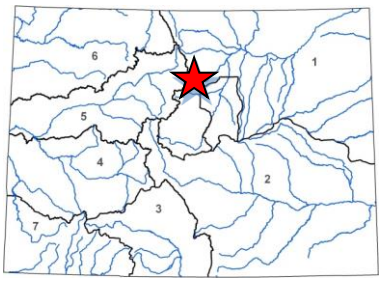
COLORADO
Colorado Water Conservation Board

Colorado Watershed Restoration Program Application

Upper Ingram Gulch Restoration Project
Fourmile Watershed Coalition

January 2020 Board Meeting



LOCATION	
County/Counties:	Boulder
Drainage Basin:	South Platte

DETAILS	
Total Project Cost:	$350,116
Colorado Watershed Restoration Program Request:	$100,116
Recommended amount:	$256,707
Other CWCB Funding:	$0
Other Funding Amount:	$250,000
Applicant Match:	$0
Project Type(s): Engineering Design and Construction	
Project Category: Watershed Restoration	
Measurable Result: 1,392 CY of mine waste removed. 3,300 Linear Feet restored. 5,000 containers planted (riparian plants).	

Since 2015, the Fourmile Watershed Coalition has been awarded 7.3 million dollars in state and federal grant funds primarily for flood recovery and stream restoration planning and construction projects. These projects include three planning projects, eight watershed/stream restoration projects and staff capacity funds. Currently, the Coalition is expanding into the Boulder Creek watershed and expanding programing into forest health and resiliency. All projects have been multi-objective and incorporated the priorities of multiple agencies and landowners.

The Upper Ingram Restoration Project proposes to prioritize, design and implement multiple smaller scale mine remediation projects within Ingram Gulch. This work will build upon ongoing and completed projects in Ingram Gulch that are incrementally improving water quality by decreasing sediment loading downstream. High sediment yields are due to increased erosion from gullying in the upper watershed as well as dozens of mine waste piles exposed during the Fourmile Fire. The primary objectives with the mine waste design is increased stabilization of the piles by encouraging vegetation growth through grading, soil amendments and native seeding and planting.

This project will engage engineering students from the Colorado School of Mines to prioritize remaining waste piles, conduct design on selected piles, and implement the designs on the highest priority piles. Three other priority piles were previously identified due to their size and location in the immediate drainage and will be relocated in 2020 as phase 1 of this project. High priority gully restoration will take place in 2020 as phase 2. Phase 3 of the project is proposed in this grant request and will further address planning recommendations developed in the Ingram Gulch Upper Watershed Restoration and Stabilization Conceptual Design Report (2017).

PROJECT SUMMARY SHEET	
Project Title	Upper Ingram Gulch Restoration Project
Location	Boulder County: Upper Ingram Gulch
Grant Request	$100,116
Cash Match Funding	$200,000
In-Kind Match Funding	$50,000
Grant Type	CWCB Watershed Restoration Grant
Name of Grantee(s)	Four Mile Fire Protection District (fiscal agent)
Name of Applicant (if different than grantee)	Fourmile Watershed Coalition
Mailing Address	1740 Fourmile Canyon Drive, Boulder CO 80302
Position/Title	Maya MacHamer- Watershed Coordinator
Email	fourmilewatershed@gmail.com
Phone	303-817-2261

Project Description: The Upper Ingram Restoration Project proposes to prioritize, design and implement multiple smaller scale mine remediation projects within Ingram Gulch. This work will build upon ongoing and completed projects in Ingram Gulch that are incrementally improving water quality by decreasing sediment loading downstream. High sediment yields are due to increased erosion from gullying in the upper watershed as well as dozens of mine waste piles exposed during the Fourmile Fire. The primary objectives with the mine waste design is increased stabilization of the piles by encouraging vegetation growth through grading, soil amendments and native seeding and planting.

This project will engage engineering students from the Colorado School of Mines to prioritize remaining waste piles, conduct design on selected piles and implement the designs on the highest priority piles. Three other priority piles were previously identified due to their size and location in the immediate drainage and will be relocated in 2020 as phase 1 of this project (CDBG-DR funds). High priority gully restoration will take place in 2020 as phase 2 (CDBG-DR funds). Phase 3 of the project is proposed in this grant request and will further address planning recommendations developed in the Ingram Gulch Upper Watershed Restoration and Stabilization Conceptual Design Report(2017). See attachments for further descriptions.

GRANT APPLICATION PROPOSAL

Qualifications Evaluation (Maximum of 20 points).

Project sponsor and stakeholder involvement:

The Fourmile Watershed Coalition (FWC) is the lead project sponsor and will provide project and financial management and grant compliance. FWC will work with professors, students, landowners and agencies to coordinate all aspects of the project.

- *The Bureau of Land Management (BLM)*: The BLM owns a significant number of parcels within the area. They have and continue to be a good partner working on mine reclamation projects in the area and will consult on mine reclamation strategy.
- *Trout Unlimited's (TU) Abandoned Mine Lands Team:* TU will provide consultation regarding mine reclamation strategies.
- *The Pine Brook Water District:* Pine Brook is a stakeholder extremely invested in water quality improvements. Pine Brook offers assistance with navigating water quality parameters and sample result interpretation.
- *Boulder County Parks and Open Space:* Boulder County owns property within Ingram Gulch and will be consulted regarding waste piles on their properties.
- *Private landowners:* There are many private landowners within the gulch who have demonstrated interest and support for environmental restoration and mine waste specifically.

In-Kind and Cash Services:

In-kind services will be provided by the Colorado School of Mines in the amount of $50,000. The services offered will include multiple students who dedicate two semesters of work toward prioritization and design of mine waste piles. All work associated with the Capstone project will be overseen by professors. Both the BLM and TU will review designs prior to implementation.

Cash match is provided through a Community Development Block Grant - Disaster Recovery administered through the Colorado Department of Local Affairs. These funds were allocated for multiple recovery projects aimed at reducing downstream sediment loading. This grant includes funds for the relocation of three high priority waste piles within the immediate drainage. Reclamation design for these piles was previously completed by Stantec Consulting (previously Norwest Corps.) in 2017. CDBG-DR funds will also support the design and implementation of restoration for six gullies identified has having high erosion potential due to fire and flood damage. Allocated implementation funds for upland gully restoration is $200,000.

Organizational Capability (Maximum of 30 points):

***History of Accomplishments and Partners*:**

Since 2015, FWC has been awarded 7.3 million dollars in state and federal grant funds primarily for flood recovery stream restoration planning and construction projects. These projects include three planning projects, eight watershed/stream restoration projects and staff capacity funds. Currently, the Coalition

is expanding into the Boulder Creek watershed and expanding programing into forest health and resiliency. All projects have been multi-objective and incorporated the priorities of multiple agencies and landowners. Highlighted Coalition projects include:

Black Swan Restoration - The Black Swan project is a flood recovery stream restoration project that also included the removal of 1900 cubic yards of mine tailings from the floodplain. FWC worked with the EPA to acquire an Administrative Order on Consent (AOC) for Good Samaritan coverage for the project. Using the AOC was an innovative method for liability coverage and is being used as an example for a new standard of Good Samaritan coverage for third parties conducting mine reclamation. Wetlands were created at applicable areas where tailings removal occurred.

Lower Ingram Gulch Restoration - This project includes 1700 linear feet of restoration within an ephemeral stream gulch. This project included innovative methods to stabilize steep, eroding slopes while working within significant human and natural constraints. DRMS closed 40 mine shafts and adits at the same time the FWC project was constructed in 2017.

Boulder County Forest Collaborative - FWC has partnered with the Colorado State Forest Service to initiate and facilitate a county wide forest collaborative. This group of federal, state and local agencies is working to increase the pace and scale of forest restoration projects as a method of addressing the increasing risk of high intensity wildfire.

Resilient Crossing Handbook - The Resilient Crossing Handbook provides an overview of watershed and stream processes and how they are applicable to the creation of more resilient culvert and bridge crossings. The handbook provides guidance for private landowners to as they navigate repair or replacement of crossings through traditional structural design processes.

FWC has worked with numerous partners to plan and implement projects. In addition to many private landowners and volunteer organizations these partners include:

- *Bureau of Land Management* - The BLM lead the NEPA review for Ingram Gulch and has been a collaborative partner through multiple years of planning and implementation in Ingram Gulch.
- *US Forest Service* - The USFS is a primary partner in the Boulder County Forest Collaborative.
- *Colorado State Forest Service* - The State Forest Service is a primary partner in the Boulder County Forest Collaborative.
- *Trout Unlimited Abandoned Mine Lands Team* - TU partners on water quality sampling projects to identify and prioritize contaminated mine waste sites for future reclamation.
- *Department of Reclamation Mining and Safety* - DRMS has consulted on FWC projects, coordinated on construction projects and provided water quality sampling grant funds.
- *Environmental Protection Agency* - FWC worked with the EPA to incorporate mine tailings removal from the floodplain into a stream restoration project
- *Colorado Geological Society* - CGS assisted the Coalition with debris flow mapping.
- *Four Mile Fire Protection District* - The District is the fiscal agent and a primary partner in developing forestry and mitigation projects.
- *Pine Brook Water District* - Pine Brook Water is an FWC Board member and supportive project partner especially for water quality and legacy mining projects.

- *Boulder County -* Boulder County is an FWC Board member. FWC and Boulder County have coordinated on outreach, design and construction on numerous flood recovery projects.
- *Other Front Range Coalitions -* Strong relations have been developed with numerous watershed coalitions. We collaborate on outreach and organizational development strategies, project planning and partnerships and share expertise.

***Level of Staffing*:**

Two staff members will dedicate time toward the implementation of this grant. The Watershed Coordinator and Grant Coordinator will dedicate approximately 30% of time toward this project. Time will be allocated to work with landowners, advise and coordinate with School of Mines staff and students, coordinate with other stakeholders and assure that all regulatory requirements are met through all phases of the project.

***Budget and Schedule*:**

The Upper Ingram Restoration Project aims to reduce sediment loading downstream by remediating exposed waste piles and restoring highly erosive gullies in the same vicinity. Cash match includes $200,000 in CDBG-DR funds that will be allocated to the design and implementation of six identified gullies. Further description of the mine reclamation and gully projects are included in the Ingram Gulch Upper Watershed Restoration and Conceptual Design document included as an attachment.

This project will begin after grant funds are contracted and in conjunction with the 2020 August semester at the School of Mines. The in-kind match amount of $50,000 was developed by the School of Mines. This figure quantifies the amount of student and professor time and materials allocated toward a project over two semesters. Task 1 (Prioritization) includes $10,000 of in-kind student match and $5280 (80hrs) of coalition staff time for supporting the students, research and evaluation, consultation with partners and consultants and site visits.

All Capstone projects through the school require agencies to contribute $5,000 in cash for overhead and supplies required to support the program. Task 2 (Design) includes $5,000 for the School of Mines students and $5280 (80hrs) of Coalition staff time for coordination, review of alternatives and final design. In-kind match from students for the design of three to four high priority pile is valued at $40,000.

Task 3 (Implementation) includes funds for the implementation of the two highest priority piles. The total cost for each pile is estimated at $30,000. This estimation comes from previous Coalition and TU project costs for similar projects. Unit price costs for fine grading, capping material (cover material, gravel and topsoil) and seeding and revegetation costs were evaluated. An estimated average for the size of the piles was determined to be 1000 cubic yards or less. If the funding is less than estimated funds will be dedicated to the next prioritized pile that will already have a design.

Staff costs associated with regulatory requirements and permitting, consultation with the BLM and EPA, legal costs, procurement and hiring, contracting, construction oversight and reporting over a six month period is estimated at $15,840 for two staff members covering all project needs (20hrs/month).

Task 4 (Monitoring) includes three days of monitoring at $1300 for one year (2021-2022). Subsequent annual monitoring will be integrated into other funding sources.

Task 5 (Grant Administration) is 8% ($7416) of the total funds request: $92,700.

Proposal Effectiveness (50 points)-

Plan Discussion:

Fourmile Creek Watershed Master Plan (2014):

- Development of the Master Plan included gathering and documenting community and stakeholder priorities and concerns. For Reach 3 (Ingram Gulch and Gold Run) the community indicated that water quality improvements and revegetation were top priorities.

Ingram Gulch Planning Project (2016):

- This plan included mapping and soil sampling of mine waste piles, water quality sampling, an ecological evaluation of the Ingram sub-watershed, a conceptual design for high priority gully restoration and restoration designs for Lower Ingram Gulch and the three waste piles that will be stabilized in 2020 with CDBG-DR funds.
- The planning document includes a conceptual design document for Upper Ingram Gulch that encompasses sediment reduction strategies including the gully restoration (CDBG-DR funds) and the waste pile prioritization and revegetation (requested CWCB funds). See attachments.

Pine Brook Water District's Source Water Protection Plan (2014):

- The goal of the Source Water Protection Plan is improving water quality for the 1200 residents served by Pine Brook Water District, in addition to the private wells along Gold Run and Fourmile Creek.
- The mine waste stabilization would take place in the "Primary Zone of the Source Water Protection Area [within 1,000 feet on either side of the surface water drainage network]. This is the most sensitive and important area to protect from potential sources of contamination."
- "Total organic carbon from the fire and large volumes of sediment from both events [flood & fire] have combined to decrease filter efficiencies, and generally increase operation and maintenance needs."
- The Source Water Protection Plan specifically references the need for improvement due to the highest potential contaminant sources and/or issues of concern being mining….forest fire, and flooding. Impacts of all of these are present in the project area.

Saint Vrain/Boulder Watershed Plan (2015)

- One of the primary objectives of the Watershed Plan is to "improve water quality or otherwise resolve stream segments designated as impaired." Gold Run flows into Fourmile Creek which is a tributary to Boulder Creek. This section of Boulder Creek and its tributaries is known to have elevated arsenic levels.
- Environmental Goal 1 within the Watershed Plan is to "restore beneficial uses for the overall St. Vrain Basin [Fourmile Creek is in the St Vrain Basin]. Impaired beneficial uses include aquatic life, domestic water supply and recreation."
- Fourmile Creek, which is a tributary to Boulder Creek, once had the highest level of gold-mining operations in the [Saint Vrain] watershed (Murphy et al. 2003).

Saint Vrain Wildfire/Watershed Assessment (2010):

- The watershed assessment was designed to identify and prioritize sixth-level watersheds based on their hazards of generating flooding, debris flows and increased sediment yields following wildfires that could have impacts on water supplies.
- Fourmile Canyon was ranked as Category 5, the highest ranking, for Composite Hazard Ranking which includes, flooding or debris flow hazard, wildfire hazard and soil erodibility.
- This restoration project will work to address hazards associated with soil erodibility and debris flows.

Multiple Objectives:

There are multiple objectives within this project and the project supports and works in conjunction with multiple other projects within the Ingram Gulch sub-watershed.

Project objectives include:

- Improve water quality by minimizing sediment (contaminated or otherwise) mobilized into tributaries and streams,
- Stabilize actively eroding upland gullies to reduce sediment loading. Promote sustainable sediment transport and/or sediment trapping with gully restoration,
- Restore and enhance wetlands by improving geomorphic conditions and floodplain connection.
- Improve habitat through native revegetation,
- Continue to work towards incremental watershed health objectives by focusing on uplands and small, but significant projects.
- Continue fire/flood recovery efforts by building coalition capacity to address legacy mining needs within the watershed,
- Support the education and professional development of Colorado School of Mines students.

Completed or ongoing work within Ingram Gulch includes:

- 2016 CDBG-DR planning project including water and soil sampling, ecological assessment of the uplands and 30% design of Lower Ingram Gulch and Upper Ingram mine waste in the drainage.
- EWP Stream restoration of Lower Ingram Gulch (2018).
- Water quality monitoring in 2017 & 2018 by the Coalition.
- Complete reconstruction of Gold Run Road including the installation of two culverts at the mouth of Ingram Gulch (2017).
- Closure of 40 mine adits/shafts in 2017. Mine waste piles will be used to backfill the holes and will be revegetated afterwards (backfilled sites include S10, S28, S35, S41 displayed in soil sampling attachment).
- BLM tree planting project in the upper basin (2017).
- Relocation and stabilization of three mine waste piles in the drainage. To be constructed in 2019/2020.

Monitoring Plan:

Each pile remediated through this project will be integrated into the Coalition's annual Monitoring Plan. Monitoring will include photo point monitoring, vegetation monitoring, water quality monitoring as applicable and evaluation of each site for erosion.

Scope of Work

GRANTEE and FISCAL AGENT (if different): Grantee: Fourmile Watershed Coalition. Fiscal Agent: Four Mile Fire Protection District

PRIMARY CONTACT: Maya MacHamer, Watershed Coordinator

ADDRESS: 1740 Fourmile Canyon Drive, Boulder CO 80302

PHONE: 303-449-3333 (office), 303-817-2261 (cell)

PROJECT NAME: Debris Flow Early Warning System

GRANT AMOUNT: $100,116

INTRODUCTION AND BACKGROUND:

The Upper Ingram Restoration Project is a holistic approach to watershed health improvements in the Ingram Gulch sub-watershed. The project includes multiple phases which are currently at various stages. Funding requested in this proposal will be used to prioritize, design and implement multiple smaller scale mine remediation projects within the gulch. This work will build upon ongoing and completed projects in Ingram Gulch that are incrementally improving water quality by decreasing sediment loading downstream. Sediment yields from mine waste piles have varying levels of heavy metals and contaminants. High sediment yields are due to increased erosion from gullying in the upper watershed as well as dozens of mine waste piles exposed and lacking vegetative cover due to the Fourmile Fire. The primary objectives with the mine waste design is increased stabilization of the piles by encouraging vegetation growth through grading, capping and/or adding soil amendments and native seeding and planting.

This project will engage engineering students from the Colorado School of Mines to prioritize remaining waste piles and conduct design on selected piles. Implementation of the two highest priority piles will occur. Other priority piles that were previously identified due to their size and location in the immediate drainage will be relocated in 2020 as phase 1 of this project (CDBG-DR funds= $700,000). High priority gully restoration will take place in 2020 as phase 2 (CDBG-DR funds= $200,000). Phase 3 of the project is proposed in this grant request and will further address planning recommendations developed in the Ingram Gulch Planning Project (2017). See attachments for further descriptions.

OBJECTIVES:

- Improve water quality by minimizing sediment (contaminated or otherwise) mobilized into tributaries and streams,

- Stabilize actively eroding upland gullies to reduce sediment loading. Promote sustainable sediment transport and/or sediment trapping with gully restoration,
- Restore and enhance wetlands by improving geomorphic conditions and floodplain connection.
- Improve habitat through native revegetation,
- Continue to work towards incremental watershed health objectives by focusing on uplands and small, but significant projects.
- Continue fire/flood recovery efforts by building coalition capacity to address legacy mining needs within the watershed,
- Support the education and professional development of Colorado School of Mines students.

TASKS:

TASK 1: Prioritization of Waste Piles.

Description of Task: Use previously completed mapping and preliminary evaluation of size and location of piles in addition to 2017 soil samples to prioritize piles for design. Colorado School of Mines students will lead this process with the assistance of the Coalition. Additional soil sampling with lab analysis will be conducted as necessary to assist with characterization of the piles.

Method/Procedure:

1. Evaluate existing data, maps and plans,
2. Visit sites to ground truth data,
3. Conduct additional sampling as necessary,
4. Prioritize 3-4 piles for design.

Deliverable: Map of project area. Prioritized list of piles.

TASK 2: Design

Description of Task: School of Mines students will conduct design of multiple mine waste piles. Prior to final design they will complete multiple alternatives for the piles. Coalition staff and partners will review the alternatives to determine which design to advance to a higher level.

Method/Procedure:

1. Provide clear goals and objectives to the design team,
2. Provide best management practices, design standards, guidelines and other direction to students prior to the design process,
3. Complete alternatives analysis for design for each pile,
4. Complete final design (30% level of design).

Deliverable: 30% design for 3-4 mine waste piles.

TASK 3: Implementation

Description of Task: Implementation includes hiring a contractor, permitting and implementing the designs. It is anticipated that design will include grading, soil amendment or capping the piles and revegetation. If the piles are near a tributary channel stabilization may be a component.

Method/Procedure:

1. Hire a contractor,
2. Acquire permits (Boulder County Limited Impact Special Use Review, Grading Permit and Stormwater Quality Permit. ACOE 404 permit, CDPHE Stormwater permit),
3. Consult with EPA and BLM to acquire Good Samaritan coverage if necessary,
4. Construct and revegetate the piles,
5. Project and permit close-out.

Deliverable: Final report, as-bulits.

TASK 4: Monitoring

Description of Task: Monitor stabilized piles to assure that vegetation is successful, piles are stable and no obvious erosion is occurring. Downstream water quality monitoring will occur as needed.

Method/Procedure:

1. Integrate each project area into the Coalitions annual monitoring plan and determine which parameters will be measured. Parameters which may be measured include vegetation monitoring and water quality monitoring.
2. Visit each site as frequently as necessary, but at least annually to monitor and assess function.

Deliverable: Reporting included in the annual monitoring data summary.

TASK 5: Gully Restoration (funded with CDBG-DR funds)

Description of Task: This task includes the design and construction of six previously identified priority gullies. Gullies were prioritized due their location, current state of erosion and long-term potential to contribute large amounts of sediment to the system.

Method/Procedure:

1. Procure a design/build team,
2. Advance the conceptual design to a 30% level of design,
3. Permitting,
4. Construct the projects,
5. Project and permit close out,
6. Monitoring.

Deliverable: Design documents, final report, as-builts

TASK 6: Grant administration

Description of Task: Prepare all required financial and reporting documents to assure grant compliance.

Method/Procedure:

1. Review grant requirements,
2. Track financial expenditures and budgets,
3. Compile accurate reimbursement requests,
4. Prepare deliverables and reports,
5. Project close out.

Deliverable: Accurate and timely requests for reimbursement and reports.

Budget and Schedule

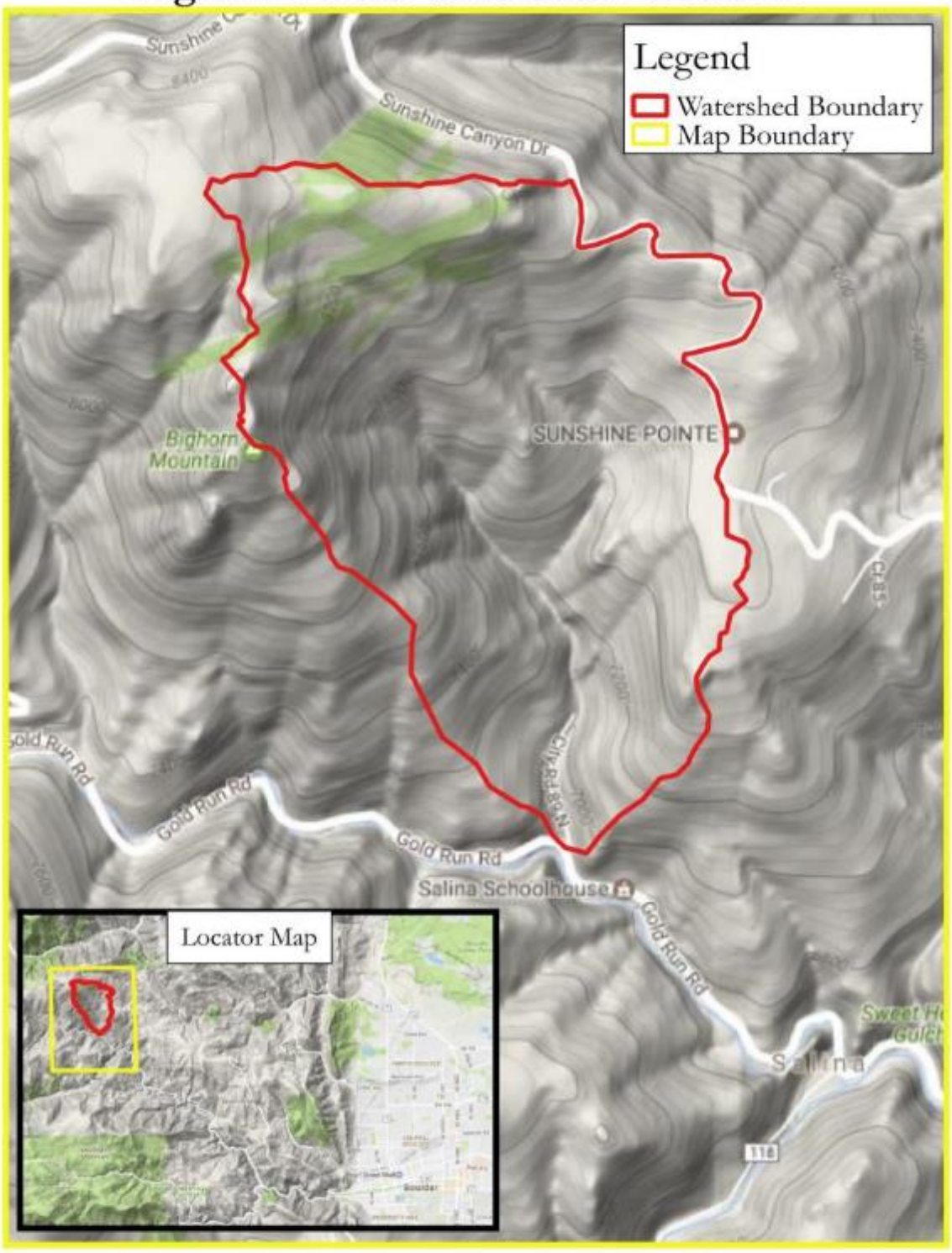
Date: 10/29/2019

Name of Applicant: Fourmile Watershed Coalition

Name of Project: Upper Ingram Restoration Project

Task No.	Task Description	Start Date	End Date	CWCB Funds	Other Funding *cash	Other Funding *in-kind	Total
1	Mine Waste Prioritization	8/1/2020	10/1/2020	$5,280		$10,000	$15,280
2	Mine Waste Design	10/1/2020	5/1/2020	$10,280		$40,000	$50,280
3	Implementation	5/1/2021	10/30/2021	$75,840			$75,840
4	Monitoring	10/30/2021	10/30/2022	$1,300			$1,300
6	Gully Restoration	1/1/2020	6/30/2020		$200,000		$200,000
5	Grant Administration	8/1/2020	10/30/2022	$7,416			$7,416
							$0
							$0
							$0
							$0
							$0
Total				$100,116	$200,000	$50,000	$350,116

Ingram Gulch: Watershed Location



Ingram Gulch
Boulder County, CO
Projection: WGS 84 Pseudo Mercator
Map Source: Google Physical Data

0 1000 2000 3000 ft

Ingram Gulch Upper Watershed Restoration and Stabilization Conceptual Design Report

Submitted To:	Maya McHammer Watershed Coordinator Fourmile Watershed Coalition
Prepared By:	AloTerra Restoration Services
Draft:	October 28, 2017

AloTerra
Restoration Services

NORWEST
CORPORATION

Conceptual Design Overview

AloTerra provided field assessments in 2016 of the distribution of mine waste piles, gulleys, vegetation cover, and other areas of concern in the upper watershed of Ingram Gulch. Based on the field data gathered, technical memoranda from Norwest, and analysis provided, we identified conceptual restoration and stabilization treatments below. Additional analysis and design is required to provide a more accurate representation of the soil, vegetation, and stabilization treatments (and costs) associated with the restoration of the Upper Ingram Gulch watershed. During this conceptual design phase, three restoration and stabilization elements were identified; ***gulley stability***, ***overburden pile restoration***, and ***restoration of the shooting range*** area of Glitter Gulch. These conceptual designs are outlined below in descriptions, tables, and design maps.

Overburden Pile Restoration

Mine waste overburden piles (i.e., waste piles) are distributed sporadically throughout the watershed, as indicated in the overburden pile priority restoration map **(Figure 1)**. Restoration priorities for waste piles are assigned based on size of pile, existing vegetation cover, steepness of hillslope upon which the waste pile exists, and distance from waste pile to adjacent drainage. Waste piles occurring within the Upper Ingram Gulch project extents are listed as low priority for the purposes of this analysis, as those piles are being addressed by the Upper Ingram 30% Design.

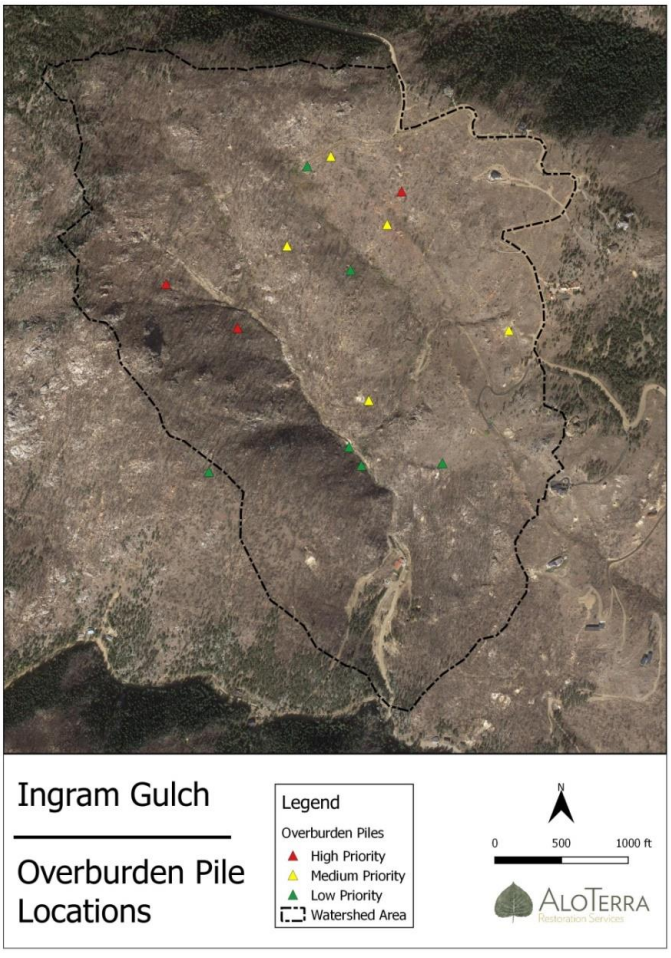


Figure 1. Distribution and prioritization of waste pile restoration treatments. Sites occurring within Upper Ingram Gulch are listed as low priority for this analysis, as they are being addressed by the Upper Ingram 30% Design.

Based on an field assessments of existing conditions, soil sampling data provided by Norwest (February 17, 2017 Technical Memorandum to the Fourmile Watershed Coalition), and the data provided by AloTerra's ecological characterization (as presented in the *Ingram Gulch Drainage 30% design report*, March 28, 2017), conceptual design recommendations for revegetation (**Figure 2**) and soil amendments are provided below.

Revegetation

Based on the remote locations of waste piles, and the upland/xeric conditions of the waste piles, adequate revegetation of these waste piles will require a combination of adequate soil amendments (i.e., based on physical and chemical conditions of the waste piles) and a seed mix tailored to the soil and hydric conditions present. For example, seed of *Apocynum* x *floricbundum* is not commercial available. As such, it may be beneficial to hand collect this species and grow this species out in containers to transplant onto waste piles, provided soil chemical and soil surface conditions are treated in a manner that improves the chances for successful establishment of this and other native species.

Seed Mix

Project Name: Ingram Gulch Watershed Concept Design
Elevation: 6970'
Site Description: Mine Waste Piles and Gulley Regrading in upper watershed

Upland/Mine Waste Piles and Gullies	**Seeding Rate (Broadcast, PLS/s.f.):**	120
Species (Common Name)	**Life**	**% Mix**
Achillea lanulosa (Western yarrow)	NPF	4
Achnatherum hymenoides (indian ricegrass, RIMROCK)	NPG	8
Apocynum x floribundum (Dogbane) (Hand collected)	NPF	2
Artemisia frigida (fringed sage)	NPF	7
Bouteloua curtipendula (sideoats grama)	NPG	7
Bromus marginatus (mountain brome, UP ecotype)	NPG	12
Elymus elymoides (bottlebrush squirreltail)	NPG	7
Elymus trachycaulus (Slender Wheatgrass, San Luis)	NPG	15
Festuca rubra (Red Fescue)	NPG	7
Koeleria macrantha (prairie junegrass)	NPG	5
Monarda fistulosa var. menthifolia (wild bergamot)	NPF	5
Pensetmon virens (Frontrange Beardtongue)	NPF	10
Poa secunda (sandberg bluegrass)	NPG	10
Regreen	n/a	1
Subtotal:		**100**

Figure 2. Draft/conceptual seed mix for overburden pile. Total seed area is approximately 5,000 square feet for high-medium priority waste piles.

Soil amendments

Based on the February 17, 2017 memorandum from Norwest to the coalition, "Ingram Gulch Soil Sampling Field Leach Test Results", the soil leachate sample results indicate potential for high pH (ranges of 4.0 to 6.5 in leachate samples), excessive arsenic, and high levels of trace minerals and other contaminations that may inhibit growth of some native vegetation on the waste piles. Soil amendment treatments will range from adding 20% organic matter (by volume, high recalcitrant portion) for piles with a low soil pH and high trace mineral concentrations, lime

additions, or covering waste piles with 2 feet of amended topsoil where pH values are below 5.0. However, additional soil sampling is necessary to determine optimal waste pile treatments and prioritization. Additional concerns, based on the soil leachate sample results, include plant toxicity resulting from high heavy metal content, electrical conductivity, and other soil chemical conditions. For soils with a pH lower than 4.5, lime treatments may be necessary to raise soil pH to a level suitable for sustained growth of native vegetation. Additional analysis of soil testing results should be conducted during subsequent design phases in order to develop waste-pile specific soil amendment treatments to ameliorate a variety of soil chemical conditions.

Gulley Restoration Design

Purpose and Background

The purpose of the gulley assessment and conceptual design phase of the project was to evaluate the state of evolution (i.e., degradation or healing) of existing gullies in the Ingram Gulch watershed, and recommend gulley treatments and treatment locations to reduce sediment delivery to the primary downstream tributary and hence Fourmile Creek.

A gulley (also "gully") is a narrow, steep-sided channel formed in hillslopes and swales by overland flows as well as sub-surface flows. Gullies form in swales, gulches, or hillslopes due to loss of vegetation, grazing pressure, base (i.e., valley bottom) elevation lowering, enhanced runoff, or other climatic or geologic shifts. The gullies in the Ingram Gulch watershed formed as a result of the 2010 post-fire run-off events, and were further exacerbated by precipitation events in 2013, and to a lesser extent by less intense events in 2014 and 2015. The primary concern of gullies within the upper watershed of Ingram Gulch is the impacts to downstream water quality, especially considering the mining history in the watershed. Because gulleys occur within most disturbed watersheds at varying levels of active degradation, or varying degrees of recovery from past disturbance, a systematic approach was implemented to better understand the spatial distribution of gulleys of varying degrees of degradation across the watershed.

Gulley Assessment

A field survey was conducted in October 2016 to evaluate the existing gullies at Ingram Gulch using AloTerra's gulley stability assessment protocol. Primary variables assessed included bank condition, bed condition, and knickpoints, with additional elements scored within each variable (**Appendix A**). Gullies in an advanced channel evolution stage, as evidenced by a combination of stable vegetated banks, stable beds, and lack of knickpoints, did not receive a full analysis, but rather were categorized as low or moderate priority (i.e., further analysis is required to determine if existing conditions warrant treatment based on watershed health goals). Such "stable" gullies are expected to remain stable absent a significant wildfire or flood event such as a 25-year storm. Following a rapid survey, a detailed gulley stability analysis was performed on Gullies 1 and 6 (**Appendix A, Figure 3**), indicating these two gullies are in an intermediate stage of channel evolution (stage II, III, or IV; **Figure 4**), capable of producing continued sediment loading downstream during moderate to high precipitation and flow events. While gullies 1 and 6 should be prioritized for further restoration design and possible treatment, there are several other moderate priority gullies that exist within the watershed whose hastened recovery and stability may benefit from minor erosion control treatments. Most of the moderate priority gullies are confined by bedrock and/or have high vegetative cover and stable banks, and as such are at a low risk of further incision during a 25-year flood event. A 30% level of assessment and design, as well as further refinement of watershed restoration goals and resources, will influence how these gullies are ultimately prioritized and/or treated. **Figure 3** represents the distribution and length of priority gulley treatments.

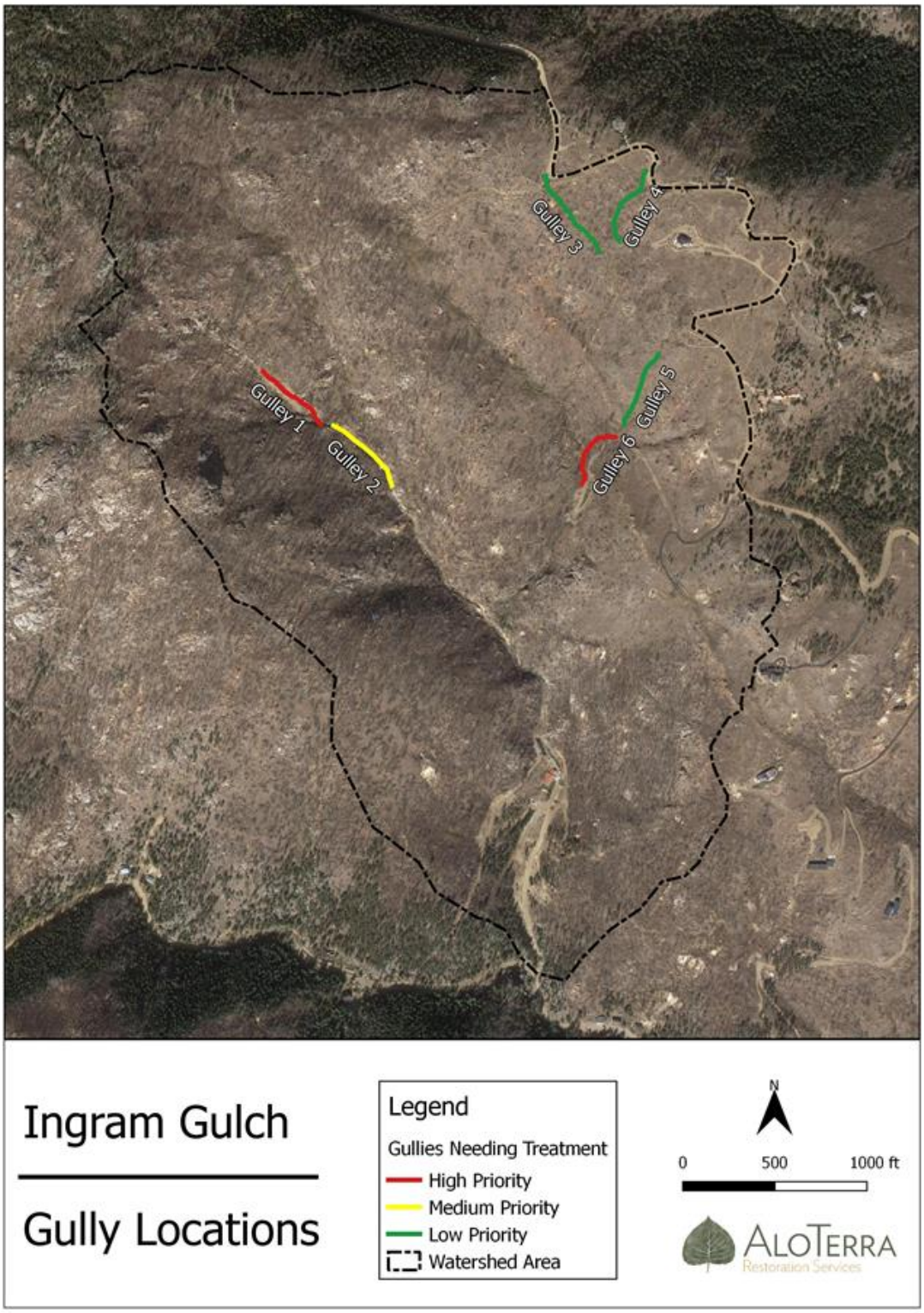


Figure 3. Priority gullies for treatment within the Ingram Gulch watershed boundaries.

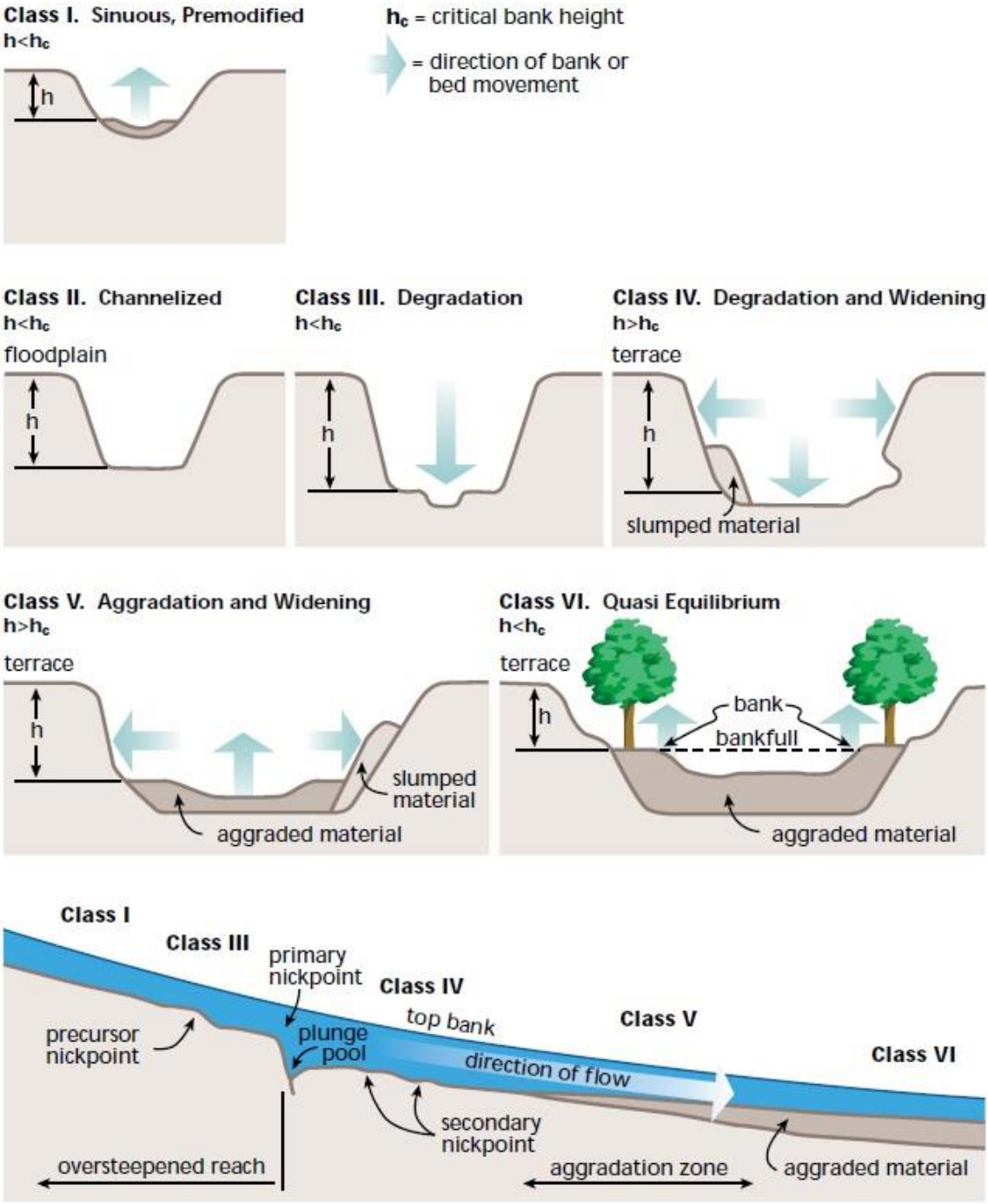


Figure 4. Channel Evolution Model following a disturbance (FISRWG 1998), modified from Schumm et al. (1984).

Gulley Stability Assessment Protocol

The gulley stability assessment protocol (the protocol) was applied at Ingram Gulch to quantify the state of unstable gullies and aid in the design of restoration treatments. The protocol included a rapid assessment of all gullies to determine the location and extent of significant active gullies. The rapid assessment was followed by an objective assessment of gullies of concern, as indicated by the rapid assessment. The objective assessment (e.g., Gulley Stability Assessment Protocol – AloTerra protocol) evaluates the biological and physical conditions of an active gulley that contribute to degrees of instability: incision, head-cutting, aggradation, widening, bed and bank substrate (i.e., consolidated or unconsolidated), and vegetation. The condition of these elements provides an understanding of the current state of evolution of the gulley, they gullies potential for continued erosion under smaller discharge events (i.e., Q25 or less), and the physical dimensions (i.e., length, height, and width) of the gulley that would influence the magnitude of restoration treatments. The protocol also provides a rapid assessment of weeds of concern surrounding the gulley. Each gulley receives a score, a larger score indicating a greater erosive potential.

Gulley Stability Results

Three gullies were identified within the Ingram Gulch watershed that have a high potential for producing significant levels of sediment into the primary tributary; Gulley 1, 2 and 6 (**Figure 3**). A Gulley Stability Assessment was not completed for Gulley 3-5 because the condition of these gulley's were observed as stable during our rapid assessment. Gulley 1 scored very poorly, with a rating of 6.01, while gulley 6 received a score of 1.86. Due to the deeper channel, steeper gradient, and the larger contributing drainage area, the treatment of gulley 1 should be prioritized over gulley 6. While gulley 6 does have the potential to contribute as much sediment as gulley 1, fewer treatments would be required to stabilize gulley 6 as compared to gulley 1 to achieve a stable state.

Gulley Treatments Recommendations

Figures 5-8 provide typical treatments for gulleys of the Ingram Gulch upper watershed. A refinement of treat typical details, locations, and priorities should be provided during a subsequent design phase.

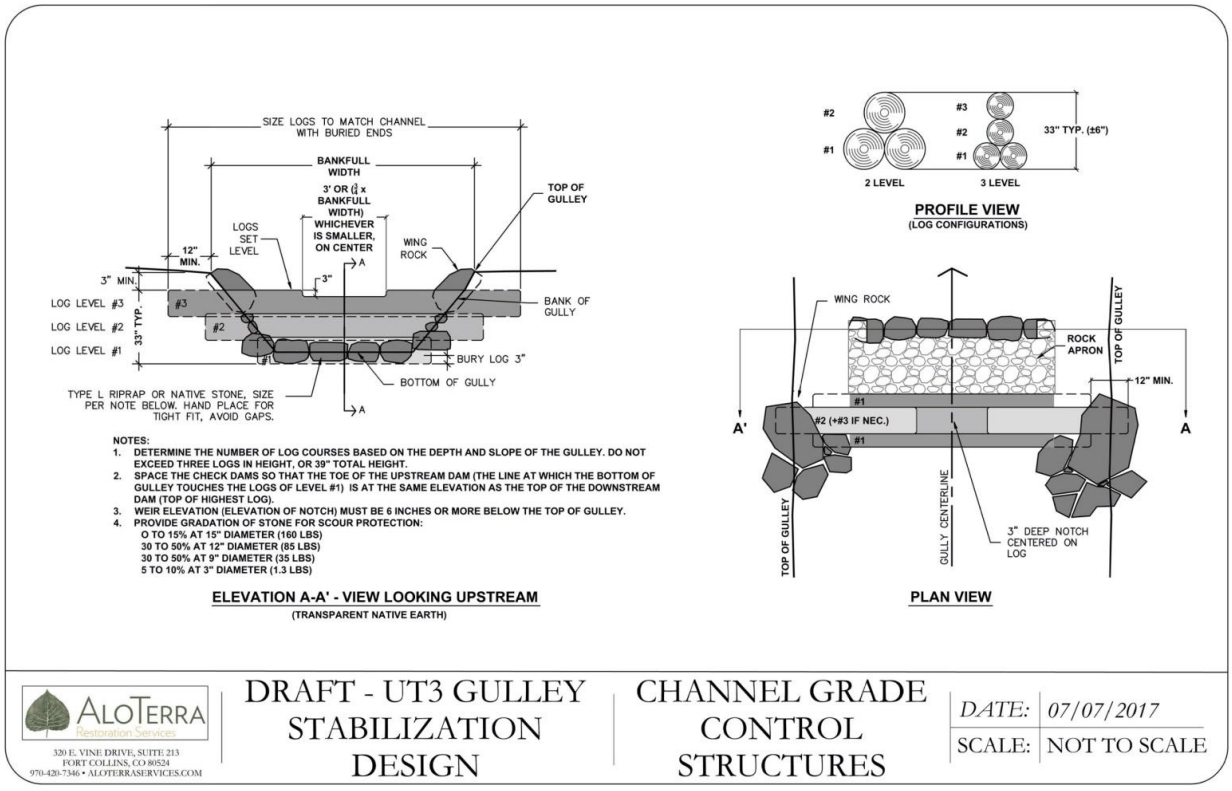


Figure 5. Typical Log-rock weir. Number of logs will range from two-five 10" diameter logs per structure.

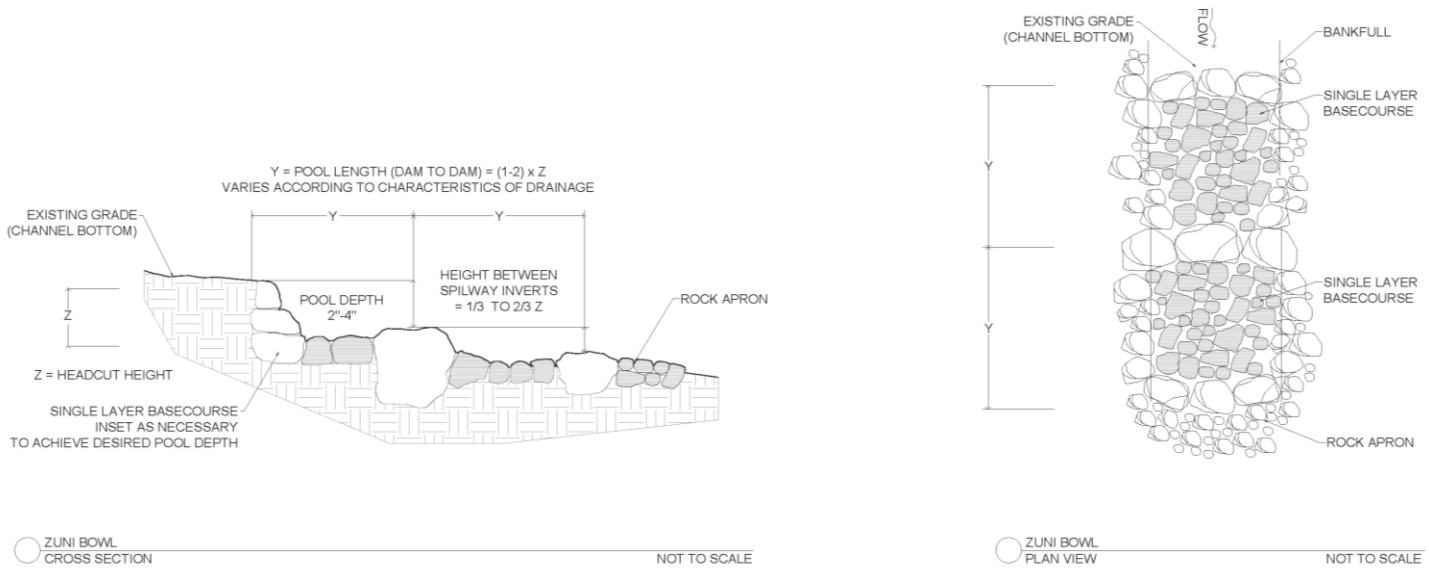


Figure 6. Typical Zuni-bowl (i.e., plunge pool). Number and depth/dimension of pools will depend on depth of headcut and size of channel.

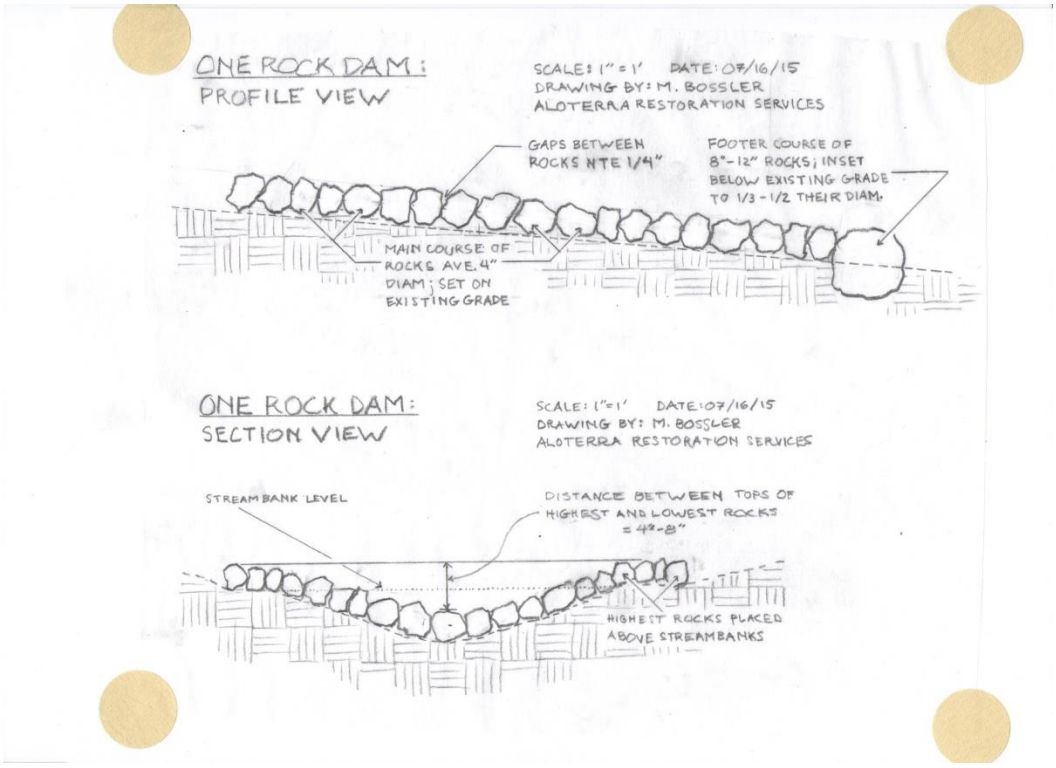


Figure 7. Typical one-rock dam (i.e., rock blanket). Dimensions will vary depending on gulley width and gradient.

Figure 8. Photos of log-rock weirs (top left and top right), one-rock dams (bottom right), and media luna (bottom left) gulley treatments that are appropriate for prioritized gullies within the study area.

Glitter Gulch Shooting Area Conceptual Design

Based on an informal assessment of the shooting area of Glitter Gulch, considering the proximity of a large denuded area adjacent to an intermittent stream, and significant geomorphic risk during high flow events, the conceptual design in Figure 9 is provided. Additional analysis is necessary during a subsequent design phase to better understand the site constraints and opportunities fully enough to inform treatments appropriate for the watershed health goals and existing conditions.

Figure 9. Conceptual design overview for shooting range area of Glitter Gulch.

APPENDIX A: Gulley Assessment Data

Gulley 1:

Gulley Stability Datasheet

Drainage: Ingram Gulch

Monitoring Date: 10/24/2016
Subwatershed: 1
Average Gradient: 28deg
Sample Point: G-1
Evolution Stage (1-6): NA
Observer (s): John G/Sam B
Photo Taken: Yes

Site Description: Southeast facing xeric slope, high severity burn

Evidence of Past Treatments (circle): NA

Average Height (bed to top of bank, feet): 3-4'
Width:Depth: 0.4375
Average Width (at Top of Bank, feet): 10'
Length of Gulley Sampled (feet): 350'

BANK CONDITION	% of total length	Multi-plier	Risk Rating
Verticle to overhanging		0.5	0
Steep (60-90 deg)	20	0.4	0.08
Moderate (30-60 deg) & unstable, little veg cover	40	0.3	0.12
< 30 deg, little veg cover	25	0.2	0.05
Stable & Vegetated	15	0.1	0.015
Total:	100		
		Rating for Feature:	0.265

KNICKPOINTS (including head-cuts)	Value	Multi-plier	Risk Rating
Number of Knickpoints	50	0.5	5
Avg. Angle (severity)	2	0.4	0.2
Competency	3.5	0.3	0.2625
Avg. Height	3	0.2	0.6
Upslope Condition	3	0.1	0.3
	Rating for Feature:		6.3625

Bed Condition/ Control Rating	% of total gulley	Multi-plier	Control Rating
Bare ground/soil	15	0.1	0.015
Litter/wood cover (>50%)	2	0.3	0.006
Veg. Canopy Cover (>20%)	5	0.5	0.025
Cobble/Boulder	70	0.7	0.49
Bedrock	8	1	0.08
	Rating for Feature:		0.616

Gulley Risk Rating (sum of risk ratings - bed condition/control rating): 6.0115

Weeds	Within 200' of each side of Gulley
Canada thistle	moderate
Mullein	low
Musk Thistle	
Dalmation toadflax	
Bull Thistle	
Cheat Grass	moderate

Soil type (place "x" for dominant soil through which the gulley is cutting)	
Sand	
Sand/Silt Loam	
Clay Loam	
Loam with <30% boulder/cobble	
Boulder/cobble with < 30% loam	X
Other (describe):	

Notes for Gulley: representative of two other gulleys to the southwest, confluence about 300 feet downstream

Recommended Treatments: Frequent log/rock weirs, appropriately spaced

Gulley 5:

Gulley Stability Datasheet

Drainage: Ingram Gulch

Monitoring Date: 10/24/2016
Subwatershed: 4
Average Gradient (%): 30%
Sample Point: G-6
Evolution Stage (1-6): NA
Observer (s): John G/Sam B
Photo Taken: Yes

Site Description: Xeric hillside, below 2 larger gullies

Evidence of Past Treatments (circle): Directional felling, logs, some riprap

Average Height (bed to top of bank, feet): 3-4'
Width:Depth: 0.4375
Average Width (at Top of Bank, feet): 8'
Length of Gulley Sampled (feet): 300'

BANK CONDITION	% of total length	Multi-plier	Risk Rating
Verticle to overhanging		0.5	0
Steep (60-90 deg)	60	0.4	0.24
Moderate (45-60 deg)	40	0.3	0.12
Low (30-45 deg)		0.2	0
Very Low (0-30 deg)		0.1	0
Total:	100		
	Rating for Feature:		0.36

KNICKPOINTS (including head-cuts)	Value	Multi-plier	Risk Rating
Number of Knickpoints	5	0.5	0.5
Avg. Angle (severity)	2	0.4	0.2
Competency	4	0.3	0.3
Avg. Height	4	0.2	0.8
Upslope Condition	3	0.1	0.3
	Rating for Feature:		2.1

Bed Condition/ Control Rating	% of total gulley	Multi-plier	Control Rating
Sand		0.1	0
Sand/silt loam	30	0.3	0.09
Clay loam		0.5	0
Cobble/Boulder	30	0.7	0.21
Bedrock	30	1	0.3
	Rating for Feature:		0.6

Gulley Risk Rating (sum of risk ratings - bed condition/control rating): 1.86

Weeds	Within 200' of each side of Gulley
Canada thistle	moderate
Mullein	low
Musk Thistle	
Dalmation toadflax	
Bull Thistle	
Cheat Grass	moderate

Soil type (place "x" for dominant soil through which the gulley is cutting)	
Sand	
Sand/Silt Loam	
Clay Loam	
Loam with <30% boulder/cobble	X
Boulder/cobble with < 30% loam	
Other (describe):	

Notes for Gulley: waterbars on road, next to gulley, bed appears stable, some large headcuts

Recommended Treatments: massive head cuts at upslope and very bottom end need treatment

N

SS03
pH = 4.63
SC = 14

SS41
pH = 4.06
SC = 32

SS31
pH = 4.15
SC = 56

SS30
pH = 6.58
SC = 6

SS30-SW
pH = 7.8
SC = 806

SS35
pH = 3.93
SC = 67

Ingram Gulch Top
pH = 7.33
SC = 321

SS32
pH = 6.4
SC = 8

SS32-33
pH = 3.23
SC = 779

Ingram Gulch Middle
pH = 8.22
SC = 342

SS25-SW
pH = 6.67
SC = 923

SS25
pH = 5.99
SC = 479

SS33
pH = 3.85
SC = 1061

Ingram Gulch Bottom
pH = 8.33
SC = 689

Glitter Gulch Mouth
pH = 8.31
SC = 646

Sed Pond
pH = 6.88
SC = 22

Ingram Gulch Below Glitter
Gulch pH = 8.37
SC = 680

SS28
pH = 8.72
SC = 116

SS10
pH = 3.85
SC = 135

SS28-SW
pH = 8.05
SC = 1480

SS05
pH = 8.92
SC = 32

SS12
pH = 6.06
SC = 12

Ingram Gulch Mouth
pH = 7.97
SC = 1088

Legend

Water Sample Type

- Stream Parameters
- Surface Water Laboratory Sample

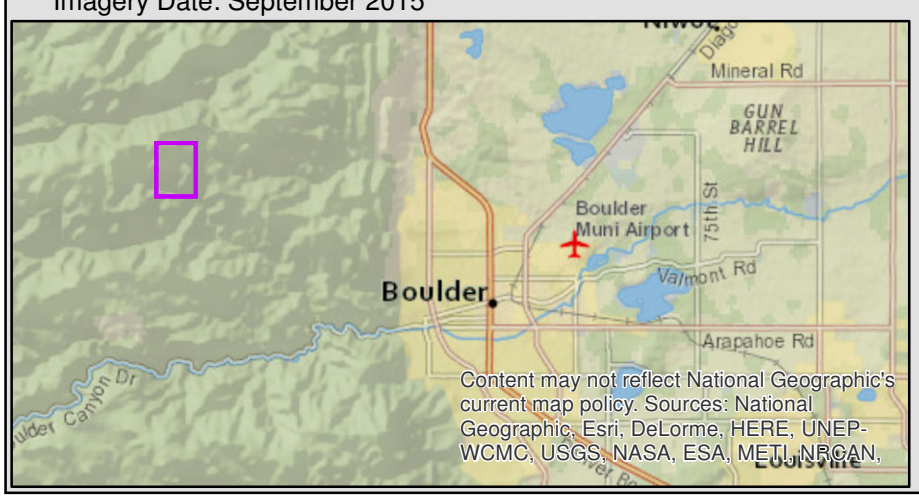
Soil Sample Type

- Field Leachate Test
- Field Leachate Test With Laboratory Sample
- Land Parcels

0 500 1,000 2,000
Feet
1:5,000

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Imagery Date: September 2015



FOURMILE WATERSHED COALITION

Ingram Gulch Restoration
Water and Soil Sampling Map

Drawing 3

Date: Nov 17, 2016	Coordinate System: NAD 1983 UTM Zone 13N	Project # 970-1	Revision A
Drawn By: DM / Chkd By: PK			

NORWEST

Document Path: H:\Norwest Documents DM\Random\Ingram Gulch\(1) Map Documents\Water_and_Soil_Sampling.mxd

MEMORANDUM

Table 3. Ingram Gulch Surface Water Handheld Meter and Laboratory Results Comparison

Parameter	Reporting Limit	Units	CSU Interpretation Tool Drinking Water Standards	Boulder Creek Segment 2b Standards		SS30-SW 11/09/2016	SS25-SW 11/09/2016	SS28-SW 11/09/2016	Ingram Gulch Mouth 11/09/2016	Ingram Gulch Mouth 12/23/2016	Ingram AS-1 12/23/2016	Ingram AS-2 12/23/2016
				Acute	Chronic							
DO (Handheld meter)	N/A	mg/L	N/A	N/A	6	8.09	4.78	7.48	8.47	N/A	N/A	N/A
DO (Handheld meter) (Spawning)	N/A	mg/L	N/A	N/A	7	8.09	4.78	7.48	8.47	N/A	N/A	N/A
DO (Handheld meter)	N/A	% Saturation	N/A	N/A	N/A	69.1	40.3	70.2	75.4	N/A	N/A	N/A
ORP (Handheld meter)	N/A	mV	N/A	N/A	N/A	253.1	274.9	207.4	215.4	N/A	N/A	N/A
pH (Handheld meter)	N/A	SU	6.5-8.5	6.5-9.0	N/A	7.8	6.67	8.05	7.97	N/A	N/A	N/A
Specific Conductance (Handheld meter)	N/A	µmhos/cm	N/A	N/A	N/A	806	923	1480	1088	N/A	N/A	N/A
Temperature (Handheld meter)	N/A	˚C	N/A	April-Oct. DM=23.9 Nov.-March DM=13.0	April-Oct. MWAT=18.3 Nov.-March MWAT=9.0	7.8	7.99	12.2	10.03	N/A	N/A	N/A
Alkalinity (Bicarbonate as CaCO3)	5	mg/L	300	N/A	N/A	140	120	220	130	N/A	N/A	N/A
Alkalinity (Carbonate as CaCO3)	5	mg/L	N/A	N/A	N/A	ND	ND	ND	ND	N/A	N/A	N/A
Alkalinity (Hydroxide)	5	mg/L	N/A	N/A	N/A	ND	ND	ND	ND	N/A	N/A	N/A
Alkalinity (Total)	5	mg/L	300	N/A	N/A	140	120	220	130	N/A	N/A	N/A
Aluminum (Diss.)	100	ug/L	200	N/A	N/A	ND	ND	ND	ND	N/A	N/A	N/A
Antimony (Diss.)	20	ug/L	6	N/A	N/A	ND	ND	ND	ND	N/A	N/A	N/A
Arsenic (Diss.)	5	ug/L	10	340	0.02 (T-Rec.)	ND	ND	ND	5.5	N/A	N/A	N/A
Arsenic (T-Rec)	0.2	ug/L	10	340	0.02 (T-Rec.)	N/A	N/A	N/A	9.9	39	69	39
Barium (Diss.)	10	ug/L	2000	N/A	N/A	58	41	14	32	N/A	N/A	N/A
Beryllium (Diss.)	1	ug/L	4	N/A	N/A	ND	ND	ND	ND	N/A	N/A	N/A
Boron	0.1	mg/L	2.4	N/A	0.75	ND	ND	ND	ND	N/A	N/A	N/A
Cadmium (Diss.) (Trout)	5	ug/L	5	4.8-11.1*	1.0-2.2*	ND	ND	ND	ND	N/A	N/A	N/A
Cadmium (Diss.)	5	ug/L	5	5.0 (T-Rec.)	N/A	ND	ND	ND	ND	N/A	N/A	N/A
Calcium (Diss.)	0.2	mg/L	N/A	N/A	N/A	93	120	200	160	N/A	N/A	N/A
Chloride	3	mg/L	250	N/A	250	110	25	7.9	28	N/A	N/A	N/A
Chromium, Hexavalent (Diss.)	20	ug/L	100	16	14	ND	ND	ND	ND	N/A	N/A	N/A
Chromium, Trivalent (Diss.)	10	ug/L	200	50 (T-Rec.)	197-435*	ND	ND	ND	ND	N/A	N/A	N/A
Cobalt (Diss.)	10	ug/L	N/A	N/A	N/A	ND	ND	ND	ND	N/A	N/A	N/A
Copper (Diss.)	15	ug/L	1300	41-103*	25-57*	ND	ND	ND	ND	N/A	N/A	N/A
Cyanide, Free	0.01	mg/L	0.2	0.005	N/A	ND	ND	ND	ND	N/A	N/A	N/A
Iron (Diss.) (Water Supply)	100	ug/L	300	N/A	300	ND	ND	ND	ND	N/A	N/A	N/A
Iron (Diss.)	100	ug/L	300	N/A	1000 (T-Rec.)	ND	ND	ND	ND	N/A	N/A	N/A
Lead (Diss.)	9	ug/L	15	231-609*	9.0-23.7*	ND	ND	ND	ND	N/A	N/A	N/A
Lead (Diss.)	9	ug/L	15	50 (T-Rec.)	N/A	ND	ND	ND	ND	N/A	N/A	N/A
Lithium (Diss.)	20	ug/L	N/A	N/A	N/A	ND	ND	ND	ND	N/A	N/A	N/A
Magnesium (Diss.)	0.2	mg/L	N/A	N/A	N/A	24	42	90	54	N/A	N/A	N/A
Manganese (Diss.) (Water Supply)	10	ug/L	50	N/A	50	ND	ND	260	ND	N/A	N/A	N/A
Manganese (Diss.)	10	ug/L	50	4448-6135*	2457-3390*	ND	ND	260	ND	N/A	N/A	N/A
Mercury (Total)	0.2	ug/L	2	N/A	0.01 (Total)	ND	ND	ND	ND	N/A	N/A	N/A
Molybdenum (Diss.)	20	ug/L	70	N/A	150 (T-Rec.)	ND	ND	ND	ND	N/A	N/A	N/A
Nickel (Diss.)	40	ug/L	20	1288-2916*	143-324*	ND	ND	ND	ND	N/A	N/A	N/A
Nickel (Diss.)	40	ug/L	20	N/A	100 (T-Rec.)	ND	ND	ND	ND	N/A	N/A	N/A
Nitrate as N	0.5	mg/L	10	10	N/A	ND	ND	ND	0.59	N/A	N/A	N/A
Nitrite as N	0.5	mg/L	1	N/A	0.05	ND	ND	ND	ND	N/A	N/A	N/A
pH (lab)	0.1	SU	6.5-8.5	6.5-9.0	N/A	8.1	7.5	8.0	8.0	N/A	N/A	N/A
Phosphorus (Total)	0.05	mg/L	N/A	N/A	0.11	ND	ND	ND	ND	N/A	N/A	N/A
Potassium (Diss.)	3000	ug/L	N/A	N/A	N/A	5800	5500	7700	7100	N/A	N/A	N/A
Selenium (Diss.)	15	ug/L	50	18.4	4.6	ND	ND	ND	ND	N/A	N/A	N/A
Silica (Diss.)	1100	ug/L	N/A	N/A	N/A	17000	17000	16000	20000	N/A	N/A	N/A
Silver (Diss.)	10	ug/L	100	16-84*	0.6-3.1*	ND	ND	ND	ND	N/A	N/A	N/A
Sodium (Diss.)	5	mg/L	N/A	N/A	N/A	12	13	16	15	N/A	N/A	N/A
Specific Conductance (Lab)	2	µmhos/cm	N/A	N/A	N/A	600	730	1000	820	N/A	N/A	N/A
Strontium (Diss.)	10	ug/L	N/A	N/A	N/A	910	1900	2500	1100	N/A	N/A	N/A
Sulfate	25	mg/L	250	N/A	250	80	350	690	450	N/A	N/A	N/A
Thallium (Diss.)	1	ug/L	2	N/A	N/A	ND	ND	ND	ND	N/A	N/A	N/A
Tin (Diss.)	100	ug/L	N/A	N/A	N/A	ND	ND	ND	ND	N/A	N/A	N/A
Titanium (Diss.)	10	ug/L	N/A	N/A	N/A	ND	ND	ND	ND	N/A	N/A	N/A
Total Dissolved Solids (TDS)	10	mg/L	500	N/A	N/A	450	660	1200	820	N/A	N/A	N/A
Total Suspended Solids (TSS)	4	mg/L	N/A	N/A	N/A	ND	4.8	ND	7.6	N/A	N/A	N/A
Vanadium (Diss.)	10	ug/L	N/A	N/A	N/A	ND	ND	ND	ND	N/A	N/A	N/A
Zinc (Diss.)	20	ug/L	5000	475-1143*	360-866*	160	27	ND	120	N/A	N/A	N/A

DM=Daily Maximum

MWAT=Maximum Weekly Average Temperature

*TVS=Table Value Standards. Table Value Standards vary depending on the sample hardness with the range of calculated standards listed.

Boulder Creek Segment 2b Standard Exceedance

CSU Interpretation Tool Drinking Water Standard Exceedance

Exceedance of both Boulder Creek Segment 2b Standard and CSU Interpretation Tool Drinking Water Standard

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MEMORANDUM

To:	Maya MacHamer	**Ref #**	970-1
CC:		**Date:**	February 17, 2017
From:	Paul Kos, Angela Welch		
Subject:	Ingram Gulch Soil Sampling Field Leach Test Results		

Introduction

The Ingram Gulch Restoration project area is located in the Rocky Mountain foothills west of the city of Boulder just above the small town of Salina, CO. The project area is entirely within the Ingram Gulch drainage basin. Ingram Gulch flows to Gold Run, which is in the Fourmile Creek watershed. Fourmile Creek flows to Boulder Creek. In September of 2010, the Fourmile Canyon fire burned over 6,000 acres including the Ingram Gulch watershed. Three years later, the September 2013 flood events also greatly impacted this watershed and downstream areas with flooding and debris flows. In addition to the severe ecological and environmental damage caused by recent disasters, Ingram Gulch has a legacy of hard rock mining. The gulch has multiple large open mine shafts and adits, actively draining mines, and piles of waste rock throughout the gulch. Multiple old and new roads cut through the landscape. The water quality and chemistry of the waste rock piles were unknown at the start of the project, and this memorandum summarizes the waste rock pile sampling and results.

Sampling Overview

Soil samples were collected on November 9th, 2016 from mine waste piles located in Ingram Gulch and Glitter Gulch, a tributary to Ingram Gulch, to determine the water reactivity and leaching potential of the mine waste piles. Norwest collected samples from 14 mine waste piles located within the Ingram Gulch watershed, with most the locations having volumes greater than 500 cubic yards, as estimated by Colorado Department of Reclamation, Mining, and Safety (CDRMS) staff. See **Drawing 1** for the sample locations. Additional smaller waste rock piles were sampled based on site knowledge and aerial photograph interpretation so that samples were collected from all areas within the watershed and from all waste rock piles associated with the stream restoration task of the project. Additional small mine waste rock piles which were not sampled exist throughout the watershed. **Table 1** summarizes the 14 mine waste pile locations visited. **Appendix A** includes photograph documentation of select mine waste piles.

The USGS Field Leach Test (FLT) manual was used to conduct the sampling and outlines the procedures used to conduct the leach tests (Hageman, 2007). Per the FLT protocols, a composite sample was collected at each location using the following steps:

1. At each location prior to soil sample collection, all equipment was decontaminated using distilled water and a clean disposable towel.
2. Gloves were worn prior to handling the mine waste material.

MEMORANDUM

3. A composite sample was collected in a bucket by randomly walking back and forth across the entire mine waste pile and collecting four to 14 individual samples, depending on the size of the mine waste pile.
4. The soil from each composite sample was mixed using a trowel and then sifted through a <2mm (#10 mesh) soil sieve.
5. The fine fraction of the sieved soil was placed in a labeled sample bag for transport to the office.

Table 1. Mine Waste Pile Locations

Location/Sample Name	Claim Name	Lat (NAD 83)	Long (NAD 83)
Sed Pond	N/A	40.05768	-105.37893
SS03	Chinook	40.06633	-105.38364
SS05	Marblehead	40.05650	-105.38035
SS10	Fairfax	40.05792	-105.38162
SS12	Relief	40.05684	-105.37893
SS25	Norma	40.05973	-105.37816
SS28	Marblehead	40.05722	-105.37944
SS30	Stump	40.06212	-105.37830
SS31	Mineral Point	40.06127	-105.38020
SS32	Chivington	40.06087	-105.38116
SS32-33	N/A	40.06051	-105.38086
SS33	Mineral Point	40.06026	-105.38037
SS35	Mountain View	40.06263	-105.37623
SS41	BLM	40.06642	-105.37910

A leach test following FLT protocols was conducted in the Norwest office on each of the 14 samples. The following procedures were used to conduct the leach test, with photograph documentation of the procedures found in **Appendix A**:

1. Nitrile gloves were worn prior to handling the mine waste material.
2. 50 grams of each sample were weighed using a laboratory scale and carefully added to a 1-liter sample bottle.
3. One liter of distilled water was measured in a 1,000-mL clean graduated cylinder and slowly added to each sample bottle.
4. Each bottle was tightly capped and vigorously hand shaken for five minutes.
5. After shaking, each bottle was allowed to settle upright for ten minutes.
6. After settling, parameter readings were taken.

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FLT Parameter Results

A calibrated handheld YSI 556 multi-parameter meter was used to measure the pH, temperature, specific conductance, dissolved oxygen (DO), and Oxidation-Reduction Potential (ORP) of each leachate sample. **Table 2** summarizes the handheld meter results of each of the 14 mine waste pile FLT samples. **Drawing 1** illustrates the 14 soil sampling locations and highlights the pH and conductivity results at each location.

Table 2. Ingram Gulch Handheld Meter Results

Location Name	Analysis	pH (S.U.)	Temp (°C)	SC (µmhos/cm)	ORP (mV)	DO (mg/l)	DO (%)
Sed Pond	FLT	6.88	25.76	22	206.1	4.95	60.7
SS03	FLT	4.63	28.22	14	182.0	5.41	69.7
SS05	FLT W/ Laboratory Sample	8.92	26.02	32	248.4	5.28	65.0
SS10	FLT W/ Laboratory Sample	3.85	28.28	135	263.3	5.14	66.3
SS12	FLT	6.06	27.33	12	217.5	5.48	69.2
SS25	FLT W/ Laboratory Sample	5.99	25.85	479	289.9	5.22	64.1
SS28	FLT	8.72	27.12	116	220.3	5.38	67.4
SS30	FLT	6.58	27.02	6	222.3	5.23	65.3
SS31	FLT	4.15	27.10	56	261.5	5.24	66.4
SS32	FLT	6.40	27.19	8	232.2	5.11	64.4
SS32-33	FLT	3.23	26.97	779	548.9	5.11	63.8
SS33	FLT W/ Laboratory Sample	3.85	27.00	1061	485.2	5.01	62.7
SS35	FLT	3.93	26.92	67	447.9	5.52	68.4
SS41	FLT W/ Laboratory Sample	4.06	26.34	32	429.0	5.64	70.0

The handheld meter results for the five samples selected for laboratory analysis were compared to the Colorado Department of Public Health and Environment, Colorado Water Quality Control Commission (CDPHE-WQCC) Boulder Creek Basin Stream Segment 2b Agriculture, Aquatic Life Cold 1, Recreation E, and Water Supply Standards (CDPHE, 2016), **Table 3**. These are the CDPHE water quality limits for the project area. Results were also compared to the Northern Plains and Mountain Regions Water Quality Program Interpretive Tool (NPMRWP), a water quality comparison tool developed by water experts at Colorado State University with input from colleagues at land-grant universities in the western U.S. (NPMRWP, 2016). Exceedances of the CDPHE-WQCC reference and the NPMRWP reference are highlighted in **Table 3**. The handheld meter results for dissolved oxygen (DO) and temperature in **Table 3** illustrate Boulder Creek Segment 2b Standard exceedances, however, these measurements are arbitrary due to the DO results impacted by the shaking of the sample during the FLT and the temperature results reflecting the indoor temperature of the distilled water used in the FLT. Exceedances of these parameters were not highlighted in **Table 3**.

Specific conductance and pH varied throughout the Ingram Gulch and Glitter Gulch drainages (**Table 2** and **Drawing 1**). Specific conductance values ranged from 6 µmhos/cm at the SS30 location to 1061 µmhos/cm at the SS33 location. There are no specific conductance limits, but higher results indicate higher dissolved

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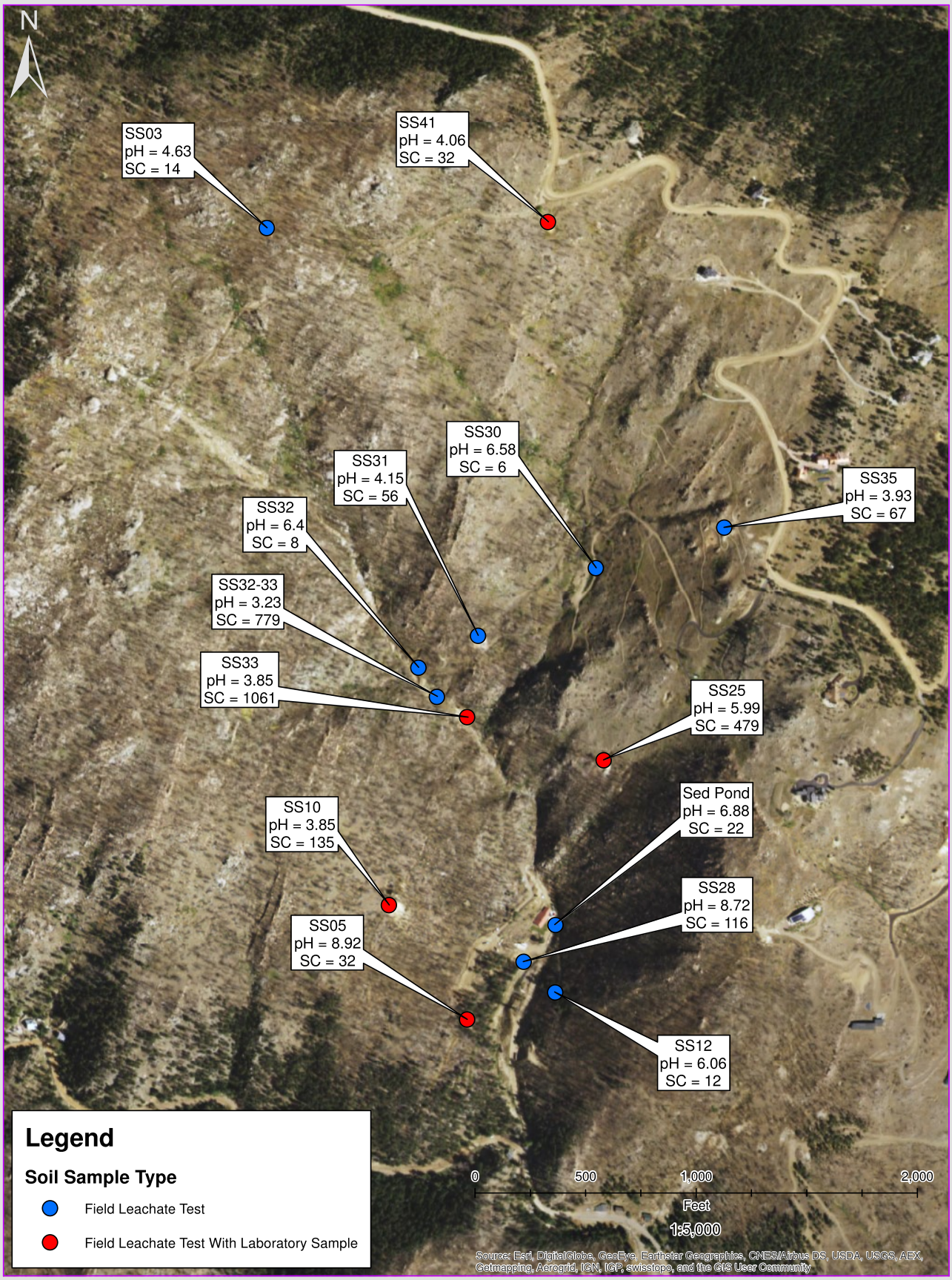
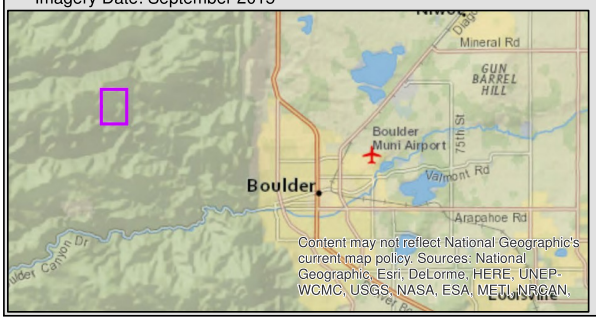
salt/ion concentrations. pH values ranged from 3.23 at the SS32-33 location to 8.92 at the SS05 location, with a pH of 7 being neutral and values above 7 considered basic and values below 7 considered acidic. Most of the FLT results indicate acidic pH values, which is common for mine waste. The SS05 and SS28 samples' handheld meter pH measurements of 8.92 and 8.72, respectively, did not exceed the CDPHE-WQCC pH standard of 6.5-9.0, however these values did exceed the NPMRWP pH standard of 6.5-8.5 (**Table 3**). The Sed Pond and SS30 samples' handheld meter pH measurements of 6.88 and 6.58, respectively, did not exceed the CDPHE-WQCC or NPMRWP pH standards. Results from the other samples indicate increasing acidity with pH values less than 6.5.



Imagery Date: September 2015



FOURMILE WATERSHED COALITION

Ingram Gulch Restoration
Soil Sampling Map

Drawing 1

Date: Nov 16, 2016	Coordinate System: NAD 1983 UTM Zone 13N	Project # 970-1	Revision A
Drawn By: DM / Chkd By: PK			

NORWEST

Document Path: H:\Norwest Documents DM\Random\Ingram Gulch\(1) Map Documents\Soil_Sampling.mxd

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Laboratory Results

Based on the FLT parameter results, five of the 14 locations were selected for laboratory analysis. The five locations selected provided coverage throughout Ingram Gulch and Glitter Gulch and were representative of lower and higher specific conductance and pH values (**Drawing 1**). These samples provide lower- and upper-bound limits of leaching potential, and they provide spatial distribution of results throughout the watershed. The FLT methods described above were repeated at larger volumes to accommodate sample bottle set filling. The samples were hand delivered to TestAmerica Laboratory located in Arvada, Colorado. TestAmerica filtered the samples (where necessary) to obtain dissolved metals values. None of the samples were filtered by Norwest. The laboratory results, included as **Appendix B**, were compared to the CDPHE-WQCC Boulder Creek Basin Stream Segment 2b Agriculture, Aquatic Life Cold 1, Recreation E, and Water Supply Standards (CDPHE, 2016), **Table 3**. This segment of Boulder Creek and its tributaries is known to have elevated arsenic levels, and there are published water quality limits for arsenic. Several of the metal standards have Table Value Standards (TVS) that are dependent on the sample hardness with the range of calculated standards listed in **Table 3**. Results were also compared to the NPMRWP standards (NPMRWP, 2016), **Table 3**. Exceedances of the CDPHE-WQCC reference and the NPMRWP reference are highlighted in **Table 3**.

Laboratory pH results were similar to the handheld meter pH results with CDPHE-WQCC pH standard exceedances from the SS10, SS33, and SS41 samples and a NPMRWP pH standard exceedance from the SS05 sample (**Table 3**). Other CDPHE-WQCC and/or NPMRWP exceedances include aluminum (SS33 and SS10), arsenic (SS33 and SS05), beryllium (SS33), cadmium (SS33), copper (SS33), manganese (SS33, SS25, and SS10), mercury (SS41, SS25, SS10, and SS05), nickel (SS33), phosphorus (all locations), sulfate (SS33), total dissolved solids (SS33), and zinc (SS41 and SS10) (**Table 3**).

Appendix C summarizes comments related to health effects for each parameter analyzed and if a water quality standard exists for that parameter. Primary drinking water standards are enforceable standards that limit the levels of contaminants in drinking water to protect public health (EPA, 2016). There is a primary drinking water standard for arsenic, beryllium, cadmium, copper, and mercury with exceedances linked to various health problems. Secondary drinking water standards are non-enforceable standards that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) but are not considered to present a risk to human health (EPA, 2016). Secondary drinking water standards exist for aluminum, manganese, sulfate, total dissolved solids, and zinc with exceedances causing taste issues. CDPHE-WQCC standards include both primary and secondary drinking water standards in addition to other parameters found by the Colorado Water Quality Control Commission to be necessary to protect waters of the state, with standards applied to specific segments of water bodies and rivers throughout Colorado (CDPHE, 2016). CDPHE-WQCC standards exist for nickel and phosphorus. In addition to a discussion on the water quality limits, potential treatment options for each parameter are discussed in **Appendix C**.

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Table 3. Ingram Gulch FLT Handheld Meter and Laboratory Results Comparison

Parameter	Reporting Limit	Units	CSU Interpretation Tool Drinking Water Standards	Boulder Creek Segment 2b Standards		SS41 11/11/2016	SS33 11/11/2016	SS25 11/11/2016	SS10 11/11/2016	SS05 11/11/2016
				Acute	Chronic					
DO (Handheld meter)	N/A	mg/L	N/A	N/A	6	5.64	5.01	5.22	5.14	5.28
DO (Handheld meter) (Spawning)	N/A	mg/L	N/A	N/A	7	5.64	5.01	5.22	5.14	5.28
DO (Handheld meter)	N/A	% Saturation	N/A	N/A	N/A	70	62.7	64.1	66.3	65
ORP (Handheld meter)	N/A	mV	N/A	N/A	N/A	429	485.2	289.9	263.3	248.4
pH (Handheld meter)	N/A	SU	6.5-8.5	6.5-9.0	N/A	4.06	3.85	5.99	3.85	8.92
Specific Conductance (Handheld meter)	N/A	µmhos/cm	N/A	N/A	N/A	32	1061	479	135	32
Temperature (Handheld meter)	N/A	°C	N/A	April-Oct. DM=23.9 Nov.-March DM=13.0	April-Oct. MWAT=18.3 Nov.-March MWAT=9.0	26.34	27	25.85	28.28	26.02
Alkalinity (Bicarbonate as CaCO3)	5	mg/L	300	N/A	N/A	ND	ND	8	ND	19
Alkalinity (Carbonate as CaCO3)	5	mg/L	N/A	N/A	N/A	ND	ND	ND	ND	ND
Alkalinity (Hydroxide)	5	mg/L	N/A	N/A	N/A	ND	ND	ND	ND	ND
Alkalinity (Total)	5	mg/L	300	N/A	N/A	ND	ND	8	ND	23
Aluminum (Diss.)	100	ug/L	200	N/A	N/A	ND	3900	ND	260	190
Antimony (Diss.)	20	ug/L	6	N/A	N/A	ND	ND	ND	ND	ND
Arsenic (Diss.)	5	ug/L	10	340	0.02 (T-Rec.)	ND	5.7	ND	ND	5.7
Barium (Diss.)	10	ug/L	2000	N/A	N/A	ND	ND	ND	ND	ND
Beryllium (Diss.)	1	ug/L	4	N/A	N/A	ND	6.6	ND	ND	ND
Boron	0.1	mg/L	2.4	N/A	0.75	ND	ND	ND	ND	ND
Cadmium (Diss.) (Trout)	5	ug/L	5	0.1-8.6*	0.03-1.7*	ND	8	ND	ND	ND
Cadmium (Diss.)	5	ug/L	5	5.0 (T-Rec.)	N/A	ND	8	ND	ND	ND
Calcium (Diss.)	0.2	mg/L	N/A	N/A	N/A	1.1	250	72	10	6.3
Chloride	3	mg/L	250	N/A	250	ND	ND	ND	ND	ND
Chromium, Hexavalent (Diss.)	20	ug/L	100	16	14	ND	ND	ND	ND	ND
Chromium, Trivalent (Diss.)	10	ug/L	200	50 (T-Rec.)	4-342*	ND	ND	ND	ND	ND
Cobalt (Diss.)	10	ug/L	N/A	N/A	N/A	ND	34	ND	ND	ND
Copper (Diss.)	15	ug/L	1300	0.5-78*	0.4-44*	ND	57	ND	ND	ND
Cyanide, Free	0.01	mg/L	0.2	0.005	N/A	ND	ND	ND	ND	ND
Iron (Diss.) (Water Supply)	100	ug/L	300	N/A	300	ND	ND	ND	ND	190
Iron (Diss.)	100	ug/L	300	N/A	1000 (T-Rec.)	ND	ND	ND	ND	190
Lead (Diss.)	9	ug/L	15	1.1-457*	0.04-17.8*	ND	ND	ND	ND	ND
Lead (Diss.)	9	ug/L	15	50 (T-Rec.)	N/A	ND	ND	ND	ND	ND
Lithium (Diss.)	20	ug/L	N/A	N/A	N/A	ND	ND	ND	ND	ND
Magnesium (Diss.)	0.2	mg/L	N/A	N/A	N/A	ND	5.6	4.8	0.88	1.5
Manganese (Diss.) (Water Supply)	10	ug/L	50	N/A	50	39	1100	75	380	ND
Manganese (Diss.)	10	ug/L	50	902-5564*	498-3074*	39	1100	75	380	ND
Mercury (Total)	0.2	ug/L	2	N/A	0.01 (Total)	7.6	ND	0.42	1.6	5.9
Molybdenum (Diss.)	20	ug/L	70	N/A	150 (T-Rec.)	ND	ND	ND	ND	ND
Nickel (Diss.)	40	ug/L	20	22-2275*	2.5-253*	ND	130	ND	ND	ND
Nickel (Diss.)	40	ug/L	20	N/A	100 (T-Rec.)	ND	130	ND	ND	ND
Nitrate as N	0.5	mg/L	10	10	N/A	ND	ND	ND	ND	ND
Nitrite as N	0.5	mg/L	1	N/A	0.05	ND	ND	ND	ND	ND
pH (lab)	0.1	SU	6.5-8.5	6.5-9.0	N/A	4.4	3.9	6.8	3.9	9.0
Phosphorus (Total)	0.05	mg/L	N/A	N/A	0.11	3.2	0.97	0.84	0.46	1.4
Potassium (Diss.)	3000	ug/L	N/A	N/A	N/A	ND	ND	ND	ND	ND
Selenium (Diss.)	15	ug/L	50	18.4	4.6	ND	ND	ND	ND	ND
Silica (Diss.)	1100	ug/L	N/A	N/A	N/A	ND	ND	1200	ND	2100
Silver (Diss.)	10	ug/L	100	0.004-50*	0.0002-1.9*	ND	ND	ND	ND	ND
Sodium (Diss.)	5	mg/L	N/A	N/A	N/A	ND	ND	ND	ND	ND
Specific Conductance (Lab)	2	µmhos/cm	N/A	N/A	N/A	32	870	350	130	37
Strontium (Diss.)	10	ug/L	N/A	N/A	N/A	ND	99	82	ND	10
Sulfate	25	mg/L	250	N/A	250	6.4	760	180	40	ND
Thallium (Diss.)	1	ug/L	2	N/A	N/A	ND	ND	ND	ND	ND
Tin (Diss.)	100	ug/L	N/A	N/A	N/A	ND	ND	ND	ND	ND
Titanium (Diss.)	10	ug/L	N/A	N/A	N/A	ND	ND	ND	ND	ND
Total Dissolved Solids (TDS)	10	mg/L	500	N/A	N/A	110	970	460	92	96
Total Suspended Solids (TSS)	4	mg/L	N/A	N/A	N/A	1000	2100	1000	100	2500
Vanadium (Diss.)	10	ug/L	N/A	N/A	N/A	ND	ND	ND	ND	ND
Zinc (Diss.)	20	ug/L	5000	6.1-875*	4.6-663*	24	520	160	100	ND

DM=Daily Maximum

MWAT=Maximum Weekly Average Temperature

*TVS=Table Value Standards. Table Value Standards vary depending on the sample hardness with the range of calculated standards listed.

Boulder Creek Segment 2b Standard Exceedance

CSU Interpretation Tool Drinking Water Standard Exceedance

Exceedance of both Boulder Creek Segment 2b Standard and CSU Interpretation Tool Drinking Water Standard

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Mine Waste Pile Recommendations

Norwest has prepared conceptual mine waste reclamation plans to prevent continued erosion of the mine waste and limit leaching potential from the mine waste piles. In general, mine waste reclamation has two primary goals: 1) keep solid material in place by limiting erosion and 2) limit metals leaching by preventing water from reaching the mine waste. These recommendations are based on regulatory guidelines and industry experience, but site specific conditions may require additional grading or capping to completely reclaim the mine waste piles.

Reclamation of the mine waste piles should follow these concepts. The reclamation slopes should be graded to 3H:1V or shallower to prevent erosion and promote topsoil placement and revegetation. Select areas may need to have steeper gradients, but this should be used only where absolutely necessary and the slopes should never be steeper that 2H:1V. A minimum of 3 feet of soil cover is recommended over the waste rock pile material. Studies suggest that similar plant growth occurs regardless of the cover depth; however, Arsenic uptake commonly occurs with plants, and the cover depth is intended to prevent roots from reaching the mine waste. Three feet of cover material is also the minimum cover depth for most mines and landfills. The cover soil material should contain sufficient organic material and nutrients to promote vegetation, and soil amendments may be required. The cover soil samples can be sent to Colorado State University for soil testing and to evaluate potential treatment options to enhance the soil. In addition, soil samples should be collected for mine waste piles exhibiting a pH of less than 5. These samples may also be sent to Colorado State University to evaluate potential treatment options such as mixing in lime and other agents to neutralize the soil, as leaching potential can typically be reduced by increasing the soil pH. The mine waste piles should be revegetated with a mixture of native grasses. The upland seed mixture for the stream restoration design should be used for this purpose. Trees, shrubs, and other deep-rooted species should be avoided to prevent the roots from extending through the cover layer.

For mine waste piles located away from drainage channels, waste material should be left in place. If no vegetation is growing on the waste pile, the pile should be stabilized, graded, capped with soil, and revegetated. If vegetation is growing on the waste pile, the pile should be seeded to encourage additional vegetation growth and stabilization.

For mine waste piles located within drainage channels, waste material should be removed and relocated to dry upland areas. The topsoil from the disposal area should be stripped and stored. Once the mine waste piles have been placed in the disposal area, the piles should be capped with the stored topsoil from the disposal area, supplemented with additional soil from nearby areas, and revegetated. The original mine waste location should also be stabilized, graded, re-soiled, and revegetated.

Previous landowner and contractor discussions have indicated materials containing arsenic may have been used during reconstruction of the access road adjacent to lower Ingram Gulch. Additional soil samples should be collected along the access road to better determine the arsenic source. One possible treatment

MEMORANDUM

option includes covering the outslope to prevent erosion and minimize arsenic laden sediment loading to Ingram Gulch.

References

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MEMORANDUM

APPENDIX A
PHOTOGRAPH DOCUMENTATION

Mineral Point-SS33 Waste Pile Located Within Ingram Gulch Channel

Fairfax-SS10 Waste Pile Located Outside of Ingram Gulch Channel

NORWEST CORPORATION

MEMORANDUM

To:	Maya MacHamer	**Ref #**	970-1
CC:		**Date:**	October 16, 2017
From:	Paul Kos		
Subject:	Ingram Gulch Mine Waste Reclamation Strategy		

Introduction

The Ingram Gulch Restoration project area is located in the Rocky Mountain foothills west of the city of Boulder just above the small town of Salina, CO. The project area is entirely within the Ingram Gulch drainage basin. Ingram Gulch flows to Gold Run, which is in the Fourmile Creek watershed. Fourmile Creek flows to Boulder Creek. In September of 2010, the Fourmile Canyon fire burned over 6,000 acres including the Ingram Gulch watershed. Three years later, the September 2013 flood events also greatly impacted this watershed and downstream areas with flooding and debris flows. In addition to the severe ecological and environmental damage caused by recent disasters, Ingram Gulch has a legacy of hard rock mining. The gulch has multiple large open mine shafts and adits, actively draining mines, and piles of waste rock throughout the gulch. Multiple old and new roads cut through the landscape. The water quality and chemistry of the waste rock piles was evaluated by Norwest, and those results are provided in the *Ingram Gulch Soil Sampling Field Leach Test Results* and *Ingram Gulch Surface Water Sampling Results* memorandums. This memorandum summarizes reclamation procedures of the mine waste piles located throughout the watershed. The open adits and shafts are being secured by the Colorado Department of Reclamation, Mining, and Safety, and no additional work should be necessary once this work is completed.

Mine Waste Pile Recommendations

Norwest has prepared conceptual mine waste reclamation plans to prevent continued erosion of the mine waste and limit leaching potential from the mine waste piles. In general, mine waste reclamation has two primary goals:

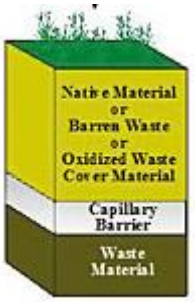
- Keep solid material in place by limiting erosion and
- Limit metals leaching by preventing water from reaching the mine waste.

These recommendations are based on regulatory guidelines and industry experience, but site-specific conditions may require additional grading or capping to completely reclaim the mine waste piles. However, mine waste often forms a natural "crust", and the waste rock material should only be disturbed if necessary to remove it from a drainage or to reduce the slope gradient. Reclamation of the mine waste piles should follow these concepts.

Each waste rock pile must have stable soil before it can be reclaimed. Primarily, this involves preventing erosion in the short-term and maintaining vegetation in the long-term. This also requires proper water management by preventing runon and controlling runoff. The reclamation slopes should be graded to 3H:1V or shallower to prevent erosion and promote topsoil placement and revegetation. Select areas may need to

have steeper gradients, but this should be used only where absolutely necessary and the slopes should never be steeper that 2H:1V. The area should be graded so that unimpacted water is routed around the waste rock pile and not towards on onto it.

A water balance cover with a capillary break is recommended. This system uses the water holding capacity of the cover soil combined with evaporation and plant transpiration to prevent water from reaching the mine waste (CDPHE, 2013). The system requires two distinct layers: the lower layer is a coarse soil (i.e. gravel) that acts as a capillary break and the upper, fine-grained soil which holds the water and plant roots. A schematic of this system is shown below.



(INAP, 2014)

A minimum of 3 feet of soil cover is recommended over the waste rock pile material. This includes both the capillary break (0.5') and the cover soil (2') and topsoil (0.5'). Studies suggest that similar plant growth occurs regardless of the cover depth; however, Arsenic uptake commonly occurs with plants, and the cover depth is intended to prevent roots from reaching the mine waste. Three feet of cover material is also the minimum cover depth for most mines and landfills. The capillary break should consist of a sandy gravel that is free of fine-grain materials. This material should consist of ½" to 4" rocks. The cover soil should be a well-graded silty soil that is placed to a firm compaction, but not compacted to optimal levels (Wilson, 1997). Clay soils should not be used. Hydraulic conductivity should be roughly 10^{-4} cm/s to 10^{-6} cm/s (Wilson, 1997). The compaction should be roughly 80%-90% of proctor density (CDPHE, 2013). The cover soil material should contain sufficient organic material and nutrients to promote vegetation, and soil amendments may be required. The topsoil may be imported material or material onsite that has been amended with compost and/or Bio-SOL.

A cover source has not been identified onsite; however, excess material from the Lower Ingram Gulch construction project could likely be used for this material provided the material is tested for organic material and other nutrients. The cover soil samples can be sent to Colorado State University for soil testing and to evaluate potential treatment options to enhance the soil. In addition, soil samples should be collected for mine waste piles exhibiting a pH of less than 5. These samples may also be sent to Colorado State University to evaluate potential treatment options such as mixing in lime and other agents to neutralize the soil, as leaching potential can typically be reduced by increasing the soil pH.

The covered mine waste piles should be revegetated with a mixture of native grasses. The upland seed mixture for the stream restoration design should be used for this purpose. The seedbed should have a roughened surface to cover the seed, reduce erosion, and improve water retention. Drill seeding is preferred over other seeding methods, provided there is suitable access for the drill seed equipment. The seeded area should be mulched following planting to improve moisture retention and reduce erosion. Seeding should

occur in the early spring or fall when germination will be most successful. Fertilization should not be necessary to support native grasses provided there are sufficient nutrients in the soil. Trees, shrubs, and other deep-rooted species should be avoided to prevent the roots from extending through the cover layer.

For mine waste piles located away from drainage channels, waste material should be left in place. If no vegetation is growing on the waste pile, the pile should be stabilized, graded, capped with soil, and revegetated. If vegetation is growing on the waste pile, the pile should be seeded to encourage additional vegetation growth and stabilization. Soil amendments or a layer of cover soil should be considered to help vegetation grow.

For mine waste piles located within drainage channels, waste material should be removed and relocated to dry upland areas. The topsoil from the disposal area should be stripped and stored. Once the mine waste piles have been placed in the disposal area, the piles should be capped with the stored topsoil from the disposal area, supplemented with additional soil from nearby areas, and revegetated. The original mine waste location should also be stabilized, graded, re-soiled, and revegetated as previously discussed.

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United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Royal Gorge Field Office
3028 East Main Street
Cañon City, Colorado 81212

In Reply Refer To:
1703 (COF020, mjs)

Mr. Chris Sturm
Colorado Water Conservation Board
1313 Sherman Street
Denver, CO 80203

NOV 1 2019

Dear Mr. Sturm,

The Bureau of Land Management Royal Gorge Field Office is pleased to support the Fourmile Watershed Coalition's grant application for funds to support continued restoration efforts in Ingram Gulch within the Fourmile Creek watershed. We have been working with the Coalition for multiple years supporting water and soil sampling, mine waste characterization and reviewing designs for mine reclamation and other stabilization projects to minimize downstream sediment loading.

The 2010 wildfire and flood events in 2011 and 2013 caused significant ecological damage within Ingram Gulch. While much of the vegetation has recovered in the area, mine waste piles that were once vegetated still remain bare. The lack of vegetation increases the opportunity for surface water run-off from the piles. Minimizing run-off through stabilization and revegetation of the piles can decrease the likelihood of heavy metals and contaminants being mobilized into downstream water sources.

The BLM's mission is to sustain the health, diversity, and productivity of public lands for the use and enjoyment of present and future generations. We accomplish this through partnerships with outstanding organizations such as the Fourmile Watershed Group where we can work together to improve water quality in the watershed through environmental restoration projects.

Our agency values the restoration work conducted by the Coalition and looks forward to continuing to partner on these important projects. We encourage you to consider this grant request.

Sincerely,

Keith E. Berger
Field Manager
Royal Gorge Field Office

www.pinebrookwater.com

Ph: (303) 443-5394
Fx: (303) 415-0621

1903 Linden Drive
Boulder, Colorado 80304

Pine Brook Water

October 30, 2019

Mr. Chris Sturm
Colorado Water Conservation Board
1313 Sherman Street
Denver, CO 80203

Re: Letter of Support for the Fourmile Watershed Coalition Watershed Restoration Grant Program

Dear Mr. Sturm,

The Pine Brook Water District would like to express our support for the Fourmile Watershed Coalition's grant application for funds to support continued legacy mine remediation in Ingram Gulch. Pine Brook Water District is acutely aware of mining impacts and their potential affects to drinking water quality. After experiencing the effects of wildfire (2010) and flooding (2011 & 2013) on raw water quality and treatment regimes the compounding effects of re-exposed mine waste piles due to those disasters is concerning.

The District obtains approximately 80% of our raw water from the Fourmile Creek watershed which is then treated and provided to approximately 1200 residents. In 2014 the District completed a Source Water Protection Plan which identified contaminants associated with legacy mining as a top concern. We have found that supporting the Fourmile Watershed Coalition's projects is one of the best ways that we are able to address water quality concerns and continually improve our drinking water for our customers.

Ingram Gulch and other areas of Gold Run were heavily mined for gold and silver and large percentages of that landscape were burned in the 2010 wildfire. Mitigating the effects of legacy mining and restoration of the burn scar are high priorities for the District. Funding this grant request will help the Pine Brook Hills and Fourmile communities continue to recover from the cascading disasters experienced over the past decade.

Sincerely,

Robert De Haas, Manager

Lauren Duncan
Abandoned Mine Restoration Project Manager
lduncan@tu.org – (720) 276-3889

October 29, 2019

Mr. Chris Sturm
Colorado Water Conservation Board
1313 Sherman Street
Denver, CO 80203

Re: Letter of Support for the Fourmile Watershed Coalition Watershed Restoration Grant Program

Dear Mr. Sturm,

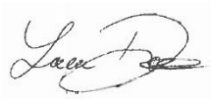
We are pleased to support the Fourmile Watershed Coalition's grant application for funds to support continued restoration efforts in Ingram Gulch within the Fourmile Creek watershed. We have been working with the Coalition for multiple years supporting and engaging in water and soil sampling, mine waste characterization and reviewing designs for mine reclamation and other stabilization projects to minimize downstream sediment loading.

The 2010 wildfire and flood events in 2011 and 2013 caused significant ecological damage within Ingram Gulch. While much of the vegetation has recovered in the area, mine waste piles that were once vegetated still remain bare. The lack of vegetation increases the opportunity for surface water run-off from the piles. Minimizing run-off through stabilization and revegetation of the piles can decrease the likelihood of heavy metals and contaminants being mobilized into downstream water sources.

Trout Unlimited's mission is to conserve, protect and restore North America's coldwater fisheries and their watersheds. We believe watershed-wide, partner-based restoration efforts like this one in Ingram Gulch are critical steps for promoting long-standing, sustainable environmental resilience.

Our organization values the restoration work conducted by the Coalition and looks forward to continuing to partner on these important projects. We encourage you to consider this grant request.

Sincerely,



Lauren Duncan
Abandoned Mine Restoration Project Manager

CIVIL&ENVIRONMENTALENGINEERING
COLORADO SCHOOL OF MINES

Mr. Chris Sturm
Colorado Water Conservation Board
1313 Sherman Street
Denver, CO 80203

Re: Letter of Support for the Fourmile Watershed Coalition's Watershed Restoration Grant Program application

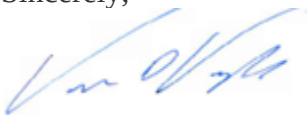
Dear Mr. Sturm,

The Colorado School of Mines Department of Civil and Environmental Engineering is pleased to support the Fourmile Watershed Coalition's grant application for mine waste pile prioritization and design. School of Mines students have participated in similar projects in the past and have been able to offer significant engineering assistance to agencies while benefiting from the practical learning environment.

Capstone Design@Mines is a two-semester course sequence for engineering students. Capstone Design@Mines is a creative, client-driven experience emerging from combined efforts in mechanical, electrical, civil, environmental, and general engineering. The engineering community widely recognizes that many of the grand challenges facing society, now and in the future, can only be met through multi-disciplinary approaches.

The Colorado School of Mines looks forward to having students work with the Fourmile Watershed Coalition so that they may experience, first-hand, how their engineering knowledge and skills can contribute to ecosystem and water quality improvements through addressing legacy mine waste issues in Colorado.

Sincerely,



Dr. Kristoph-Dietrich Kinzli P.E.
Teaching Professor
Colorado School of Mines
Department of Civil and Environmental Engineering

FOUR MILE FIRE PROTECTION DISTRICT

October 29, 2019

Colorado Water Conservation Board
1313 Sherman Street
Denver CO, 80302

RE: Letter of Support for Fourmile Watershed Coalition Grant Application:
"Upper Ingram Gulch Restoration Project".

To the CWCB:

I am writing in support of the Fourmile Watershed Coalition seeking funding for the Upper Ingram Gulch Restoration Project.

Fourmile Canyon, and Ingram Gulch in particular, is an area of complex terrain in confined canyon/stream beds, and was severely damaged by the 2010 fire and 2013 flood. The restoration projects completed by the Coalition to date have already proven beneficial for the both the emotional and physical recovery of our community, and we welcome more. This proposed design project will continue build on this solid foundation in order to further sustain the benefit and safety of our residents and property.

The Four Mile Fire Protection District has been extremely invested and supportive of the Fourmile Watershed Coalition's restoration projects, and we continue the support of the Coalition's work into this at-risk area.

Sincerely,

Bret Gibson
Four Mile Fire Chief

1740 Four Mile Canyon Drive. Boulder. Colo. 80302
303-449-3333

MAYA MACHAMER

Fourmilewatershed@gmail.com – 3180 17th Street, Boulder, Colorado, 80304 – (303)817-2261

Dynamic, results-driven professional with experience in effective program development and implementation. Articulate and influential communication skills, serving as a valuable coordinator, liaison, and advocate. Proven track record of completing set objectives within time and budget parameters. Expertise encompasses: program planning and implementation, project management, creative problem solving and conflict resolution, relationship building and community outreach, research, data collection, analysis, and reporting, grant writing and compliance.

Employment History

Watershed Coordinator, Fourmile Watershed Coalition **2015-Present**

- Planning and implementing disaster recovery projects including stream restoration, mine reclamation and forest health projects.
- Obtaining and managing 7.3 million dollars in disaster recovery funds; primarily state and federal funding including CWCB, DOLA and EWP funds.
- Organizational development, community engagement and education.

Project and Volunteer Coordinator, Long Term Flood Recovery Group (Boulder, Co) **2014- 2015**

- Planned and managed volunteer interior construction projects and outdoor landscape repair projects for flood affected Boulder County residents.
- Created systems to facilitate the delivery of needed assistance.

Emergency Management Intern, Office of Emergency Management (Boulder, CO) **2009 – 2010**

- Provided direct support for Emergency Management and Preparedness operations by responding to public inquires, organizing public outreach activities, preparing documents and researching information.
- Provided Logistical support in the Emergency Operations Center during the Fourmile Fire.

Paramedic, Denver Health Paramedics (Denver, CO) **2006 – 2013**

- Effectively responded to emergency calls providing emergency medical services and administering pre-hospital advanced life support.
- Received a Certificate of Appreciation in recognition of life-saving tactics in May of 2009.
- Awarded Employee of the Year in 2010.

Disaster Medical Assistance Team Member (DMAT), Colorado **2010 – 2013**

- On-call to provide national and international disaster medical assistance.

Education

Master's Degree in Public Administration with a concentration in Emergency Management
University of Colorado at Denver, 2012.
Bachelor's Degree Sociology with a certificate in Peace and Conflict Studies
University of Colorado at Boulder, 2000

Catherine Price

5898 Fourmile Canyon Drive, Boulder, CO 80302
903-235-7754 catherinehprice@gmail.com

Education & Certification

Southern Methodist University Dallas, Texas August 2002—May 2006
Bachelor of Arts, Corporate Communications and Public Affairs

The Yoga Institute Houston, Texas March 2008—December 2010
Certified Yoga Instructor
Owned and operated Cat Price Yoga - 2010

Professional Roles

Grants Manager Boulder, Colorado
Fourmile Watershed Coalition

- Work with internal Fire District and Watershed Coalition staff to determine funding needs and budget
- Track, report, and monitor grant funds, submitting requests for reimbursements and advance payments, awareness and adherence to State and Federal compliance requirements, and monitoring payments of contractors and consultants
- Manage multiple complex grants and oversee the timely completion of financial reports to funders
- Support Outreach, Project Management, Marketing and Fundraising, Organizational Development, and General Administrative Tasks

Project Management Consultant Shreveport, Louisiana
Sheer Technology, LLC

- Manage client engagements for business process evaluations, technical application selection and integration, website builds and redesigns, and marketing collateral creation
- Lead sales and marketing initiatives for Sheer Technology, including work order proposal writing, RFP bid fulfillments, as well as campaign content and materials production
- Explore and analyze procedural tasks and/or challenges providing in-depth deliverables, such as assessment reports and business or functional requirement documents
- Provide business and technical project management for a variety of industries (i.e. accounting/financial firms, medical technology companies, lobby/advocacy groups)

Director of Communications Dallas, Texas
Mary Crowley Cancer Research Centers

- Managed public relations and marketing efforts
  - Coordinated with PR firm to arrange interviews, develop text for services offered and emergent developments in research, and advise concepts for marketing opportunities
- Planned and executed internal and external events
  - International Conference on Gene Therapy of Cancer (2005—2007)
    - 100+ researchers and physicians convene to discuss the latest breakthroughs in cancer therapy research in a 3-day forum
  - Fundraising and Auxiliary events, Board meetings, partnership presentations, media events
- Linked patients and physicians with the center
  - Created monthly open trial cards for network sites and referring physicians
  - Fielded and directed contacts with prompt service
- Assisted Development Director with grant submissions and funding request applications
  - Created development materials for targeted audiences and mass distribution

Personal Profile

Character & Employee Strengths

- Amiable, independent, and detail oriented
- Excellent organizational, computer, and communication skills
- Experience in Microsoft Office, Adobe Contribute, WordPress and similar platforms, Google Earth, custom-built applications and programs, Sage ACT, Photoshop, and social networking forums

Interests & Activities

- Creativity and innovation
- Architecture and interior design
- Travel, yoga, and outdoor recreation