EXECUTIVE SUMMARY

Project Title:	Evans Gulch Restoration Project
Grant Number:	FAAA2016 1427
Project Start Date:	August 11, 2015
Project Completion Date:	February 15, 2019

FUNDING

Total Budget:	**$329,151.12**
Total EPA Section 319 Grant:	$253,000.00
Total EPA Section 319 Grant Funds Utilized:	**$196,640.58**
Federal Agency Contributions:	
State and Private Contributions:	
Freeport-McMoRan	$38,891.28
Newmont Mining	$17,698.90
Parkville Water District	$435.00
CO Division of Reclamation Mining and Safety	$30,000.00
Local Entities (Lake Co. Road and Bridge - *materials)*	$2,400.00
Other Various Match (CMC, TU Chapter, etc)	$43,085.36
Total Expenditures of EPA Funds:	**$196,640.58**
Total Section 319 Match Accrued:	**$132,510.54**

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Executive Summary

The Evans Gulch Restoration Project was a collaboration between landowners, local, state and federal agencies, and several nonprofit groups. Trout Unlimited (TU) was the lead fiscal sponsor and the recipient of this Nonpoint Source Program (NPS) grant, which began when the contract was executed on 8/11/2015.

Trout Unlimited focused efforts on the Evans Gulch watershed because of its former listing on the State's impaired waters list, and subsequent 303(d) listing as segment COARUA07 for zinc exceedances. The fact that Evans Gulch is the drinking water source for Leadville and Lake County made this project an even higher priority.

Five objectives and seven tasks were initially set and attained for the Evans Gulch Restoration Project through the project implementation plan (PIP) with the ultimate goal of implementation of reclamation plans. This project embodied a cradle to grave type model with development of a sampling and analysis plan (SAP), execution of two and a half years of monitoring, data consolidation and evaluation, site selection, landowner consent, design, contracting, and construction oversight. When TU conceptualized this project there were no identified sites, and when TU finished work in September 2018, three different sites had been reclaimed. Through the 2018 construction season, work was completed at the Silver Spoon, Streamside, and Valley mine sites. Specifically, this consisted of two acres of waste consolidation and revegetation, 50 feet of stream bank stabilization, one acre of mine waste grading and erosion control, 200 feet of buck and rail fence construction, installation of a culvert beneath County Road 3, 150 feet of channel construction, and over 140 willow plantings/transplants.

Several public education and outreach activities were completed during the duration of project which included various tours of the watershed with local charter schools, community colleges, and State Universities. A significant volunteer participation aspect was utilized early on in each of the water and soil sampling efforts. Public information meetings were also held throughout the project through attendance, presentations, and discussions at local watershed group meetings and Lake County Open Space Initiative meetings. Periodic newsletters were submitted to highlight restoration efforts internally to TU, as well as several local newspaper pieces documenting before and during construction activities. Challenges with liability, project scoping, and landowner consent were met and successfully dealt with by TU staff throughout the project. TU is extremely proud of the work put into developing this project and getting a chance to ultimately carry it out.

1.0 Introduction

The Evans Gulch watershed is a subset of the East Fork of the Upper Arkansas River Watershed U.S. Geological Survey (USGS) HUC 12 boundary. The corresponding HUC 12 code is 110200010202 with the entire reach of Evans Gulch highlighted blue towards the southern boundary of the watershed (Figure 1.1).

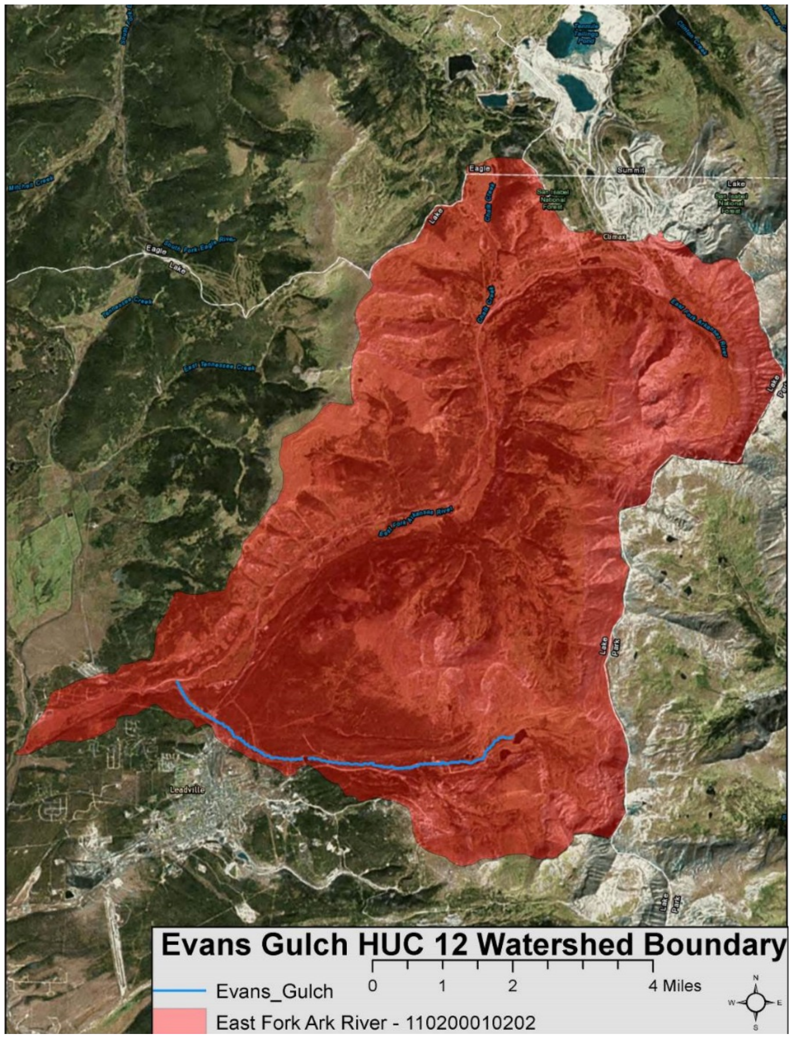


Figure 1.1: HUC 12 Boundary of Evans Gulch, which is included in the East Fork of the Arkansas River watershed boundary.

Evans Gulch represents a five mile long segment in the Upper Arkansas River basin that is also part of the historic mountainous “mineral belt”. Evans Gulch is a large glacial valley that extends down the west slope of Mount Evans from elevations above 13,200 feet (ft) above mean sea level (MSL) to the Arkansas Valley at approximately 9,900 ft above MSL. It is bordered on the north by Prospect Mountain and on the south by Iron Hill, Breece Hill, and Ball Mountain. Evans Gulch contains two tributary drainages in the upper watershed; Lincoln Gulch and South Evans Gulch. Average annual precipitation is 18 inches with the wettest months being July and August and the driest months being December and January.

The five mile reach of Evans Gulch begins in the western basin of Mount Evans, picks up notable flows from South Evans Gulch, Lincoln Gulch, Johnson Gulch, and Little Evans Gulch before crossing HWY 91 and joining with the East Fork of the Arkansas River on the north side of HWY 24. During this stretch, Evans Gulch passes through Mountain Lake, Diamond Lake, and several Parkville Water District (PWD) reservoirs along County Road 3, or Mosquito Pass Road.

Evans Gulch is typical of a high alpine stream channel with varying gradients, riparian vegetation consisting largely of willows, and a low water temperature. Downstream of Diamond Lake and along County Road 3, Evans Gulch maintains a consistent grade of 2-4% and passes through several wetland type areas. The streambed is primarily composed of cobble bedforms and possesses a riffle-type channel. In areas unaffected by mine wastes, the stream channel is stable due to the ample amounts of riparian vegetation. However, the areas of Evans Gulch that pass through or near mine waste piles have degraded bank conditions due to the presence of unconsolidated soils. According to Rosgen's Geomorphic Classification, Evans Gulch would primarily be a B classification with moderate relief, colluvial deposition, and moderate entrenchment and width-to-depth ratio. Rapids are the predominate feature of the stream, though there are also infrequent scour pools. Limited flow data shows that the stream typically flows at 2-3 cubic feet per second (cfs) in the upper reaches of the watershed to over 65.5 cfs during July peak flow near the confluence of the Arkansas River. South Evans Gulch has shown historic peak flow values of around 26 cfs during spring runoff, while Lincoln Gulch has an ephemeral flow regime. As noted in the Total Maximum Daily Load Assessment (TMDL), there have been no recent studies of aquatic life in Evans Gulch, but previous sampling showed brook trout and a macroinvertebrate community in the waterway (CDPHE, 2009).

The bedrock formations beneath the surface of Evans Gulch and nearby areas are a series of sedimentary strata that range in age from Cambrian to Pennsylvanian and consist of quartzite, limestone, dolomite and shale (HDR, 2002). These Paleozoic sedimentary formations were intruded during the late Cretaceous or early Tertiary periods in several episodes by sills and dikes (HDR, 2002). These porphyry intrusions created the major portion of the mineralized zones and ore deposits, which is why the area was heavily mined beginning in the late 1800s (BOR, 1997). The result of this historic mining was the discharge and deposition of mine waste that has since degraded water quality in Evans Gulch. Ore deposits were mined, and wastes were deposited on the surface, usually located near water and scattered throughout the watershed. These waste materials became subject to weathering which releases remaining contaminant metals into surface and ground water (HDR, 2002). These conditions led the Environmental Protection Agency (EPA) to include part of Evans Gulch within Operable Unit (OU) 6 of the California Gulch Superfund listing, though the agency has no future remediation plans for the watershed.

1.1 TMDL Summary

Section 303(d) of the federal Clean Water Act (CWA) requires states to periodically submit to the U.S. Environmental Protection Agency (EPA) a list of water bodies that are water-quality impaired. Water-quality limited segments are those water bodies that have a classification or standard that is not fully achieved. This list of water bodies is referred to as the “303(d) List”. In Colorado, the agency responsible for developing the 303(d) list is the Water Quality Control Division (WQCD). The List is adopted by the Water Quality Control Commission (WQCC) as Regulation No. 93. The WQCC adopted the applicable 303(d) list in 2012 and is now part of the integrated 305(b) and 303(d) reports.

For waterbodies and streams on the 303(d) list a Total Maximum Daily Load (TMDL) is used to determine the maximum amount of a pollutant that a water body may receive and still maintain water quality standards. The TMDL is the sum of the Waste Load Allocation (WLA), which is the load from point source discharge, Load Allocation (LA) which is the load attributed to natural background and/or non-point sources, and a Margin of Safety (MOS) (Equation 1).

(Equation 1) **TMDL=WLA+LA+MOS**

TMDLs account for critical conditions and seasonal variation.

Evans Gulch, or Segment 7, flows west through Mountain Lake and Diamond Lake, past the Fortune Mine, Matchless Mine, and above Leadville through the historic mineral belt trail. The upper and lower portions of Evans Gulch are included in Operable Unit (OU) 6, which is one of the 12 units created through the California Gulch Superfund listing. Even though portions of Evans Gulch are included in OU 6, a majority of the sampling locations and sources of contamination lie outside the boundary.

The TMDL states that zinc exceeded the standard in May, July, and August (Table 1.1). This could have been attributed to the increase in flow at spring runoff resulting in a flushing effect and exceedance of chronic TVS. Load reductions range from 3% in August to 21% in May. The high volume of mine tailings/waste piles that line the creek and floodplain along Evans Gulch could likely be the source of standard exceedances. The potential effect of non-point source pollution on Evans Gulch was evaluated through the associated Watershed Management Plan (WMP) and will be further evaluated in future sampling events in the watershed.

Table 1.1: Ambient concentrations of dissolved zinc in Segment 7, Evans Gulch of the Upper Arkansas as seen in the TMDL.

	Avg. Hardness	Zn-D, TVS	Zn-D, 85th%	% Reduction
Jan	100	124	27	0%
Feb	115	140	23	0%
Mar	130	156	18	0%
Apr	120	145	18	0%
May	59	79	**100**	21%
Jun	76	98	66	0%
Jul	82	105	**114**	8%
Aug	87	110	**114**	3%
Sep	90	114	15	0%
Oct	94	118	16	0%
Nov	98	122	16	0%
Dec	100	124	15	0%
Annual	93	117	113	0%

1.1.1 303(d) Listing

Evans Gulch first appeared on Colorado's 303(d) list of impaired waterways in 1998 for dissolved zinc. This listing refers to the mainstem of Evans Gulch (Segment 7) from the source area to the confluence with the Arkansas River. The TMDL was completed in 2009 with the goal of attainment of aquatic life classification, which is Aquatic Life Cold 1 (Table 1.2).

Table 1.2: Water body ID description for Evans Gulch showing TMDL Criteria.

Waterbody ID	Beneficial Uses	WQ Impairment	TMDL Status
COARUA07	Aquatic Life Cold 1, Recreation E, Water Supply, Agriculture;	Zinc	Completed

1.1.2 Segment Classifications and Beneficial Use

The aforementioned zinc exceedances impair the Aquatic Life Cold 1 classification for Evans Gulch. The classified uses listed in WQCD Regulation 33 are Aquatic Life Cold 1, Recreation E, Water Supply, and Agricultural (WQCC, 2014). PWD holds the only discharge permit in the watershed and through its treatment system and water sources, PWD can provide a peak daily demand of 3.5 million gallons per day (MGD) and an average daily demand of 1.36 MGD (Parkville, 2013). Evans Gulch is one of the primary surface water sources for PWD, and any contamination could prove detrimental to the ability to meet demand if disablement occurs for an extended period of time.

2.0 Project Goals, Objectives, and Activities

The Evans Gulch Restoration Project had five main objectives with seven subtasks with the overarching goal of reduction of zinc loading and other metals into Evans Gulch through non-point source mine reclamation projects. Other general environmental goals included improvement of stream system through channel restoration, establishing vegetation along degraded banks and improving natural conditions where applicable.

The project also focused on several programmatic goals that included: (1) Demonstration of successful Good Samaritan mine restoration work through existing tools; (2) Maintain good relationships with local stakeholders and include in all project decision making; (3) Improve Evans Gulch fishery; and (4) Complete project work prioritized in the Evans Gulch Watershed Plan. All of these environmental and programmatic goals strive to meet TU's mission to conserve, protect, and restore North America's trout fisheries and their watersheds.

To accomplish these goals, the project had five objectives that are discussed in further detail below:

Objective 1: Manage project
Objective 2: Continued Incorporation of Sampling and Analysis Plan (SAP)
Objective 3: Reclamation Design
Objective 4: Implementation of Reclamation Design
Objective 5: Develop Public Relationship and Involvement

Objective 1: Manage project
Task #1: Manage grant, oversee project, submit required semi-annual and final reports. Upload water quality data to the EPA STORET database.
Product: Project reports to CDPHE for review and approval; assessment reports completed, and implementation project completed. Periodic updates of water quality data to the EPA STORET database.
Actual: Submitted semi-annual reports to CDPHE, as well as invoices and supporting information in a timely manner. Watershed Management Plan was also completed for CDPHE approval through this Task. EPA STORET database updates through submission of data to WQCD staff after sampling.
Task #2: Gain landowner approval and support of project activities through outreach. This will be done through meetings and by making phone calls, sending letters, and emails to landowners that are in desired project areas along Evans Gulch.
Product: Signed letters or emails from selected landowners stating their support and approval of the project. Cooperation from landowners with sites identified under the Project Priority Ranking scale.
Actual: This was accomplished through several letters, phone calls, and in-person meetings with two main property owners. The final step in the process was developing and gaining signatures for two Participating Agreements, thus allowing construction work to take place at the Silver Spoon, Streamside, and Valley Sites.

Objective 2: Continued Incorporation of Sampling and Analysis Plan (SAP)
Task #3: TU and project partners will continue to carry out the established monitoring plan (CDPHE, 2014). TU, WQCD, and Colorado Mountain College (CMC) will continue to conduct high flow, low flow, and summer storm event water quality monitoring in 2015. A slight variation to the SAP will be incorporated in 2015 by adding three sites and removing a 2014 site. The site alterations are aimed at better determining loading sources.
Product: Use of monitoring results to update any remaining sections of the Watershed Plan. Use results to verify source loading areas to be targeted in a Reclamation Design. Data will also be used to determine whether loading reductions are being achieved and progress is being made towards attaining water quality standards.
Actual: This Task was accomplished through the development of a water quality database and WMP that prioritized reclamation sites and developed a conceptual plan for each site. High and low flow events were carried out in 2014 and 2015 with an additional summer storm event.
Task #4: After completion of water quality analysis and identification of project sites, a soil sampling plan will be implemented to determine site soil chemistry.
Product: Results will guide TU in selecting the proper BMP to be used in a Reclamation Design.
Actual: Soil sampling was carried out in August 2016 with CDPHE, TU, and DRMS. These results went into a soil database that ranked the four sites where samples were taken.

Objective 3: Reclamation Design
Task #5: Based on results and analysis from completed SAP, TU and project partners will develop engineering/design options for reducing zinc and other metals loading into Evans Gulch. The final design will focus on the areas between sites EG14 and EG13, specifically at the Silver Spoon, Streamside, and Valley Mine sites.
Product: Detailed Reclamation Design for the treatment of non-point source contributing areas. This design will have incorporated data from Task #4 to select proper mine tailings/waste treatment BMPs. Photo points will also be established to document before and after conditions.
Actual: A detailed 30% reclamation design was begun in February 2018 and completed in July 2018 recommending cut/fill balances, native plants, in-situ amendment amounts, and procedures for in-stream habitat feature construction.

Objective 4: Implementation of Reclamation Design
Task #6: TU and project partners will implement Reclamation Design identified in Task #5.
Product: Installation of appropriate BMPs on selected mine tailings/waste piles will result in loading reduction of zinc and other heavy metals to Evans Gulch. Incremental improvement will help Evans Gulch attain water quality standards for dissolved zinc.
Actual: Once final comfort and design approval letters were received, TU and H-2 Enterprises constructed recommended BMPs per the 30% design completed in Task 5. All construction work was efficiently completed in less than one month of start date.

Objective 5: Develop Public Relationship and Involvement

Task #7: Inform Lake County Open Space Initiative (LCOSI), Lake County Water Advisory Board, and other interested stakeholders on status of project and solicit feedback. Publicize project on TU website, newsletters, blogs, and annual reports. Share project information at appropriate conferences and meetings.
Product: Inform the public by presenting project updates at two meetings per year, as well as through TU's national website exemplifying lessons learned.
Actual: TU staff presented about the Evans Gulch project several times over the course of four to five years. These meetings included water quality presentations of 2014/15 data to LCOSI, Headwaters of the Arkansas Watershed Group (HAWG) meetings, TU Chapter Meetings, and local charter school presentations. TU also worked with Leadville Herald staff to inform community of upcoming and ongoing construction work through two articles. County Commissioners, Road and Bridge staff, and Parkville staff were also informed of construction schedule.

3.0 Monitoring Results and Discussion of SAP

3.1 Sampling and Analysis Project Plan (SAPP)

A Sampling and Analysis Plan (SAP) was utilized throughout the project, which was initially created by CDPHE (CDPHE, 2016). The SAP goes into detail about sampling locations and site descriptions, as well as frequency of samples and water quality parameter listings. It also included brief description of sites and associated sampling maps that clarified sampling locations. Updates to the SAP were performed in 2016 to incorporate protocols and procedures of the 2016 soil sampling event.

3.2 Existing Data Inventory

3.2.1 WQ Reports

Including TMDL measurements, water quality samples have been periodically recorded in Evans Gulch starting in June of 1991 through June of 2004. A higher concentration of samples was taken in 1994-95 and 2000-2003. Various organizations have participated in sampling since 1991 including Colorado Parks and Wildlife (CPW, formerly CDOW), EPA, CDM Smith, Colorado State University (CSU), American Smelting and Refining Company (ASARCO), Colorado Mountain College (CMC), and PWD. The samples have been analyzed for the typical abandoned mine metals group and have included surface water (14-16 sites), ground water (2 sites), mine water (2 sites), spring (2 sites), and surface/ground/spring water (2 sites) locations. Even though several water quality sampling locations exist in the watershed, there has been no sequential monitoring for a duration of more than two years between sites. Additionally, only one of the surface water sites has had samples recorded at times other than high and low flow. This set of samples was taken in 2003 during the months of April, June, July, August, September, and November. Flow and hardness values were not recorded for several of these samples, especially during the 2000-01 timeframe.

To bridge the gap in sampling data in the watershed, surface water quality studies took place in Evans Gulch over the course of 2.5 years since spring of 2014. These environmental investigations focused on abandoned mine sites within the gulch and quantified loading to/from adjacent drainages. Specifically, high and low flow measurements were taken by TU, CDPHE, and other project partners at 13 sites in 2014 and 2015. Specific loading sources were also identified through this effort, which helped ultimately define clean-up priorities carried out in summer of 2018.

3.2.2 Soil Reports

In addition to water quality, a soil sampling event took place on August 8th, 2016 at four mine tailings/waste piles that were identified for restoration through prior water quality analysis. Representatives were present from TU, WQCD, and DRMS during the event. The approach for soil sampling involved evenly gridding each site into 30 sub-sites where X-ray Fluorescence (XRF) measurements were taken with a field meter. Three samples per site (10%) were then bagged and sent to a lab for verification analysis. During sampling, a composite sample was compiled for each site, and used in a Field Leachate Test (FLT). This procedure involved mixed a weighed sample of composite soil and mixing it with deionized water. The combined mixture was vigorously shaken and filtered through a 0.45 um filter for dissolved metals analysis at CDPHE labs. FLT and soil chemistry data from each site will be essential in determining site prioritization and BMP methodology for non-point source clean-up. Further information on sampling techniques can be found in the SAP created by CDPHE in 2016.

4.0 Data Analyses and Characterizations

4.1 Water Quality Concentration Evaluations and Exceedances

Sampling data gathered during the two years of monitoring was essential in guiding TU on which sites should be prioritized for reclamation. The subsequent sections below describe those results and how they were used to effectively select sites.

Table value standards (TVS) and hardness-based chronic and acute standards were evaluated for the abandoned mine lands (AML) suite of metals for all 13 monitoring locations within the Evans Gulch watershed using the Evans Gulch Water Quality Database (TU, 2015). The subsequent sections are broken up based on drainage and features to discuss dissolved zinc exceedances, unless otherwise specified. All concentrations correspond to 2014-15 data. It should also be noted that chronic standards are based on the 85th percentile of sample data. Chronic standards in any graphs below are simply shown to give an approximate representation of where concentrations are relative to calculated chronic standards.

4.1.1 Evans Gulch

Sites included in this section of the discussion from upstream to downstream are EG16, EG02, EG04, EG12, EG13, EG14, EG14A, and EG15. These sites are located on the mainstem of Evans Gulch. Further discussion of the South Evans and Lincoln Gulches occurs in subsequent sections.

Site EG02, the most downstream site adjacent to the Hwy. 91 crossing, is not graphed because only one data point was recorded during 2014. Water was not flowing at this site during the 2015 fall sampling, but the high flow sampling results showed zinc concentrations above chronic and below acute TVS. The next site upstream is EG01, which was adjacent to the mineral belt trail and below the Big Evans Reservoir outlet. High, summer, and low flow samples at EG01 all yielded results that fell below both chronic and acute standards. Zinc concentrations fluctuated in Evans Gulch between sites EG04 and the control site of EG15 due to various inputs. Site EG04, the first site above Big Evans Reservoir, also exhibited zinc concentrations below both chronic and acute standards with the exception of the high flow 2015 sampling event (Figure 4.1).

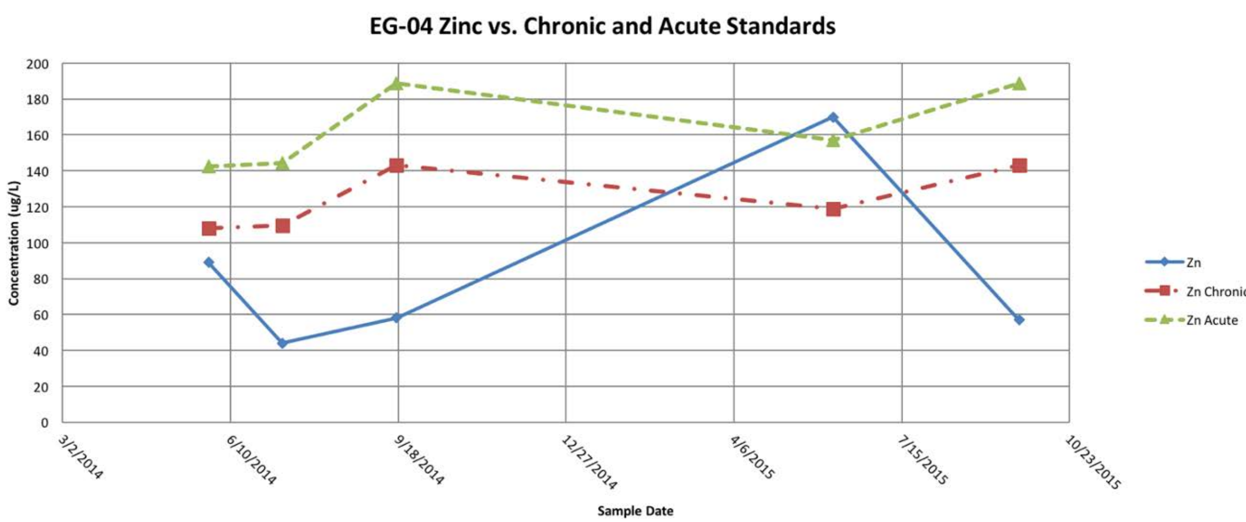


Figure 4.1: EG04 Zinc concentrations plotted vs. acute and chronic standards

Above the Lincoln Gulch influence and immediately below the input of South Evans Gulch is site EG12. Zinc concentrations of 200 µg/L and 340 µg/L were recorded at EG12 during high flow monitoring in 2014 and 2015, respectively. Both of these values were above both chronic and acute standards (Figure 4.2). Specifically, the acute standard in 2015 was exceeded by 211 µg/L, which is a large increase from 2014 data. However, 2015 fall sampling at EG12 fell inline with 2014 low flow data yielding zinc concentrations below both chronic and acute standards. This seemed to be a trend for all other sites in the watershed, and follows the TMDL exceedances associated with spring runoff and summer rainfall events.

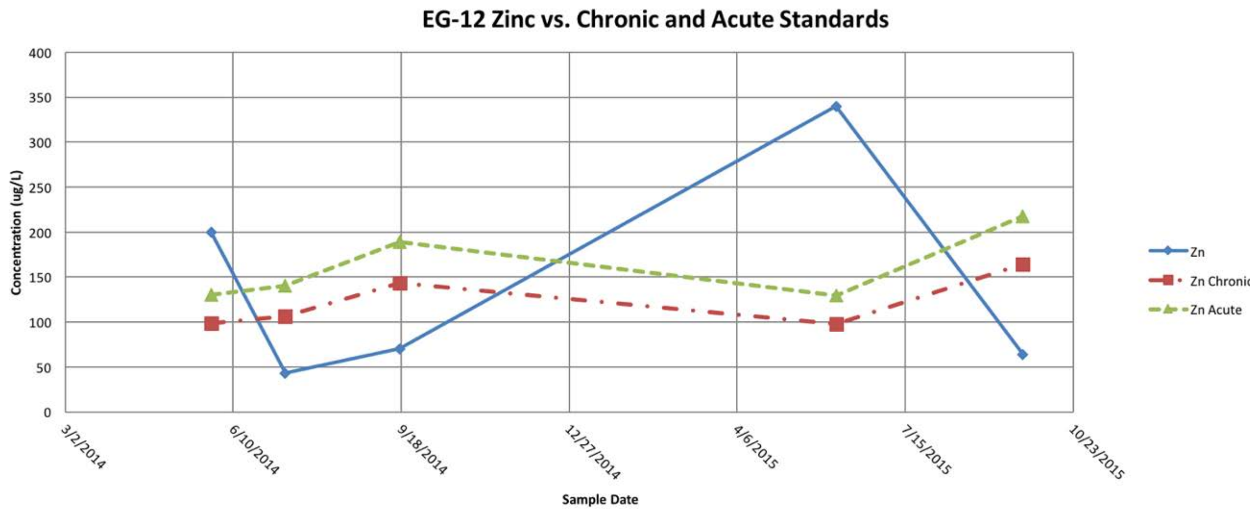


Figure 4.2: Zinc concentrations at EG12 showing influence of Iron Springs.

Site EG13 is upstream of the South Evans input, but below the streamside tailings and Valley Mine input that abut the creek and line the floodplain. Of all Evans Gulch mainstem sites, zinc high flow data produced the highest concentration of 210 µg/L and 490 µg/L in 2014 and 2015, respectively. Both chronic and acute standards were again exceeded during this sampling timeframe with the zinc concentration 361 µg/L above the acute standard in 2015 (Figure 4.3). Low flow 2015 sampling saw zinc concentrations at EG13 drop significantly to 32 µg/L, which fell below both chronic and acute standards.

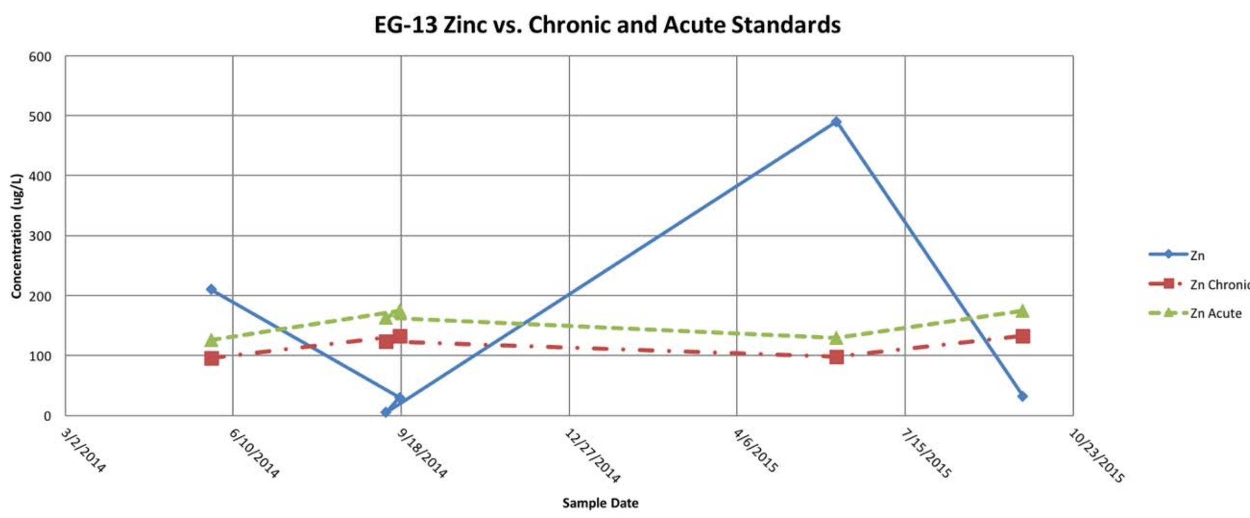


Figure 4.3: Zinc concentrations at EG13 above Iron Springs confluence. Note reduced concentrations.

Site EG14 is upstream of EG13 and was created to show the input of several mine tailings/waste piles that compose the floodplain between the two sites. A zinc concentration of 430 µg/L was observed during 2015 high flow sampling, which was above both chronic and acute standards (Figure 4.4). This value was approximately 325 µg/L above the acute standard. All other sampling events besides high flow 2014 saw reduced concentrations of zinc and attainment of both chronic and acute standards.

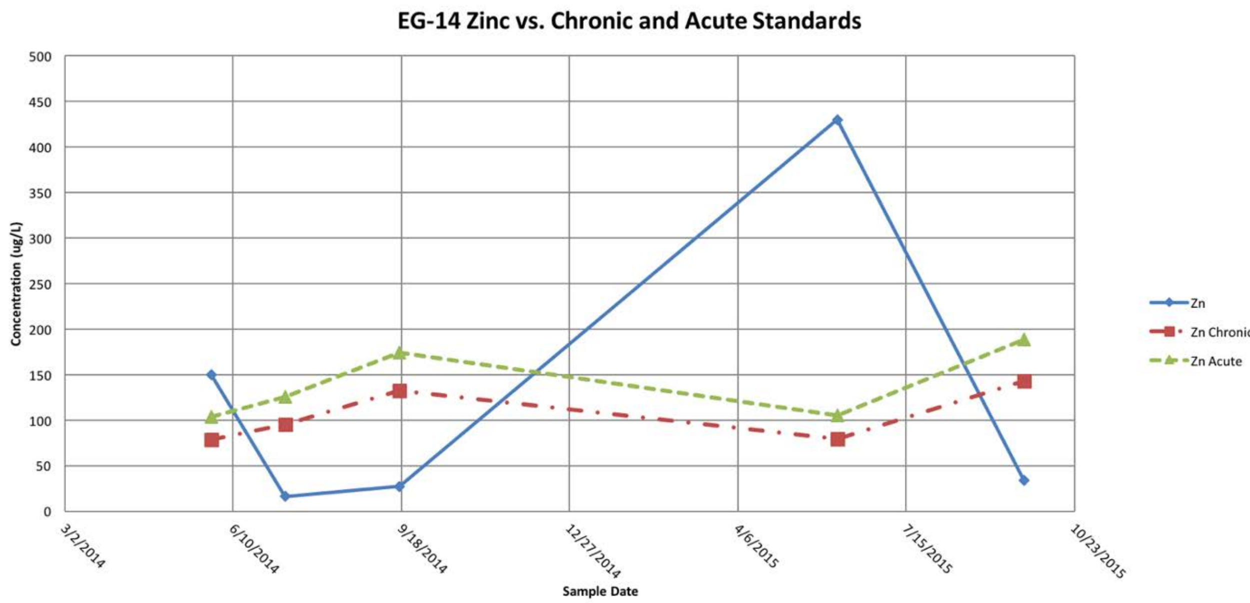


Figure 4.4: Zinc concentrations at EG14 below the Laurium Mine.

Above most of the historic mining influence is site EG15, which represented the control site for Evans Gulch. Both high and low flow data yielded values well below chronic and acute standards, and did not exceed a zinc concentration of 10 µg/L (Figure 4.5). However, a 140 µg/L increase in zinc concentration was observed between sites EG15 and EG14 during 2014 high flow leading to the creation of site EG14A.

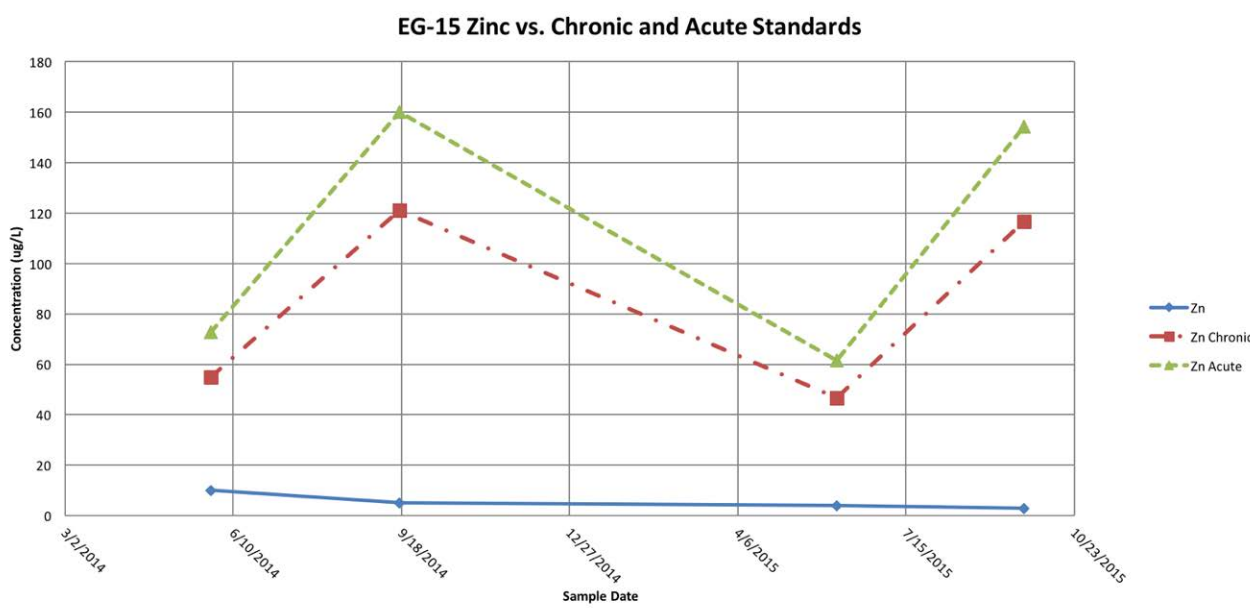


Figure 4.5: EG15 zinc concentrations showing exceedance of chronic standards.

Site EG14A was added to the 2015 set of sampling sites because of the aforementioned increase in observed zinc concentrations between EG15 and EG14 during 2014 high flow conditions. The goal of this site was an attempt to identify the source between these two sites. A significant increase above chronic and acute standards was observed during 2015 high flow conditions at site EG14A (Figure 4.6). Specifically, a concentration of 480 µg/L was recorded during high flow, which was the second highest concentration behind EG13.

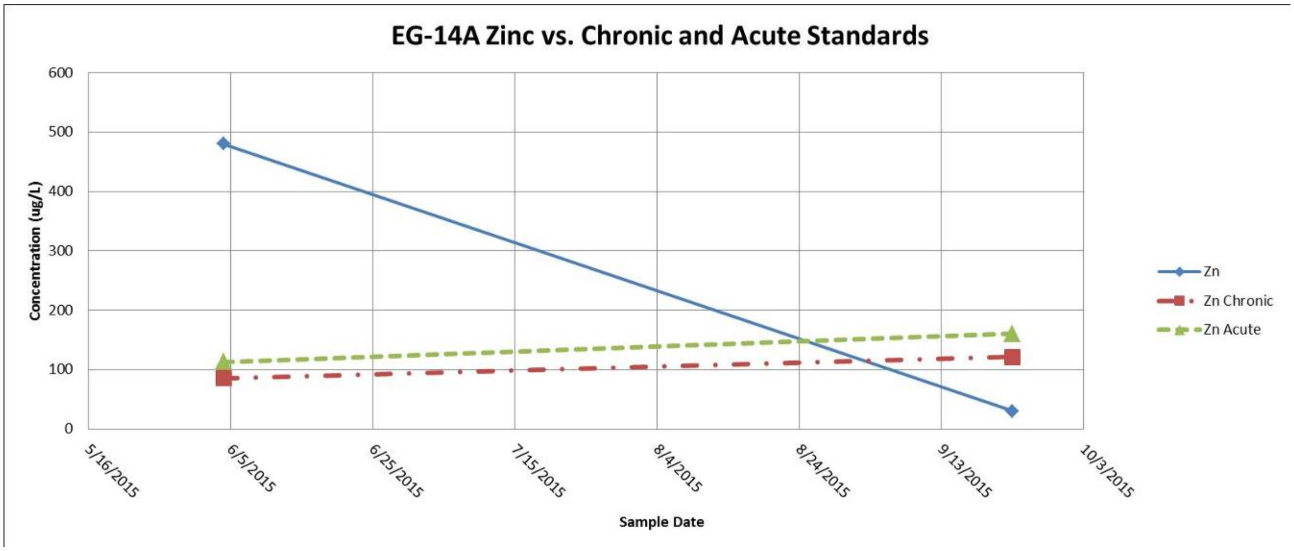


Figure 4.6: EG14A zinc concentrations showing exceedances of chronic and acute standards during high flow 2015.

To further evaluate the variability of zinc concentrations moving from upstream to downstream, a max zinc concentration graph was developed for the high flow sampling event that took place in June 2015 (Figure 4.7). The purpose of this Figure is to show how concentration of dissolved zinc varies between the most upstream control site (EG-15) to the most downstream site (EG-16) located immediately upstream of the confluence with the East Fork of the Arkansas River. At almost negligible concentrations at EG-15, zinc spikes up to nearly 500 ug/L at EG-14A, which is located downstream of the Famous Mine/Dolly Varden claims. Levels of zinc are maintained between 400-500 ug/L through sites EG-14 and EG-13 that are adjacent to the Valley Mine and Streamside tailings area. Levels then continue to fall below 300 ug/L and 200 ug/L at downstream sites EG-12 and EG-04, respectively. Zinc concentrations level out to 130 ug/L at the most downstream site (EG-16) before the confluence with the East Fork. This graph indicates that high concentrations of zinc are maintained between upstream sites EG-14A and EG-13 due to their proximity to mining features. Once non-point source begin to diminish, and after the input of South Evans Gulch at EG-12, water quality begins to improve and zinc concentrations start to level out approaching Big Evans Reservoir.

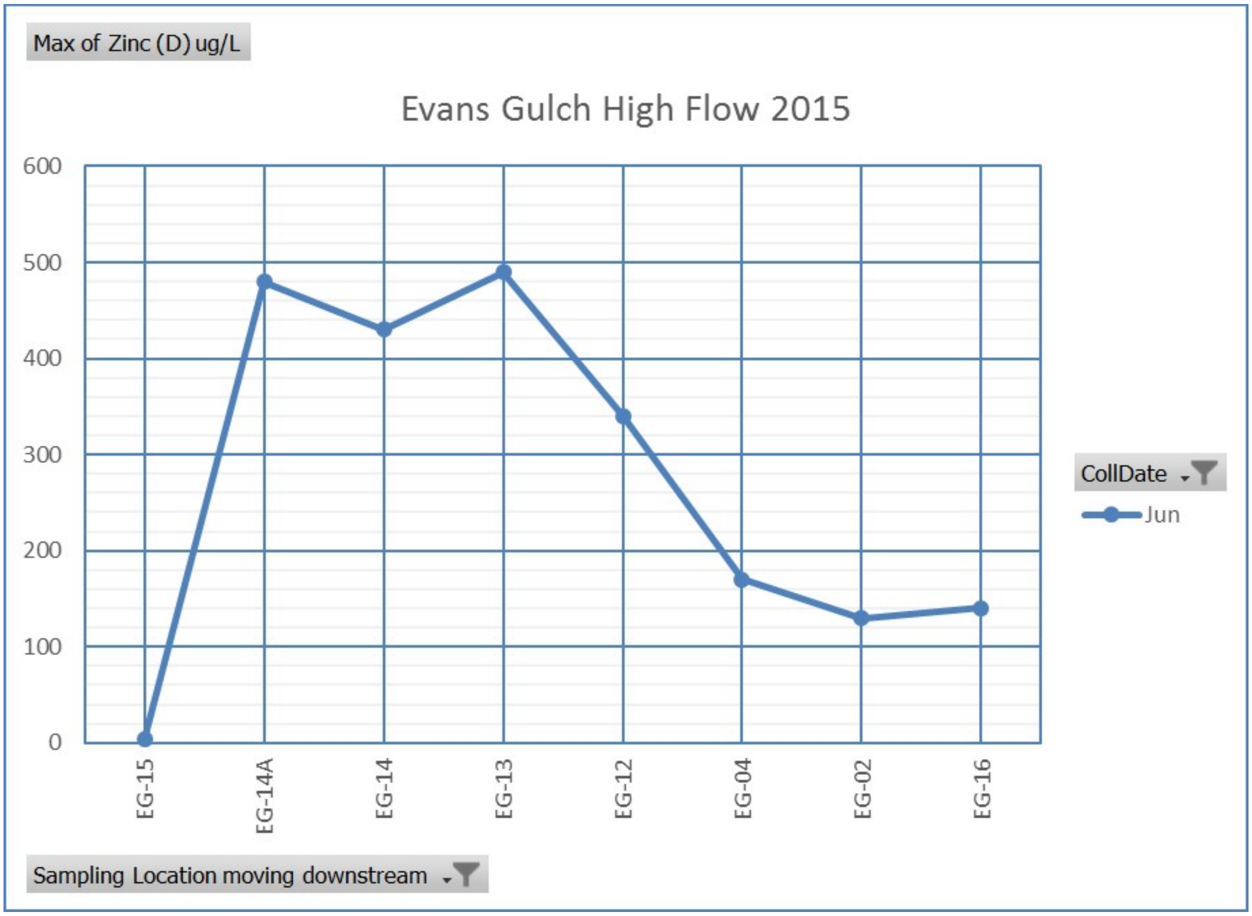


Figure 4.7: Maximum concentrations of zinc (ug/L) during the high flow sampling event in on June 4th, 2015. Moving left to right on the x-axis are sampling locations beginning at the most upstream location (EG-15) and moving downstream to EG-16 at the confluence with the East Fork of the Arkansas River.

4.1.2 South Evans Gulch

Three sites compose the South Evans Gulch drainage with SEG11 being the most upstream, unaffected site, and SEG10 being the farthest downstream. South Evans Gulch is the first drainage that adds flow to the mainstem of Evans Gulch flowing from an upstream to downstream direction. Like Evans Gulch, South Evans is littered with historic mine tailings/waste deposits that have the potential to degrade water quality via non-point source pollution. Although Evans Gulch is not listed for cadmium contamination, sites SEG10 and SEG10.5 both exceed chronic standards for high and low flow values. Acute values are not exceeded, but this jump in cadmium during high and low flow conditions should be noted.

Site SEG10 is several hundred yards upstream of the confluence with Evans Gulch and is the most downstream site on South Evans Gulch. Both chronic and acute standards were exceeded during high flow measurements at SEG 10 (Figure 4.8). However, as opposed to Evans Gulch sites, low flow measurements were slightly below chronic standards by less than 5 µg/L. This was opposite of mainstem Evans Gulch, which saw significant decreases (> 50%) in zinc concentrations between high and low flow measurements.

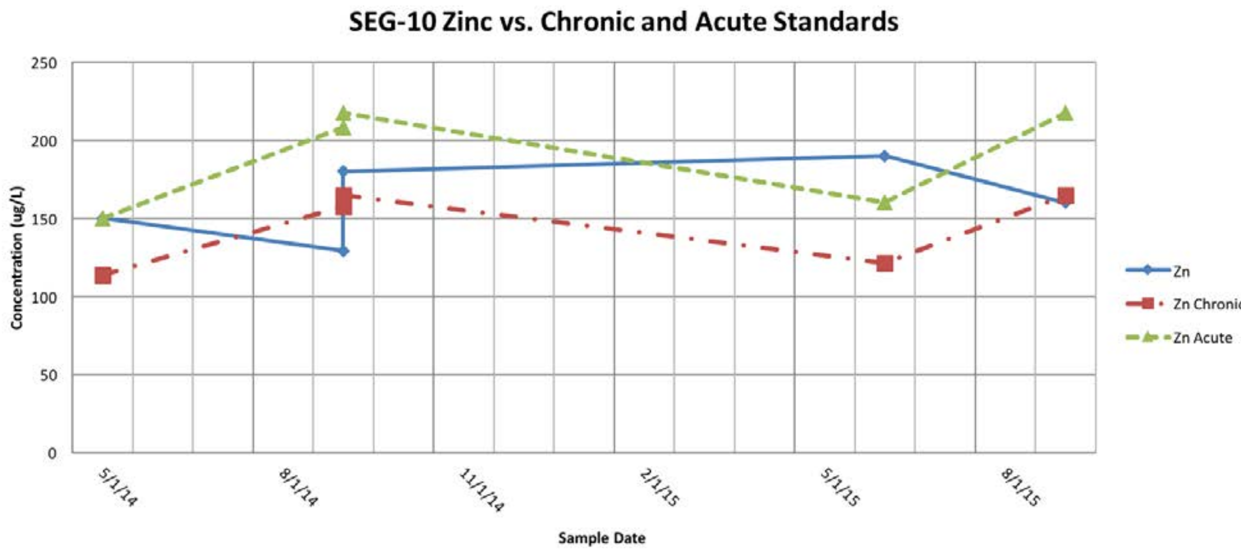


Figure 4.8: Zinc concentrations at SEG10 above both chronic and acute standards.

Upstream of SEG10 and below the outlet of the mine tailings pond is the location of SEG10.5. Site SEG10.5 was created in the field as an opportunity sample to evaluate the input of the mine tailings pond between the roadway and South Evans Gulch. Water in this pond is constantly in contact with fine grained tailings that make up the banks and pond bottom. High and low flow measurements yielded zinc concentrations above chronic standards and acute standards. (Figure 4.9). A 10 µg/L increase in zinc concentrations during the low flow sampling was observed between SEG10.5 and SEG10. Site SEG10.5 saw decreases in zinc concentrations from high to low flow measurements.

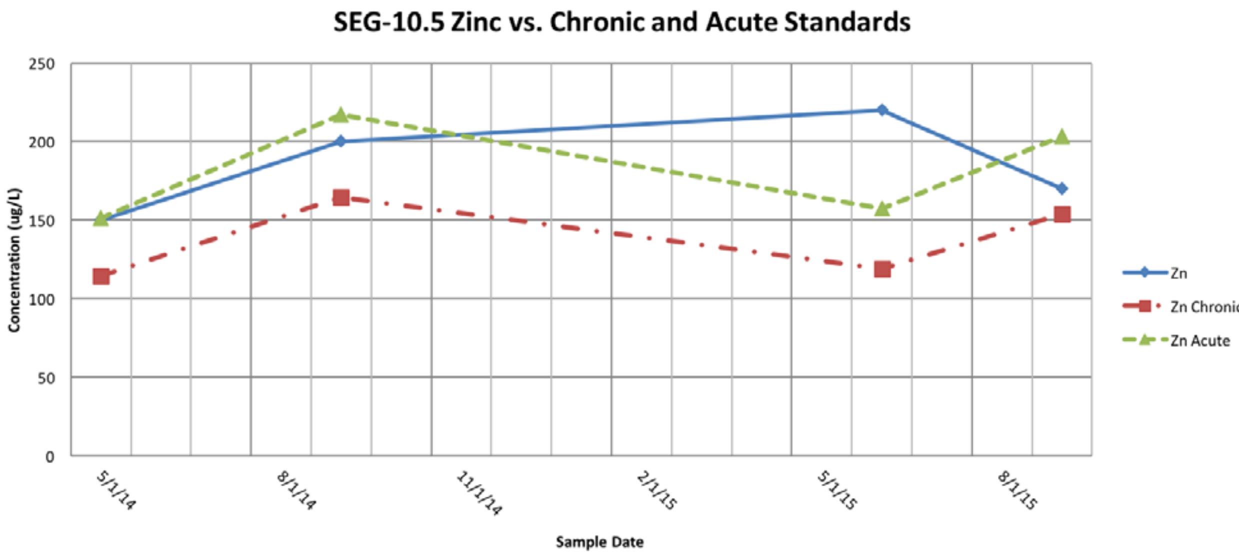


Figure 4.9: Zinc concentrations at SEG10.5 relative to chronic and acute standards.

Upstream of the mine tailings/waste piles and mine tailings pond is site SEG11. This site corresponds to a historic monitoring site, and represents the control site for South Evans Gulch. Site SEG11 has been consumed by a beaver pond network so flow data was not recorded during high or low flow monitoring. Concentration values for both cadmium and zinc were far below chronic and acute standards for all monitoring events in 2015.

To further evaluate the variability of zinc concentrations moving from upstream to downstream, a max zinc concentration graph was developed for the high flow sampling events that took place in May 2014 and June 2015 (Figure 4.10). The purpose of this Figure is to show how concentration of dissolved zinc varied between the most upstream control site (SEG-11) to the most downstream site (SEG-10) located upstream of the confluence with Evans Gulch at site EG-12. Almost negligible concentrations were observed in both years at SEG-11, while zinc spikes between 150 and 225 ug/L were recorded at site SEG-10.5, which is located downstream of the discharging mine pool. Levels of zinc slightly decreased between 150 and 190 ug/L once making it to site SEG-10. There seemed to be a small dilution effect during the June 2015 event between site SEG-10.5 and SEG-10. However, once zinc concentrations spike at SEG-10.5 due to the mine pool outflow, they maintain above chronic and acute standards moving downstream to site SEG-10. This graph indicates that high concentrations of zinc are maintained between upstream sites SEG-10.5 and SEG-10 due to their proximity to mining features.

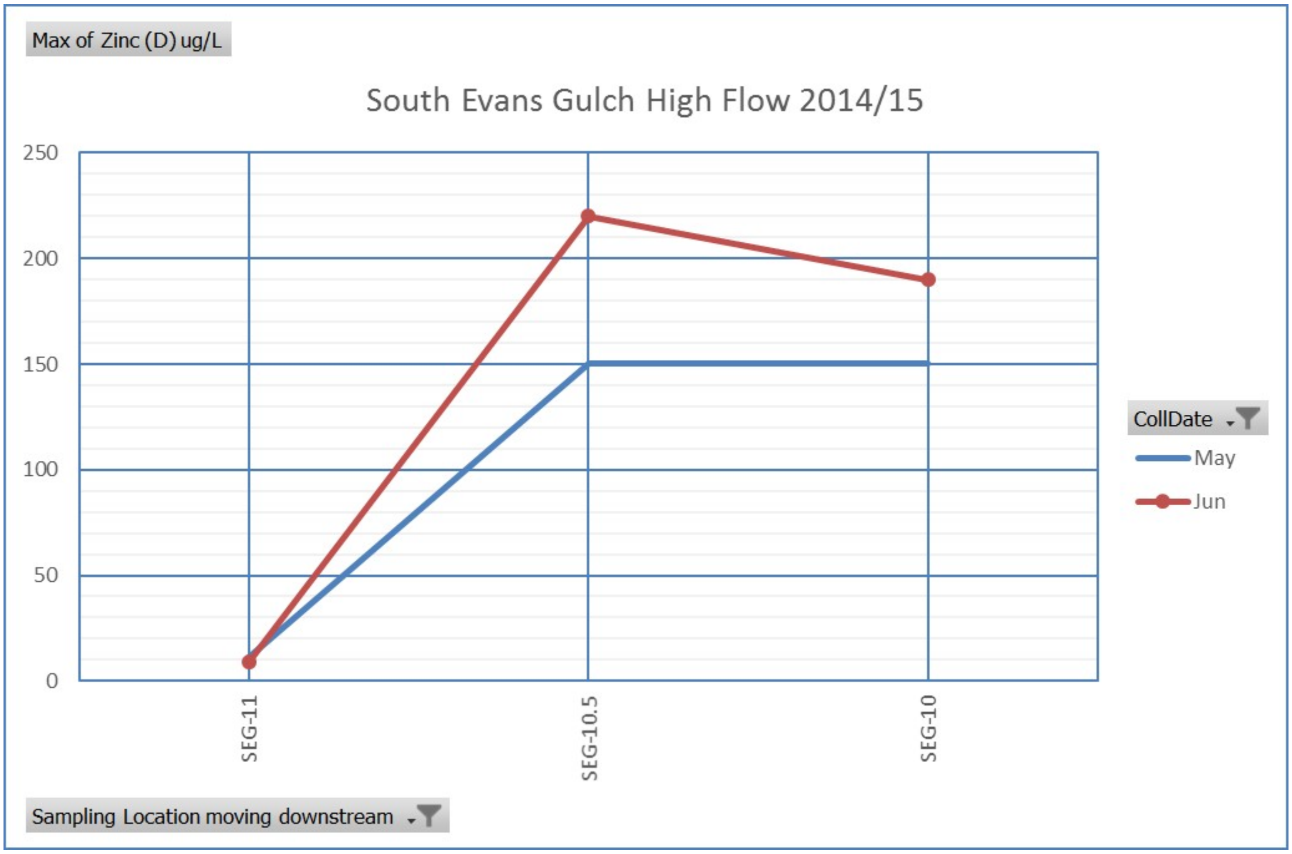


Figure 4.10: Maximum concentrations of zinc (ug/L) on South Evans Gulch during high flow sampling events of May 2014 and June 2015. Moving left to right on the x-axis are sampling locations beginning at the most upstream location (SEG-11) and moving downstream to SEG-10, which is upstream of the confluence with Evans Gulch at EG-12.

4.1.3 Lincoln Gulch

The Lincoln Gulch monitoring site (LEG01) is located between Evans Gulch and the outflow of the sedimentation pond at the base of the Lincoln Gulch riprap channel (Figure 4.11). The water level in this pond is highly dependent on the time of year. For the couple months associated with high flow, the pond is at the level shown in Figure 4.8. The pond is primarily dry for the remaining months unless filled briefly by a significant rainfall event. Therefore, spikes in zinc levels from Lincoln Gulch would occur during spring runoff and summer precipitation events, corresponding with the rest of the Evans Gulch watershed.

Water quality measurements at LEG01 were recorded only for high flow due to the absence of water during low flow sampling. Cadmium and zinc concentrations were the highest of all sites in the watershed. For example, a cadmium concentration of 41 µg/L was recorded in 2015, which was over 7.8 times the acute standard. In 2015, a zinc concentration of 8,900 µg/L was recorded, which corresponded to 28.3 times the acute standard. Even through only 0.0468 cfs was the recorded high flow value, consideration should be given to this drainage contribution during a several hundred-year flood event. This site will help further quantify the potential effect of Lincoln Gulch on downstream Evans Gulch.

Figure 4.11: Sedimentation pond at the termination of the riprap lined section of Lincoln Gulch.

4.2 Quantify Pollutant Loads and Load Reductions

In addition to comparison of metals concentrations with chronic and acute standards, loading rates were also quantified for each of the 12 sites in the monitoring plan for Evans Gulch 2014-15 data. Like the concentration analysis, sites are broken up to reveal significant loaders and their contribution to up and downstream sites. Loading was calculated at each site, and influence between sites and features was done by subtracting the load from an incoming/upstream site, when applicable. This exercise allowed to for evaluation of load resonating from a feature, seep, or site, which allowed for verification of loading sources moving downstream through the watershed. Loads were calculated for zinc since it was the primary contaminant of concern (COC) in the associated TMDL.

4.2.1 Identification of Loading Calculations and Methods

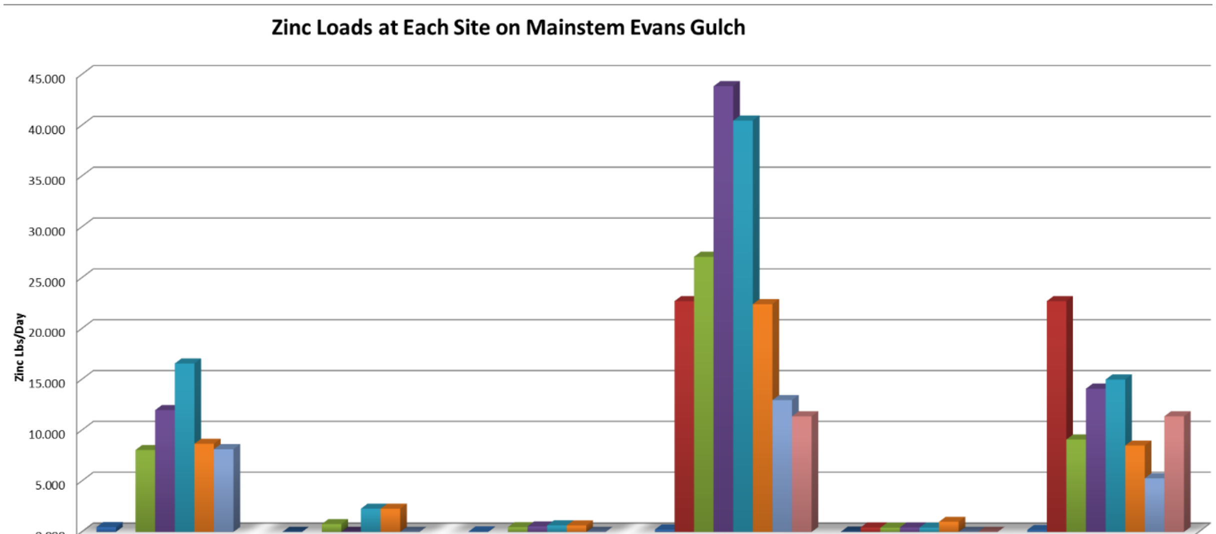
Loading calculations were performed for each site and sampling event to convert metals concentrations into loading rates. To be able to successfully calculate individual loading rates, an associated flow rate also had to be recorded during the sampling event. Flow was measured in cubic feet per second (cfs) and metal concentrations were measured in micrograms per liter (ug/L). To calculate a loading rate in pounds per day (lbs/day) the following equation was used:

$$((\frac{[ug/L]*2.205*10^{-9}}{0.0353})*[cfs])*86,400)$$

Loading rates were evaluated similarly to the way that chronic and acute standards were in regards to location. Bar charts were also useful to compare loading rates per site and sampling event. A "0.000" in the bar chart signifies either a non-measurable flow or an event in which the site was not sampled. An average column is included in each bar chart, which represents the average of high, mid-summer, and low flow 2014-15 data.

4.2.2 Evans Gulch

The loading evaluation for Evans Gulch is broken down for all of the sites within the mainstem (Figure 4.12). This analysis has sites listed from the most upstream site (EG-15) to the most downstream site (EG-16) at the confluence with the East Fork to best show how loads varied throughout the watershed. It should be noted that these loading rates are at each site, and not extrapolated from each site. This shows how the total load fluctuates as it moves through the entire watershed. The highest zinc loading rate (43.84 lbs/day) was observed at site EG13 during 2015 high flow conditions. An average loading rate resulting from EG12 was 14.984 lbs/day. The next highest consistent average load was recorded at site EG13, which is upstream of site EG12 and downstream of several mine tailings/waste piles located in the floodplain. A significant note from 2015 data evaluation would be the observation of 22.693 lb/day at the newly established EG14A site. The formation of this site shows that priority should be given to the mine waste pile on the DollyVarden/Annie C claim.

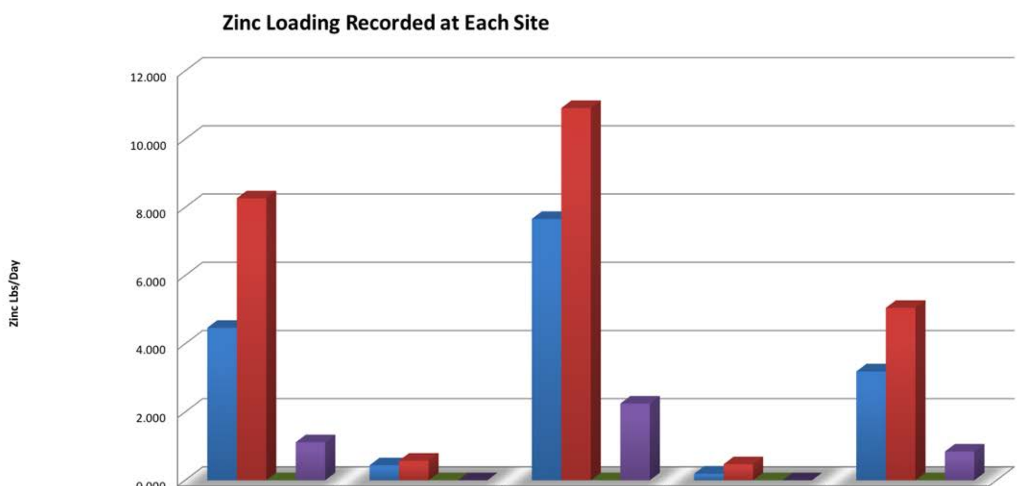


	High Flow 2014	Mid-Summer flow 2014	Low Flow 2014	High Flow 2015	Low Flow 2015	Average
EG-15	0.459	0.000	0.038	0.225	0.021	0.180
EG-14A				22.693	0.431	22.693
EG-14	8.055	0.763	0.458	27.059	0.406	9.084
EG-13	11.980	0.000	0.534	43.846	0.432	14.090
EG-12	16.558	2.279	0.638	40.461	0.418	14.984
EG-04	8.665	2.276	0.632	22.405	0.991	8.495
EG-02	8.138	0.000	0.000	12.966	0.000	5.276
EG-16				11.371	0.000	11.371

Figure 4.12: Zinc loading rates at each site on the mainstem of Evans Gulch for 2015

4.2.3 South Evans and Lincoln Gulches

Both contributing drainages are combined on one bar chart for the simplicity of analyses. Site SEG10.5 yielded the highest loading rates for all sampling intervals in 2014 and 2015, followed by SEG10, LEG01, and SEG11, respectively (Figure 4.13). The 2015 high flow loading rate for SEG10.5 was 10.912 lbs/day, followed by 7.660 lbs/day at site SEG10, and 0.00 lbs/day at the control site, SEG11. The influence of the mine tailing pile and pond discharge is evident by the large increase in load between SEG11 and SEG10.5. Site LEG01 had a high flow loading rate of 2.248 lbs/day, which is indicative of the low flow value rather than the 8,900 ug/L observed zinc concentration. Site LEG01, and Lincoln Gulch, have the ability to severely degrade downstream water quality given a prolonged flood event.



	High Flow 2014	Low Flow 2014	High Flow 2015	Low Flow 2015	Average
SEG-10 - South Evans Gulch downstream of mine influences	4.469	0.437	7.660	0.190	3.189
SEG-10.5 - South Evans Gulch downstream IBEX pile	8.265	0.572	10.912	0.468	5.054
SEG-11 - South Evans Gulch upstream of large taillings deposits and within Beaver Pond network.	0.000	0.000	0.000	0.000	0.000
LEG-01 - Lincoln Gulch downstream of settling pond outlet	1.113	0.000	2.248	0.000	0.840

Figure 4.13: Zinc loading rates for sites in South Evans Gulch and Lincoln Gulch

4.2.4 Loading Discussion

The discussion of loading rates primarily focused on the high flow time period when Evans Gulch does not commonly meet TVS. The sites of SEG11 and EG15 yielded very low loading rates, as well as concentration values, thus verifying their “control” status within the watershed. Loading rates between control site EG15 and EG14 saw a 26.8 lbs/day increase in 2015, which is much higher than the 7.6 lbs/ day increase in 2014. This significant jump in loading between sites was unexpected, and was quantified by the addition of site EG14A between the two locations. The result of this addition was approximately a 22.468 lbs/day increase between EG15 and EG14A. A definitive rise of 16.8 lbs/day was observed moving downstream between sites EG14 and EG13. This type of increase was anticipated due to the mine tailings/waste piles that are located in this area along the creek and in the floodplain (Figure 4.14).

Figure 4.14: Mine tailings/waste piles located between sites EG14 and EG13. The left photo represents before conditions and the right photo shows re-graded and re-vegetated piles of Streamside in the foreground and Valley in the background. The active erosion in the left photo was on reason for including this site in the reclamation plan.

A 3.38 lbs/day decrease was observed between sites EG13 and downstream site EG12 in 2015. Last year there was an increase in loading between these sites, which was unexpected because of the lack of mine structures between the locations. The data from 2015 is more indicative of the surrounding conditions. However, EG12 is downstream of the confluence with South Evans Gulch, which saw a loading rate of 7.66 lbs/day at the most downstream site (SEG10). Even though this loading rate at SEG10 was almost 3.0 lbs/day higher than the 2014 value, a direct correlation to EG12 loads was unattainable. However, in 2014, this additional load from South Evans Gulch almost equaled the difference between EG13 and EG12 and could explain the rise between sites. It is possible that zinc loads from the large mine tailings/waste piles and tailing pond adjacent to site SEG10.5 could be affecting water quality downstream in Evans Gulch during periods of low flow due to its continual drainage (Figure 4.15)

Figure 4.15: Mine tailings/waste piles and tailings pond adjacent to South Evans Gulch. The outflow of the pond flows left out of the frame and into South Evans Gulch above site SEG10.5.

Zinc loading rates are reduced by almost 50% between EG12 and downstream EG04 even with a 1.1 lbs/day contribution from LEG01 between sites. The influence from LEG01 could be considered minimal given the reduction in load from EG12 to EG04. Data from 2015 showed a decrease in zinc loading moving downstream towards the confluence with the East Fork of the Arkansas River. Specifically, a 22.405 lbs/day zinc load was recorded at EG04 while a 12.966 lbs/day zinc load was observed downstream at EG02 adjacent to Hwy 91. The furthest site downstream, EG16, then saw a continued decrease in zinc load of 11.371 lbs/day, which still is a pretty significant source to the East Fork of the Arkansas River.

4.2.5 Load Rankings and Reductions

To prioritize short and long-term goals, a project priority ranking was developed evaluating the amount of load measured from eight sites during high flow sampling efforts in 2014-15 (Table 4.1). Only the high flow values are discussed in the table below because Evans Gulch has historically exceeded TVS during spring runoff or precipitation events. These loads are slightly different than the loads discussed in prior sections and were calculated by subtracting the upstream load from the given load at a particular site. Through this methodology, the load resulting from *each* site can be extrapolated, which is more applicable for source determination. Sites at which load values are negative mean that a decrease in load was observed when subtracted from the load present at the most immediate upstream location. A project priority ranking was created based the load values resulting from each site. This ranking was meant to act as reference for project partners to prioritize and plan future clean-up projects within Evans and South Evans Gulch. Based on the ranking system below, EG14A, EG13, and SEG10.5 were deemed the top three most important project sites. The methodology behind the top ranking stems from consistently high load vales from site EG-14A, as well as the accessibility of the two suspected loading sources adjacent to site EG-14 and EG-13. The number one ranked site is EG14A, which captures loading from the Dolly Varden/Annie C claims and its associated waste piles. These piles sit near the edge of Evans Gulch and have shown to be a significant loader to the watershed, as evidenced by the 22.468 lbs/day value observed in 2015. Since access for this site was never gained due to ownership by Leadville Corp., priority focus moved to sites where ownership was granted. Therefore, sites EG-13 and EG-14 were ranked second and fourth, respectively and see loading input from the Valley Mine area and Streamside tailings that abut Evans Gulch immediately upstream of EG-13. Landowners in this vicinity were cooperative, which made these sites a high priority for cleanup opportunities. Site SEG10.5 was ranked number three because of its continual loading via the discharge of the mine pool that bordered by mine tailings/waste. It also was a fairly easy conceptual first clean-up step, which would involve draining the pond to prevent future discharge into South Evans Gulch.

Based on the 2014-15 data, the South Evans drainage, EG14A, and the contributions near EG13 made up the three largest source contributors of zinc load to Evans Gulch. However, beyond these three sites, there are significantly less identifiable loading sources and sites. Excellent data was gathered using the SAP in 2014-15, as well as a 2016 soil sampling event at four sites.

Table 4.1: Project priority ranking of sources based on 2014-15 high flow zinc loading rates resulting from each site.

Sampling Site and Suspected Source	2014 High Flow Zn Load (lbs/day)	2015 High Flow Zn Load (lbs/day)	Project Priority Ranking
EG15 – Control Site on EG	0.459	0.224583	**8**
EG14 – In between mine waste deposits	7.596	4.366	**4**
EG13 – DS of streamside tailings and Valley mine	3.925	16.787	**2**
SEG10.5 – Tailings Pile and pond outflow	8.265	10.912	**3**
EG12 – Below SEG confluence	4.578	-3.385	**6**
LEG01 – Lincoln Gulch pond outflow	1.113	2.248	**5**
EG04 – DS of Lincoln Gulch inflow	-7.893	-18.056	**7**
EG14A – DS of Annie C waste piles	N/A	22.468	**1**

4.2.6 Source Identification

Through the 2014-15 water quality sampling efforts and subsequent data investigation, four mine tailings/waste piles were identified as non-point source loaders in the watershed (Figure 4.16). The pile associated with EG13 North is referred to as the Streamside tailings and has an area of 0.24 acres. Across the drainage is EG13 South, which is considered the Valley Mine complex. This site has a footprint of 1.10 acres and shows evidence of stained drainage into Evans Gulch during high flow. The South Evans Gulch drainage source is a large pile and pond discharge representing 1.23 acres.

Additionally, 2015 sampling revealed a new source upstream of EG14 and EG14A at the Dolly Varden/Annie C mine waste pile. This site was ranked number one on the priority ranking and was briefly investigated during 2016 soil sampling, but not considered for reclamation due ownership issues. Not shown on the map was an additional site selected during talks in early 2018 with the landowner of the Streamside and South Evans Gulch sites. This site was called the Silver Spoon and is directly north and across the road from the Streamside site shown on the map below.

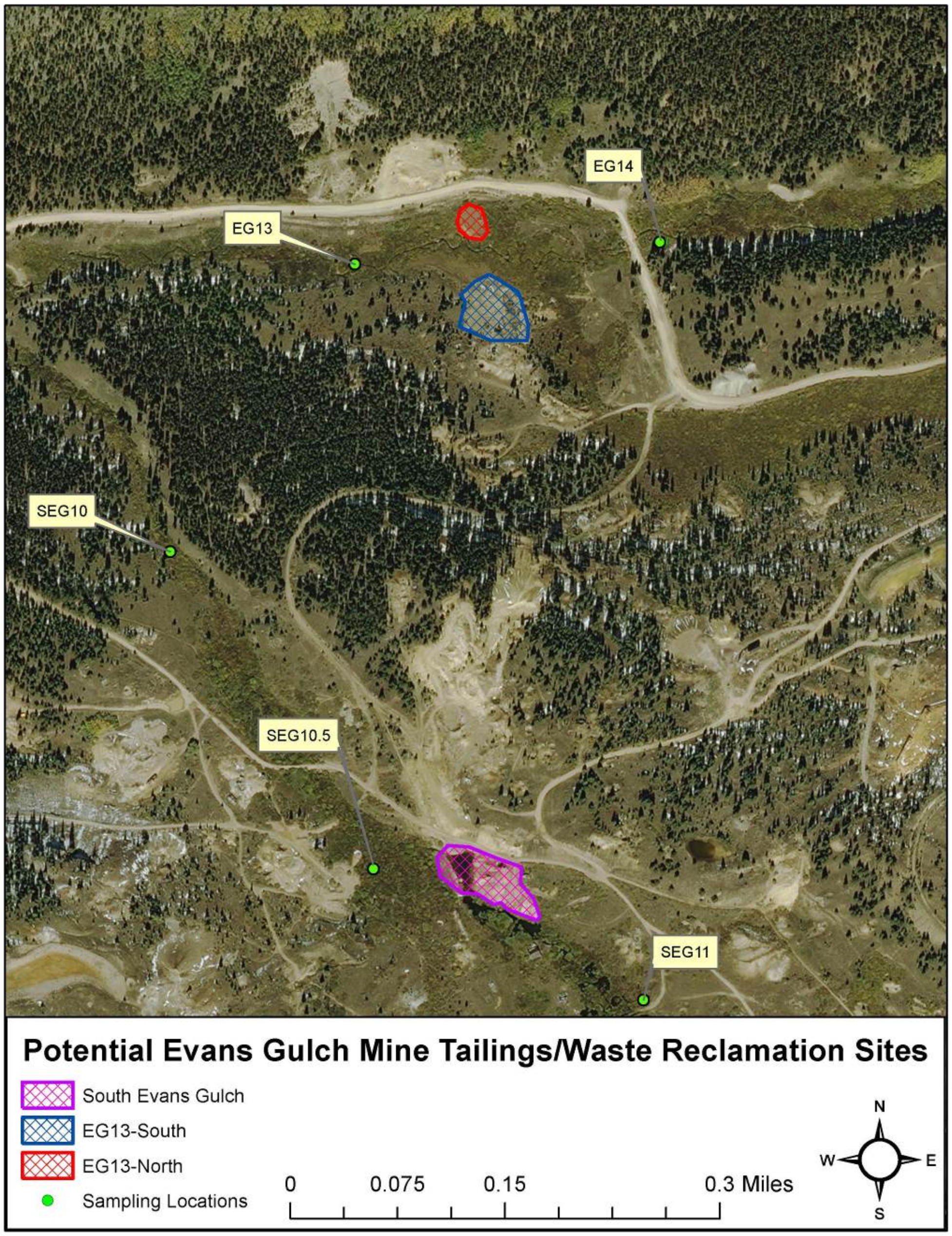


Figure 4.16: Identified non-point source locations in the Evans Gulch Watershed

4.3 Sampling Evaluation and Exceedances

Evaluating the soil sampling results from the August 2016 event revealed high concentrations of zinc and other heavy metals suspected to be contained in the mine waste and tailings present on site. This data allowed TU and project partners the ability to determine if sites could be treated in place, or if other BMPs would have to be utilized to best reclaim each site.

4.3.1 EG-13 North – Streamside Tailings

The Streamside tailings site (0.24 acres) abutted the right bank of Evans Gulch between WQ sampling sites EG-14 and EG-13. Zinc concentrations throughout the 30 XRF sample sites ranged between 694 mg/kg to a maximum of 16,562 mg/kg. Of the 30 sample sites, four locations exceeded 10,000 mg/kg while 24 yielded numbers higher than 1,000 mg/kg.

Results from the FLT investigations produced a dissolved zinc concentration of 200 ug/L, which fell between the chronic and acute site-specific standards of 172.04 ug/L and 227.14 ug/L, respectively. This analysis shows that the Streamside tailings pile can potentially degrade the receiving waters of Evans Gulch during high flow or high intensity rainfall events. Although the FLT concentration does not exceed the acute TVS, it has the potential to have a longer-term effect compared to the chronic standard.

4.3.2 EG-13 South – Valley Mine

Located across the drainage from the Streamside tailings area, the Valley Mine was approximately 1.10 acres with a variety of waste rock and fine-grained tailings. Although this site does not abut Evans Gulch like Streamside, it has a large dead zone that extends from the toe of the waste rock pile towards Evans Gulch. Zinc concentrations throughout the 30 XRF sample sites ranged from a minimum of 216 mg/kg to a maximum of 14,227 mg/kg. Of the 30 sample sites, two locations exceeded 10,000 mg/kg while 13 yielded numbers higher than 1,000 mg/kg. Upon initial comparison, zinc concentrations at the Valley Mine site were a fair bit lower than those from the Streamside site. Specifically, there are 15 sites at the Valley Mine that had concentrations below 1,000 mg/kg while Streamside only had two below that threshold. However, subsequent FLT values from the Valley Mine were an order of magnitude above those from the Streamside site, which agree with the type of waste rock and tailings present at the Valley site.

Results from the FLT investigations produced a dissolved zinc concentration of 9,800 ug/L, which largely exceeded both the chronic and acute site-specific standards of 54.82 ug/L and 72.38 ug/L, respectively. This analysis showed that the Valley Mine site can certainly degrade the receiving waters of Evans Gulch during high flow or high intensity rainfall events. The dead zone adjacent to the toe of the waste rock pile was also a good indication of poor water quality that is phytotoxic to the surrounding plant community. This site has the potential to have a longer-term detrimental effect to the watershed compared to the Streamside tailings site.

4.3.3 Dolly Varden/Annie C

While smaller in area than the Valley Mine, the Dolly Varden/Annie C have taller and steeper slopes of unconsolidated tailings that abut a long section of Evans Gulch immediately upstream of WQ monitoring site EG-14A. It should be noted that full access was not received for this site so only 12 XRF sites were measured as part of the sampling at this site. Zinc concentrations throughout these 12 XRF sample sites ranged between 503 mg/kg to a maximum of 46,871 mg/kg. Of the 12 sample sites, seven locations exceeded 10,000 mg/kg while 4 yielded numbers higher than 1,000 mg/kg. The maximum zinc concentration at this site was approximately 30,000 mg/kg larger than highest values found at the Streamside or Valley sites. With seven sites higher than 10,000 mg/kg, the Dolly Varden/Annie C had one more site above that threshold than Streamside and Valley sites combined. The increases in zinc concentrations at site EG-14A during the 2015 WQ sampling event could be a direct result of the non-point source runoff from this site. If future access is granted for this entire site, a full soil sampling event should take place to officially characterize the pile contents and runoff potential. Because a landowner access was not in place for most of the site, a FLT test was not completed during this event. This should be considered in the future in accordance with SAP protocol and considered for future phases of the project.

4.3.4 South Evans Gulch

The South Evans Gulch site was the only location not in the predominant Evans Gulch drainage. However, it is the largest in area of all the potential source areas at 1.23 acres. Part of this large tailings and waste rock pile abuts the right bank of South Evans Gulch upstream of site SEG-10.5. Zinc concentrations throughout the 30 XRF sample sites ranged between 477 mg/kg to a maximum of 14,142 mg/kg. Of the 30 sample sites, six locations exceeded 10,000 mg/kg while 19 yielded numbers higher than 1,000 mg/kg. The six locations that exceeded 10,000 mg/kg at this site equal the total of locations exceeding that threshold at both Streamside and Valley combined. Thus, showing that zinc present in the surrounding tailings/waste rock could be degrading the water quality of the associated mine pool. Results from the FLT investigations produced a dissolved zinc concentration of 3,300 ug/L, which largely exceeded both the chronic and acute site-specific standards of 141.96 ug/L and 187.43 ug/L, respectively. Second to only the Valley mine in dissolved zinc runoff potential, South Evans Gulch showed that it can also produce non-point source runoff in excess of TVS standards. This analysis showed that the South Evans Gulch pile and mine pool provide perennial degradation to the receiving waters of South Evans Gulch during high flow, high intensity rainfall, or even as a baseline. The perennial discharge and contact of the pond surface water with pyritic tailings/waste rock could be the underlying source of year-long contamination in South Evans Gulch. Previous water quality analyses displayed that zinc concentrations exceed the chronic standards in both 2014/15 high and low flow sampling events. This is contradictory to mainstem Evans sites that all fall below both acute and chronic standards during low flow periods. Draining the pond and re-grading the tailings/waste rock to eliminate a perennial source was a priority for this scope of work, but was ultimately tabled because of fluvial hazard concerns from remedial EPA staff.

4.4 Recommended Actions

The priority rankings in Table 4-1 were initially used as a guide and justification for reclamation. Ultimately, higher ranked sites like EG-14A and SEG were dropped from the reclamation plan due to lack of owner approval or agency concerns. Therefore, reclamation design was focused entirely on the Evans Gulch side of the watershed at the Silver Spoon, Streamside, and Valley Mine sites. TU worked with Duraroot Consultants beginning in February of 2018 to develop a 30% design at these three selected sites that would later guide construction and reclamation efforts.

5.0 30% Design Summary

Trout Unlimited (TU) staff contracted with Duraroot Consultants and H-2 Enterprises LLC in early 2018 on a design-build contract. Work associated with this contract began in February 2018 when a scoping meeting took place between TU, Duraroot, H-2, EPA, and CDPHE staff regarding proposed site locations, BMP selection, schedule, data gaps, and liability protection mechanism. It was during this meeting that four sites were initially included in the 30% design scope, which included the Silver Spoon, Streamside, Valley Mine, and South Evans Gulch (SEG) sites. However, after subsequent data gathering and technical memo for the SEG site, EPA Remedial staff decided the fluvial hazard risk was too large so that project site was dropped from the 2018 plan. Therefore, TU and Duraroot moved forward on reclamation designs for the Silver Spoon, Streamside, and Valley Mine sites, which began in April 2018 with a drone flyover of the sites (Figure 5.1), followed by soil sampling, and amendment calculations. The Streamside and Valley Mine were two sites prioritized for reclamation through the loading evaluation and ranking process, but the Silver Spoon had not been included because the landowner was initially averse to any work being done at this site. Through further discussions in the Spring of 2018, this landowner became more involved with the project and ultimately supported a limited scope of work (SOW) at the Silver Spoon site. Since SEG had been eliminated from the design plan, the Silver Spoon was included in its place since project funding was available and active erosion of mine wastes were occurring on site.

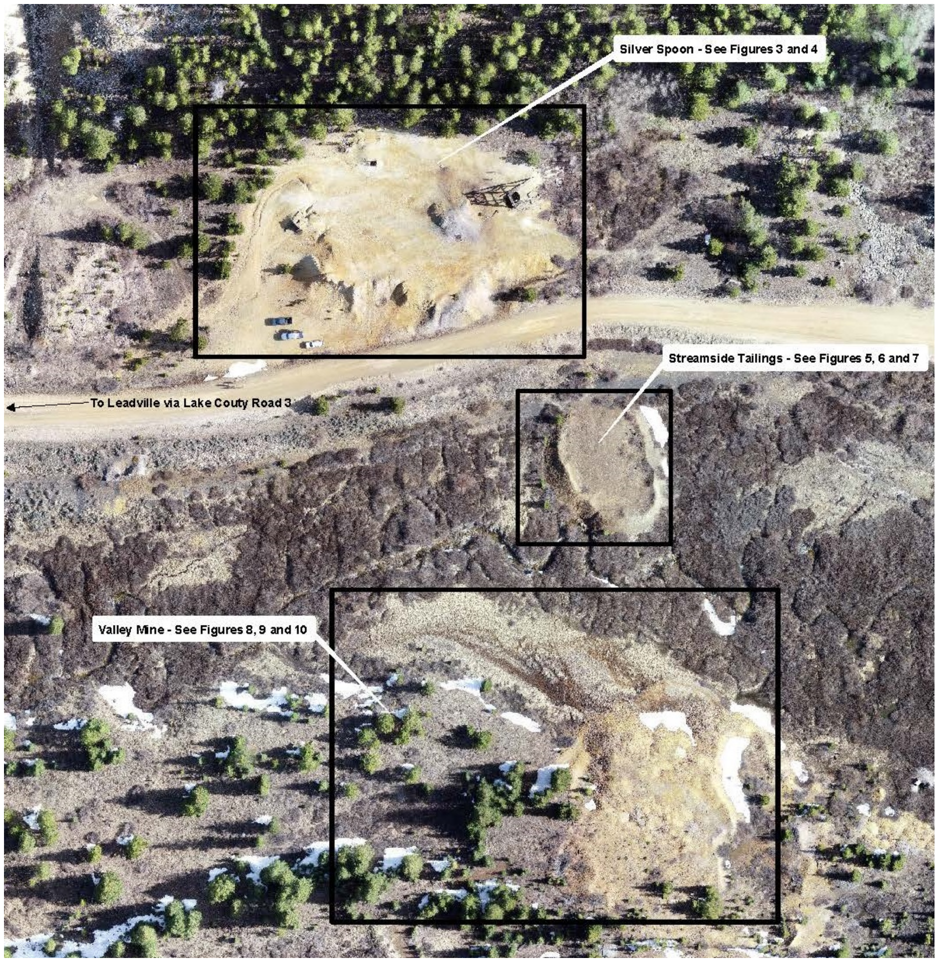


Figure 5.1: Aerial plan view of site extent for 2018 construction activities. The Silver Spoon mine site is on the northern portion of County Road 3, while Streamside and Valley Mine are on the south side, respectively. This aerial drone flyover will provide before conditions when compared to post-construction.

Since all proposed work was occurring in the main Evans Gulch drainage, the site footprint was relatively compact as shown in Figure 5.1. Lake County Rd. 3 divides the site with the Silver Spoon portion of work taking place on the north side of the road while Streamside and Valley happening on the south side of the road. The initial drone flyover gave good representation of the aerial extent of contamination, and will allow for good comparison with post-reclamation conditions when time allows. Design plans to the 30% level were created for each site with input from TU and project partners via a final meeting that took place in July of 2018. After this meeting, the field schedule, duties, and final design set was assembled into one package for use during construction and design approval letter. Portions of the final 30% design set are described in the subsections below for each site.

5.1 Silver Spoon

As mentioned above, the Silver Spoon SOW developed later in the project after consent and support was gained from the property owner. Since the owner wanted to have the option for reprocessing this material at some point, revegetation and in-situ treatment were not a design option. Instead, rough grading, erosion control, clean water management, and site safeguarding were included in the SOW (Figure 5.2). In its current condition, the over-steepened waste slopes and perennial seep were creating non-point source contamination along with an ice hazard in the winter. Therefore, approximately 325 cubic yards (CY) of waste was proposed for regrading to slopes no steeper than 2:1. Almost 800 linear feet of erosion control logs (wattles) were also prescribed to provide immediate erosion control to the freshly graded slopes. Due to the perennial seep present on site, 100 feet of EPDM and rock lined channel were also proposed to convey the clean water beneath Co. Rd. 3 via a 30 foot long culvert. This would reduce the interaction between the mine waste and water while also eliminating the ice plug that covers the road in the winter. Not shown on the design is approximately 280 feet of buck and rail fence that will be installed to prevent trespassing and OHV usage on the site.

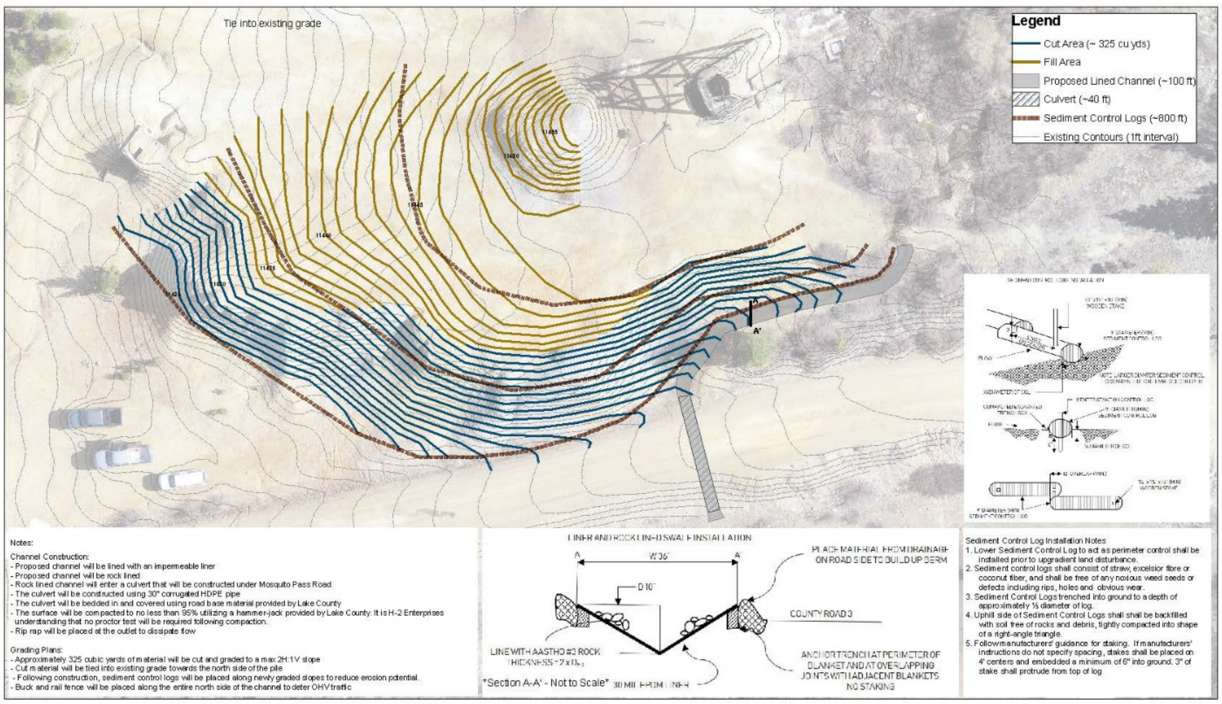


Figure 5.2: Silver Spoon 30% design detail showing re-graded slopes, wattle installation, channel path, and culvert location. Buck and rail fence is not shown, but is also included in plan.

5.2 Streamside

As one of the main suspected loaders between WQ monitoring sites EG 14 and EG 13, Streamside was ranked high on the prioritization list. The mine waste and tailings directly abutting over 40 feet of Evans Gulch were a priority during the design process. Soil samples taken in spring of 2018 revealed that lime/limestone wouldn't be necessary for revegetation of the waste pile due to the higher pH and decent organic content. The general plan involved excavation of over-steepened slope, and placement of that material on the re-graded pile (Figure 5.3). This would allow for an accessible floodplain bench along the right bank of Evans Gulch. This newly created bank would be stabilized with three locally harvested root wads that would also provide habitat. Up to 12 willows were recommended for installation between root wad structures to provide immediate stability with combination of sedge mats. The slope from the edge of the floodplain bench was specified at a slope of no more than 30 degrees up to the re-graded pile. The waste pile would then be graded to facilitate positive drainage in multiple directions while also reducing the steep slopes existing on the pile. Once final grading was completed, 1,000 pounds of 3-6-3 fertilizer and 50 cubic yards of compost would be mixed into the top 6-12 inches, followed by a native seed mix and mulch.

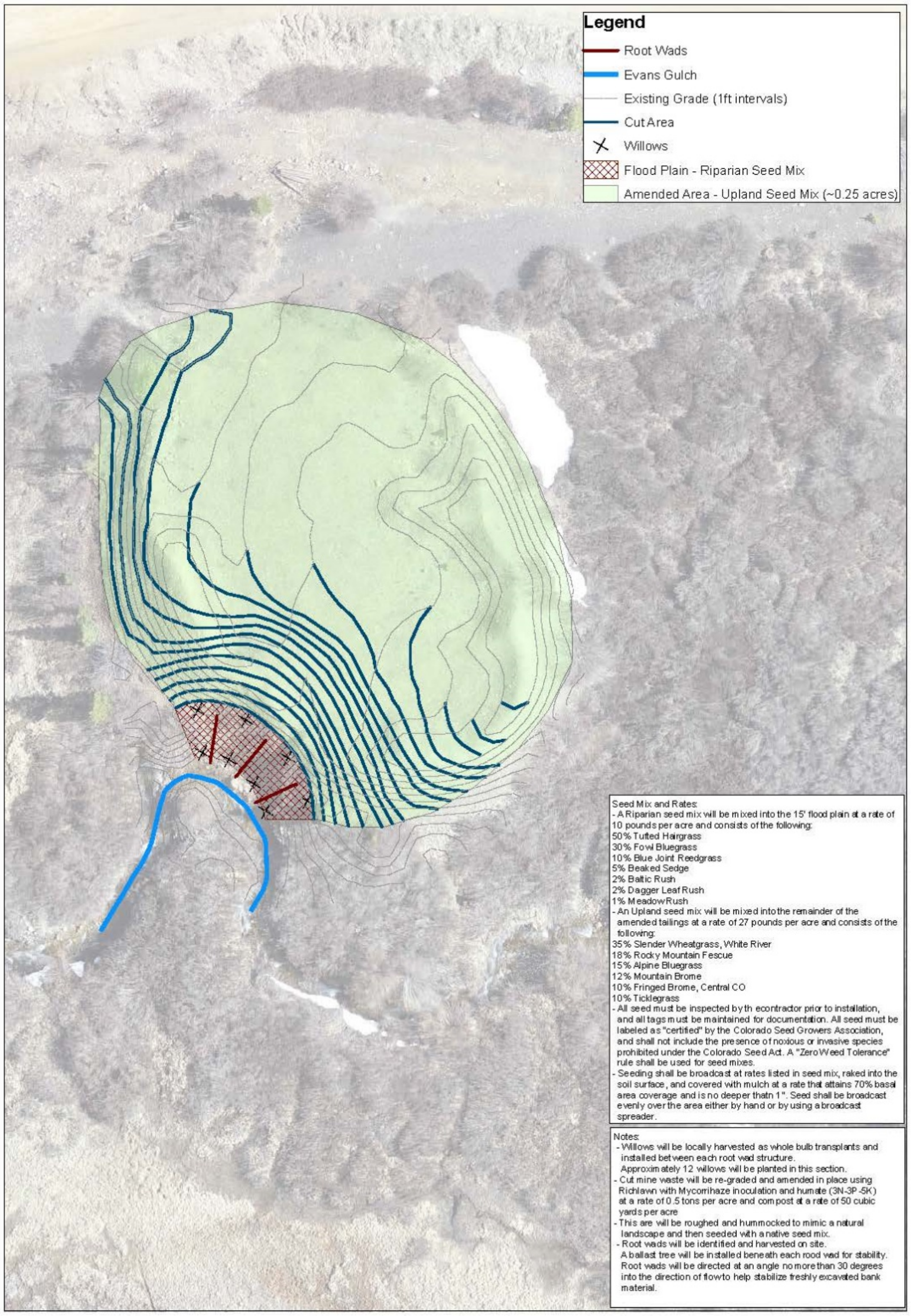


Figure 5.3: 30% design detail of the Streamside site showing section of over-steepened waste to be relocated on top of the pile, as well as proposed contour lines of cut material. A floodplain bench will be created with a combination of three root wads, 12 willows, and sedge mats.

5.3 Valley Mine

The Valley Mine was ranked second on the prioritization matrix due to the large dead zone visible downslope of the mine waste pile. It was this area, along with the mine waste pile that were the focus of the 30% design scope at this site. In a similar approach to the Streamside site, general waste pile re-grading was recommended at slopes no more than 3:1 (Figure 5.4). However, due to the more acidic nature of the waste material, TU specified that 100 tons of fine grained limestone be placed on top of the graded surface to help with buffering. After placement of limestone, the design also called for 1,000 pounds of 3-6-3 fertilizer, 30 cubic yards of compost, and 300 tons of a clean fill cap material. The addition of the cap material would help prevent migration of material off site, while also providing a buffer between waste and the ecological community. The cap should then be seeded and mulched to facilitate growth of a native plant community. The dead zone area of the Valley Mine will include application of 3-6-3 fertilizer and native seed broadcast by hand to promote more vegetation growth. Approximately 40 whole willow clumps will be transplanted along with 100 live cuttings to help buffer migration of contaminated material and fill in the wetland. These two main phases of the design will hopefully improve the water quality in Evans Gulch.

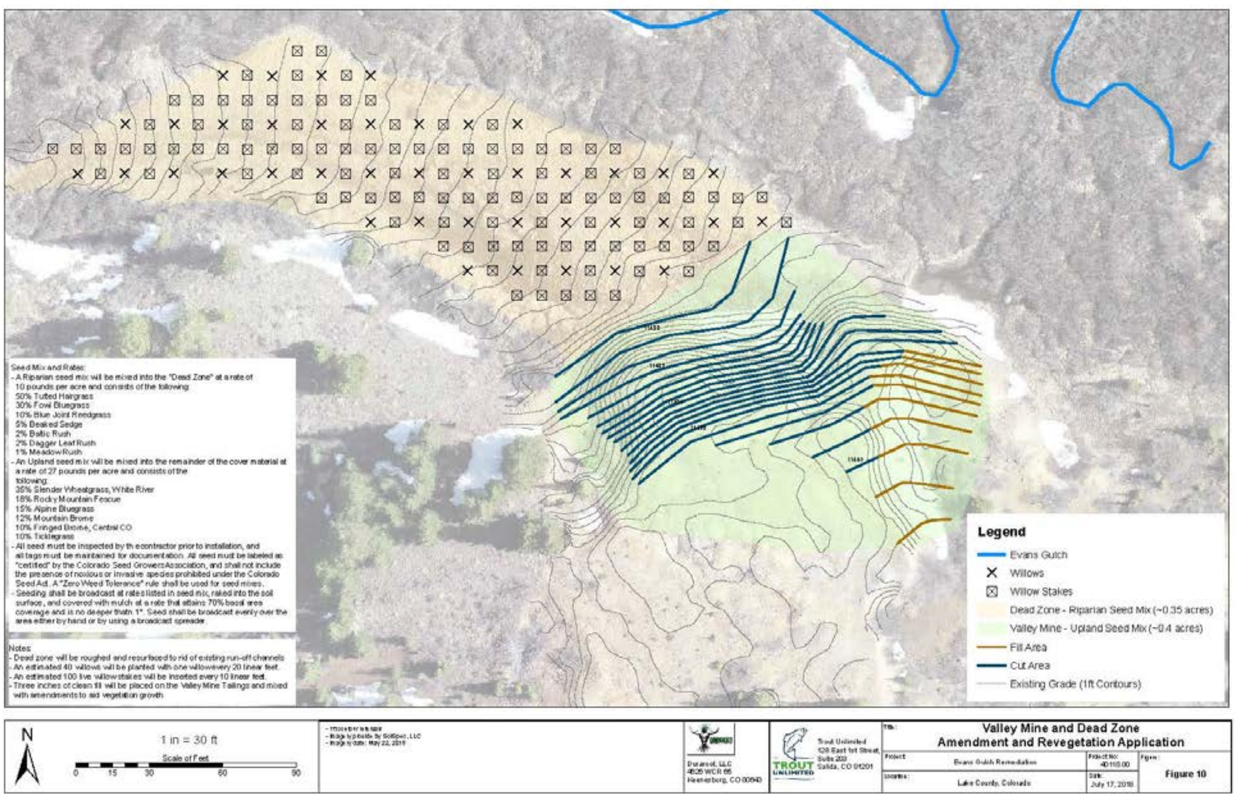


Figure 5.4: 30% design detail of the Valley Mine depicting location of 40 willow clumps and 100 cuttings in the dead zone, as well as cut/fill areas of the waste pile that are to be re-graded, amended, and revegetated.

6.0 Construction Summary

Through the aforementioned sampling and design process, TU was able to prioritize three sites for reclamation that were suspected sources of non-point source pollution. After the final project meeting with EPA, State, and Contractors in July 2018, all necessary permits to complete work were acquired by TU staff. These included a general grading and excavation permit from Lake County, confirmation of deference from U.S. Army Corp. of Engineers for stream work, Comfort Letter, and design approval letter. Due to delays and deliberations on Comfort/Design Approval letter language construction was bumped back a week, and ultimately began on August 20th, 2018 when H-2 Enterprises mobilized to the site. Construction operations lasted just over three weeks ending with a final walk-through taking place on September 11th, 2018 with EPA, Contractors, and TU staff.

6.1 Silver Spoon Reclamation

Although the Silver Spoon site was closest to Co. Rd. 3, work was completed last due to the culvert installation and ongoing DRMS work at the site to safeguard a collapsed stope where the former head frame was located. As discussed in the design sections, work at this site was focused on reducing the interaction of seep flow with existing mine waste. Prior to construction, the perennial seep flowed across mine waste and along the toe of a steep slope next to the road. Not only did this pick up heavy metals along the way, but it also created an ice flow across the road in the winter. TU staff worked with the contractor to install 30 feet of 2.5 ft. diameter reinforced HDPE culvert beneath the road so seep water would have a better route to flow during the winter (Figure 6.1). Proper precautions were taken by the crew and the full section of culvert was installed in one day to minimize traffic issues. After proper compaction of road base material and collar installation, a 100 ft. section of EPDM lined channel was excavated from the seep source to the edge of the culvert collar. This process allowed for seep water to be immediately turned into the culvert to minimize saturation of mine waste along the roadway. Following placement of EPDM liner, approximately 50 tons of 9-15 inch riprap was placed throughout the length of the channel up to the collar. As seen in Figure 6.1, a rock apron was constructed between the channel and culvert collar on the upstream side to capture flow into the culvert. In addition to rock apron placement, riprap was also placed on the downstream side of the culvert in the form of a rock lined channel that will help disperse and attenuate flow over the fill slope below. After successful installation of the culvert and channel, the slope of the mine waste piles was reduced through grading and compaction, followed by installation of wattles for erosion control. The top two to three feet of the steepest portion of the mine waste piles was taken off to reduce the slope and promote a more dispersed flow regime. To conclude work at the site, the crew assembled over 200 feet of buck and rail fence to preclude site access, while providing a more refined parking and turn-around area.

Figure 6.1: Before (upper left) conditions showing excavator and seep flow trending towards the mine waste pile on the edge of the frame and during (upper right) showing depth of excavation and road disturbance necessary to install the culvert. During this excavation, water was diverted around the culvert in the right of the photo. The after conditions (bottom) show installed culvert with collar and interface with lined section of channel. Note that former seep path to the right is dry because water is flowing through culvert in the photo.

6.2 Streamside Reclamation

The proposed design at the Streamside site had the most direct correlation to mine waste and Evans Gulch. The 40 ft. long, 20 ft. high mine waste pile that abutted Evans Gulch was excavated and consolidated with the rest of the pile. This was accomplished by first installing a silt fence to reduce sediment loading to Evans Gulch during construction (Figure 6.2).

Figure 6.2: (Left) Before conditions showing Streamside tailings pile abutting Evans Gulch; (Right) During construction conditions with part of pile removed and graded as excavator benches its way down towards the bankfull elevation.

Once the BMP was in place, the operator benched his way down in bucket-depth sections, until bankfull elevation was achieved. During the excavation process, mine waste was rotated 180 degrees away from Evans Gulch and graded by a D5 dozer. Per the design specification, approximately 115 cubic yards (CY) of mine waste was removed through this excavation effort and consolidated through the subsequent grading. The dozer worked concurrently to minimize the side slopes, while creating a crown that promoted dispersed drainage away from the creek. Once a majority of the waste was removed from the stream edge, the installation of three root wads took place to promote bank stability and trout habitat. Root wads were locally harvested from behind the Silver Spoon site and placed perpendicular to flow to help dissipate bank velocities (Figure 6.3). These features were set below the water surface elevation and then anchored with several feet of compacted fill material. Four live willow transplants were installed between each root wad to provide immediate stability prior to vegetation establishment (Figure 6.4). Several sedge mats and live willow stakes were also utilized along the bank for additional stability. These features will help reduce erosion during next year's runoff. Following completion of bank work, the remainder of the main face was benched to a 3:1 slope and hummocked with the excavator bucket to reduce sheet flow. Following the re-grading process, the entire pile was amended in place with 1,000 pounds of 3-6-3 fertilizer and 50 CY of compost to facilitate vegetation growth and reduce erosion. To finalize revegetation, a mixture of wood straw and weed-free agricultural straw was crimped into the top of the cap and all disturbed surfaces. As a last series of steps, tree branches were scattered across the site to add diversity and facilitate micro-community development, while a couple large boulders were placed to close the reclaimed access road.

Figure 6.3: Photo showing excavator transporting root wad from Silver Spoon to Streamside area.

Figure 6.4: After conditions showing graded and amended pile with establishment of clean floodplain bench. A total of three root wads were installed in the bank in conjunction with 12 whole willow transplants and six sedge mats to provide bank stability and trout habitat. TU staff is shown in the photo installing live willow cuttings into the bank.

6.3 Valley Mine Reclamation

The largest phase of work on the Evans Gulch project was at the Valley Mine directly across the drainage from the Streamside Site. This site had the largest volume of waste rock with the most acid generating potential. In addition to the large volume of waste rock, a dead zone emanating from the toe of the pile was evident through the adjacent wetland. Since this phase of construction involved the largest quantity of amendments, a staging area was created towards the back of the site where equipment and material could be stored. Construction at this site consisted of re-grading steep slopes of the pile to a minimum of 3:1 and consolidation of waste from wetland edge and steep side slopes to the top of the pile. During grading operations, a mini-excavator was used to harvest and install 40 live willow bulbs to the barren wetland in the dead zone (Figure 6.5). Once willow clumps were specifically placed, the

Figure 6.5: Mini-excavator shown installing whole willow clumps to the dead zone area downslope of the Valley Mine. Over 40 total willows were transplanted.

dead zone was amended with 200 pounds of 3-6-3 fertilizer, seeded with a riparian seed mix, and mulched. TU staff also cut and installed 100 live willow cuttings throughout the dead zone to increase future coverage. After completion of dead zone work, incorporation of amendments to the graded waste pile was performed with skid steers and excavator (Figure 6.6). The specific quantity and order of application are listed below:

- 100 tons of limestone 85% purity
- 300 tons of clean fill placed at a thickness of three inches
- 600 pounds of 3-6-3 fertilizer and 30CY of compost
- 1 acre of native upland seed mix and a combination of wood straw and ag. straw

After pile was capped with clean material, the fertilizer and compost were mixed into the soil in a hummocking manner creating undulations in the surface to reduce sheet flow and rilling. The upland seed and straw mixture were hand broadcast and crimped in where applicable.

Figure 6.6: (Top) Before conditions showing steep slopes of Valley Mine waste pile along with wetland and dead zone devoid of willow and other species. (Bottom) After conditions showing freshly reshaped pile along with 40 live willow transplants and 100 willow cuttings in the wetland. After amendments were incorporated into the pile, clean fill material was placed on top, seeded, and mulched to promote vegetation growth.

6.4 Final Construction Summary

The total construction and design costs for this project totaled $194,605 with various matching sources from Freeport McMoRan, Newmont Mining, and Colorado Division of Reclamation Mining and Safety (DRMS). In-kind match was also gathered from Trout Unlimited, Lake County Road and Bridge, and Parkville Water District. Efforts from 2018 construction will hopefully reduce erosion of mine waste and non-point source loading to Evans Gulch. With Evans Gulch sustaining a local fishery and providing drinking water for Leadville and Lake County, TU hopes that work associated with this reclamation effort benefits the local residential and ecological communities.

7.0 Post Reclamation and Next Steps

Due to the long duration of sampling, landowner consent, and agency input, the Evans Gulch Restoration Project took almost the entire five-year grant cycle to complete. However, sound data was generated and used to put together a reclamation design that effectively targeted non-point sources of pollution. Since the construction was completed in late summer of 2018, there was no post-project surveys or sampling events due to the grant expiration date of 2/15/19. However, a loading reduction estimate was performed as an initial concept of how effective the construction efforts were in 2018

(Table 7.1). Site EG13 was selected as part of the loading reduction estimate because it was located immediately downstream of all three sites that were reclaimed in 2018. Therefore, if BMPs were successful in reducing non-point source loading measurable change would be observed at this site. Assuming a load reduction of 20%, an estimated reduction of 2.071 lbs/day could be realized at site EG13, which translates to a yearly potential reduction of 756.00 pounds. This is a significant amount on a yearly basis and could translate to overall improvement of water quality at this site and downstream locations. The 20% is a conservative estimate and will hopefully yield higher results when verified through future water quality sampling TU and WQCD. In addition to the loading reduction estimate, TU staff was able to broadly calculate the amount of contaminated sediment reduction as part of the BMP incorporation at the EG13 area. The former Streamside site contained a mine waste pile that abutted Evans Gulch for over 40 linear stream feet and was 15 feet tall. This section of mine waste was perennially at risk of erosion during over-bank flood events. The BMPs utilized at Streamside consolidated this on-site while also establishing a stable, floodplain bench. Basic geometry and field measurements calculated this effort at approximately 200 cubic yards (CY) of mine waste removed from the floodplain.

Table 7.1: Estimated load reductions on a per/day and per/year basis due to reclamation efforts in 2018.

Sampling Site and Suspected Source	2014/15 Average High Flow Zn Load (lbs/day)	Estimated Zn loading reduction from construction (lbs/day) (~20%)	Estimated Zn load reduction from construction (lbs/year) (~20%)	Estimated Mine Waste Removed from Floodplain during Construction (CY)
EG13 – DS of streamside tailings and Valley mine	10.356	2.071	756.00	200

TU will work with CDPHE staff and the measurable results program (MRP) to generate post-project data over the next few years. This data will be important to evaluate effectiveness of 2018 reclamation, assess TMDL status, compare loading reduction estimates, and determine if there is a need for additional future projects or maintenance. Also included in future monitoring will be soil sampling at the Streamside site to ensure effective mitigation of bank-full bench soil remediated through 2018 construction. TU also plans to contract with Duraroot before expiration of this grant to generate a post-project drone flyover of the site area to have a before and after representation of overall conditions. This aerial survey will allow TU staff to effectively share the success of the project through future presentations and conferences. Performed in conjunction with the aerial survey and future sampling events, TU will continue to monitor photo points to document effectiveness of treatment and determine if future maintenance is necessary.

If future work is deemed necessary through any post-project water or soil sampling, TU will work to secure funding to do so at pertinent sites. Past water quality sampling has shown a need for reclamation at the Annie C/Dolly Varden site near EG14A, which saw large spike in zinc loading downstream of the pile during runoff. This site was ranked first on the prioritization matrix, but was not included in the reclamation plan due to ownership issues. Leadville Corp. used to be the former owner but has since changed hands. This change in ownership could open the door to being able to work on the site in the future if data suggests. Another possible site for future reclamation is at the Cleveland and Little Winnie claims in the South Evans Gulch watershed. The owner of these claims also had ownership of the Silver Spoon and Streamside sites that were completed in 2018. They are planning to reprocess the existing tailings and waste rock present on the two aforementioned claims. To do so they will need a reclamation plan, and talks have been ongoing with TU to help secure funding for in-situ revegetation. This would be a good opportunity to demonstrate how re-processing tailings/waste rock could be a beneficial step in mine reclamation.

8.0 Summary of Public Participation

Public participation in this project saw contributions from various local groups, colleges, schools, and other entities. Early on in the project, Colorado Mountain College (CMC) and its students were essential in assisting with water quality sampling and analysis. The staff from CMC installed and maintained auto-sampling units when trying to capture storm events. Several field trips were also conducted with CMC students to describe monitoring data and plans for future reclamation. TU staff presented water and soil data, and reclamation design plans at several meetings held at CMC campus. These meetings were meant to inform the local public about the project and proposed plans for reclamation, while providing an avenue for feedback and comments. The main organizations conducting these meetings were Lake County Open Space Initiative (LCOSI) and the former Headwaters of the Arkansas Watershed Group (HAWG). These meetings allowed TU staff to meet County Commissioners, industry partners, and other specialists in the environmental field to discuss the project and solicit feedback. Over the course of the project, TU staff presented on the initial concepts, mid-project results, and post-project conditions and construction summary. These events took place in 2014, 2016, and 2020, respectively.

In addition to maintaining an educational aspect with CMC over the course of the project, TU staff conducted several tours with a local Lake County Environmental Charter School, Colorado State University, and an interested group of environmentalists from Tasmania. These tours allowed TU to answer questions from interested groups and promote an environmental thought process when it comes to reclamation as a whole.

Jason Willis presented on the Evans Gulch project at two separate TU Collegiate Peaks Chapter meetings over the course of the project to inform membership about the work taking place in their headwaters. During the second meeting, Jason was able to secure $3,000 in cash match from the Chapter to put towards monitoring during the initial phases of the project. A follow up presentation is scheduled for late 2019 with the Chapter to summarize construction efforts and current conditions.

Prior to construction, and during the first phases of reclamation in August 2018, Jason Willis worked with a reporter from the Leadville Herald on two articles describing the reclamation plan, and current construction conditions so Lake County residents could be informed of project status. Jason plans to follow up with the reporter to put together a post-project summary that will act as the third and final part of the project series.

Throughout the life of the project, TU staff worked closely with Parkville Water District (PWD) to ensure a common goal of water quality improvement in Evans Gulch was achieved. TU kept PWD staff up to date on water quality sampling events, results, designs, and construction schedules throughout the life of the project. Communication was very important during work at the Streamside site when stream and bank work took place this past August. TU and PWD staff worked together to shut off intakes for a four-hour window during construction to ensure no impacts to downstream water quality were observed. The input from PWD was a valued resource throughout the project.

9.0 Aspects of the Project That Did and Did Not Work Well

The main aspect of the project that did not work well was project site selection. A period of almost two years went by between water quality sampling in 2015 and site selections in late 2017. This was due to difficult negotiations with landowners. A takeaway from this project that can be applied to others in mining districts is to allow time to not only reach out to landowners, but develop an actual relationship before trying to complete a project on their property. This was a learning experience, but an aspect that took longer than expected.

Data was shared with CDPHE, CMC, and DRMS throughout the course of the project so partner organizations were always privy to the most recent data. The WQCD conducted uploads to EPA STORET to maintain formatting, while TU staff and partners collected the data. It is suggested that data uploads to EPA STORET or Colorado Data Sharing Network continue to be performed by WQCD staff when collected by 319 grant recipient. This means seamless integration and upload of data to STORET.

All other Objectives and sub-tasks were completed over the course of the project. TU staff was efficient in submitting semi-annual reports and invoices to CDPHE staff, as well as the submittal of this final report. One of the biggest hurdles over the course of the project was gaining landowner consent for sampling and project implementation. In the beginning of the project, TU staff sent over 65 landowner consent letters for sampling access, which were essential in shaping the SAP. After completion of the SAP and priority ranking additional landowner consent was necessary through participation agreements for specific sites. This process turned out to be long, and drawn out, but ultimately resulted in consent for four out of the five top ranked sites. Countless emails, phone calls, and document revisions were established over several years to finally attain signed participating agreements. Consent for project implementation might have been the most difficult and time-consuming part of the project. The incorporation of the SAP was well executed by TU, CMC, and CDPHE staff over the 2.5 years of monitoring. Datasets correlated well with suspected non-point source loaders during each of the high flow monitoring events, which allowed for precise prioritization and BMP selection. Successful development of reclamation designs based off of existing datasets were clear, concise, and useful for project partners through the conceptualization phase. Although construction was delayed one week due to agency input and liability steps, TU and H-2 Enterprises were able to move smoothly and efficiently during the three week construction window. This streamlined construction approach was facilitated by the 30% design that was adaptable in the field. Over the course of the project, and during construction, TU staff maintained a transparent relationship with the local public and private landowners. As mentioned in the above section, TU staff made extensive efforts to attend local meetings and keep pertinent groups informed of project progress.

10.0 Literature Cited

(BOR, 1997) – United States Department of the Interior, Bureau of Reclamation. *Draft Environmental Geology of Operable Unit 6, Removal Action Design Data, California Gulch Superfund Site, Leadville, Colorado*. Prepared for the U.S. Environmental Protection Agency. February 1997.

(CDPHE, 2009) - Colorado Department of Public Health and Environment, Water Quality Control Division. *Total Maximum Daily Load Assessment – Arkansas River/Lake Cree/Chalk Creek/Evans Gulch Lake/Chaffee County, Colorado*. June 2009

(CDPHE, 2014) - Colorado Department of Public Health and Environment, Water Quality Control Division. *TMDL Bridge to Restoration, Sampling and Analysis Plan*. Pages 2-12. May 2013.

(Cleasby et al., 2002) – Cleasby E. Thomas, Nimick A. David. *Metal Concentrations and Sources in the Miller Creek Watershed, Park County, Montana, August 2000*. USGS Water-Resources Investigations Report 02-4148. 2002.

(HDR, 2002) - HDR Engineering, Inc. *Final Focused Feasibility Study Operable Unit 6*. Prepared for the U.S. Environmental Protection Agency. September 2002.

(Parkville, 2013) - Parkville Water District. *Source Water Protection Plan – Surface and Groundwater Plan*. August 22, 2013.

(Rosgen, 1996) – Rosgen, Dave. *Applied River Morphology Second Edition*. Wildland Hydrology. 1996.

(TU, 2015) – Willis, Jason. *Evans Gulch Water Quality Database*. Trout Unlimited. Prepared for Colorado Department of Public Health and Environment. May 2015.

(USFS, 2005) – U.S. Forest Service. *Final EA Environmental Assessment for Watershed and Fisheries* Conservation Treatments. Rio Grande National Forest, USFS, US Department of Agriculture. April 2005.

http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5203020.pdf