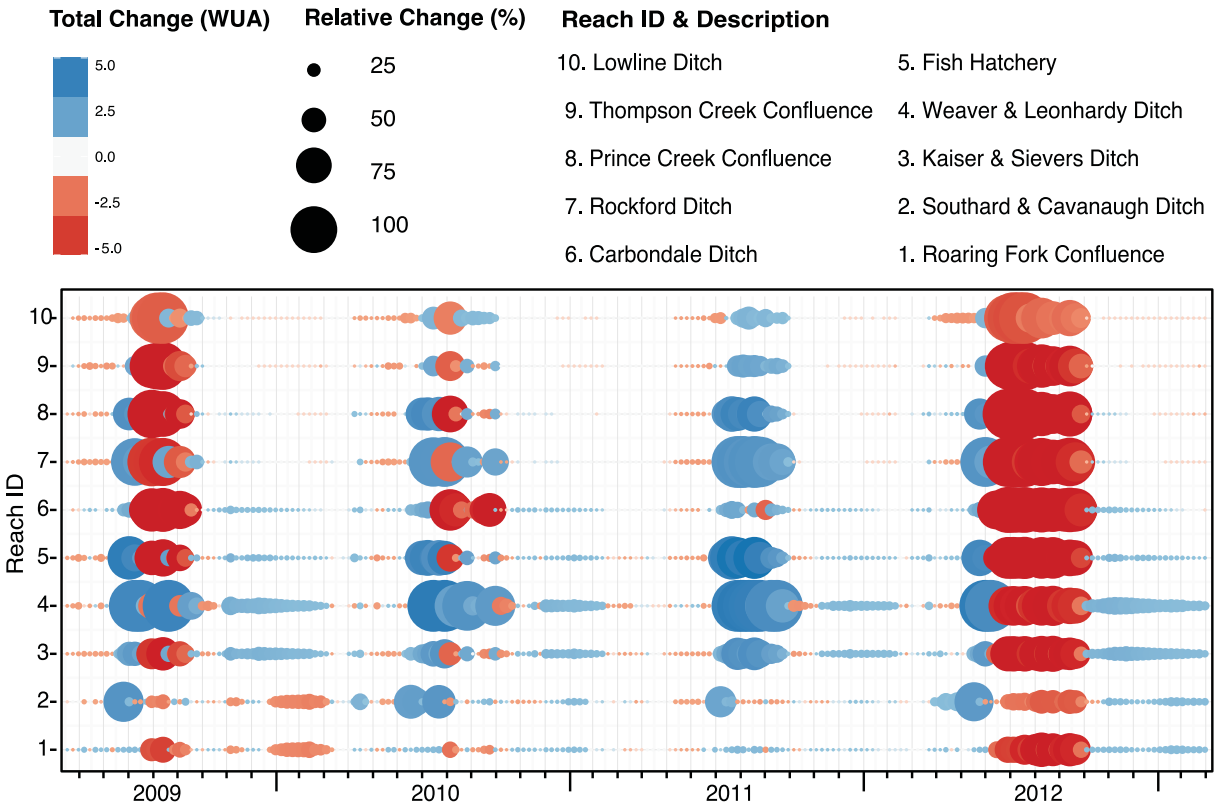


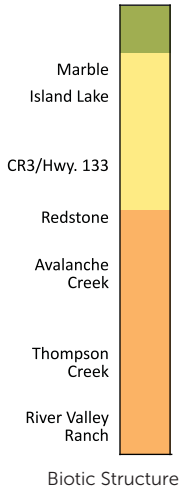
Figure 2-7: Changes in adult rainbow habitat availability due to water management and use on the lower Crystal River across a range of hydrological conditions. Larger, redder circles indicate a significant reduction in habitat quality and availability. Blue circles indicate a relative increase in habitat quality brought about by reductions in water velocity or by late season return flows that accompany agricultural water uses

Management Response Opportunities

- Water conservation programs for treated and raw municipal water supply
- Irrigation application method and conveyance system efficiency upgrades
- Market-based streamflow bypass agreements
- Water leasing programs
- Off-channel reservoir construction
- Stream habitat enhancement projects

2.4.4 *Biotic Structure*

Biotic structure considers the total biomass and species diversity of microbes, macrophytes, macroinvertebrates, fish and amphibians, and other animals. The degree to which a stream can support complex trophic structures when assessed against reference conditions is a prime indicator of overall ecosystem health. The living components of the stream system are the components most frequently recognized for their ties to EGS. The biotic makeup of a stream is impacted by all other ecosystem state variables. As a result, any activity that impairs other processes at the watershed, reach, or channel scale may similarly affect biotic structure. For example, disruptions in the hydrological regime impact the structural complexity of the streambed and water column. This complexity is an important control on habitat quality for fish and macroinvertebrates and, where it is reduced, a corresponding impairment of biotic structure may result.



Functional Assessment

The Crystal enjoys a healthy biotic structure above Redstone. Some moderate impairment is evident below this location. The condition of macrophytes and macroinvertebrates in most locations along the Crystal do not indicate impairment by human activities. Some exceptions exist for macroinvertebrates in Coal Basin where significant bed mobilization and sediment transport events likely produce local, short-lived extirpations. Evidence for impairments to biotic structure focus on fisheries. The lower Crystal does not support robust whitefish and sculpin populations, or sustainable rainbow trout fishery—despite active management and stocking by CPW in support of the latter. Comparison of historical rainbow trout, brown trout, and whitefish population data sets for the upper Crystal River, lower Crystal River, and lower Eagle River indicate fundamental differences in community structures (Figure 2-8). Assessing Crystal River fisheries data against available reference conditions and consideration of prior assessments of hydrological regime, water quality, channel morphology, and physical structure suggest that modification of local hydrology in support of municipal and agricultural water uses alters channel hydraulics and increases water temperature

extremes—critical determinates of habitat quality and extent.

Assessment Methodology

Conversations with long-time residents in the Crystal River valley indicate that the absence of a robust fishery in the Crystal River near Carbondale is a long-recognized chronic condition. The Colorado Department of Parks and Wildlife (CPW), the United States Forest Service (USFS) and Roaring Fork Conservancy (RFC) provided data instrumental in assessing biological conditions on the Crystal. A comparative review of data collected by CPW at multiple points along the river corridor elucidated species diversity, total biomass, and age class distributions of the Crystal River fishery. Assessing the degree of departure of the fishery from natural conditions relied heavily on expert review and communication of resource management expectations by CPW staff. A direct comparison of data collected on the Crystal with nearby reference streams supported those discussions. Relevant literature [40,41] provided the basis for assessing macroinvertebrate community health. Data collected by USFS and RFC helped characterize the structure and health of benthic macroinvertebrate communities. Macroinvertebrate condition was assessed according methodologies outlined in the WQCD Aquatic Life Use Attainment Policy Statement.[12]

Management Response Opportunities

- Water conservation programs for treated and raw municipal water supply
- Irrigation application method and conveyance system efficiency upgrades
- Market-based streamflow bypass agreements
- Water leasing programs
- Off-channel reservoir construction
- Stream habitat enhancement projects

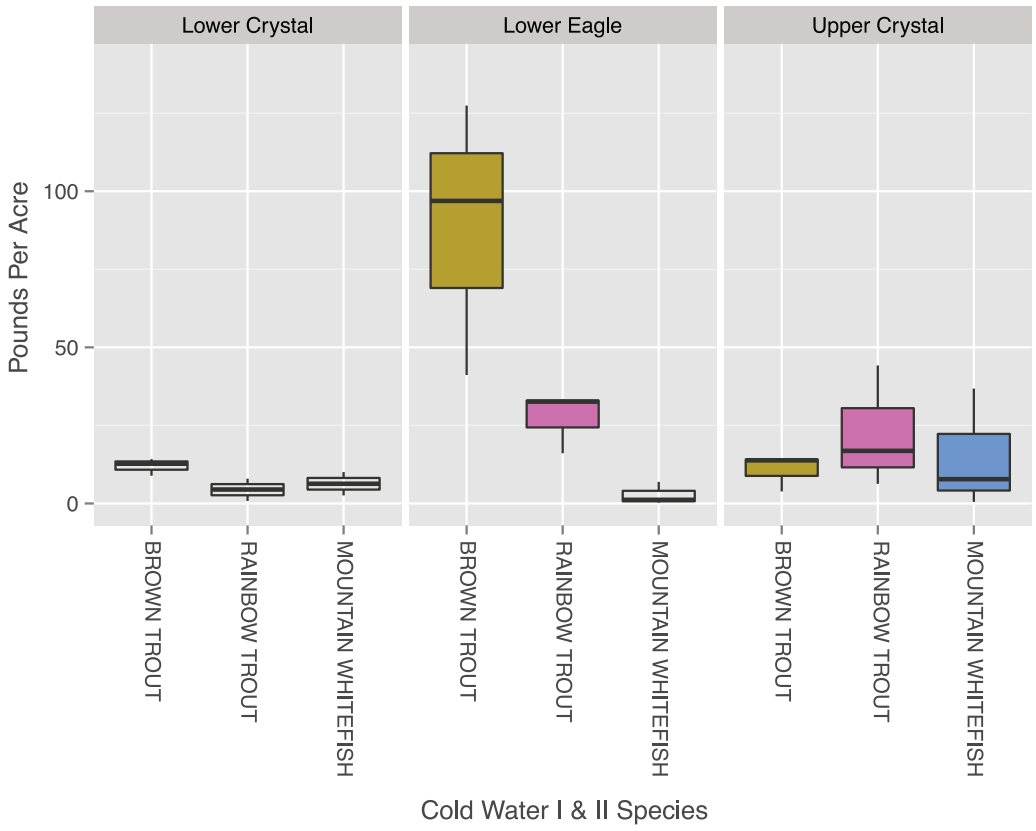


Figure 2-8: Differences in fish species biomass between the upper and lower Crystal River and the lower Eagle River

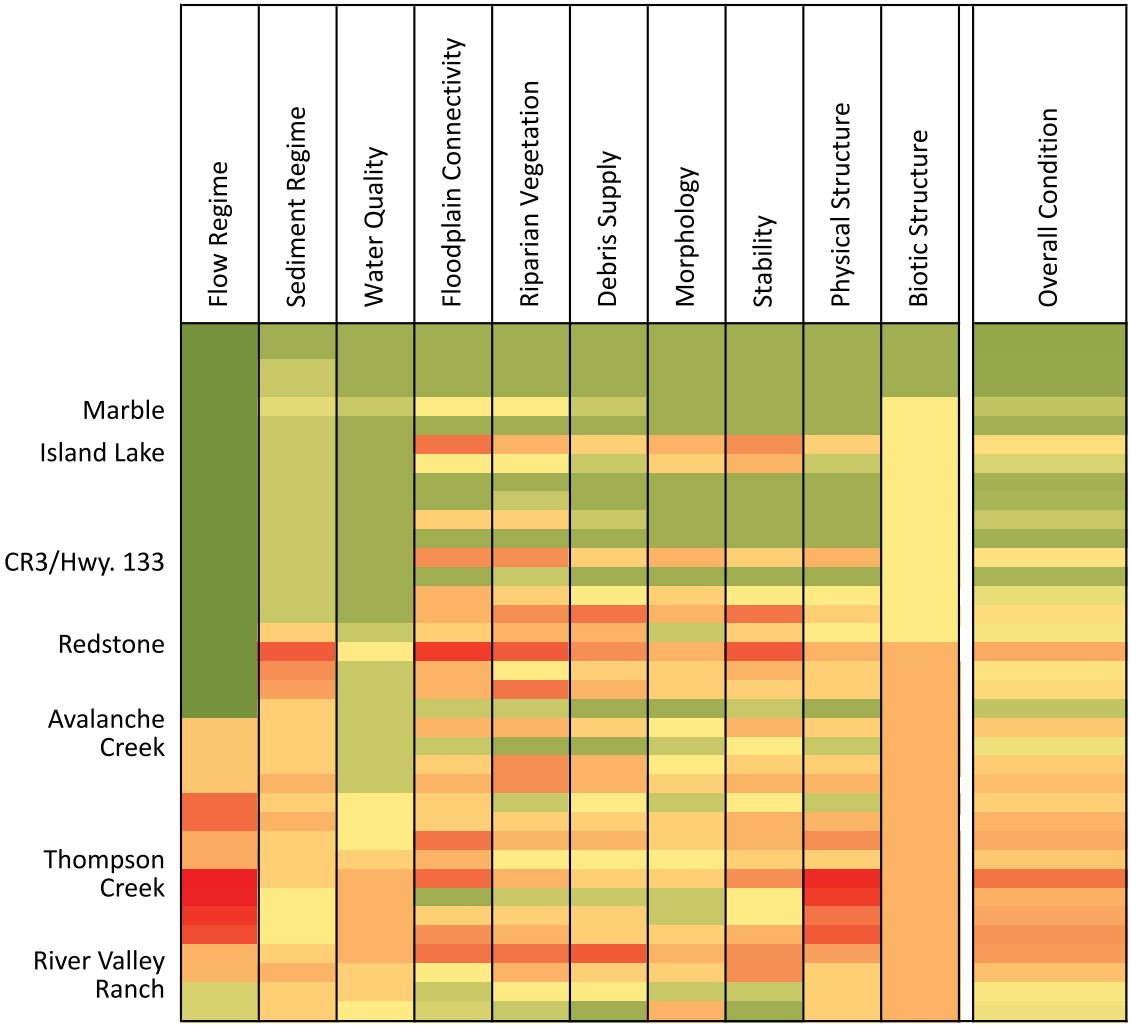
2.5 AGGREGATED FUNCTIONAL CONDITION

Functional assessment of the various components of the Crystal River ecosystem illuminated three important conclusions:

1. Flow regime alteration in the 7 miles of the Crystal River above its confluence with the Roaring Fork impairs physical structure, limits aquatic habitat quality, and may be responsible for observed impairments to local trout fisheries.
2. Moderate site-specific impacts to floodplain connectivity, riparian vegetation, debris supply, stream morphology and stability exist at several locations throughout the river corridor, particularly in the vicinity of Redstone.
3. The upper reaches of the Crystal River exhibit adequate functional condition.

The CRMP identifies a wide variety of management options to lessen observed impacts to ecosystem function at a range of spatial scales and at different locations in the watershed (Table 2-5). Few external stressors exist in the headwaters of the Crystal contributing to a generally healthy ecosystem above Redstone. Constraints on function slowly increase in the downstream direction due to the cumulative effects of floodplain development and surface water diversions. The reaches of Crystal River between Thompson Creek and the confluence with the Roaring Fork exhibit the most degraded overall functional condition. This pattern most strongly reflects late summer modifications to the hydrological regime and cascading impacts on channel hydraulics, water temperature, habitat quality and availability, and biotic structure. The dominant nature of the impacts to streamflow and habitat suggest that management strategies that focus on these two variables will yield the greatest overall benefit to the Crystal River.

Grade	Score	Level of Impairment
A	90-100	Negligable
B	80-90	Mild
C	70-80	Significant
D	60-70	Severe
F	50-60	Profound/Unsustainable



Management Response Opportunities	State Variable Addressed
Water conservation programs for treated and raw municipal water supply	Flow Regime, Water Quality, Physical Structure, Biotic Structure
Irrigation application and conveyance system efficiency upgrades	Flow Regime, Water Quality, Physical Structure, Biotic Structure
Market-based streamflow bypass agreements	Flow Regime, Water Quality, Physical Structure, Biotic Structure
Water leasing programs	Flow Regime, Water Quality, Physical Structure, Biotic Structure
Off-channel reservoir construction	Flow Regime, Water Quality, Physical Structure, Biotic Structure
Low flow channel modification/stream habitat enhancement projects	Physical Structure, Biotic Structure
Limited erosion control projects on historical mining and roadway surfaces in Coal Basin	Sediment Regime
Culvert and/or bridge installation through historical railroad grade at Red Wind Point	Floodplain Connectivity, Stability
Limited floodplain reconnection at the mouth of Coal Basin and Thompson Creek	Floodplain Connectivity
Conservation and protection of limited high-quality floodplain habitats	Floodplain Connectivity
Targeted removal of invasive species near the Roaring Fork River	Riparian Vegetation
Moratorium on riparian forest removal practices	Riparian Vegetation, Debris Supply
Enhanced grazing exclosure buffer widths above the Carbondale Ditch headgate.	Riparian Vegetation, Debris Supply
Small-scale riparian restoration below Bowles and Holland Ditch	Riparian Vegetation, Debris Supply
Replacement of push-up dams with permanent grade control structures	Morphology, Stability
Bridge span widening during future infrastructure replacement projects	Stability

Table 2-5. Management response opportunities on the Crystal River address observed constraints on state variables.

3 EXISTING WATER USES

Local resource management and water conservation organizations—the Roaring Fork Conservancy and Public Counsel of the Rockies—considered functional ecosystem assessment results and expressed concern that observed impairments to the hydrological regime push the Crystal River to a less-desirable state, reducing delivery of important ecosystem goods and services. This concern initiated a focused investigation of opportunities to mitigate impacts on late season streamflows and habitat structure in the lower seven miles of the watershed. Evaluation of projects and programs to address constraints on ecosystem function necessarily considered the social and economic systems reliant upon existing patterns of water use. The CRMP utilized a robust characterization and engineering analysis of existing water uses to provide an evidence-based foundation for recommendations that met stakeholder goals.

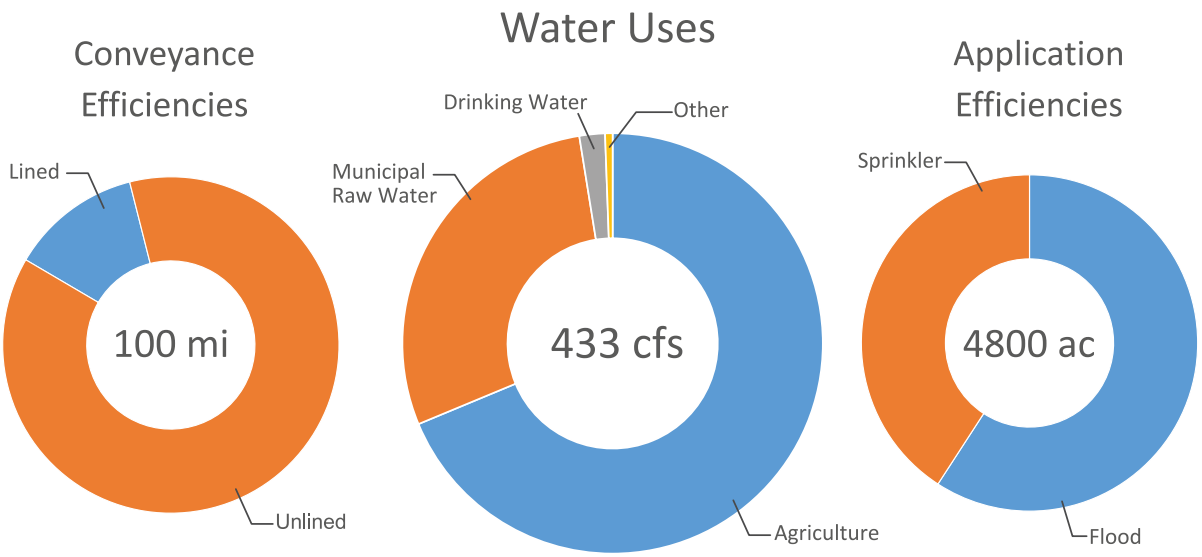


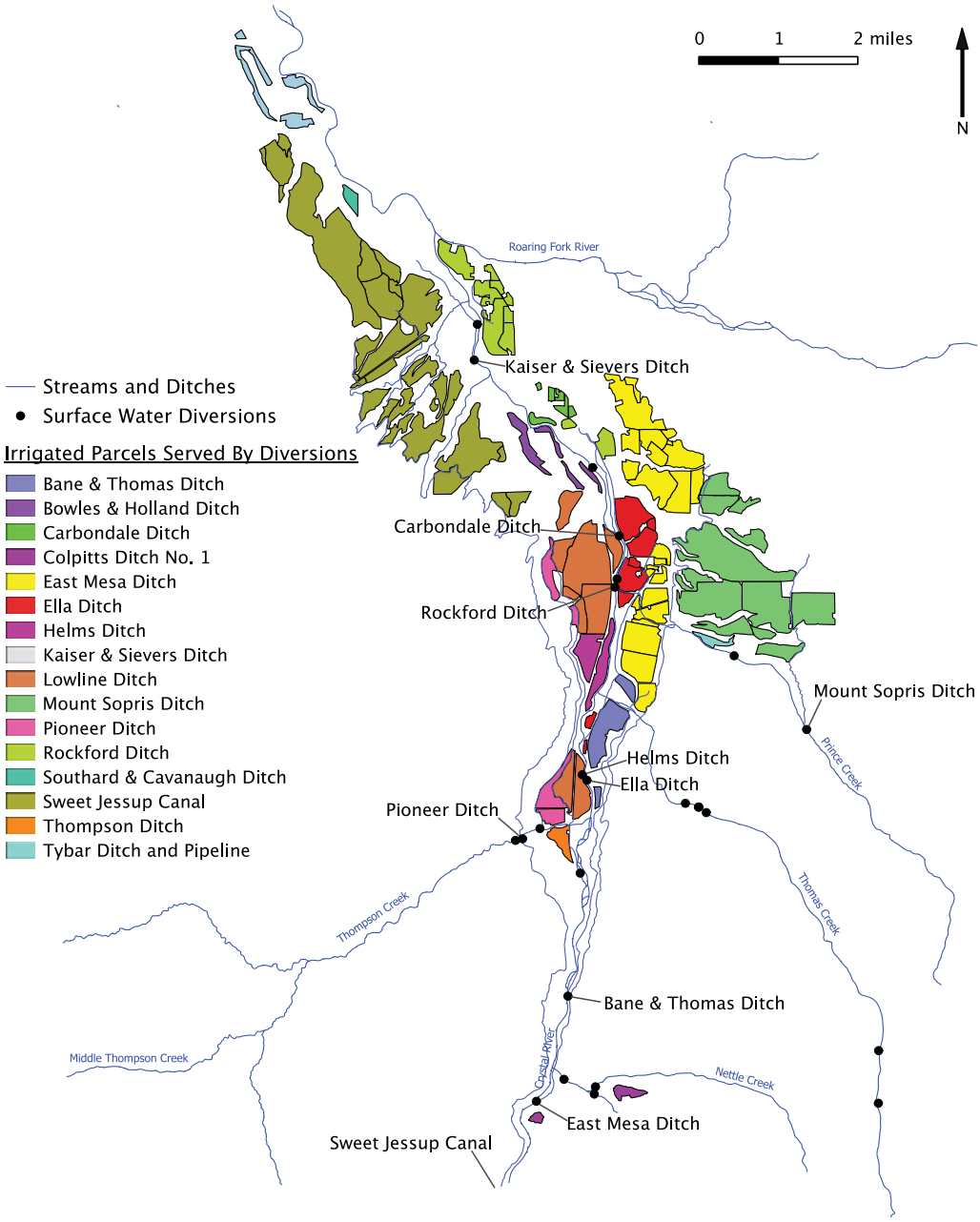
Figure 3-1: Summary of water uses and supporting infrastructure on the Crystal River and its tributaries. 433 cfs of surface water diversions are conveyed along approximately 100 miles of ditch and pipe to support municipal uses and about 4800 acres of irrigated land

3.1 WATER RIGHTS OVERVIEW

Legal and administrative frameworks governing the use of water on the Crystal River allocate water among multiple users according to the Prior Appropriation System. Water from the River supports agricultural production, municipal water use, operation of a Colorado Parks and Wildlife (CPW) fish hatchery, and a minimum instream flow right (Figure 3-1) according to a seniority system that places the oldest existing uses ('senior rights') in priority over other new uses ('junior rights').

3.1.1 Municipal Use Rights

The Town of Carbondale supplies local residents with treated drinking water from diversions on Nettle Creek. Backup sources include a well field near the CPW fish hatchery and another in the Roaring Fork River's alluvial aquifer. Existing water rights are generally considered adequate to accommodate future population growth in the Town and surrounding areas. The Town's adjudicated surface water diversion rate on Nettle Creek is 5.75 cfs.


0
1
2 miles
N
Roaring Fork River
Kaiser & Sievers Ditch
Carbondale Ditch
Rockford Ditch
Mount Sopris Ditch
Prince Creek
Helms Ditch
Ella Ditch
Pioneer Ditch
Thompson Creek
Thomas Creek
Bane & Thomas Ditch
Middle Thompson Creek
Crystal River
Nettle Creek
East Mesa Ditch
Sweet Jessup Canal
Streams and Ditches
Surface Water Diversions
Irrigated Parcels Served By Diversions
Bane & Thomas Ditch
Bowles & Holland Ditch
Carbondale Ditch
Colpitts Ditch No. 1
East Mesa Ditch
Ella Ditch
Helms Ditch
Kaiser & Sievers Ditch
Lowline Ditch
Mount Sopris Ditch
Pioneer Ditch
Rockford Ditch
Southard & Cavanaugh Ditch
Sweet Jessup Canal
Thompson Ditch
Tybar Ditch and Pipeline

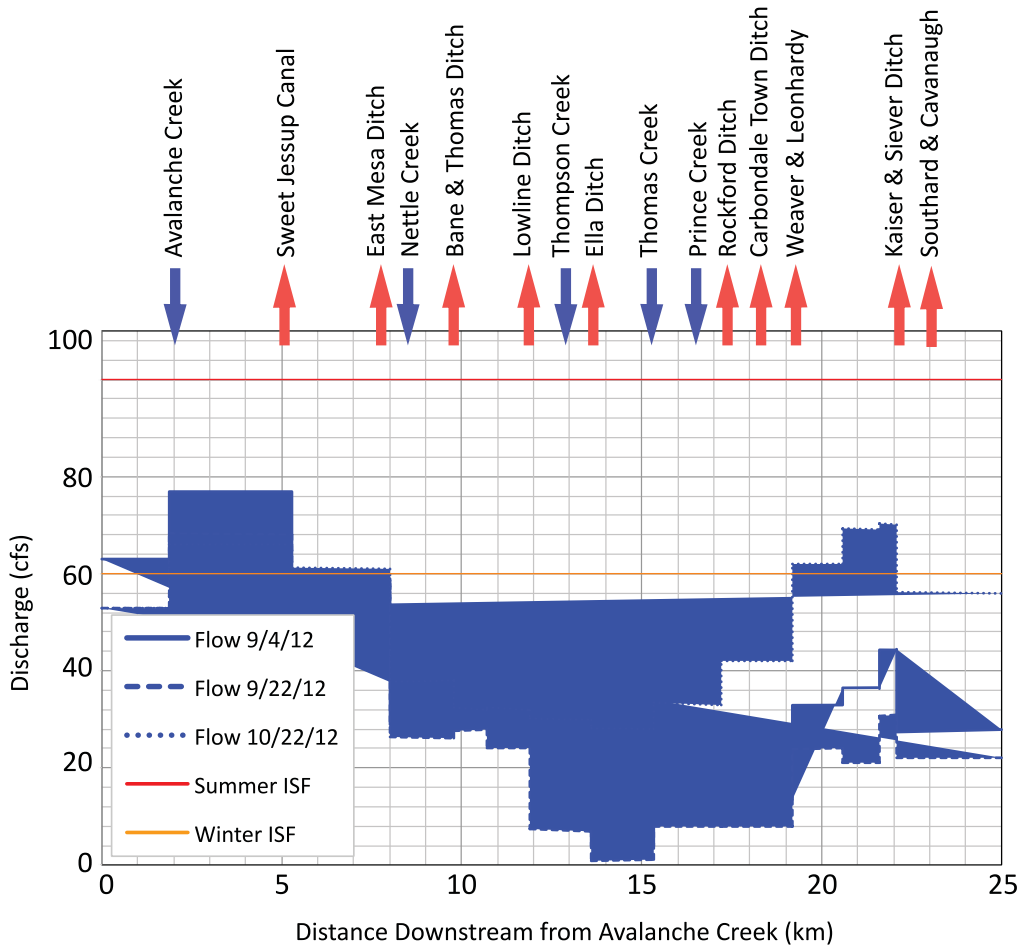


Figure 3-3: Longitudinal patterns in streamflow observed on the Crystal River in the late summer of 2012

3.1.3 CWCB Instream Flow Rights

The CWCB holds a junior instream flow (ISF) right on the Crystal River between its confluences with Avalanche Creek and the Roaring Fork River. ISF rights are intended to provide some measure of environmental use benefit under the Prior Appropriation System. The ISF right (100 cfs summer / 60 cfs winter) on the Crystal is frequently not met during moderate and severe drought conditions in late summer and early fall (Figure 3-3).

3.1.4 Trans-basin Diversions

A single, trans-basin diversion moves water out of the headwaters of Thompson Creek and into the Willow Creek drainage to the west. This 24 cfs junior surface water diversion right only diverts flow during spring runoff and generally does not affect water availability for other uses in the Crystal River watershed.

3.2 WATER USE ASSESSMENT

The balance of water flowing into the Crystal River and its tributaries from snowmelt and rainfall, moving out of the river into canal networks and onto fields, evaporating, and returning to the river via surface or groundwater constitute the primary components of a local water budget. The responses of physical and legal water demands to hydrological conditions determine the allocation of water among the various uses present in the system. In the case of individual agricultural users, the characteristics of the infrastructure used to convey water and the irrigation application method largely determine the timing and location of surface and groundwater return flows (Figure 3-4). Synergies between water availability and use efficiencies conspire to create demand shortages at different locations over the course of a water year. The water use assessment described in the CRMP characterized management and use of water on the Crystal River by integrating analyses of watershed hydrology and water rights administration under the Prior Appropriation System.

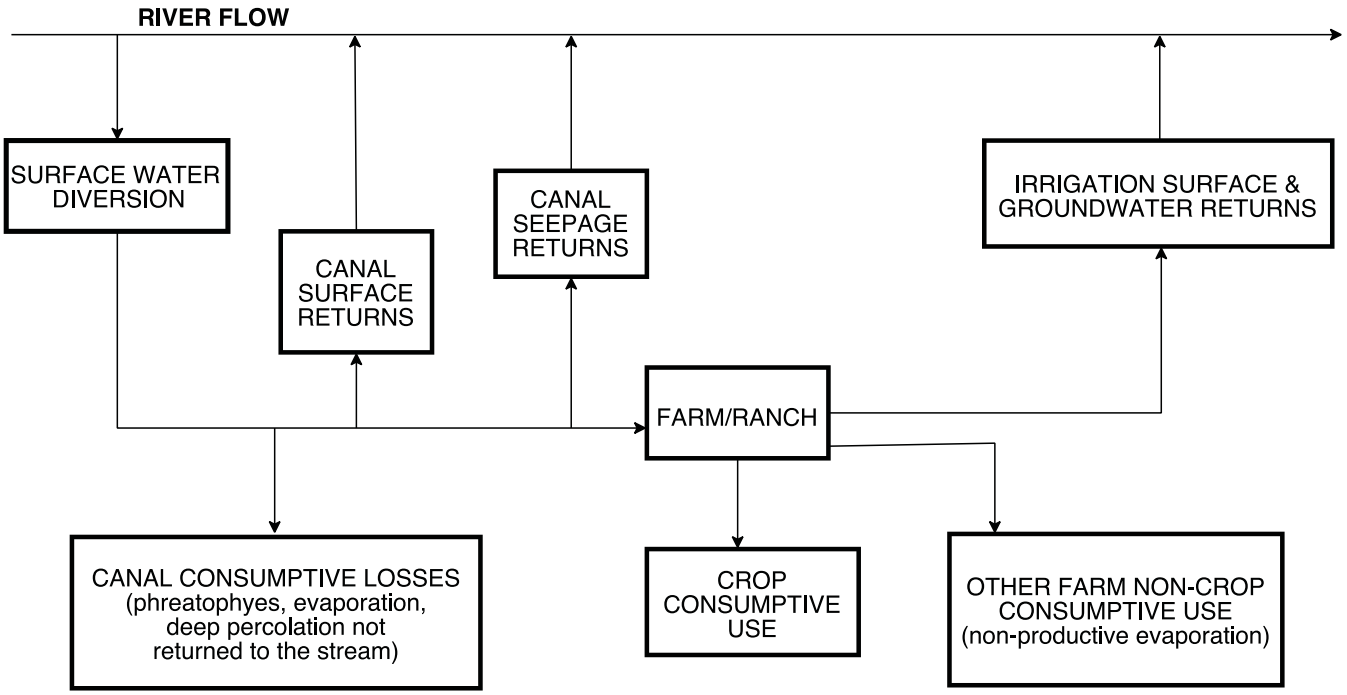


Figure 3-4: Irrigation system schematic indicating the various pathways water travels along between a point of diversion and a point of use.[10]

3.2.1 Hydrological Simulation Modeling

Water resource planning questions addressed in the CRMP regarding water availability, patterns of local use, and discrepancies between use needs and water supply relied heavily on hydrological simulations. The hydrological modeling component of the EcoDSS simulated tributary inflows, allocated surface water to diversions according to Colorado Water Law, and routed groundwater and surface water return flows from irrigated acreages back to the river on a daily timestep across a range of drought and flood conditions (Appendix A). The EcoDSS derived diversion information, including structure names, locations, decreed amounts, priority date, application type, and irrigated acres, from the Colorado Division of Water Resources water rights database, HydroBase. Calculation of lag response coefficients for groundwater returns from irrigated acreages required estimates of water application efficiency, aquifer transmissivity, specific yield, and the least-cost path distance between irrigated parcels and the Crystal River. Estimating return flow fractions for each water demand required investigation into the water application method used on each irrigated parcel. For each water right, return flow fractions and locations were modeled according to the distributed ownership amounts and spatial orientation of associated irrigated parcels. Where necessary, information communicated by the local Water Commissioner and several water users helped refine HydroBase data. Historical gauge records and hydrological predictions for ungauged basins generated streamflow boundary conditions. Published hydrogeological studies provided the necessary input information for groundwater simulations. The simulated river network extended from Avalanche Creek to the Roaring Fork River and included all significant agricultural and municipal water diversions on the Crystal River mainstem, Nettle Creek, Thompson Creek, Thomas Creek and Prince Creek (Figure 3-5).

3.2.2 System Efficiencies

Evaluating the relative efficiencies of water conveyance and application systems represented a critical planning step that helped identify conservation opportunities that can benefit ecosystems and reduce maintenance obligations for local users. In the Crystal River watershed, many water conveyance and irrigation water application systems look much as they did in the early 20th century. Most ditches are unlined and flood irrigation is the most typical water application method (Figure 3-1). Water diverted for irrigation satisfies crop needs only after accounting for ditch seepage, evaporative losses, surface runoff, and hydraulic push water requirements (Table 3-1). Reducing the amount of water "lost" to these inefficiencies by lining or piping ditches or switching to sprinkler irrigation will require diverting less water to satisfy existing crop demands (see Section 3.3). When and where efficiency upgrades lead to diversion reductions, they can benefit other junior users and, potentially, ecosystem needs present in the system.
For any given surface water demand, there exist several paths that diverted water moves along before being evaporated, consumed by vegetation, or returned to the river. Many of these paths do not directly reflect the intended use of the diverted water, but provide important secondary benefits, nonetheless. Seepage of water from unlined ditches supports vibrant riparian communities of willow and cottonwood on several benches and terraces in the lower Crystal River valley. These riparian zones provide important habitat to numerous

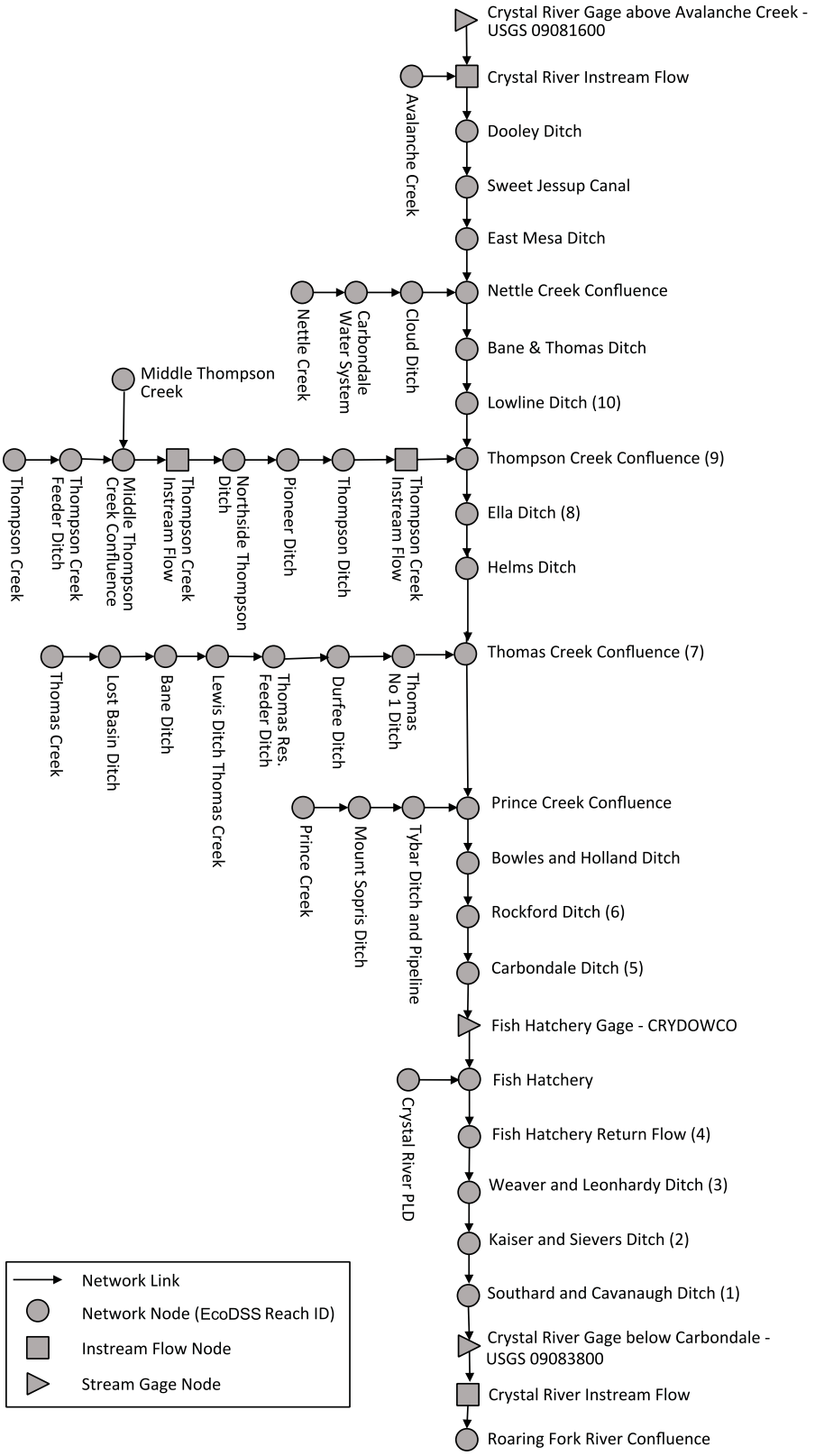


Figure 3-5: EcoDSS hydrological simulation network

System	Efficiency (%)
Primary Conveyance Efficiency	
Lined	95%
Unlined (200-2000m)	75%
Unlined (>2000m)	60%
On-farm Conveyance Efficiency	
Fields larger than 50 acres	
Unlined	80%
Lined or Piped	90%
Fields up to 50 acres	
Unlined	70%
Lined or Piped	80%
Application Efficiency	
Surface Irrigation Systems	
Wild Flood	30-50%
Graded Furrow	50-80%
Level Furrow	65-95%
Level Basins	80-95%
Sprinkler (non-center pivot)	
Side Roll	60-85%
Moving Big Gun	55-75%
Lateral Move	
Spray heads w/hose feed	75-95%
Spray heads w/canal feed	70-95%
Center Pivot Irrigation Systems	
Impact heads w/end gun	75-90%
Spray heads w/o end gun	75-95%
Microirrigation Systems	
Surface Drip	70-95%
Subsurface Drip Irrigation (SDI)	75-95%
Microsprinklers (microspray)	70-95%

Table 3-1: Estimated efficiency rates of water conveyance and application systems[2,26]

avian and terrestrial species. Critically, system inefficiencies that produce lagged groundwater returns from ditches and fields benefit streamflows and river ecology in late summer and early fall. The soil types and unconsolidated material present in the Crystal River valley and alluvial aquifer promote relatively rapid rates of infiltration and groundwater movement.[25] Anecdotal evidence provided by local residents, field data collection, and review of EcoDSS simulation results indicate that the influence of groundwater return flows on the Crystal River is strongest between the CPW fish hatchery and the Roaring Fork River. The modest increase in streamflows produced by these groundwater inputs is sufficient enough to produce measureable ecosystem benefit between the CPW fish hatchery and the Roaring Fork River during times of moderate or severe drought (Appendix A).

3.2.3 Demand Shortages

The convergence of priority system administration, hydrological conditions, and total system efficiency dictates the River's ability to meet the full array of existing uses. In places and times where a junior water right is "called out" by a senior user or where conveyance or application system inefficiencies exceed full agricultural use needs, shortages exist. Most demand shortages in the Crystal River Valley exist for agricultural users on tributaries where water supply is limited (Figure 3-6). However, agricultural users on the mainstem Crystal River also experience shortages in late summer. These shortages are particularly acute during moderate and severe drought conditions. The CWCB ISF right, the only water right reflecting ecosystem needs, is shorted in many reaches between the Sweet Jessup Canal and the Roaring Fork River in drought years. Resolution of this demand shortage represents a significant challenge due to the relatively large size of the ISF right and the significant use pressures on the Crystal during drought years when water supply is particularly constrained.

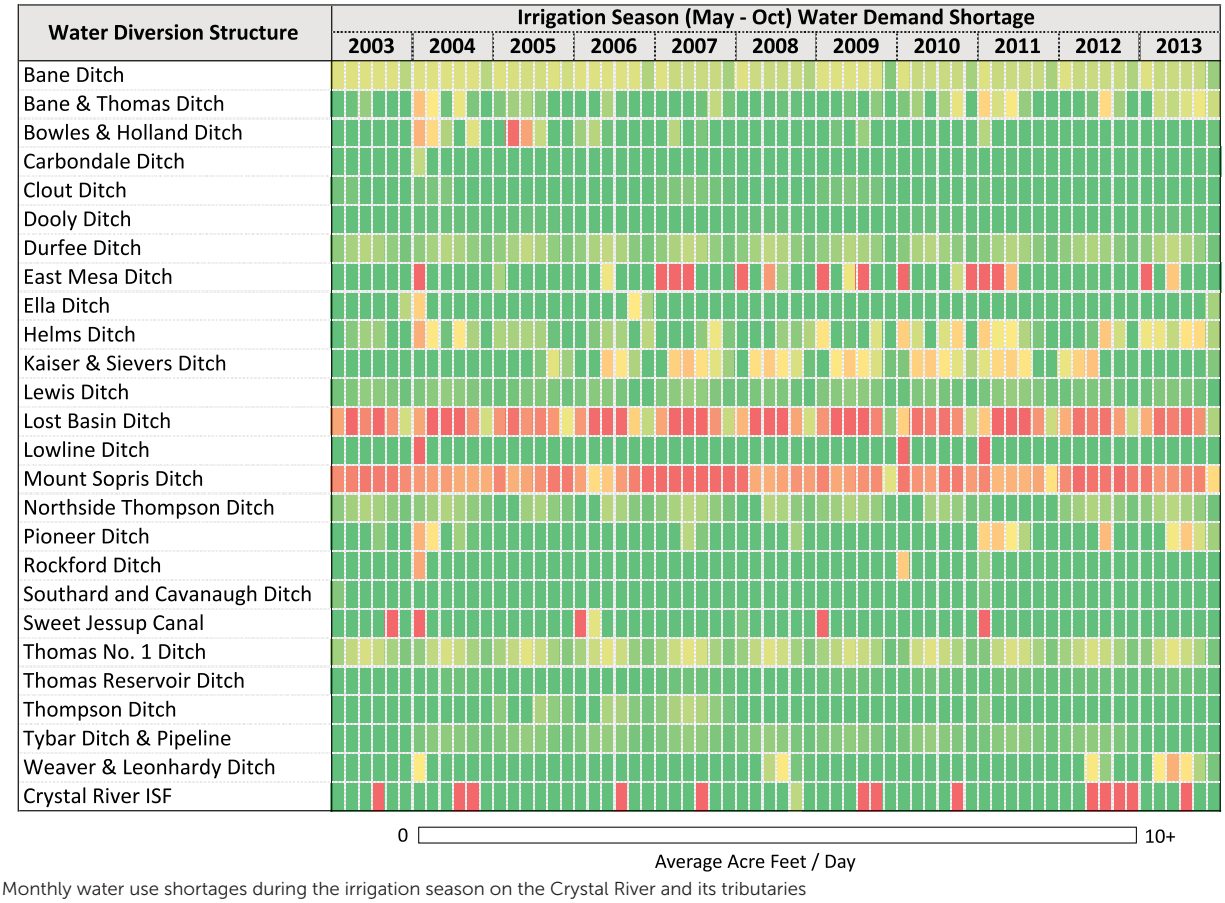


Figure 3-6: Monthly water use shortages during the irrigation season on the Crystal River and its tributaries

The State of Colorado supports use of established methods and criteria for calculating consumptive and non-consumptive demands and shortages. Approaches for evaluating irrigation demands consider geographic location, air temperature, irrigated acreage, system inefficiencies, and crop type. The State's adopted approach for determining ecosystem water demands relies on the R2Cross methodology.[56] This approach relies on hydraulic calculations that approximate baseflow habitat connectivity requirements for trout. Unfortunately, this relatively rigid approach does not adequately reflect ecosystem adaptations to natural variability in hydrological conditions or the Crystal River stakeholders' collective tolerance for water management strategies that impart some degree of ecosystem risk.

Assessments of ecosystem demand shortages presented in the CRMP are based on the Mean 7-Day Annual Minimum (7Q) flow, one of the most widely used low flow indices. Ecological research indicates the utility of the 7Q as: the minimum streamflow needed during drought conditions; the critical streamflow needed to protect and maintain aquatic habitat and ecosystem integrity; and the continuous chronic criterion for aquatic life.[18,34,39,46] The Sustainability Boundary Approach (SBA) and Presumptive Standard provide a framework for target flow ranges by defining allowable deviation of flow from the natural hydrograph in terms of degrees of ecosystem risk (Table 3-2).[27,36,38] Application of these methods to the 7Q brackets baseflow ranges corresponding to different hydrological conditions that reflect low, moderate, and high risk to ecosystem function (Figure 3-7). Existing management practices indicate an absence of ecosystem demands shortages in average years. However, moderate (1 in 5 year) and severe (1 in 20 year) drought conditions produce shortages between Thompson Creek and the CPW fish hatchery.

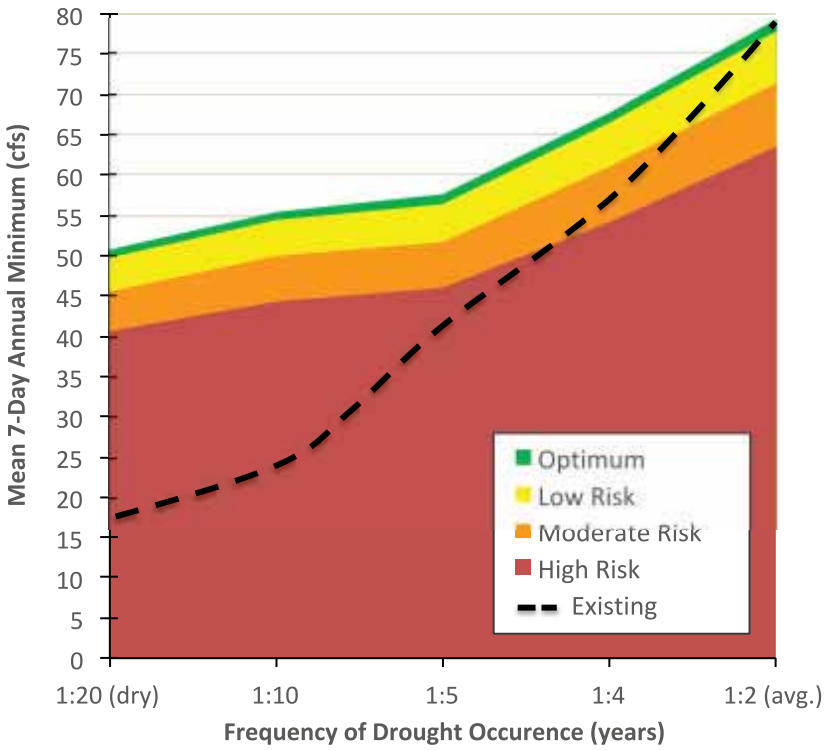


Figure 3-7: Ecosystem need shortages on the Crystal River below Thomas Road Bridge as described by application the SBA approach to the 7Q under different drought conditions.

3.3 OVERALL PATTERNS OF WATER USE

Assessments of ecosystem function, water management and use identified the prominent limiting conditions for consumptive and non-consumptive use needs on the Crystal River. Significantly, reduced late summer baseflows in moderate and severe drought conditions and the resultant impacts on physical structure and aquatic biota, particularly fish, constitute the most acute impairment of ecosystem function. Water use assessments conclude that agricultural use shortages impact users on tributaries more significantly than on the mainstem of the Crystal River. The most persistent shortages on the Crystal River mainstem are the CWCB ISF right, ecosystem needs computed as the 7Q, and the junior diversions on the Kaiser and Sievers and Bane and Thomas ditches. The alternative management strategies detailed in Section 4 respond to the overlapping themes and management prospects that emerged from reviews of water use patterns, legal and administrative considerations, and evaluations of ecosystem function.

4 ALTERNATIVE MANAGEMENT STRATEGY EFFECTIVENESS

Water is a limited resource, and balancing consumptive and non-consumptive use needs generally involves tradeoffs. This is certainly the case on the Crystal River where the most acute impacts on the ecosystem are tied to municipal raw water supplies and agricultural production. Identifying feasible management alternatives that respond to hydrological regime modifications and aquatic habitat quality required explicit consideration of the types and locations of existing water uses, and the frequency at which they experience shortages (Figure 4-1). Ecosystem and agricultural water demand shortages and irrigation system inefficiencies represent important opportunities and constraints for future actions designed to enhance support of ecosystem function without negatively impacting existing water users. In this vein, the CRMP considered the relative effectiveness of the following management strategies for meeting the stated planning Goal:

- Market-based incentives for water conservation or bypass flows
- Infrastructure improvements and efficiency upgrades
- Reservoir construction
- Habitat enhancements and channel modification projects

Effectiveness characterization for each of the above management strategies relied heavily on application of the EcoDSS to evaluate two primary assessment criteria: 1) the magnitude, frequency, and duration of ecological lift brought about by a given change in management, and 2) the severity and frequency of water use shortages that result from strategies that support or enhance ecosystem function.

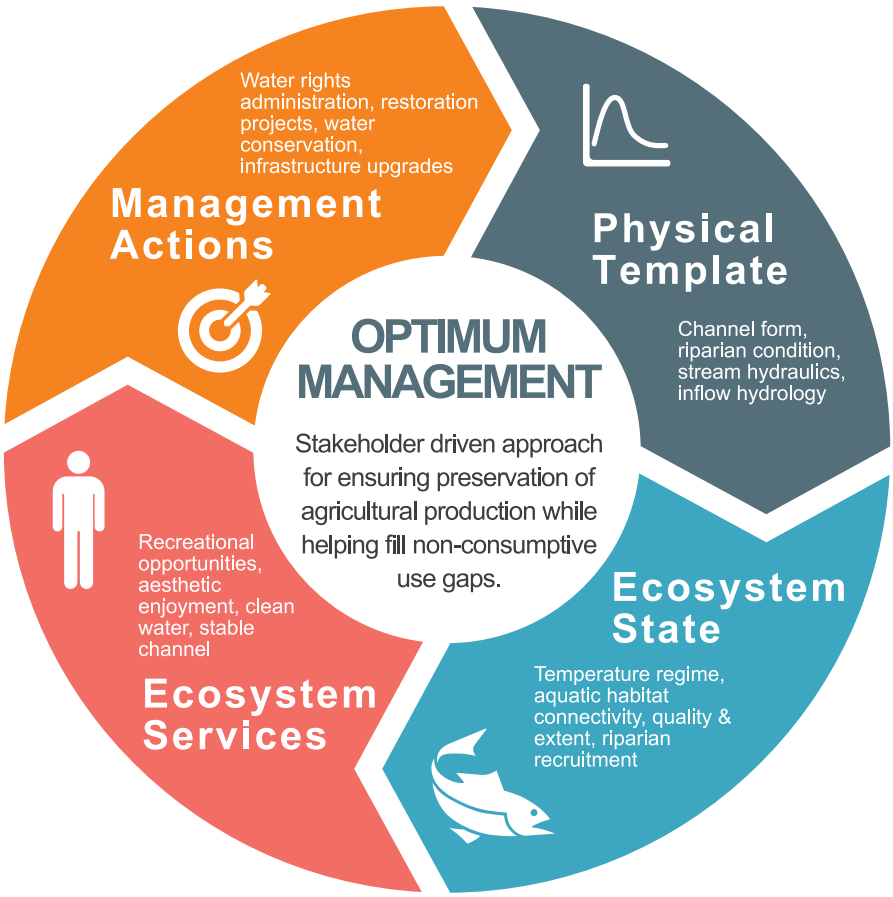


Figure 4-1: Changes to the physical components of river systems alters ecosystem dynamics associated with the delivery of EGS. Where the community perceives diminished EGS, consideration of alternative management strategies is necessary to affect physical conditions in a manner that promotes more desirable ecosystem behavior



4.1 MARKET BASED STRATEGIES



4.1.1 Non-Diversion Agreements

Non-diversion agreements compensate agricultural water users for bypassing varying quantities of water otherwise destined for fields and pastures. This approach assumed no formal water leasing through the CWCB instream flow program or shepherding of water downstream past junior users. **Bypass terms approximated a "gentleman's agreement" where leased water remained instream and was available to junior water users both upstream and downstream from the point of diversion**. Depending on the efficiency of a given diversion system and the size of the bypass, voluntary diversion reductions can negatively impact the productivity of irrigated agriculture. Therefore, appropriate compensation terms must be reached to ensure a net benefit to participating agricultural users. The fact that bypassed water is available to junior water rights in the system constitutes a net benefit to other agricultural or municipal users. Depending on the orientation of bypass flows and the junior users that consume them, ecosystem use needs may incur some benefit or see further impairment.

The most effective application of this simulated approach on the Crystal River bypassed water from large senior and junior water users between the Sweet Jessup Canal and the Rockford Ditch. Bypass flows on the order of 10-18% of average diversion rate from several of the larger diversions in this focus area (e.g. Sweet Jessup Canal, East Mesa Ditch, Ella Ditch, and Lowline Ditch) generated significant benefits to aquatic habitat availability during moderate drought in the most heavily impacted sections of River (Figure 4-2). Simulated diversion bypasses did increase shortages for some producers. Unfortunately, the assessment could not evaluate terms of an Agreement that would compensate users for participation (because those terms have not been worked out), prohibiting a complete evaluation of agricultural effectiveness.

4.1.2 Short-Term Water Leasing

The Colorado Water Trust (CWT) works with the CWCB Instream Flow Program to implement short-term water leasing contracts that temporarily transfer part or all of a water right to an adjudicated instream flow. Water leasing programs aim to benefit ecosystem function by shepherding leased water past junior users to the point of historical groundwater return flow. Lease contracts require agricultural producers to fallow

a portion of irrigated land commensurate with the quantity of leased water. Therefore, appropriate compensation terms ensure a net benefit to both ecosystem needs and agricultural users.

Modeling investigations assessed outcomes associated with full-season and split-season leasing arrangements with large senior water rights holders on the Crystal River. The most effective leasing opportunities simulated on the Crystal existed upstream of the Carbondale and Rockford ditches in the late summer. Split season leasing arrangements with one or more users that cumulatively contributed between 15-30 cfs to river baseflows in August and September significantly improved aquatic habitat quality and reduced ecosystem risk associated with hydrological regime modifications during moderate (1-in-5 to 1-in-10 year) drought conditions. The fact that leased water was unavailable to junior water rights in the system produced no net benefit or loss to other agricultural or municipal users. These users continued to operate within the system as they otherwise would have in the absence of the leasing arrangement. Due to their voluntary nature, leasing contracts will only occur where water rights holders receive some net benefit (financial, emotional, etc.).

4.2 CONSERVATION BASED STRATEGIES



4.2.1 Ditch Lining

Ditch lining or piping increases conveyance system efficiency by reducing seepage loss, evaporation, and transpiration by phreatophytes. Converting an earthen ditch to a concrete ditch or pipeline conserves up to 30% of diverted water, depending on soil type, ditch length, and canal geometry (Table 3-1).[6] This type of infrastructure upgrade represents a relatively permanent conservation measure. Benefits of conservation accrue mainly to water users served by a ditch system by reducing the likelihood that they are affected by shortages. If users choose to leave conserved water in the stream (e.g. under a Non-Diversion Agreement) it can additionally benefit junior water users and ecosystem function. A notable ecosystem impact to ditch lining or piping includes the desiccation of cottonwood galleries and wetlands supported by seepage.

The EcoDSS approximated reductions in conveyance system incidental losses based on the length of ditch between the headgate and the turnout to the receiving farm or ranch. Modeling did not assess the effects of on-farm conveyance system improvements. All conservation gains accrued back to the river at the point of the surface water diversion. Simulations showed that non-consumptive water uses benefit little if lining or piping occurs on ditches low in the watershed or those with large senior rights because upstream junior users consume the conserved water to alleviate demand shortages. Ditch system upgrades yield the largest ecosystem benefit when applied to large diversions that convey junior water rights. Most of these are not positioned appropriately in the watershed to produce benefits in the most impacted reaches of Crystal River. Lining or piping all ditches in the watershed did provide widespread ecosystem benefits in the most critical time period (August-September) under moderate or severe drought (Figure 4-2). Widespread infrastructure upgrades also tended reduce agricultural use demand shortages experienced by junior users

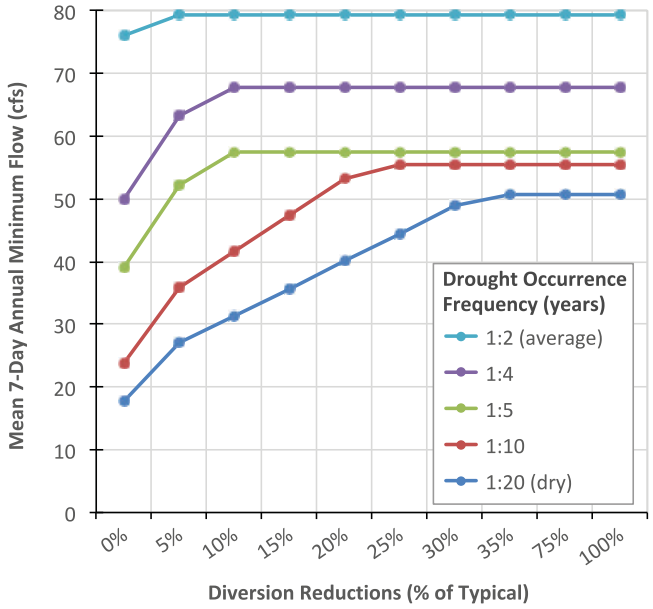


Figure 4-2: Changes in 7Q at the Thomas Road Bridge as a function of diversion reductions. Diversion reduction may be achieved through Non-Diversion Agreements, conservation gains resulting from ditch lining or sprinkler irrigation, or a combination of the two. Upper inflection points on the 7Q curves indicate a transition to optimal hydrological regime behavior

on the mainstem of the Crystal River. The EcoDSS predicted modest reductions in late season return flows below the CPW fish hatchery in the fall and winter months as a result of lining all earthen ditches in the watershed.

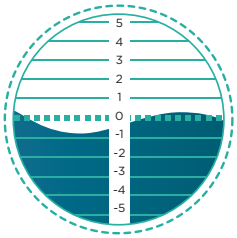


4.2.2 Sprinkler Irrigation

Conversion from flood irrigation to sprinklers reduces seepage loss, evaporation from ponding, and surface water runoff. Shifting to more efficient water application methods conserves up to 50% of diverted water, depending on soil type, irrigated acreage, crop type, and local topography (Table 3-1).6 Benefits of conservation accrue mainly to water users implementing sprinkler irrigation on their property. Water conservation reduces the likelihood that a user is affected by water shortages, but does come with increased maintenance and energy costs in many cases. If users choose to leave conserved water in the stream it can benefit junior water users and ecosystem function.

The EcoDSS approximated reductions in groundwater infiltration and hydraulic push-water requirements achieved

by conversion to sprinkler irrigation. All conservation gains accrued back to the river at the point of surface water diversion. Similar to ditch lining, this scenario yielded little benefit to non-consumptive water uses when conversion to sprinkler irrigation occurred on parcels served by ditches low in the watershed or those served by large senior rights. Water application method upgrades yielded the largest ecosystem benefit when either applied to large irrigated parcels served by junior diversion rights high in the watershed or when applied to all parcels currently utilizing flood irrigation. Simulation of widespread conversion to sprinkler did predict widespread ecosystem benefits in the most critical time period (August-September) under moderate or severe drought (Figure 4-2). Reductions in late season return flows that negatively impact ecosystem needs in the fall and winter months are modest in comparison to the gains achieved through conservation.



4.2.3 Irrigation Scheduling

Irrigation scheduling refers to the practice of calculating and applying only the amount of water required by a crop. This approach can reduce surface water diversion requirements by: 1) reducing surface water runoff, 2) limiting deep percolation below the root zone, 3) decreasing evaporation and ponding, and 4) reducing crop evapotranspiration during non-sensitive life stages by controlling soil water depletion.2 Several manual or modeling based approaches exist for calculating the quantity and timing of irrigation needs for various crop types in Colorado. Agricultural producers use this approach as a means for reducing water requirements without decreasing yields.2 Successful implementation requires measurement devices for ascertaining water application quantities and/or infiltration depths. The wide variety of techniques available for assessing soil and crop water needs produces substantial variability in the water savings produced by this approach. If users choose to leave conserved water in the stream it can benefit junior water rights and ecosystem function. If applied broadly throughout a watershed, irrigation scheduling can reduce the occurrence frequency of water shortages.

Simulation of irrigation scheduling in the EcoDSS indicated opportunity for modest reductions in the frequency and magnitude of shortages experienced by junior water users and the CWCB ISF in the Crystal River. Of course, this was only the case when simulations allocated conserved water back to the point of surface water diversion to make it available to other users in the watershed. Use of conserved water to two large upstream diversions (e.g. Sweet Jessup Canal and East Mesa Ditch) to compensate for shortages in dry years negated any ecosystem benefit realized by this management strategy (Figure 4-3).

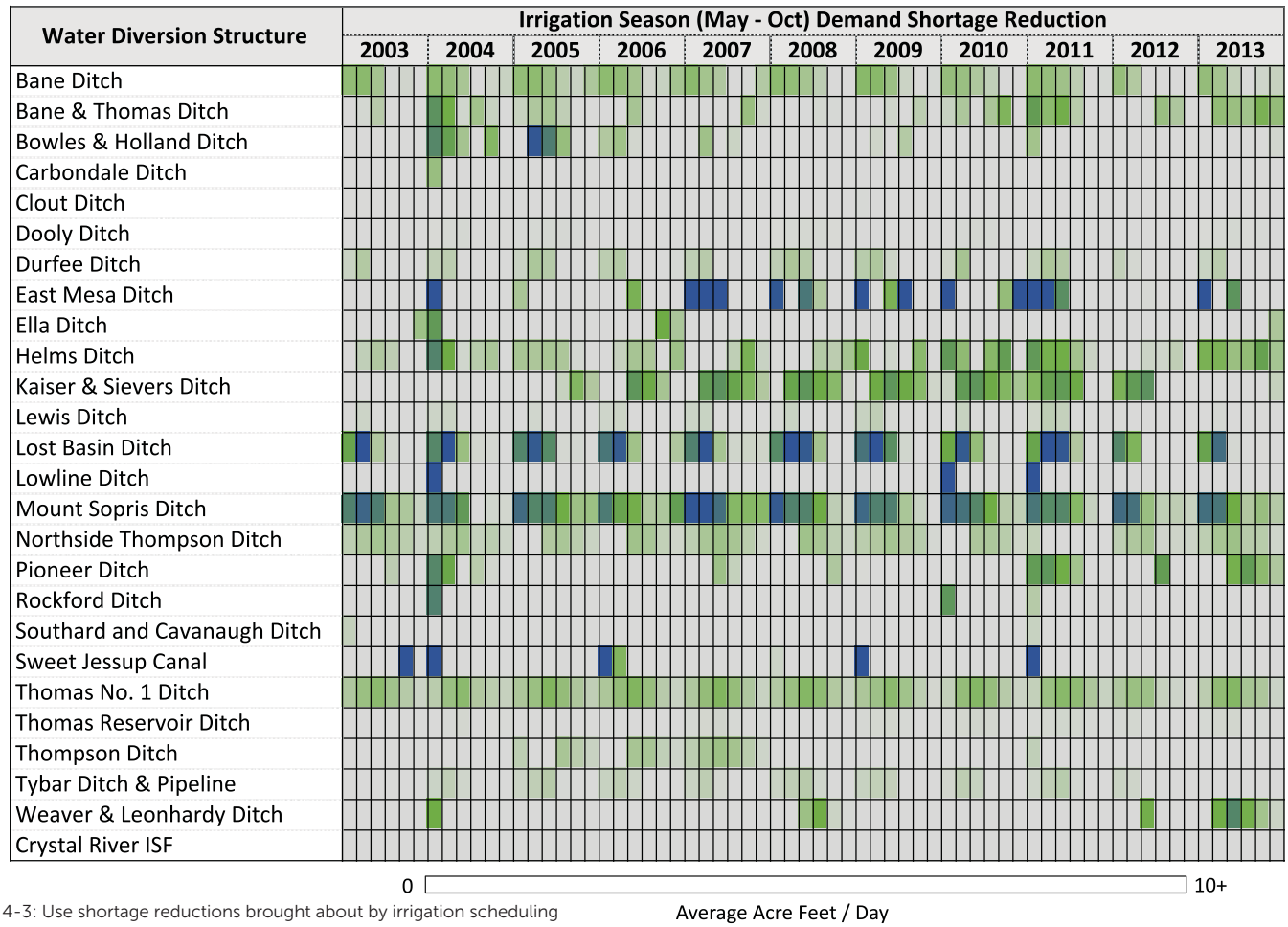


Figure 4-3: Use shortage reductions brought about by irrigation scheduling

4.3 SUPPLY BASED STRATEGIES



4.3.1 Off-Channel Reservoir

Reservoir development is a typical management response to resolving water demand shortages. Reservoirs impound water during snowmelt runoff when peaking streamflows constitute an abundant water supply for downstream users. During late-summer baseflow periods when hydrological conditions and use pressures create consumptive and non-consumptive use need shortages, reservoirs release stored water back into the system to partially or fully satisfy those demands. The transiting of water from the reservoir site to downstream user may provide incidental ecosystem benefits on intermediate stream reaches. The benefit of water storage to consumptive uses is generally a function of a reservoir's position in the stream network, the seniority of the storage right, and the projected water yield. Non-consumptive use benefits produced by reservoirs are less straightforward. Dams create longitudinal discontinuities in a river network that disrupt the flow of organisms, sediment, and energy that may negatively impact channel evolution, morphology, and the distribution of aquatic biota. These impacts may be offset where the most significant downstream ecosystem impairments occur due to late-summer water depletions. Notably, small water storage projects are listed as a priority in the 2015 Colorado Water Plan and, therefore, may enjoy a broad base of support among water planning and administration agencies/organizations at the regional and state level.

A water supply alternative tested by the EcoDSS simulated the development of a reservoir on North Thompson Creek. The reservoir's firm yield was estimated at 3,000 AF in keeping with previous planning and water availability studies.[4,5] The reservoir provided 25 cfs to downstream users for 60 days during the late-summer period (August-September) where the most acute non-consumptive use need appear. Shepherding the released flows to the DWR streamgauge at the CPW fish hatchery provided significant benefit to aquatic habitat quality and extent. Alternatively, if some or all of the released water was allocated to users on Thompson Creek or as augmentation supply to support out-of-priority diversions by a junior user in the Crystal River above the confluence with Thompson Creek, the benefits to ecosystem function rapidly declined.

4.4 CHANNEL MODIFICATION STRATEGIES



4.4.1 Grade Control Structures

In places where water users rely on temporary push-up dams to force water toward surface water diversions, some localized impacts to habitat connectivity occur. Construction of push-up dams also requires significant investments of time and energy to create and maintain them throughout an irrigation season. Installation of permanent grade control structures may reduce impacts to aquatic habitat and simultaneously decrease work requirements by water users to maintain headgate effectiveness.

Evaluations of grade control structure designs through application of the EcoDSS confirmed moderate benefits to aquatic habitat quality and availability at late-summer streamflows experienced during moderate and severe drought (Appendix A, E). The Carbondale Ditch and Kaiser and Sievers headgate locations are most amenable to construction of grade control structures. Aggrading bedforms in the vicinity of the Lowline Ditch headgate mean installation of a grade control at this location will likely require significant maintenance.



4.4.2 Inset Channel

Modifications of river channel structure represents an appealing and often-contemplated method for resolving ecosystem needs on rivers where alternative water management solutions are either infeasible or unpalatable to local water users. Inset channel design represents one approach for "fitting" the river to the modified hydrological regime where the greatest constraints on ecosystem function occur during late-summer baseflows. Inset channels create a preferential pathway for water to move along during periods of low flow. This pathway is narrower and deeper than the main channel. Inset channels are designed to maintain habitat quality and availability by creating deeper pools, runs and glides and limiting extreme temperature variability caused by large width-depth ratios.

Assessment of inset channels through the EcoDSS indicated limited benefits to ecosystem function. The Crystal River has a relatively steep grade. Simulation of inset channels indicated a significant increase in channel velocities and subsequent degradation of aquatic habitat. Furthermore, the high bedload transport regime present on the River will likely result in significant ongoing maintenance requirements for designed channels.



4.4.3 Fish Habitat Enhancements

An alternative to inset channel design exists in the form of fish habitat enhancements. Artificial, hardened structures aim to create deep scour pools and eddies—important holding habitat for adult trout—on reaches where a modified hydrological regime reduces the physical complexity of the channel. The enhancement of fish habitat quality can help mitigate the impacts of reduced streamflows during low flow periods. Habitat enhancement projects must pay special attention to the background bedload sediment transport

regime and the hydraulic characteristics of the designed channel to ensure adequate conveyance of sediment through the project area and anticipate ongoing maintenance requirements. Hardened structures may also produce unintended consequences for channel evolution and morphology—important functional components of the ecosystem.

Predictive modeling of the impact of fish habitat enhancement projects on the Crystal River indicates a two to three-fold gain in high quality habitat availability at flows below 20 cfs. The benefit decreases to approximately a 1-fold gain in habitat as flows approach 100 cfs. This pattern indicates that structural modification of the stream channel may represent a practical management approach for resolving non-consumptive use shortages on the lower Crystal River. Fishery habitat enhancement may be used alone or in concert with other water management approaches to alleviate impairments to hydrological regime and physical structure that may represent important bottlenecks for ecosystem function. To achieve the largest gains in aquatic habitat, structures on the Crystal River need to be closely spaced. As is the case with inset channels, high bedload transport rates may result in significant ongoing maintenance requirements for designed channels.



5 IDENTIFIED MANAGEMENT PRIORITIES

The CRMP considered the relative effectiveness of a wide array of market-based programs, efficiency measures, water supply projects, and channel modifications for achieving the project Goal. Unfortunately, no single option represented a panacea for meeting all existing needs and addressing observed ecosystem impairments. Each alternative was associated with a unique set of environmental, capital, and social costs and benefits. In order to align planning recommendations with local preferences, the CRMP relied on a facilitated stakeholder process to consider the relative effectiveness and feasibility of the various management alternatives. Resource experts and stakeholders that participated in this process included representatives from the following:

- Crystal River Valley Water Rights Holders/Agricultural Producers
- Colorado Division of Water Resources
- Town of Carbondale
- United States Forest Service
- River Valley Ranch
- Coryell Ranch
- Crystal Valley Environmental Protection Association
- Colorado River Water Conservation District
- Natural Resources Conservation Service
- Pitkin County Open Space and Trails
- American Rivers
- Colorado Parks and Wildlife
- Trout Unlimited

Stakeholders considered alternative management strategies in the context of the overarching Goal. Characterization of management alternative effectiveness considered the relative and absolute gains in aquatic habitat quality on the Crystal River between the Sweet Jessup Canal and the Roaring Fork River in moderate and severe droughts between July and October. Considerations of feasibility explored political will, capital and ongoing maintenance costs, administrative and legal constraints, community expectations for water use, and the potential for leveraging existing projects or plans (Figure 5-1). Final assessment and prioritization of management actions factored in the degree to which each action balanced agricultural production, existing water use needs, and the ecological integrity of the River. From this process, two alternatives emerged as the most viable short-term strategies for managing consumptive and non-consumptive use needs:

- A market-based solution promoting bypass flows between Sweet Jessup Canal and Carbondale Ditch
- A combination of ditch-lining and short-term water leasing by the Town of Carbondale on the Carbondale Ditch and Weaver and Leonhardy Ditch.

These flexible alternatives maximize ecological lift, ensure positive benefit to affected water users, and rely on realistic funding mechanisms for implementation. The discussion below represents a consensus-based prioritization of short-term management actions for the Crystal River.

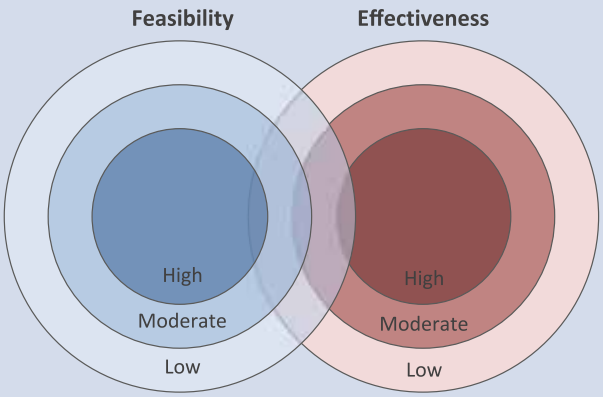


Figure 5-1: The most effective management options are rarely the most feasible. Optimization of management generally reflects some degree of compromise between the two

5.1 NON-DIVERSION AGREEMENTS FOR AGRICULTURAL USERS

Market-based solutions for water management exhibit a high degree of flexibility both in their structure and implementation. The ability to implement market-based solutions periodically and only during times of acute need make them ideally suited to resolving late-season low flow issues on the Crystal River. Stakeholders indicated strong preference for informal market-based strategies that do not require filings in Water Court. In response to this local interest, the Colorado Water Trust (CWT) developed a Non-Diversion Agreement framework to bypass flows past headgates located between the Sweet Jessup Canal and the Carbondale Ditch. The framework intends to maintain streamflow in critical reaches at, or above, a target streamflow during July, August and September in moderate (e.g. 1-in-5 or 1-in-10 year) droughts. CWT proposes compensation for willing water users who reduce diversion amounts in order to meet the target flow. Market-value compensation will reimburse water users for each 1 cfs of verified diversion reduction per day. The framework caps payments to individual water users relative to their total diversion right such that a single user does not deplete the total funding allocated to the program. This feature is meant to encourage the broad participation necessary to maximize ecological lift. The framework reimburses users for new diversion reductions until one of the following occurs: a) the program fund is exhausted, b) the target flow is met, or c) the month of September ends.

CWT's framework for Non-Diversion Agreements is neither a water transfer, nor a water lease, and does not require a Water Court filing or Division of Water Resources (DWR) administrative approval. To protect water rights from future challenge, participants will be enrolled in a Senate Bill 13-019 regional water conservation program through the Colorado River Water Conservation District. Any water rights holder upstream of Thomas Creek may voluntarily participate in the program. However, the most effective implementation requires broad participation by senior and junior rights in the target area. As noted previously, without participation of junior users, implementation of a non-diversion agreement on a senior water right may result in use of that water by an upstream junior user. This undesirable scenario may actually work to intensify constraints on ecosystem function on critical reaches of the Crystal River during low flow periods.

As a practical matter, Non-Diversion Agreements require a threshold condition to trigger their implantation. Typically, setting environmental flow targets involves integrating a river's physical processes and specific biological, physical, hydrological, and geomorphological requirements with the water use needs and values of the stakeholder group. The environmental flow setting approach utilized by stakeholders during development of the CRMP considered hydrologic metrics relevant to aquatic habitat quality during periods of low flows. Stakeholders accepted the 7Q as the hydrological metric of interest and indicated tolerance for moderate ecosystem risk under average to moderate drought conditions (Figure 5-1). In the driest years, this management target seeks flow augmentation through Non-Diversion Agreements of approximately 25 cfs. In moderate drought, Agreements will target bypasses on the order of 10-15 cfs. Reaching these targets will require diversion reductions between 5-18% (depending on drought severity) by a majority of the water users on the Crystal River mainstem above the Carbondale Ditch. Critically, any quantity of diversion reduction that elevates the 7Q above 15 cfs produces measureable benefit to the Crystal. Therefore, the success of Non-Diversion Agreements is not contingent upon attaining the full target bypass rate. Historical and simulated hydrological conditions indicate that diversion reductions for a period of thirty or more days may be required to completely satisfy program goals.

5.1.1 Examples of Similar Programs

Non-Diversion Agreements and water leasing programs are currently used in other Colorado basins for supporting critical water use demands that otherwise experience shortage under normal administration. While these examples fail to provide perfect examples of the program developed for the Crystal River, they are instructive in their details and successes.

1. The North Sterling Irrigation District (NSID) maintains a 25 year agreement with Xcel Energy to lease agricultural water on an as-needed basis for the Pawnee Power Plant in Brush, CO.56 Landowners within the District willing to lease water formed the Point of Rocks Water Company, LLC to facilitate the agreement. As part of the agreement, Xcel Energy may request up to 3,000 AF of consumptive use water between November and March each year. In exchange, landowners receive an annual base payment for participation in the program, regardless of whether water is requested. Xcel provides additional payment to the NSID and Point of Rocks Water Company members if water is delivered to the Pawnee Power Plant.

2. Landowners on Ohio Creek in the Gunnison River Basin partnered with Trout Unlimited, the Natural Resources Conservation Service, the Colorado River Water Conservation District, Gunnison River Water Conservation District, and the CWCB to improve the existing irrigation delivery system and water management in the Upper Ohio Creek Valley. Water users installed remote headgate monitoring equipment, converted a remote parcel from flood to sprinkler irrigation, developed and coordinated irrigation management plans to better match diversions and water delivery with crop demands during drought periods. Voluntary diversions reductions of up to 25% bypass water to support environmental uses. The project aims to increase minimum streamflows, improve water quality, and protect aquatic habitat in Castle and Ohio Creeks below the Acme Ditch.

5.1.2 Feasibility and Next Steps

CWT's proposed diversion reduction program is amenable to key agricultural interests in the Crystal River Valley insomuch as it provides financial incentive for participation and legal protections for water rights holders. In September 2013, CWT made a temporary agreement with seven landowners to test the management outcomes of voluntary diversion reductions on flows in the Crystal River. The framework agreement presented here builds on that initial work. The approach capitalizes on the effectiveness of market-based solutions to successfully respond to competing stakeholder interests. It also provides the necessary legal protections to water rights holders in the form of enrollment in a regional water conservation plan to ensure existing rights are not diminished in Water Court due to periods of reduced use. Appropriate pricing of water for reimbursements to agricultural producers is critical to ensuring no net loss to those water users. The impact of diversion reductions on agricultural production is a function of the water conveyance application inefficiencies present on a given ditch. Large diversion rights or high efficiencies promote large tailwater return flows from some ditch systems. Diversion reductions implemented on these systems may decrease total water deliveries in a way that diminishes tailwater returns without significantly impacting the quantity of water applied to a field to meet crop needs. Where users elect to implement efficiency upgrades and participate in Non-Diversion Agreements, compensation provided by the CWT program may be used to offset capital expenditures on those infrastructure improvements.

Successful implementation of this high-priority management alternative relies on the following actions:

- Enrollment of a significant number of water rights holders with diversion rights between the Sweet Jessup Canal and the Carbondale Ditch.
- Identification of appropriate water pricing strategies for the Crystal River.
- Development of a method to verify diversion reductions at the headgate on a daily or weekly basis.
- Development of methods and models to compute expected daily diversion rates based on a wide range of historical conditions and administration under Colorado Water Law.
- Development of methods and models to verify that diversion reductions are not an artifact of standard agricultural practices (e.g. cutting hay).
- Development of appropriate stream gauging infrastructure to identify important management triggers and thresholds

If CWT cannot implement the above actions or secure widespread participation in non-diversion agreements, short-term split season leasing of senior water rights under the CWCB Instream Flow Program represents a viable market-based alternative. Short term leasing of water from the Sweet Jessup Canal or the East Mesa Ditch would yield the largest ecosystem benefits. Return flows from these ditch systems accrue to the Roaring Fork River. Therefore, any leased water on the Crystal would be shepherded along the entire length of the river to its confluence with the Roaring Fork. Leasing monies transferred to water users can be used to support infrastructure maintenance and upgrades or compensate for any drop in agricultural yield caused by diversion reductions.

5.2 TOWN OF CARBONDALE CONSERVATION AND EFFICIENCY PLANNING

The Town of Carbondale must work to match conservation and management measures implemented by the agricultural community. Doing so will leverage stakeholder investment in the planning processes and demonstrate the community's willingness to participate in important local environmental issues. According to Carbondale's Municipal Water Efficiency Plan,17 the Town's total water rights are sufficient to meet future water demand forecasts if no conservation occurs. Regardless of sufficient supply, Carbondale set a potable water efficiency goal of 2% savings per year until 2050, demonstrating commitment to efficient resource use. While this represents an admirable conservation goal, it does not apply to the majority of surface water diverted by the Town and used to support trees, green lawns and landscaping in parks and along transportation corridors. The Municipal Water Efficiency Plan does identify the need for improved infrastructure and efficiency in raw water conveyance systems. The Town commonly lines portions of ditches and laterals when they are impacted by a development project. The CRMP recommends that the Town make lining a considerable portion of the remaining earthen ditch sections a high priority action item. This can best be achieved by ensuring that ditch lining is considered in all future relevant development review processes or during design and planning for sidewalks, parks, and other public spaces.

Currently, the Town does not charge residential customers for raw water usage from the ditch system. This makes incentivizing water conservation in times of shortage difficult. Metering use from ditches throughout Town is likely cost-prohibitive. Therefore, a more promising avenue for bringing market forces to guide water use by residents is to curtail raw water supplies during times of drought. Surface water diversion reductions by the Town of Carbondale in drought years would force more residents to water lawns and gardens with treated water, which is subject to tiered rate structures that disincentivize wasteful or inappropriate use. Bypass of water past the Town's surface water diversions should be formalized through short-term leasing agreements under the CWCB Instream Flow Program. Without leases in place, conserved water would be used by upstream junior users, exacerbating low flow conditions in the critical reaches of the Crystal River.

5.2.1 Feasibility and Next Steps

Town of Carbondale planning documents indicate political will exists to implement recommended water conservation actions. Reducing raw water supply in drought years, thereby forcing more residents to use treated water, will increase awareness of water supply issues in times of scarcity. Shifting users to a metered system will also generate revenue for the Town's utility department, which can be used to fund water conservation measures in other parts of the ditch system. Lining ditches should decrease ongoing maintenance costs for water conveyances, yielding additional financial benefit to the Town over the long run. Carbondale's support of strategic conservation projects and partnerships is critical to comprehensive efforts to optimize use of limited water supplies in the Crystal River Watershed.

Successful implementation of this high-priority management alternative requires Town staff and elected officials to complete the following actions:

- Develop short-term leasing arrangements under the CWCB Instream Flow Program with groups like the Colorado Water Trust.
- Consider the methods available to quantify crop "dry-up" in municipal spaces and private properties affected by water leasing terms.
- Characterize of the potable water supply's ability to support additional outdoor irrigation use in times of drought.
- Consider the revenue implications of increased potable water use in dry years.
- Consider an equitable cost sharing programs for raw water users to help support conservation upgrades and of the Town's ditch system.

5.3 FUTURE CONSIDERATIONS

The high-priority management actions identified above are favorable and appear feasible on relatively short planning horizons. Additional management solutions may play important roles in optimizing water uses to support agricultural, municipal, and environmental needs over the long term. Their consideration on the Crystal River largely depends on identification of appropriate funding mechanisms to support their implementation.

5.3.1 Channel Modification Projects

Structural enhancement projects on the River can improve adult trout habitat quality during low flow periods. This type of project would be most effective in the area between Thompson Creek and the CPW Fish Hatchery, and would be somewhat beneficial between the hatchery and the Kaiser and Sievers Ditch headgate (Figure 5-2). Recent cost estimates for constructing artificial fishery habitat on the Crystal River ranged from $215-245 per linear foot.42 The relatively high cost of this project type represents a barrier to implementation; although, granting programs like Great Outdoors Coloraodo (GOCO) may present a viable funding option for channel modifications completed on public property. Characteristics of the natural sediment regime also necessitate careful planning and design to minimize long-term maintenance costs and ensure that changes in channel hydraulics do not negatively impact riparian communities, channel morphology, and channel evolution.

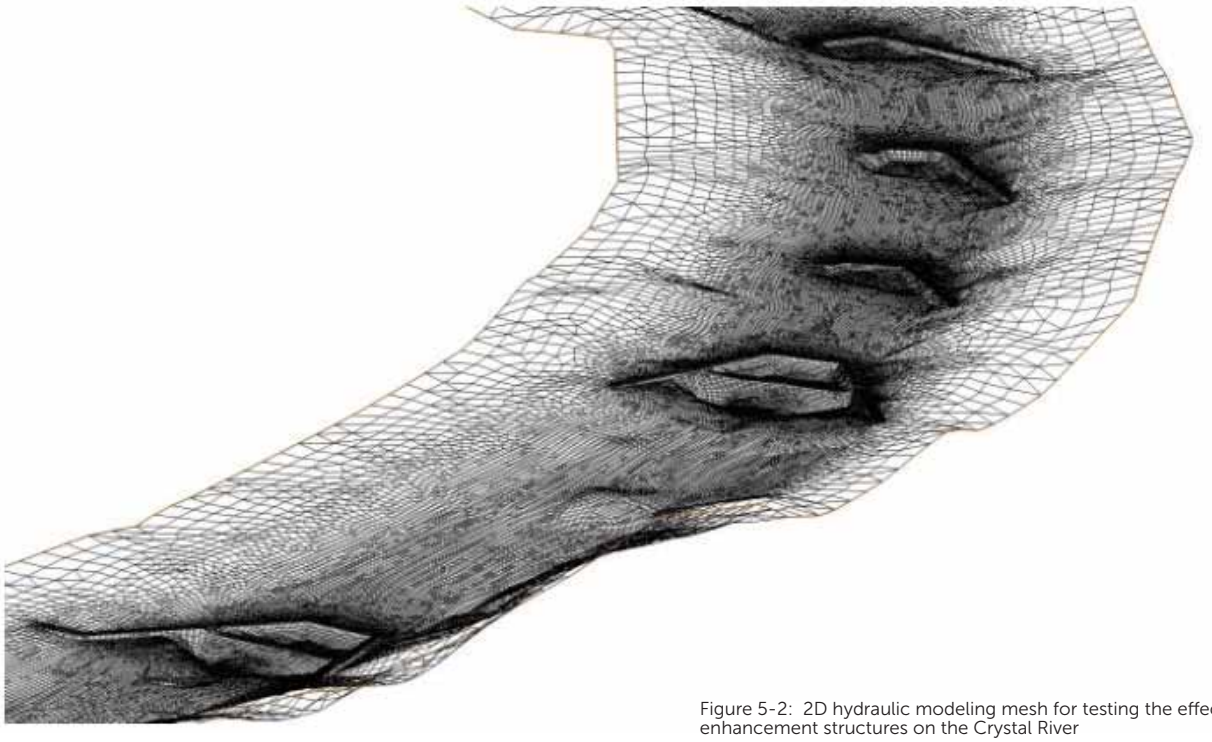


Figure 5-2: 2D hydraulic modeling mesh for testing the effectiveness of artificial habitat enhancement structures on the Crystal River

Installation of grade control structures at the headgates for the Carbondale Ditch and Kaiser and Sievers Ditch will reduce annual maintenance costs by limiting the need for push-up dams at these locations. When designed properly, grade-control structures also reduce aquatic habitat fragmentation and improve aquatic organism passage, yielding a net benefit to ecosystem function. Depending on site conditions and design elements, development of grade controls may approach $100,000.52 High bedload transport on the Crystal River may necessitate some ongoing maintenance of these structures to ensure they continue to function as originally designed. Future consideration of grade control structure development should focus on funding sources. The Colorado River Water Conservation District (CRWCD) and the Natural Resource Conservation Service (NRCS) both offer granting programs to support this type of agricultural infrastructure development. Design and installation of a grade control structure at the Carbondale Ditch may necessitate complex permitting and contracting arrangements due to the fact that the Town's headgate is located on private property. The NRCS is a logical source of funding for a project of this scale, but that agency cannot contract with municipal entities. Therefore, the property owner where the headgate is located would need to act as the fiscal agent and contractee for the project.

5.3.2 Off-Channel Reservoir

Development of a 3,000-5,000 AF reservoir on Thompson Creek may provide opportunity to alleviate existing consumptive use shortages and, simultaneously, improve ecosystem condition. Late season releases could significantly improve ecosystem impairment caused by severe flow depletion on Thompson Creek. Depending on the location of the downstream use, water from the reservoir could help meet identified late-season low flow targets on the Crystal River mainstem. Reservoir development requires overcoming several financial, administration, legal, and public interest barriers. Capital costs for a project of this size in the Thompson Creek watershed are estimated at $9.75 million.35 Due to possible reservoir siting on public lands, the permitting and approval process for a potential reservoir could be lengthy and may face opposition from groups concerned with associated environmental impacts. Additional costs may come in the form of private land purchases, water rights acquisitions, and planning study updates. Water from this reservoir could cost as much as $3,200 per acre-foot. Annual dam operations, inspections, and maintenance/repair costs may serve to increase this figure. During development of the Plan, no user in the Crystal River watershed indicated that these costs were reasonable for local agricultural producers. It is also likely that costs would prohibit securing reservoir releases exclusively for environmental uses. However, downstream junior users in the Colorado River basin may see its benefits as an augmentation supply. Future consideration of off-channel reservoir development in the Crystal River watershed should begin with conversations between local agricultural producers, conservation groups, representatives from the CRWCD, and the owner(s) of conditional storage water rights in the Thompson Creek watershed. These conversations should focus on estimated costs and timelines for reservoir development, anticipated or expected water use demands on the Crystal River and elsewhere that might benefit from water storage, and the willingness of various parties to pay for that stored water.

5.3.3 Ditch Lining and Sprinkler Irrigation

Despite the predicted benefits that water efficiency upgrades can provide to agricultural producers in the form of reduced severity and frequency of shortages in dry years, the high costs associated with these upgrades makes them difficult for individual water users or small ditch companies to implement. The NRCS estimates capital costs of sprinkler system installation to be $17 to $75 per linear foot. Ditch lining estimates range from $5-100 per linear foot for HDPE or flexible piping, materials commonly used in this area in projects attempting to eliminate water conveyance losses. Actual costs can vary widely based on materials, labor, and installation, and specialized additional requirements or engineering.52 A recent piping project on the Bowles and Holland Ditch cost approximately $100/ft, while a more complex piping effort on the East Mesa Ditch approached $400/ft. Capital expenditures may be offset by the reductions in ongoing maintenance and operation costs accrued to a water user or ditch company. To make widespread water infrastructure improvements a viable option for improving ecosystem function on the Crystal River, local water users must have access to a reliable funding source. During development of the Plan, local water users expressed interest in exploring the possibility, desirability, and feasibility of securing a dedicated fund for financing infrastructure improvements. Local conservation organizations promoting alternative water management on the Crystal River should investigate how such a fund could be managed, supported by grants and/or philanthropic gifts, and distributed among local users. Water conservation groups may need to further incentivize infrastructure projects by acting as the fiscal agent for infrastructure project contracts.

In order for efficiency upgrades to benefit the ecosystem and other users, conserved water must be left in the stream. Widespread perceptions regarding risk of water right abandonment and a general lack of appropriate incentives limit the likelihood that users bypass conserved water past headgates. Rather, efficiency upgrades typically benefit only the users they serve. Implementation of conservation measures under a regional water conservation plan created under Colorado Senate Bill 13-019 provides water users with the legal protections necessary to leave conserved water in the stream, consequence free. In this way, conservation gains can be shared among many local use needs. Conservation groups should actively work with the CRWCD to sign interested water users into the conservation plan. Before implementing infrastructure projects, attention should be given to the value the community places on cottonwood galleries, riparian zones, and wetlands created by ditch seepage that would otherwise be dried out by ditch lining or piping. Finally, strategies for bypassing conserved water past headgates must be carefully considered to ensure that potential use of conserved water by upstream junior users does not exacerbate existing impairments to the hydrological regime on critical reaches.

5.4 MOVING FORWARD

Changing demographics and local economies place increasing value on the Crystal River's aesthetic, environmental and recreational attributes while retaining important cultural ties to a strong heritage of agricultural production. Residents in the Town of Carbondale enjoy large shade trees, verdant gardens, and green open spaces supported by a free raw-water supply sourced from the River. Agricultural producers, in turn, depend on use of the Crystal River to support their livelihoods and maintain vast open spaces terraced along the flanks of Mount Sopris and across the valley floor. The convergence of multiple water use needs and water scarcity on the Crystal River during periods of drought leads to demand shortages for junior water users and impairment of various measures of ecosystem function.

Local recognition of these issues led to development of the Crystal River Management Plan as a tool for optimizing management decisions to support this wide array of community needs and environmental concerns. The findings and recommendations presented in the various sections of the Plan are summarized below:

- Few external stressors exist in the headwaters of the Crystal contributing to a generally healthy ecosystem above Redstone.
- Constraints on ecosystem function slowly increase in the downstream direction due to the cumulative effects of floodplain development and surface water diversions.
- The reaches of Crystal River between Thompson Creek and the confluence with the Roaring Fork exhibit the most degraded overall functional condition.
- Reductions in late summer baseflows produce cascading impacts on channel hydraulics, water temperature, and physical habitat quality and availability.
- Supply shortages on water-limited tributaries are common. Demand shortages on the Crystal River exist for the junior rights on the East Mesa Ditch, Sweet Jessup Canal, Helms Ditch, and Kaiser & Sievers Ditch. The CWCB ISF right is frequently short in late summer.
- Water efficiency upgrades (e.g. sprinkler irrigation and ditch lining) can significantly reduce the frequency and magnitude of demand shortages experienced by agricultural producers.
- The most feasible and effective management options for meeting planning goals include 1) Non-Diversion Agreements between the Sweet Jessup Canal and Carbondale Ditch, and 2) ditch lining and short term water leasing by the Town of Carbondale on the Carbondale Ditch and Weaver and Leonhardy Ditch.
- Non-Diversion Agreements of approximately 25 cfs in severe drought and 10-15 cfs during moderate drought will meet management goals for maintaining moderate risk to ecosystem function. Current conditions place the ecosystem at high risk for unfavorable change.
- Reaching management targets will require diversion reductions between 5-18% (depending on drought severity) between the Sweet Jessup Canal and the Carbondale Ditch.
- Stakeholders should continue to investigate the feasibility of stand-alone water efficiency infrastructure projects, off-channel reservoir development, and channel modifications to simultaneously promote ecosystem function and the long-term sustainability of local agricultural production.

Population growth trends indicate that the Town of Carbondale will experience a doubling in size in the coming decades. Projections from climate data indicate that climbing temperatures will shift the timing of snowmelt runoff and increase the frequency and severity of hot and dry summer conditions. These changes will place increasing strain on the riverine environment at the same time that demand shortages for existing uses become more common. Without tools and structured plans for responding to these challenges, tensions between stakeholders will continue to mount. This Plan recommends several high-priority actions for ensuring that the local community is adequately equipped to deal with shifting community values, economic foundations, and climate realities in a way that minimizes conflict between users groups and achieves high levels of environmental resiliency.

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CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT
CRYSTAL RIVER - CARBONDALE, CO
PRELIMINARY DESIGN SET - OCTOBER 2019

SHEET INDEX

SHEET NO.	SHEET TITLE
G01	COVER SHEET
G02	SITE PLAN & HORIZONTAL CONTROL PLAN
CW00	PROJECT ACCESS AND CARE OF WATER OVERVIEW - PLAN
CW01	RIFFLE AND DIVERSION STRUCTURE CARE OF WATER - PLAN
CW02	TYPICAL BANK CONSTRUCTION ISOLATION - PLAN
CW03	CARE OF WATER DETAILS
CW04	CARE OF WATER DETAILS
R01	RIFFLE AND GRADE CONTROL STRUCTURES - PLAN AND PROFILE
R02	RIFFLE AND GRADE CONTROL STRUCTURES - SECTIONS
R03	DOWNSTREAM CHANNEL - PLAN AND PROFILE
R04	DOWNSTREAM CHANNEL - SECTIONS
R05	UPSTREAM CHANNEL - PLAN AND PROFILE
R06	UPSTREAM CHANNEL - SECTIONS
BK00	BANK RESTORATION - OVERVIEW
BK01	BANK RESTORATION STA 21+71.0 - PLAN AND SECTIONS
BK02	BANK RESTORATION STA 23+81.0 - PLAN AND SECTIONS
BK03	BANK RESTORATION STA 25+86.0 - PLAN AND SECTIONS
BK04	BANK RESTORATION STA 27+78.0 - PLAN AND SECTIONS
BK05	BANK RESTORATION STA 29+77.0 - PLAN AND SECTIONS
BK06	BANK RESTORATION STA 33+15.0 - PLAN AND SECTIONS
L00	UPLAND IMPROVEMENTS - OVERVIEW
L01	ACCESSIBLE RAMP
L02	UPLAND IMPROVEMENTS
L03	UPLAND IMPROVEMENTS
L04	UPLAND IMPROVEMENTS
L05	UPLAND IMPROVEMENTS
L06	UPLAND IMPROVEMENTS
D01	UPLAND IMPROVEMENT DETAILS
D02	UPLAND IMPROVEMENT DETAILS
D03	UPLAND IMPROVEMENT AND RIVER ACCESS DETAILS
D04	WETLAND, TREE AND SHRUB PLANTING DETAILS
D05a	PLANTING AND SEEDING NOTES
D05b	PLANTING LIST AND SEEDING NOTES
D06	BANK RESTORATION DETAILS
D07	BOULDER CLUSTER DETAILS
D08	BOULDER GRADE CONTROL DETAILS
D09	ENGINEERED RIFFLE DETAILS
D10	MAINTENANCE ACCESS RAMP DETAILS
D11	GATE MODIFICATION DETAILS
D12	DIVERSION "ISLAND" REHABILITATION DETAILS

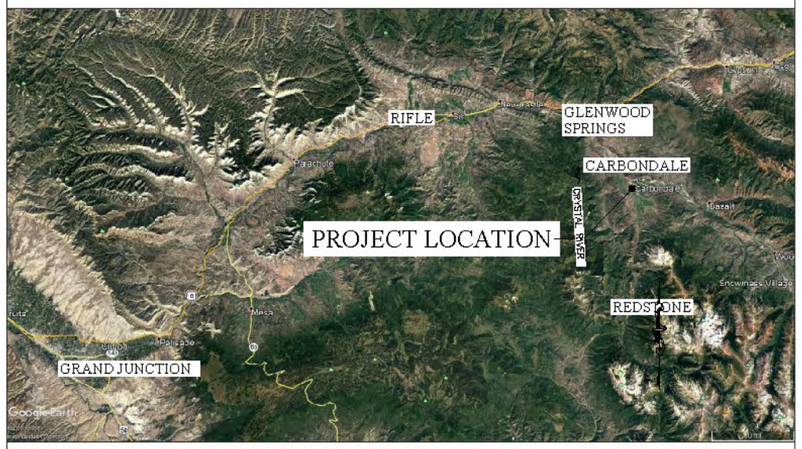
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LOCATION MAP



NTS

VICINITY MAP



NTS

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT
COVER SHEET

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

Town of Carbondale
511 Colorado Ave
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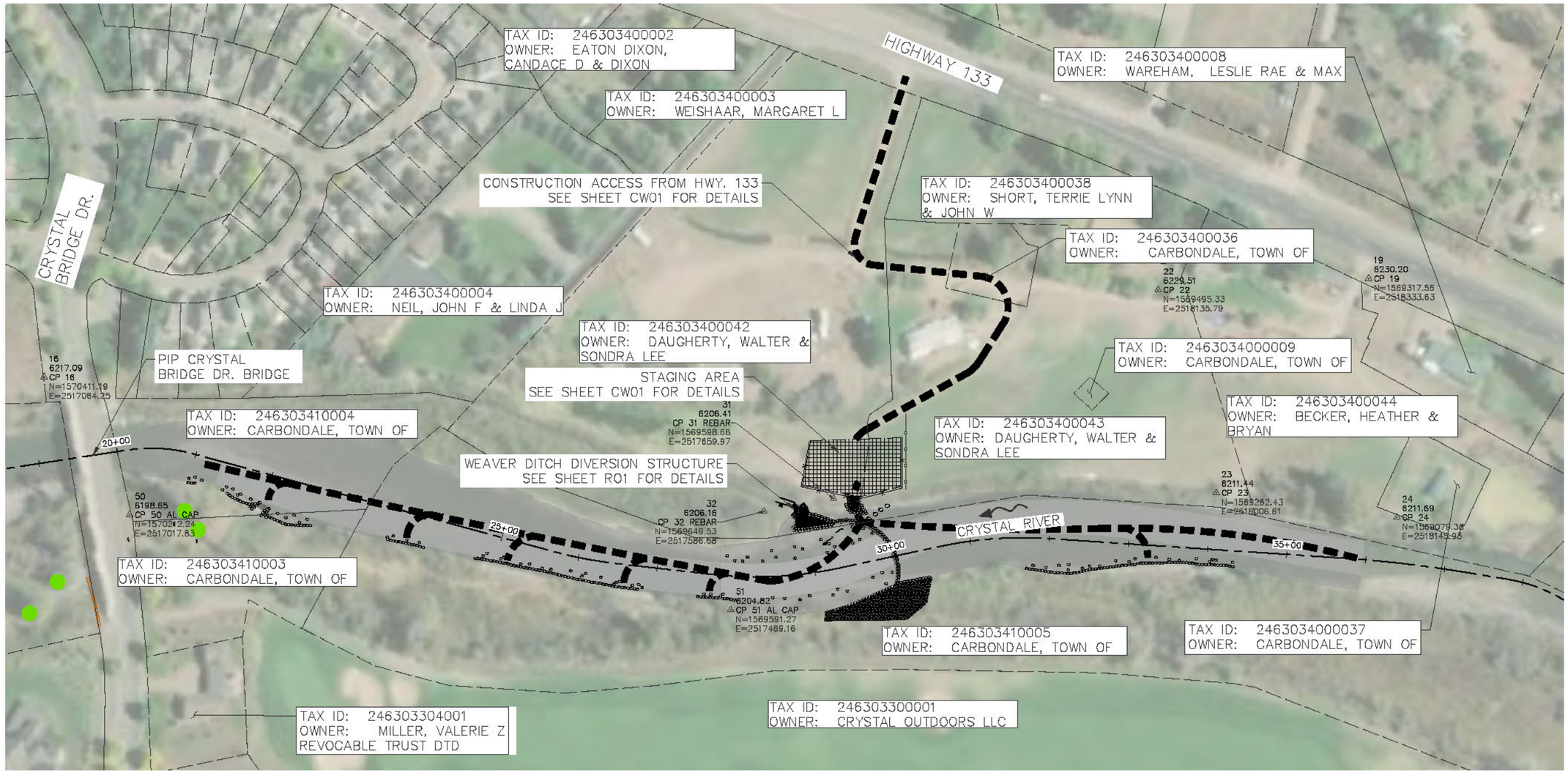
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PROJECT NAME AND ADDRESS

Crystal River Restoration and Weaver Ditch Efficiency Project
Carbondale, CO 81623

Project	Sheet
38047	G01
Date: OCT 2019	
Scale: NTS	

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION



HORIZONTAL DATUM:

NORTH AMERICAN DATUM 1983 (NAD83) – COLORADO STATE PLANE, CENTRAL ZONE, US SURVEY FOOT

VERTICAL DATUM:

NORTH AMERICAN VERTICAL DATUM 1988 (NAVD–88)

CONTROL POINT TABLE

POINT #	NORTHING	EASTING	ELEVATION	DESCRIPTION
16	1570411.1930	2517064.2470	6217.09	CP 16
19	1569317.5830	2518333.6290	6230.20	CP 19
22	1569495.3280	2518135.7870	6229.51	CP 22
23	1569262.4300	2518006.8110	6211.44	CP 23
24	1569079.3770	2518145.9360	6211.69	CP 24
31	1569588.5830	2517659.9660	6206.41	CP 31 REBAR
32	1569649.5320	2517586.6750	6206.16	CP 32 REBAR
50	1570212.2360	2517017.8360	6198.65	CP 50 AL CAP
51	1569591.2870	2517489.1580	6204.82	CP 51 AL CAP
52	1568310.4820	2518213.1880	6216.42	CP 52 AL CAP

0 70 140 Feet

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT SITE ACCESS PLAN & HORIZONTAL CONTROL PLAN

No.	REVISION/UPDATE	Date

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Town of Carbondale
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Carbondale, CO 81623

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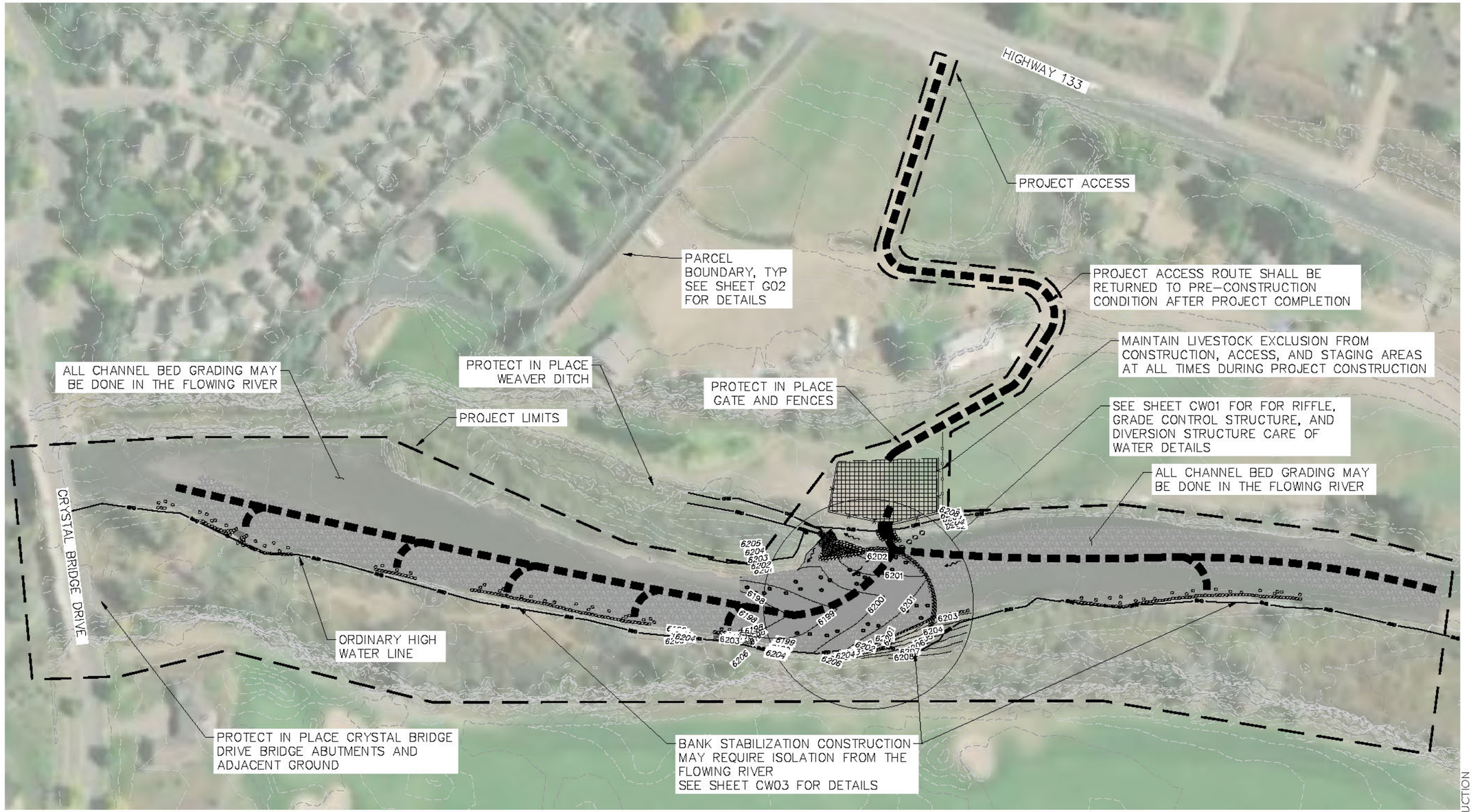
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and Weaver Ditch Efficiency Project
Carbondale, CO 81623

Project	Sheet
38047	G02
Date: OCT 2019	
Scale: 1"=70' AT FULL SIZE	



CONSTRUCTION NOTES:

1) CARE OF WATER (CW) PLAN SHOWN IS FOR PERMITTING AND COST ESTIMATION ONLY. FINAL CW PLAN IS WHOLLY THE RESPONSIBILITY OF THE CONTRACTOR. SEE SPECIFICATIONS FOR DETAILS.
2) CONTRACTOR IS RESPONSIBLE FOR LOCATING AND PROTECTING IN PLACE ALL UTILITIES WITHIN THE PROJECT LIMITS
3) IF CHANNEL CONSTRUCTION REQUIRES ISOLATION FROM THE CRYSTAL RIVER, COFFER SYSTEM DETAILS SHALL BE INCLUDED IN THE CW PLAN. SEE SHEETS CWXX AND CWXX AND SPECIFICATIONS FOR DETAILS.
4) ALL TREES AND ESTABLISHED VEGETATION WITHIN THE DISTURBANCE AREA NOT SPECIFIED AS PROTECT IN PLACE SHALL NOT BE REMOVED OR DAMAGED UNLESS NECESSARY FOR ACCESS OR WITHIN GRADING AREAS.
5) SEE SPECIFICATIONS FOR BMPS, CARE OF WATER AND MATERIALS DETAILS AND SPECIFICATIONS.

LEGEND

	STAGING AREA
	ACCESS ROUTE
	SILT FENCE
	EAST COFFER ISOLATION (OPT.)
	WEST COFFER ISOLATION (OPT.)
	DIVERSION DAM
	OIL BOOM
TC TC TC	TURBIDITY CURTAIN
	LIVESTOCK EXCLUSION FENCE

0 60 120 Feet

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT
PROJECT ACCESS AND CARE OF WATER OVERVIEW - PLAN

No.	REVISION/UPDATE	Date

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PROJECT NAME AND ADDRESS

Crystal River Restoration
and Weaver Ditch Efficiency Project
Carbondale, CO 81623

Project	Sheet
38047	CW00
Date: OCT 2019	
Scale: 1"=60' AT FULL SIZE	

LEGEND	
	STAGING AREA
	ACCESS ROUTE
	SILT FENCE
	EAST COFFER ISOLATION (OPT.)
	WEST COFFER ISOLATION (OPT.)
	DIVERSION DAM
	OIL BOOM
TC TC TC	TURBIDITY CURTAIN
	LIVESTOCK EXCLUSION FENCE

THE CRYSTAL RIVER MAY BE DIVERTED THROUGH THE WEAVER DITCH INLET AND THROUGH THE DIVERSION RETURN CHANNEL DURING RIFFLE GRADE CONTROL STRUCTURE CONSTRUCTION. ALTERNATIVELY THE CONTRACTOR MAY ISOLATE EITHER SIDE OF THE STRUCTURE SEQUENTIALLY FROM THE FLOWING RIVER WITH COFFER DAMS

SEE SHEET CW03 FOR TEMPORARY ACCESS RAMP DETAILS

DIVERSION STRUCTURE MODIFICATIONS, PERMANENT ACCESS RAMP CONSTRUCTION, AND ISLAND MODIFICATIONS MUST BE DONE IN ISOLATION FROM THE FLOWING RIVER

DIVERTED FLOW

DIVERTED FLOW

PUMP

CRYSTAL RIVER

OIL BOOM (TYP) (SEE SHEETS CW03 AND CW04 FOR DETAILS)

BOULDER CLUSTERS MAY BE INSTALLED IN THE FLOWING RIVER

ISOLATION AREA PUMP SYSTEMS IF NEEDED INCLUDES FILTERED OUTFLOW SEE SHEETS CW05 AND CW06 FOR DETAILS

CRYSTAL RIVER

PUMP

RIFFLE GRADING MAY BE DONE IN THE FLOWING RIVER

TURBIDITY CURTAIN (TYP) (SEE SHEETS CW03 AND CW04 FOR DETAILS)

ORDINARY HIGH WATER LINE

0 10 20 Feet

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PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT RIFFLE AND DIVERSION STRUCTURE CARE OF WATER - PLAN

No.	REVISION/UPDATE	Date

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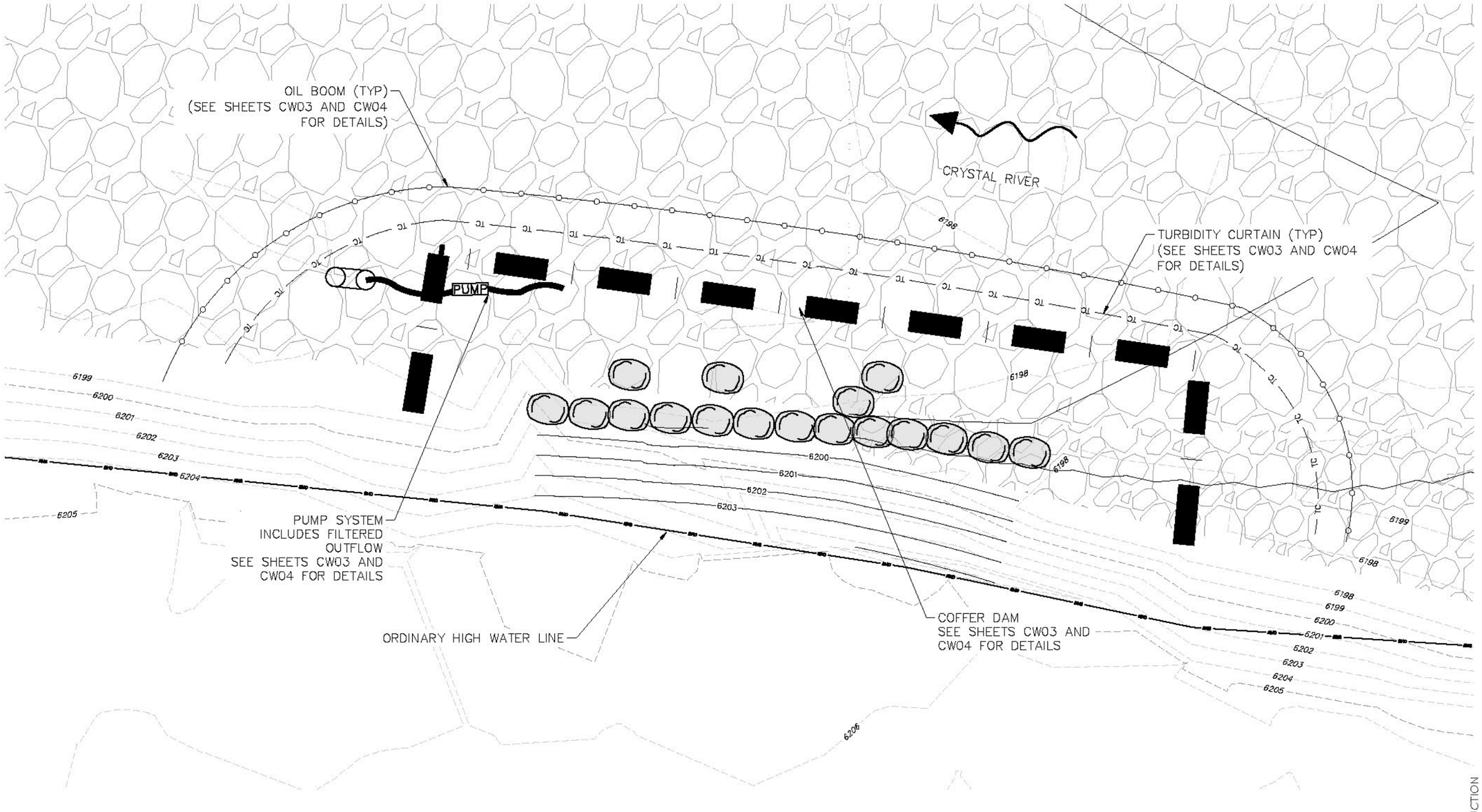
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Crystal River Restoration and Weaver Ditch Efficiency Project
Carbondale, CO 81623

Project	Sheet
38047	CW01
Date: OCT 2019	
Scale: 1"= 10' AT FULL SIZE	



LEGEND	
	STAGING AREA
	ACCESS ROUTE
x x x x x x	SILT FENCE
	EAST COFFER ISOLATION (OPT.)
	WEST COFFER ISOLATION (OPT.)
	DIVERSION DAM
	OIL BOOM
TC TC TC	TURBIDITY CURTAIN
	LIVESTOCK EXCLUSION FENCE

0 5 10 Feet

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT
TYPICAL BANK CONSTRUCTION ISOLATION - PLAN

No.	REVISION/UPDATE	Date

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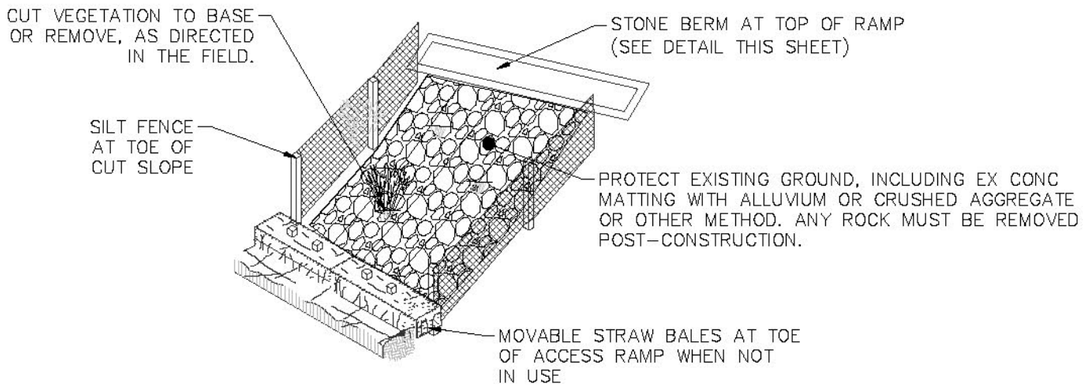
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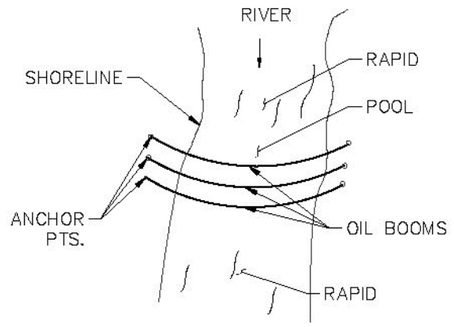
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Crystal River Restoration
and Weaver Ditch Efficiency Project
Carbondale, CO 81623

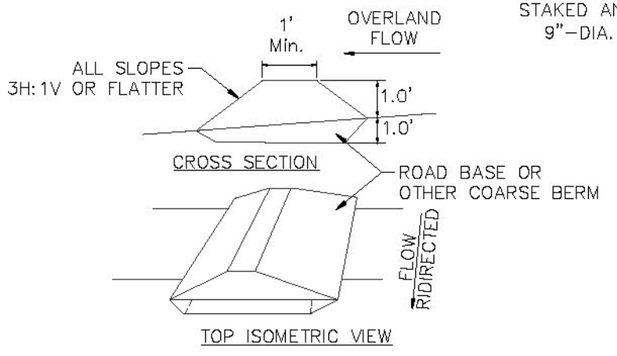
Project	Sheet
38047	CW02
Date: OCT 2019	
Scale: 1"=5' AT FULL SIZE	



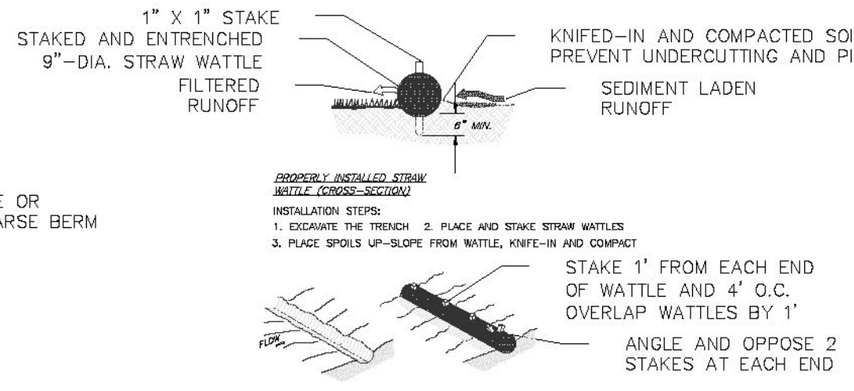
1 / CW01 TEMPORARY EQUIPMENT ACCESS (TYP.)
NTS



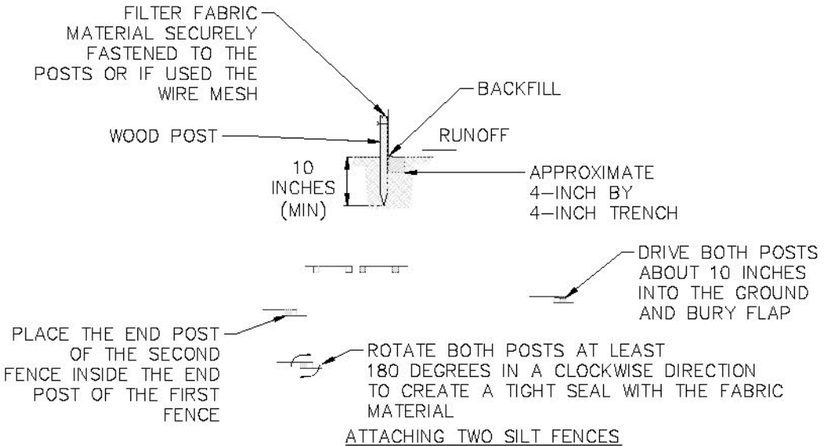
2 / CW01 OIL BOOM (TYP.)
PLAN VIEW-NTS

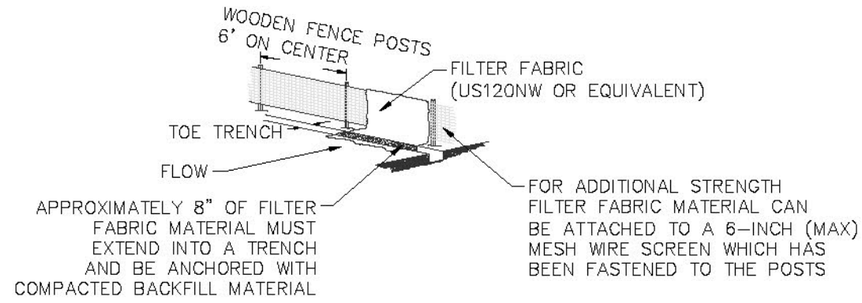


3 / CW01 STONE BERM (TYP.)
NTS

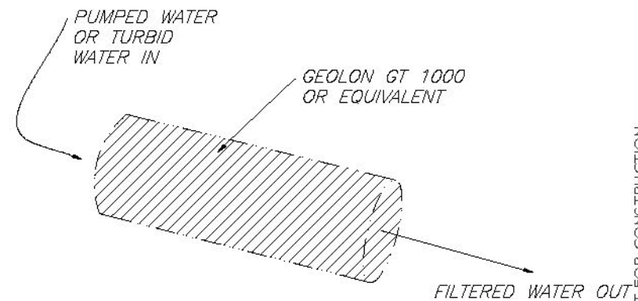


4 / CW01 STRAW WATTLE (TYP.)
NTS





5 / CW01 SILT FENCE (TYP.)
NTS



TO BE USED TO FILTER ALL PUMPED WATER

6 / CW01 GEO-TUBE FILTER
NTS

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT
CARE OF WATER DETAILS

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

Town of Carbondale
511 Colorado Ave
Carbondale, CO 81623

DESIGN FIRMS NAME AND ADDRESSES

RIVER RESTORATION CO.

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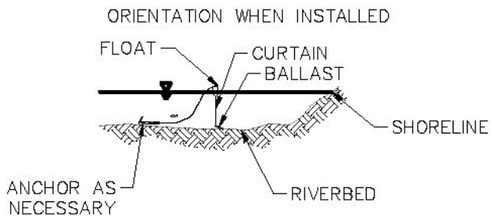
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Carbondale, CO 81623
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www.dhmdesign.com

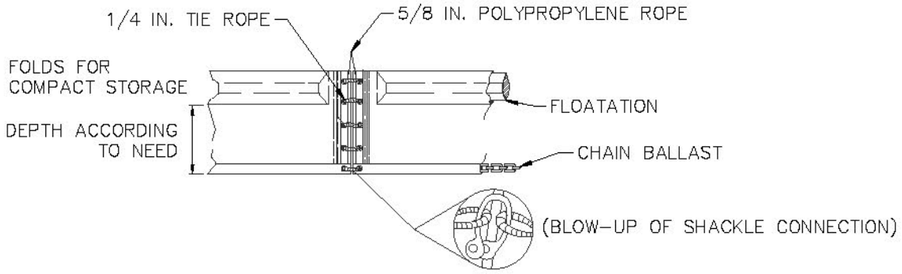
PROJECT NAME AND ADDRESS

Crystal River Restoration and Weaver Ditch Efficiency Project
Carbondale, CO 81623

Project	Sheet
38047	CW03
Date: OCT 2019	
Scale: NOT TO SCALE	



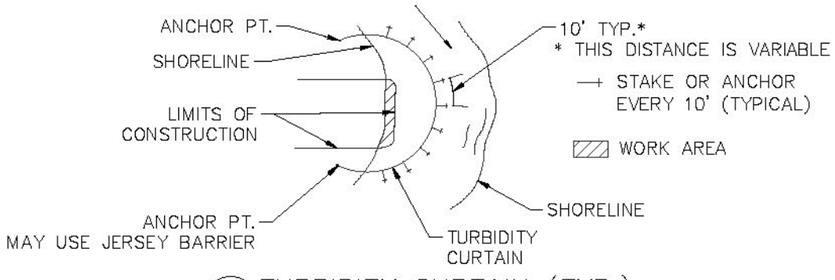
1 CW02 TURBIDITY CURTAIN (TYP.)
SECTION VIEW–NTS



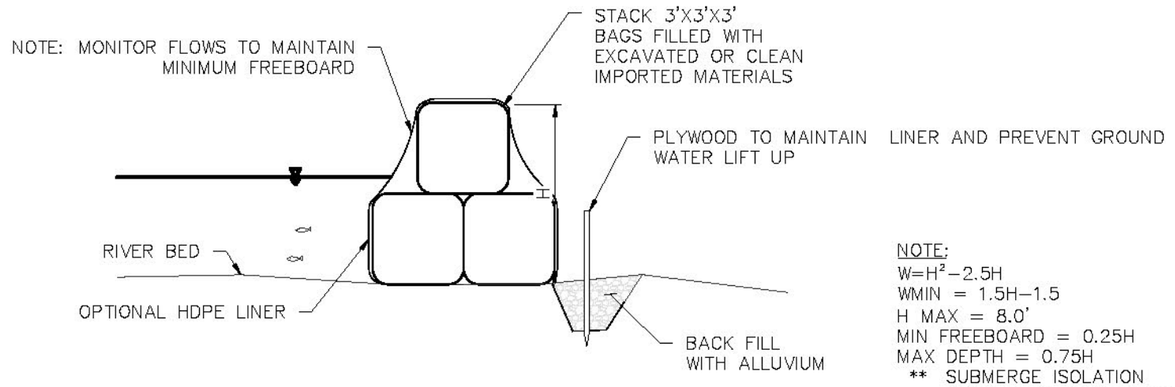
SILTMASTER II PERMEABLE GEOTEXTILE DREDGE BARRIER NON–WOVEN DBNW BY PARKERSYSTEMS OR EQUIVALENT

2 CW02 TURBIDITY CURTAIN (TYP.)
PROFILE VIEW–NTS

TYPICAL LAYOUTS
STREAMS, PONDS, AND LAKES (PROTECTED AND NON–TIDAL)

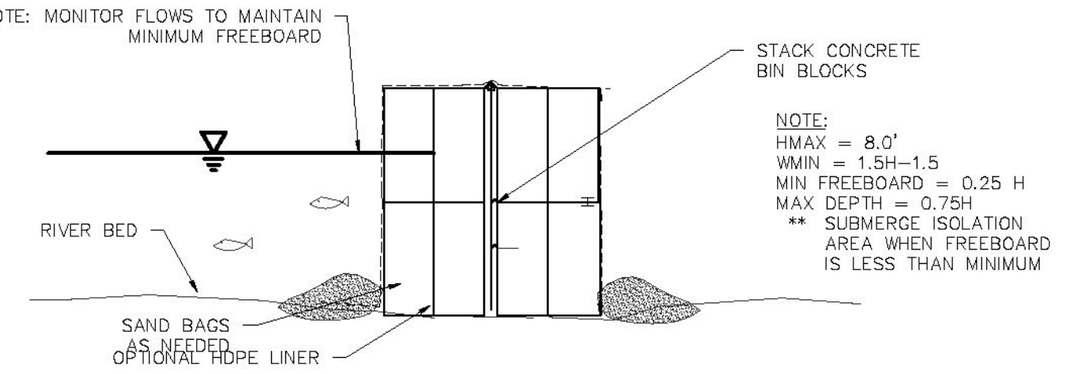


3 CW02 TURBIDITY CURTAIN (TYP.)
PLAN VIEW–NTS



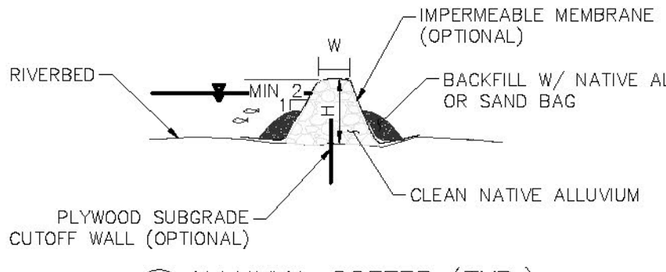
4 CW02 SAND BAGS COFFER DAM (TYP.)
SECTION VIEW–NTS

NOTE:
W=H²–2.5H
WMIN = 1.5H–1.5
H MAX = 8.0'
MIN FREEBOARD = 0.25H
MAX DEPTH = 0.75H
** SUBMERGE ISOLATION AREA WHEN FREEBOARD IS LESS THAN MINIMUM



NOTE:
HMAX = 8.0'
WMIN = 1.5H–1.5
MIN FREEBOARD = 0.25 H
MAX DEPTH = 0.75H
** SUBMERGE ISOLATION AREA WHEN FREEBOARD IS LESS THAN MINIMUM

5 CW02 CONCRETE BARRIER COFFER DAM (TYP.)
SECTION VIEW–NTS



NOTE:
H MAX = 8 '
W = 0.5 x H
MAX DEPTH = 6'
MIN FREEBOARD = 0.25 H
** SUBMERGE ISOLATION AREA WHEN FREEBOARD IS LESS THAN MINIMUM

6 CW02 ALLUVIAL COFFER (TYP.)
SECTION VIEW–NTS

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PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT
CARE OF WATER DETAILS

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

Town of Carbondale
511 Colorado Ave
Carbondale, CO 81623

DESIGN FIRMS NAME AND ADDRESSES

RiverRestoration.org, LLC
P.O. Box 248
Carbondale, CO 81623
www.RiverRestoration.org

DHM DESIGN
311 Main St, Suite 102
Carbondale, CO 81623
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www.dhmdesign.com

PROJECT NAME AND ADDRESS

Crystal River Restoration and Weaver Ditch Efficiency Project
Carbondale, CO 81623

Project	Sheet
38047	CW04
Date: OCT 2019	
Scale: NOT TO SCALE	

PERMANENT MAINTENANCE ACCESS RAMP AND CONSTRUCTION ACCESS LOCATION
SEE SHEET D10 FOR PERMANENT RAMP DETAILS

EXISTING CONTOURS, TYP.

FILTER BOULDERS TO PROTECT DITCH INLET
SEE SHEET D12 FOR DETAILS

EXISTING WEAVER DITCH DIVERSION STRUCTURE
SEE SHEET D11 FOR UPGRADE AND MODIFICATION DETAILS

BOULDER GRADE CONTROL STRUCTURE AT HEAD OF RIFFLE
SEE SHEET D08 FOR DETAILS

EXISTING CONTOURS, TYP.

EXISTING ISLAND TO BE STABILIZED AND PARTIALLY REBUILT WITH BOULDER
SEE SHEET D12 FOR MODIFICATION DETAILS

UPSTREAM CHANNEL GRADING
SEE SHEETS R05 – R06
FOR DETAILS

DOWNSTREAM CHANNEL GRADING
SEE SHEETS R03 – R04 FOR DETAILS

PROPOSED CONTOURS, TYP.

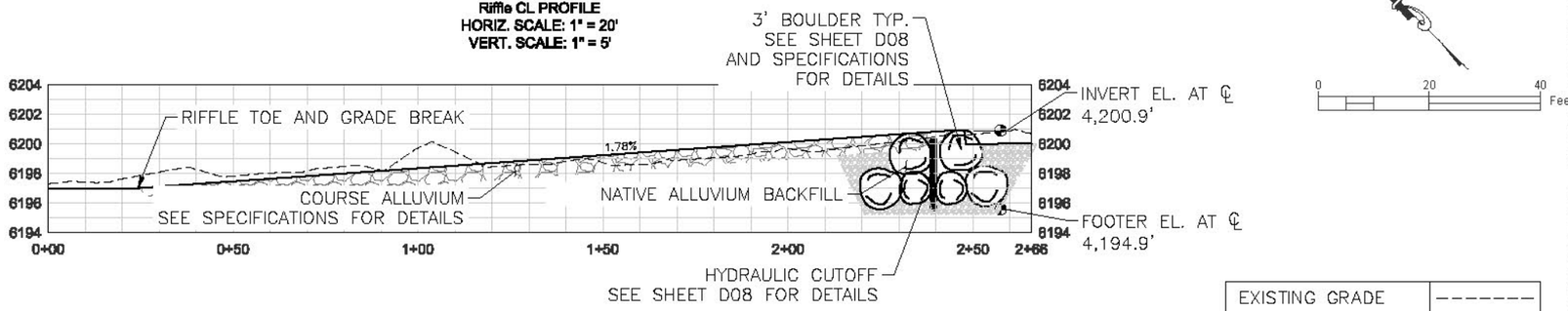
BOULDER CLUSTER FISH PASSAGE STRUCTURES
SEE SHEET D07 FOR DETAILS

RIFFLE ℄ PROFILE

EXISTING COBBLE BED MATERIAL SHALL BE SORTED INTO 2 GRADATION CLASSES AND REDISTRIBUTED TO CONSTRUCT RIFFLE
COURSER GRADATION SHALL BE INSTALLED IN THE CHANNEL THALWEG TO A DEPTH OF 1 FOOT
SEE SPECIFICATIONS FOR DETAILS ON MATERIAL CLASSES AND SHEET R02, D09 AND SPECIFICATIONS FOR RIFFLE CONSTRUCTION DETAILS

BANK TOE PROTECTION, FILL AND STABILIZATION
SEE SHEETS BK05 AND D01 FOR DETAILS

Riffle CL PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



EXISTING GRADE	--------
PROPOSED GRADE	————

0 20 40 Feet

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PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT

RIFFLE AND GRADE CONTROL STRUCTURES - PLAN AND PROFILE

No.	REVISION/UPDATE	Date

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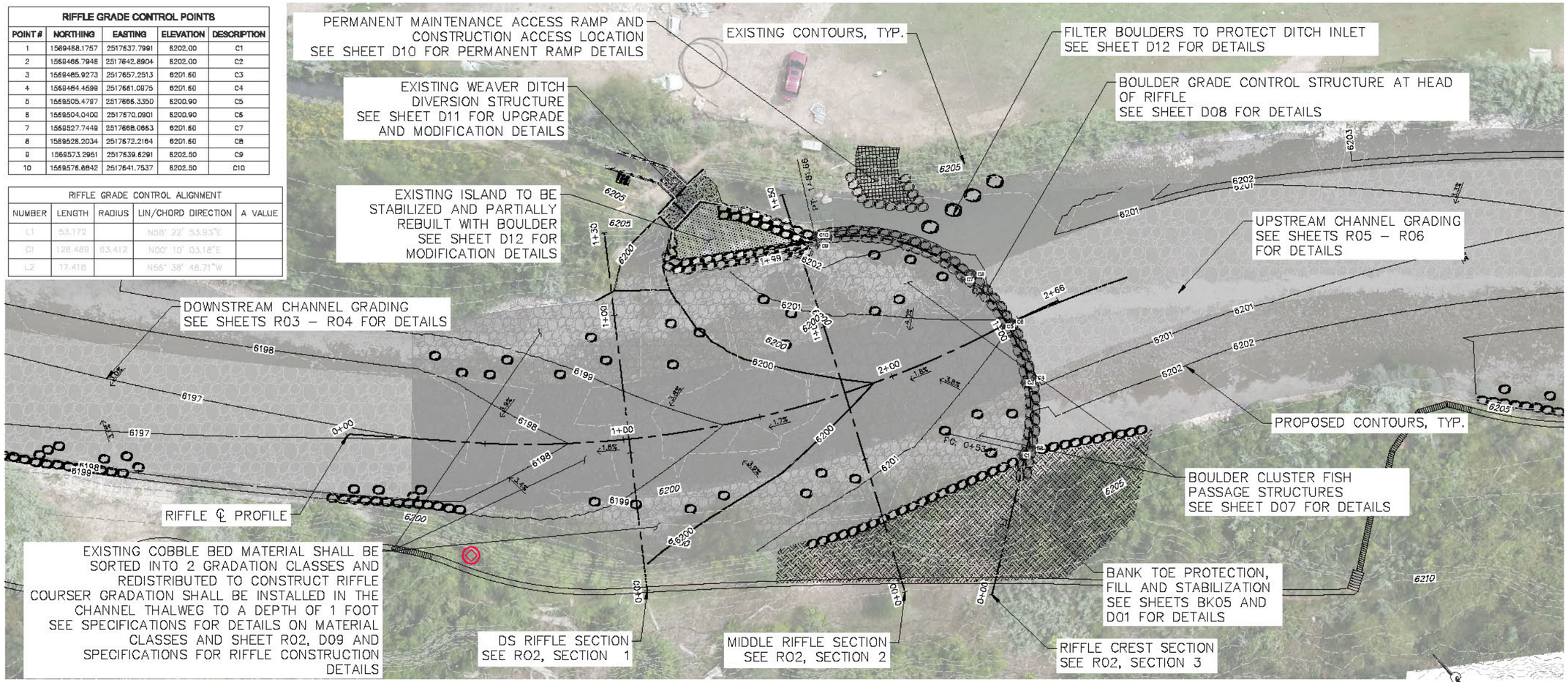
PROJECT NAME AND ADDRESS

Crystal River Restoration
and Weaver Ditch Effiacency Project
Carbondale, CO 81623

Project	Sheet
38047	R01
Date: OCT 2019	
Scale: 1"=20' AT FULL SIZE	

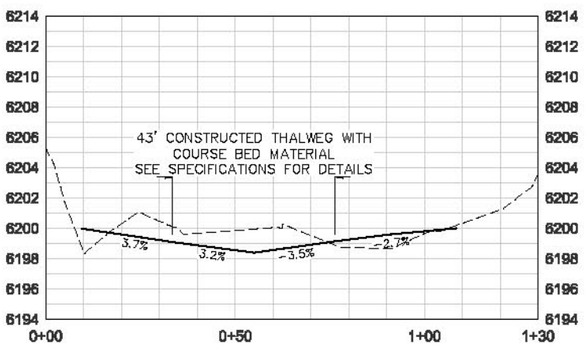
RIFFLE GRADE CONTROL POINTS				
POINT #	NORTHING	EASTING	ELEVATION	DESCRIPTION
1	1569488.1757	2517637.7991	6202.00	C1
2	1569486.7948	2517642.8904	6202.00	C2
3	1569485.9273	2517657.2513	6201.60	C3
4	1569484.4598	2517661.0875	6201.60	C4
5	1569505.4787	2517666.3350	6200.90	C5
6	1569504.0400	2517670.0901	6200.90	C6
7	1569527.7448	2517668.0653	6201.60	C7
8	1569526.2034	2517672.2164	6201.60	C8
9	1569573.2951	2517639.6291	6202.50	C9
10	1569576.6842	2517641.7537	6202.50	C10

RIFFLE GRADE CONTROL ALIGNMENT				
NUMBER	LENGTH	RADIUS	LIN/CHORD DIRECTION	A VALUE
L1	53.172		N58° 22' 53.93"E	
C1	128.489	63.412	N00° 10' 03.18"E	
L2	17.418		N56° 38' 48.71"W	

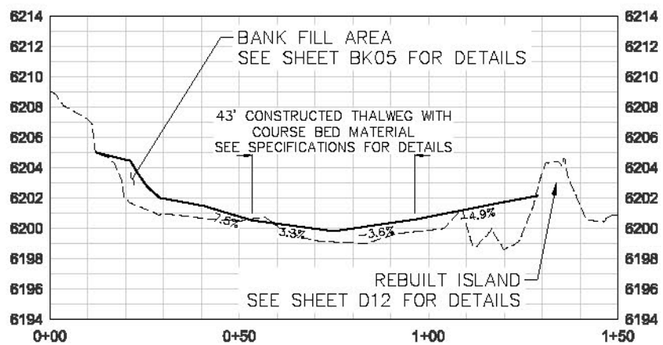


EXISTING GRADE	- - - - - - - -
PROPOSED GRADE	————

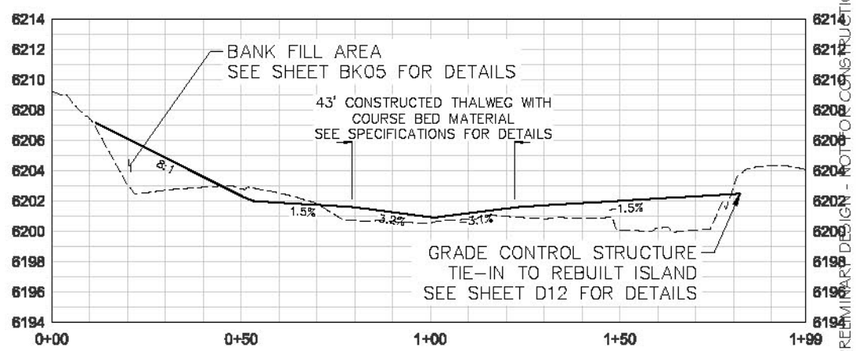
R02 1 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



R02 2 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



R02 3 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



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PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT

RIFFLE AND GRADE CONTROL STRUCTURES - SECTIONS

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

Town of Carbondale
511 Colorado Ave
Carbondale, CO 81623

DESIGN FIRMS NAME AND ADDRESSES

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DHM DESIGN
311 Main St, Suite 102
Carbondale, CO 81623
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www.dhmdesign.com

PROJECT NAME AND ADDRESS

Crystal River Restoration
and Weaver Ditch Efficiency Project
Carbondale, CO 81623

Project	Sheet
38047	R02
Date: OCT 2019	
Scale: 1"=20' AT FULL SIZE	

RE-GRADED NATIVE ALLUVIAL BED MATERIAL FOR CONSTRUCTED CHANNEL MARGINS AND COBBLE BAR SEE SPECIFICATIONS FOR DETAILS

DS CHANNEL ℄ ALIGNMENT SEE PROFILE THIS SHEET

EXISTING CONTOURS, TYP

PROPOSED CONTOURS, TYP

BOULDER TOE PROTECTION AND HABITAT BOULDERS SEE SHEETS BK01-BK06 AND D06 AND D07 FOR DETAILS

BOULDER JETTY STRUCTURES TO CREATE ACCESS EDDY SEE D SHEETS FOR DETAILS

SEE L SHEETS FOR UPLAND IMPROVEMETNS

BOULDER TOE PROTECTION AND HABITAT BOULDERS SEE SHEETS BK01-BK06 AND D06 AND D07 FOR DETAILS

COURSE GRADATION ALLUVIAL BED MATERIAL FOR 43 FT WIDE LOW FLOW CHANNEL SEE SPECIFICATIONS FOR DETAILS

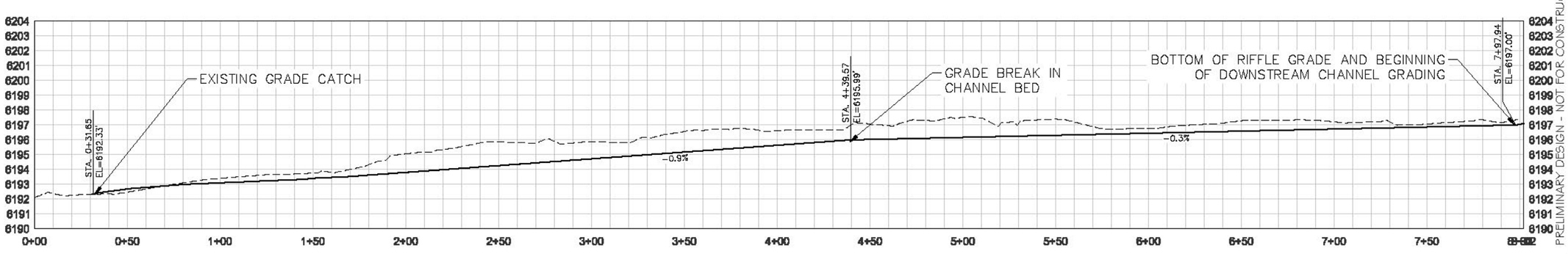
BOULDER TOE PROTECTION AND HABITAT BOULDERS SEE SHEETS BK01-BK06 AND D06 AND D07 FOR DETAILS

BOULDER TOE PROTECTION AND HABITAT BOULDERS SEE SHEETS BK01-BK06 AND D06 AND D07 FOR DETAILS

EXISTING GRADE	- - - - - - -
PROPOSED GRADE	———

0 30 60 Feet

DS CHANNEL PROFILE
HORIZ. SCALE: 1" = 30'
VERT. SCALE: 1" = 4'



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PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT

DOWNSTREAM CHANNEL - PLAN AND PROFILE

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

Town of Carbondale
511 Colorado Ave
Carbondale, CO 81623

DESIGN FIRMS NAME AND ADDRESSES

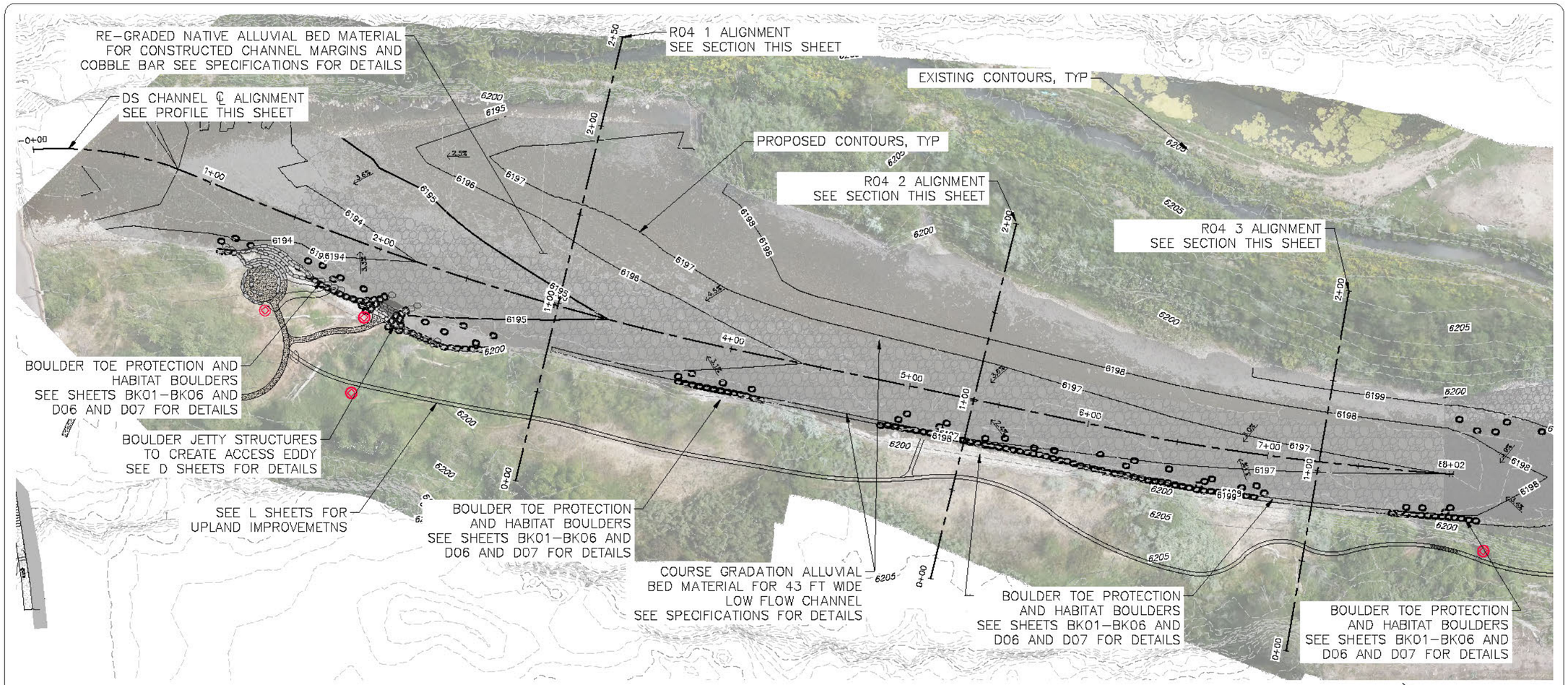
RiverRestoration.org, LLC
P.O. Box 248
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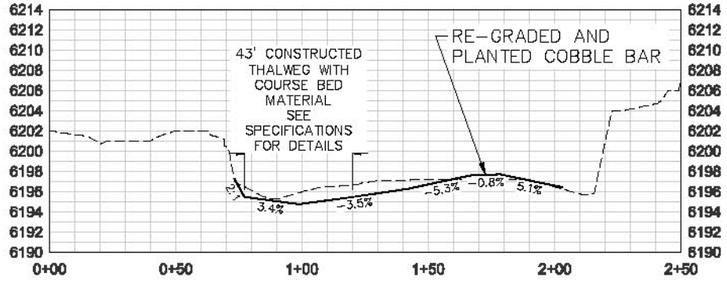
PROJECT NAME AND ADDRESS

Crystal River Restoration
and Weaver Ditch Efficiency Project
Carbondale, CO 81623

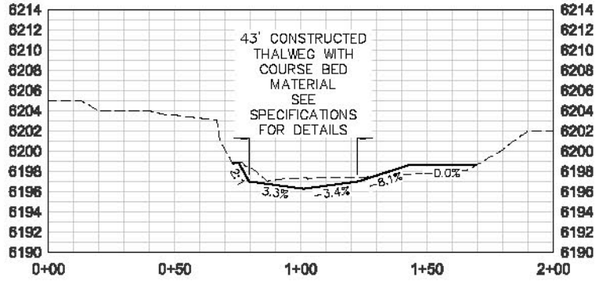
Project	Sheet
38047	R03
Date: OCT 2019	
Scale: 1"=30' AT FULL SIZE	



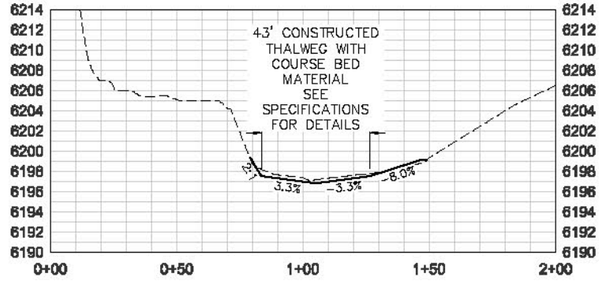
R04 1 PROFILE
HORIZ. SCALE: 1" = 30'
VERT. SCALE: 1" = 8'



R04 2 PROFILE
HORIZ. SCALE: 1" = 30'
VERT. SCALE: 1" = 8'



R04 3 PROFILE
HORIZ. SCALE: 1" = 30'
VERT. SCALE: 1" = 8'



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PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT
DOWNSTREAM CHANNEL - SECTIONS

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

Town of Carbondale
511 Colorado Ave
Carbondale, CO 81623

DESIGN FIRMS NAME AND ADDRESSES

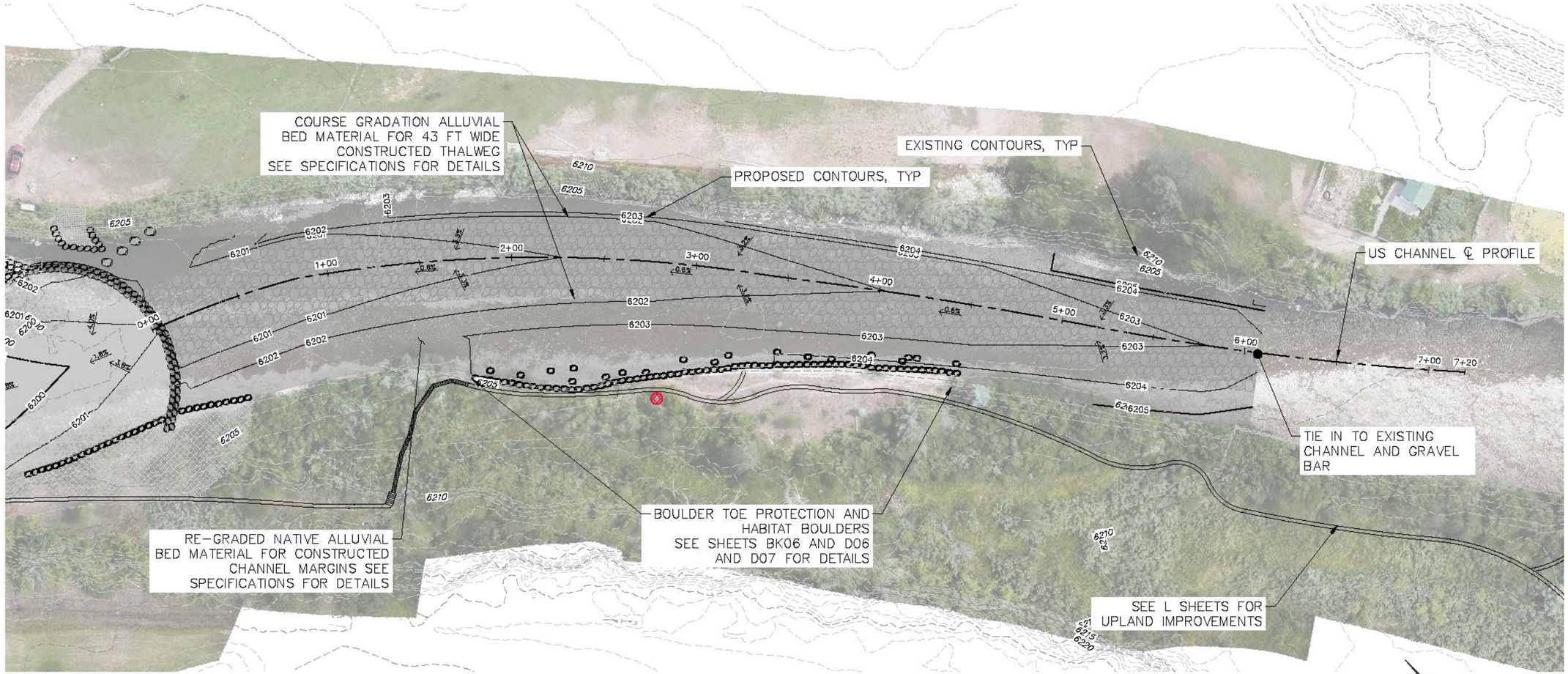
RiverRestoration.org, LLC
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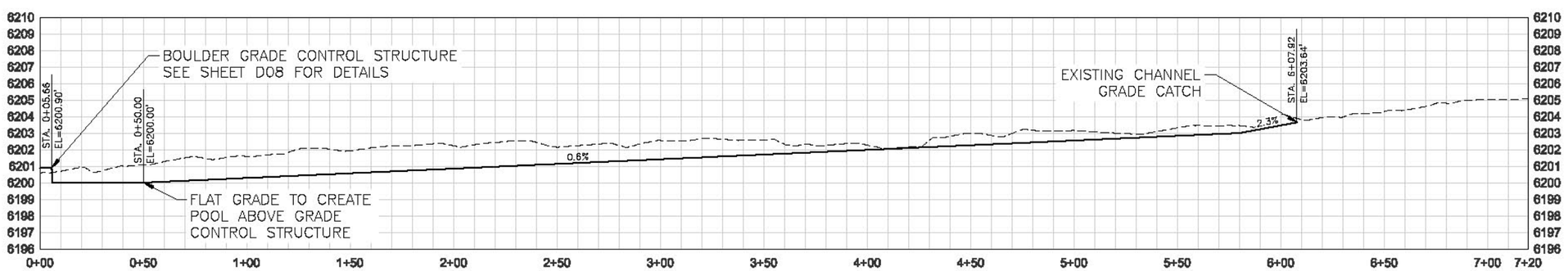
PROJECT NAME AND ADDRESS

Crystal River Restoration
and Weaver Ditch Efficiency Project
Carbondale, CO 81623

Project	Sheet
38047	R04
Date: OCT 2019	
Scale: 1"=30' AT FULL SIZE	



US Channel PROFILE
HORIZ. SCALE: 1" = 30'
VERT. SCALE: 1" = 4'



PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT

UPSTREAM CHANNEL - PLAN AND PROFILE

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

Town of Carbondale
511 Colorado Ave
Carbondale, CO 81623

DESIGN FIRMS NAME AND ADDRESSES

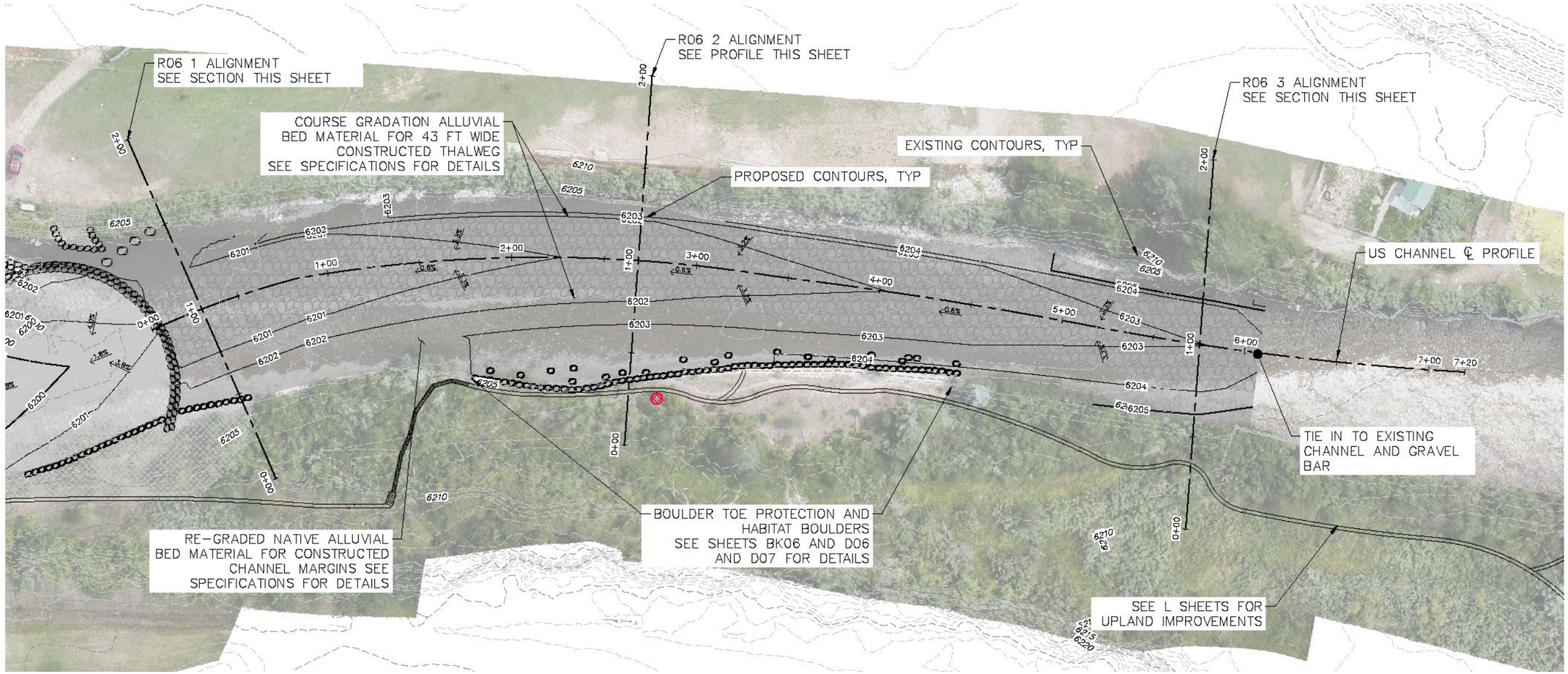
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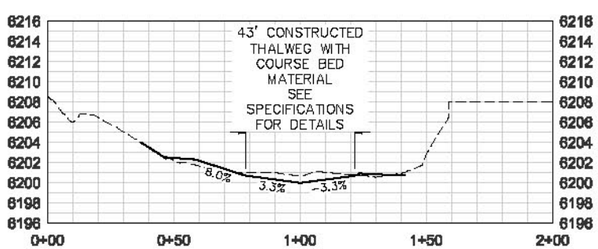
Project	Sheet
38047	R05
Date: OCT 2019	
Scale: 1"=30' AT FULL SIZE	



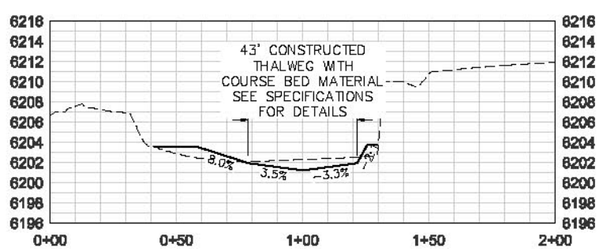
EXISTING GRADE	- - - - - - -
PROPOSED GRADE	———

0 30 60 Feet

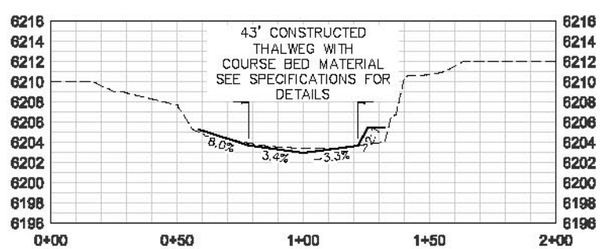
R06 1 PROFILE
HORIZ. SCALE: 1" = 30'
VERT. SCALE: 1" = 8'



R06 2 PROFILE
HORIZ. SCALE: 1" = 30'
VERT. SCALE: 1" = 8'



R06 3 PROFILE
HORIZ. SCALE: 1" = 30'
VERT. SCALE: 1" = 8'



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PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT

UPSTREAM CHANNEL - SECTIONS

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

Town of Carbondale
511 Colorado Ave
Carbondale, CO 81623

DESIGN FIRMS NAME AND ADDRESSES

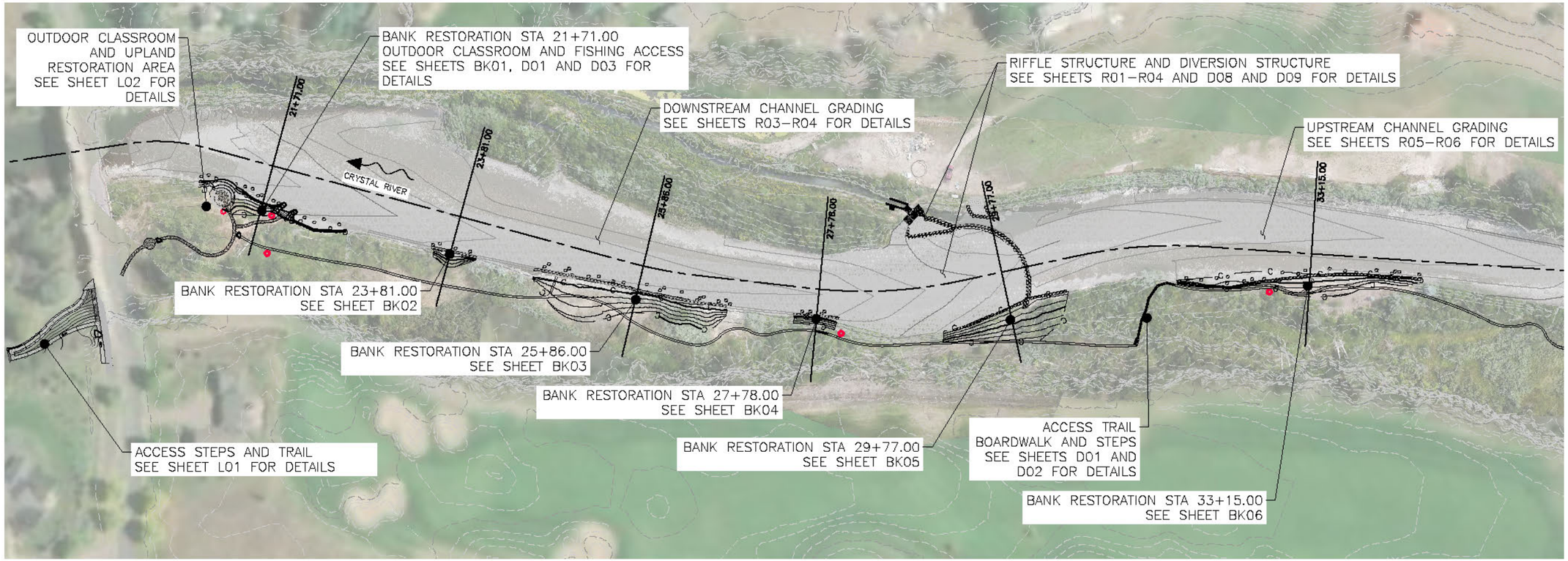
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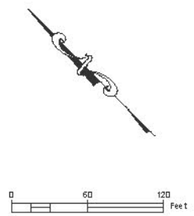
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PROJECT NAME AND ADDRESS

Crystal River Restoration
and Weaver Ditch Efficiency Project
Carbondale, CO 81623

Project	Sheet
38047	R06
Date: OCT 2019	
Scale: 1"=30' AT FULL SIZE	





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PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT
BANK RESTORATION - OVERVIEW

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

Town of Carbondale
511 Colorado Ave
Carbondale, CO 81623

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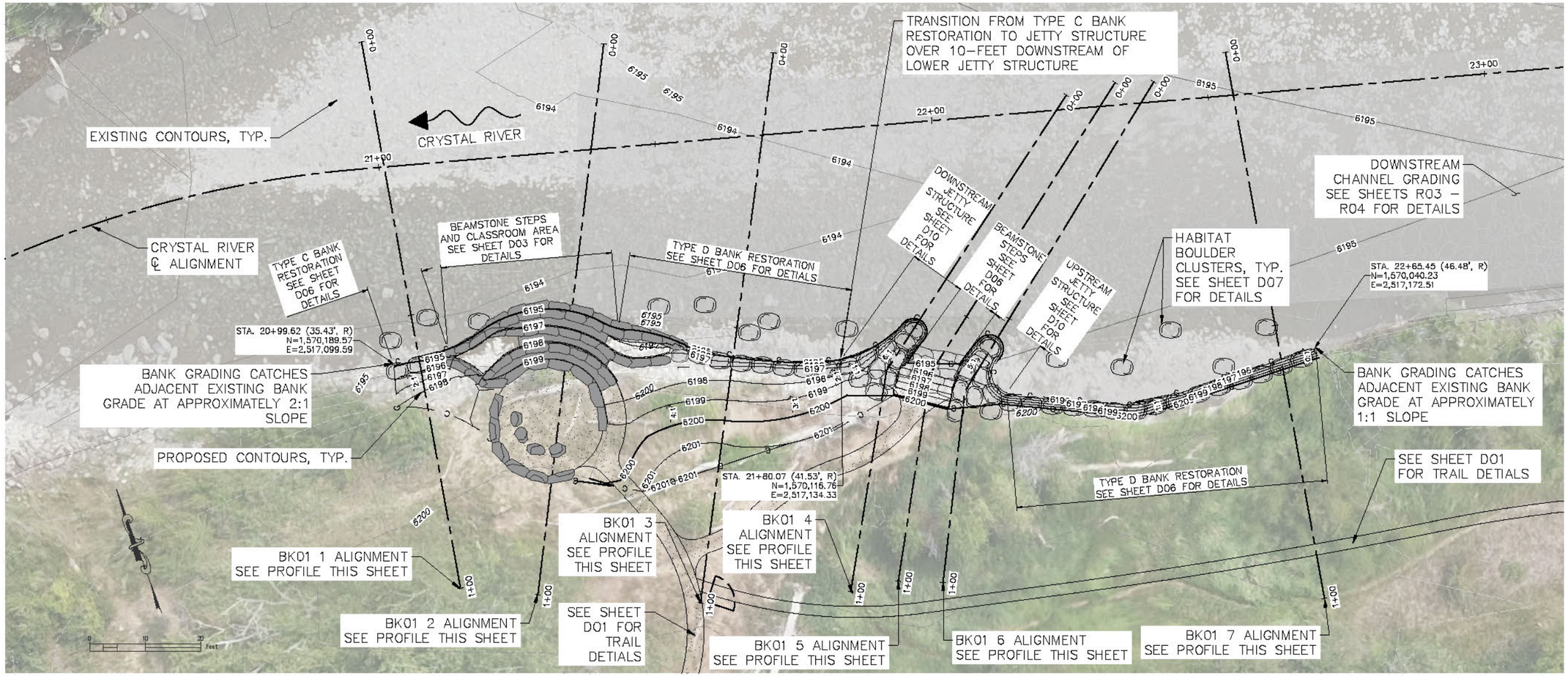
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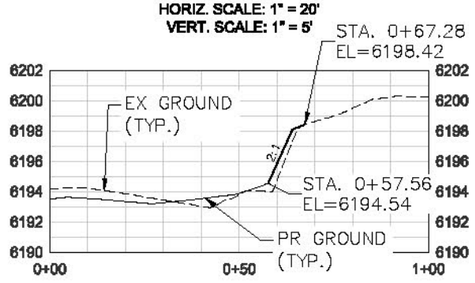
PROJECT NAME AND ADDRESS

Crystal River Restoration
and Weaver Ditch Efficiency Project
Carbondale, CO 81623

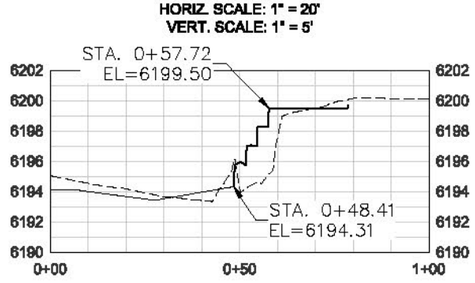
Project	Sheet
38047	BK00
Date: OCT 2019	
Scale: 1"=30' AT FULL SIZE	



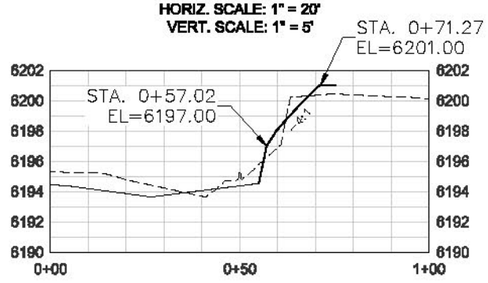
BK01 1 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



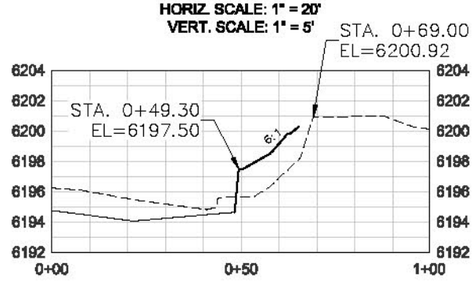
BK01 2 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



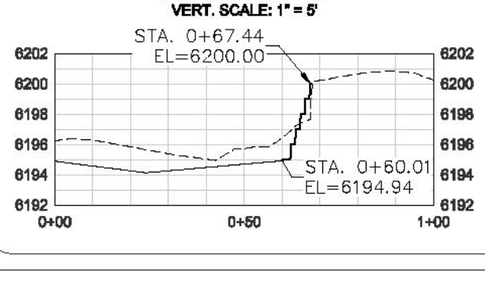
BK01 3 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



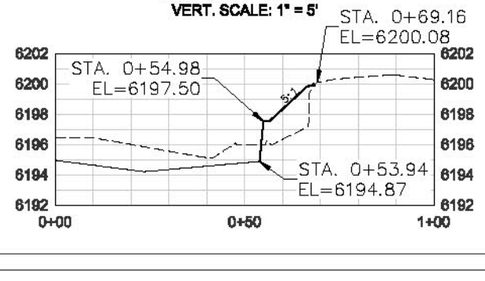
BK01 4 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



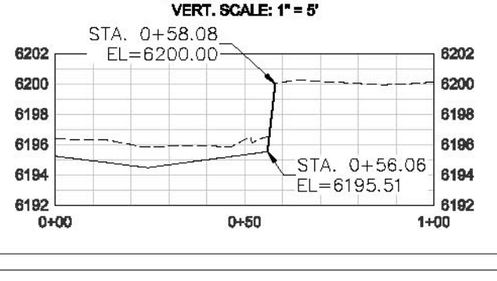
BK01 5 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



BK01 6 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



BK01 7 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'





EXISTING GRADE	--------
PROPOSED GRADE	————

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT
BANK RESTORATION STA 21+71.00 - PLAN AND SECTIONS

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

Town of Carbondale
511 Colorado Ave
Carbondale, CO 81623

DESIGN FIRMS NAME AND ADDRESSES

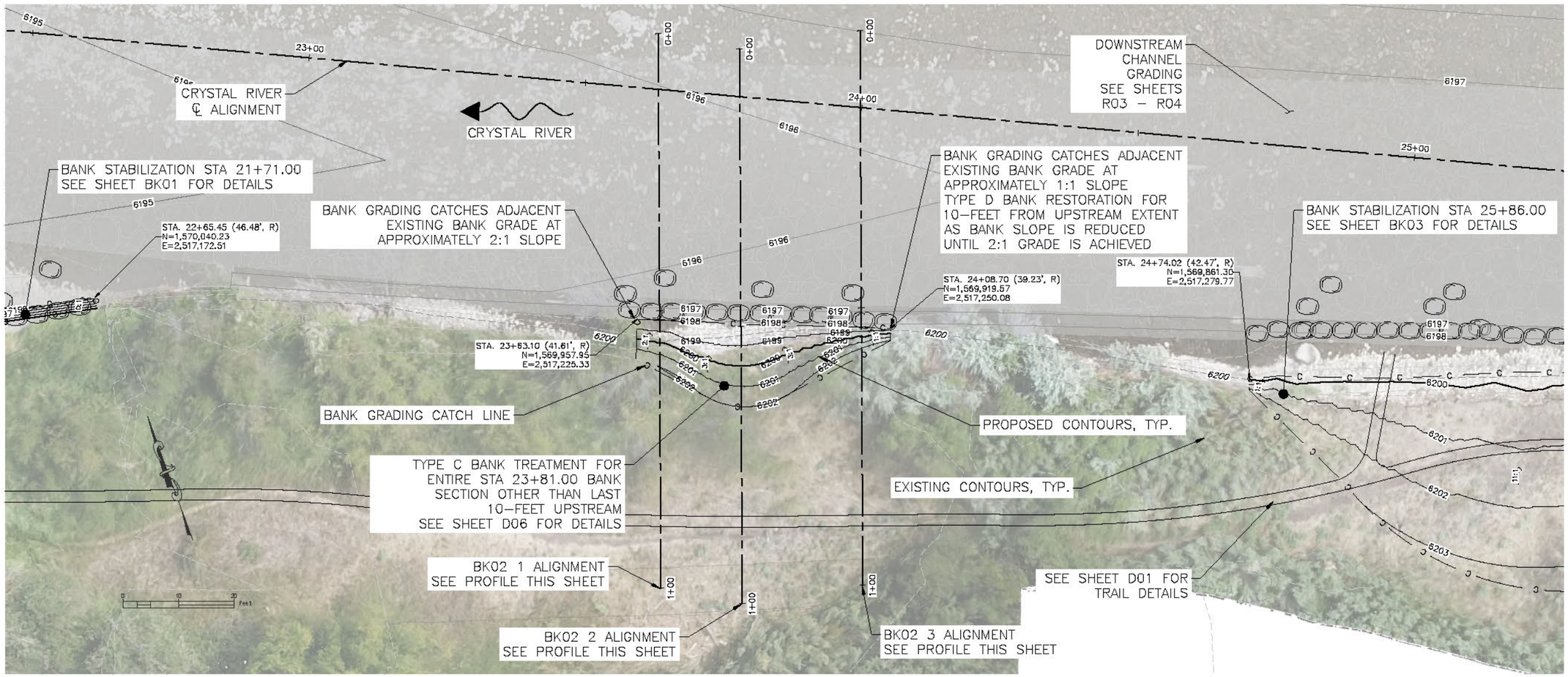
RiverRestoration.org, LLC
P.O. Box 248
Carbondale, CO 81623
www.RiverRestoration.org

DHM DESIGN
311 Main St, Suite 102
Carbondale, CO 81623
970.963.6520
www.dhmdesign.com

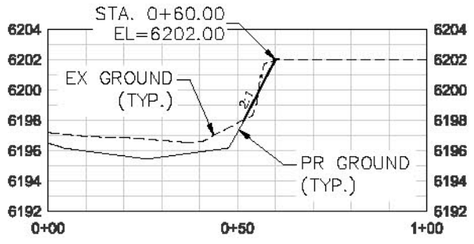
PROJECT NAME AND ADDRESS

Crystal River Restoration
and Weaver Ditch Efficiency Project
Carbondale, CO 81623

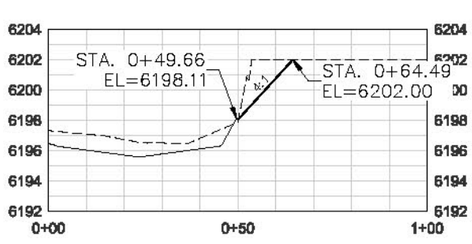
Project	Sheet
38047	BK01
Date: OCT 2019	
Scale: 1"= 10' AT FULL SIZE	



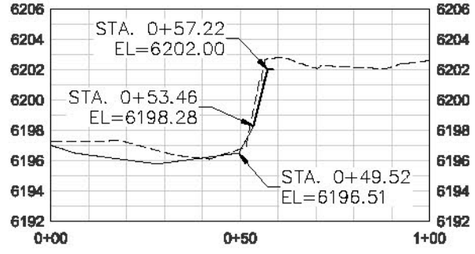
BK02 1 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'

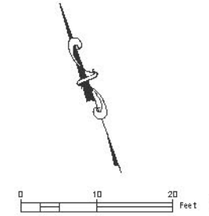


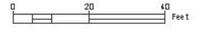
BK02 2 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



BK02 3 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'







EXISTING GRADE	- - - - - - -
PROPOSED GRADE	———

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT
BANK RESTORATION STA 23+81.00 - PLAN AND SECTIONS

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

Town of Carbondale
511 Colorado Ave
Carbondale, CO 81623

DESIGN FIRMS NAME AND ADDRESSES

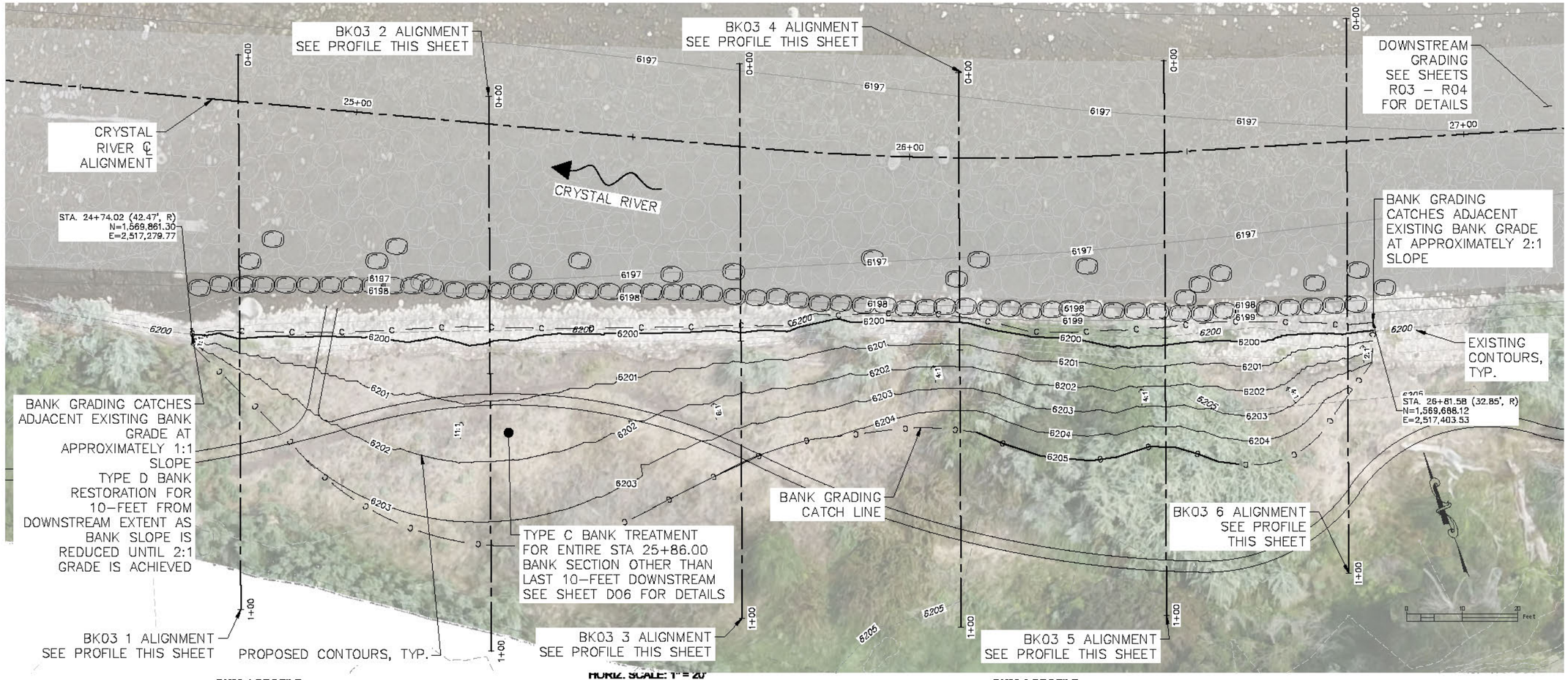
RiverRestoration.org, LLC
P.O. Box 248
Carbondale, CO 81623
www.RiverRestoration.org

DHM DESIGN
311 Main St, Suite 102
Carbondale, CO 81623
970.963.6520
www.dhmdesign.com

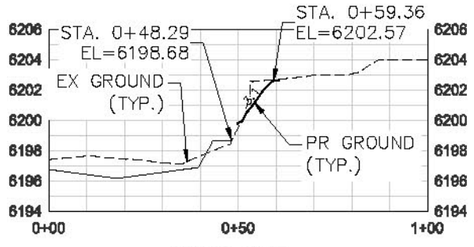
PROJECT NAME AND ADDRESS

Crystal River Restoration
and Weaver Ditch Efficiency Project
Carbondale, CO 81623

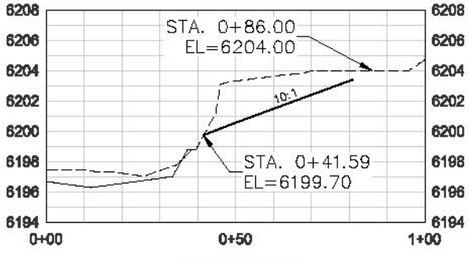
Project	Sheet
38047	BK02
Date: OCT 2019	
Scale: 1"= 10' AT FULL SIZE	



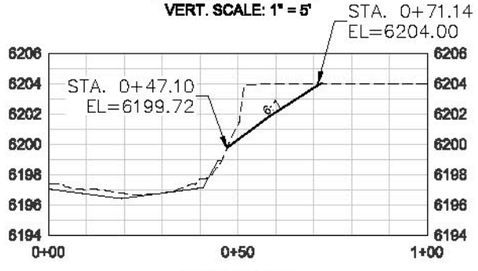
BK03 1 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



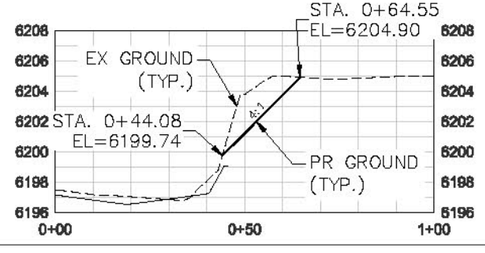
BK03 2 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



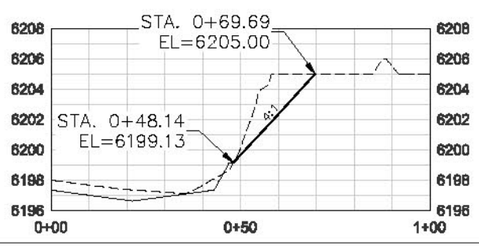
BK03 3 PROFILE
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VERT. SCALE: 1" = 5'



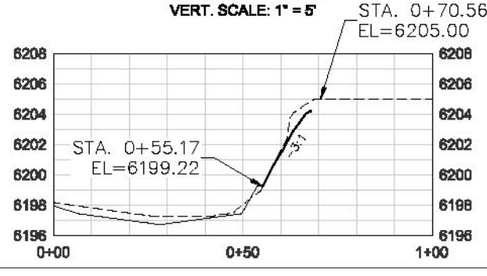
BK03 4 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



BK03 5 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



BK03 6 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



0 20 40 Feet

EXISTING GRADE	
PROPOSED GRADE	

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT
BANK RESTORATION STA 25+86.00 - PLAN AND SECTIONS

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

Town of Carbondale
511 Colorado Ave
Carbondale, CO 81623

DESIGN FIRMS NAME AND ADDRESSES

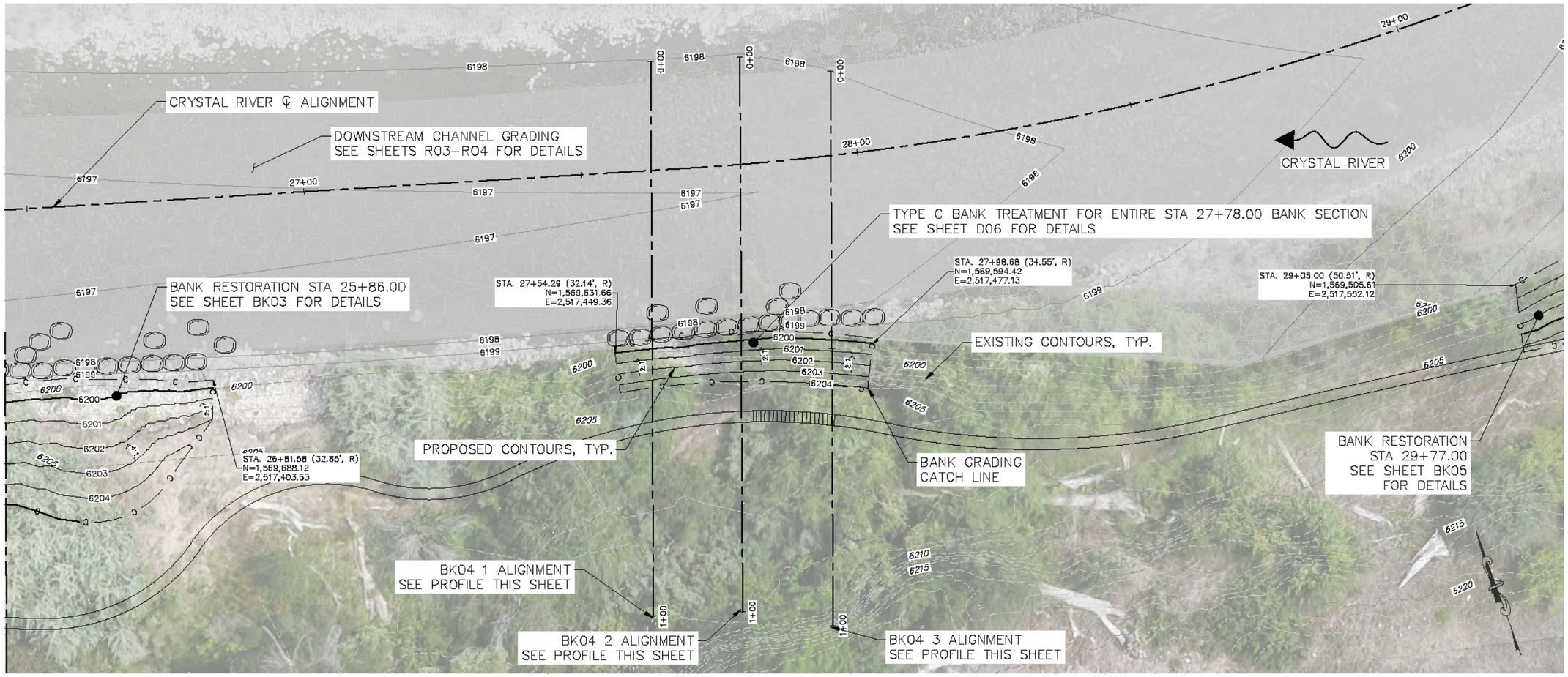
RiverRestoration.org, LLC
P.O. Box 248
Carbondale, CO 81623
www.RiverRestoration.org

DHM DESIGN
311 Main St. Suite 102
Carbondale, CO 81623
970.963.6520
www.dhmdesign.com

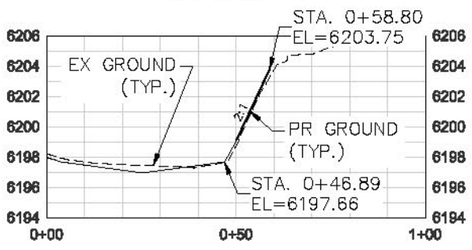
PROJECT NAME AND ADDRESS

Crystal River Restoration
and Weaver Ditch Efficiency Project
Carbondale, CO 81623

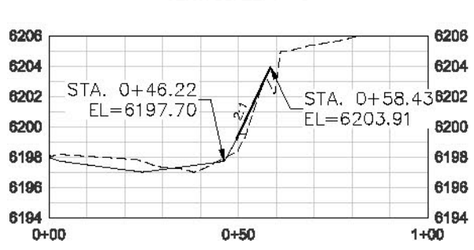
Project	Sheet
38047	BK03
Date: OCT 2019	
Scale: 1"= 10' AT FULL SIZE	



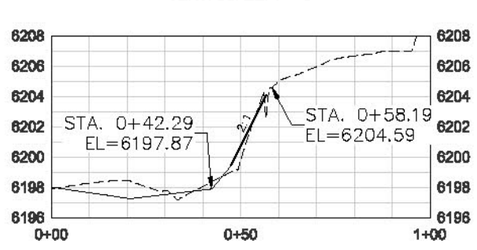
BK04 1 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



BK04 2 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



BK04 3 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



0 20 40 Feet

EXISTING GRADE	- - - - - - -
PROPOSED GRADE	———

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT
BANK RESTORATION STA 27+78.00 - PLAN AND SECTIONS

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

Town of Carbondale
511 Colorado Ave
Carbondale, CO 81623

DESIGN FIRMS NAME AND ADDRESSES

RiverRestoration.org, LLC
P.O. Box 248
Carbondale, CO 81623
www.RiverRestoration.org

DHM DESIGN
311 Main St, Suite 102
Carbondale, CO 81623
970.963.6520
www.dhmdesign.com

PROJECT NAME AND ADDRESS

Crystal River Restoration
and Weaver Ditch Efficiency Project
Carbondale, CO 81623

Project	Sheet
38047	BK04
Date: OCT 2019	
Scale: 1"= 10' AT FULL SIZE	

STA. 27+54.32 (32.14', R)
N=1,569,631.66
E=2,517,449.36

STA. 27+98.68 (34.55', R)
N=1,569,594.42
E=2,517,477.13

STA. 29+05.00 (50.51', R)
N=1,569,505.61
E=2,517,552.12

STA. 30+41.76 (36.47', R)
N=1,569,441.11
E=2,517,678.41

STA. 31+69.45 (37.37', R)
N=1,569,366.66
E=2,517,769.65

STA. 32+79.22 (30.98', R)
N=1,569,290.48
E=2,517,845.89

DOWNSTREAM CHANNEL GRADING
SEE SHEETS R05–R06 FOR DETAILS

RIFFLE AND RIFFLE GRADE CONTROL STRUCTURE
SEE SHEETS R01–R04 FOR DETAILS

RIFFLE GRADE
CONTROL STRUCTURE
KEY–IN TO BANK

CRYSTAL RIVER

EXISTING CONTOURS, TYP.

BANK STABILIZATION
STA 27+78.00
SEE SHEET BK04 FOR
DETAILS

TYPE C BANK TREATMENT FOR ENTIRE
STA 29+77.00 BANK SECTION
SEE SHEET D06 FOR DETAILS

BANK GRADING
CATCHES ADJACENT
EXISTING BANK GRADE
AT APPROXIMATELY 2:1
SLOPE

UPSTREAM CHANNEL GRADING
SEE SHEETS R05–R06 FOR DETAILS

BANK GRADING
CATCH LINE

BANK GRADING
CATCHES ADJACENT
EXISTING BANK GRADE
AT APPROXIMATELY 8:1
SLOPE

CRYSTAL RIVER ℄
ALIGNMENT

BK05 1 ALIGNMENT
SEE PROFILE THIS SHEET

BK05 2 ALIGNMENT
SEE PROFILE THIS SHEET

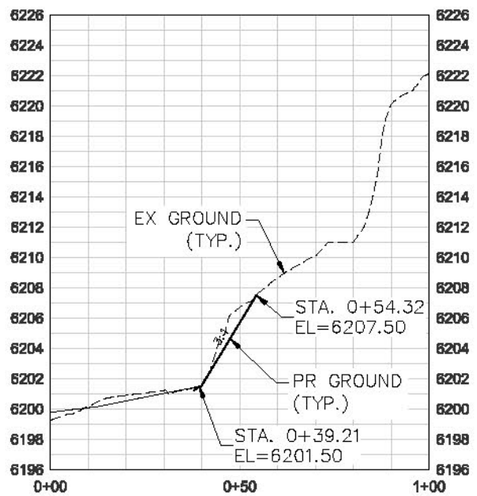
BK05 3 ALIGNMENT
SEE PROFILE THIS SHEET

PROPOSED CONTOURS, TYP.

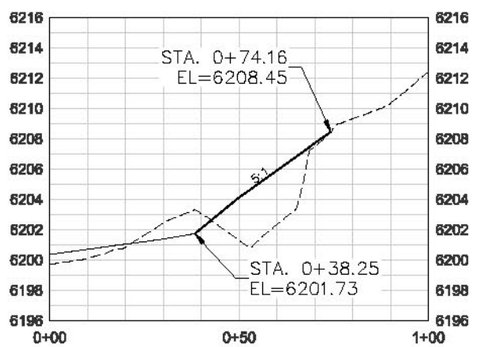
BANK STABILIZATION
STA 33+15.00
SEE SHEET BK06 FOR
DETAILS

0 20 40 Feet

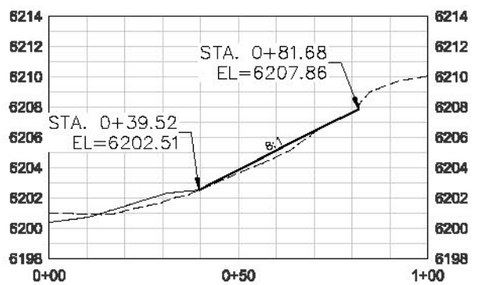
BK05 1 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



BK05 2 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



BK05 3 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



0 20 40 Feet

EXISTING GRADE	- - - - - - -
PROPOSED GRADE	———

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT
BANK RESTORATION STA 29+77.00 - PLAN AND SECTIONS

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

Town of Carbondale
511 Colorado Ave
Carbondale, CO 81623

DESIGN FIRMS NAME AND ADDRESSES

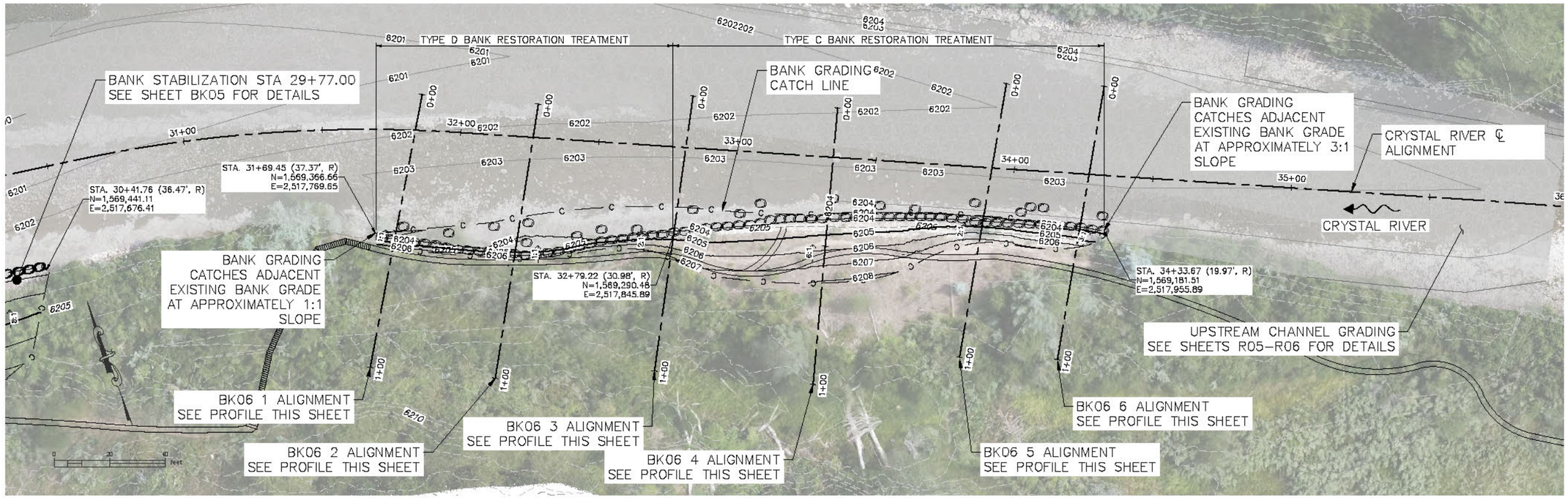
RiverRestoration.org, LLC
P.O. Box 248
Carbondale, CO 81623
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DHM DESIGN
311 Main St, Suite 102
Carbondale, CO 81623
970.963.6520
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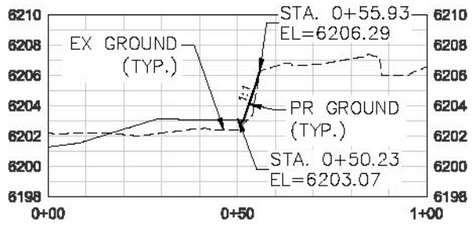
PROJECT NAME AND ADDRESS

Crystal River Restoration
and Weaver Ditch Efficiency Project
Carbondale, CO 81623

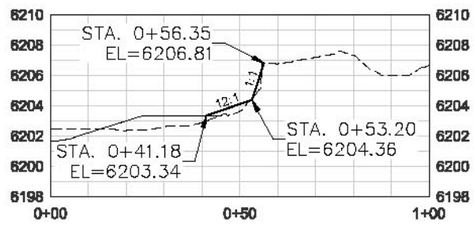
Project	Sheet
38047	BK05
Date: OCT 2019	
Scale: 1"=20' AT FULL SIZE	



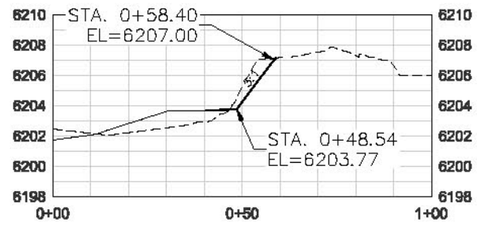
BK06 1 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



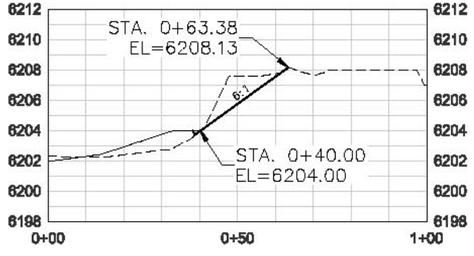
BK06 2 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



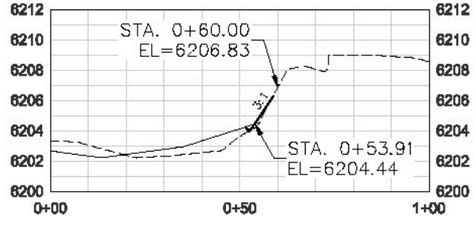
BK06 3 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



BK06 4 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



BK06 6 PROFILE
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 5'



EXISTING GRADE	- - - - - - -
PROPOSED GRADE	———

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT
BANK RESTORATION STA 33+15.00 - PLAN AND SECTIONS

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

Town of Carbondale
511 Colorado Ave
Carbondale, CO 81623

DESIGN FIRMS NAME AND ADDRESSES

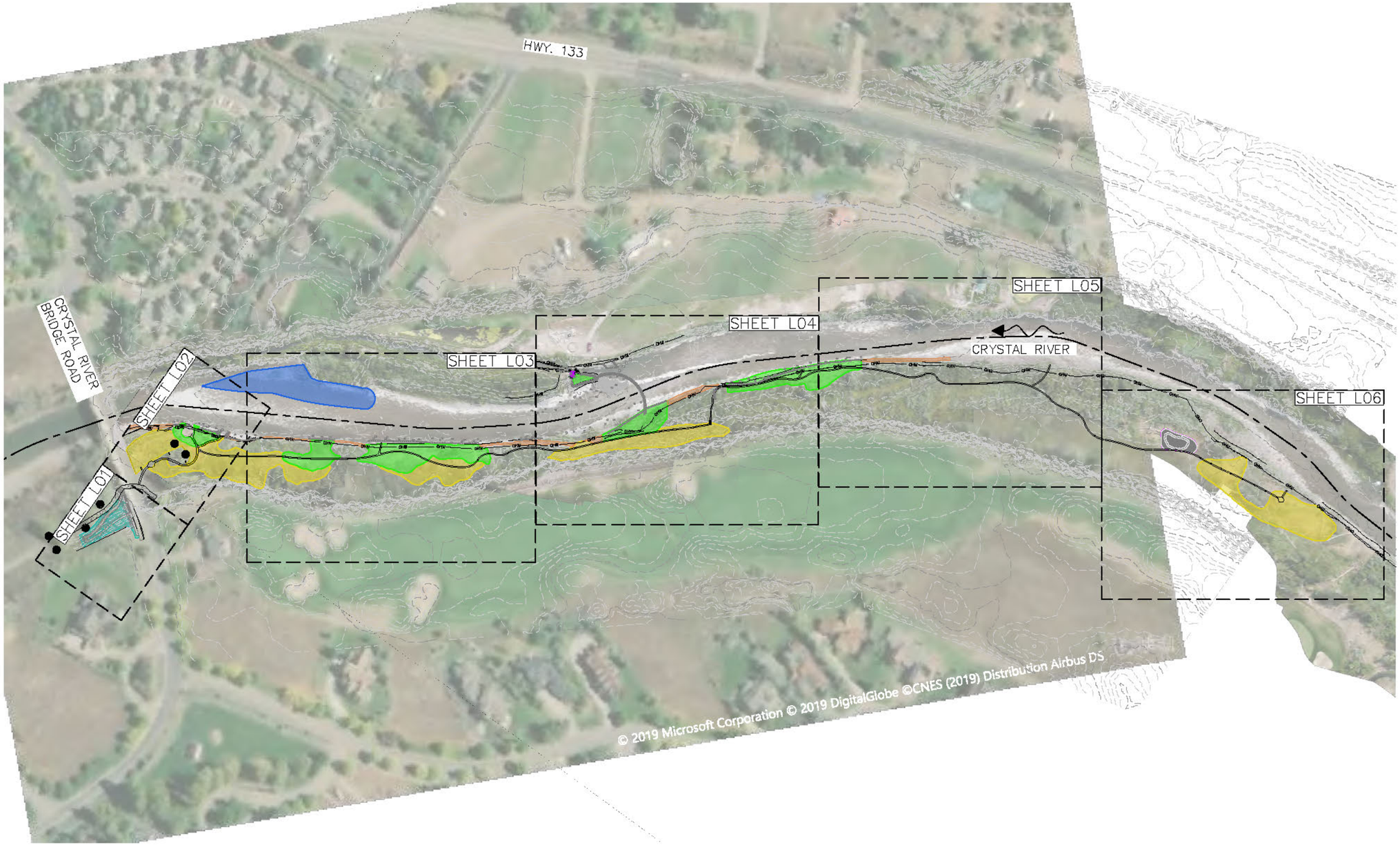
RiverRestoration.org, LLC
P.O. Box 248
Carbondale, CO 81623
www.RiverRestoration.org

DHM DESIGN
311 Main St, Suite 102
Carbondale, CO 81623
970.963.6520
www.dhmdesign.com

PROJECT NAME AND ADDRESS

Crystal River Restoration
and Weaver Ditch Efficiency Project
Carbondale, CO 81623

Project	Sheet
38047	BK06
Date: OCT 2019	
Scale: 1"=20' AT FULL SIZE	



CONSTRUCTION NOTES:

1) PROVIDE ALLOWANCE FOR 8 INTERPRETIVE SIGNS AND 2 KIOSK SIGNS.

0 100 200 Feet

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT
UPLAND IMPROVEMENTS - OVERVIEW

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

Town of Carbondale
511 Colorado Ave
Carbondale, CO 81623

DESIGN FIRMS NAME AND ADDRESSES

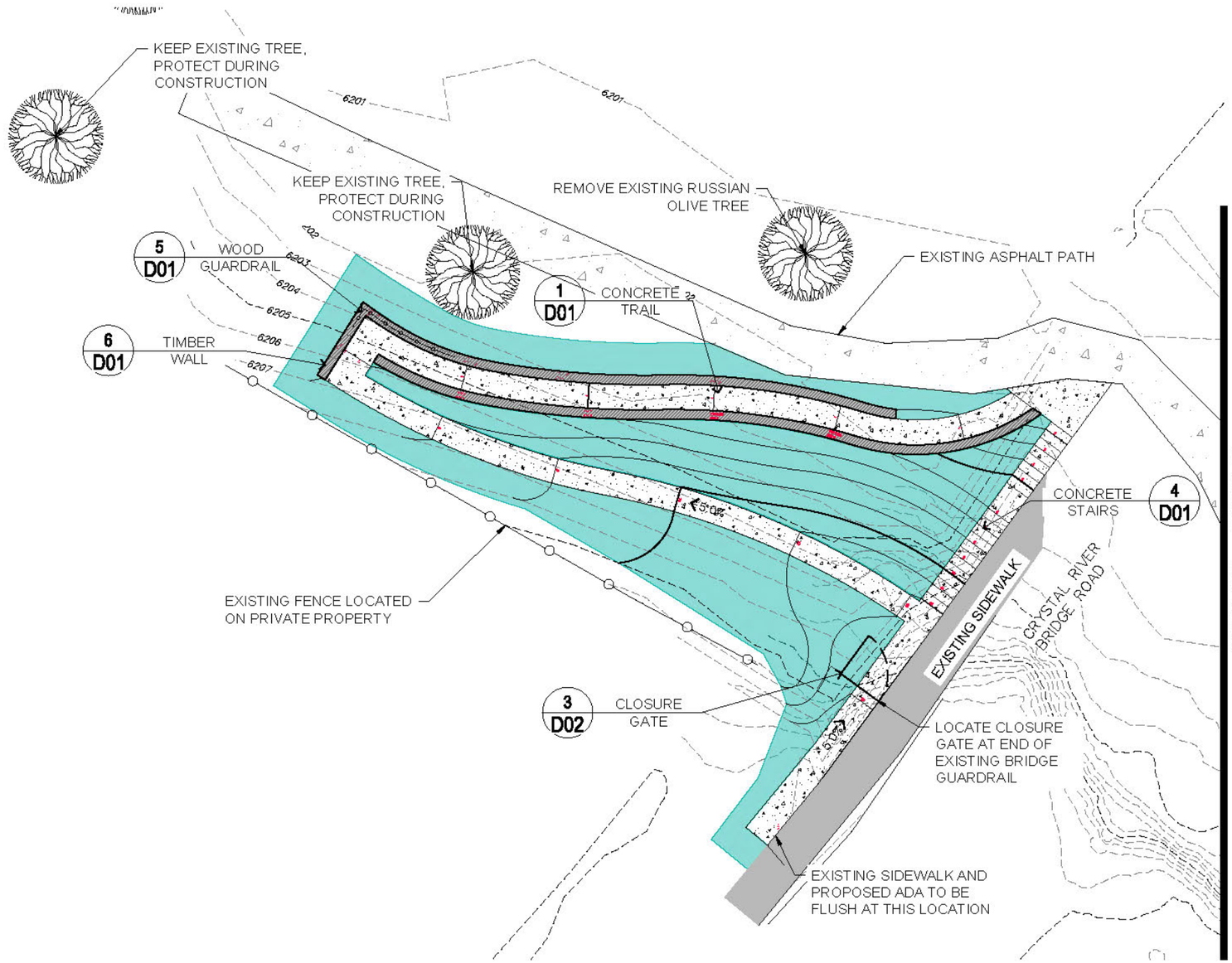
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PROJECT NAME AND ADDRESS

Crystal River Restoration
and Weaver Ditch Efficiency Project
Carbondale, CO 81623

Project	Sheet
38047	L00
Date: OCT 2019	
Scale: 1"=20' AT FULL SIZE	



CONSTRUCTION NOTES:

1) SEE SHEETS D01–D05 FOR PLANTING AND SEEDING LISTS, AND PLANTING DETAILS

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT ACCESSIBLE RAMP

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

Town of Carbondale
511 Colorado Ave
Carbondale, CO 81623

DESIGN FIRMS NAME AND ADDRESSES

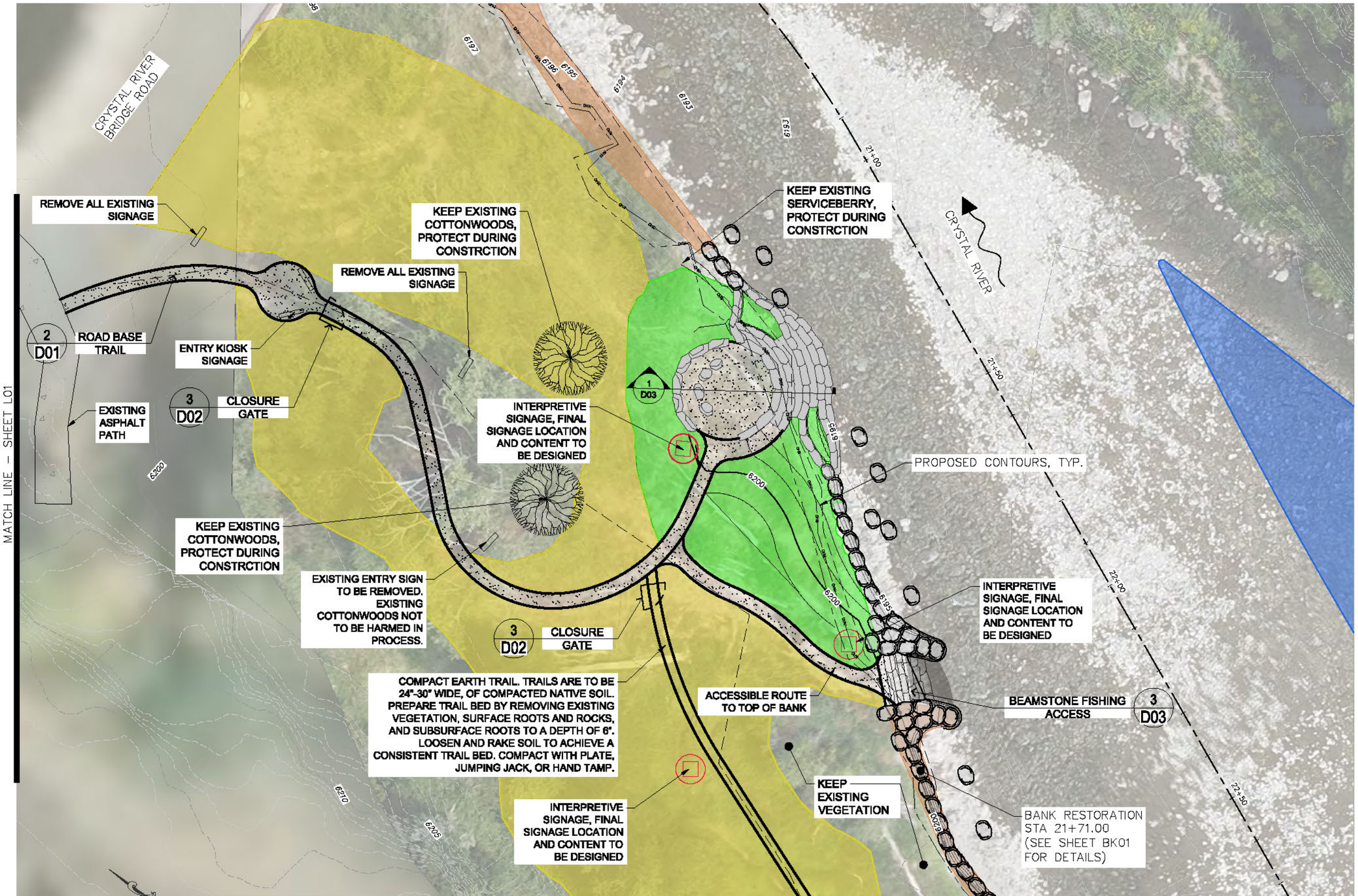
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P.O. Box 248
Carbondale, CO 81623
www.RiverRestoration.org

DHM DESIGN
311 Main St, Suite 102
Carbondale, CO 81623
970.963.6820
www.dhmdesign.com

PROJECT NAME AND ADDRESS

Crystal River Restoration
and Weaver Ditch Efficiency Project
Carbondale, CO 81623

Project	Sheet
38047	L01
Date: OCT 2019	
Scale: 1"= 10' AT FULL SIZE	



CONSTRUCTION NOTES:

1) SEE SHEETS D01–D05 FOR PLANTING AND SEEDING LISTS, AND PLANTING DETAILS
2) EXISTING DEADFALL WITHIN DISTURBANCE AREAS TO BE STOCKPILE AND FIELD LOCATED FOR HABITAT

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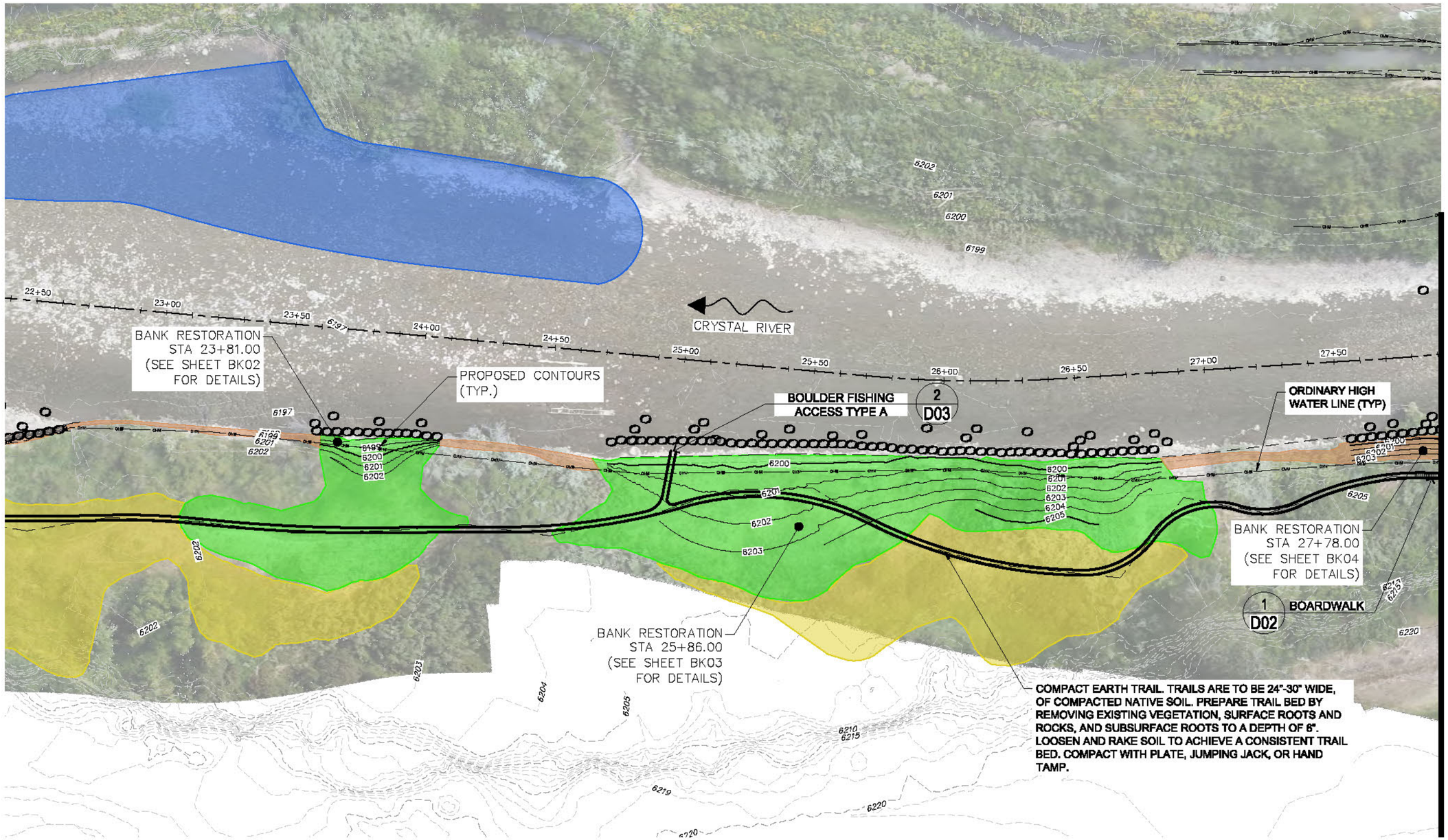
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Project	Sheet
38047	L02
Date: OCT 2019	
Scale: 1"= 20' AT FULL SIZE	



CONSTRUCTION NOTES:

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0 20 40 Feet

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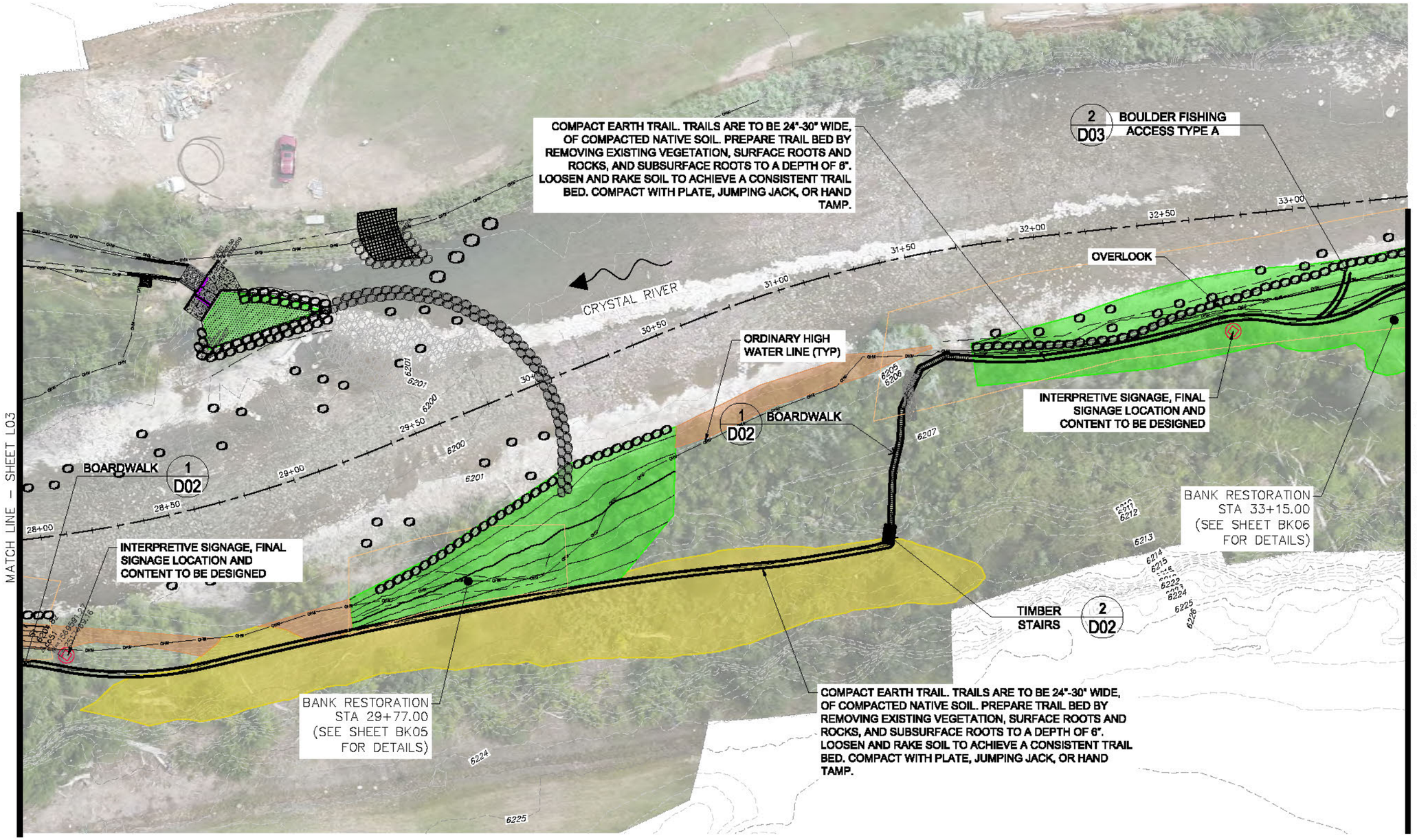
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Project	Sheet
38047	L03
Date: OCT 2019	
Scale: 1"= 20' AT FULL SIZE	



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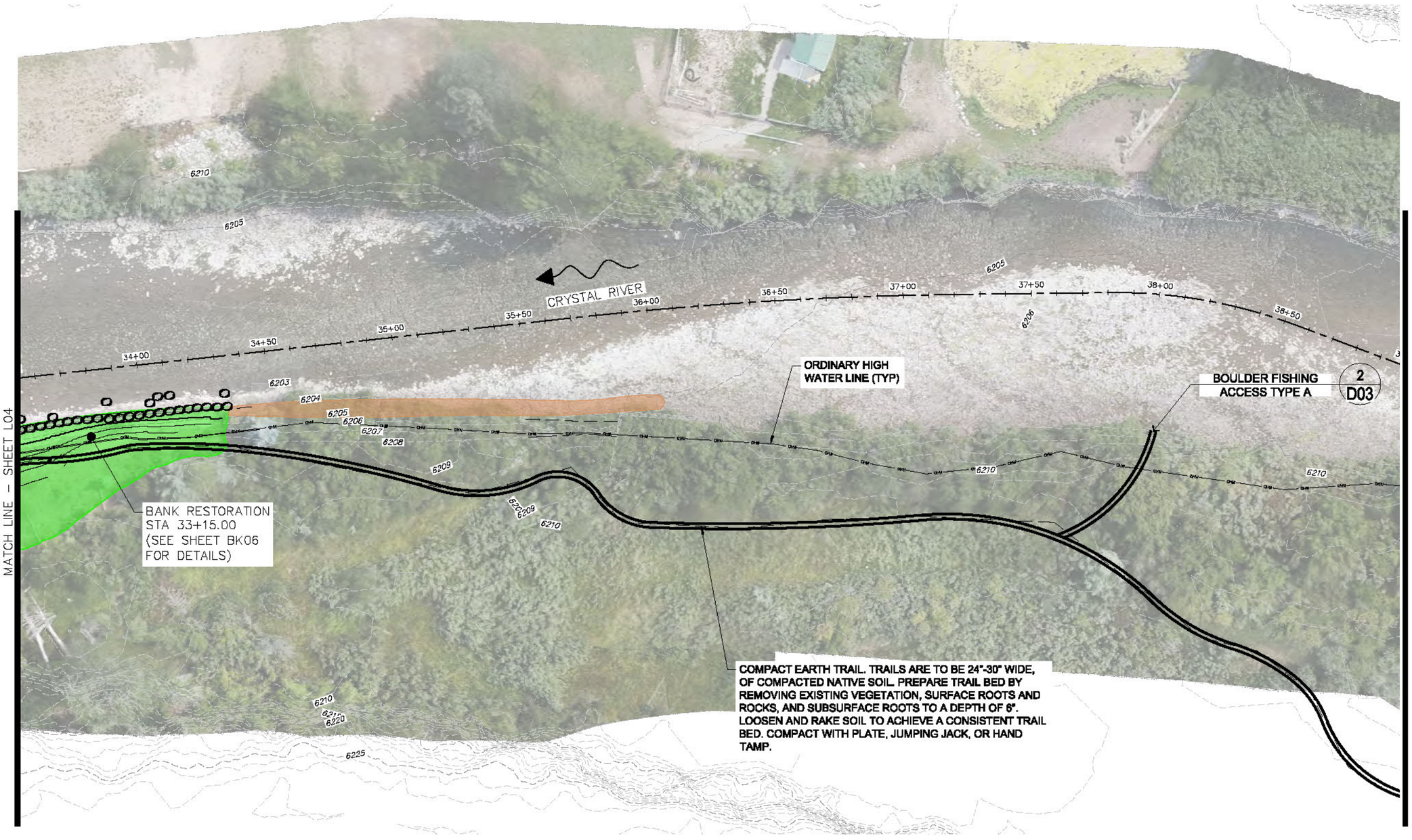
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Project	Sheet
38047	L04
Date: OCT 2019	
Scale: 1"=20' AT FULL SIZE	



CONSTRUCTION NOTES:

1) SEE SHEETS D01–D05 FOR PLANTING AND SEEDING LISTS, AND PLANTING DETAILS

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PRELIMINARY

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Project	Sheet
38047	L05
Date: OCT 2019	
Scale: 1"=20' AT FULL SIZE	

MATCH LINE – SHEET L05

INTERPRETIVE SIGNAGE, FINAL SIGNAGE LOCATION AND CONTENT TO BE DESIGNED

SEE INSET

ORDINARY HIGH WATER LINE (TYP)

CRYSTAL RIVER

INTERPRETIVE SIGNAGE, FINAL SIGNAGE LOCATION AND CONTENT TO BE DESIGNED

INTERPRETIVE SIGNAGE, FINAL SIGNAGE LOCATION AND CONTENT TO BE DESIGNED

BOULDER FISHING ACCESS TYPE B

4
D03

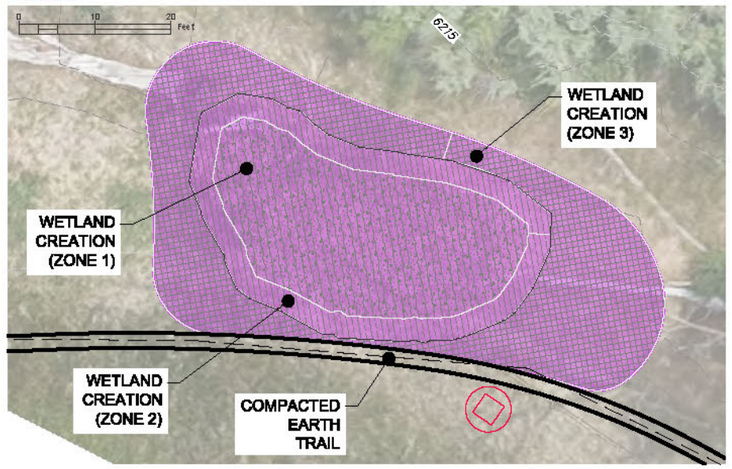
COMPACT EARTH TRAIL. TRAILS ARE TO BE 24"-30" WIDE, OF COMPACTED NATIVE SOIL. PREPARE TRAIL BED BY REMOVING EXISTING VEGETATION, SURFACE ROOTS AND ROCKS, AND SUBSURFACE ROOTS TO A DEPTH OF 6". LOOSEN AND RAKE SOIL TO ACHIEVE A CONSISTENT TRAIL BED. COMPACT WITH PLATE, JUMPING JACK, OR HAND TAMP.

0 20 40 Feet

CONSTRUCTION NOTES:

1) SEE SHEETS D01–D05 FOR PLANTING AND SEEDING LISTS, AND PLANTING DETAILS

INSET



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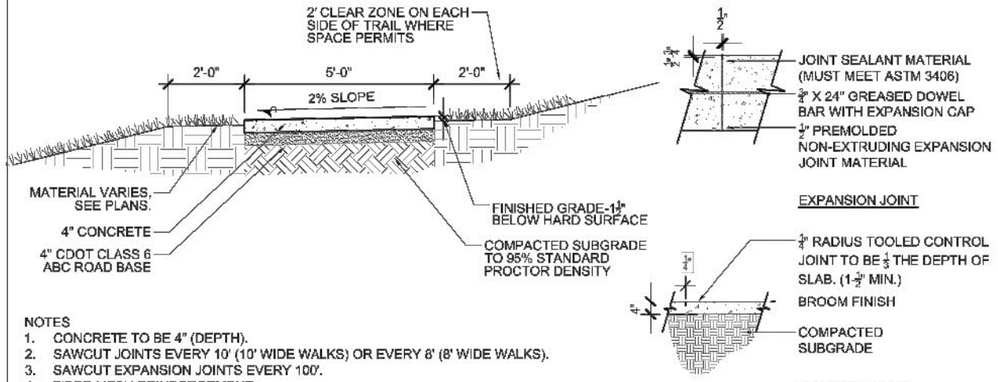
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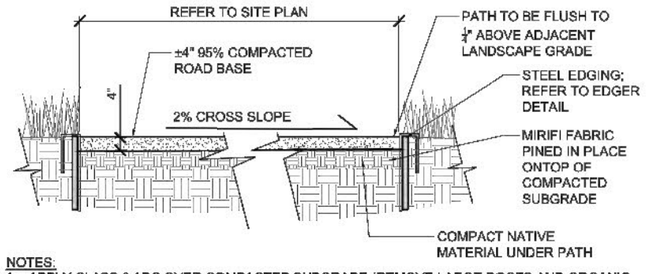
Project	Sheet
38047	L06
Date: OCT 2019	
Scale: 1"= 20' AT FULL SIZE	



NOTES
1. CONCRETE TO BE 4" (DEPTH).
2. SAWCUT JOINTS EVERY 10' (10' WIDE WALKS) OR EVERY 6' (8' WIDE WALKS).
3. SAWCUT EXPANSION JOINTS EVERY 100'.
4. FIBER MESH REINFORCEMENT.
5. 3000 PSI AT 28 DAYS.
6. CROSS SLOPE SHOULD FOLLOW NATURAL SLOPE OF SURROUNDING GRADE .
7. SEE PLANS FOR LAYOUT .
8. ALL CONCRETE WALKS TO HAVE BROOM FINISH .
9. CREATE A 2'-0" SHOULDER ON EACH SIDE OF CONCRETE WALK WHERE SPACE ALLOWS.
10. LONGITUDINAL SLOPE TO BE 5% MAX.

1 / D01 — CONCRETE TRAIL

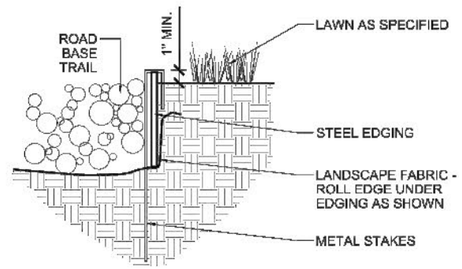
SCALE: 1/2" = 1'-0"



NOTES:
1. APPLY CLASS 6 ABC OVER COMPACTED SUBGRADE (REMOVE LARGE ROOTS AND ORGANIC MATERIAL FROM SURFACE OF SUB-GRADE.) INSTALL CLASS 6 ABC TO A DEPTH OF 4" IN TWO EQUAL LIFTS, MOISTEN AND COMPACT. COMPACT WITH PLATE OR VIBRATORY ROLLER.
2. PROVIDE SAMPLES OF MATERIAL FOR OWNER SELECTION.
3. WIDTH OF PATH VARIES, SEE SITE PLANS.
4. CROSS SLOPE DIRECTION TO BE DETERMINED IN FIELD.

2 / D01 — ROAD BASE PATH

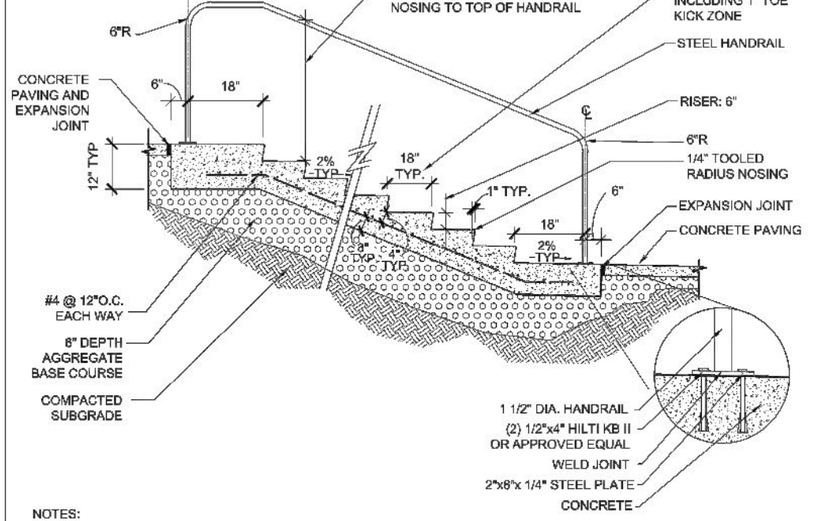
NOT TO SCALE



NOTES:
1. SET ALL EDGING 1" ABOVE FINISH GRADE AS SHOWN.
2. EDGING SHALL ABUT ALL CONCRETE CURBS AND WALKS PERPENDICULAR, AND FLUSH W/ GRADES OF CONCRETE.
3. ALL JOINTS TO BE SECURELY STAKED.
4. EDGER TO BE 12 GAUGE, 4" DEPTH; POWDER-COATED BROWN.

3 / D01 — STEEL EDGER

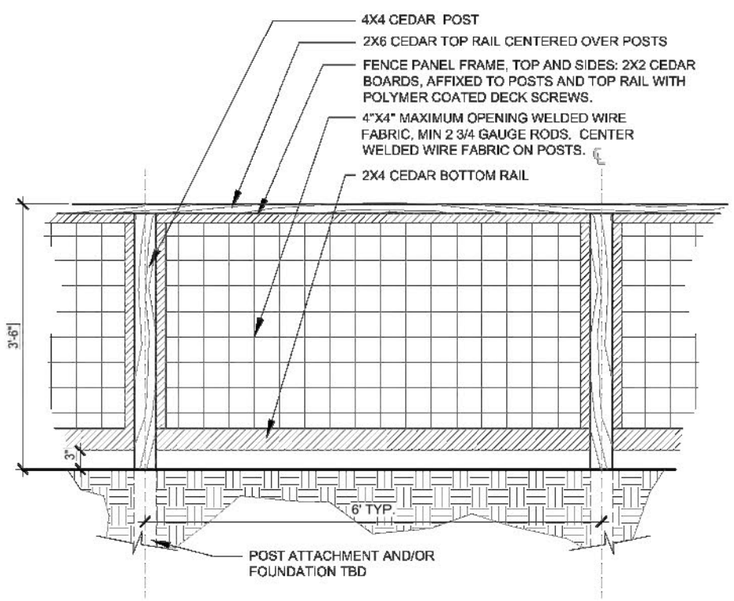
NOT TO SCALE



NOTES:
1. SEE PLAN SET FOR NUMBER AND LOCATION OF TREADS AND RISERS.
2. PROVIDE SHOP DRAWINGS FOR HANDRAIL ASSEMBLY FOR APPROVAL BY A LICENSED STRUCTURAL ENGINEER PRIOR TO CONSTRUCTION.
3. STAIRS WITH 3 OR MORE RISERS REQUIRE HANDRAIL ON BOTH SIDES.
4. STAIR SETS WITH 6 OR MORE RISERS REQUIRE INTERMEDIATE POST AT MIDPOINT OF RAIL. SET POSTS EQ. DISTANCE APART. INTERMEDIATE POST MATERIAL, ANCHOR, AND FINISH TO MATCH REST OF HANDRAIL.
5. ALL CONCRETE TREADS TO HAVE 1" RADIUS TOOLED EDGE NOSING.
6. ALL HANDRAIL JOINTS TO BE WELDED. GRIND WELDS SMOOTH. HANDRAIL TO BE WELDED AND FINISHED PRIOR TO INSTALLATION.

4 / D01 — CONCRETE STAIRS

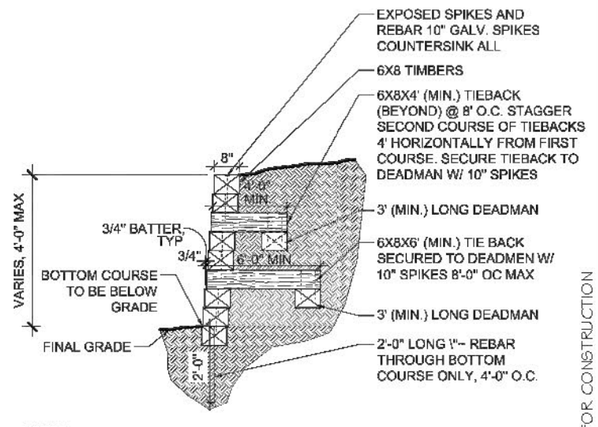
NOT TO SCALE



NOTES
1) ALL CEDAR MEMBERS TO BE SMOOTH-SAWN AND FINISHED WITH CLEAR FENCE SEALANT.
2) FIXING HARDWARE TO BE POLYMER COATED DECK/FENCE SCREWS.
3) WELDED WIRE FABRIC TO BE GALVANIZED.

5 / D01 — WOOD GUARDRAIL

SCALE: 1" = 1'-0"



NOTES:
1. ALL TIMBERS WILL BE 6"x8"x8' SELECT, PRESSURE TREATED, FREE OF MAJOR SURFACE DEFECTS, CRACKS & WARPING.
2. EACH 8'-0" LENGTH OF TIMBER TO RECEIVE A MINIMUM OF FOUR (4)- 10" GALVANIZED SPIKES (MIN. 2' O.C.). SHORT LENGTHS WILL RECEIVE AS MANY SPIKES AS NECESSARY TO PROPERLY SECURE TIMBERS. STAGGER TIMBERS AT JOINTS 2'-0" MIN.

6 / D01 — TIMBER WALL

SCALE: 1" = 1'-0"

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UPLAND IMPROVEMENT DETAILS

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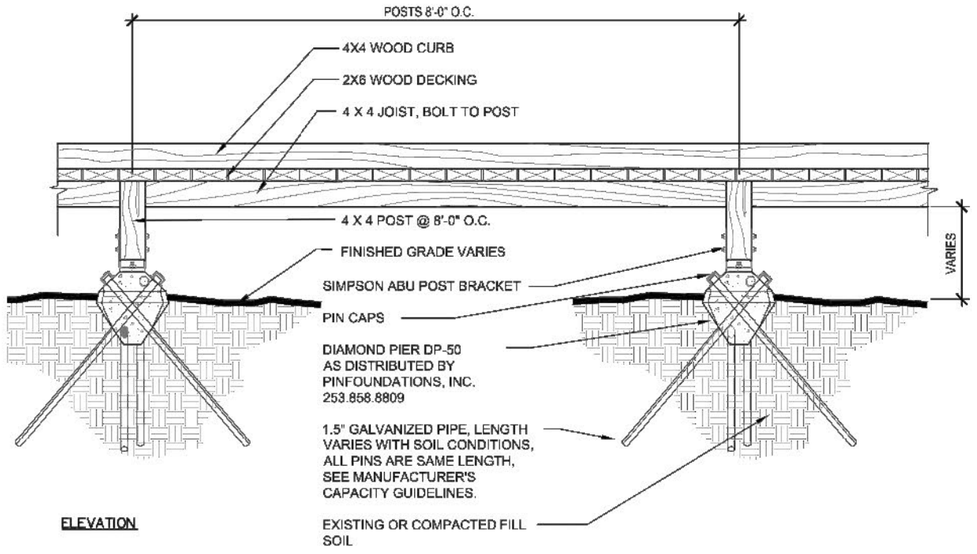
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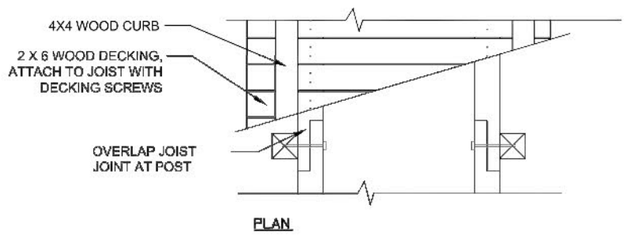
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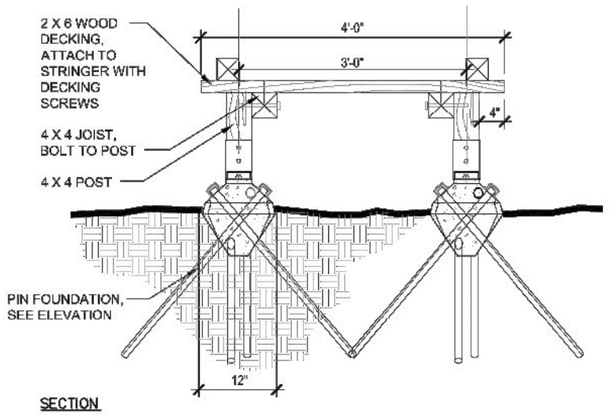
Project	Sheet
38047	D01
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ELEVATION



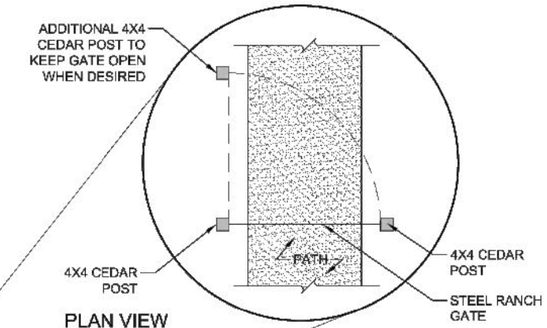
PLAN



SECTION

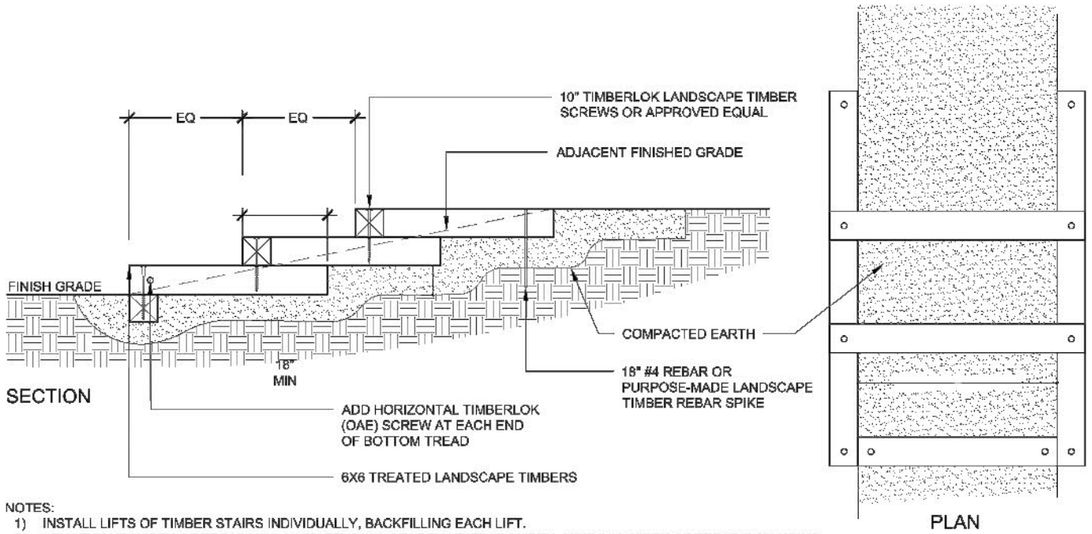
1 D02 BOARDWALK

SCALE: 1" = 1'-0"



PLAN VIEW

SCALE: 1/2" = 1'-0"



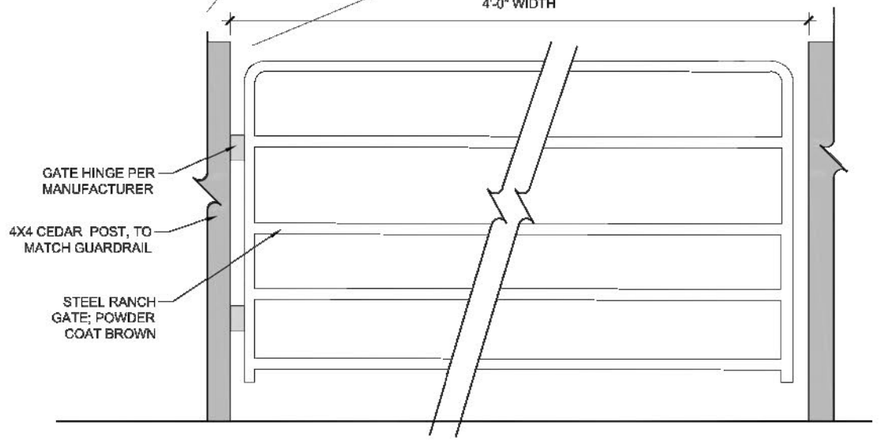
SECTION

PLAN

NOTES:
1) INSTALL LIFTS OF TIMBER STAIRS INDIVIDUALLY, BACKFILLING EACH LIFT.
2) LENGTH AND WIDTH OF TREAD WILL VARY PENDING GRADE AND TRAIL WIDTH. MINIMUM WIDTH OF TREAD (INCLUDING LANDSCAPE TIMBERS) TO BE 3'. MINIMUM TREAD LENGTH 12". TREADS TO BE EQUAL LENGTH FOR ENTIRE RUN OF STAIR.

2 D02 TIMBER STAIRS

SCALE: 3/4' = 1'-0"



NOTES
1) ALL CEDAR MEMBERS TO BE SMOOTH-SAWN AND FINISHED WITH CLEAR FENCE SEALANT.
2) FIXING HARDWARE TO BE POLYMER COATED DECK/FENCE SCREWS.
3) CLOSURE GATESS TO INCLUDE CLOSURE SIGNAGE. SIGNAGE TO BE DEVELOPED IN FUTURE PHASES BY OTHERS.

3 D02 CLOSURE GATE

SCALE: 1" = 1'-0"

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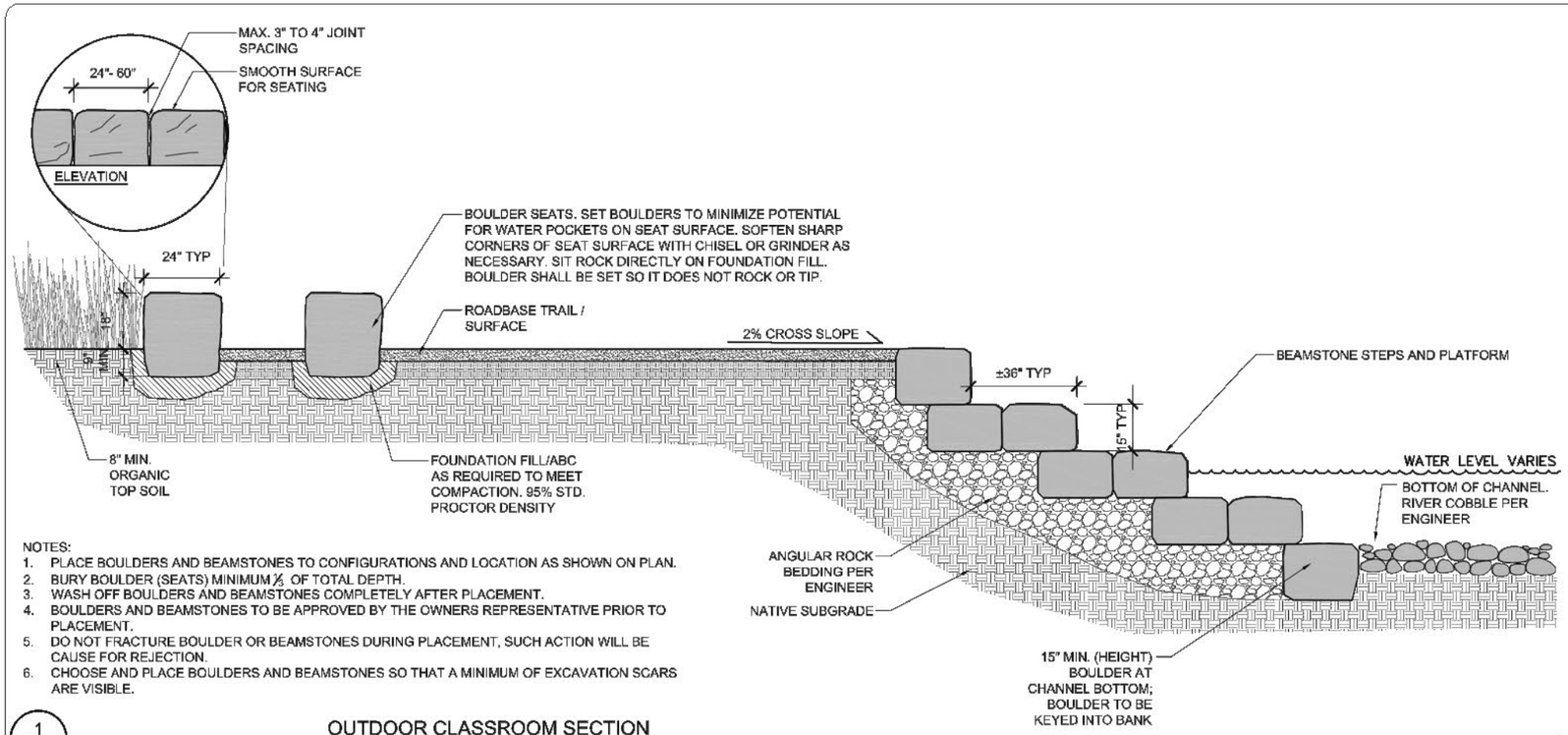
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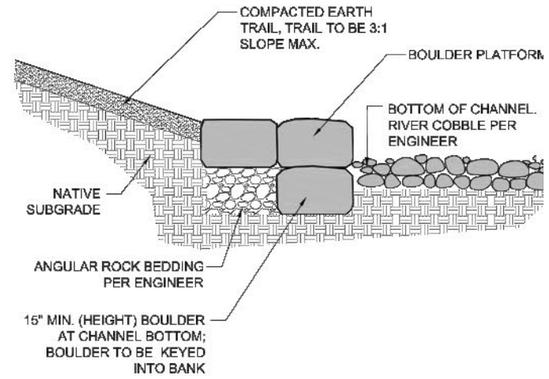
Project	Sheet
38047	D02
Date: OCT 2019	
Scale: NOT TO SCALE	



NOTES:
1. PLACE BOULDERS AND BEAMSTONES TO CONFIGURATIONS AND LOCATION AS SHOWN ON PLAN.
2. BURY BOULDER (SEATS) MINIMUM ⅓ OF TOTAL DEPTH.
3. WASH OFF BOULDERS AND BEAMSTONES COMPLETELY AFTER PLACEMENT.
4. BOULDERS AND BEAMSTONES TO BE APPROVED BY THE OWNERS REPRESENTATIVE PRIOR TO PLACEMENT.
5. DO NOT FRACTURE BOULDER OR BEAMSTONES DURING PLACEMENT, SUCH ACTION WILL BE CAUSE FOR REJECTION.
6. CHOOSE AND PLACE BOULDERS AND BEAMSTONES SO THAT A MINIMUM OF EXCAVATION SCARS ARE VISIBLE.

1 / D03 OUTDOOR CLASSROOM SECTION

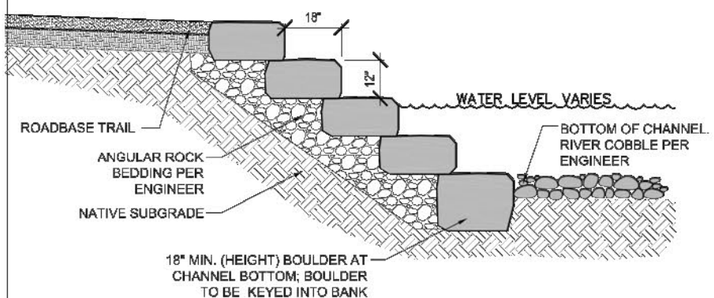
SCALE: 1/2" = 1'-0"



NOTES:
1. DO NOT FRACTURE BOULDER DURING PLACEMENT, SUCH ACTION WILL BE CAUSE FOR REJECTION.
2. CHOOSE AND PLACE BOULDERS SO THAT A MINIMUM OF EXCAVATION SCARS ARE VISIBLE.
3. BOULDERS TO BE SELECTED TO PROVIDE A FLAT AND LEVEL STEPPING SURFACE.
4. INSTALL BOULDER BETWEEN ANY TRAIL/COBBLE INTERFACE.

2 / D03 BOULDER FISHING ACCESS TYPE A

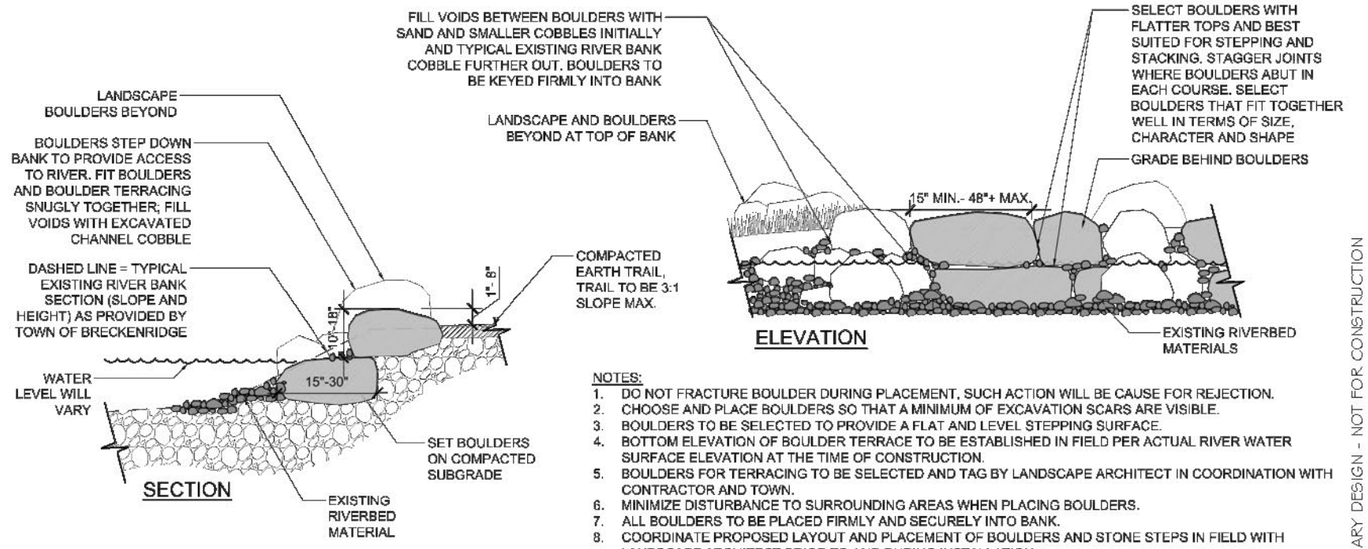
SCALE: 1/2" = 1'-0"



NOTES:
1. PLACE BEAMSTONES TO CONFIGURATIONS AND LOCATION AS SHOWN ON PLAN.
2. WASH OFF BEAMSTONES COMPLETELY AFTER PLACEMENT.
3. BEAMSTONES TO BE APPROVED BY THE OWNERS REPRESENTATIVE PRIOR TO PLACEMENT.
4. DO NOT FRACTURE BEAMSTONES DURING PLACEMENT, SUCH ACTION WILL BE CAUSE FOR REJECTION.
5. CHOOSE AND PLACE BEAMSTONES SO THAT A MINIMUM OF EXCAVATION SCARS ARE VISIBLE.

3 / D03 BEAMSTONE FISHING ACCESS

SCALE: 1/2" = 1'-0"



NOTES:
1. DO NOT FRACTURE BOULDER DURING PLACEMENT, SUCH ACTION WILL BE CAUSE FOR REJECTION.
2. CHOOSE AND PLACE BOULDERS SO THAT A MINIMUM OF EXCAVATION SCARS ARE VISIBLE.
3. BOULDERS TO BE SELECTED TO PROVIDE A FLAT AND LEVEL STEPPING SURFACE.
4. BOTTOM ELEVATION OF BOULDER TERRACE TO BE ESTABLISHED IN FIELD PER ACTUAL RIVER WATER SURFACE ELEVATION AT THE TIME OF CONSTRUCTION.
5. BOULDERS FOR TERRACING TO BE SELECTED AND TAG BY LANDSCAPE ARCHITECT IN COORDINATION WITH CONTRACTOR AND TOWN.
6. MINIMIZE DISTURBANCE TO SURROUNDING AREAS WHEN PLACING BOULDERS.
7. ALL BOULDERS TO BE PLACED FIRMLY AND SECURELY INTO BANK.
8. COORDINATE PROPOSED LAYOUT AND PLACEMENT OF BOULDERS AND STONE STEPS IN FIELD WITH LANDSCAPE ARCHITECT PRIOR TO AND DURING INSTALLATION.

4 / D03 BOULDER FISHING ACCESS TYPE B

SCALE: 1/2" = 1'-0"

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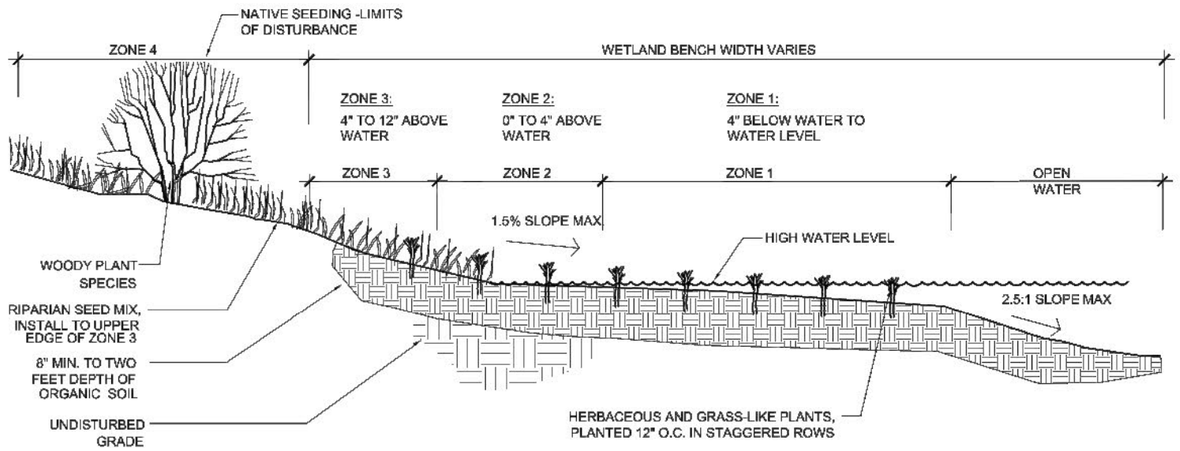
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PROJECT NAME AND ADDRESS

Crystal River Restoration
and Weaver Ditch Efficiency Project
Carbondale, CO 81623

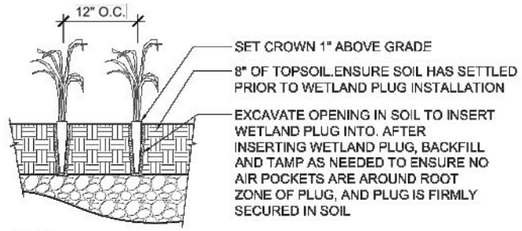
Project	Sheet
38047	D03
Date: OCT 2019	
Scale: NOT TO SCALE	



PLANTING NOTES:
1. ALL WOODY AND HERBACEOUS PLANT MATERIAL TO BE PLACED IN APPROPRIATE, FIELD VERIFIED HYDROLOGIC ZONE. TO BE VERIFIED IN FIELD BY LANDSCAPE ARCHITECT PRIOR TO COMPLETION.
2. ALL DISTURBED SOIL SHALL BE SEEDED WITH THE RIPARIAN SEED MIX .

1 D04 — TYPICAL WETLAND CROSS SECTION

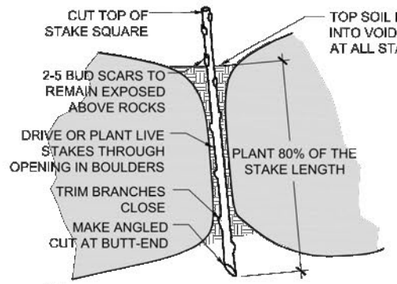
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NOTES:
1. COORDINATE WETLAND PLUG DELIVERY, WATER LEVELS PRE AND POST PLANTING, AND SEQUENCE OF WETLAND PLUG AND OTHER PLANT INSTALLATION WITH DHM DESIGN, TOWN OF CARBONDALE, AND INSTALLATION TEAM.

2 D04 — WETLAND PLUG INSTALLATION

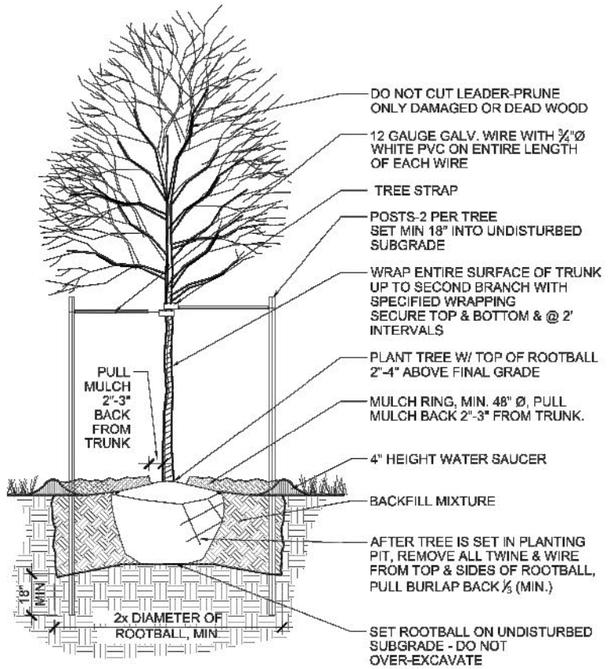
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NOTES:
1. LIVE STAKES TO BE 24" LONG MIN. BY 3/4"- 3" DIAMETER.
2. TYPICAL SPACING TO BE 1-3' APART.
3. HARVEST AND PLANT STAKES DURING THE DORMANT SEASON.
4. USE HEALTHY, STRAIGHT, AND LIVE WOOD AT LEAST 1 YEAR OLD.
5. MAKE CLEAN CUTS AND DO NOT DAMAGE STAKES OR SPLIT ENDS DURING INSTALLATION. USE A PILOT BAR IN FIRM SOILS.
6. SOAK CUTTINGS FOR 24 HOURS (MIN) PRIOR TO INSTALLATION.
7. TAMP THE SOIL AROUND THE STAKE.

3 D04 — LIVE STAKING DETAIL

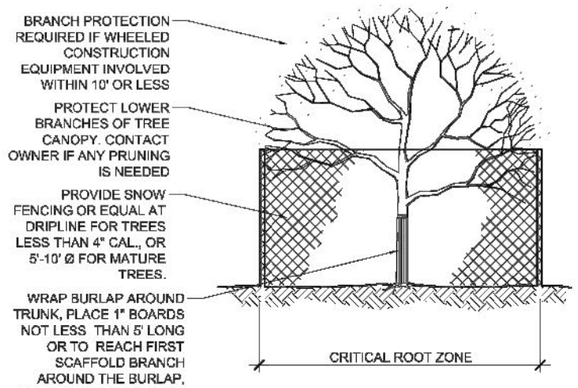
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NOTE: MULCH SHOULD BE 4" DEEP.

4 D04 — DECIDUOUS TREE PLANTING

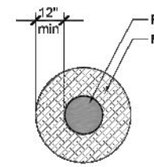
NOT TO SCALE



NOTES
1. CONTRACTOR WILL PRESERVE & PROTECT EXISTING TREES ON SITE, DURING DEMOLITION AND CONSTRUCTION OPERATIONS AS NECESSARY, INCLUDING CANOPIES, TRUNKS, AND ROOT SYSTEMS.
2. TREES THAT ARE IN PERIL OF DAMAGE, OR TREES WITHIN 10' OF DEMOLITION OF CONSTRUCTION ACTIVITIES, OR TREES IDENTIFIED SPECIFICALLY BY OWNER, SHALL RECEIVE TREE PROTECTION.
3. CONTRACTOR SHALL CONTACT OWNER IF FIELD CONDITIONS ARE SIGNIFICANTLY DIFFERENT THAT WHAT IS SHOWN ON THE PLANS.
4. IT IS ACKNOWLEDGED THAT CONSTRUCTION AND DEMOLITION ACTIVITIES WILL OCCUR CLOSE TO TRUNKS AND OVER CRITICAL ROOT ZONES. HOWEVER, THE CONTRACTOR WILL AVOID ALL UNNECESSARY DAMAGE TO TREES.
5. IN AREAS WHERE FENCING WILL INTERFERE WITH TRAIL CONSTRUCTION, OR WHERE FENCING CANNOT BE INSTALLED, WRAP TRUNK WITH BURLAP AS PER DETAIL. CONSULT WITH OWNER PRIOR TO APPLYING PROTECTIVE WRAP TO VERIFY CONDITIONS.
6. ALL DISTURBED ROOTS SHALL BE TRIMMED TO BE CLEAN CUTS. DO NOT LEAVE BARE ROOTS EXPOSED. COVER WITH A BREATHABLE TEMPORARY COVER SUCH AS GEOTECH FABRIC AND A 1" LAYER OF SOIL IF ROOTS ARE TO BE UNCOVERED FOR MORE THAN ONE DAY. WATER AS NECESSARY TO KEEP ROOTS ALIVE.

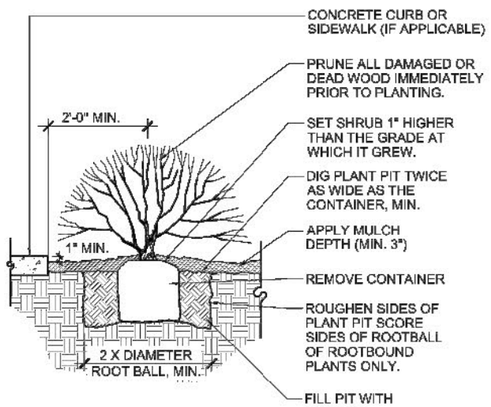
5 D04 — TREE PROTECTION DETAIL

NOT TO SCALE



NOTE:
MULCH ALL SHRUBS PLANTED IN NATIVE SEED AREAS A MINIMUM OF 12" BEYOND ROOT BALL.

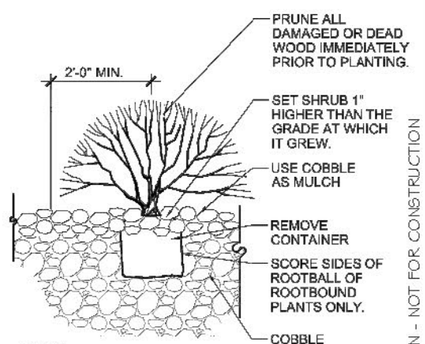
MULCHING SHRUBS IN NATIVE SEED AREAS



NOTES:
1. ANY BROKEN OR CRUMBLING ROOTBALLS WILL BE REJECTED.
2. REMOVING THE CONTAINERS WILL NOT BE AN EXCUSE FOR DAMAGED ROOTBALLS.
3. HOLD GRADE 1" BELOW EDGE OF WALK OR CURB

6 D04 — SHRUB PLANTING (IN NATIVE AREAS)

NOT TO SCALE



NOTES:
1. ANY BROKEN OR CRUMBLING ROOTBALLS WILL BE REJECTED.
2. REMOVING THE CONTAINERS WILL NOT BE AN EXCUSE FOR DAMAGED ROOTBALLS.

7 D04 — SHRUB PLANTING (AT COBBLE ISLAND)

NOT TO SCALE

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT

WETLAND, TREE AND SHRUB PLANTING DETAILS

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

Town of Carbondale
511 Colorado Ave
Carbondale, CO 81623

DESIGN FIRMS NAME AND ADDRESSES

RiverRestoration.org, LLC
P.O. Box 248
Carbondale, CO 81623
www.RiverRestoration.org

DHM DESIGN
311 Main St, Suite 102
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970.963.6520
www.dhmdesign.com

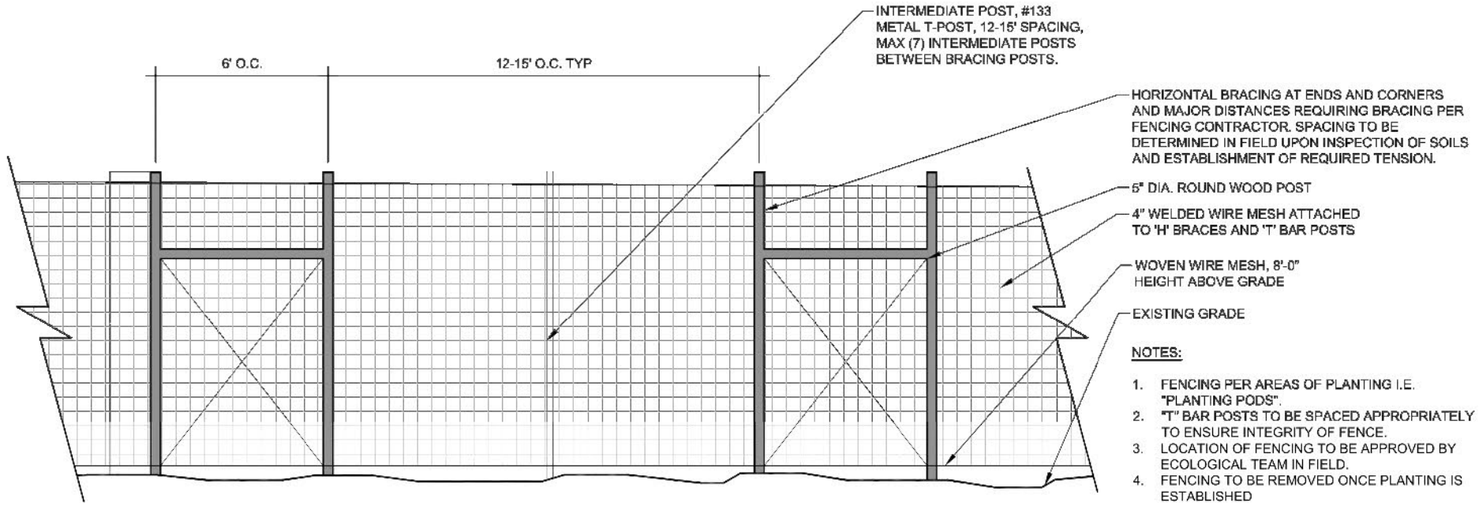
PROJECT NAME AND ADDRESS

Crystal River Restoration
and Weaver Ditch Efficiency Project
Carbondale, CO 81623

Project	Sheet
38047	D04
Date: OCT 2019	
Scale: NOT TO SCALE	

PLANTING NOTES

1. TO THE MAXIMUM EXTENT POSSIBLE, TOPSOIL THAT IS REMOVED DURING CONSTRUCTION ACTIVITY SHALL BE CONSERVED FOR LATER USE ON AREAS REQUIRING REVEGETATION AND RESTORATION.
2. SHRUBS AND TREES TO BE PLANTED IN GROUPS.
3. THE CONTRACTOR ASSUMES RESPONSIBILITY FOR NOXIOUS VEGETATION CONTROL AND MONITORING. NOXIOUS VEGETATION CONTROL METHODS AND SCHEDULE TO BE REVIEWED AND APPROVED BY THE LANDSCAPE ARCHITECT.
4. THE CONTRACTOR SHALL STAKE ALL KEY RESTORATION AREAS AND SHALL RECEIVE APPROVAL FROM THE OWNER'S REPRESENTATIVE PRIOR TO PROCEEDING WITH CONSTRUCTION.
5. BOUNDARY OF RESTORATION SEEDING TO BE OUTLINED IN THE FIELD BY LANDSCAPE ARCHITECT.
6. CONTRACTOR SHALL NOT WILLFULLY PROCEED WITH CONSTRUCTION AS DESIGNED WHEN IT IS OBVIOUS THAT UNKNOWN OBSTRUCTIONS, AREA DISCREPANCIES AND/OR GRADE DIFFERENCES EXIST THAT MAY NOT HAVE BEEN KNOWN DURING DESIGN. SUCH CONDITIONS SHALL BE IMMEDIATELY BROUGHT TO THE ATTENTION OF THE OWNER'S AUTHORIZED REPRESENTATIVE. THE CONTRACTOR SHALL ASSUME FULL RESPONSIBILITY FOR ALL NECESSARY REVISIONS DUE TO FAILURE TO GIVE SUCH NOTIFICATIONS.
7. CONTRACTOR SHALL BE RESPONSIBLE FOR MAKING HIMSELF FAMILIAR WITH ALL UNDERGROUND UTILITIES, PIPES AND STRUCTURES. CONTRACTOR SHALL TAKE SOLE RESPONSIBILITY FOR COSTS INCURRED DUE TO DAMAGE AND THE REPLACEMENT OF SAID UTILITIES. LOCATION OF EXISTING UTILITIES SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO ACTUAL CONSTRUCTION. FOR INFORMATION CONTACT: UTILITY NOTIFICATION CENTER OF COLORADO, 303.232.1991 OR 8-1-1.
8. CONTRACTOR TO CONTACT THE UTILITY NOTIFICATION CENTER OF COLORADO BEFORE DIGGING, INCLUDING BUT NOT LIMITED TO, TRENCHING AND SHRUB AND TREE PLANTING PITS. IF UTILITIES OCCUR AT LOCATIONS OF PROPOSED SHRUBS, OR WITHIN EIGHT (8) FEET OF PROPOSED TREES, THE CONTRACTOR SHALL REPORT SUCH CONDITIONS TO THE OWNER'S REPRESENTATIVE. DAMAGE TO EXISTING UTILITIES BY THE LANDSCAPE CONTRACTOR IS THE RESPONSIBILITY OF THE LANDSCAPE CONTRACTOR.
9. ALL EXISTING IMPROVEMENTS TO REMAIN SHALL BE PROPERLY AND ADEQUATELY PROTECTED FROM DAMAGE DURING CONSTRUCTION OPERATIONS. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO RESTORE TO THE ORIGINAL CONDITION ANY EXISTING ITEMS THAT ARE DAMAGED OR DISTURBED IN ANY WAY.
10. ROUGH GRADE AND FINISHED GRADING WILL BE PERFORMED BY OTHERS. LANDSCAPE CONTRACTOR SHALL BE RESPONSIBLE FOR FINE GRADING AFTER SOIL AMENDMENT OPERATIONS TO ALLOW FOR MULCH AND SOD INSTALLATION. LANDSCAPE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING POSITIVE DRAINAGE. CONTRACTOR TO NOTIFY OWNER'S REPRESENTATIVE OF ANY POORLY DRAINED AREAS PRIOR TO COMMENCING WORK.
11. CONTRACTOR SHALL USE LOCAL BEST MANAGEMENT PRACTICES FOR OBTAINING AND INSTALLING LANDSCAPE MATERIALS. COMPLETE THE WORK USING SKILLED PERSONNEL, PROFICIENT IN THE TRADES REQUIRED & IN A NEAT , ORDERLY AND RESPONSIBLE MANNER & WITH RECOGNIZED STANDARDS OF WORKMANSHIP.
12. ALL PLANTS TO BE APPROVED BY OWNER'S REPRESENTATIVE PRIOR TO INSTALLATION. NOTIFY OWNER FOR INSPECTION AND APPROVAL OF PLANT MATERIAL AT TIME OF DELIVERY. ANY PLANT NOT MEETING OWNER'S APPROVAL MAY BE REJECTED AT ANY TIME PRIOR TO FINAL ACCEPTANCE.
13. PLANT MATERIAL MUST MEET CURRENT LANDSCAPE NURSERY STANDARDS &/OR ANSI Z60.1.
14. IF PLANTS ARE NOT AVAILABLE, NOTIFY OWNER FOR APPROVAL OF CHANGE BEFORE MAKING SUBSTITUTIONS.
15. THE OWNER'S AUTHORIZED REPRESENTATIVE MUST APPROVE ALL PLANTING LAYOUTS PRIOR TO PLANTING. ALL ADJUSTMENTS SHALL BE MADE BY THE CONTRACTOR PRIOR TO INSTALLING PLANTS. THE CONTRACTOR SHALL NOT DIG PLANT PITS UNTIL LOCATIONS ARE APPROVED.
16. MINOR FIELD ADJUSTMENTS TO THE PLANTING PLANS MAY BE NECESSARY BASED ON THE ACTUAL SITE CONDITIONS. ADDITIONAL LANDSCAPING MAY BE REQUIRED BASED UPON FIELD CONDITIONS DURING THE SITE INSPECTION PRIOR TO INITIAL ACCEPTANCE. CONTRACTOR MUST OBTAIN APPROVAL FROM THE OWNER PRIOR TO ADJUSTING THE DESIGN.
17. TREE BASKETS SHALL BE REMOVED FROM ROOTBALLS AND KEPT BY THE PLANTED TREE UNTIL VERIFIED BY THE OWNER'S REPRESENTATIVE.
18. MULCH -
    - 18.1.1. MULCH RINGS AROUND SHRUBS IN NATIVE AREAS SHALL BE A MINIMUM OF 2' Ø AND 4" OF MULCH (DEPTH).
    - 18.1.2. DO NOT BURY PLANTS WITH MULCH.
    - 18.1.3. MULCH AROUND TREES SHALL BE 4" DEEP.
    - 18.1.4. PULL MULCH BACK 6" FROM TRUNK OF TREES AS PER DETAILS.
    - 18.1.5. MULCH RINGS AROUND TREES IN NATIVE AREAS SHALL BE MINIMUM 8' Ø.
19. WHEN PLANTING TREES, THE 1ST STRUCTURAL ROOT SHOULD BE PLACED 1" ABOVE THE FINISHED GRADE. SEE DETAILS.



NOTES:

1. FENCING PER AREAS OF PLANTING I.E. "PLANTING PODS".
2. "T" BAR POSTS TO BE SPACED APPROPRIATELY TO ENSURE INTEGRITY OF FENCE.
3. LOCATION OF FENCING TO BE APPROVED BY ECOLOGICAL TEAM IN FIELD.
4. FENCING TO BE REMOVED ONCE PLANTING IS ESTABLISHED

1 / D05 WILDLIFE PROTECTION FENCING

NOT TO SCALE

SEEDING NOTES

SEEDING AREA PREPARATION

1. LIMIT SUBGRADE PREPARATION TO AREAS TO BE PLANTED WITHIN TWO WEEKS OF SUBGRADE PREPARATION. FOLLOWING SUBGRADE PREPARATION, NO VEHICLE TRACKING, EQUIPMENT ACCESS OR MATERIALS STAGING IS TO OCCUR IN PREPARED AREAS, EXCEPT FOR OPERATIONS DIRECTLY RELATED TO SEED INSTALLATION.
2. MOISTEN PREPARED AREA BEFORE PLANTING IF SOIL IS DRY. WATER THOROUGHLY AND ALLOW SURFACE TO DRY BEFORE PLANTING. DO NOT CREATE MUDDY SOIL.
3. LOOSEN THE SURFACE OF AREAS TO BE SEEDED WITH HAND RAKES BEFORE APPLYING SEED.ALL EVERGREEN TREES SHALL BE A MINIMUM OF 12' FROM TRAILS, OR WALKS. EDGING SHALL BE MINIMUM OF 8' FROM EVERGREEN TREES.

BROADCAST SEEDING

1. BROADCAST SEEDING PROTOCOL TO INCLUDE ALL NATIVE REVEGETATION ZONES AND AREAS NOT SUITABLE FOR DRILL SEEDING.
2. DO NOT USE WET SEED OR SEED THAT IS MOLDY OR OTHERWISE DAMAGED IN TRANSIT OR STORAGE. DELIVER SEED TO JOB SITE IN THE ORIGINAL UNOPENED CONTAINERS AND SAVE LABELS.
3. SEED SHALL BE UNIFORMLY SOWN BY BROADCASTING.
4. BROADCAST SEEDING RATES SHALL BE ONE AND ONE HALF TIMES THE AMOUNT SPECIFIED. BROADCAST SEEDING SHALL BE RAKED OR CHAIN DRAGGED INTO THE SOIL TO A DEPTH OF APPROXIMATELY ONE-QUARTER INCH (1/4") TO ONE-HALF INCH (1/2").
5. THE SEEDING SHALL BE DONE IN TWO (2) SEPARATE APPLICATIONS CROSSING THE AREA AT RIGHT ANGLES TO ONE ANOTHER TO GUARANTEE EVEN COVERAGE.
6. DO NOT SEED DURING HIGH WINDS OR WHEN THE GROUND IS FROZEN OR OTHERWISE UNABLE TO BE WORKED.
7. PROTECT SEEDED AREAS AGAINST EROSION BY UNIFORMLY SPREADING STRAW MULCH AFTER COMPLETION OF SEEDING OPERATIONS. SPREAD UNIFORMLY AT A MINIMUM RATE OF 2 TONS PER ACRE (45 KG PER 100 SQ. M) TO FORM A CONTINUOUS BLANKET 1-1/2-INCHES (38-MM) LOOSE DEPTH OVER SEEDED AREAS. SPREAD BY HAND, BLOWER, OR OTHER SUITABLE EQUIPMENT.
8. FOLLOW STRAW APPLICATION BY BONDED FIBER MATRIX. ATTACH FIBER VIA. HYDRO MULCH AT MANUFACTURER RECOMMENDED RATES. HYDRO MULCH EXAMPLES: RAINIER FIBER, FLEXTERA.
9. PROTECT SEEDED SLOPES EXCEEDING 3:1 AGAINST EROSION WITH EROSION-CONTROL BLANKETS INSTALLED AND STAPLED ACCORDING TO MANUFACTURER'S RECOMMENDATIONS.
10. PROTECTION OF SEEDED AREAS: PROVIDE BARRIERS AS REQUIRED TO PREVENT PEDESTRIAN OR VEHICULAR TRAFFIC OVER NEWLY SEEDED AREAS UNTIL COMPLETION.
11. AT THE END OF ONE GROWING SEASON, ALL SEEDED AREAS SHALL ACHIEVE 85% GERMINATION AND BE FREE OF WEEDS AND OTHER UNDESIRABLE VEGETATION.
12. USE SPECIFIED MATERIALS TO REESTABLISH SEEDING AREA THAT DOES NOT COMPLY WITH REQUIREMENTS AND CONTINUE MAINTENANCE UNTIL ESTABLISHMENT IS SATISFACTORY.

NOTE: WETLAND PRESERVATION AREAS TO BE SURVEYED AND FENCED PRIOR TO CONSTRUCTION. DISTURBANCE TO WETLANDS NOT EXPRESSLY IDENTIFIED AS WITHIN AREAS OF DISTURBANCE IS NOT PERMITTED AT ANY TIME UNDER ANY CIRCUMSTANCE. SHOULD DISTURBANCE TO ANY WETLANDS OUTSIDE OF DISTURBANCE AREAS BECOME NECESSARY, CONTRACTOR IS TO CONTACT OWNER'S REP PRIOR TO COMMENCING WORK IN THAT AREA.

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT

PLANTING AND SEEDING NOTES

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

Town of Carbondale
511 Colorado Ave
Carbondale, CO 81623

DESIGN FIRMS NAME AND ADDRESSES

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www.RiverRestoration.org

DHM DESIGN
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www.dhmdesign.com

PROJECT NAME AND ADDRESS

Crystal River Restoration
and Weaver Ditch Efficiency Project
Carbondale, CO 81623

Project	Sheet
38047	D05a
Date: OCT 2019	
Scale: NOT TO SCALE	

PLANTING LIST

	UPLAND PLANTING	2,882 SF		
	ACER GLABRUM / ROCKY MOUNTAIN MAPLE	6	5 GAL	20% @ 120" oc
	ARTEMISIA TRIDENTATA / BIG SAGEBRUSH	6	5 GAL	20% @ 120" oc
	CHRYSOTHAMNUS NAUSEOSUS / RUBBER RABBITBRUSH	6	5 GAL	20% @ 120" oc
	POPULUS ANGUSTIFOLIA / NARROWLEAF POPLAR	6	5 GAL	20% @ 120" oc
	PRUNUS VIRGINIANA MELANOCARPA / WESTERN CHOKEBERRY	6	5 GAL	20% @ 120" oc
	RIPARIAN CREATION TYPE 1	26,685 SF		
	ALNUS TENUIFOLIA / THINLEAF ALDER	123	5 GAL	11% @ 60" oc
	BETULA OCCIDENTALIS / WATER BIRCH	123	5 GAL	11% @ 60" oc
	CORNUS SERICEA / RED TWIG DOGWOOD	123	5 GAL	11% @ 60" oc
	POPULUS ANGUSTIFOLIA / NARROWLEAF POPLAR	123	5 GAL	11% @ 60" oc
	SALIX BEBBIANA / BEBB`S WILLOW	123	5 GAL	11% @ 60" oc
	SALIX DRUMMONDIANA / DRUMMOND`S WILLOW	123	5 GAL	11% @ 60" oc
	SALIX LASIANDRA / WHIPLASH WILLOW	123	5 GAL	11% @ 60" oc
	SALIX MONTICOLA / ROCKY MOUNTAIN WILLOW	123	5 GAL	11% @ 60" oc
	SHEPHERDIA ARGENTEA / SILVER BUFFALOBERRY	134	5 GAL	12% @ 60" oc
	RIPARIAN CREATION TYPE 2 (COBBLE ISLAND)	13,281 SF		
	SALIX BEBBIANA / BEBB`S WILLOW	139	5 GAL	25% @ 60" oc
	SALIX DRUMMONDIANA / DRUMMOND`S WILLOW	139	5 GAL	25% @ 60" oc
	SALIX LASIANDRA / WHIPLASH WILLOW	139	5 GAL	25% @ 60" oc
	SALIX MONTICOLA / ROCKY MOUNTAIN WILLOW	139	5 GAL	25% @ 60" oc
	RIPARIAN ENHANCEMENT	45,105 SF		
	ALNUS TENUIFOLIA / THINLEAF ALDER	52	5 GAL	11% @ 120" oc
	BETULA OCCIDENTALIS / WATER BIRCH	52	5 GAL	11% @ 120" oc
	CORNUS SERICEA / RED TWIG DOGWOOD	52	5 GAL	11% @ 120" oc
	POPULUS ANGUSTIFOLIA / NARROWLEAF POPLAR	52	5 GAL	11% @ 120" oc
	SALIX BEBBIANA / BEBB`S WILLOW	52	5 GAL	11% @ 120" oc
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	SALIX LASIANDRA / WHIPLASH WILLOW	52	5 GAL	11% @ 120" oc
	SALIX MONTICOLA / ROCKY MOUNTAIN WILLOW	52	5 GAL	11% @ 120" oc
	SHEPHERDIA ARGENTEA / SILVER BUFFALOBERRY	57	5 GAL	12% @ 120" oc
	WETLAND CREATION (ZONE 1)	703 SF		
	CAREX AQUATILIS / WATER SEDGE	117	10 CU IN MIN.	16% @ 12" oc
	CAREX LANUGINOSA / WOOLY SEDGE	125	10 CU IN MIN.	17% @ 12" oc
	CAREX NEBRASKENSIS / NEBRASKA SAGE	125	10 CU IN MIN.	17% @ 12" oc
	CAREX UTRICULATA / BEAKED SEDGE	125	10 CU IN MIN.	17% @ 12" oc
	SCHOENOPLECTUS ACUTUS / HARDSTEM BULRUSH	125	10 CU IN MIN.	17% @ 12" oc
	SPARGANIUM EURYCARPUM / COMMON BUR REED	117	10 CU IN MIN.	16% @ 12" oc
	WETLAND CREATION (ZONE 2)	359 SF		
	CAREX MICROPTERA / SMALL WINGED SEDGE	53	10 CU IN MIN.	14% @ 12" oc
	ELEOCHARIS PALUSTRIS / GREAT SPIKE RUSH	53	10 CU IN MIN.	14% @ 12" oc
	JUNCUS ARCTICUS / WIRE RUSH	53	10 CU IN MIN.	14% @ 12" oc
	JUNCUS CONFUSES / COLORADO RUSH	56	10 CU IN MIN.	15% @ 12" oc
	JUNCUS ENSIFOLIUS / SWORDLEAF RUSH	56	10 CU IN MIN.	15% @ 12" oc
	JUNCUS TRACYII / TORREY`S RUSH	53	10 CU IN MIN.	14% @ 12" oc
	SCHOENOPLECTUS PUNGENS / AMERICAN THREESQUARE BULRUSH	53	10 CU IN MIN.	14% @ 12" oc
	WETLAND CREATION (ZONE 3)	987 SF		
	CALAMAGROSTIS CANADENSIS / BLUEJOINT REED GRASS	342	10 CU IN MIN.	33% @ 12" oc
	FESTUCA THURBERI / THURBERS FESCUE	342	1 GAL	33% @ 12" oc
	GLYCERIA STRIATA / FOWL MANNA GRASS	342	1 GAL	33% @ 12" oc
	LIVE STAKES	4,417 SF		
	POPULUS ANGUSTIFOLIA / NARROWLEAF POPLAR	345	CUTTINGS	30% @ 24" oc
	SALIX SPP / WILLOW	804	CUTTINGS	70% @ 24" oc

SEEDING MIXES

	NON-IRRIGATED SEED MIX	
	ACHNATHERUM HYMENOIDES / INDIAN RICE GRASS	10%
	BOUTELOUA GRACILIS / BLUE GRAMA	15%
	ELYMUS TRACHYCAULUS / SLENDER WHEATGRASS	25%
	NASSELLA VIRIDULA / GREEN NEEDLEGRASS	15%
	PASCOPYRUM SMITHII / WESTERN WHEATGRASS	25%
	PSEUDOROEGNERIA SPICATA / BLUEBUNCH WHEATGRASS	10%
	TOTAL: 2,882 SF	
	RIPARIAN SEED MIX - CREATION	
	CALAMAGROSTIS CANADENSIS / BLUEJOINT REED GRASS	10%
	DESCHAMPSIA CESPITOSA / TUFTED HAIR GRASS	20%
	ELYMUS TRACHYCAULUS / SLENDER WHEATGRASS	20%
	GLYCERIA STRIATA / FOWL MANNA GRASS	10%
	JUNCUS ARCTICUS / WIRE RUSH	10%
	PASCOPYRUM SMITHII / WESTERN WHEATGRASS	20%
	POA SECUNDA / BLUEGRASS	10%
	TOTAL: 26,685 SF	
	RIPARIAN SEED MIX - ENHANCEMENT	
	CALAMAGROSTIS CANADENSIS / BLUEJOINT REED GRASS	10%
	DESCHAMPSIA CESPITOSA / TUFTED HAIR GRASS	20%
	ELYMUS TRACHYCAULUS / SLENDER WHEATGRASS	20%
	GLYCERIA STRIATA / FOWL MANNA GRASS	10%
	JUNCUS ARCTICUS / WIRE RUSH	10%
	PASCOPYRUM SMITHII / WESTERN WHEATGRASS	20%
	POA SECUNDA / BLUEGRASS	10%
	TOTAL: 473 SF	
	WETLAND SEED MIX	
	DESCHAMPSIA CESP. "PERU CREEK" / TUFTED HAIR GRASS	30%
	ELYMUS LANCEOLATUS "SODAR" / SODAR STREAMBANK WHEATGRASS	30%
	CALAMAGROSTIS CANADENSIS / BLUEJOINT REED GRASS	5%
	JUNCUS ARCTICUS / WIRE RUSH	10%
	POA PALUSTRIS / FOWL BLUEGRASS	25%
	TOTAL: 200 SF	

SOILS

	RIPARIAN CREATION TOPSOIL (IMPORTED, 6" DEPTH)
	TOTAL: 13,343 CF

*ALL OTHER AREAS (RIPARIAN ENHANCEMENT, WETLAND CREATION, AND UPLAND PLANTING) TO USE EXISTING TOPSOIL ON SITE.

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT

PLANTING LIST AND SEEDING MIXES

No.	REVISION/UPDATE	Date

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Town of Carbondale
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Carbondale, CO 81623

DESIGN FIRMS NAME AND ADDRESSES

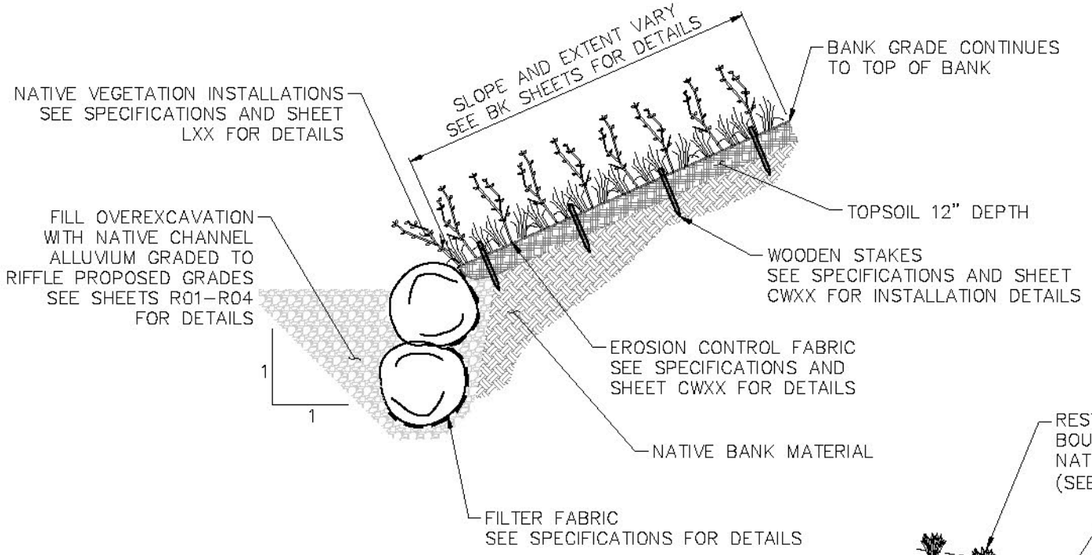
RiverRestoration.org, LLC
P.O. Box 248
Carbondale, CO 81623
www.RiverRestoration.org

DHM DESIGN
311 Main St, Suite 102
Carbondale, CO 81623
970.963.6520
www.dhmdesign.com

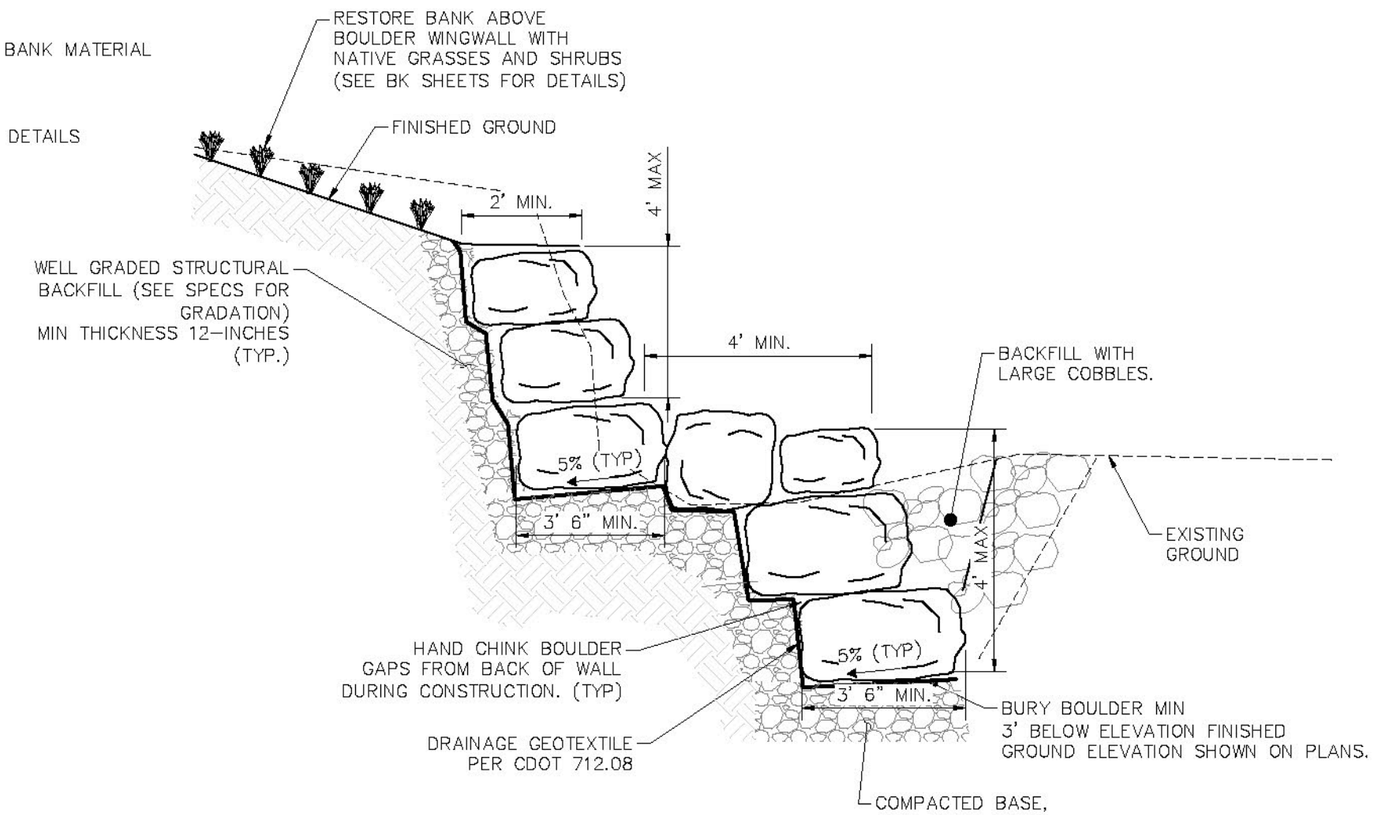
PROJECT NAME AND ADDRESS

Crystal River Restoration
and Weaver Ditch Efficiency Project
Carbondale, CO 81623

Project	Sheet
38047	D05b
Date: OCT 2019	
Scale: NOT TO SCALE	



1 / D06 **BANK RESTORATION - TYPE "C"**
N.T.S.



2 / D06 **BANK RESTORATION - TYPE "D"**
N.T.S.

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT
BANK RESTORATION DETAILS

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

Town of Carbondale
511 Colorado Ave
Carbondale, CO 81623

DESIGN FIRMS NAME AND ADDRESSES

RiverRestoration.org, LLC
P.O. Box 248
Carbondale, CO 81623
www.RiverRestoration.org

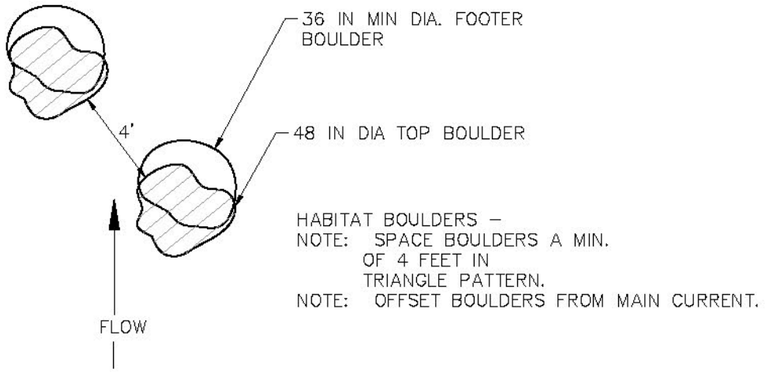
DHM DESIGN
311 Main St, Suite 102
Carbondale, CO 81623
970.963.6520
www.dhmdesign.com

PROJECT NAME AND ADDRESS

Crystal River Restoration
and Weaver Ditch Efficiency Project
Carbondale, CO 81623

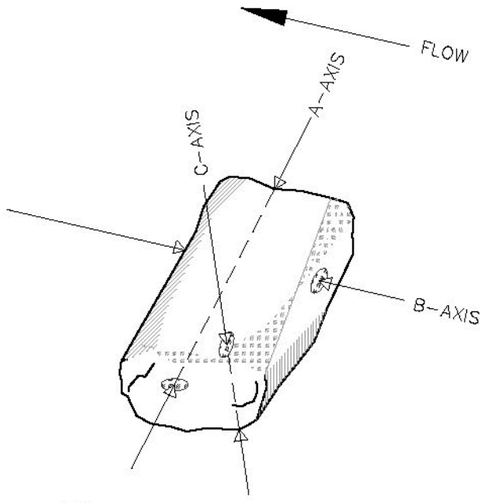
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38047	D06
Date: OCT 2019	
Scale: NOT TO SCALE	

DETAIL NOT INCLUDED
IN THIS SUBMITTAL

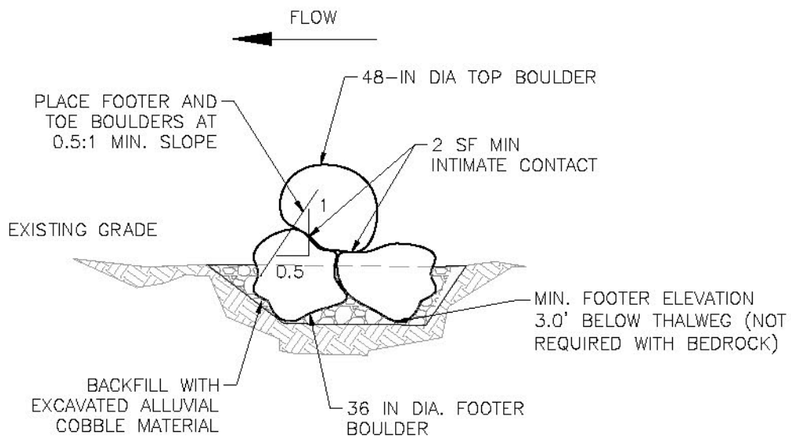


3A / D07 **HABITAT BOULDER CLUSTER DETAIL - PLAN VIEW**
N.T.S.

1 / D07 **DETAIL TO BE DETERMINED**
N.T.S.



2 / D07 **BOUNDER AXIAL PLACEMENT**
N.T.S.



NOTE: WHEN TOP BOULDER IS EXPOSED,
OFFSET FOOTER BOULDERS IN THE UPSTREAM &
DOWNSTREAM DIRECTIONS, PERPENDICULAR TO FLOW

3B / D07 **HABITAT BOULDER CLUSTER DETAIL - SECTION**
N.T.S.

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT
BOULDER CLUSTER DETAILS

No.	REVISION/UPDATE	Date

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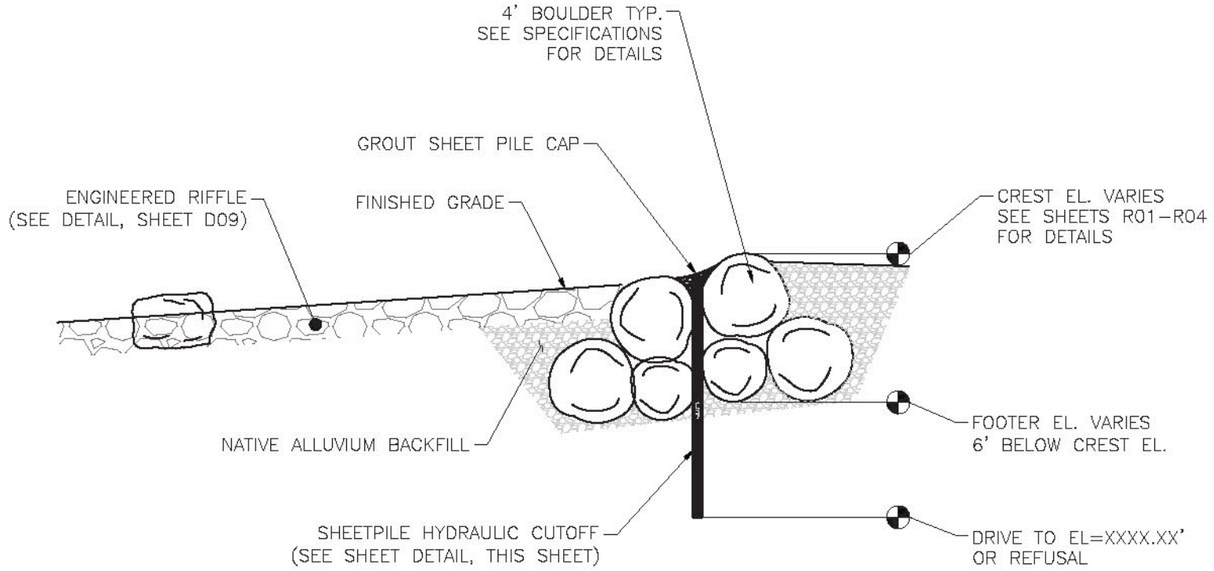
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Carbondale, CO 81623

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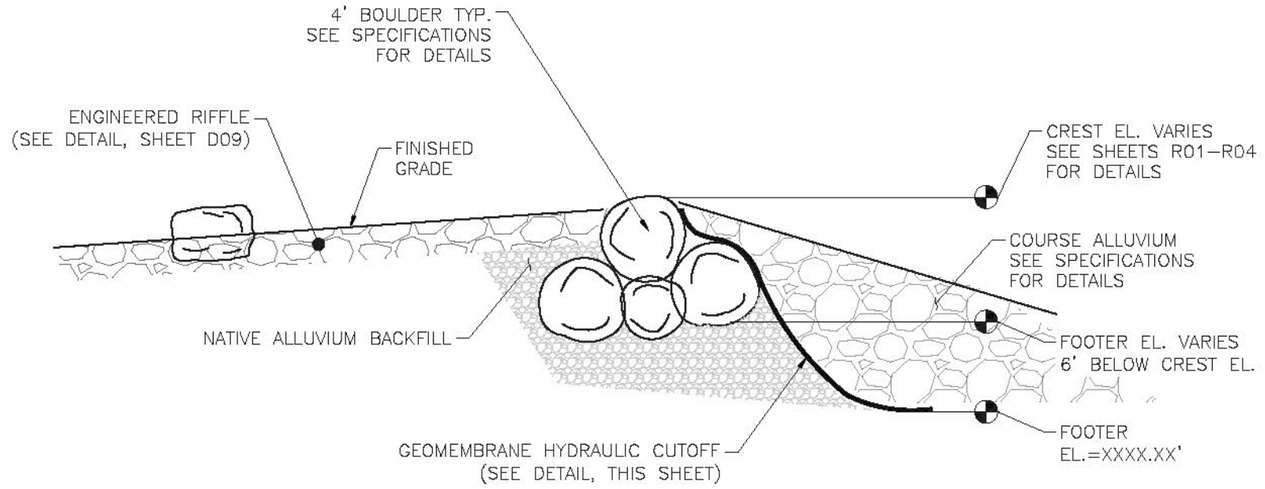
1 / D08 **SHEETPILE HYDRAULIC CUTOFF**
N.T.S.



3A / D07 **BOULDER GRADE CONTROL STRUCTURE DETAIL - OPT 1**
N.T.S.

DETAIL NOT INCLUDED
IN THIS SUBMITTAL

2 / D08 **GEOMEMBRANE HYDRAULIC CUTOFF DETAIL**
N.T.S.



3B / D07 **BOULDER GRADE CONTROL STRUCTURE DETAIL - OPT 2**
N.T.S.

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

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PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT
BOULDER GRADE CONTROL DETAILS

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

Town of Carbondale
511 Colorado Ave
Carbondale, CO 81623

DESIGN FIRMS NAME AND ADDRESSES

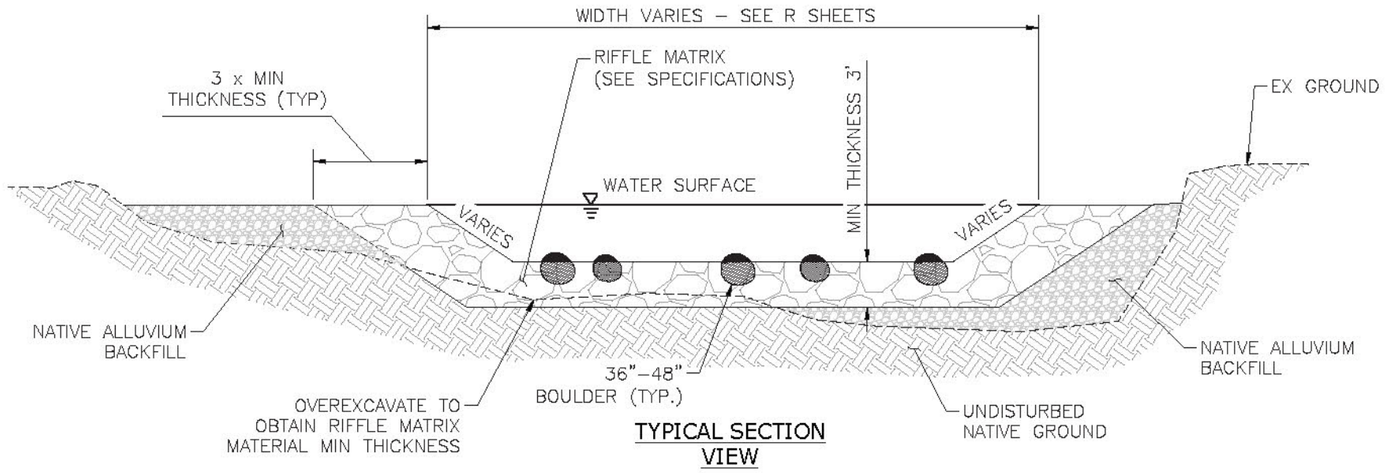
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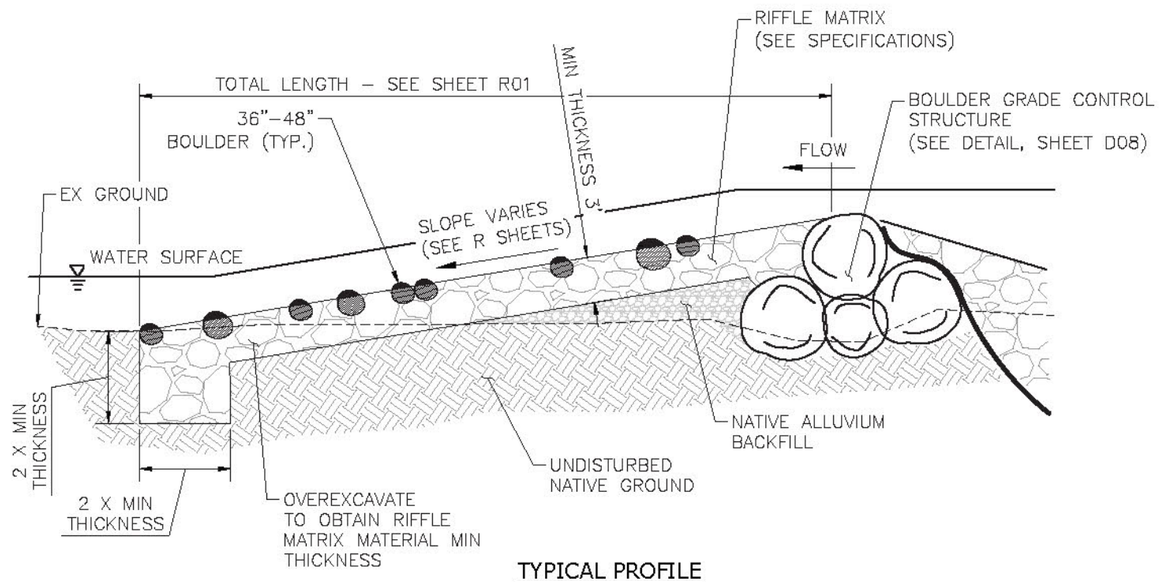
PROJECT NAME AND ADDRESS

Crystal River Restoration
and Weaver Ditch Efficiency Project
Carbondale, CO 81623

Project	Sheet
38047	D08
Date: OCT 2019	
Scale: NOT TO SCALE	



TYPICAL SECTION
VIEW



TYPICAL PROFILE
VIEW

1 / D09 ENGINEERED RIFFLE DETAILS
N.T.S.

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT
ENGINEERED RIFFLE DETAILS

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

Town of Carbondale
511 Colorado Ave
Carbondale, CO 81623

DESIGN FIRMS NAME AND ADDRESSES

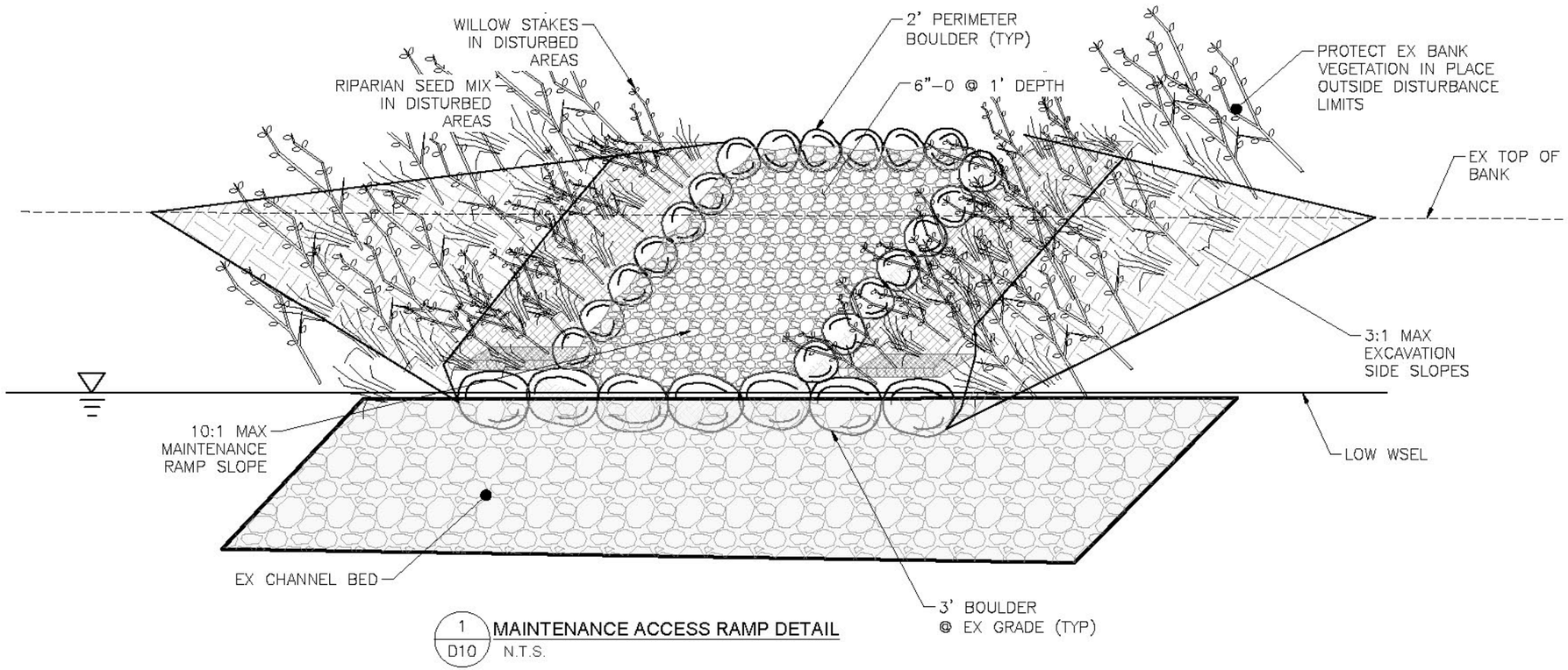
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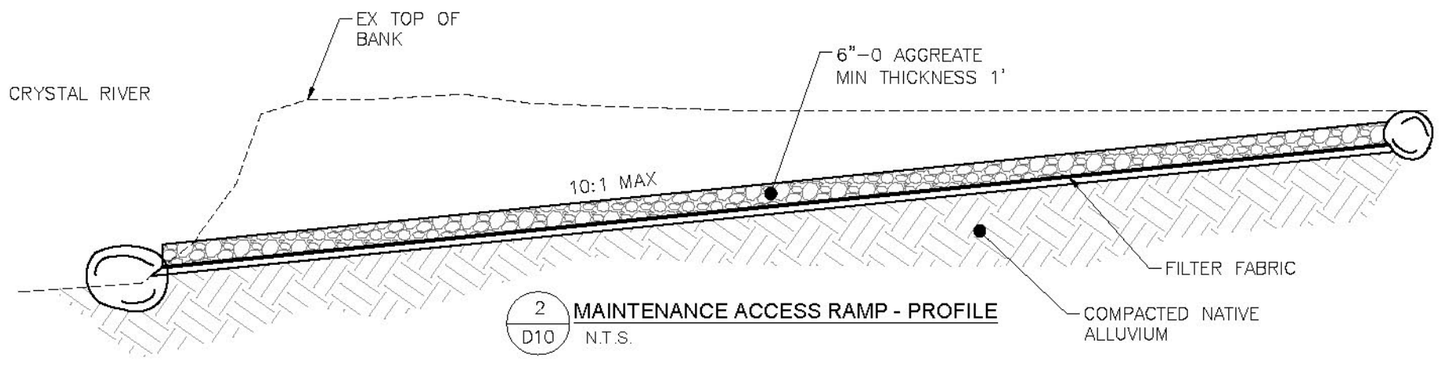
PROJECT NAME AND ADDRESS

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and Weaver Ditch Efficiency Project
Carbondale, CO 81623

Project	Sheet
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Date: OCT 2019	
Scale: NOT TO SCALE	



1 / D10 MAINTENANCE ACCESS RAMP DETAIL
N.T.S.



2 / D10 MAINTENANCE ACCESS RAMP - PROFILE
N.T.S.

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT
MAINTENANCE ACCESS RAMP DETAILS

No.	REVISION/UPDATE	Date

CLIENT NAME AND ADDRESS

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Carbondale, CO 81623

Project	Sheet
38047	D10
Date: OCT 2019	
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DETAIL NOT INCLUDED
IN THIS SUBMITTAL

1 / D11 **DIVERSION GATE MODIFCATION DETAIL**
N.T.S.

DETAIL NOT INCLUDED
IN THIS SUBMITTAL

2 / D11 **SLUICE GATE MODIFICATION DETAIL**
N.T.S.

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT
GATE MODIFICATION DETAILS

No.	REVISION/UPDATE	Date

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DETAIL NOT INCLUDED
IN THIS SUBMITTAL

1 / D12 DIVERSION "ISLAND" REHABILITATION DETAIL
N.T.S.

DETAIL NOT INCLUDED
IN THIS SUBMITTAL

1 / D12 FILTER BOULDER DETAILS
N.T.S.

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER/LANDSCAPE ARCHITECT STAMP

PRELIMINARY

CRYSTAL RIVER RESTORATION AND WEAVER DITCH EFFICIENCY PROJECT
DIVERSION ISLAND REHABILITATION DETAILS

No.	REVISION/UPDATE	Date

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Town of Carbondale
511 Colorado Ave
Carbondale, CO 81623

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Carbondale, CO 81623

Project	Sheet
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Date: OCT 2019	
Scale: NOT TO SCALE	



Proposal for Crystal River Restoration and Weaver Ditch Efficiency Project

Prepared by

River Restoration.org

DHM Design

lōtic hydrological

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September 22, 2017

Matt Annabel
Aspen Valley Land Trust
320 Main Street
Suite 204
Carbondale, CO 81623

RE: Request for Proposal/Information for Crystsal River Restoration and Weaver Ditch Efficiency Project.

Dear Matt,

Thank you for the opportunity to submit our proposal for planning and design of the Crystal River Restoration and Weaver Ditch Efficiency Project. RiverRestoration is pleased to present a comprehensive team for the project. RiverRestoration will lead the project and provide expertise in the planning and design of the in-channel and floodplain components. DHM Design, Inc. will also play a major role in the project, leading the planning and design effort for improvements associated with Riverfront Park, including trails, public gathering space, educational opportunities and vegetation management. Lotic Hydrological rounds out this all-star team, providing continuity from the Crystal River Management Plan, review of conceptual alternatives and participating in the stakeholder coordination and public involvement.

The project team members are all based out of Carbondale, Colorado. We are intimately familiar with the Crystal River and the project reach, having fished and paddled these waters for years. This local presence and knowledge is augmented with decades of experience working on rivers throughout the state and county. We have a proven track record of creating places that introduce and encourage stewardship of our river ecosystems. We are excited about the chance to be a part of this transformative and placemaking project in our home community.

The following proposal provides a detailed overview of the experience and approach of the RiverRestoration team in completing planning and design for Crystal River Restoration and Weaver Ditch Efficiency project. We are available to begin work immediately and will work effectively and efficiently to complete the project. We look forward to the opportunity to discuss our ideas with you directly. Thank you for being dedicated to the river community and moving this exciting project forward. Be sure to contact us with any questions or comments.

Sincerely,

Jason Carey, P.E.
Principal River Engineer
RiverRestoration
PO Box 248
Carbondale, CO 81623
970.947.9568
jason.carey@riverrestoration.org

Stephen Ellsperman
Principal/Director of Ecological Planning
DHM Design
311 Main Street #102
Carbondale, CO 81623
970.369.6520
sellsperman@dhmdesign.com

Seth Mason
Principal Hydrologist
Lotic Hydrological, LLC
PO Box 1524
Carbondale, CO 81623
970.903.7561
seth@lotichydrological.com



TABLE OF CONTENTS

01 FIRM OVERVIEWS 6
02 PROJECT PHILOSOPHY 12
03 PROJECT APPROACH 20
04 PROJECT TEAM 35
05 EXAMPLE PROJECTS 40

01 FIRM OVERVIEWS

The following pages provide a brief introduction of the firms making up this project team. Our team provides an unequivocal wealth of local knowledge and intimacy with the Crystal River and its riparian environment. RiverRestoration will lead an expert team of engineers, ecologists, watershed scientists, and landscape architects to seamlessly integrate aquatic habitat with the riparian ecology it supports.





Established in 2004, RiverRestoration is a river engineering firm with a mission to make rivers better places. We have the insight to enhance the social, economic, and environmental values flowing in the river every day. Our team of river engineers, watershed scientists and passionate river stewards is dedicated to creative solutions and new thinking for our rivers. With a track record including implementation of over 90 river centric projects, RiverRestoration provides the creative planning, engineering and technical support required for a successful river project. Our goal is for whole system design that includes restoration, preservation, enhancement and beneficial use of river and riparian ecosystems. We employ a collaborative approach that balances the functional needs of water users, recreation and the environment for long-term, sustainable solutions. Our applied philosophy is that healthy rivers can exist as an integral part of our human environment.

At RiverRestoration we apply state of the art technology and science as an analytical approach to design of natural channels. This results in acurate predictions of channel response that leads to sustainable riparian and aquatic habitat regeneration. We examine projects on broad time and spatial scales. Long-term function of geomorphology and sediment transport is central to our design. We connect communities to their rivers by designing river interaction as a central theme. These plans take into account habitat-function, recreation use, non-point source pollution reduction, low impact stormwater design and water rights. We establish a vision with clients and guide strategies to bring that vision to implementation, including assistance with grants and funding opportunities.

Our multi-purpose designs have widespread benefits. These benefits attract a broad coalition to support the project merits. We communicate with stakeholders and agencies to minimize impacts, build support, and enhance habitat. Agency insight informs our designs and our designs turn regulators into advocates. Our planning work with natural resource agencies have not only aided in improved designs, but been a source of funding for the projects involved. We perform technical engineering including hydrographic surveys, multi-dimensional hydraulic modeling, sediment modeling, and flood hazard remapping to solve river issues. Often times our projects require FEMA map revisions. We are experienced in the CLOMR/LOMR process. We prepare native riparian landscape plans, soil and planting specifications, wetland delineations, and assessments of riparian and aquatic habitat conditions. We design environmentally sensitive diversion structures, or reduce or remove existing dams, while restoring aquatic and geomorphic processes and integrating passage for fish, sediment and boats. We appropriately locate and design recreation and whitewater enhancement projects without degrading ecology or conflicting with other uses. Our finished products are often complimented as being organic, as well as state of the art.

Main office: 818 Industry Place, Carbondale, CO 81623

Branch office: 1234 South 900 East; Ste. 200, Salt Lake City, UT 84105

Years in business: 13 years

Size of firm: 8 employees

Primary contact: Jason Carey, 970.947.9568x101, jason.carey@riverrestoration.org

Our core competencies include:

- natural channel design
- hydraulic design
- river stability analysis
- floodplain determination
- reservoir capacity analysis
- dam removal design
- sediment and erosion control
- diversion structure design
- aquatic habitat design
- whitewater park design
- topographic and hydrographic survey
- construction management
- fish and boat passage design
- aquatic barrier design

FIRM OVERVIEW

DHM DESIGN
www.dhmdesign.com

DHM Design is a story of innovation and growth.

Established in 1975, we are an internationally recognized leader in landscape architecture, land planning, urban design and ecological planning. Our experience embraces a diverse portfolio of planning and design projects:

National Park Service
Resorts and Communities
Historic and Civic Facilities
Parks, Open Space, and Greenways
Ecological Restoration
Mixed-use Developments
Urban Transportation Systems
Private Estates and Rural Properties

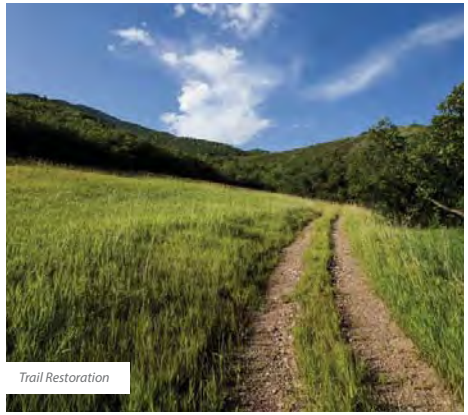

Gold Medal Waters of the Frying Pan River
River, Wetland, & Stream Restoration

ECOLOGICAL SERVICES
Planning | Analysis | Restoration

DHM Design is passionate about enhancing the interconnection between natural systems and human development and is dedicated to protecting the integrity of the land and ecosystem in every aspect of the planning and design processes.

The DHM Design Team has spent 40 years developing an important understanding of how connections and relationships to the natural environment can be communicated through master planning processes. DHM Design is unique in that it offers in house solutions that emphasize ecological planning and natural resource management in every aspect of the planning and design processes. Our ecological team members are not outside consultants, but principals within our firm and work carefully with our design staff on all aspects of our projects. Our approach to natural area master planning is to first understand the resource carefully with dedicated analysis of the ecological components of a site. All decisions must come from this careful understanding, and through this process, sustainable and creative opportunities emerge.

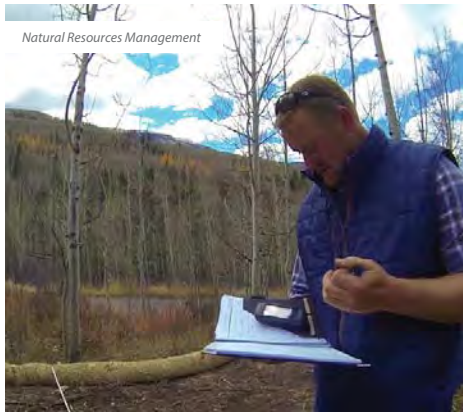
DHM Design considers ecological planning the true intersection of landscape architecture, planning, and ecological services. We make a commitment to include ecological planning into how we approach all projects, from large-scale private ranches to small urban parks. These are not considered external services, but rather integrated into each of our projects. We pride ourselves in discovering unique ecological opportunities that connect landscape architecture and our design approach with the greater natural world around us.


Trail Restoration


Parks, Open Space, & Greenways


Wetland Restoration


Private Estates, Ranch, and Rural Properties

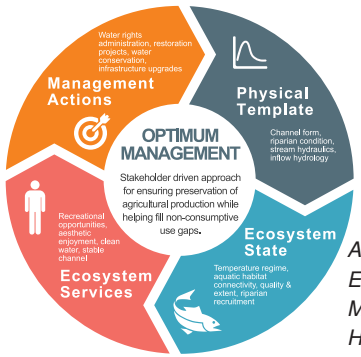

Natural Resources Management

Owner:	**Seth Mason**
Location:	**Carbondale, CO**
Firm Established:	**2011**
Size of firm:	**4 employees**
Website:	**www.lotichydrological.com**

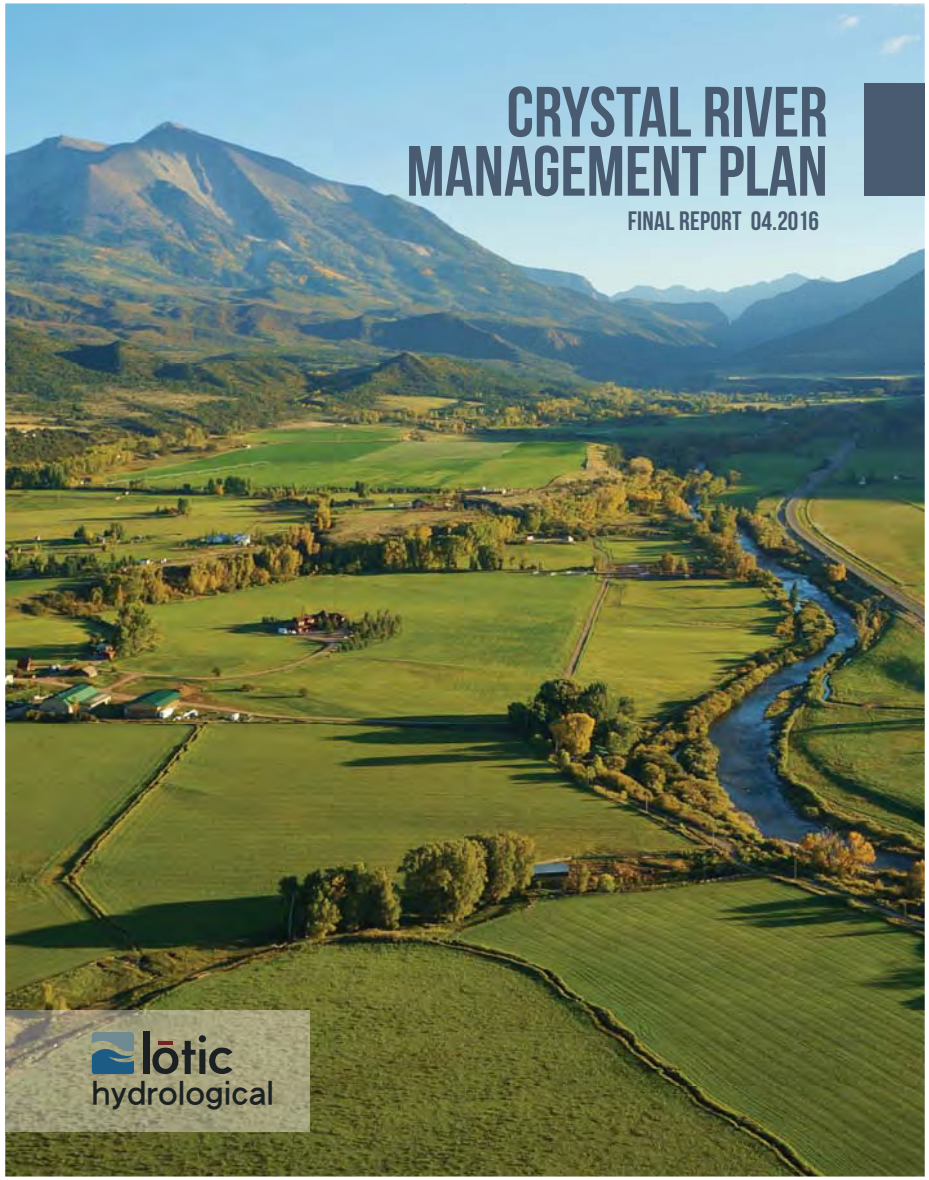
Lotic Hydrological, LLC provides technical expertise, water resource engineering services and a firm commitment to scientific problem solving when engaged in both field data collection and complex quantitative analysis. We generate the high quality data tools and interpretations necessary to inform science based decision-making in public policy development and natural resource management. Our goal is to help clients implement strategies that protect diverse water uses, while maintaining high levels of environmental quality and contributing to the long-term stewardship of our regional water resources. Our firm employs a diverse technical skill set, strong leadership, interpersonal, and communication skills, and a broad knowledge base for considering the multi-faceted nature of natural resource management issues. We are practiced and effective at engaging stakeholders and presenting technical material to diverse audiences in a variety of formats. We work independently or collaboratively to implement various phases of natural resource project management, including: problem identification, environmental data collection and management; quantitative data analysis; synthesis of results; and technical reporting. We work with city and county governments, State and Federal agencies, nonprofit organizations, and specialized subcontractors. A small staff and flexible business model allow us to remain highly responsive to clients as we execute projects. These characteristics and our focus on producing high-quality and timely work products also help us create and maintain long-term relationships with the clients we serve.

Firm Capabilities:

- **Hydrological, Ecological, and Hydraulic Data Collection and Analysis**
- **Water Resources Planning and Program Management**
- **High Impact Data Visualization**
- **Water Resources Engineering**
- **Data Life-cycle Management**
- **Remote Data Acquisition Network Development and Maintenance**
- **GIS Services and Geostatistical Analysis**
- **Stakeholder Engagement**
- **Dialogue Facilitation**



Alternative Management Strategy Effectiveness for the Crystal River Management Plan written by Lotic Hydrological



PROJECT RESPONSIBILITIES

RIVERRESTORATION

«Project Management/Administration
«Stakeholder Coordination
«Hydrographic and Topographic Survey
«River Assessment and Hydraulic Analysis
«Sediment Transport Assessment
«Weaver Ditch Headgate Assessment and Design
«In-channel Habitat Features Assessment and Design
«Bank Stability Assessment and Design
«Permitting
«Fundraising
«Plans, Specifications and Cost Estimation
«Bid and Construction Support

DHM DESIGN

«Stakeholder Coordination
«Public Process
«Vegetation Mapping and Restoration Design
«Trails Assessment and Design
«Garthering Spaces/Outdoor Classroom «Assessment and Design
«Interpretive Features Design
«Permitting
«Fundraising
«Plans, Specifications and Cost Estimation
«Bid and Construction Support

LOTIC HYDROLOGICAL

«Project Continuity
«Public Process
«Review Concept Alternatives
«QA/QC

STAKEHOLDER GROUP

Town of Carbondale
Aspen Valley Land Trust
Roaring Fork Conservancy
American Rivers
Colorado Parks and Wildlife
Public Council of the Rockies

INTERESTED PARTIES

River Valley Ranch
Ranchers/Agricultural
General Public








Our project team specializes in a wholistic approach to river restoration projects. This section discusses the team's vision for the project site, enhancing the site's valuable resources with a light, system-integrated approach.The team is experienced in working with this broad field of stakeholders and plans to involve them throughout the design process.

02 PROJECT PHILOSOPHY

PROJECT PHILOSOPHY

Without going through the rigorous and scientific process of developing the project, we are hesitant to provide a specific, proposed solution. The data collection phase could uncover a previously unknown constraint, the stakeholder coordination and public meeting process could reveal new needs of the community and the hydraulic and engineering analysis could render a proposed project element infeasible.



RiverRestoration performed comprehensive hydrologic survey of the Crystal River to develop 2D hydraulic models for the Crystal River Management Plan.

Having disclosed this hesitation, the project team assembled is tailor made for this project. The project team has a combined +100 years of working with rivers and riparian corridors. This includes years of work and study on the Crystal River, understanding not only the physical, ecological, and hydraulic characteristics of the corridor, but also the relationships associated with the complex irrigation system that relies on Crystal River water. The team is made up entirely of Roaring Fork Valley residents who have floated, fished and explored this reach of the Crystal River many times. We know this river and are excited about the opportunity to develop the project as an amenity for our community and as a benefit for the Crystal River and its ecosystem.

The following pages describe our project "philosophy", describing potential improvements associated with the river channel and the upland areas that will help meet the project's goals and objectives. These concepts and ideas will be used as a starting point for a successful project the Stakeholder Group and the public will be proud off.

River improvements

The Crystal River through the project reach is a fairly stable channel, both laterally and vertically. At low flows the reach is characterized by a series of riffle and pools, which becomes more of a continuous run at higher flow rates. There is a large cobble deposit immediately upstream of the Crystal Bridge Drive bridge, likely due to the constriction caused by the bridge abutments and piers. Overall the banks are stable through the project reach, with large cobble toes and vegetation. However, in the downstream third of the project there is some minor bank erosion occurring in areas. As documented in the Crystal River Management Plan, this reach of the Crystal River sees extremely low flows during the late summer and early fall months, primarily due to diversions upstream. During these low flows the channel is over-widened, resulting in shallow flow conditions, particularly through the riffles. The Weaver Diversion, owned by the Town of Carbondale, is located approximately half-way up the project reach on the opposite side of the river from Riverfront Park. The diversion utilizes a partial channel spanning boulder structure to maintain water surface elevations in the river for the diversion. The headgate itself includes a concrete flume to minimize sediment and debris entering the ditch. The project team contacted Mark O'Meara at the Town of Carbondale to discuss the diversion. He stated that this particular diversion requires little maintenance on an annual basis, especially when compared to the Town Ditch, which required maintenance 2-3 times a year. He did mention that the Town is hoping to automate the headgate in the future and the existing structure is inadequate for attaching telemetry and actuating equipment. A State of Colorado fish hatchery is located further upstream, also on the



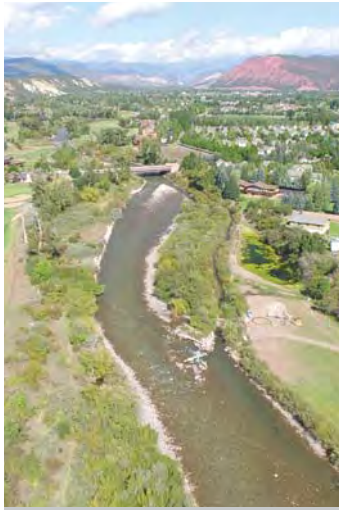
Aerial view of south end of project reach. Image by RiverRestoration

The Crystal River Management Plan identified a number of watershed, reach and channel-level variables that are degraded through the project reach. These include flow regime, water quality (temperature), floodplain connectivity, riparian vegetation, debris supply, and physical structure. Some of the factors, including flow regime and water quality are difficult to address in a site-specific project of this nature. Factors such as floodplain connectivity, riparian vegetation, debris supply and physical structure can be at least partially addressed through improvements associated with this project.

The team proposes a light-handed, science based approach to improvements in the Crystal River through the project reach. Based on the project's goals, four primary in-channel components will be addressed: the Weaver Diversion, banks stability, aquatic organism habitat features, and floodplain connectivity.

Weaver Diversion

The Weaver Diversion will be a primary focus, as identified in Foal 3 of the RFP. Here the team will survey the headgate area during low water and model the diversion extensively using 1D and 2D hydraulic models. These models will allow the team to evaluate existing conditions and develop some alternatives that meet the needs of the Town of Carbondale while improving habitat opportunities, channel stability and reducing maintenance requirements. The team will strive to develop solutions that minimize impacts to the Crystal River, using only natural materials and limiting structure size and extents. Proposed solutions could include a reconfiguration of the current boulder structure that is more precisely designed to maintain diversion water surface elevations and channel stability long term without impacting fish passage through the reach. There can also be an opportunity to include fish habitat elements in the diversion improvements. There is also a potential for the preferred alternative to be maintain the status quo. Through the detailed evaluation and analysis process, the project team will provide the stakeholder group with data and recommendations for making an informed decision on Weaver Diversion requirements.

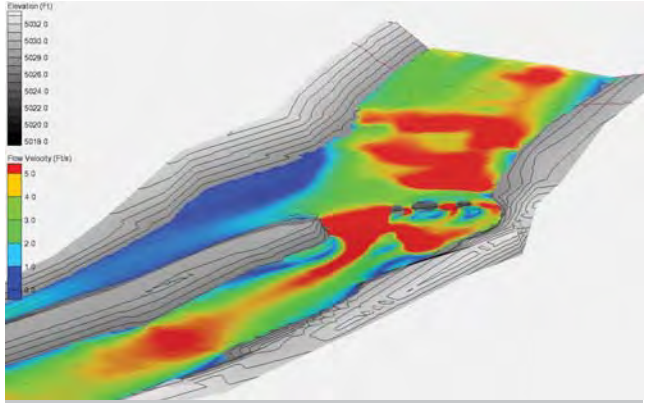


Looking north at the Weaver Diversion head gate

There is not a structural engineer currently on the team. If through alternative selection process, the stakeholder group would like to include a rebuild of the Weaver headgate structure in preparation for future automation infrastructure, the team will bring on Glenwood Structural and Civil to perform the design work of the concrete structure.

Bank Stability

The team will take a similar, light-handed approach to the bank stability improvements. As part of the River Assessment, the team will walk the entire bank of the Crystal River through the project reach documenting existing bank conditions. Proposed bank repair will be focused on areas that are showing significant erosion and on areas where proposed park improvements such as trails, designated river access points, outdoor classrooms and other infrastructure are proposed adjacent to the bank. The bank repairs will be founded upon a boulder toe with footer placed below the calculated scour depth. Above the boulder reinforced toe the bank repair will consist of either a bouldered slope or a laid back slope with riparian vegetation. The team has also used log crib walls with great success elsewhere in Colorado and these will be considered as well. The bank repair options will be dependent based on location. River access points would be incorporated into areas of boulder stabilization where applicable.



2D Model result of the Petz Smith Diversion Structure on the Weber River near Morgan. UT

Aquatic Habitat Improvements

Fish and macroinvertebrate habitat elements will be incorporated throughout the project where appropriate. These elements will typically take the form of sets of large boulders placed in the river, which will increase the diversity of hydraulic conditions, and provide fish holding areas adjacent to food supply. These "fish" boulders tend to create localized scour holes around them, so the boulders at the surface will be placed on additional boulder buried below the scour depth. The boulder placement will be chosen based on how these small structures interact with the existing river dynamics. The detailed hydraulic modeling of the project reach will guide the decision making process as to where these habitat features make the most sense.

The project will also look at the incorporation of small coves graded into the river bank and rock vanes attached to the river bank. Both these options provide additional aquatic habitat but are more impactful to the river and may negatively affect channel hydraulics. The team will evaluate the potential for these features in the 2D hydraulic model.

Additional bank vegetation through the project reach is another element that will improve fish habitat potential in the project reach by providing shade along the riverbanks. The riverside trees will also contribute leaf litter and other debris, contributing to macroinvertebrate health, which will make its way up the food chain. Vegetation and upland improvements are discussed in more detail below.

The team also has extensive experienced with the design and placement of large woody debris. These structures can be used for bank stabilization as well as aquatic habitat. Placement of wood structures should be carefully considered, as they can trap floating debris more easily and become a navigation hazard. The team will work with the stakeholder group to determine if large wood habitat structures are appropriate for the project reach.

Floodplain connections



Interpretive signage of a gravel pit reclamation and floodplain reconnection project at the Ela Wildlife Sanctuary on the Colorado River in Grand Junction.

Finally in regards to in-channel improvements, the team will analyze the potential for lowering pockets of the existing flood plain bench to allow these areas to inundate more frequently. In addition to the seasonal flooding, the lowered land will be closer to the groundwater table. Floodplain connectivity will provide hydrologic and soil conditions for additional wetlands and riparian vegetation in the park. These connected floodplains also provide additional food sources for the aquatic world, with both food for macroinvertebrates and fish. Upland animal and insect species will also benefit from these additional wetter areas. These changes to the floodplain bench will be incorporated in the design process for the Riverfront Park improvements.



Reconnection of the Audubon Ela Sanctuary ponds to high flows in the Colorado River



Wetland boardwalk rendering by DHM Design

Upland Area Improvements

Riverfront Park is a narrow, half mile long strip of area between the Crystal River and the RVR golf course. With the exception of a few educational signs, a primitive trail and a couple of picnic benches, the park is a natural open space area. The majority of the project area is on a historic floodplain bench of the river with a wide diversity of riparian and wetland plant species. The park has two wider sections at the northern and southern ends with a narrow piece of land connection the two.



Existing riparian corridor at the project site

The project team agrees with the stakeholder's stated goal of keeping the park's wild nature intact. Through input from the stakeholder group and the public the team will develop alternatives that minimize impacts to the project area's healthy riparian corridor while meeting the stated goals of the project. Ideas for the main project elements are discussed in detail below.

Riparian and Wetland Vegetation Restoration

Restoration of the riparian and wetland vegetation in Riverfront Park will be very selective. The decision to revegetate an area will be based on a couple of key factors: other improvements being made in the vicinity (trails, bank stabilization, public spaces, etc.), changes in hydrology due to floodplain benching or side channel connections and areas of heavy invasive species infestation, such as the area at the far southern end of the park. Overall, the existing riparian community is fairly health and diverse, so large scale changes are not recommended. The existing cottonwood trees on site tell an interesting story. There are a number of older cottonwoods nearing the end of their lifespan and very young cottonwoods. There are very few middle aged trees because of a history of grazing on the site. The elimination of grazing on the site will help these existing young trees establish. The team will propose planting additional cottonwood in select areas to further enhance the presence of this important member of the riparian community. Supplemental planting with Alders, River Birch, dogwood and a variety of willow species in order to improve the overall diversity of the plant community may also be recommended. The team will also evaluate the existing wetland vegetation. Recommendations may include supplemental planting with a greater diversity of native wetland plant species, particularly in areas adjacent to a potential boardwalk and educational and interpretive areas. Areas impacted as a part of any bank stability or trail access work would also be a focus for vegetation restoration along these same lines.

Side channel connection

A prominent feature of the existing park is a remnant channel of the Crystal River that runs along the west side of the park. It is especially prevalent on the south half of the site, highlighted by a healthy strip of more wetland based vegetation. The team will develop alternatives for reconnecting this side channel during a broader range of flow events, enhancing the potential for wetland creation through the site. The side option will be evaluated from a hydraulic perspective, modeling the system and determine at what flows water could be routed to the enhanced side channel withough further exacerbating low flow conditions in the Crystal during the summer and fall months. There are potential sources of groundwater for the enhanced wetland areas, including irrigation runoff/percolation from the golf course and leakage from the adjacent irrigation ditch. These wetlands could be the focus of education opportunities discussed in more detail below, including boardwalks and overlooks.



Outdoor classroom and river connection on the Roaring Fork River as a part of the Basalt River Restoration by DHM Design

Public Gathering Spaces

Through site visits and a discussion with stakeholders, two locations have been identified for outdoor classroom and public gathering spaces. The first of these is on the north end of the project, near Crystal Bridge Drive. The area along the river bank is degraded here, reducing impacts to healthy riparian area elsewhere. The space would be placed right along the bank with multiple access points down to the river to provide visitors with an opportunity to get to the water. This access could be for educational purpose, such as studying macroinvertebrates, or for recreational opportunities such as angling.

The second public gathering space would be near the existing cottonwood grove at the south end of the park. This space would be more focused on the wetland and upland areas. Amenities may include: a boardwalk and overlook of the enhanced wetland created by the reconnected side channel and an interactive exhibit describing ecological benefits of riparian features such as downed nurse logs and understory vegetation.

As with all other project elements, final locations for public gathering space will be developed through a collaborative process with the project team, stakeholder group and general public.



At the Pilot Project site, residents of Helper CIty, UT learning about the river restoration planned for the Price River

Education/interpretive opportunities

The proximity to schools, residential neighborhoods, and existing trail networks such as the Crystal Valley Trail create an ideal opportunity for educational and interpretive elements that could reach a large and diverse segment of the community. We believe that every site has a unique story to tell and this parcel is no exception. An outdoor classroom area will be a key feature in the site design. The proposed trails will link together places on the site that help create a unique narrative. Topics for interpretation and signage may include, wetland and riparian ecology, river ecosystems, macroinvertebrates, water rights, irrigation and agriculture. Our team has worked together with the Roaring Fork Conservancy on similar local projects and we see them as playing an integral role as we move forward with the educational and interpretive programming. Our team will also work with an interpreter to translate all of the signage into Spanish in order to reach a broad range of users, consistent with the diversity in our community.



Boardwalk access provides a unique opportunity to school groups



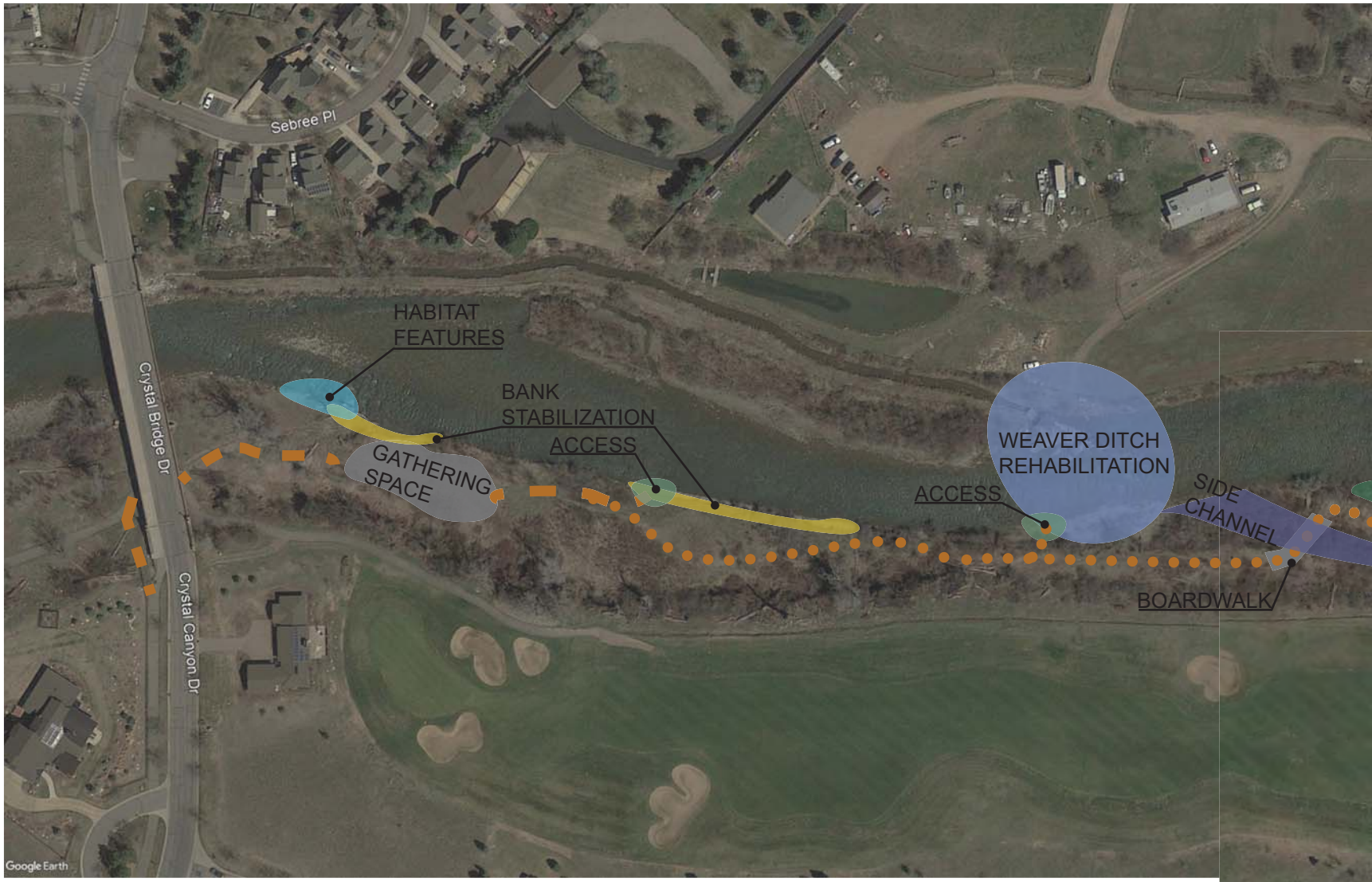
Native sturgeon are released into the Grand River as a part of the Grand Rapids River Revitalization project



Stormwater retuwn wetland and boardwalk from the Ogden River Restoration provides and opportunity for public education on green infrastructure principles

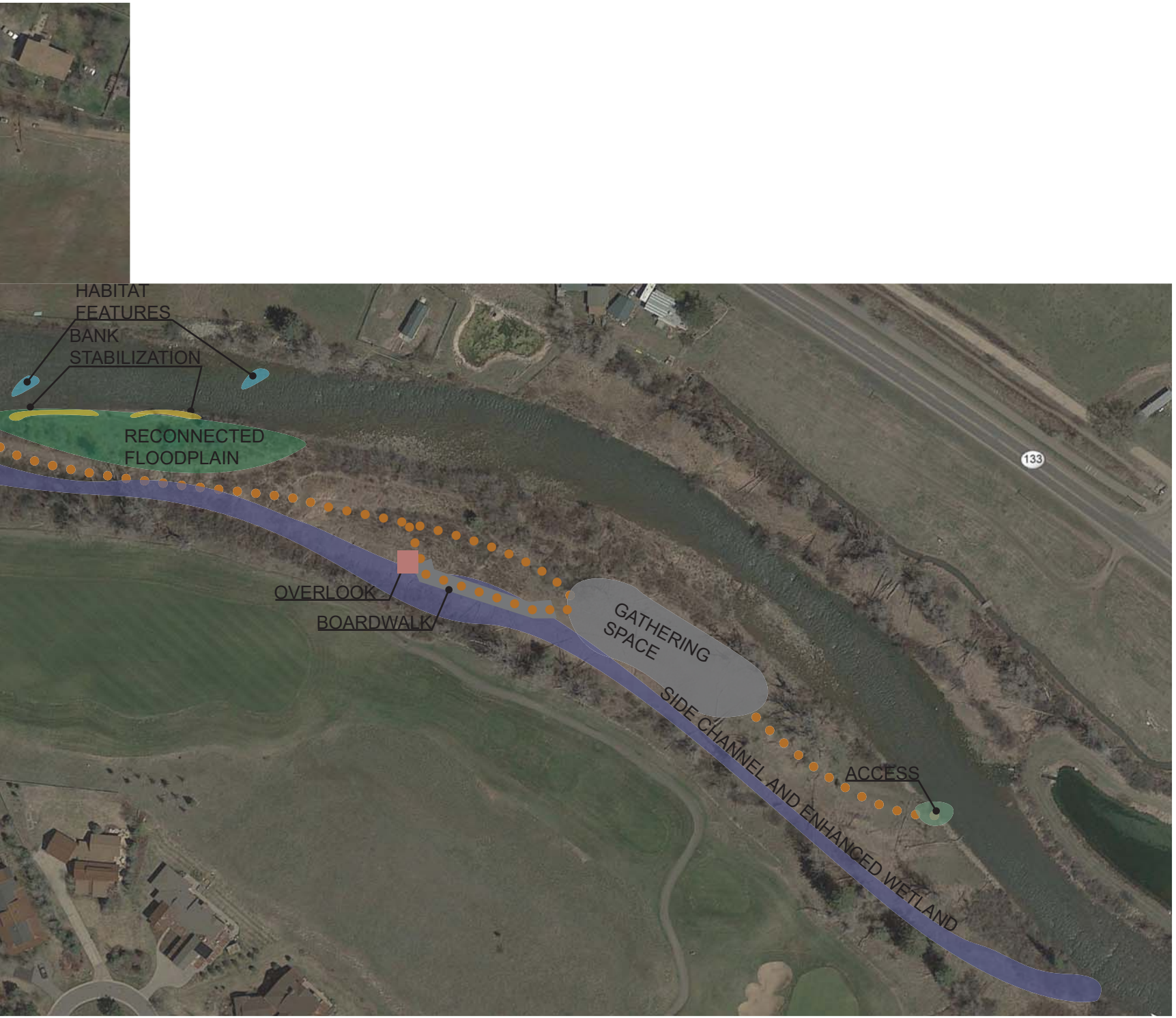
Trail improvements

An improved trail system will provide connectivity for park visitors to the different planned amenities, as well as allow them to experience the wilder sections of the riparian corridor. These trails will follow existing trail corridors were possible to minimize impact to healthy vegetation areas. The trails will take two forms. A primary trail, with a wider, firmer surface will connect to the public gathering space and interpretive, educational areas located at the north edge of the project. This trail will be more accessible for less mobile individuals. Visitors will take a more primitive, narrower trail as they travel south through the park towards the second public gathering space near the cottonwood grove. The trails will pass through several existing and healthy riparian areas. A low boardwalk could be used in a few areas as is pass by wetter areas such a floodplain connection areas and the re-established secondary channel. As will all other project element, alternatives for the trail system configuration will be developed through a collaborative process with the project team, stakeholder group and general public.



PROJECT PHILOSOPHY SCHEMATIC

We will work with the Stakeholder Group to develop a range of conceptual alternatives that incorporate these project elements. See next page for north portion of the site.


HABITAT FEATURES
BANK STABILIZATION
RECONNECTED FLOODPLAIN
133
OVERLOOK
BOARDWALK
GATHERING SPACE
SIDE CHANNEL AND ENHANCED WETLAND
ACCESS

03 PROJECT APPROACH

Drawing on experience from over 100 river projects, the team has a tried and true approach to successful implementation. This section will describe the tasks we have identified to complete the planning and design to develop construction documentation.



PROJECT APPROACH

Task 1 - Project Management and Coordination

For the duration of the project, the team is fully prepared to provide quality project management and oversight. This will include hosting kick-off and coordination meetings, tracking and monthly reporting of project status and budgets, communicating regularly with Aspen Valley Land Trust (AVLT) and implementing QA/QC procedures. Regular and consistent interaction with the Stakeholder group will greatly benefit the project. A communication feedback loop will allow for continuous input from the Stakeholder group, helping to eliminate surprises associated with the project's progress, and save time and costs associated with redoing work because a design goal or constraint changed. The project team will quickly respond to emails and phone calls. The team is entirely based in Carbondale and will be available for in-person meetings upon request.



On-site coordination with stakeholders in Grand Rapids, Michigan

Task 2 – Site Inventory and Assessment

This task will be vital to the project, by identifying opportunities and constraints associated with the project. The information collected during this task will be key in developing a feasible, sustainable project that meets the Stakeholder's four main goals.

Stakeholder input and Existing Data Review – Prior to performing a site inventory and assessment, the project team will solicit input from project stakeholders. The long term corporate knowledge provided by the stakeholder group will be invaluable during the data collection phase, helping the team to focus their efforts and highlighting known areas of concern not to be overlooked. The team will also review existing documentation available for the project reach, including prior studies, historical photographs, maintenance records and development plans. This information will provide further insight into the project area and how it has changed over time.

River and Trails Assessment – The project team will visit the site and perform a detailed assessment of the river and trails through the project. The river assessment will include documentation of existing conditions at Weaver Diversion, bank conditions and overall geomorphological characteristics of the project reach. Trail assessment will include locating existing trails, both planned and social trails and documenting their locations and conditions.

Field Inventory and Analysis and Vegetation Mapping – Our goal is to gain a deep understanding of the existing environmental conditions, opportunities and challenges. Our environmental and ecological inventory, site analysis and assessment will be comprehensive, and include all existing natural resource and ecological systems through a thorough field investigation. We will investigate and define key characteristics of the ecology of the site and document them carefully on a specific plan, while communicating the findings of the investigation in a report. In addition to traditional methods of site surveying, the project team also plans to utilize drone technology to survey and record data from an aerial perspective which we have also found to be an effective communication tool. As a part of this task we will complete the following investigations and incorporate the findings into the plan and text narrative description:

A. *Rapid Wetland Community Survey and Assessment*
Our team will investigate the wetland communities (riverine and off-channel) and document their locations. We will rate each of these communities for importance and function throughout the corridor and present findings on a site plan, and describe them as a part of the findings. This effort will assist the design effort by identifying important wetland opportunities and constraints. This process is not a wetland delineation, as defined by the US Army Corps of Engineers, because we feel this effort is not cost effective at the concept development level. A specific jurisdictional determination of wetland boundaries will be completed if a selected project is identified during the design phase that includes a potential wetland impact.

A rapid wetland survey and riparian community assessment was performed in Delta, CO on the Gunnison River. Flag delineated sensitive riparian vegetation and it was recorded via hand held GPS to be input into work site plans.



B. *Riparian Systems and Habitat Assessment*
Our team will investigate the riparian systems found along the Crystal River Project area and document their locations. We will rate each of these riparian systems for importance and function and present findings on a site plan and describe them as part of the findings.

C. *Environmentally Sensitive Lands*
Our team will work with staff and stakeholders, as well as the greater team, to identify environmentally sensitive lands within the project area boundaries. We will describe and document these landscapes on a site plan and describe the specific environmental attributes attributed to the designation.

D. *Wildlife and Plant Species*
Our team will compile a list of species known to occur or likely to occur within the project limits. We compile this list utilizing a suite of resources and field site analysis to provide an accurate picture of the wildlife and plant species associated with the project area. The lists will inform the design effort in terms of identifying specific protections or opportunities/constraints from a wildlife or plant standpoint.

E. *Fisheries Habitat Assessment*
Our team will investigate the River for fisheries habitat, including location and function, and document their locations. We will rate each of these fisheries habitat systems for importance and present findings on a site plan and describe them as part of the findings. We will also identify key fisheries habitat gaps or improvement opportunities and include them as part of the finding.

F. *Restoration Opportunities Survey*
Our team will provide an investigation and analysis of restoration opportunities within the project boundaries. This restoration opportunity survey will incorporate specific locations identified within the riverine or riparian locations throughout the site which should be incorporated and documented within the plans. The restoration opportunities survey will classify the type of restoration identified and prioritize the restoration zones in terms of importance and cost/benefit.

G. *Corridor Recreation, Education and Interpretation* Opportunities Survey/Documentation
Our team will identify, as a part of the process, likely locations for recreational, educational and interpretive amenities in the terms of interface with the natural resources and ecology of the site. This process will help the team to understand where likely locations for trail or amenity improvement would be least likely to affect natural processes or environmentally sensitive locations. This process will also help to identify the unique features of the site that can serve as the basis for and interpretive and educational programming elements. In addition, the team will provide important information about where local, state, and federal permitting would be easiest accomplished within the natural resource protection framework.

Survey - RiverRestoration performs hydrographic and topographic surveys in-house for its projects and we have found that this allows our designers to become familiar with the river and the site. RiverRestoration conducted the hydrographic survey used for the Crystal River Management Plan and is knowledgeable with the Crystal River and the project reach. In-channel, the project team will augment this prior survey effort with detailed mapping of the Weaver Ditch diversion area as well as banks along Riverfront Park that are showing signs of erosion. The team uses a total station and survey grade GPS to collect data and will process the information in AutoCAD Civil 3D.


RiverRestoration collecting hydrographic and topographic data.

For the Riverfront Park area of the project, the team contacted the Garfield County GIS department about the availability of LiDAR through the project reach. Through a partnership with Colorado Geological Survey, the County recently flew and received LiDAR data for the entire County, including the project reach. The data has not yet been processed, but the team is confident that it will be available by Notice to Proceed, either through the general processing of the data or through special request for this project. This LiDAR data will greatly reduce the cost of on-the-ground survey in the park. On-the-ground survey will be utilized to field verify the LiDAR's accuracy and support the vegetation mapping effort discussed above.

Task 3 – Hydrologic and Hydraulic Analysis

The hydraulic and hydrologic analysis phase is where the success of the project will be determined. The most clear and detailed plans and thorough construction support is irrelevant if the project is not initially designed with the river in mind. A surprising amount of in-channel work is completed without this critical component and, as a result, these types of projects typically require the heavy use of unnatural materials such as grout and concrete. The Crystal River is in a developed area with infrastructure adjacent to the channel. Understanding how the river functions and how the proposed work will affect these functions is crucial to the success of the project.

Hydrology - The project team will review and verify existing hydrologic studies and determine the flow regime for which to design the in-channel features. The team will include the Stakeholders Group in the decision making process about Weaver Ditch function and in-channel habitat function at various flow rates.

Hydraulics - Using hydrographic survey data and hydrologic analysis, the team will develop 1-dimensional (1D) (using HEC-RAS) and 2D (using SRH-2D) hydraulic models of existing conditions to establish a baseline for comparison purposes. Water surface elevation measurements taken during the hydrographic survey will be used for boundary conditions and calibration of the hydraulic models. The existing conditions hydraulic models will be used for understanding the river, providing insight into ditch operations, fish passage, angling opportunities and habitat conditions. The existing conditions models will also help the team quantify existing bank erosion and bed scour potential as well as current sediment transport characteristics.

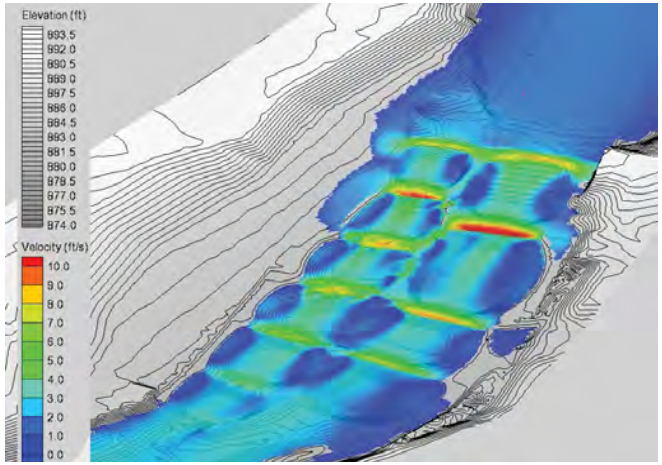


Figure output from 2D modeling of dam mitigation at the North River Valley Park in Ames, Iowa.

Using an iterative approach, the team will develop conceptual alternatives that meet the project goals and constraints from a hydraulic and physical standpoint. 1D and 2D hydraulic models will be used to evaluate the performance of proposed concepts, including impacts to water surface elevations, water depths, velocities and flow patterns. Modeling results such as water surface elevations, water depths and flow velocities will influence design decisions made in regards to flood plain impacts, side channel connections, fish passage/aquatic habitat, angling opportunities, and access points.

Sediment transport and erosion/scour models will also be developed using the hydraulic model output. Shear stress modeling results and sediment data collected will allow the team to evaluate how proposed changes will affect sediment transporting through the reach and develop designs that effectively handle sediment inputs over the long term.

Task 4 – Public Meetings and Stakeholder Involvement

We value the input of the project stakeholders and feel that it is important to provide a variety of opportunities for stakeholders and members of the community to become involved in the design process. The team will conduct a series of one-on-one meetings with interested stakeholders including Aspen Valley Land Trust, The Roaring Fork Conservancy, American Rivers, Town of Carbondale, River Valley Ranch, etc. Our goal is to understand their goals, ideas, concerns and issues and support for the project. The team will also conduct two public workshops that will be scheduled during the concept development and preliminary design process. The goal of the first public workshop would include: informing the public about the project, sharing draft goals to ensure alignment with public needs, sharing of initial concept plans to stimulate conversations, gather ideas and concerns. We recommend an open house format with display boards to allow us to conduct informal one on one conversations with the public over the course of 2 hours +/-. The goal of the second public workshop would include: updating the public about the project (review of process for those who may not have attended the first workshop), sharing draft goals to ensure alignment with public needs, presentation of a draft plan to gather final input or concerns. We want the public to feel that they had a meaningful role in the planning process and that we have listened to their ideas and concerns. We want enough information and possible consensus in order to feel comfortable completing a final Design.

Task 5 – Conceptual Alternatives Development

The alternative concepts will include possible options for the in-channel and riverside amenities, and provide the opportunities, constraints and costs associated with each. The team RiverRestoration has assembled was chosen for the expertise in their respective fields, experience on similar projects and local knowledge. At the conclusion of this phase, the team will provide a detailed and comprehensive study of the project reach that allows the Stakeholder Group to make smart decisions about the project's future direction.



Public meeting lead by DHM Design on the Bohn Park and Lyons Valley River Park in Lyons, CO.

Alternatives development – Using stakeholder input and data collected as a guide, the project team will develop 3 alternatives for improvements to the Crystal River through the project reach and to Riverfront Park. These alternatives will consider:

- Ability to meet the Project's four identified goals.
- Impacts to riparian corridors, wetlands and other sensitive areas.
- Construction Costs.
- Long-term maintenance requirements and costs.

As part of this effort, the team will generate graphics that will clearly communicate the concepts to the Stakeholder group and the general public. The alternatives will be developed in such a way that components can be mixed and matched (e.g. alternative 1's river work with alternative 3's educational and interpretive plan)

Illustrative section of boardwalk through the healthy riparian woodland habitat that surrounds the Rocky Mountain Institute in Basalt, CO to communicate design intent and alternative options.



Construction Cost Estimate – The project team will develop construction cost estimates for each of the conceptual alternatives. The Stakeholder group relies on the project team to provide an estimate of project costs at various stages throughout the design process. The costs are used to make decisions on the scope of the project, fundraising efforts, and budgets. The project team is skillful at developing accurate costs for construction and has a wide range of resources at their disposal, including past projects, contractors, vendors, and manufacturers. The team knows how important these numbers are to the Stakeholder group and will take the time and effort to get them right.

Design Report – The project team will author an Alternatives Report, documenting the design process and providing the stakeholder team with a complete and concise source of information for making project decisions. The design report will summarize the evaluation of each alternative in regards to the project's four primary goals. The amount of information and variables that will be generated as part of this study can be overwhelming without a strong plan to evaluate alternatives objectively. The team will work with the Stakeholder Group to develop a procedure for evaluating and ranking the alternative concepts.

Presentation to stakeholders and the public – The project team will present the conceptual alternatives to the Stakeholder group and the general public, providing a detailed breakdown of the pro's and con's of each alternative and answering any questions that may arise.



Exhibit to supplement a study report for low head dam mitigation at North River Valley Park in Ames. These exhibits have been used in City Council meetings, public meetings, and grant applications

Upon completion of this task, the Stakeholder Group will have the details needed to make an informed choice about which alternative should be selected for construction. This decision making process is especially important for this project, as the various stakeholders have been conflicted in the past as to which direction the project should head. A consensus amongst the group is needed to confidently move the project into the design and permitting stage.

Task 6 – Preliminary Design

Once the preferred alternative is chosen, the team will refine the design and create a preliminary construction plan set and construction cost estimate. The preliminary plan set will be critical for the permitting process as this is the level that communicates the project to the regulatory agencies. The updated cost estimate will allow the Stakeholder group to further focus their budgeting and fundraising efforts.

Preliminary Construction Plan Set –The creation of a quality plan set takes attention to detail and a strong understanding of what is needed to successfully build a project. They inspire confidence with the regulatory and permit agencies, knowing that they are reviewing will be what is constructed. They give contractors confidence that they are bidding on what they will have to construct, reducing bidding price increases associated with risk. The design team has standardized, rigorous drafting and QA/QC procedures that minimizes errors and generates a quality product.

Task 7 – Permitting

There are a number of permit requirements associated with working in a waterway. Most critical are the US Army Corps (USACE) 404 permit, Clean Water Act 401 Certification, and National Flood Insurance Program compliance. The project team has successfully permitted numerous in-channel projects throughout Colorado and the rest of the country. The scope includes coordination with regulatory agencies in the pre-design stage of the project in order to limit the potential for project delays and obtain permits in a timely manner, as well as uncover concerns so that they can be addressed in preliminary and final design. We have found that starting this process as early as possible often has the added benefit of creating project proponents out of regulators.

The project team has a strong relationship and extensive experience working with the USACE Grand Junction regulatory office that holds jurisdiction over this site and all of our other work in Western Colorado. We have experience in coordination with Colorado Parks and Wildlife (CPW) to ensure the passage of fish through any proposed in-stream structure. The project team understands what CPW wants to view the project favorably and knows how to design the project to meet these requirements.

Floodplain impacts are always a factor when designing and constructing in-channel work. The team will strive to design the project so that it will not raise the 100-year flood elevation. By doing so, the project will only need a floodplain development permit from Garfield County and will not require a Letter of Map Revision (LOMR) with FEMA. To do this successfully, a strong background in hydraulic modeling and the understanding of how in-channel structures affect water surface elevations at different flow levels as needed.

Because of the in-channel and riparian nature of the work, the project will require a wetland delineation for the 404 permit application with the USACE. The project team has a qualified wetland ecologist on staff with over 20 years of experience identifying and delineating wetlands. The findings of the field work will be flagged for inclusion in the survey and will be documented in a wetland delineation report for submittal with the permit application. Having the wetland boundaries included in the base map will allow the design team to minimize impacts to existing wetlands. This will help streamline the permitting process and help the Stakeholder group avoid expenses associated with wetland mitigation.

Task 8 – Fundraising

Many of our projects have had successful fund raising campaigns of which we have played a leading role. Fundraising and coalition building on projects is a big part of RiverRestoration's approach. We often work with clients at project inception to help local groups in building a project from the ground up. We have helped clients raise millions of dollars in funding for projects throughout the west. The team can communicate the technical merits and costs of designs for a wide variety of fundraising opportunities. The Project team has the experience, knowledge and relationships to help the Stakeholder Group develop a fundraising strategy for the project and to develop a plan for building local and regional support for the project.

Future funding opportunities that the team can assist with for construction of the project include: GOCO for the Riverfront Park Improvements, Colorado Basin Round Table for the river and diversion work, the Pitkin County Health River and Streams Board, and any others the Stakeholder Group identifies and viable.



School group in Helper, Utah assisting with revegetation effort on the Price River



Interpretive sign at the Avon Whitewater Park in Avon, CO



School group in Basalt, UT assisting with revegetation effort on the Roaring Fork River

Task 9 – Final Design

Once the permitting effort and stakeholder review and coordination are complete, the project team will put the finishing touches on the design and construction documents, preparing the project for bid and construction.– The project team follows the mantra “the devil is in the details”, and this will be reflected in the quality of the construction plans set and supporting documents. The team will update and finalize the construction plan set, update the cost estimate and produce technical specifications for the project work.

Construction Specifications – Specifications often do not get looked at until something goes wrong. Then this important document becomes a key factor in the decision of liability. A strong set of specifications will protect the Stakeholder group from additional costs associated with errors made during construction. In-channel work is unique work and it is not covered extensively in CDOT or APWA standards that are relied upon for most civil projects. The project team has spent many years developing a thorough set of specifications that would be tailored and utilized for this project.

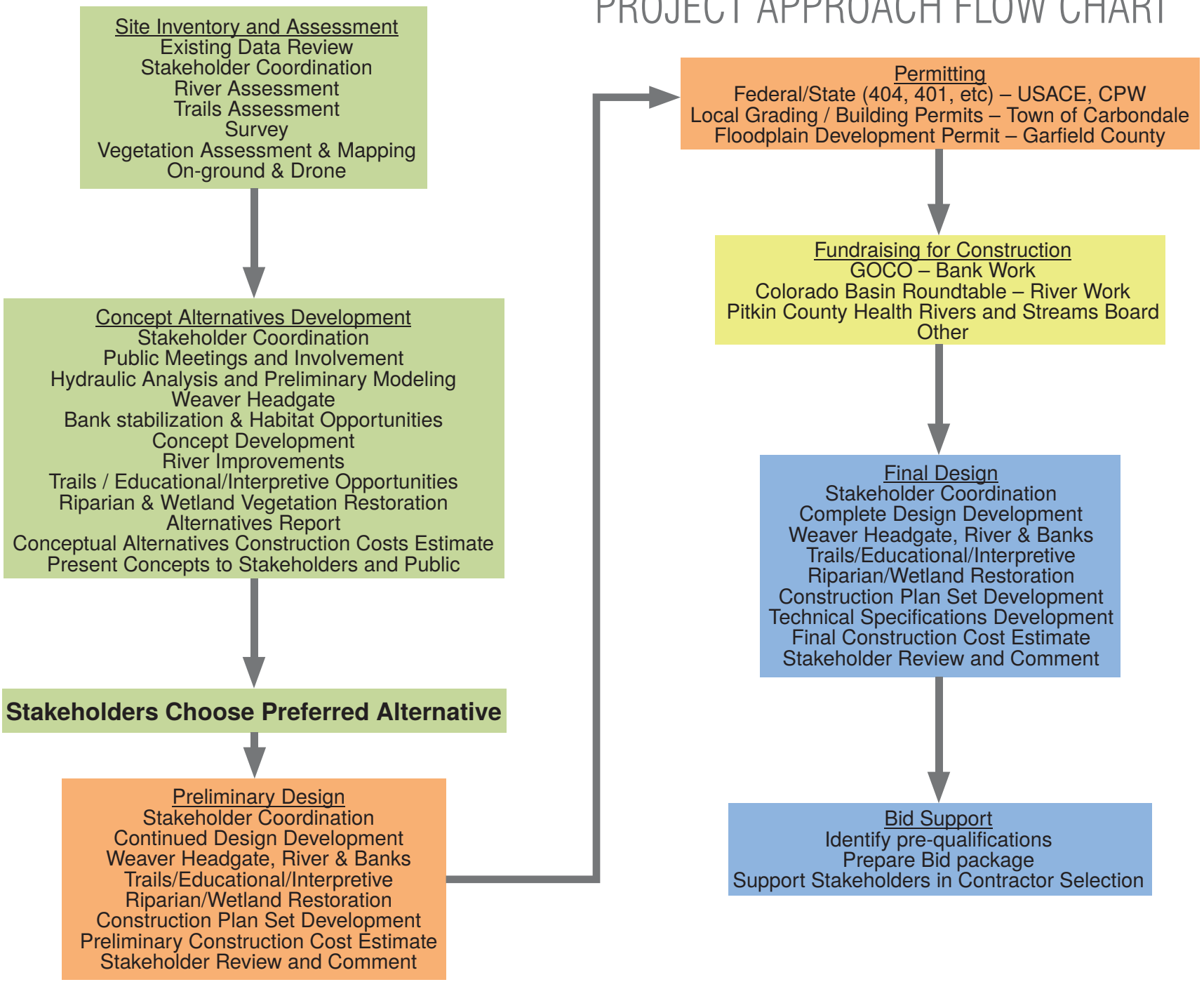
Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRRR)- As part of the final design process, the project team will develop a OMRRR report that details maintenance requirements and anticipated costs of the various project elements. This will provide the Stakeholder group with a framework to develop future budget and staffing needs for the constructed project.

Task 10 – Bid Support

The project team’s job is not complete once the plans are stamped and signed. This is particularly true in the dynamic environment of river projects. The project team will help the Stakeholder group through the bid process to select a qualified contractor. The team will review submitted bids and provide the Stakeholder Group a memo explaining our opinion of which contractor to select. The team has been through the bid-construction process many times and knows how to set pre-qualification and screen out the typical “dirt” contractor from those who know how to work in rivers. Selecting the right contractor will reduce headaches and construction costs for the project.



PROJECT APPROACH FLOW CHART



DESIGN FEE BREAKDOWN

Our project approach and fees included in this proposal are an estimate based on our extensive experience on similar projects. We are trying to provide a realistic picture of potential costs in order to help the Stakeholder Group move forward with the process. The team understands the budgetary constraints associated with raising funds to plan and build a project on the scale of the Crystal River Restoration and Weaver Ditch Efficiency Project and made every attempt to reduce planning costs while still providing the services the team feels are needed for a successful project.



The project approach can easily be phased, adjusted, or tailored to the specifics of this project as decisions are made by the stakeholders regarding the overall scope and the preferred level of site programming. To reflect this phasing potential, the project approach flow chart and fee sheet have both been color coded to represent a possible 3 phases of the design process.



The first phase, colored in green, will take the project through the data collection, analysis and conceptual alternatives development phase. At the conclusion of this phase the Stakeholder Group will have selected a preferred alternative, with a strong understanding of the level of effort and construction costs associated with implementing that alternative. The total estimated fees for this first phase are $88,486.



The second phase, colored in orange, will take the preferred alternative through the preliminary design and permitting process. At the conclusion of this phase the Stakeholder Group will have a preliminary plan set for the selected alternative, an updated and detailed construction cost estimate and permits in hand from the US Army Corps of Engineers plus state and local permitting agencies. The total estimated fees for the second phase are $49,774.

The third phase, colored in blue, will take the project through final design, bid documents, and contractor selection. At the conclusion of this phase the Stakeholder Group will have a final set of construction documents, including plans and specifications and a contractor selected for construction. The total estimated fees for the third phase are $61,043.

This third phase total includes a $7,290 fundraising task for raising funds for construction. This task could be a standalone phase or removed from the project scope entirely. It is colored in yellow.

Planning costs for Phases 2 and 3 are best estimates based on our experience on similar projects and the Stakeholder's prior comments that the group is looking for an approach that minimizes impacts to the Crystal River and its riparian corridor. These totals will be partially dependent on the stakeholder-selected preferred alternative and may need to be adjusted once a preferred design is chosen.

Please see the design fee summaries on the following pages for more details about planning costs for each of the three phases.





Town of Carbondale
partners - Aspen Valley Land Trust, Roaring Fork Conservancy, and American Rivers
Crystal River Restoration and Weaver Ditch Efficiency Project

Phase 1 - Design Fee Breakdown
September 22, 2017

Task	*Description*	Principal Engineer (RRO)	Project Manager/ Engineer (RRO)	Hydraulic Scientist/PhD (RRO)	Engineer Field / EIT (RRO)	Watershed Scientist/Hydrologist (RRO)	Landscape Designer (RRO)	Hydrographic Survey Crew (RRO)	Principal Ecologist (DHM)	Sr Associate Landscape Architect (DHM)	Natural Resources Coordinator (DHM)	Designer (DHM)	Principal Hydrologist (Lotic)	Watershed Scientist (Lotic)	*Total Hours*	*Total Budget by Task*
1.0	**Project Management and Coordination**	**3**	**10**	**1**			**1**		**5**	**4**			**2**		**26**	**$ 3,783.0**
2.0	**Site Inventory and Assessment**	**10**	**20**	**16**	**20**			**24**	**8**	**8**	**32**	**32**			**170**	**$ 22,598**
3.0	**Hydrologic and Hydraulic Analysis**	**2**	**12**	**60**	**76**										**150**	**$ 16,958**
4.0	**Public Meetings and Stakeholder Involvement**		**12**						**16**	**36**		**16**	**4**		**84**	**$ 11,416**
5.0	**Conceptual Alternatives Development**	**9**	**60**	**20**	**64**		**8**		**6**	**46**		**52**	**8**	**4**	**277**	**$ 33,731**
	Total Hours	24	114	97	160		9	24	35	94	32	100	14	4	707	
	Billing Rate	$171.00	$143.00	$128.00	$95.00	$113.00	$109.00	$200.00	$165.00	$135.00	$115.00	$100.00	$150.00	$125.00		
	Total Labor Cost	*$4,047*	*$16,302*	*$12,416*	*$15,200*		*$981*	*$4,800*	*$5,720*	*$12,690*	*$3,680*	*$10,000*	*$2,150*	*$500*		***$ 88,486***
	Direct Expenses															
	Equipment Rental															
	Office Supplies															
	Presentation Materials															
	Consultant Total															$ 88,486

Town of Carbondale
partners - Aspen Valley Land Trust, Roaring Fork Conservancy, and American Rivers
Crystal River Restoration and Weaver Ditch Efficiency Project

Phase 2 - Design Fee Breakdown
September 22, 2017

Task	*Description*	Principal Engineer (RRO)	Project Manager/ Engineer (RRO)	Hydraulic Scientist/PhD (RRO)	Engineer Field / EIT (RRO)	Watershed Scientist/Hydrologist (RRO)	Landscape Designer (RRO)	Hydrographic Survey Crew (RRO)	Principal Ecologist (DHM)	Sr Associate Landscape Architect (DHM)	Natural Resources Coordinator (DHM)	Designer (DHM)	Principal Hydrologist (Lotic)	Watershed Scientist (Lotic)	*Total Hours*	*Total Budget by Task*
1.0	**Project Management and Coordination**	**3**	**10**	**1**			**1**		**5**	**4**			**2**		**26**	**$ 3,783**
6.0	**Preliminary Design**	**4**	**38**	**10**	**96**	**4**	**8**		**11**	**42**		**64**			**277**	**$31,727**
7.0	**Permitting**		**28**		**72**				**4**		**24**				**128**	**$14,264**
	Total Hours	7	76	11	168	4	9		20	46	24	64	2		431	
	Billing Rate	$171.00	$143.00	$128.00	$95.00	$113.00	$109.00	$200.00	$165.00	$135.00	$115.00	$100.00	$150.00	$125.00		
	Total Labor Cost	*$1,140*	*$10,868*	*$1,408*	*$15,960*	*$452*	*$981*		*$3,245*	*$6,210*	*$2,760*	*$6,400*	*$350*			***$ 49,774***
	Direct Expenses															
	Equipment Rental															
	Office Supplies															
	Presentation Materials															
	Consultant Total															**$ 49,774**

Town of Carbondale
partners - Aspen Valley Land Trust, Roaring Fork Conservancy, and American Rivers
Crystal River Restoration and Weaver Ditch Efficiency Project

Phase 3 - Design Fee Breakdown
September 22, 2017

Task	*Description*	Principal Engineer (RRO)	Project Manager/ Engineer (RRO)	Hydraulic Scientist/PhD (RRO)	Engineer Field / EIT (RRO)	Watershed Scientist/Hydrologist (RRO)	Landscape Designer (RRO)	Hydrographic Survey Crew (RRO)	Principal Ecologist (DHM)	Sr Associate Landscape Architect (DHM)	Natural Resources Coordinator (DHM)	Designer (DHM)	Principal Hydrologist (Lotic)	Watershed Scientist (Lotic)	*Total Hours*	*Total Budget by Task*
1.0	**Project Management and Coordination**	**3**	**10**	**1**			**1**		**5**	**4**			**2**		**26**	**$ 3,783**
8.0	**Fundraising**	**2**	**12**				**48**								**62**	**$ 7,290**
9.0	**Final Design**	**5**	**56**		**118**		**8**		**16**	**42**	**16**	**104**			**365**	**$ 41,495**
10.0	**Bid Engineering Services**	**4**	**12**		**8**				**7**	**16**		**20**			**67**	**$ 8,475**
	Total Hours	14	90	1	126		57		28	62	16	124	2		520	
	Billing Rate	$171.00	$143.00	$128.00	$95.00	$113.00	$109.00	$200.00	$165.00	$135.00	$115.00	$100.00	$150.00	$125.00		
	Total Labor Cost	*$2,337*	*$12,870*	*$128*	*$11,970*		*$6,213*		*$4,565*	*$8,370*	*$1,840*	*$12,400*	*$350*			***$ 61,043***
	Direct Expenses															
	Equipment Rental															
	Office Supplies															
	Presentation Materials															
	Consultant Total															**$ 61,043**

ESTIMATED CONSTRUCTION COSTS

Estimating construction costs at this point in the project's progression would be little more than an educated guess. It may actually be a detriment, setting unrealistic expectations with the stakeholder group and the general public. The project team's approach will be to begin estimating construction costs at the conceptual design level, providing the stakeholder group with a detailed construction cost estimate for each of the alternatives. The concepts will intentionally be placed at different pricing levels to provide the stakeholders with a wide range of budgeting options as the project moves forward into the permitting and final design stages. In addition the conceptual alternatives will be set up to where the stakeholder group can pick and choose project elements to create the project that best meets the project's goals and the project's budgetary constraints. The construction cost estimate will be updated again at the preliminary and final design level, providing the stakeholder group with the information needed to properly plan and budget construction of the project.



We've provided two example cost estimates from prior projects to demonstrate the level of detail the project will provide to the stakeholder group. The first is Pentz-Smith Diversion repair, a similar sized diversion project on the Weber River near Morgan, Utah. The second is from a phase of the Basalt River Restoration project.

The team anticipates that the proposed project can be complete in 1 construction year. The in-channel portion of the project will need to be completed within the in-water work window for the Crystal River, which is from mid-August through the end of September. If the selected alternative includes a large amount of in-channel work, an extension may be applied for with the US Army Corps of Engineers. The upland area work can be constructed in a similar timeframe. Revegetation may be delayed depending on the construction start date in order to plant new vegetation at the optimal time. Ecological factors such as heron and eagle nesting periods may also affect the construction timing. All constraints that may affect the timing of construction will be identified during the data collection phase and incorporated into the design process.



Construction of the in-channel work will require the use of heavy machinery, such as excavators and dump trucks. The construction materials will consist of large boulder, some weighing several tons. Access to the Weaver Diversion can be made from the east side of the river at the current maintenance access point adjacent to the diversion. Access to the bank stabilization and habitat feature can also likely be made from the east side of the river, though coordination with the USACE and CPW will be required as this will result in equipment crossing the river. West side access points will be more challenging, though doable, especially towards the north end of the project. As part of the design process, the project team will develop construction staging, construction access and temporary river management plans for the proposed design to show the stakeholder group and the permitting agencies how construction will occur.

Construction of the upland areas, including vegetation enhancement, trails, public gathering and interactive elements will also be designed with construction access in mind. Much of the proposed project elements in the southern portion of the park may be installed by hand or with the use of a small vehicles. Access from the golf course may also be negotiated. The larger project elements, including the accessible trail may be able to take advantage of larger equipment that can access the north end of the park through already degraded areas.

As a point of emphasis, construction access and level of impact will be factored into the alternatives evaluation. Concepts that result in large impacts to Riverfront Park's healthy riparian and wetland vegetation will likely not make the cut.









PROJECT IMPLEMENTATION

Project implementation will largely depend on the selected alternative and the available construction budget. The project team is skilled at managing these scenarios, dividing the project into constructible phases as funding allows. And the project lends itself to a phased approach.

As an example, the Weaver Diversion could be improved as a standalone project, receiving money from a CWCB grant. The remainder of the in-channel work, including bank stabilization and habitat features could be built as a separate project, funded through a fish habitat related funding source. The upland work could be divided into separate projects as well. Dependent on the location, removal of invasive species and restoration of native riparian and wetland plants could be performed prior to the installation of the public gathering spaces





and improved trails, allowing the vegetation to become more established prior to seeing greater number of park visitors. This would also prevent the new trails from being damaged by the landscape contractor.

There are a myriad of ways the project could be implemented, and the project team is ready to guide the stakeholder group through this process.

LONG TERM MAINTENANCE

As part of the project development, the team will develop an Operations, Maintenance, Repair, Replacement and Rehabilitation (OMRRR) Plan. Produced as part of the final design process, the OMRRR plan will provide the stakeholder group insight and detail into inspection procedures and maintenance needs. The narrative below describes expected inspection and maintenance requirement based on the project teams experience with similar projects.

In-channel improvements

Weaver Diversion – Of the in-channel project elements, the Weaver Diversion will likely need regular inspection, similar to programs established for the Town of Carbondale's other diversions. This will likely be on an annual or six-month basis. Inspection items would include shifting or scouring of the boulder grade control in the river, bank erosion adjacent to diversion, accumulation of sediment at the headgate or within the ditch, and damage to the concrete structure or the headgate itself. During low water periods the diversion should be inspected to verify adequate water delivery is being made to the ditch. Repairs to the Weaver Diversion would be made with heavy equipment and access would occur from the existing access road to the structure. Minor maintenance items such as sediment removal or repositioning boulders could be made in the river. More complete repairs would potentially require work area isolation.

Bank Stabilization – The team does not anticipate that scheduled maintenance will be required for bank stabilization measures installed in the project. Park staff would be expected to inspect bank stabilization measures on an annual basis, in late June or early July after runoff. In the unlikely scenario that damage or settling of the structure was found during inspection, the structure would be evaluated and repaired on a case by case basis. The repair could likely be made with an excavator in the river. Access could be made from the Weaver Diversion access on the east side of the river.

Aquatic Habitat Elements – Similar to the bank stabilization measures, the team does not anticipate that scheduled maintenance will be required for aquatic habitat elements installed in the project reach. Slight movement of features such as the fish rock is acceptable and the feature would continue to function. Habitat features attached to the riverbank would benefit from a cursory inspection every couple of years to check for stability. Damage, while unlikely, would be repaired on a case by case basis. Again, the repair could likely be made with an excavator in the river and access could be made from the Weaver Diversion access on the east side of the river.

Upland Areas

Trails – inspection and maintenance of the trail system will be identical to other trails in the Town of Carbondale's park system. Work will include vegetation trimming and removal of trash and debris left by park visitors. Downed trees across the trails will need to be removed or cut and pushed aside. As the trails will be fairly flat, erosion will be less likely of a concern, but still may cause damage to the trails over time, necessitating repair. The surface of the accessible, primary trail will likely need to be augmented with new material (likely either crushed rock or wood chips) every couple of years. All of this maintenance can be done using hand tools or small, portable power tools. The primary trail may be able to support a UTV or other small vehicle.



Outdoor Classrooms/public spaces and interpretive areas – Similar to the trails discussion above, the outdoor classroom and interpretive areas will likely need vegetation management on a regular basis. Items such as benches and tables will need to be inspected and maintained. Damage could occur from vandalism, a fallen tree, decay over time, or even an extreme flood event. Erosion in high traffic areas should be monitored and treated if bare spots form. Treatment may be moving the attraction that's causing the high traffic or planting additional vegetation.

Vegetation Restoration – The project's existing and new planted riparian and wetland corridor will benefit greatly from regular removal of invasive species. This could be done as part of an annual or semi-annual volunteer day. Hazard branches and trees should be removed if in the vicinity of public gathering spaces or frequently used trails. Depending on the location and type of vegetation, two to three years of temporary establishment irrigation may be required for new vegetation. Irrigating certain part of the site could be challenging, so this requirement will be minimized. The temporary irrigation system could be a design-build system developed in conjunction with landscape contractor. A likely source of irrigation water would be an agreement with the golf course who's irrigation system is immediately east of the project.













Our team is comprised of experts in their field. Each team member is a passionate steward of the Crystal River and all live within its watershed and familiar with many of the involved stakeholders. This section provides a brief bio of each team member who will be involved with the design work on the project. Full resumes are included in Attachment A.

04 PROJECT TEAM

JASON CAREY, P.E. | RIVERRESTORATION
PRINCIPAL RIVER ENGINEER



Jason Carey, P.E., Principal River Engineer and founder of RiverRestoration in Carbondale, has more than 18 years of experience, in river planning and design. Jason is a leading innovator in the river engineering field, continually developing new solutions and higher function for our rivers. He has managed over 90 major river engineering projects. Jason's experience encompasses analytical river restoration design, and river recreation enhancement. His skills include geomorphic assessments, river stability analysis, bio-stabilization, sediment transport analysis, floodplain determination, flood damage assessment, dam break analysis, hydraulic design of structures in the river environment, design of fish and boat passage, hydraulic bridge design, design of habitat for specific fish species, and whitewater park design. He holds a Master of Science in Civil Engineering from the University of Utah (1998) and a Bachelor of Science in Physics from Fort Lewis College (1994). Jason is currently registered as a Professional Engineer in Colorado (#38797) and eight other states.

QUINN DONNELLY, P.E. | RIVERRESTORATION
PROJECT MANAGER AND RIVER ENGINEER



Quinn Donnelly, P.E. is a river engineer with 11 years of experience working on a broad range of water resource projects. He has worked in the Carbondale RiverRestoration office for 2 and a half years. Quinn's areas of expertise include open channel hydraulics and modeling, stormwater management modeling and design, and stream restoration and bank stabilization design. His technical skills include hydrologic and hydraulic modeling in SWMM and HEC-RAS, designing and drafting in AutoCAD Civil 3D, and analyzing and mapping in ArcGIS. Quinn has led and managed consultant teams on complex, multi-faceted projects, including recent projects in Oregon and Utah. Prior to RiverRestoration, Quinn worked at Otak, Inc, a civil/water resource engineering firm in Portland, Oregon. He spent a summer as a student hydrologic technician for the US Geological Survey in Fairbanks, Alaska. Prior to his engineering career, Quinn served as an aircraft maintenance officer in the U.S. Air Force. Quinn has a professional certification in River Restoration from Portland State University (2013), a Master's degree in Civil Engineering with a Water Resources emphasis from the University of Washington (2005), and a Bachelor's degree in Civil Engineering from the University of Virginia (1998). Quinn is currently a registered P.E. in Oregon (#78109).

S. MICHAEL SCURLOCK, PhD., P.E. | RIVERRESTORATION
LEAD HYDRAULIC MODELER



Michael Scurlock, Ph.D, has been working in hydraulic river research for over 7 years with a focus on engineering design guideline development for river restoration structures. He has worked in RiverRestoraton's Carbondale office for two years. During his graduate education at Colorado State University, Dr. Scurlock worked at the hydraulics laboratory at the Engineering Research Center and served as a principal investigator on projects investigating hydraulic structures for river restoration applications. He developed extensive knowledge of in-stream structures and created design guidelines for rock-weirs, bendway weirs, spur dikes, and bank-attached vanes which have been published in peer-reviewed journals and conferences. His skills include natural river enhancement and restoration, numerical simulation of open-channel flow, hydraulic structure design, sediment transport, and geomorphic response. He holds a PhD. in Civil and Environmental Engineering from Colorado State University (2014), a Master of Science in Civil and Environmental Engineering from Colorado State University (2010), and a Bachelor of Science in Environmental Resource Management from Texas State University (2007). Michael is currently a registered P.E. in Colorado (#517359) and Wyoming (#15648).

HATTIE JOHNSON | RIVERRESTORATION
LANDSCAPE DESIGNER



Hattie has four years of professional Landscape Architecture experience. Her skills include native vegetation planting plans, grading plans, river access design, and AutoCAD, SketchUp and Adobe Creative Suite drafting and rendering. At RiverRestoration her responsibilities include technical office administration, marketing, conceptual design and rendering. Growing up near Atlanta, Hattie played in creeks and forests across the southeast on countless camping and river trips. Hattie is an avid kayaker, mountain biker, and skier. She spends her free time organizing river clean ups and fundraising events to protect recreational river access. She moved to Colorado after receiving her Bachelors of Landscape Architecture from the University of Georgia in Athens, GA.

STEPHEN ELLSPERMAN | DHM DESIGN
PRINCIPAL | DIRECTOR OF ECOLOGICAL PLANNING



Stephen has 25 years of experience in all aspects of natural resource management, permitting, and planning. From park and open space management to wetland design and construction, Stephen's work is permeated by his deep connection to ecological relationships. He is passionate about the protection and understanding of native ecosystems and strives to harmonize project planning with ecological conditions and future opportunities. Stephen's ability to translate the ecological processes at work within each project is an invaluable resource that enriches both the design and the client's attitude towards environmental awareness.

JENNIFER DICUOLLO | DHM DESIGN
SENIOR ASSOCIATE | PROFESSIONAL LANDSCAPE ARCHITECT



With a strong background in architectural studies, art, and landscape architecture, Jen believes in the transformative value of detail. She uses color, texture, and materiality to shape the client's experience and to define the personal expression of the space. Her studies in Turkey focused on balancing the impacts of tourism and development with the preservation of authentic character. Through her service on the Planning and Zoning Commission for the Town of Carbondale, she embraces a similar challenge closer to home.

SETH MASON | LOTIC HYDROLOGICAL
PRINCIPAL HYDROLOGIST



Seth has over eight years of experience in hydrological research, watershed sciences, and water resource planning. He specializes in hydrological modeling; stream characterization; deployment and operation of data collection and management systems; and development and coordination of water quality monitoring and assessment activities. Seth works extensively with city and county governments, federal agencies, and 501(c)3 organizations. Seth currently serves on the Board of Directors of Eagle Mine Ltd., a nonprofit organization established to monitor and disseminate information about the Superfund cleanup efforts at the Eagle Mine Site near Red Cliff, Colorado.

When he's not finger painting, eating dirt or jumping in puddles with his two young sons, Seth enjoys getting outside on skinny skis, fat skis, mountain bikes and various types of river craft. A retired member of the U.S. Men's Whitewater Raft Team, Seth still spends many summer days seeking out whitewater or floating through one of Colorado's scenic river canyons. In the winter, you will often find him Nordic skiing on the Roaring Fork valley's numerous cross-country skiing trails, or chasing face shots in the Aspen Highlands Bowl. Seth serves as a board member on the Mount Sopris Nordic Council and the United States Rafting Association—organizations focused on making frozen and liquid water sports more accessible and enjoyable to the communities they serve.





05 EXAMPLE PROJECTS

Our team is highly experienced in planning and implementation of river projects. The following pages describe projects completed by all team members that are of a similar scope and size.



OGDEN RIVER RESTORATION



After river restoration

For over 100 years, the Ogden River had been used as a dumping ground for waste material and channelized in an attempt to maximize industrial land to the detriment of stream health. The project vision, to restore a naturally functioning Ogden River with vibrant greenspaces connecting to the urban landscape, was led by RiverRestoration. Design features included interior floodplains, glide, riffle, pool sequences, stormwater buffering, and overall improved stream health. Riparian habitat was increased five-fold. A 1.1-mile river trail was aligned with boardwalks crossing over constructed wetland stormwater return areas. Concentrated river access was created at over 20 locations, including innovative river access ramps. Whitewater parks, fishing habitat, and swimming-safe rapids were created throughout. Over 6,000 tons of recyclable debris, 9,000 tons of trash, 7 whole cars and 2,500 tires and 200 car batteries were removed from the channel.

The structures installed in the channel were designed to affect the morphology of the river bed. The encroached channel had very uniform cross section, habitat type, and substrate size. Innovative riffle structures were designed and located with the intent to capture and refresh with gravel at a steeper gradient than the uniform channel. Thalweg formation was promoted with location of scour vanes and boulder clusters.



Boardwalk over a stormwater return wetland

Flooding during construction in 2011 was a channel forming event and the channel response was very positive, with refreshed riffles, a scoured thalweg, deep pools and productive glides. The morphological response was just in time to test the natural habitat function in the severe drought condition of 2012. The deep pools and thalweg helped the survival of the new fishery and the designation as Blue Ribbon trout waters.

Awards:

- ***Utah's 46th Blue Ribbon fishery***
- ***American Fisheries Society Utah Chapter Conservationist of the Year Award to Ogden City 2011***
- ***Utah DEQ Water Quality Board Sudweeks Award 2012***
- ***Migratory Bird City***



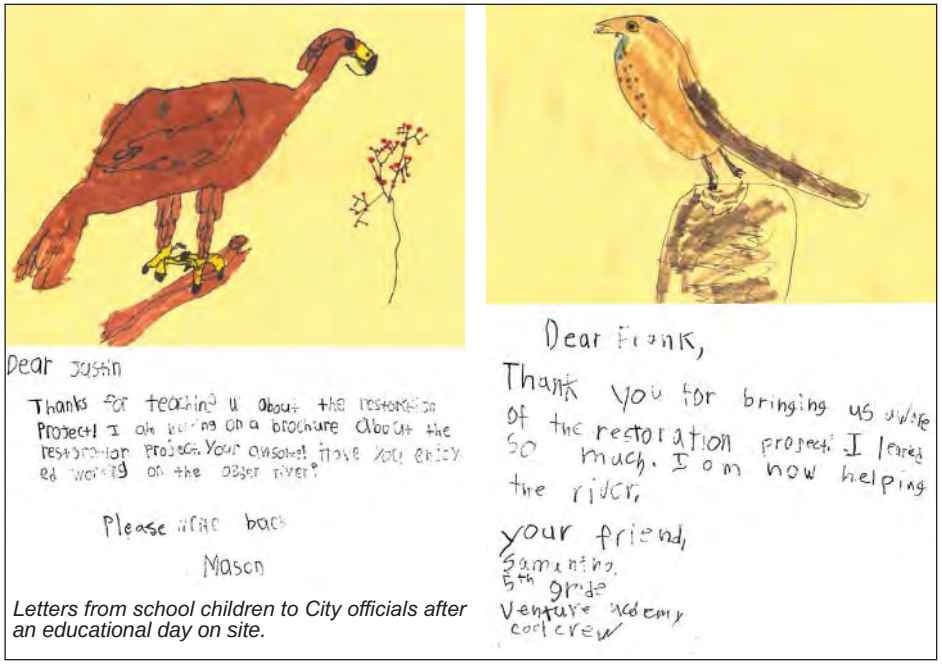
River access feature

The project was listed by the USACE on WRDA 206 list and Senator Bennet supported the project in the 2008 Federal budget; however, federal funds were not appropriated. Project momentum languished until April of 2009 when substantial American Recovery and Reinvestment Act (ARRA) monies were set aside for the project. Since that time the successes and merits of the project have been widely acknowledged and celebrated and the support, both monetary and communal, has snowballed. It was once the city trash dump. Now the Ogden River is at the heart of the revitalization of Ogden City.

OGDEN RIVER RESTORATION CONT.

Creating a sustainable interface between the urban and restored natural areas is a long-term goal of the project. The developable areas were remapped and taken out of the 100-year flood hazard by increasing the channel conveyance with interior floodplains. The interior floodplains serve as a greenspace for the community. Today the community embraces their river as a valued resource flowing in the heart of the City. The community has wholly embraced the project. Local school groups have actively used the riverbanks a an outdoor classroom, local groups organize volunteer days, and residents enjoy respite areas along the shore.





Letters from school children to City officials after an educational day on site.

Quick Facts:

- **The Ogden River Restoration was a phased design while building approach.**
- **Design drawings, construction details, specifications, and permits were developed within 9 months.**
- **Construction started on the first phase of the project with $1M from 2009 ARRA.**
- **The Restoration was completed within three years for a total project cost of $6M.**
- **Assistance was provided for fund raising and stakeholder coordination.**
- **A CLOMR/LOMR was prepared by RiverRestoration**

Project Highlights:

- **Restored riffle, pool, glide morphology**
- **7 Wetland stormwater return areas**
- **1.1 miles of riverwalk**
- **20 concentrated river access features**
- **1 whitewater recreation enhancement**
- **17 acres of delineated riparian easement**
- **350,000 native plantings**
- **Comprehensive invasive species removal**
- **1 Irrigation diversion with improvements**
- **1 New USGS gage station**



After river restoration

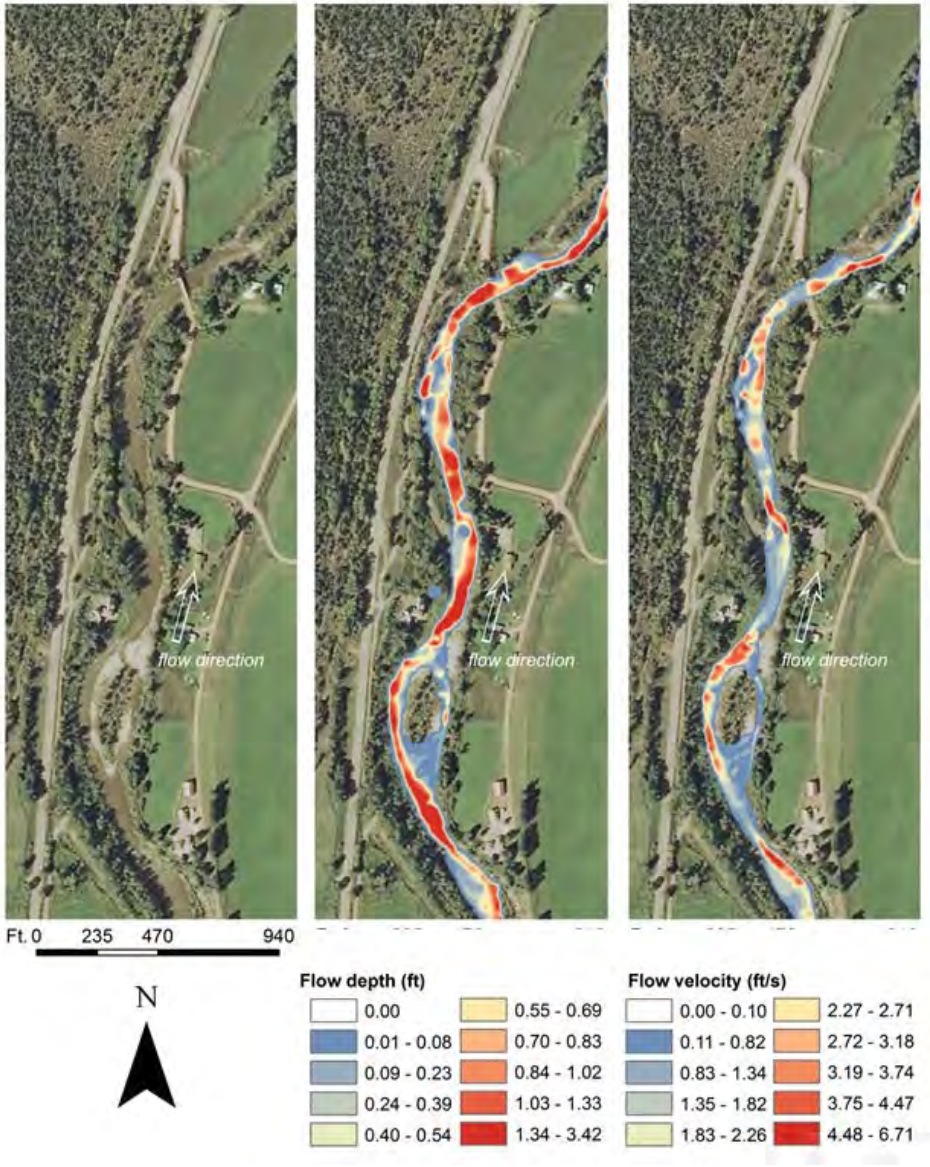
Scope: **Comprehensive planning, channel restoration design, erosion and scour analysis, flood impacts analysis, water quality improvement, recreation enhancement and access, section 404 permit, local SWPP permit**
Status: **Construction completed 2011**
Location: **Ogden River | Ogden, Utah**
Contact: **Justin Anderson, Ogden City Engineer | 801.629.8982**

The Crystal River is located in central Colorado, running from its headwaters near Marble, CO to its confluence with the Roaring Fork River in Carbondale, CO required a stream management plan to evaluate the habitat impact from water diversion. RiverRestoration analyzed bathymetric data and developed a two-dimensional hydraulic model of a seven-mile reach of the Crystal River. The model was calibrated to accurately simulate water-surface elevations, flow velocities, and boundary shear stresses. An example of flow depth and velocity simulation results overlaid on an aerial image from a subsection of the project reach is provided in the adjacent figure. Numerical simulation results closely matched field observations. Model output was used, to correlate hydraulic parameters to existing habitat metrics and to investigate in-stream structure options as an alternative to flow releases for habitat impact.



Crytal River in Carbondale, CO

This modeling exercise provided and initial evaluation of proposed structures and found a low flow channel alternative as less impactful and would provide more long term channel stability.



Flow depth and velocity results from 2-D simulations; Crystal River, CO

CRYSTAL RIVER STREAM MANAGEMENT PLAN HYDRAULIC MODELING

Contact: Lotic Hydrological | Seth Mason, Principal Hydrologist (970) 903.7561 | seth@lotichydrological.com | P.O. Box 1524 Carbondale, CO 81623

COTTONWOOD POND WETLAND ENHANCEMENT AND RESTORATION


Before riparian restoration

RiverRestoration staff completed the design for revegetation of a small pond adjacent to the Jordan River in West Valley City, Utah. This design involved removal of noxious and invasive plants and restoration of wetland and riparian areas adjacent to the pond.


1 year After riparian restoration

The implementation of the project was completed by West Valley City staff and Utah Conservation Corps members with oversight from RiverRestoration. The design of the revegetation was based on projected inundation periods and depth to groundwater around the pond and implementation used containerized plant materials and wetland sod.

Contact: Jordan River Commission| Laura Hansen | 801.589.8479


Before riparian restoration


1 year After riparian restoration


After riparian restoration

OGDEN NATURE CENTER AVOCET POND RESTORATION

RiverRestoration staff is working with the Ogden Nature Center to reduce the cover of the invasive Phragmites australis in a 2 acre groundwater fed pond within the 160 acre preserve. We also developed an inventory of noxious weeds across the facility and continue to provide advice on managing the long-term sustainability of habitats on the preserve. We facilitated discussion between stakeholders to develop goals, objectives, and specific tasks related to controlling and containing noxious weeds on this conservation property in the rapidly urbanizing area of Ogden, Utah. We also developed an action plan to reduce the spread of and containment of noxious weed infestations on the property.

Contact: Ogden Nature Center | Mary McKinley, Executive Director |director@ogdennaturecenter.org | 801.621.7595


During restoration


During restoration

HELPER CITY RIVER REVITALIZATION

Contact: City of Helper | Jona Skerl | jonaskerl@helpercity.net | 435.472.5391



After restoration

As part of 3.3 mile channel restoration project along the Price River in Helper, Utah, the RiverRestoration team designed and implemented a riparian restoration plan for the riverbanks along the project reach. The plan included the removal of a number of invasive and noxious plant species and replacement with native riparian trees, shrubs and grasses. The team used water surface elevations and groundwater data collected during the site survey and modeled using 2-dimensional hydraulic models to determine the appropriate plants for use at the various banks elevations and locations. RiverRestoration worked closely with the landscape contractor to ensure the plants were installed at the correct time and in the correct locations. RiverRestoration continues to monitor the site and provide monitoring and direction to the contractor during the plant establishment period.



Before restoration

BIG BEND HABITAT RESTORATION

As part of a larger river restoration planning effort for a 70 acres site along Jordan River in West Jordan, Utah, RiverRestoration has developed and is implementing a vegetation management plan for the removal of invasive and noxious plant species and replacement with site appropriate native species. This work is being performed ahead of significant construction that will disturb portions of the site over the next 10 years. The team first inventoried the project area and developed an overall plan and set of Best Management Practices to guide future vegetation management work. RiverRestoration staff has supervised groups of volunteers and Utah Conservation Corps crews in completion of the onsite work, removing swaths of Russian Olives, Phragmites and other invasive/ noxious species. Over 1000 native plants have been installed in area where the removal has occurred and irrigation has been developed for the plant establishment period. A phased approach was developed because migratory neotropical songbirds use the site's Russian Olives for nesting. By only removing a portion of the Russian Olives at a time and replacing them with appropriate native plants, the team is able to methodically remove the site's invasive species while still providing critical habitat for these birds. The work being performed now will also help the team develop a detailed, site specific approach to replanting the disturbed areas once the large scale construction activities occur.

Contact: City of West Jordan | Charles Tarver |charlest@wjordan.com | 801.569.5062



UCC crews removing tamarisk

MERCER-BINGHAM JUNCTION WETLAND MITIGATION


Before riparian restoration

Current RiverRestoration staff completed a planting plan and provided field oversight for wetland and riparian restoration along the Jordan River in Midvale City. Explicit direction was given to field crews involved in landscaping design and implementation of required mitigation on 12 acres of floodplain wetlands related to Brownfield site redevelopment area. The property involved was the subject of mitigation activities related to the Murray Smelter Superfund cleanup.


One year after riparian restoration


Two years after riparian restoration


Before river restoration

GORDON CREEK FISH PASSAGE IMPROVEMENT


One year after river restoration

A bridge at the end of Gordon Creek Circle was stabilized in emergency fashion, resulting in a significant concrete drop and head cut in the channel. Trout Unlimited and the Utah DWR wished to restore this section of Gordon Creek to restore the channel, providing fish passage to all life stages of the cutthroat trout. Restoration had to be achieved without rebuilding the bridge or abutments. The banks were stabilized to support the aging bridge. Riparian vegetation was restored along the banks. The subsequent growth has improved water quality at the site.

Contact: Trout Unlimited | Paul Burnett, Utah Water Project Biologist |pburnett@tu.org | 801.436.4062


Three years after river restoration

DHM DESIGN

BASALT RIVER RESTORATION

Basalt, Colorado

Over the course of three years, DHM has been working a multi-disciplinary team of engineers, hydrologists, planners, and the Town of Basalt to plan, design, permit, and oversee the restoration of the Roaring Fork River through an important reach within the community. The restoration of a natural alignment of the Roaring Fork River, the restoration of an active and vital floodplain, the establishment and restoration of diverse and native riparian habitat and vegetation, and the connectivity of multiple raw water and ditch systems are all goals of this restoration project. Our efforts extend beyond the river's edge to the restoration of side channels, critical fish spawning habitat, and significant wetland system development and protection. Located within the heart of downtown Basalt, the goal of this project was not only to restore the river systems and riparian systems, but also to more closely integrate the river into the lives of the Basalt residents and visitors. We created passive recreation experiences in these areas, allowing visitors to observe wildlife diversity that these restored ecosystems support. Our team led the significant federal, state, and local permitting for the project and completed all of the site planning, restoration design, and habitat planning. We conducted significant investigations into the baseline conditions of the natural resources and site and these activities informed our design and permitting approach. A more active riverfront park and event space is in the planning stage and will include created elements within the floodplain zone to be designed and constructed to withstand and recover from flood events.

CLIENT
Town of Basalt

PROJECT TEAM
DHM Design

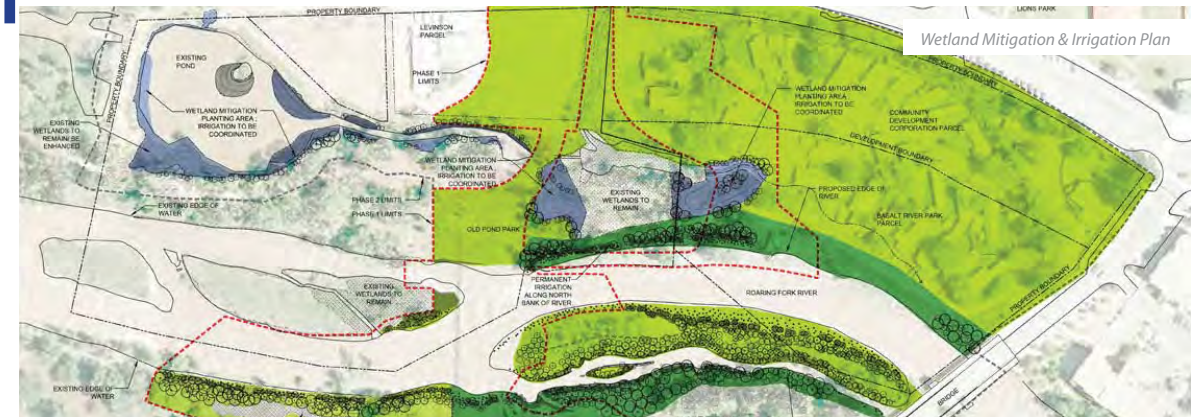
PROJECT DATA
5 Acres
Gold Medal Fishing Waters Preservation
Riverfront Park
Downtown Core Transformation

SERVICES
Conceptual Design
Master Planning
Landscape Architecture
Site Inventory & Analysis
River Stability and Flood Mitigation
Riparian Habitat and Water Systems Restoration
Redefinition of Floodplain
Realignment of River
Permitting Services

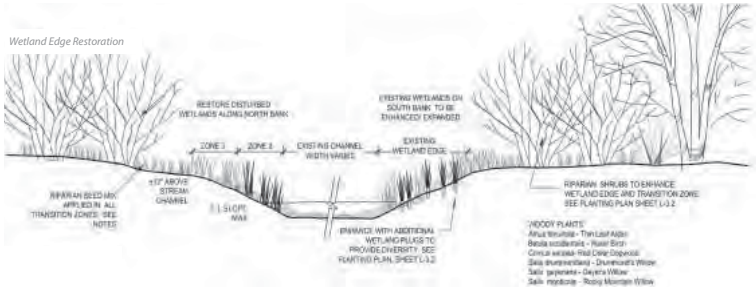
STATUS
In Progress


Spawning Channel


Riparian Planting



Wetland Mitigation & Irrigation Plan



Contact: Town of Basalt | Susan Philp, Planning Director |susan.philp@basalt.net | 970.927.4701

DHM DESIGN

BLUE RIVER TRAIL

Silverthorne, Colorado

DHM Design, along with The Greenway Team, prepared a master plan of trail improvements along the Blue River and worked extensively with the Town of Silverthorne and the community to design and implement extensions of the trail. The trail was designed to be compatible with homes, businesses, roads and the natural environment. The design team provided simulations of bridge crossings, design of access points and interpretive panels that were ultimately implemented in several sections of the trail. Numerous sections were created to identify optimal trail widths and grading to protect the vegetation. Trail design strived to integrate the trail with the surrounding environment by using grading, landscaping and decking to avoid disturbing the native wetlands.

CLIENT
Town of Silverthorne

PROJECT TEAM
DHM Design
The Greenway Team

PROJECT DATA
Approximately 3 Miles of Trail Along the Blue River

SERVICES
Master Planning
Site Design
Landscape Architecture
Construction Documents

STATUS
Segment 1 - 4 Completed
Segment 5 Under Design











Contact: Town of Silverthorne | Susan Lee, Planner II |slee@ silverthorne.org | 970.262.7363

DHM DESIGN

JOHNSON HABITAT PARK

Denver, Colorado

2015 APWA Project Award for Large Community
2015 AGE Ace Bronze Award
2015 CASFM Honor Award
2015 CCASLA Merit Award

The overall project goal at Johnson-Habitat Park was to create a premier environmental education center directly adjacent to Denver's South Platte River. Features include an outdoor classroom, fire ring, overlook plaza, tent pads for children and families to experience, many for the first time, the joy of camping outdoors overnight. Additionally, there are two river access platforms for boats and fishing, trailhead rest areas, interpretive signage, and soft surface trails that connect with the improved hard surface regional South Platte River Trail that traverses the park.

Johnson-Habitat Park is the outcome of an intensely collaborative process between the design team, the City and County of Denver, the Greenway Foundation, The Trust for Public Land, the community, and many non-profit organizations. The $5.5 million dollar park design improves the ecological function of the park, restoring the river's edge, restoring wetlands and contaminated soils, highlighting the natural systems, history, and connecting the park to the city and river with an enhanced regional trail. The park has become the flagship outdoor environmental educational center that serves a local non-profit in their efforts to build awareness and appreciation for Denver's waterways.



CLIENT
City and County of Denver
Department of Parks & Recreation

PROJECT TEAM
DHM Design
ICON Engineering
Architerra Group

PROJECT DATA
Urban Camping
River Access
New Park Amenities
Environmental Restoration/
Education

SERVICES
Feasibility Report
Schematic Design Report
Master Planning
GOCO RCI Grant Assistance
Interpretive Signage

STATUS
Completed



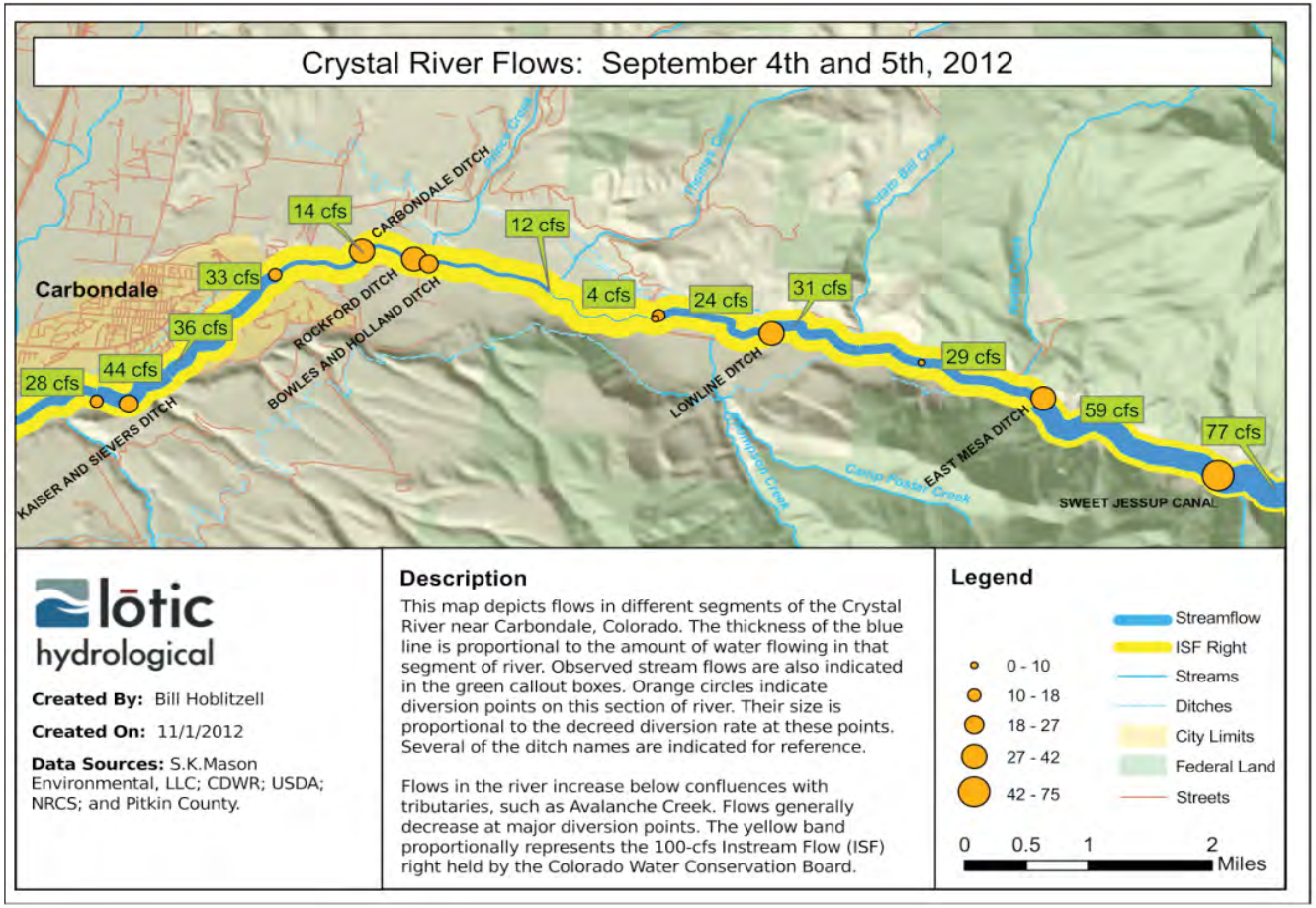


Contact: City of Denver, Parks and Recreation | Michael Bouchard, Assistant Director of Design & Construction |michael.bouchard@denvergov.org | 720.913.0632

Crystal River Stream Management Plan

May 2014- May 2016

Lotic produced a guidance document for implementing management alternatives in the Crystal River watershed aimed at addressing late-season low-flow conditions that impair stream health. This work responded to questions articulated by a diverse group of stakeholders in the Crystal River watershed by conducting six interdisciplinary evaluations of existing physical, biological, and resource management conditions and developing a structured decision support framework for guiding management decisions. The resulting decision support system explicitly simulated watershed hydrology; allocation and administration of water under Colorado's water rights system; two-dimensional channel hydraulics along 8 miles of the lower Crystal River; and the interplay between channel form, changes in streamflow, and the quality and availability of aquatic habitat. Results from this effort identified, prioritized, and provided initial project scoping for alternative management actions and/or structural solutions available to improve ecological conditions and functions in the Crystal River while recognizing the management constraints imposed by the competing objectives of various local stakeholder groups. A copy of this document can be obtained at this location: http://www.roaringfork.org/your-watershed/crystal-river/stream-management-plan/.



- ***Applied FACStream framework to assess ecosystem condition***
- ***Developed extensive 2D hydraulic model to assess sediment dynamics and aquatic habitat quality***
- ***Developed water rights allocation and accounting hydrological daily simulation model***
- ***Engaged diverse stakeholder group to discuss opportunities for water management***

San Miguel Pilot Project

April 2016-Ongoing

Lotic is helping Trout Unlimited, the San Miguel Watershed Coalition, and the Southwest Basin Roundtable develop a prototyped approach for assessing non-consumptive use needs and evaluating management opportunities for meeting those needs in the San Miguel watershed. This project considers channel maintenance flows, riparian conditions, aquatic habitat quality and connectivity, and recreational use preferences. Field data is being used to develop and refine hydrological and hydraulic simulation models that characterize existing conditions and enable evaluation of 'what-if' scenarios. Stakeholder engagement will guide selection of management opportunities to evaluate in the assessment framework. Planning outcomes intend to instruct future water planning, granting and approval processes. This project is currently underway and no final report is available at this time.



- ***Worked with diverse stakeholder group to identify environmental and recreational water use needs***
- ***Characterized fluvial geomorphology, aquatic habitat, riparian condition, and sediment transport dynamics throughout the San Miguel watershed***

Contact: Trout Unlimited and Southwest Basin Roundtable | Mely Whiting |mwhiting@tu.org | 720.470.4758

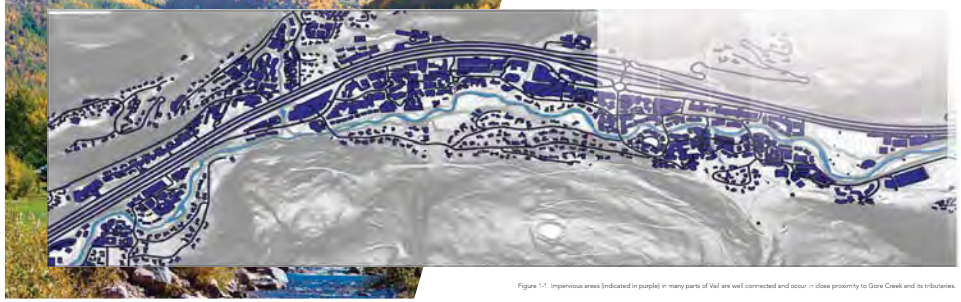
Gore Creek Strategic Action Plan

October 2014-May 2016

Lotic developed a strategic action plan that provides a framework for Town of Vail to initiate actions designed to address current water quality impairments and aquatic health issues affecting Gore Creek and its tributaries. Effort focused on two primary goals: a) identifying strategies and actions needed to protect and improve water quality in the Gore Creek Watershed, and b) outlining an implementation plan that includes prioritized actions and estimated budgets for achieving water quality goals over the next ten years. The plan identifies 200+ strategic actions in five distinct strategy areas: regulatory changes, implementation of best management practices, education and outreach, streambank restoration and structural BMP projects, and ongoing data collection and monitoring. During the final phases of the project, worked with a community advisory group of homeowner associations, county government, local businesses, special districts, and community organizations to review, refine and rank recommended actions based on feasibility and effectiveness. The full plan can be downloaded at: http://www.vailgov.com/projects/restore-the-gore

- ***Collated and developed a set of water quality development standards for high mountain towns***
- ***Utilized five strategy areas—regulations, best management practices, education and outreach, data collection, and site specific strategies—to provide recommendations for improving water quality conditions on Gore Creek***
- ***Worked with community advisory group to evaluate the relative feasibility and effectiveness of each recommendation***
- ***Supported Town staff in a formal review and adoption process of the completed plan by Vail Town Council***

Contact: Town of Vail| Kristen Bertuglia |kbertuglia@vailgov.com | 970.477.3455



ATTACHMENT A

JASON CAREY, P.E.

PRINCIPAL RIVER ENGINEER

QUALIFICATIONS

Natural Channel Design
Fish Passage/Barrier Design
Whitewater & Boat Chute Design
Dam Removal
Hydraulic & Floodplain Modeling
Sediment Transport Analysis
Hydrographic Survey
Expert Witness Testimony
Fluvial Geomorphic Evaluation
Hydrologic Analyses

REGISTRATIONS

Professional Engineer in Colorado (#38797)
Professional Engineer in Utah (#318641-2202)
Professional Engineer in California (#C64838)
Professional Engineer in Oregon (#88654)
Professional Engineer in Michigan (#6201060830)
Professional Engineer in New Mexico (#21505)
Professional Engineer in Iowa (#21608)
Professional Engineer in Idaho (#14100)
Professional Engineer in Kentucky (#26578)
Past Secretary Glenwood Whitewater Events
Past Vice President River Management Society SW

BACKGROUND

Jason Carey, P.E. holds eighteen years of practice as a River Engineer. Mr. Carey is a leading innovator in the field, continually developing new solutions for our rivers. Sixty-Seven of Mr. Carey's river designs have been successfully constructed, including 12 whitewater recreation enhancements on various dams with multiple fish and boat passage issues. Mr. Carey has managed ninety-three major projects involving river restoration, geomorphic assessment, natural channel design, wetlands restoration, river stability analysis, bio-stabilization, sediment transport, floodplain determination, reservoir capacity analyses, dam break analysis, hydraulic design of structures in the river environment, design of erosion control measures, design of irrigation canals, hydraulic bridge design, diversion structure design, design of habitat for specific fish species, and whitewater park design. Mr. Carey also provides expert witness testimony for water rights, whitewater recreation and river hydraulics.

SELECTED WORK EXPERIENCE

Black Gore Creek Total Maximum Daily Load **2004-present**

Mr. Carey led a multi agency, multi disciplinary team in developing a TMDL to address the sediment impacts of Interstate-70 on Black Gore Creek at Vail pass. Active stake holders include the White River National Forest; Colorado Department of Transportation; Colorado Department of Public Health and Environment; Environmental Protection Agency; Eagle County; Town of Vail; Eagle River Water and Sanitation District; Eagle River Washed Council. My Carey has been instrumental in developing a functional non-point source TMDL, developing a Load Capacity calculation and analyzing Source Allocation and associated Sediment Budget. Mr. Carey has prepared and executed a Sediment Source Monitoring Plan to support implementation of the TMDL

Black Gore Creek Capital Projects **2005-present**

Mr. Carey is the Principal Engineer coordinating the design and implementation of sediment stabilization and removal projects in Black Gore Creek. These projects utilize new techniques and creative solutions for reducing the impact of sediment on the watershed such as sand wanding, geo-tubes and log cribbings. Mr. Carey performed reconnaissance level surveys to identify potential projects outside of the highway corridor. Mr. Carey has lead hydrographic survey and prepared preliminary design at five sites, and performed final design, plans and permitting for two sites. Implementation at two sites is anticipated in the summer of 2006.

Eagle River Recreation Enhancement Plan **2005-2006**

Mr. Carey is Project Manager for the development of a river recreation enhancement plan for Eagle County. The Plan includes inventory and assessment of 116 access points, 23 use reaches and 183 in-stream hazards. Furthermore, the Plan prioritizes and develops concept design for fifteen projects to enhance river recreation.

WRDA Section 206, Yampa River Hayden Restoration **2001-2004**

(with TetraTech)Mr. Carey acted as Project Manager for an ecosystem approach to river restoration of approximately 10 miles of the Yampa River in Colorado. Mr. Carey directed surveying efforts, characterized existing conditions, identified environmental degradations, developed alternative solutions, and analyzed cost effectiveness to present a recommended plan of action. Mr. Carey was instrumental in the development of a Data Identification Report and a Detailed Project Report and an Environmental Assessment for the Sacramento District COE. This project required that Mr. Carey deliver a very high level of coordination between project sponsors, stakeholders, The Nature Conservancy, the Fish and Wildlife Service, and the COE. The project includes the design of environmentally sensitive diversion structures, irrigation delivery systems, and invasive fish species exclusion structures.

Ogden River Restoration **2006- 2013**

Mr. Carey acted as Principal River Engineer leading this complex engineering project that would typically include a large staff for implementation. Mr. Carey lead the planning, design, engineering, hydrographic survey, permitting, fund raising, and construction review of the comprehensive restoration of 1.1 miles of the Ogden River. All aspects of visioning and completing this project were under the direct charge of Mr. Carey. Design incorporated geomorphology, sediment transport, hydrology and hydraulics.

This 1.1 mile reach of river that previously travelled through abandoned junk yards and concrete dumps has now been awarded status as Utah's 46th Blue Ribbon fishery and the prestigious Sudweeks Award. The design included a mile long riverwalk with 6 boardwalks over constructed stormwater finishing wetlands. The construction of wetland areas are a major accomplishment that will serve as stormwater buffering areas for discharges striving to meet the MS4 phase II permit and draft TMDL goals. The riverwalk provides a number of hard and soft access points which serve to appropriately guide visitors to the river's edge while protecting sensitive riparian areas. Floodplain connection and FEMA remapping with a CLOMR/LOMR were major achievements of the project. In 2011 the channel experienced floods exceeding the 100-year event for 42 days. The improved capacity and channel stability inherent in the design conveyed the floods without major incident.

Town of Vail 2010 Flooding Damage Assessment and Repair Plan **2010-present**

Mr. Carey led the comprehensive investigation and emergency repair plan for damage caused by a significant flood event within the Town of Vail in June of 2010. Flows exceeded the 100-year event on the main channel and the 500-year event on a number of tributaries. Mr. Carey prioritized 64 projects for damage repair with cost opinions. Projects included stabilizing crossings of three bridges, a major utility, and a diversion intake. Four projects were designed and guided through construction within 6 months of damage. Four additional projects were completed a year later and five additional projects are in the final phases of design. Major channel realignments and channel training were required. Improved flood conveyance, bank stability and infrastructure protection was achieved at each project with designs that accommodated habitat and morphology.

Glenwood Springs River Recreation Enhancements **2007-2010**

Mr. Carey served as Principal River Engineer for the development of a whitewater park on the Colorado River for the City of Glenwood Springs, Colorado. The project was successfully constructed in winter 2008 with Mr. Carey leading the construction stakeout and monitoring. Runoff in 2008 revealed the project to be a huge success with a giant wave forming on the feature. The project has been a multi-year multi-faceted project. A Conditional Letter of Map Revision has been filed with FEMA. Multiple funding applications were made. 401 and 404 permitting through the Colordao Department of Health and Environment and the US Army Corps of Enginners were obtained. The Colorado Department of Transporation and Federal Highways Administration licenses were required. A complete plans and specifications package was competitively bid with four bidders. Mr. Carey successfully led the team of engineers and scientists that have efficiently completed all of these tasks.

JASON CAREY, P.E.

PRINCIPAL RIVER ENGINEER

EMPLOYMENT HISTORY

RiverRestoration ***2/2004 – Current***
River Engineer/ Principal
P.O. Box 248, Carbondale, CO 81602

Tetra Tech/Infrastructure Southwest Group (formerly FLO Engineering) ***3/1998-2/2004***
River Engineer/ Project Manager
410 S. French Street, Breckenridge, CO 80424

Lambert and Associates ***3/1990 – 9/1993***
Geotechnical Engineering Technician
411 Bodo Drive, Durango, CO 81301

EDUCATION

Master of Science, Civil and Environmental Engineering, University of Utah *3/1998*
Thesis: *Mesoscale Modeling of Snow Water Equivalent, Kennecott Copper Mine*

Bachelor of Science, Physics, Fort Lewis College *12/1994*
Dissertation: *Evaluation of Optical Seeing with the Differential Image Motion Monitor, Fort Lewis Observatory Site.*

PUBLICATIONS

Hecla Junction Flood Mitigation and Stream Restoration Concept Plan *2008*
C.J. Schott, J.P. Carey, PE. Colorado Water Conservancy Board.
http://cwcb.state.co.us/NR/rdonlyres/9D9B09E7-5D3D-475C-8DB8-91069F10A9FC/0/HeclaReport10Aug07.pdf

Site surveys, floodability assessments, design and engineering for floodplain habitat restoration *2003*
Colorado River Recovery Program Project Number: C-6-HYD. Jason Carey, PE

Floodability Assessments and Post-Restoration Sedimentation and Erosion Monitoring/Evaluation for the Floodplain Habitat Restoration Program; Green River, UT - Colorado River, CO - Gunnison River, CO, Colorado River Recovery Program Project Number: C-6 HYD. Bill Fullerton and Jason Carey, PE *2001*

Combining the Corps of Engineers' Ecosystem Restoration Program with Local Funding Opportunities along the Arkansas River, City of Pueblo, Colorado. World Water Congress Bridging the Gap: Meeting the World's Water and Environmentla Resource Challenges. World Water and Environmental Resources Congress. Ira Artz, Jason Carey, Bill Fullerton, David Batts, Chris Lee and Richard Fike. Edited by Don Phelps and Gerald Sehlke, May 20-24, 2001, Orlando, Florida. *2001*

Opportunities of the Corps of Engineers' Ecosystem Restoration Program and Its Application to the City of Alamosa, Colorado. Water Resources 2000: Building Partnerships. Joint Conference on Water Resource Engineering and Water Resources Planning and Management 2000. Ira Artz, David Batts, Jason Carey, and Khaled Abu-Zeid. Edited by Rollin H. Hotchkiss & Michael Glade, July 30- August 2, 2000 Minneapolis, Minnesota. *2000*

AWARDS

Corps of Engineers Great Lakes and Ohio River Division, Commander's Project Team of the Year Award Nomination, *Section 206, South Fork New River Restoration Plan, Boone, North Carolina*.

Quinn Donnelly, P.E.
RIVER ENGINEER/PROJECT MANAGER

QUALIFICATIONS

Project Management
Open Channel Hydraulics and Modeling
Stormwater Management System Modeling and Design
Stream Restoration / Bank Stabilization Design
Hydrologic Analysis

REGISTRATIONS

Professional Engineer in Oregon (#78109PE)

SELECTED WORK EXPERIENCE

Big Bend Restoration Project **2014-Current**

Quinn is serving as the project manager for an ongoing project on the Jordan River for the City of West Jordan. The overall project includes the enhancement of 70 acres of agricultural land for habitat restoration and recreational purposes. Habitat enhancements include the realignment of the Jordan River through the site, bank stabilization, and creation of 15 acres of wetland and riparian habitat. Vegetation management plans will remove a variety of invasive/noxious species and replace them with native plants. Recreational enhancements will include an urban fishery, several miles of primary and secondary trails. The design team is coordinating with over 20 stakeholders, numerous state and federal regulatory agencies to outline and meet project objectives. The team has also raised over $200K to date through grant and other funding mechanisms. The project is currently at the 30 Percent design level.

Columbine Drive Culvert Replacement **2014-2015**

As the project engineer, Quinn led the design effort for the Town of Vail to replace a failing culvert over Bighorn Creek in East Vail, Colorado. The steep, eleven percent gradient stream channel transports significant sediment during flood events, which had caused damage to the existing corrugated metal culvert. Water was also flowing around and under the culvert, resulting in loss of roadway embankment. The proposed 8'x5' concrete box culvert increased the culvert capacity significantly, allowed for passage of sediment, and minimized opportunities for stream flow to bypass the culvert opening. The banks upstream and downstream of the crossing were rebuilt with tier and boulder retaining walls and native vegetation, providing a natural look that fit in with the aesthetics of the neighborhood. Construction was complete in the fall of 2015 and was finished with zero change orders.

Helper City River Revitalization, Helper, Utah ***2014-Current***

As the project engineer, Quinn performed site survey and develop construction documents for a dam removal project on the Price River in Helper, Utah for Trout Unlimited. The project included the removal of a dilapidated and dangerous diversion dam and installation of three rock-arch structures to provide recreation (boat) and fish passage through the project reach. The project was the second phase of comprehensive restoration of the Price River through 3 miles of the urban core of Helper. The Price River was heavily impacted by railroads, highway and urban encroachment, water development, and riparian and aquatic invasive species. Construction was complete in 2016.

Weber River Diversion Fish Passage Fishway **2014**

As a project engineer, Quinn developed detailed construction documents for a proposed fish ladder around an existing irrigation dam on the Weber River in central Utah as part of a Trout Unlimited funded project. The structure, which allows passage for several fish species, including the endangered Bluehead Sucker, was incorporated into an existing intake/fish screen structure and included detailed 2D hydraulic modeling as part of the design process. Construction on the project was completed in the Spring of 2015.

Colorado Dam Paddle Trail Improvements; Bend, Oregon ***2011-Current***

Unique project that is retrofitting a dangerous lumber mill dam on the Deschutes River in Bend, Oregon with three separate channels for providing fish passage, whitewater recreation and habitat enhancements. As the project engineer, Quinn utilized AutoCAD Civil 3D and HEC-RAS to design and evaluate the performance of the 600 foot long fish passage channel which will also provide safe passage for river users not wanting to use the more advanced whitewater channel. Work included modeling of existing and project conditions, analysis of fish passage / recreational requirements, floodplain analysis, and a management plan for frazil ice. As part of a five consultant firm team, he prepared construction documents for the $9.1M project. Construction due for completion in 2016.

NW 38th Avenue/SE 20th Street Improvements; Camas, Washington ***2012-2014***

As water resource task lead, Quinn designed a stormwater management system for street, sidewalk, and bike lane improvements that created a total of 7 acres of contributing impervious area requiring treatment and detention. After an extensive alternatives analysis, a proprietary treatment system was selected which reduced facility footprint size and long term maintenance costs. Strict treatment requirements associated with the need for phosphorus removal limited acceptable options. The wider road necessitated the realignment of approximately 2,000 feet of stream channel, which included habitat improvements such as large wood and varying channel shape and roughness. The design took advantage of the new stream channel alignment to create an enhanced floodplain and wetland mitigation area that reduces the size of conventional stormwater ponds needed to meet Washington's Department of Ecology robust detention requirements. *(Work Prior to RRO)*

Sara Junction Slope Stabilization; Clark County, WA ***2013***

As project engineer, Quinn designed emergency embankment repair of NW 179th St in rural Clark County, Washington. Roadway had been forced to close due to undercutting and embankment failure caused by stream bank erosion on adjacent Whipple Creek. Site assessment included stream characterization and hydraulic modeling in HEC-RAS. The design consisted of a new rock embankment to support the roadway and 100 ft of bioengineered stream bank protection with large wood and wrapped soil lifts to prevent erosion, provide habitat, and minimize impact to the active stream channel. The design allowed for streamlined permitting so that the repairs could be done promptly. Quinn provided support during construction, advising contractor on work area isolation and techniques for installation of large wood, ballast boulders and fabric wrapped soil lifts. *(Work Prior to RRO)*

EMPLOYMENT HISTORY

RiverRestoration ***10/2014 – Current***
River Engineer / Project Manager
P.O. Box 248, Carbondale, CO 81623

Otak, Inc ***2/2006-9/2014***
Water Resources Engineer
808 SW 3rd Ave, Portland, OR 97204

US Geological Survey ***5/2005-9/2005***
Student Hydrologic Technician
3400 Shell St Fairbanks, AK 99701

US Air Force ***2/1999-9/2004***
Aircraft Maintenance Officer
Sumter, SC; Prince Sultan AB, Saudi Arabia; Spangdahlem, Germany; Tallil AB, Iraq

EDUCATION

Master of Science, Civil Engineering with Water Resources Emphasis, University of Washington	*12/2005*
Bachelor of Science, Civil Engineering, University of Virginia	*12/1998*
River Restoration Professional Certification, Portland State University	*9/2013*

AWARDS

APWA Washington Project of the Year Award in the Disaster / Emergency, Less Than $5 Million category, *Sara Junction Slope Stabilization*, Clark County, Washingon.

ATTACHMENT A

S. MICHAEL SCURLOCK, Ph.D, P.E.

PROJECT MANAGER, RIVER ENGINEER

QUALIFICATIONS

Natural Channel Design
River Stabilization Techniques
Hydraulic Structure Design
1D, 2D, 3D CFD Modeling
Physical Modeling
Systems Analysis and Optimization
Sediment Transport Analysis
Fluvial Geomorphic Evaluation
Hydrographic Mapping and Surveying
Geospatial Analysis

REGISTRATIONS

Professional Engineer Wyoming (#15648)
Professional Engineer Colorado (#517359)

SELECTED WORK EXPERIENCE

Physical modeling of bank-stabilization river-restoration structures ***2012 - 2015***

Dr. Scurlock served as a principal investigator researching bank stabilization structures in natural river environments. Large scale physical models were designed and constructed to evaluate mean-flow and turbulent velocity fields and boundary shear-stress effects due to the installation of bendway weirs, spur dikes, and bank-attached vanes. Dr. Scurlock developed the research plan, structure design, and data collection plan, and managed a team for model operation. Insights gained during research include applicable design guidelines, critical structure hydraulic information, and a comprehensive description of flow fields which were previously unavailable. Results of the research had widespread implications and provided state-of-the-art knowledge of transverse in-stream structure flow hydraulics for river-restoration applications.

Design guideline development for bank stabilization structures ***2009 - 2014***

Transverse in-stream structures are commonly installed in channel bends as a method of erosion reduction and mitigation of unwanted river migration. Dr. Scurlock developed a mathematical model capable of predicting hydraulics resulting from structure installation as a function of structure and channel geometries. The model is readily implemented in practice, utilizing parameters typically obtained during channel design. The model was calibrated using data from physical models of spur dikes and bank-attached vanes and compared with data from field installations. Resulting design tools represented the leading edge of river migration control design, providing desired hydraulic conditions while significantly reducing construction costs.

Numerical modeling of river restoration structures ***2013- 2015***

Dr. Scurlock led efforts for computational fluid dynamics simulations of bendway weirs in representations of natural topography channels. Efforts represented a new branch of hydraulic research, combining data from physical models with numerical simulations to develop design tools for engineering practitioners. Numerical simulations were shown to match well with laboratory data and have strong potential in natural river environments and hydraulic structure design. Dr. Scurlock developed tools during the numerical modeling program to rapidly investigate various hydraulic structures and design options in a variety of river environments.

Investigation of distribution of hydraulic forces in channel bends ***2011- 2012***

Channel-bend hydraulics present complex environments for engineering design. Hydraulic forces are distributed throughout the channel bend as a function of width to depth ratio, local positioning and total length of the channel bend, and radius of curvature. Using physical model data, Dr. Scurlock developed methodologies for the prediction of boundary shear-stress distributions throughout river channel bends. The developed methods provide engineering practitioners tools for adaptive bank-stabilization design, allowing protection measures to target areas of high erosion potential while reducing costs in areas of low priority.

Hydraulic design guidelines for rock-weir restoration structures ***2009 - 2014***

Traditional grade-control structures, or low-head dams, are installed to halt river degradation or to cause desired upstream water-surface elevations. Typically constructed of abrupt concrete crests, traditional structures may disrupt fish passage and impair riparian health. Rock-weir structures, e.g. A-weirs, U-weirs, and W-weirs, are an emerging type of grade-control with strong benefits to habitat and river ecosystem quality. Dr. Scurlock performed

significant research on rock-weirs, developing comprehensive design guidelines for stage-discharge, scour depth prediction, scour volume prediction, and energy dissipation.

EMPLOYMENT HISTORY

RiverRestoration ***4/2015-Current***
River Engineer
P.O. Box 248, Carbondale, CO 81602

Colorado State University Hydraulics Laboratory ***08/2007-4/2015***
Principal Investigator/Research Assistant
1320 Campus Delivery, 80523, Fort Collins, CO 80523

EDUCATION

Doctor of Philosophy, Civil and Environmental Engineering, Colorado State University *05/2014*
Dissertation: *Quantification of transverse in-stream structure hydraulics*

Master of Science, Civil and Environmental Engineering, Colorado State University *12/2010*
Thesis: *Equilibrium scour downstream of three-dimensional grade control structures*

Bachelor of Science, Environmental Resource Management, Texas State University *05/2007*

PUBLICATIONS

Abt, S.R., Scurlock, S.M., Thornton, C.I., Cox, A.L., and Holste, N.J. (2016). “Bendway weir riprap sizing criteria.” *Journal of Hydraulic Engineering.* DOI: 10.1061/(ASCE)HY.1943-7900.0001209.

Carey, J.P., Scurlock, S.M., and Prins, S.E. (2016). “Coupled ecological and hydraulic approach to assess potential impacts on habitat suitability.” *ASCE EWRI Conference Proceedings.*

Scurlock, S.M. (2016). “Application of design strategies for transverse instream structures.” *ASCE EWRI Conference Proceedings*.

Gordon, E.H., K. Collins, R. Klinger, C. Holmquist Johnson, and S.M. Scurlock (2016). “Rock weir design guidance.” U.S. Department of the Interior, Bureau of Reclamation, Technical Service Center.

Scurlock, S.M., Thornton, C.I., and Abt, S.R. (2015). "One-dimensional modeling techniques for three-dimensional grade-control structures." *Journal of Hydraulic Engineering*. (141).

Baird, D.C., Fotherby, L., Klumpp, C.C., and Scurlock, S.M. (2015). “Bank stabilization design guidelines.” U.S. Department of the Interior, Bureau of Reclamation, Technical Service Center. Report No. SRH-2015-25.

Scurlock, S.M., Cox, A.L., Baird, D.C., Thornton, C.I., and Abt, S.R. (2015). “Hybrid hydraulic modeling of river-training structures in sinuous channels.” *SED-HYD 2015 Conference Proceedings*.

Scurlock, S.M., Thornton, C.I., Abt, S.R., and Baird, D.C. (2015). “Convective acceleration effects from transverse in-stream structure installations.” *SED-HYD 2015 Conference Proceedings.*

Scurlock, S.M., Baird, D.C., Thornton, C.I., Abt, S.R., and Cox, A.L. (2014). "Shear-stress distributions within a prismatic and native-topography channel." *ASCE EWRI Conference Presentation.*

Scurlock, S.M., Thornton, C.I., Baird, D.C., and Abt, S.R. (2014). “Quantification of transverse in-stream structure hydraulics.” *Journal of Hydraulic Engineering.* DOI: 10.1061/(ASCE)HY.1943-7900.0000952.

Scurlock, S.M. (2014). "Quantification of hydraulic effects from transverse instream structures in channel bends." Dissertation. In partial fulfillment of the requirements of the degree of Doctor of Philosophy in Civil Engineering, Colorado State University, Fort Collins, CO, May.

Scurlock, S.M., Thornton, C.I., and Abt, S.R. (2012). "Equilibrium scour downstream of three-dimensional grade-control structures." *Journal of Hydraulic Engineering*. (138). 167-176.

Scurlock, S.M., Baird, D.C., Thornton, C.I., Abt, S R., and Cox, A L. (2012). "Middle Rio Grande physical modeling - Transverse instream structure analysis: Maximum and average velocity ratios

within the prismatic channel." Report submitted to United States Bureau of Reclamation. Colorado State University, Department of Civil Engineering. Fort Collins, CO.

Scurlock, S.M., Baird, D.C., Thornton, C.I., Abt, S.R., Cobb, A.H., and Cox, A.L. (2012). "Middle Rio Grande physical modeling - Shear stress distributions within the prismatic and native-topography channels." Report submitted to United States Bureau of Reclamation. Colorado State University, Department of Civil Engineering. Fort Collins, CO.

Scurlock, S.M., Cox, A.L., Baird, D.C., Thornton, C.I., and Abt, S.R. (2012). "Middle Rio Grande physical modeling - Transverse instream structure analysis: Maximum outer-bank velocity reduction within the prismatic channel." Report submitted to United States Bureau of Reclamation. Colorado State University, Department of Civil Engineering. Fort Collins, CO.

Scurlock, S.M., Cox, A.L., Baird, D.C., Thornton, C.I., Parker, T.R., and Abt, S.R. (2012) "Middle Rio Grande Physical Modeling - Native topography: Construction and evaluation of baseline hydraulic conditions." Report submitted to United States Bureau of Reclamation. Colorado State University, Department of Civil Engineering, Fort Collins, CO.

Scurlock, S.M., Thornton, C.I., Cox, A.L., Abt, S.R. (2012). "Middle Rio Grande Physical Modeling - Native topography dataset evaluation summary." Report submitted to United States Bureau of Reclamation. Colorado State University, Department of Civil Engineering, Fort Collins, CO.

Scurlock, S.M., Cox, A.L., Thornton, C.I., and Baird, D.C. (2012). "Maximum velocity effects from vane-dike installations in channel bends." *ASCE EWRI Conference Proceedings*.

Thornton, C.I., Meneghetti, A.M., Collins, K., Abt, S.R., and Scurlock, S.M. (2011). "Stage-discharge relationships for U-, A-, and W-weirs in un-submerged flow conditions." *Journal of American Water Resources.* (47:1). 169-178.

Scurlock, S.M., Thornton, C.I., and Abt, S.R. (2011). "One-dimensional modeling techniques for energy dissipation in U-weir grade-control structures." *ASCE EWRI Conference Proceedings*.

Scurlock, S. M. (2009). "Equilibrium scour downstream of three-dimensional grade-control structures." Thesis. In partial fulfillment of the requirements in the degree of Masters of Science in Civil Engineering, Colorado State University, Fort Collins, CO, October.

Scurlock, S. M. (2009). "One-dimensional modeling techniques and energy dissipation in rock weir grade-control structures." Report submitted to United States Bureau of Reclamation. Colorado State University, Department of Civil Engineering, Fort Collins, CO.

Scurlock, S. M., Cox, A. L, Thornton, C. I. (2008). "M&T pump station physical modeling." Report submitted to Musseter Engineering Inc., June. Colorado State University, Department of Civil Engineering, Fort Collins, CO.

HATTIE JOHNSON
LANDSCAPE DESIGNER

QUALIFICATIONS

Landscape design
River access design
Graphic communication
Riparian planting plans
Grant and fundraising support
Community outreach
Construction document production

SELECTED WORK EXPERIENCE

Grand River Rapids Revitalization, Grand Rapids, MI **2013-Present**

This comprehensive and community-lead project seeks to restore the namesake rapids of Grand Rapids. Ms. Johnson has been involved with multiple aspects of the Grand Rapids Restoration Project since beginning at RiverRestoration in 2013. She has performed project management, permitting coordination and compilation, preliminary river access design, design renderings, fundraising material production, grant writing, and floodwall redesign. Ms. Johnson is assisting in the coordination effort between the design processes of the river revitalization and river corridor improvements.

Helper City River Revitalization, Utah **2011-Present**

Ms. Johnson has assisted with river access design and fundraising efforts for a comprehensive restoration of the Price River through 3 miles of the urban core of Helper, Utah. The Price River was heavily impacted by railroads, highway and urban encroachment, water development, and riparian and aquatic invasive species. The project was hydrographic surveyed and scoped with budget estimates. As of 2016 two diversion dams have been modified with fish and boat passage, a third is under construction, and a fourth is under design.

Gore Creek Bank Stabilization Vail, CO **2014-2015**

A section of the Gore Valley Trail adjacent to the Vail Public library was constructed decades ago and was in need of repair. A popular and unofficial overlook of Gore Creek had a dangerous and eroding bank. Ms. Johnson collaborated with Valley Crest Design Group, who were realigning and improving the trail, to create safe access to the bank and stabilize the highly eroded bank. Log crib walls from on-site tree removal and native riparian vegetation were used to stabilize the bank. Construction is set to begin in May 2015.

Gore Canyon Whitewater Feature at Pumphouse Kremmling, CO **2013-2015**

A whitewater park on the Colorado River near Kremmling was designed in order for Grand County to apply for a Recreational In-Channel Diversion (RICD) water right. The project is located on Bureau of Land Management property. The site is a very popular campground, boat launch, and trailhead and sees as many as 200,000 visitors a year. ADA accessible access was a requirement of the project for viewing of the new whitewater feature. Ms. Johnson provided final design and construction drawings, specifications, and bid documents as well as construction oversight. The project was completed April 2015. Ms. Johnson has performed multiple as-built surveys and inspections to monitor the conditions and recreational value of the whitewater feature. Ms. Johnson has organized a competitive event at the feature the past two years as a platform to celebrate the recreational and environmental benefits of the project.

HATTIE JOHNSON
LANDSCAPE DESIGNER

EMPLOYMENT HISTORY

RiverRestoration
Landscape Designer
P.O.Box 248 Carbondale, CO 81623 *9/2013-Present*

Arkansas Valley Adventures
Property Manager and Trip Leader,
431 Chicago Creek Rd. Idaho Springs, Colorado 80452 *May 2011-August 2013*

Altgelt & Associates
Landscape Architecture Intern,
4559 Sandpiper Ct. Boulder, Colorado 80301 *May 2011- August 2011*

EDUCATION

Bachelor of Landscape Architecture, Magna Cum Laude with Honors *Spring 2012*
University of Georgia, Athens, GA

ATTACHMENT A

DHM DESIGN

STEPHEN ELLSPERMAN

Principal | Director of Ecological Planning



Stephen has 25 years of experience in all aspects of natural resource management, permitting, and planning. From park and open space management to wetland design and construction, Stephen's work is permeated by his deep connection to ecological relationships. He is passionate about the protection and understanding of native ecosystems and strives to harmonize project planning with ecological conditions and future opportunities. Stephen's ability to translate the ecological processes at work within each project is an invaluable resource that enriches both the design and the client's attitude towards environmental awareness.

ABOUT

EDUCATION

B.S. in Natural Resource Management
Colorado State University, 1991

BOARD COMMITMENTS

Roaring Fork Conservancy
2000-Present

Eagle County Regional Planning Commission
2012-2014

Aspen Center for Environmental Studies
Rock Bottom Ranch Council
2011-Present

Eagle County Open Space Board
2006-2009, 2011-2012

Pitkin County Open Space and Trails Management Plan
Advisory Committee, 2013-2015

AREAS OF EXPERTISE

Due Diligence
Permitting
Mitigation and Restoration
Restoration Design and Revegetation
Wetland Restoration & Construction
Stormwater Management
Wildlife Habitat
Natural Resource Master Planning
River System Restoration & Planning
Ecological Restoration
Reclamation
Open Space Planning & Management
Trails System Planning & Implementation
Community Forestry

NOTABLE WORK

Basalt River Restoration | Basalt, CO

Over the course of three years, DHM has been working a multi-disciplinary team of engineers, hydrologists, planners, and the Town of Basalt to plan, design, permit, and oversee the restoration of the Roaring Fork River through an important reach within the community. The restoration of a natural alignment of the Roaring Fork River, the restoration of an active and vital floodplain, the establishment and restoration of diverse and native riparian habitat and vegetation, and the connectivity of multiple raw water and ditch systems are all goals of this restoration project. Our efforts extend beyond the river's edge to the restoration of side channels, critical fish spawning habitat, and significant wetland system development and protection. Located within the heart of downtown Basalt, the goal of this project was not only to restore the river systems and riparian systems, but also to more closely integrate the river into the lives of the Basalt residents and visitors. We created passive recreation experiences in these areas, allowing visitors to observe wildlife diversity that these restored ecosystems support. Our team led the significant federal, state, and local permitting for the project and completed all of the site planning, restoration design, and habitat planning. We conducted significant investigations into the baseline conditions of the natural resources and site and these activities informed our design and permitting approach. A more active riverfront park and event space is in the planning stage and will include created elements within the floodplain zone to be designed and constructed to withstand and recover from flood events.

Jennie Adair Park | Aspen, CO

2008 CCASLA Design Award, ALCC Presidents Stewardship Award

The Jennie Adair Regional Stormwater Quality Project demonstrates how a stormwater and water quality extended detention basin can be designed to meet specific engineering criteria while simultaneously providing valuable wildlife habitat and beautiful public park space. The project was envisioned as a stormwater facility that would utilize natural and engineered systems to improve the quality of water flowing into the Roaring Fork River from approximately one-third of the storm sewers in central Aspen.

ATTACHMENT A

STEPHEN ELLSPERMAN

Principal | Director of Ecological Planning

RECENT PROJECTS

Natural Resource Master Planning

4 Diamond Ranch; Wilsall, MT
Basalt Bluffs; Basalt, CO
Bear Wallow Ranch; New Castle, CO
Blue Creek Ranch; Carbondale, CO
Cerise Ranch; Garfield County, CO
Certificate of Excellence for Management Planning
City of Aspen Noxious Vegetation Master Plan; Aspen, CO
Colorado Wildlife Society 2012
Cozy Point Ranch; Pitkin County, CO
Junebug Farm; Eagle County, CO
Midland Park Open Space; Basalt, CO
Pokorny Development; Basalt, CO
River Valley Ranch Natural Resources Master Plan; Carbondale, CO
Rocky Mountain Institute; Basalt, CO
Sky Mountain Open Space; Snowmass, CO
Windriver Ranch; El Jebel, CO

River System Restoration & Planning

Basalt River Restoration; Basalt, CO
Bear Dance Ranch; Eagle County, CO
Flying Fish Project; Basalt, CO
James H Smith Open Space; Aspen, CO
Mills Property; Pitkin County, CO
Old Pond Park; Basalt, CO
Porcupine Ranch Stream Restoration; Castle Valley, UT
South Platte River Restoration; Larimer County, CO

Rural

Bear Ridge Ranch; Old Snowmass, CO
BelleJack Blue Ranch; Woody Creek, CO
Clear W Ranch; Pitkin County, CO
Double L Ranch; Durango, CO
Evans Ranch; Telluride, CO
Frying Pan Canyon Ranch; Eagle County, CO
JY Bagby Ranch; Big Hole Valley, MT
Moon Run Ranch; Old Snowmass, CO
Mountain King Ranch; Jackson, WY
Porcupine Creek Ranch; Jackson, WY
Sutey Ranch & Crystal River Ranch; Roaring Fork Valley, CO
Ucross Foundation & Ranch; Sheridan, WY
ASLA Colorado President's Award of Excellence in Planning 2011
ASLA Colorado Land Stewardship Award 2011
Wildhorse Ranch; Harney County, OR
ASLA Award of Honor in Analysis and Planning 2007
ASLA Oregon Award of Excellence 2008

Stormwater Management

Jennie Adair Regional Wetlands; Aspen, CO
ALCC Grand Award 2007
Rio Grande Park Regional Stormwater Project; Aspen, CO

Ecological Restoration

Americus Ranch; Bozeman, MT
Miles Property; Redstone, CO
Rock Bottom Ranch Corona Creek Restoration; Eagle County, CO
Weber Creek Ranch; Mancos, CO
Ziegler-Snowmass Divide CE Restoration; Snowmass, CO

Reclamation

10th Mountain Hut System; Leadville, CO
Aspen Mass Restoration Project; Aspen, CO
Henry Stein Park; Pitkin County, CO
Little Ajax; Aspen, CO
Yellowstone Basin Ranch; West Yellowstone, MT

Open Space Planning & Management

Crown Mountain Park Master Plan; El Jebel, CO
Little Ajax Open Space; Aspen, CO
Marolt / Thomas Open Space; Aspen, CO
Moore Open Space; Aspen, CO
Platte Farm Open Space; Denver, CO
Smuggler Mountain Open Space; Pitkin County, CO

Trails System Planning & Implementation

Crested Butte Trails Master Plan; Crested Butte, CO
Crystal Valley Trail; Marble, CO

Community Forestry

Aspen Alps Forestry & Planning; Aspen, CO
City of Aspen Community Forest Master Plan; Aspen, CO
Society of Municipal Arborist Master Plan Excellence Award, 2008
Maroon Creek Ranch Forestry; Aspen, CO
Roaring Fork Club Forestry Master Plan; Basalt, CO
Ulery's Lake Cabins; Moonlight Basin, MT

Residential

76 Placer Lane; Aspen, CO
Blackie Residence & Ranch; Snowmass, CO
Ducote Residence; Aspen, CO
Knollwood Forestry; Basalt, CO
Skyline Residence; Kiev, Ukraine
Wheeler Ranch; Watson Divide, CO

ATTACHMENT A

DHM DESIGN



JENNIFER DICUOLLO

Senior Associate | Professional Landscape Architect (CO)

With a strong background in architectural studies, art, and landscape architecture, Jen believes in the transformative value of detail. She uses color, texture, and materiality to shape the client's experience and to define the personal expression of the space. Her studies in Turkey focused on balancing the impacts of tourism and development with the preservation of authentic character. Through her service on the Planning and Zoning Commission for the Town of Carbondale, she embraces a similar challenge closer to home.

ABOUT

EDUCATION

B. of Architectural Studies
Brown University, 2002

B. of Studio Art
Brown University, 2002

M. of Landscape Architecture
University of Colorado Denver, 2008

CERTIFICATIONS

Professional Landscape Architect
Colorado

COMMITTEES

RVR Design Review Committee
January, 2014 - Present

Planning and Zoning Commission
Town of Carbondale, CO 2010 - Present

AREAS OF EXPERTISE

Residential Design
Ecological Design
River Restoration
Project Management
Public Process

RECENT PROJECTS

Red Butte Residence; Aspen, CO
Basalt Community Campus; Basalt, CO
Wood Duck Lane; Aspen, CO
Grayhead Residence; Telluride, CO
Clear W Ranch; Pitkin County, CO
Crystal River Ranch; Carbondale, CO
Ucross Ranch; Ucross, WY
Portland Light Rail; Portland, OR
Aspen Valley Hospital; Aspen, CO
Lift One Lodge; Aspen, CO

NOTABLE WORK

Basalt River Restoration | Basalt, CO

The Basalt River Restoration represents a collaborative and comprehensive approach to achieving a number of long-standing social, environmental, economic and community goals including public access to the river, a riverfront park, redefinition of the floodplain and the transformation of a prominent downtown corner location. DHM has been retained by the Town of Basalt to shepard the site planning effort. DHM is involved in all aspects of the process from community meetings and design to coordination with engineers and federal agencies for proposed restoration improvements. In the end, this project has the potential to offer the best of public/ private partnerships resulting in a new riverfront park that will add immeasurably to the character and vitality of the Town of Basalt.

Carbondale Gateway Park | Carbondale, CO

The intersection of State Highways 82 and 133 represent the primary gateway to the Town of Carbondale. The Town commissioned the Gateway Feasibility Study to gather public input, initiate conversations with CDOT and CDOW (now CPW), river users, and other stakeholders to begin the process of planning this important and largely unimproved threshold to Town. The project area included the highway intersection, the CDOT bridge over the Roaring Fork River, a large private parcel containing a campground and public river put-in, access to the river corridor and to the heavily used Red Hill trails, and extended to the confluence of the Roaring Fork and Crystal Rivers. The team led a public process seeking to understand, document, and analyze the many opportunities and potentially conflicting use pressures for the project.

The resulting Feasibility Study outlined proposals for improving the aesthetics of the entry to Town; enhancing pedestrian connectivity to the river, Red Hill Trails, and the valley-wide Rio Grande Trail; acquiring properties to create a cohesive, publicly-owned gateway; managing facilities to allow for the balance of users; and implementing recreation improvements such as a river boating park and pedestrian bridge on the Roaring Fork River.

ATTACHMENT A

JENNIFER DICUOLLO

Senior Associate | Professional Landscape Architect (CO)

RECENT PROJECTS

Campus

Aspen Valley Hospital Master Plan; Aspen, CO
LEED Certification, 2012

Cultural

Aspen Civic Center Master Plan; Aspen, CO
Carbondale Comprehensive Plan; Carbondale, CO
Gunnison County Courthouse

Parks & Recreation

Aspen Bike Park Feasibility Study; Aspen, CO
Aspen Golf Clubhouse; Aspen, CO
Aspen Recreation Center; Aspen, CO
Carbondale Community and Recreation Center; Carbondale, CO
LEED Platinum Certification 2009
CCASLA Merit Award for Design 2009
CCASLA Land Stewardship Award for Design 2009
Carbondale Gateway Park; Carbondale, CO
CDOW Outdoor Discovery Center and Regional Division Office;
Crown Mountain Park; El Jebel, CO
Glassier Open Space Planning; Roaring Fork Valley, CO
Gunnison, CO
North Face Park; Carbondale, CO
Orchard Mesa Park; Grand Junction, CO
Rio Grand Trail Head; Basalt, CO
Rocky Mountain National Park Amphitheater; Estes Park, CO
Steamboat Springs Community Center; Steamboat Springs, CO
LEED Certification, 2008
Truscott Tennis Courts; Aspen, CO
Wingate Park; Grand Junction, CO

Residential Planning

Bella Vista; Silt, CO
Burlingame Ranch Affordable Housing; Aspen, CO
ASLA Award of Honor in Analysis and Planning 2005
River Valley Ranch Design Review Board; Carbondale, CO
River Valley Ranch Streetscape; Carbondale, CO
Top of Mill; Aspen, CO
Truscott Affordable Housing; Aspen, CO

Residential

Burlingame Ranch Single Family Residence; Aspen, CO
DRCL Ranch Guest House; Aspen, CO
Grayhead Residence; Telluride, CO
Missouri Heights Residence; Carbondale, CO
River Valley Ranch Residence; Carbondale, CO
River Valley Ranch Water Feature; Carbondale, CO
South Aspen Street Townhomes; Aspen, CO
Starwood Residence; Aspen, CO
Wheeler Residence; Aspen, CO
Woody Creek Residence; Aspen, CO

Resort

Breckenridge Summer Use Planning; Breckenridge, CO
Lift One Lodge; Aspen, CO
Lodge at Aspen Mountain; Aspen, CO

Urban, Transportation, & Streetscape

Basalt Ave Highway 82 Underpass; Basalt, CO
Downtown Montrose Plan; Montrose, CO
Mill Street; Aspen, CO
Neale Avenue Improvements; Aspen, CO
Park and Brown Improvements; Aspen, CO
Portland Light Rail Vision; Portland, OR
Telluride Four Corners Mixed Use Development; Aspen, CO
Town of Frisco Streetscape and Wayfinding; Frisco, CO

Rural & Ranch

Aspen Valley Ranch; Aspen, CO
Miller Farm; Boulder, UT
Rocky Mountain Biological Laboritory; Gothic, CO

lōtic hydrological

Seth Mason, M.S.

Principal Hydrologist

Background

Seth has over eight years of experience in hydrological research, watershed sciences, and water resource planning. He specializes in hydrological modeling; stream characterization; deployment and operation of data collection and management systems; and development and coordination of water quality monitoring and assessment activities. Seth works extensively with city and county governments, federal agencies, and 501(c)3 organizations. Seth currently serves on the Board of Directors of Eagle Mine Ltd., a non-profit organization established to monitor and disseminate information about the Superfund cleanup efforts at the Eagle Mine Site near Red Cliff, Colorado.

Education

M.S., Land Resources and Environmental Sciences, Montana State University, 2010

B.A., Environmental Studies (Water Resources Track), University of Colorado, 2005

Recent Project Experience

Crystal River Stream Management Plan, *Roaring Fork Conservancy*
Produced a guidance document for implementing high-priority projects and executing feasible water resource management alternatives in the Crystal River watershed aimed at addressing late season low-flow conditions that impair stream health. This work responded to questions articulated by a diverse group of stakeholders in the Crystal River watershed by conducting six interdisciplinary evaluations of existing physical, biological, and resource management conditions and developing a structured decision support framework for guiding management decisions. The resulting decision support system explicitly simulated watershed hydrology; allocation and administration of water under Colorado's water rights system; 2-dimensional channel hydraulics along 8 miles of the lower Crystal River; and the interplay between channel form, changes in streamflow, and the quality and availability of aquatic habitat. Results from this effort identified, prioritized, and provided initial project scoping for alternative management actions and/or structural solutions available to improve ecological conditions and functions in the Crystal River while recognizing the management constraints imposed by the competing objectives of various local stakeholder groups.

Learning By Doing, *Northwest Colorado Council of Governments*
Participated in an adaptive management program to operate Denver Water's Moffat transmountain diversion system in a manner that mitigates and enhances environmental conditions in the Fraser and upper Colorado River basins.

Water Quality Sampling and Analysis Plan, *City of Aspen*
Developed a guidance document and set of standard operating procedures for assessing long-term water quality trends on the Roaring Fork River, estimating event mean concentrations for various pollutants in stormwater discharges, and identifying illicit discharges and other water quality impairments within the City of Aspen.

Gore Creek Strategic Action Plan, *Town of Vail*
Developed a strategic action plan for addressing observed water quality impairments on Gore Creek near the Town of Vail. Evaluated and prioritized an array of tasks that fell within five primary categories: education and

outreach campaigns, regulatory changes, implementation of best management practices, streambank restoration and structural BMP projects, and ongoing data collection and study.

Water Quality Monitoring and Assessment Program, *Eagle River Watershed Council*
Coordinated water quality monitoring and assessment activities, provided data interpretation and technical assistance to local governments and resource managers, identified data gaps, and suggested actions to remedy perceived water quality impairments in the Eagle River watershed. Compiled annual technical reports assessing current water quality conditions and trends. Coordinated watershed-wide data collection efforts among multiple agencies to maximize efficiency and fill data gaps. Engaged stakeholders and the general public to enhance community-wide understanding of water quality issues. Developed a long-term water quality monitoring plan for data collection entities within the watershed.

Snapshot Assessment of Two Distressed Rivers*, Roaring Fork Conservancy*
Collected synoptic measurements of streamflow and water quality on the Roaring Fork River through the City of Aspen and the Lower Crystal River near Carbondale over several dates in late summer during severe drought conditions. Analyzed data to elucidate relationships between longitudinal changes in streamflow, water temperature, and other easily measured water quality parameters during late-summer baseflow. Identified several dates/locations on both study segments where existing management decisions severely deplete streamflows during drought. Assessment results provided the foundation for discussions regarding needs and opportunities for alternative management of water resources on the Roaring Fork and Crystal River.

Lower Crystal River Assessment, *Roaring Fork Conservancy*
Constructed a water rights allocation and accounting simulation model for surface water in the Lower Crystal River. Simulated daily streamflow conditions during average, moderate drought, and severe drought conditions in association with several alternative water conservation scenarios. Identified longitudinal patterns in stream discharge produced by each environmental condition and management scenario pairing. Formatted results for input into framework for assessing ecological benefits of alternative water management scenarios.

Presentations and Publications

Ward. A.S., Kelleher, C.A., Mason, S.J.K., Wagener, T. McIntyre, N., McGlynn, B., Runkel, R. (In Preparation) A software tool to assess uncertainty in transient storage model parameters using Monte Carlo simulations. *Freshwater Science*

Mason, S.J.K., Cleveland, S., Izurieta, C. Llovett, P., Poole, G.C. (2014) A Centralized Tool for Managing, Archiving, and Serving Point-In-Time Data in Ecological Research Laboratories. *Environmental Modelling and Software. 51: 59-69.* http://dx.doi.org/10.1016/j.envsoft.2013.09.008

Mason, S.J.K., B.L. McGlynn, and G.C. Poole, (2012) Hydrologic response to channel reconfiguration on Silver Bow Creek, Montana. *Journal of Hydrology 438-439: 125-136.*
http://dx.doi.org/10.1016/j.jhydrol.2012.03.010

Mason, S.J.K., Cleveland, S., Izurieta, C., Llovet, P., Poole, G.C. (2012) The Virtual Observatory and Ecological Informatics System (VOEIS): Using RESTful architecture and an extensible data model to provide a unique data management solution. Spring Runoff Conference (April 3-4, Logan, UT)

Mason, S.J.K., B.L. McGlynn, and G.C. Poole, (2010). Hydrologic behavior in restored streambeds: Does function follow form? Montana Section AWRA Conference (October 14-15, Helena, MT).

Mason, S.J.K., B.L. McGlynn, and G.C. Poole, (2010). Assessing hydrologic response to channel reconfiguration. RRNW Annual Symposium (February 1-4, Stevenson, WA).

Leadership Positions

Member, US Men's Whitewater Raft Team

Train and compete with teams of four or six men in international, continental, and national whitewater raft races and championships. Participate in Time Trial, Head-to-Head Sprint, Slalom, and Downriver racing disciplines. Training and racing require hard work in inclement weather and the ability to react quickly to changing circumstances in high-stress situations. Maintaining optimum team dynamics requires open lines of communication and constant introspection to ensure that team interests are placed above self interests.

Director, Eagle Mine Limited

Develop technical information about the Eagle Mine Superfund cleanup site and the water quality of the Eagle River. Facilitate public meetings focused on regulatory decisions made by State and Federal agencies. Provide comments to State and Federal agencies during the development of Focused Feasibility Studies and Consent Decrees to ensure that cleanup measures at the site address local communities' concerns with ongoing water quality degradation.

Director, Spring Gulch Nordic Council

Manage development and maintenance activities at the Spring Gulch Trail System. Organize Nordic ski races and fundraising events. Write grants to secure funding for trail development and other infrastructure improvements.

Technical Qualifications

Field Proficiencies

Solar array and battery bank setup
Meteorological tower set-up
Radio telemetry communication systems
Bathymetric mapping
Acoustic Doppler Current Profilers
Survey-grade GPS equipment
Mapping-grade GPS equipment

Methodological Proficiencies

Stream discharge measurements (ADCP, dilution gauging, velocity-area techniques)
Stream tracer experiments (NaCl, Rhodamine WT)
Synoptic stream temperature gauging
Stream metabolism experiments
Numerical solute transport modeling
Geostatistical analysis
Benthic macroinvertebrate sampling

Programming and Computing Proficiencies

Python
ArcGIS / QGIS
Matlab
Javascript / HTML
R
Loggernet, CR-Basic, and Edlog (Campbell Scientific)
Microsoft Office (Word, Excel, Access)

PROJECT: Pentz-Smith Diversion Repair - Morgan, UT **Ver 3 -Date:** ***February 15, 2017***

100% Design - Cost Opinion - Preferred Alternative - Inlet Boulders, Instream Grade Control Structures and Bank Stabilization

Description	Quantity	Unit	Unit Cost	Total Cost	Totals	*Notes / Assumptions*
Site Preparation						
Locate Existing Sewer Line	1	LS	$1,000	$1,000		
Staging Area	1	LS	$1,500	$1,500		
Access Repair	1	LS	$2,500	$2,500		
PIP Mature Trees/Transplanting shrubs	3	EA	$200	$600		
Silt fence	301	LF	$5	$1,503		
Access road	657	LF	$5	$3,285		
Access ramp	2	EA	$1,000	$2,000		
Erosion and Sediment Control	1	LS	$2,000	$2,000		
Care of Water	1	LS	$19,105	$19,105		
				Sub Total:	**$33,493**	
Inlet Boulders						
Channel Excavation	28	CY	$15	$425		
Furnish, Deliver and Place Boulder	34	TON	$90	$3,103		
Alluvial Backfill	8	CY	$10	$79		*Assumed 25% of boulder volume. Assumes onsite material to be used.*
Haul and Disposal of Alluvial Material	20	CY	$20	$409		
Remove Accumulated Sediments at Inlet and Haul Off	39	CY	$25	$986		*Includes dewatering of material prior to disposal.*
				Sub Total:	**$5,001**	
Habitat Boulders						
Channel Excavation	28	CY	$15	$425		
Furnish, Deliver and Place Boulder	34	TON	$90	$3,103		
Alluvial Backfill	5	CY	$10	$47		*Assumed 25% of boulder volume. Assumes onsite material to be used.*
Haul and Disposal of Alluvial Material	24	CY	$20	$472		
				Sub Total:	**$4,046**	
Instream Grade Control Structures w/ Bank Stabilization						
Upstream Grade Control Structure (G.C. #1)						
Channel Excavation	283	CY	$15	$4,245		
Furnish, Deliver and Place Boulder	206	TON	$90	$18,513		
Alluvial Backfill	186	CY	$10	$1,863		*Assumed 20% of boulder volume*
Bank Vegetation Restoration	140	SY	$15	$2,102		
Haul and Disposal of Material	97	CY	$20	$1,934		*Difference between Exc volume and backfill*
G.C. #1 Bank Stabilization						
Bank Excavation and Haul Off	29	CY	$40	$1,157		
Furnish, Deliver and Place Boulder	188	TON	$90	$16,907		
General Backfill	17	CY	$10	$169		
Hydrodrain Geotextile Liner	116	SY	$15	$1,745		
Downstream Grade Control Structure (G.C. #2)						
Channel Excavation	282	CY	$15	$4,230		
Furnish, Deliver and Place Boulder	188	TON	$90	$16,907		
Alluvial Backfill	191	CY	$10	$1,914		*Assumed 20% of boulder volume*
Bank Vegetation Restoration	142	SY	$15	$2,136		
Haul and Disposal of Material	91	CY	$20	$1,812		*Difference between Exc volume and backfill*
G.C. #2 Bank Stabilization						
Bank Excavation and Haul Off	25	CY	$40	$1,007		
Furnish, Deliver and Place Boulder	118	TON	$90	$10,603		
General Backfill	15	CY	$10	$148		
Hydrodrain Geotextile Liner	104	SY	$15	$1,561		
				Sub Total:	**$88,952**	
ITEMIZED CONSTRUCTION SUBTOTAL					**$131,493**	
CONSTRUCTION WITH CONTIGENCY				**$131,493**		
Land Survey (LS)				$0		
Geotechnical Engineering				$0		
Structural Engineering				$0		
Utility Relocations				$0		
Traffic Control		LS		$2,000		
Hydrographic Survey				$0		*Included in Current Contract*
Cultural Resource Survey and Report				$0		
Full Wetland Delineation				$0		
Lands and Easements (Permanent)				$0		
Lands and Easements (Construction)				$0		
Lands and Easements Processing				$0		
Construction Bonding/Ins (5%)				$6,575		*5% construction after design*
Mob and Demob (5%)				$6,575		*5% construction*
Environmental Assessment Recovery Prgm				$0		
Engineering Design				$0		*Included in Current Contract*
Hydraulic Modeling				$0		*Included in Current Contract*
Permitting 404, 401				$0		*Included in Current Contract*
UDOT ROW License				$0		
Permitting Floodplain				$0		*Included in Current Contract*
Plans and Specifications for bid				$0		*Included in Current Contract*
Construction Stakeout				$3,000		
Construction Review Observations				$5,000		
Vegetation Replacement YR 2				$3,000		
TOTAL PROJECT COST OPINION				**$157,642**		

OK SGM 9/5/13

Engineer's Estimate

Roaring Fork River Phase 1 Sanitary Sewer Replacement

September 4, 2013

Item	Description	Quantity	Unit	Unit Price	Total	Sub Totals
Sanitary Sewer Crossing						
55	Abandon in-place 10" Line with Fly Ash Slurry	330	LF	$ 10.00	$ 3,300.00	
56	Abandon Existing Manhole - Sanitary Sewer River Crossing	1	EA	$ 500.00	$ 500.00	
132	6" Sanitary Sewer Service Installed on 16" Main for Future Extension	1	EA	$ 1,500.00	$ 1,500.00	
57	Modify Existing Manhole	1	EA	$ 750.00	$ 750.00	
58	Temporary Shoring for Sanitary Installation	1	LS	$ 19,000.00	$ 19,000.00	
59	Dewatering (Including Two Sediment Basins) for SS Construction	1	LS	$ 8,000.00	$ 8,000.00	
60	By-Pass Pumping	1	LS	$ 8,000.00	$ 8,000.00	
61	16" DIP Class 350 with Protecto 401 lining	318	LF	$ 165.00	$ 52,470.00	
62	18" PVC SDR 26	23	LF	$ 100.00	$ 2,300.00	
63	4ft Standard Manhole	2	EA	$ 4,250.00	$ 8,500.00	
	SUBTOTAL					**$ 104,320.00**
Reinforcement Alternatives (Bid All Alternatives)						
0	**Alternative 1 - Concrete Encasement on Helical Piers**					
64	Concrete Encasement	98	CY	$ 325.00	$ 31,850.00	
65	Reinforcing Steel	8,079	LBS	$ 1.00	$ 8,079.00	
66	Helical Piers (1.75" Square)	205	LF	$ 37.00	$ 7,585.00	
	SUBTOTAL					**$ 47,514.00**
	Alternative 1B - Concrete Encasement on Drilled Caissons					
64	Concrete Encasement	98	CY	$ 325.00	$ 31,850.00	
65	Reinforcing Steel	8,079	LBS	$ 1.00	$ 8,079.00	
135	Drilled Caisson (15 inch)	102	LF	$ 150.00	$ 15,300.00	
	SUBTOTAL					**$ 55,229.00**
	Alternative 2 - Steel Casing Pipe on Helical Piers					
67	30in Welded Steel Casing Pipe (3/8" Wall) w/ Bituminous Protective Coating	260	LF	$ 115.00	$ 29,900.00	
68	Reinforced Concrete Saddle (Complete-in-Place)	5	EA	$ 1,750.00	$ 8,750.00	
69	Helical Piers (1.75" Square)	170	LF	$ 37.00	$ 6,290.00	
	SUBTOTAL					**$ 44,940.00**
	Alternative 2B - Steel Casing Pipe on Drilled Caissons					
67	30in Welded Steel Casing Pipe (3/8" Wall) w/ Bituminous Protective Coating	260	LF	$ 115.00	$ 29,900.00	
68	Reinforced Concrete Saddle (Complete-in-Place)	5	EA	$ 1,750.00	$ 8,750.00	
135	Drilled Caisson (15 inch)	85	LF	$ 150.00	$ 12,750.00	
	SUBTOTAL					**$ 51,400.00**

SOA 9/5/13

Engineer's Estimate

Roaring Fork River Phase 1 Sanitary Sewer Replacement

September 4, 2013

Item	Description	Quantity	Unit	Unit Price	Total	Sub Totals
	Civil					
2	Mobilization and Demobilization (For SS Project Only)	1	LS	$ 12,750.00	$ 12,750.00	$ 12,750.00
	Indirect Costs					
6	Surveying (For Sanitary River Crossing Project Only)	1	LS	$ ~~4,000.00~~ 4,300	$ ~~4,000.00~~ 4,300	
52	Pothole Utilities	2	EA	$ 500.00	$ 1,000.00	
						$ 5,000.00
ALTERNATE 1 COST:						$ 169,584.00
ALTERNATE 1B COST:						$ 177,299.00
ALTERNATE 2 COST:						$ 167,010.00
ALTERNATE 2B COST:						$ 173,470.00

ATTACHMENT B

Engineer's Estimate

Roaring Fork River Restoration & Park Construction - Phase 1

September 4, 2013

9/5/13

Item	Description	Quantity PH1	Unit	Unit Price	Total	Sub Totals
General						
1	Mobilization and Demobilization	1	LS	$ 60,000.00	$ 60,000.00	
3	Temporary Facilities	1	LS	$ 12,000.00	$ 12,000.00	
110	Health and Safety Plan	1	LS	$ 2,000.00	$ 2,000.00	
	SUBTOTAL					**$ 74,000.00**
Removals - River Construction						
10	Unclassified Excavation Phase 1 (Complete-In-Place on the RMI site)	1,933	CY	$ 18.00	$ 34,794.00	
7	Clearing and Grubbing (Entire Site)	1	LS	$ 15,000.00	$ 15,000.00	
8	Removal of Large Trees	38	EA	$ 150.00	$ 5,700.00	
116	Removal and Disposal of Dead Woody Debris from River	1	LS	$ 1,200.00	$ 1,200.00	
	SUBTOTAL					**$ 56,694.00**
River Construction						
21	Water Control	1	LS	$ 80,000.00	$ 80,000.00	
22	24" Angular Block Boulders	160	CY	$ 90.00	$ 14,400.00	
23	36" Angular Block Boulders	780	CY	$ 100.00	$ 78,000.00	
24	48" Angular Block Boulders	190	CY	$ 165.00	$ 31,350.00	
25	36" Rounded Boulders	100	CY	$ 300.00	$ 30,000.00	
26	Angular Rock Bedding - Type VL Riprap	350	CY	$ 50.00	$ 17,500.00	
	SUBTOTAL					**$ 251,250.00**
Erosion Control						
111	Stormwater Mgmt. Plan	1	LS	$ 4,000.00	$ 4,000.00	
50	Erosion Control Blanket, 100% Coir Blanket	4,600	SF	$ 1.50	$ 6,900.00	
17	Silt Fence	1,800	LF	$ 2.00	$ 3,600.00	
18	Construction Fence (includes wetland protection)	4,650	LF	$ 4.00	$ 18,600.00	
16	Vehicle Tracking Pad	3	EA	$ 3,000.00	$ 9,000.00	
113	Stabilized Staging Area	1	EA	$ 10,000.00	$ 10,000.00	
114	Concrete Washout	1	EA	$ 750.00	$ 750.00	
115	Cattle Fence	460	LF	$ 16.00	$ 7,360.00	
	SUBTOTAL					**$ 60,210.00**

ATTACHMENT B

Engineer's Estimate

Roaring Fork River Restoration & Park Construction - Phase 1

September 4, 2013

SOH 9/5/13

Item	Description	Quantity PH1	Unit	Unit Price	Total	Sub Totals
Site Construction - RMI Site						
109	Remove and Stockpile Topsoil from Construction Activity Area on RMI Site to be Used in Phase 2	1	LS	$ 2,000.00	$ 2,000.00	
	SUBTOTAL					**$ 2,000.00**
River Improvements Landscape						
31	6' - B&B - Alnus tenufolia - Thinleaf Alder	20	EA	$ 350.00	$ 7,000.00	
32	2.5" cal. - Populus angustifolia - Narrowleaf Cottonwood	15	EA	$ 450.00	$ 6,750.00	
33	5 gal. - Betula occidentalis - River Birch	16	EA	$ 40.00	$ 640.00	
34	5 gal. - Cornus sericea - Red Osier Dogwood	32	EA	$ 40.00	$ 1,280.00	
35	5 gal. - Salix bebbiana - Bebb's Willow	0	EA	$ 40.00	$ -	
37	5 gal. - Salix drummondiana - Drummond's Willow	18	EA	$ 40.00	$ 720.00	
38	5 gal. - Salix lasiandra - Whiplash Willow	27	EA	$ 40.00	$ 1,080.00	
39	5 gal. - Salix monticola - Rocky Mountain Willow	10	EA	$ 40.00	$ 400.00	
40	5 gal - Shepherdia argentea - Silver Buffaloberry	15	EA	$ 40.00	$ 600.00	
41	Live Stakes - Salix spp. - Willow	150	EA	$ 40.00	$ 6,000.00	
42	Live Stakes - Populus angustifolia - Narrowleaf Cottonwood	150	EA	$ 9.00	$ 1,350.00	
131	Topsoil Import	660	CY	$ 70.00	$ 46,200.00	
43	Wetland Seed and Mulch	2,792	SF	$ 0.30	$ 837.60	
44	Riparian Seed and Mulch	10,252	SF	$ 0.30	$ 3,075.60	
51	Irrigation	7	Per Zone	$ 6,155.00	$ 43,085.00	
125	Disturbance Area Seed and Mulch	43,650	SF	$ 0.30	$ 13,095.00	
	SUBTOTAL					**$ 132,113.20**
Indirect Costs						
4	Traffic Control	1	LS	$ 2,500.00	$ 2,500.00	
5	Construction Surveying	1	LS	$ ~~8,300.00~~ 9,600	$ ~~8,300.00~~ 9,600	
	SUBTOTAL					**$ 10,800.00**
TOTAL PHASE 1 PROJECT COST:						**$ 587,067.20**

ATTACHMENT B

Engineer's Estimate

Roaring Fork River Restoration & Park Construction - Phase 2

September 4, 2013

OK SOA 9/5/13

Item	Description	Quantity PH2	Unit	Unit Price	Total	Sub Totals
General						
1	Mobilization and Demobilization	1	LS	$ 90,000.00	$ 90,000.00	
	SUBTOTAL					**$ 90,000.00**
Removals - River Construction						
9	Removal and Salvage Non-Grouted Boulders/Riprap	250	CY	$ 40.00	$ 10,000.00	
124	Unclassified Excavation Phase 2 (Complete-In-Place on the CDC and Pan & Fork Park Site)	7,460	CY	$ 18.00	$ 134,280.00	
11	Remove and Dispose of Unsuitable River Bank Material	70	CY	$ 100.00	$ 7,000.00	
7	Clearing and Grubbing (Entire Site)	1	LS	$ 40,000.00	$ 40,000.00	
14	Remove Grouted Boulders at Proposed Headwall Location	300	SF	$ 100.00	$ 30,000.00	
116	Removal and Disposal of Dead Woody Debris from River	1	LS	$ 1,000.00	$ 1,000.00	
	SUBTOTAL					**$ 222,280.00**
River Construction						
21	Water Control	1	LS	$ 90,000.00	$ 90,000.00	
22	24" Angular Block Boulders	620	CY	$ 90.00	$ 55,800.00	
23	36" Angular Block Boulders	2,460	CY	$ 100.00	$ 246,000.00	
24	48" Angular Block Boulders	590	CY	$ 150.00	$ 88,500.00	
26	Angular Rock Bedding - Type VL Riprap	1,200	CY	$ 50.00	$ 60,000.00	
72	Type "L" Soil Riprap	170	CY	$ 65.00	$ 11,050.00	
28	Install Concrete Headwall (Type CDOT M601.1) with Headgate and 16 LF of CMP	1	LS	$ 8,000.00	$ 8,000.00	
91	Sawcut, Remove and Replace Existing Concrete Curb and Gutter	32	LF	$ 28.50	$ 912.00	
93	Sawcut, Remove and Replace Existing Concrete Sidewalk	224	SF	$ 9.00	$ 2,016.00	
	SUBTOTAL					**$ 562,278.00**
Erosion Control						
111	Stormwater Mgmt. Plan	1	LS	$ 4,000.00	$ 4,000.00	
50	Erosion Control Blanket, 100% Coir Blanket	8,700	SF	$ 1.50	$ 13,050.00	
17	Silt Fence	1,000	LF	$ 2.00	$ 2,000.00	
18	Construction Fence (includes wetland protection)	1,184	LF	$ 4.00	$ 4,736.00	
16	Vehicle Tracking Pad	1	EA	$ 3,000.00	$ 3,000.00	
19	Sedimentation Basin	1	EA	$ 4,000.00	$ 4,000.00	
	SUBTOTAL					**$ 30,786.00**

ATTACHMENT B

Engineer's Estimate

Roaring Fork River Restoration & Park Construction - Phase 2

September 4, 2013

9/5/13 SCK

Item	Description	Quantity PH2	Unit	Unit Price	Total	Sub Totals
Site Construction Removals - Pan & Fork and RMI						
123	Removal of Trees greater than 4" dia. (Phase 2)	1	LS	$ 5,000.00	$ 5,000.00	
76	Topsoil Removal, Stockpile, and Placement (Top 6")	1	LS	$ 800.00	$ 800.00	
77	Removal of Street Lights	1	EA	$ 200.00	$ 200.00	
78	Removal of Existing Fence	1,345	LF	$ 1.00	$ 1,345.00	
79	Removal of Existing Culverts	184	LF	$ 2.00	$ 368.00	
80	Removal of Existing Mailboxes	1	LS	$ 200.00	$ 200.00	
81	Removal of Existing Stairway	1	LS	$ 500.00	$ 500.00	
83	Disconnect and Abandon Existing Gas and Services	1	LS	$ 5,000.00	$ 5,000.00	
84	Disconnect and Abandon Existing Electric Services	1	LS	$ 5,000.00	$ 5,000.00	
85	Disconnect and Abandon of Existing Telephone Services	1	LS	$ 5,000.00	$ 5,000.00	
86	Abandon Existing Sewer Manholes	1	EA	$ 850.00	$ 850.00	
87	Remove Existing Asphalt	2,321	SY	$ 5.00	$ 11,605.00	
88	Remove Existing Concrete Trailer Pads & Other Existing Concrete from Site	350	CY	$ 10.00	$ 3,500.00	
89	Utility Locates	1	LS	$ 500.00	$ 500.00	
136	Removal of Existing Sewer Manholes	2	EA	$ ~~1,000.00~~ 400	$ ~~2,000.00~~ 800	
	SUBTOTAL					$ 41,868.00
Site Construction - Pan & Fork and RMI						
	Holy Cross Relocation					
90	Sawcut, Remove and Replace Existing Asphalt	430	SY	$ 70.00	$ 30,100.00	
91	Sawcut, Remove and Replace Existing Concrete Curb and Gutter	20	LF	$ 28.50	$ 570.00	
92	Sawcut, Remove and Replace Existing Concrete Crosswalk	120	SF	$ 11.00	$ 1,320.00	
93	Sawcut, Remove and Replace Existing Concrete Sidewalk	65	SF	$ 9.00	$ 585.00	
94	4' Deep Utility Trench	2,160	LF	$ 22.00	$ 47,520.00	
95	Electrical Transformer or Splice Vault Installation	4	EA	$ 800.00	$ 3,200.00	
	Sanitary Sewer / Pan & Fork REMOVE & REPLACE EXISTING MANHOLE & CONNECT TO EX. PIPES					
96	~~Interconnection to Existing Sewer Manhole with 8" Main~~	2	EA	$ ~~6,500.00~~ 8,500	$ ~~13,000.00~~ 17,000	
97	8" SDR 26 PVC Sewer Pipe	604	LF	$ 85.00	$ 51,340.00	
98	4' Diameter Standard Sanitary Manhole	~~4~~ 2	EA	$ ~~8,500.00~~ 4,250	$ ~~34,000.00~~ 8,500	
99	6" Sanitary Sewer Service Installed on 8" Main for Future Extension	3	EA	$ 500.00	$ 1,500.00	
60	By-pass Pumping	1	LS	$ 10,000.00	$ 10,000.00	
	Water Main Sleeve					
100	15" C900 PVC Sleeve	160	LF	$ 60.00	$ 9,600.00	
101	10" C900 PVC Sleeve	60	LF	$ 55.00	$ 3,300.00	

ATTACHMENT B

Engineer's Estimate

Roaring Fork River Restoration & Park Construction - Phase 2

September 4, 2013

OL Sort 9/5/13

Item	Description	Quantity PH2	Unit	Unit Price	Total	Sub Totals
Site Construction - Pan & Fork and RMI						
	Two Rivers Groundwater Mitigation					
102	4' Diameter Standard Storm Manhole	1	EA	$ 8,000.00	$ 8,000.00	
103	10" Perforated PVC Pipe	765	LF	$ 81.50	$ 62,347.50	
104	18" HDPE Culvert	75	LF	$ 35.00	$ 2,625.00	
105	24" HDPE Culvert	180	LF	$ 40.00	$ 7,200.00	
133	24" Nyoplast Drain Basin	1	EA	$ 450.00	$ 450.00	
	East Storm					
102	4' Diameter Standard Storm Manhole	1	EA	$ 8,000.00	$ 8,000.00	
106	5' Diameter Standard Storm Manhole	1	EA	$ 9,000.00	$ 9,000.00	
104	18" HDPE Culvert	75	LF	$ 35.00	$ 2,625.00	
105	24" HDPE Culvert	180	LF	$ 40.00	$ 7,200.00	
	Pan & Fork and CDC Grading					
107	Remove, Sort, and Replace Subsurface Fill Material and Organics in Pan and Fork Site	14,000	CY	$ 18.00	$ 252,000.00	
108	Temporary Ditch	820	LF	$ 5.00	$ 4,100.00	
134	RMI Topsoil - Phase 2 Placement	1	LS	$ 1,500.00	$ 1,500.00	
118	Structural Fill (Import)	13,600	CY	$ 36.00	$ 489,600.00	
		SUBTOTAL				$ 1,060,682.50
Miscellaneous Park Items						
119	Topsoil and Compost for Community Gardens Planting Areas	1	LS	$ 5,000.00	$ 5,000.00	
120	Restore all Existing Irrigation at Community Garden	1	LS	$ 5,000.00	$ 5,000.00	
121	Provide & Install Sod at Community Garden	1	LS	$ 5,000.00	$ 5,000.00	
		SUBTOTAL				$ 15,000.00

ATTACHMENT B

Engineer's Estimate

Roaring Fork River Restoration & Park Construction - Phase 2

September 4, 2013

OL SOA 9/5/13

Item	Description	Quantity PH2	Unit	Unit Price	Total	Sub Totals
River Improvements Landscape						
31	6' - B&B - Alnus tenufolia - Thinleaf Alder	25	EA	$ 350.00	$ 8,750.00	
32	2.5" cal. - Populus angustifolia - Narrowleaf Cottonwood	52	EA	$ 450.00	$ 23,400.00	
33	5 gal. - Betula occidentalis - River Birch	74	EA	$ 40.00	$ 2,960.00	
34	5 gal. - Cornus sericea - Red Osier Dogwood	38	EA	$ 40.00	$ 1,520.00	
35	5 gal. - Salix bebbiana - Bebb's Willow	44	EA	$ 40.00	$ 1,760.00	
37	5 gal. - Salix drummondiana - Drummond's Willow	89	EA	$ 40.00	$ 3,560.00	
38	5 gal. - Salix lasiandra - Whiplash Willow	80	EA	$ 40.00	$ 3,200.00	
39	5 gal. - Salix monticola - Rocky Mountain Willow	59	EA	$ 40.00	$ 2,360.00	
40	5 gal - Shepherdia argentea - Silver Buffaloberry	62	EA	$ 40.00	$ 2,480.00	
41	Live Stakes - Salix spp. - Willow	350	EA	$ 9.00	$ 3,150.00	
42	Live Stakes - Populus angustifolia - Narrowleaf Cottonwood	350	EA	$ 9.00	$ 3,150.00	
131	Topsoil Import	1,685	CY	$ 70.00	$ 117,950.00	
43	Wetland Seed and Mulch	2,918	SF	$ 0.30	$ 875.40	
44	Riparian Seed and Mulch	21,108	SF	$ 0.30	$ 6,332.40	
51	Irrigation	19	Per Zone	$ 6,155.00	$ 116,945.00	
125	Disturbance Area Seed and Mulch	217,935	SF	$ 0.30	$ 65,380.50	
	SUBTOTAL					$ 363,773.30
Wetlands Mitigation						
	Trees					
31	6' - B&B - Alnus tenufolia - Thinleaf Alder	10	EA	$ 350.00	$ 3,500.00	
32	2.5" cal. - Populus angustifolia - Narrowleaf Cottonwood	13	EA	$ 450.00	$ 5,850.00	
49	3" - To be selected by Town of Basalt - See Revegetation Plan sheet L-5.0	2	EA	$ 550.00	$ 1,100.00	
	Shrubs					
33	5 gal. - Betula occidentalis - River Birch	12	EA	$ 40.00	$ 480.00	
34	5 gal. - Cornus sericea - Red Osier Dogwood	91	EA	$ 40.00	$ 3,640.00	
36	5 gal. - Lonicera involucrata - Twinberry Honeysuckle	18	EA	$ 40.00	$ 720.00	
35	5 gal. - Salix bebbiana - Bebb's Willow	18	EA	$ 40.00	$ 720.00	
37	5 gal. - Salix drummondiana - Drummond's Willow	16	EA	$ 40.00	$ 640.00	
38	5 gal. - Salix lasiandra - Whiplash Willow	10	EA	$ 40.00	$ 400.00	
39	5 gal. - Salix monticola - Rocky Mountain Willow	4	EA	$ 40.00	$ 160.00	
	Herbaceous Plants - Created and Restored Wetlands					
45	Zone 1 Plantings (Spaced 12" O.C.)	2,700	EA	$ 3.00	$ 8,100.00	
46	Zone 2 Plantings (Spaced 12" O.C.)	5,250	EA	$ 3.00	$ 15,750.00	
47	Zone 3 Plantings (Spaced 12" O.C.)	8,916	EA	$ 3.00	$ 26,748.00	
44	Riparian Seed and Mulch	7,765	SF	$ 0.30	$ 2,329.50	
	Herbaceous Plants - Existing Wetlands to be Enhanced					
48	Zone 2 & Zone 3 Plantings (Spaced 24" O.C.)*	2,380	EA	$ 3.00	$ 7,140.00	
	* Plant quantities in existing wetlands to be enhanced are approximate. Adjust quantities in field based on existing conditions.					

Engineer's Estimate

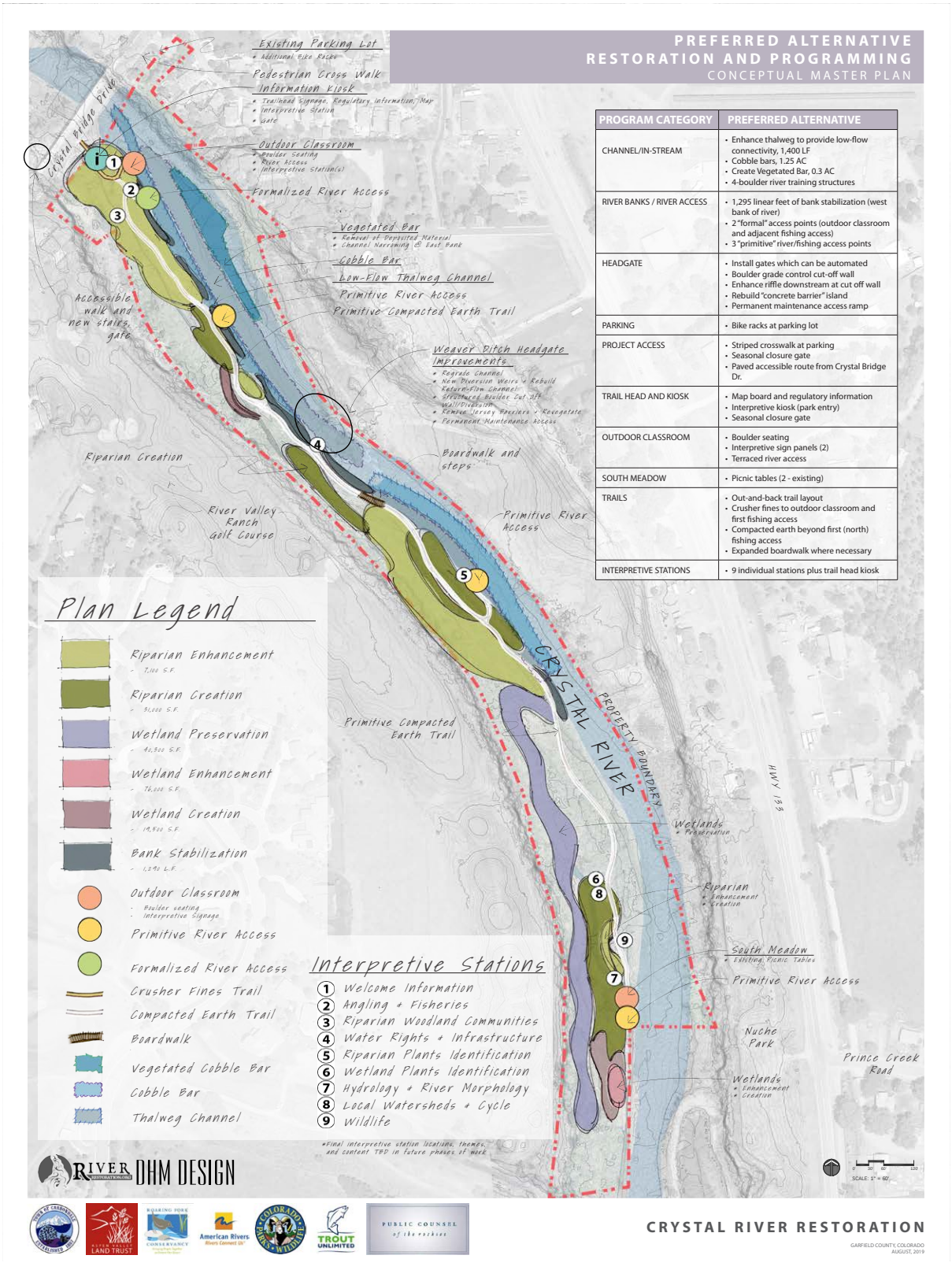
Roaring Fork River Restoration & Park Construction - Phase 2

September 4, 2013

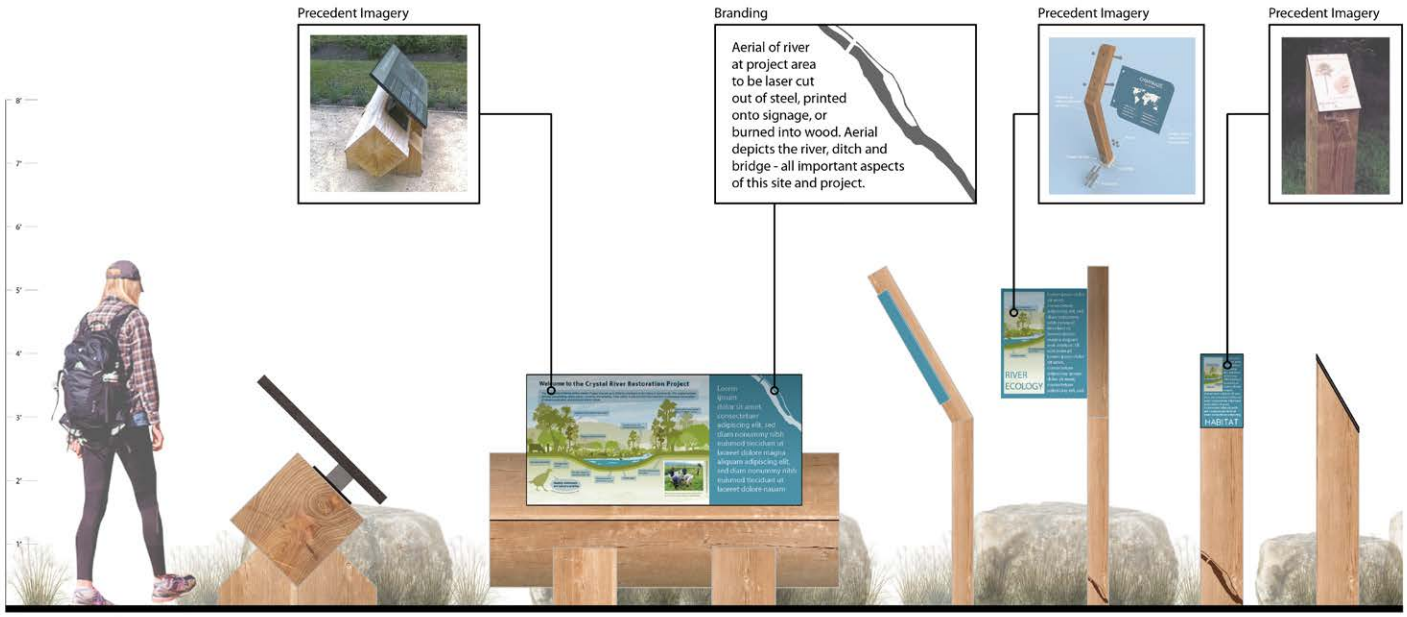
9/5/13 SDA

Item	Description	Quantity PH2	Unit	Unit Price	Total	Sub Totals
	Miscellaneous					
128	Fallen Cottonwood Logs	4	EA	$ 300.00	$ 1,200.00	
129	Wetland Stepping Stones	15	EA	$ 67.50	$ 1,012.50	
127	Waterfowl Protection Fencing	1,850	LF	$ 4.50	$ 8,325.00	
130	Hydric Soil (8") Per Wetland Spec	500	CY	$ 0.30	$ 150.00	
126	Dewatering of Pond for Installation of Wetland Benches	1	LS	$ 2,500.00	$ 2,500.00	
131	Topsoil Import	150	CY	$ 0.30	$ 45.00	
	SUBTOTAL					**$ 90,510.00**
Indirect Costs						
4	Traffic Control	1	LS	$ 4,000.00	$ 4,000.00	
5	Construction Surveying	1	LS	$ ~~27,000.00~~ 31,100	$ ~~27,000.00~~ 31,100	
52	Pothole Utilities	10	EA	$ 500.00	$ 5,000.00	
	SUBTOTAL					**$ 36,000.00**
TOTAL PHASE 2 PROJECT COST:						**$ 2,513,177.80**

Appendix A: Master Plan Preferred Alternative



PROGRAM CATEGORY	PREFERRED ALTERNATIVE
CHANNEL/IN-STREAM	• Enhance thalweg to provide low-flow connectivity, 1,400 LF • Cobble bars, 1.25 AC • Create Vegetated Bar, 0.3 AC • 4-boulder river training structures
RIVER BANKS / RIVER ACCESS	• 1,295 linear feet of bank stabilization (west bank of river) • 2 "formal" access points (outdoor classroom and adjacent fishing access) • 3 "primitive" river/fishing access points
HEADGATE	• Install gates which can be automated • Boulder grade control cut-off wall • Enhance riffle downstream at cut off wall • Rebuild "concrete barrier" island • Permanent maintenance access ramp
PARKING	• Bike racks at parking lot
PROJECT ACCESS	• Striped crosswalk at parking • Seasonal closure gate • Paved accessible route from Crystal Bridge Dr.
TRAIL HEAD AND KIOSK	• Map board and regulatory information • Interpretive kiosk (park entry) • Seasonal closure gate
OUTDOOR CLASSROOM	• Boulder seating • Interpretive sign panels (2) • Terraced river access
SOUTH MEADOW	• Picnic tables (2 - existing)
TRAILS	• Out-and-back trail layout • Crusher fines to outdoor classroom and first fishing access • Compacted earth beyond first (north) fishing access • Expanded boardwalk where necessary
INTERPRETIVE STATIONS	• 9 individual stations plus trail head kiosk



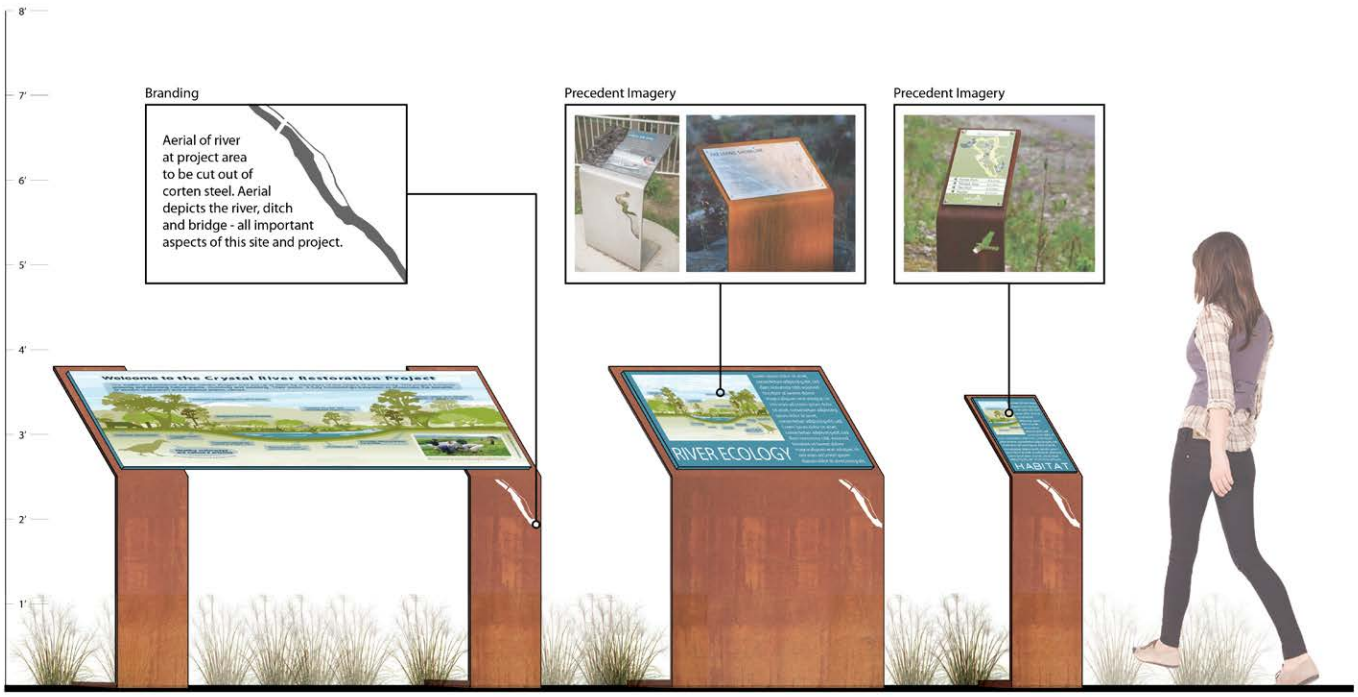
Note: Graphics and images provided to show design intent and to help guide final signage design. Final dimensions and sign content to be coordinated and designed.

Kiosk Sign

Interpretive Sign
Type 1

Interpretive Sign
Type 2

SCALE: 3/4" = 1'-0"



Note: Graphics and images provided to show design intent and to help guide final signage design. Final dimensions and sign content to be coordinated and designed.

Kiosk Sign

Interpretive Sign
Type 1

Interpretive Sign
Type 2

SCALE: 1" = 1'-0"

Appendix B: Recommendations from the Riparian Restoration Plan & Ecological Integrity Assessment

1.0 Restoration Opportunities

There are ample opportunities for riparian habitat preservation, enhancement and restoration across the Project Area. The project ream has developed a restoration concept which addresses the existing conditions with four types of interventions by ecologic community type:

- Preserve
- Enhance
- Create
- Future Restoration Opportunities

These opportunities are conceptual in nature and based on initial field visits and data collection. The project team anticipates further collaboration with stakeholders groups to develop the presented opportunities into two (2) comprehensive concept alternatives.

1.1 Restoration Concept

The Project Area restoration concept focuses on three main ecologic communities, riparian, wetland and in channel. For the purpose of this report and based on stakeholder goals, upland communities are reserved for future restoration opportunities. The surveyed riparian and wetland communities are recommended for preservation, enhancement or creation.

- Preservation - The protection of intact and functioning wetland or riparian through ecologic and landscape planning and site development.
- Enhancement - The restoration of partially functioning healthy wetlands and riparian areas. This can include noxious weed elimination, planting, seeding, and other restoration techniques.
- Creation - Identifying and re-establishing areas that are heavily degraded but have the opportunity due to location and surrounding vegetation for full restoration activities resulting in the creation of a new wetland or riparian area.

The in-channel restoration opportunities are discussed in Section 4.1.3.

Maps of these opportunities can be found at the end of this section. All priorities and decisions about restoration actions should be guided by stakeholder goals and values.

1.1.1 Riparian Restoration Opportunities

As discussed in the existing conditions section, the health and quality of the riparian environment within the Project Area is good. **The project team recommends 10.1 acres for preservation, 0.45 acres for enhancement, and 1.1 acres for creation.**

4.1.1.1 Riparian Preservation
Riparian preservation would include developing a regular monitoring and maintenance plan to preserve the high quality riparian habitat. Monitoring noxious and native vegetation will preserve and sustain current riparian conditions. By limiting access to sensitive areas and minimizing disturbance by directing human traffic through way-finding and the creation of designated, formalized paths impacts can be reduced. The project team recommends preserving approximately 10.4 acres of high quality riparian habitat.

4.1.1.2 Riparian Enhancement
Riparian enhancement will improve existing conditions to increase habitat value. This is done through the development and implementation of a weed management plan to control noxious vegetation, identifying arboricultural maintenance needs/plans and increasing plant diversity through planting and seeding. The resulting enhancement will provide increased habitat value for wildlife and improve overall ecological conditions. The project team recommends that Project Area Stakeholders consider interventions to enhance approximately .45 acres of Riparian habitat.



Image 4-1 This image demonstrates highly degraded ecologic conditions near the river on the left side of the photograph. This is an area recommended for riparian creation. Near the center of the photo, healthy forbes indicate an intact wetland which could be enhanced.



Image 4-2 A high quality wetland can be seen on the right side of the image. This area would be recommended for wetland preservation. On the left side of the image, closer to the Crystal River there is an area recommended for wetland creation

4.1.1.3 Riparian Creation
Riparian creation is the most intensive of the three types of restoration. This involves grading the topography to create elevations with the appropriate available water to support native riparian vegetation plantings. Areas identified within the report are immediately adjacent to the river bank and are located in close proximity to the river water table. Areas identified for bank stabilization as part of river improvements are ideal locations for this recommended intervention as bank stabilization and riparian creation are both interventions with overlapping goals. The project team recommends 1.1 acres of Riparian Creation.

1.1.2 Wetland Restoration Opportunities

As discussed in the existing conditions section, the health and quality of the wetland environment within the Project Area is good to excellent. The project team recommends 1.6 acres for preservation, .076 acres for enhancement, and .17 acres for creation.

4.1.2.1 Wetland Preservation
Wetland preservation includes regular monitoring and maintenance of plant species, the percent cover of the plants, and the hydrological conditions on site. Monitoring can assist with understanding overall wetland health, identify trends, and allow for short term and long term preservation planning. The construction of boardwalks in these areas would dramatically reduce human impacts and provide excellent learning and wildlife viewing opportunities. The project team recommends 1.6 acres for wetland preservation.

4.1.2.2 Wetland Enhancement
Wetland Enhancement including noxious and invasive species control, selective planting and maintenance can enhance what is already considered a high quality wetland within the Project Area. The project team recommends that at the Project Area Stakeholders consider .076 acres within the Project Area for wetland enhancement.



Image 4-3 This location of the assessment area has mature trees and shrubs suitable for riparian preservation. The herbaceous ground cover is mostly noxious weeds making it a candidate for riparian creation

4.1.2.3 Wetland Creation
Appropriate hydrological conditions to support wetland plant species can be created by grading the topography of appropriate sites within the Project Area. The location of the proposed wetland creation sites (See maps "Restoration Opportunities - Study Area A" and "Restoration Opportunities - Study Area B" at the end of this section) allows for ease of colonization of adjacent wetland plant species. Minimal grading would be required to achieve successful wetland creation in this area. The project team recommends that at the Project Area Stakeholders consider approximately 7,225 square feet for wetland creation.



Image 4-4 An example of healthy PER wetlands and riparian shrublands. Both areas are recommended for preservation

1.1.3 Bank and Channel Restoration Opportunities

Several locations along the west bank of the river have been identified as opportunities for restoration. This restoration work can take several forms depending on the location and other project goals such as river access, angling locations and educational



Image 4-5 The shrubs in this image are in good health and these woody vegetated zones are recommended for preservation. The wide swaths of brome in the foreground of the photograph are an opportunity for riparian enhancement.

opportunities. In higher traffic and access areas, the bank restoration will be comprised of boulders. Lower traffic area restoration activities will utilize vegetation and large wood, with boulders only used for toe reinforcement. Examples of this type of restoration are shown in Images 4-6 and 4-7. Proposed locations are shown on the maps at the end of this section.

The Weaver Ditch diversion structure will be the primary focus of the in-channel improvements. Proposed modifications will create a stable boulder structure in the river that allows for proper function at a wide range of flows with reduced maintenance requirements. The headgate structure itself will also be modified to allow for reduced maintenance needs and the ability to add an automated system in the future.

The team will also look at the section of the channel downstream of the diversion which is experiencing higher sediment accumulation. Options here include the creation of a thalweg and potentially a localized, slight narrowing of the channel to increase sediment transport capacity. Sections of river upstream of the Weaver Diversion will likely be unmodified with the exception of bank work. This area of the river is highlighted on the Existing Conditions maps in section 3.



Image 4-6 An example of a bank repaired with boulders and steps

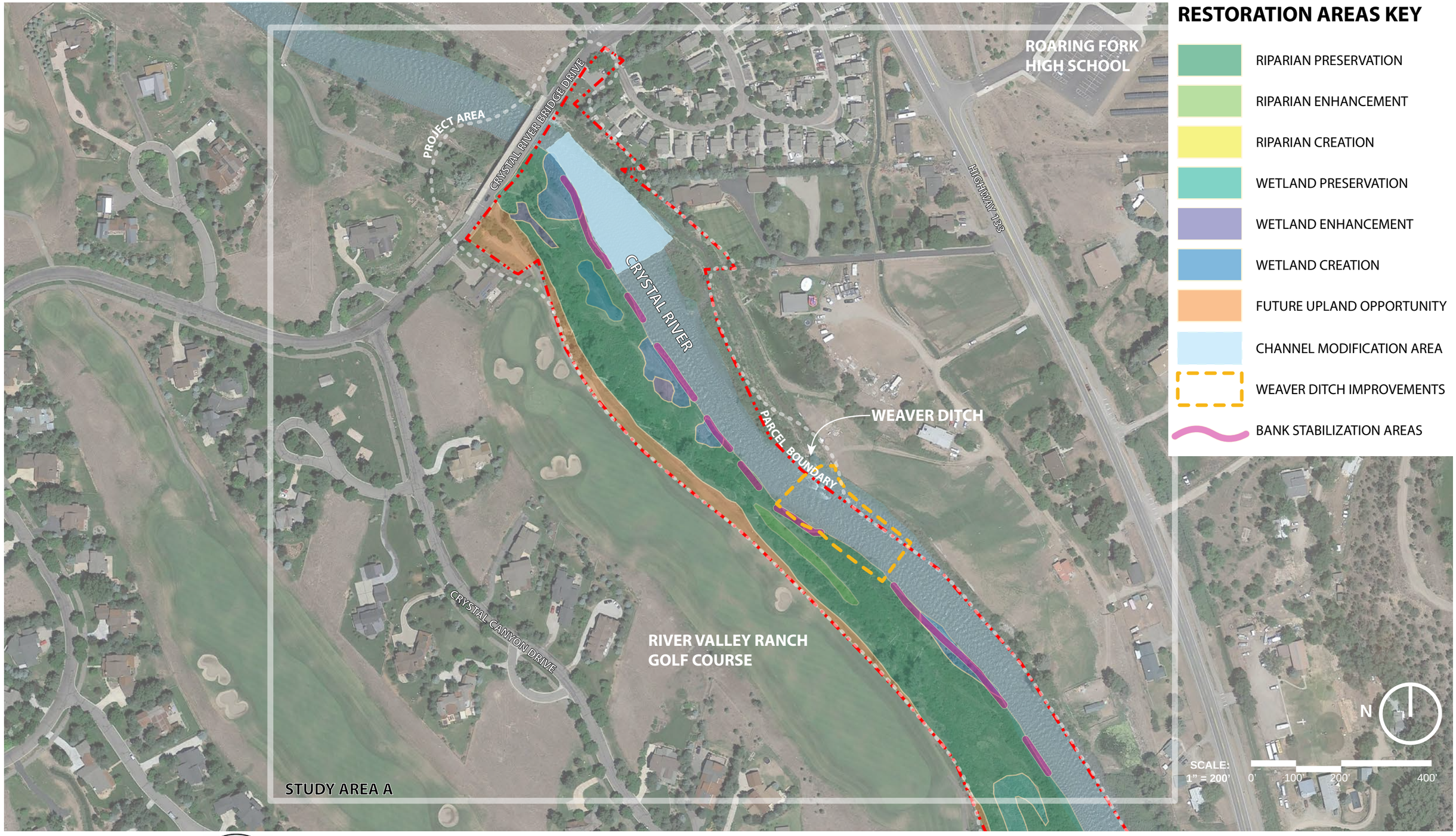


Image 4-7 An example of a bank repaired with vegetation

1.2 Ecological Performance Standards (Success Criteria)

Ecological performance standards and success criteria for riparian enhancement and creation opportunities should be established and agreed upon by all stakeholders, designers, and agencies to provide a clear road map for success. Vegetative success criteria can include the identification of thresholds for percent cover, vegetative composition, and native vs. non native species. New plantings and seeded areas should be monitored on a regular basis to ensure success. Areas where hydrological conditions are necessary for growth should be monitored regularly. For creation and enhancement areas, adjustments to site conditions may be necessary to allow for optimal success.

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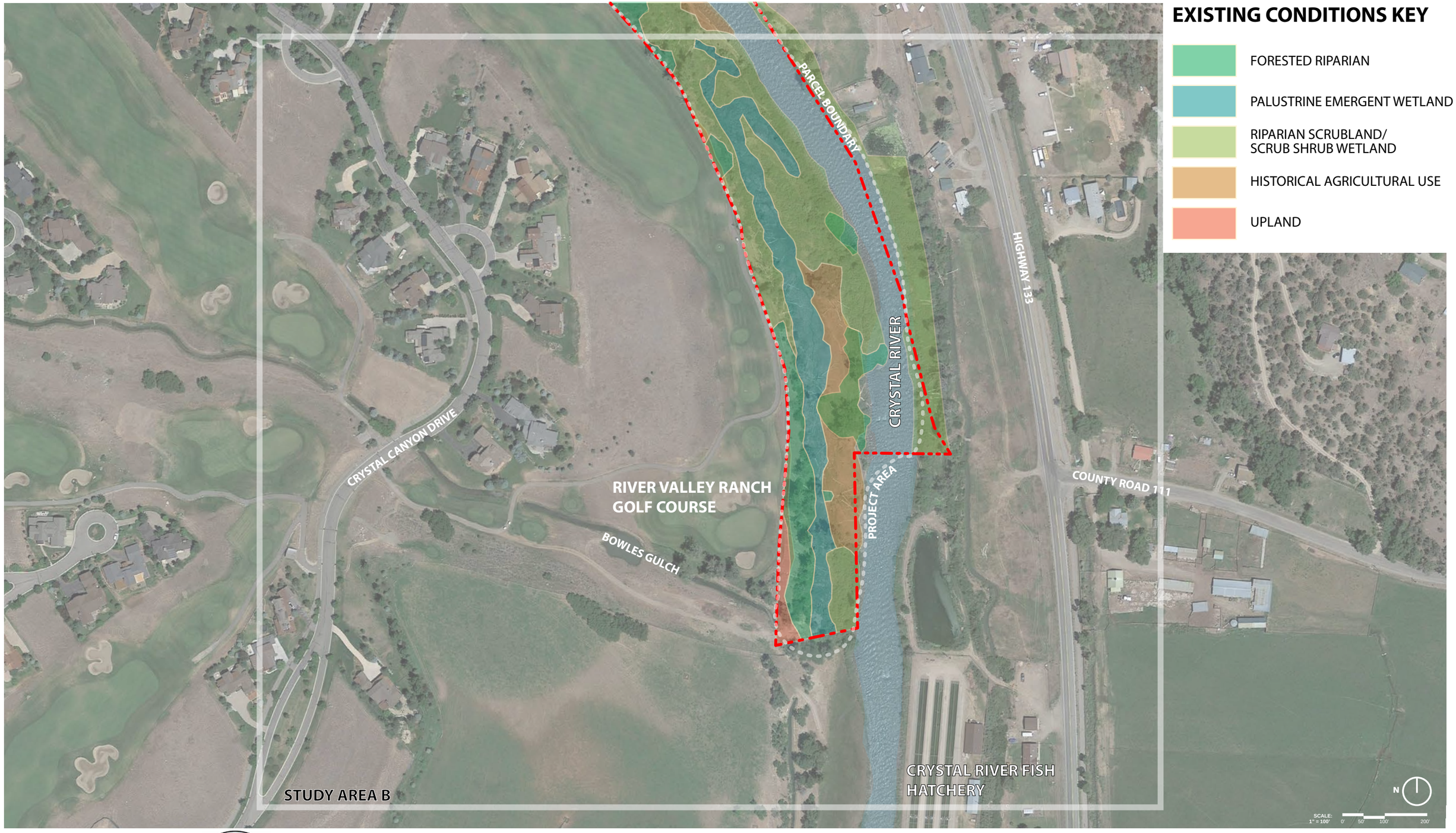


DHM DESIGN

CRYSTAL RIVER RESTORATION | RESTORATION OPPORTUNITIES - STUDY AREA A

GARFIELD COUNTY. COLORADO
November 2018

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EXISTING CONDITIONS KEY

- FORESTED RIPARIAN
- PALUSTRINE EMERGENT WETLAND
- RIPARIAN SCRUBLAND/ SCRUB SHRUB WETLAND
- HISTORICAL AGRICULTURAL USE
- UPLAND

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1.0 Recreation, Education and Interpretation Opportunities

1.1 Existing Conditions

The current on-site opportunities for people to engage with the ecology and nature of the Project Area are limited while human use of the Project Area is evident. Existing amenities such as the trail, river access, interpretive and regulatory information and gathering places have become degraded and weathered overtime. These spaces are generally in disrepair and are no longer as effective as they once were.

The main trail along the site is heavily overgrown and can be difficult to locate and navigate. Areas of the trail have eroded into the river and navigation through the overgrowth is difficult in sections. This trail overgrowth and degradation has resulted in informal "social trails" winding through the site and degraded river banks from informal access points contributing to erosion and bank destabilization.

The Project Area contains a number of interpretive signs, however these signs have become worn over time and are dated. Many signs are no longer visible due to vegetation overgrowth and do not describe the ecologies of the locations where they stand. Instructional and regulatory signs are not concentrated or clearly placed near the main access point near the bridge.

The current inventory of sign topics include:

- Bald eagle closure area notice
- No dogs or glass containers regulation
- Riverfront Park entrance sign
- 8 Interpretive Signs
  - "River Valley Ranch Wetlands"
  - "Riparian Woodland"
  - "Fisheries"
  - "Wetland Plants - What herb is this?"
  - "Aquatic Plants"



Image 5-1 View of the proposed southern gathering area with views of Mount Sopris



Image 5-2 Example of an outdoor classroom with seating and naturalized elements



Image 5-3 Navigating the overgrown trail



Image 5-4 Example of current interpretive signage



Image 5-5 Picnic benches on South end of Project Area



Image 5-6 Informal river access with visable erosion

- "Wetland Plants"
- "Willows"
- "Birds of the Wetlands"

There are no formal gathering places with the exception of two picnic tables near the south end of the site (see Image 5-5). The area is both hard to locate and in disrepair due to age and lack of maintenance. Several informal gathering spaces exist and are evident in areas where the vegetation has been disturbed.

Additional challenges existing on site are the small parking area, lack of alternative transportation options such as a bike rack, lack of designated pedestrian crossing area and a visual disconnect resulting in difficulty locating the site. The access point beneath the bridge is difficult to find, is steep and the stairs are in disrepair. The site is currently not universally accessible.

Opportunities for new recreational, educational and interpretive amenities have been identified. There are many unique features of the site that have the potential to serve as the basis for recreational, interpretive and educational programming elements for diverse audiences. There are a wealth of opportunities to program the site building on interactive, recreational, and interpretive experiences, while simultaneously improving, restoring and protecting the health and ecology of the Crystal River and its riparian corridor.

This tandem approach of creating recreational amenities that also provide ecological benefits is the recommended method to bring cultural and ecological value to the site simultaneously. The following sections identify opportunities for; public gathering spaces, educational and interpretive sites, trail and way-finding improvements, access and recreation. No significant local, state or federal permitting challenges are anticipated for the recreation, education and interpretive opportunities.

These opportunities are conceptual in nature and



Image 5-7 An apple tree in the Project Area hints at the past land uses and history of the area



Image 5-8 Example of an interactive interpretive site element, this map is both tactile and informative

based on initial field visits and data collection. The project team anticipates further collaboration with stakeholders groups to develop the presented opportunities into two (2) comprehensive concept alternatives.

1.2 Public Gathering Spaces

Through site visits and a discussion with stakeholders, two locations have been identified for outdoor classroom and public gathering spaces (see maps at the end of this section). One at the north end of the park near Crystal Bridge Drive and one at the south end of the park. As with all other project elements, final locations for public gathering space will be developed through a collaborative process with the project team, stakeholder group and general public.

- North end near Crystal Bridge Drive: The area along the river bank is degraded, reducing impacts to healthy riparian areas elsewhere. Optimally, gathering space would be placed along the bank with multiple access points down to the river to provide visitors with an opportunity to access the river and bank. This access could serve as an educational opportunity and/or for recreational opportunities such as angling. This gathering space could also serve as an area to inform the public about regulations or special information about the park. This is the most ideal site for a universally accessible gathering space.

- South End: The second public gathering space would be near the existing cottonwood grove at the south end of the park. This space could be more focused on the wetland and upland areas or the park. Amenities may include: a boardwalk and overlook of the enhanced wetland created by the reconnected side channel and an interactive exhibit describing ecological benefits of riparian features such as downed nurse logs and understory vegetation. This location also has the potential to serve as an outdoor classroom with seating, shade and interactive interpretive elements.

Constraints of these two sites include the limited amount of parking available near the bridge and access to the area for people of different abilities and mobility types. Stakeholders should consider what the target audience is for these gathering places and what additional amenities will need to be on site to facilitate those user types.

1.3 Educational and Interpretive Opportunities

Many interpretive elements have already been introduced to the site. The proximity to schools, residential neighborhoods, and existing trail networks such as the Crystal Valley Trail create an ideal opportunity for educational and interpretive elements that could reach a large and diverse segment of the community. The project team recommends expanding and updating the current interpretive materials and making them more accessible and interactive. These interventions could include bilingual signage, the inclusion of tactile elements, view platforms and three dimensional exhibits.

Every site has a unique story to tell and this parcel is no exception. Identifying additional interpretive opportunities and communicating a larger, more engaging story is a goal moving forward. Interpretive elements to consider are as follows:

- Updating and expanding current interpretive topics
- Hydrology and river morphology
- Expanded information about variety of birds and their habitats
- Human history including indigenous populations, European settlers, ranchers and farmers
- Water infrastructure in our communities as it pertains to the Weaver Diversion
- Understanding place through landmarks such as Red Hill and Mount Sopris
- The water cycle and our local watersheds
- Insects and macro invertebrates in wetlands and riparian areas
- Angling
- Water rights and irrigation

The proposed new amenities would link together



Image 5-9 Navigating the trail can be tricky, the surface material changes through out the site



Image 5-10 Example of a boardwalk through an ecologically sensitive area



Image 5-11 Bird houses have been installed in the Project Area. Enhancing wildlife habitat would encourage passive recreation such as birding



Image 5-12 Example of a durable surface used for river access, helping to prevent erosion, fisheries health and bank destabilization

places on the site that help create a unique narrative. The project team recommends ongoing collaboration to create the educational and interpretive programming. In conjunction with the interpretive elements, an outdoor classroom area is a is a key recommendation of this report.

1.4 Recreational Opportunities

Currently the Project Area supports many passive recreation activities such as angling, walking, hiking, bird watching, picnicking, and nature play. All of these activities could be enhanced by improving, updating and programing the Project Area. A dual benefit of the proposed enhancements is that they would help to protect the restored ecology by directing people into areas specifically designed for recreation and intentionally directing people away from ecologically sensitive areas.

Angling opportunities would be greatly improved by the recommended river bank restorations and in-stream restorations proposed in Section 4.0. Fishing and fishing access could also be greatly improved and made more standardized by formalizing river access points to places along the bank which are safe, stable and offer opportunities to interact with the river.

Walking and hiking through the site could be improved in a host of ways. Trail improvements and access are discussed in the following section. Hiking and walking offer low impact exercise to many people. The gentle grade of the Project Area makes this site ideal for people of many ability levels and provides access to a wide range of people.

The existing bird watching opportunities on the site have the potential to be expanded. Wetland and riparian areas host some of the greatest bird life of any ecosystem type. The ecological restorations recommend in section 4.0 would improve the habitat of bird populations and provide birding enthusiasts with an incredible in-town amenity. Focusing on this recreation type also gives the project team an opportunity to collaborate and work with other specialty groups such as the local Audubon Society chapter. Furthermore, focusing on bird watching as a major element of recreation on the site will encourage users to protect the ecosystem and respect the Project Area.

Finally picnicking, nature play and exploration are recreation objectives that can be easily met by formalizing public gathering areas. A focus on these types of recreation gives families, school groups and people of all ages a passive and enjoyable way to experience the natural environment. These elements can easily and imaginatively be incorporated through seating, shade and interactive interpretive elements.

1.5 Trail Improvements and Access

The project team advocates for an improved trail system that provides access and connectivity for park visitors. An ideal trail system would lead visitors to the different planned amenities, as well as allow them to experience the riparian corridor. The recommendation is for the trail to follow existing trail corridors, where possible, to minimize impact to healthy vegetation areas. The incorporation of a small loop trail could be a valuable asset allowing visitors to engage with unique places within the Project Area. Importantly, the existing trail needs to be cleared of obtrusive vegetation, undergo over-due maintenance, be reinforced in areas where it is eroding and have way finding practices such as clear lines of sight and signage.

There are three types of trails which would be most appropriate for the site. The primary trail type would be composed of a wide, firm surface and would connect to the universally accessible public gathering spaces and interpretive, educational areas. This trail would be accessible for less mobile individuals. The second type of trail would be more primitive and narrow. This trail could pass through several existing and healthy riparian areas. Finally, low boardwalks could be used in a few areas such as floodplains, connection areas and the re-established secondary channel.

As with all other project elements, alternatives for the trail system configuration will be developed through a collaborative process with the project team, stakeholder group and general public.



RECREATION AREAS KEY

- EXISTING PARKING AREA
- PROPOSED IMPROVED PEDESTRAIN CROSSING AND BIKE RACK
- PROPOSED IMPROVED ACCESS AND RAMP
- PROPOSED PUBLIC GATHERING AREA
- ECOLOGIC PRESERVATION ZONE
- PROPOSED WEAVER DITCH REHABILITATION
- PROJECT AREA ACCESS ROUTE
- PROPOSED TRAIL FOLLOWING EXISTING ALIGNMENT
- PROPOSED FORMALIZED RIVER ACCESS POINT

INTERPRETIVE OPPORTUNITIES

1. WELCOME INFORMATION, MONUMENT SIGN, AND SITE REGULATIONS
2. ANGING AND FISHERIES
3. RIPARIAN WOODLAND COMMUNITIES
4. WATER INFRASTRUCTURE AND WATER RIGHTS
5. RIPARIAN PLANTS, IDENTIFICATION
6. HUMAN HISTORY
7. SCRUB AND SHRUB HABITATS

N

SCALE:
1" = 200'
0' 100' 200' 400'

DHM DESIGN

TOWN OF CARBONDALE ESTABLISHED 1887

CRYSTAL RIVER RESTORATION | RECREATION OPPORTUNITIES - STUDY AREA A

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RECREATION AREAS KEY

- PROPOSED PUBLIC GATHERING AREA
- ECOLOGIC PRESERVATION ZONE
- PROPOSED BOARDWALK LOOP
- PROPOSED TRAIL FOLLOWING EXISTING ALIGNMENT
- PROPOSED BOARD WALK TRAIL
- PROPOSED FORMALIZED RIVER ACCESS POINT

INTERPRETIVE OPPORTUNITIES

- (8) BIRDS
- (9) ORIENTEERING
- (10) HYDROLOGY AND RIVER MORPHOLOGY
- (11) WATER CYCLE AND LOCAL WATERSHEDS
- (12) INSECTS AND INVERTEBRATES
- (13) WILDLIFE
- (14) WETLAND PLANT IDENTIFICATION

N

SCALE:
1" = 200'
0' 100' 200' 400'