APPENDIX C. Watershed Restoration Plan.

Exhibit 1. Conceptual Projects to address priority watershed needs.

Need 1): Improve water quality.

Conceptual Projects	**Watershed Benefit**
Inventory water quality at all inactive mines.	Better understanding of metal and acid inputs from individual, abandoned mines.
Assess inactive mine sites for remediation, prioritize sites and conduct projects.	Improved water quality.
Characterize aquatic life above Ouray.	Better understanding of current aquatic conditions which might inform rule making for standards.
Study of Ouray Hydro dam flushing events.	Better understanding of impact of flushing (sediment & pollutants) on river below Ouray.
Support Good Samaritan Legislation	Possibility of using active in addition to passive treatments for greater mine remediation benefits without incurring liability.

Need 2): Promote water conservation and strive to mimic in-stream natural flow regimes to extent possible.

Conceptual Projects	**Watershed Benefit**
Coordinate with water users and water managers on conservation strategies to improve in-stream flows.	Increased in-stream flows, cooler water temperatures, improved aquatic habitat, increased recreation potential.
Collaborate with partners to educate public on water conservation strategies.	Changed behavior, reduced water consumption.

Need 3): Improve riverine ecosystem function.

Conceptual Projects	**Watershed Benefit**
Conduct watershed assessments (channel monitoring, watershed mapping) to inform project planning.	Better understanding of current conditions and change over time which could inform project development and prioritization.
Protect sensitive areas: encourage easements, revegetation, removal of invasive species.	Improved riparian habitat & water quality, flood mitigation.
Conduct floodplain assessment to identify potential floodplain reconnection sites.	Flood mitigation and improved water quality.
Conduct river restoration to improve in-stream and riparian habitats, bank stabilization, ecosystem functioning.	Increased habitat diversity, recreation potential, reduced erosion and flooding.
Encourage private land owners to enhance or maintain riparian buffers and wetlands.	Improved riparian habitat & water quality, flood mitigation, ecosystem functioning.

Need 4): Improve recreation opportunities.

Conceptual Projects	**Watershed Benefit**
Educate the public about rights, responsibilities and safety hazards.	Increased public awareness.
Increase public river access (easements)	Increased safety and recreation potential.

Need 5): Create a stable stakeholder group through outreach and education.

Conceptual Projects	**Watershed Benefit**
Create regular volunteer activities and service projects.	Community ownership in the UWP.
Organize regular community events or meetings.	Increased awareness of UWP and understanding of watershed issues.
Collaborate with partner organizations.	Increased awareness and productivity.
Develop K-12 watershed educational programs with local schools.	Enhanced stewardship ethic and understanding of environment.
Maintain consistent communication through newsletters, press releases, participation in partner events.	Increased awareness and engagement.

Exhibit 2. Project Implementation Plan.

Project Title	Upper Uncompahgre Watershed Mine Remediation

1.0 - Project Proposal Summary

Sponsor			
Organization Name	Uncompahgre Watershed Partnership		
E-mail address	UWPcoordinator@gmail.com		
Mailing Address	PO Box 392		
City, State and Zip	Ridgway, CO 81432		
Telephone Number	970-416-5372	Tax ID Number	46-2946756

Project Coordinator or Primary Contact	
Name	Agnieszka Przeszlowska
Title	Coordinator
E-mail Address	UWPcoordinator@gmail.com
Mailing Address	PO Box 392
City, State and Zip	Ridgway, CO 81432
Telephone Number	970-416-5372

Project Funding
CO NPS Funds Requested $163,125 + Match (cash/in-kind) $340,796 = Total Project Cost $503,921
Federal Funds - Federal Cooperator Contribution (please do not include in the total) = $10,000

Project Start Date	Feb. 1, 2014	Project End Date	Feb. 14, 2018

Project Location	
WQCC Regulation River Basin	#35 Gunnison and Lower Dolores River Basins
Sub-Watershed(s)	Uncompahgre
HUC(s) - 8 or 12 digit USGS Hydrologic Unit Codes	14020006
Impaired Segment(s) Waterbody ID(s)	COGUUN02 (HUC-12: 140200060205), COGUUN07 (HUC-12: 140200060203), COGUUN09 (HUC-12: 140200060202)

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NPS Pollution Source categories to be addressed (Check all that apply)			
	Agriculture		Silviculture
X	Habitat Modification (drainage/filling wetlands, stream bank destabilization)		Hydrologic Modification (changes to water flow as in reservoir, diversions, etc.)
	Urban runoff/Stormwater		Groundwater Loading
X	Mining		Natural Sources
	Construction		Other:

NPS Pollutants to be addressed (Check all that apply)			
	Excess Nitrogen		Pesticides
	Excess Phosphorus		Selenium
	Sedimentation		Temperature
	Pathogens/Bacteria	X	pH
X	Metals		Habitat impact
	Low dissolved oxygen		Other:

Estimate Load Reduction, if checked for excess nitrogen, excess phosphorus and/or sedimentation	
# pounds of nitrogen reduced by project	Reference:
# pounds of phosphorus reduced by project	Reference:
# tons of sediment load reduced by project	Reference:
# pounds of metals reduced by project: Sneffels Creek (Atlas Mill): 0.8 lb/day of Zinc; Gray Copper Gulch (Vernon Mine): 0.65 lb/day of Cu and 20 lbs/day of Fe; Uncompahgre River (COGUUN02, Michael Breen Mine): TBD in SAPP.	Reference: Consultation with Jeff Litteral and Julie Anear, DRMS, and Skip Feeney WQCD *
# pounds of selenium reduced by project	Reference:

* Only metals of concern based on impaired and monitoring and evaluation list status. At Atlas Mill, we assumed 100% reduction from removal of tailings and re-routing of stream channel from tailings area based on CDPHE ARR Canyon Creek study instead of CDPHE WQCD 2012 data. At the Vernon Mine on Gray Copper Gulch the estimates were calculated by summing the differences in metals from above and below sites (WQCD 2012 data) at high flow and assuming a 50% reduction by either removing waste rock or re-routing adit drainage from draining through waste rock. Estimated load reduction in Uncompahgre River (Michael Breen site) is not estimated at this time because of low stream flows at time of sampling in 2012 and inconclusive data.

The nonpoint source of water quality impairments in the upper Uncompahgre Watershed is mine drainage from legacy mining operations. These impairments are identified as priorities in the Uncompahgre Watershed Plan 2012 (Executive Summary p. iii, Sec. 8, p.8-5 and Sec. 9, 10 http://www.uncompahgrewatershed.org/wp-content/uploads/2012/03/UncompahgrePlan-Jan2013.pdf). The Uncompahgre Watershed Partnership (UWP) requests NPS funds to implement remediation projects at 3 abandoned mine sites, all of which contribute acid mine drainage or heavy metals to segments on the 303(d) list of impaired waters and/or Colorado's Monitoring & Evaluation (M&E) list. **Additional funding from the Water Quality Improvement Fund (WQIF) will be used to expand and enhance tasks proposed in the original NPS project.** The project sites include 1) Atlas Mill on Sneffels Creek COGUUN09, 2) Vernon Mine on Gray Copper Gulch COGUUN07, and 3) Michael Breen Mine on Uncompahgre River COGUUN02. Although these sites contribute acid mine drainage or heavy metals to their respective waterbodies, other numerous mines and natural mineralization processes contribute acid drainage and heavy metals to headwater streams and the Uncompahgre River. Thus, in this project reductions in heavy metal loads and improved pH will be assessed at the site scale for each respective water body. The UWP will partner with Colorado Division of

Reclamation Mining and Safety (DRMS) to obtain technical guidance on remediation of the 3 sites using established best management practices (BMPs).

Additionally, this project budgets time and resources to perform headwaters characterization of additional sites throughout the Upper Uncompahgre headwaters area to continue restoration planning. Data are needed to assess other nonpoint sources. Potential sampling sites include portions of waterbodies described in Section 2.2 (Uncompahgre River's tributaries: Poughkeepsie Gulch and Mineral Creek above the Michael Breen Mine; Gray Copper Gulch upstream of Vernon Mine) as well as Canyon Creek drainage. All sites to be sampled will be selected and characterized in the Sample Analysis Project Plan (SAPP).

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2.0 - Statement of Need

2.1 – General Watershed Information

The Uncompahgre River Watershed (HUC 14020006) drains 1,115 square miles (713,876 acres) of the Gunnison Basin in southwestern Colorado. The Uncompahgre River originates in Lake Como at 12,215 ft. in the Uncompahgre National Forest and flows approximately 75 miles to Confluence Park, Delta where it joins the Gunnison River at an elevation of 4,915 ft. The upper watershed (upstream of City of Ouray) is characterized by the San Juan Mountains which are a mixture of pre-Cambrian metamorphics with mid-Tertiary Andesitic volcanic intrusions that have deposited several minerals in extractable quantities, including gold, lead, silver, and copper. The upper watershed is characterized by steep, glacial valleys and confined stream channels. The lower watershed (north of City of Ouray) of the Uncompahgre River Valley is characterized by sedimentary rocks, low gradient streams, and wide alluvial valley floors. Approximately half of the land in the Uncompahgre River Watershed is managed for conservation and recreation by the federal government. The rest of the lands are private: residential, commercial, and agricultural. Approximately 11% of the watershed is irrigated agriculture. The primary past and present land uses in the watershed include mining, production agriculture, residential and commercial development, recreation, and tourism.

Natural mineralization rates of the ore-rich Red Mountain Massif and high mining activity at the turn to mid-20th century have resulted in high heavy metal loading in Uncompahgre's headwaters. One of the largest mining operations in the watershed was the Idarado Mine (now part of Newmont Mining Corporation) which was operational on Red Mountain Creek, Uncompahgre River's main headwater tributary, until 1979. In 1983, the State of Colorado filed a lawsuit against Idarado using the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The lawsuit was settled in 1992 and Idarado implemented a remediation plan as required by a Consent Decree resulting from Natural Resource Damage Claims brought forth by the state. Because impacts from Idarado's sites are being mitigated with oversight from CDPHE, this project proposal will address acid mine drainage and heavy metals loading from other legacy mines as defined in the Uncompahgre Watershed Plan (Executive Summary p. iii), goal 1: improve water quality by reducing heavy metals and meeting Total Maximum Daily Loads (TMDLs) for water bodies

in the upper Uncompahgre watershed. Water Quality Control Division Environmental Data Unit Staff investigations of restoration potential further refined priorities to a few key water bodies or stream segments based on a statewide assessment of waters impaired by heavy metals. Staff considered several factors including, the degree of impairment (i.e. not far from meeting standards), low concentration of mines, accessibility, and partner remediation support. By applying this filter and commencing field investigations in 2012, partners were able to facilitate or expedite restoration planning within the Uncompahgre watershed (Sec. 3.1 Environmental & Programmatic Goals). The priority water bodies or stream segments are cited in the Uncompahgre Watershed Plan (Page 8-6).

The waterbodies and water quality problems to be addressed in this project are discussed below in Section 2.2 and 2.3. Pre- and post-implementation data will be collected at the site scale within the respective waterbodies. As part of the headwaters assessment of this project, additional water quality data will be collected at other sites which likely contribute additional contaminants to the waterbodies discussed below. These data are needed to assess other nonpoint sources and inform future restoration planning in the watershed. The final selection of headwaters assessment sites will be part of SAPP development

2.2 – Waterbody Description

The seasonal flow patterns of the Uncompahgre River and the tributaries listed below are comprised of a low, base-flow period that runs from August through April followed by a high flow period that runs from May through July. Typical peak flows occur in late May through late June from snowmelt runoff. Numerous high runoff periods occur during the monsoon season of July and August from strong thunderstorms.

Waterbody description for the three waterbodies of focus, especially in the vicinity of key sources, is listed below. Uses, attainment status and other data are included in Table 1.

Table 1. Waterbody Information.

Waterbody ID	Beneficial Uses	WQ Impairment 303(d)	TMDL Status	Colorado M&E
COGUUN09	Aquatic Life Cold 1, Recreation P, Water Supply, Agriculture	Cd, Zn (Sneffels Cr)		Pb (Canyon Cr)
COGUUN07 (Gray Copper Gulch)	Aquatic Life Cold 2, Recreation P, Water Supply, Agriculture	Cu		Fe(Trec), pH
COGUUN02 (Uncompahgre River)	Aquatic Life Cold 2, Recreation P, Agriculture	Mn (WS)	Cd, Cu, Zn (2011)	Pb

1. Sneffels Creek (Atlas Mill)

WBID: COGUUN09
Flow characteristics: Seasonal snowmelt driven, no gaging station present. Flow measurements at Atlas Mill recorded in 2012 sampling events were 5.78 cfs for low flow and 41.19 cfs for high flow. The 2012 drought conditions are evident when compared to the Sept. 1999 sampling event during which low flows were 10.48 cfs (ARR Canyon Creek Watershed 2000).
Geomorphic classification: Rosgen classification B-1,
Physical condition: Low entrenchment, moderate sinuosity, single channel
Stream stability: stable, limited sediment supply, to boulder substrate
Stream order: Second order
HUC-12: 140200060202

Aquatic chemistry and biology: Sneffels Creek is use protected and classified as an Aquatic Life, Cold water Class 1, Recreation, Class P, Water Supply and agriculture (Table 1). The stream is on the 303(d) List for cadmium and zinc and on the Monitoring and Evaluation List for lead because its water quality does not support aquatic life, cold water class 1 communities.

CDPHE Hazardous Materials and Waste Management Division analyses of 1999 surface waters in Sneffels Creek (ARR Canyon Creek Watershed 2000) indicated dissolved and total concentrations of manganese and zinc between Atlas Mill and confluence with Imogene Creek to be significantly higher than at the upstream-most background site. Increased manganese and zinc were attributed to inputs from Governor's Basin above Atlas Mill and inputs from Atlas Mill and tailings. The in-stream zinc concentrations exceed chronic Table Value Standards (TVS). CDPHE personnel also noted springs originating from the Atlas Tailings pile and most likely entering Sneffels Creek near the pile. Total metals analysis of water from one of these springs (Sample AM-SP-01) indicated that cadmium, copper, iron, lead, silver and zinc levels exceeded acute table value standards established for downstream Canyon Creek. The Atlas Mill tailings were estimated to add 0.8 lbs/day of zinc attributable to tailings material entering Sneffels Creek, in addition other metals present in stream sediment samples collected below the mill site were attributed to "the offsite migration and transport of sediments from pile materials during high-flow events." In comparison, data collected by WQCD in 2012 at Atlas Mill also showed that in-stream zinc exceeded both acute and chronic TVS during high flows at locations above and below the mill site. Cadmium chronic TVS were exceeded above and below the mill site during the 2012 high flow periods. Other 2000 and 2012 data are compared in Table 2. Currently no biological data exist for Sneffels Creek. No macroinvertebrate data were collected in 1999 (ARR Canyon Creek Watershed 2000) nor 2012 by WQCD. UWP and CDPHE however, collected macroinvertebrates in fall 2013 and results are pending. Additional biological and water quality sampling pre- and post-project implementation at Atlas Mill as well as additional sampling of COGUUN09 (part of headwaters assessment) will be incorporated into the SAPP.

Data collected by WQCD in 2012 showed inconsistent and limited dissolved zinc and cadmium loadings from the Atlas Mill. The most significant load increases are experienced above the Atlas Mill.

Table 2. Data collected at Sneffels Creek below Atlas Mill tailings at high flows. 1999 data were collected for ARR Canyon Creek Watershed 2000, 2012 data were collected by WQCD.

Year	pH	Hardness	Al	Cd	Cu	Fe	Mn	Zn
1999	7.14	59	108	0	2.5	82	111	77
2012	7.61	36		0.55	<5	7	150	120

2. Gray Copper Gulch (Vernon Mine)

WBID: COGUUN07

Flow characteristics: Seasonal snowmelt driven, no gaging station present. Flow measurements recorded in 2012 sampling events were 0.11 cfs for low flow and 15.20 cfs for high flow.

Geomorphic classification: Rosgen Class A-2

Physical condition: Entrenched

Stream stability: stable, limited sediment supply, cobble to boulder substrate, single channel

Stream order: Second order

HUC-12: 140200060203

Aquatic chemistry and biology: Gray Copper Gulch is use protected and classified as an Aquatic Life, Cold water Class 2, Recreation, Class P, Water Supply and agriculture (Table 1). The stream is on the 303(d)-listed for copper and on the Monitoring and Evaluation List for iron and pH because its water quality does not support aquatic life, cold water class 2 communities.

CDPHE Hazardous Materials And Waste Management Division conducted water quality sampling and analysis as part of 2000 Combined Assessment Analytical Results Report (ARR) Corkscrew and Gray Copper Gulches Watershed Ouray County, Colorado (CERCLIS ID # 0008969974), The results indicated the entire length of Gray Copper Gulch below the Vernon Mine exceeds chronic and acute standard for iron. 2012/2013 WQCD water quality sampling results confirm the ARR and Nash (USGS DDS-73 2002) results of low pH values and elevated copper and iron concentrations. WQCD 2012 indicated copper values in Gray Copper Gulch exceeded chronic and acute standards (Appendix B, Table 5). No biological data exist for the stream however, 2012 visual observations indicated absence of aquatic species. Macroinvertebrate sampling will be included in the SAPP for this project.

Data from WQCD 2012 high flow sampling event indicate dissolved copper in stream load values increase from 1.1 lbs per day directly above the Vernon Adit to 2.4 lbs per day directly below the adit. Data from WQCD 2012 low flow sampling event indicate dissolved copper in stream concentration values increase from 16 ug/L directly above the Vernon Adit to 340 ug/L directly below the adit.

Additional biological and water quality sampling pre- and post-project implementation at Vernon Mine as well as additional sampling upstream of Vernon Mine (part of headwaters assessment) will be incorporated into the SAPP.

3. Uncompahgre River (Michael Breen Mine)

WBID: COGUUN02

Flow characteristics: There is no gaging station information for this segment. The 2009 TMDL report used the formula: Uncompahgre at Ouray USGS gaging station * 0.15 to estimate COGUUN02 flows. Based on the USGS flow record from 2001-2012 of annual mean flow ranges from 59 cfs to 166 cfs, flows from COGUUN02 would range from 8.85 cfs – 24.9 cfs. Low flow values collected during the drought year of 2012 were 3.65 cfs. No high flow measurements were taken below Michael Breen due to the high flow and narrow canyon at and below the site.

Geomorphic classification: Rosgen classification A-2, steep slope, bedrock mountain channel with low sinuosity

Physical condition: Entrenched, minimal disturbance, intact riparian conditions, cobble to boulder substrate

Stream stability: stable, limited sediment supply and single channel

Stream order: Third order

HUC-12: 140200060205

Aquatic chemistry and biology: This segment of the Uncompahgre River is use protected and classified as an Aquatic Life, Cold water Class 2, Recreation, Class P, and agriculture (Table 1). The stream is impaired by manganese, cadmium, copper, zinc and 303(d)-listed for manganese, and on the Monitoring and Evaluation List for lead because its water quality does not support aquatic life, cold water class 2 communities.

Little water quality data exist for this segment of the Uncompahgre River. Sampling by WQCD in 2012 showed TVS values were exceeded in the river during the high flow event for cadmium, copper and zinc for sites below the Michael Breen Mine (Appendix B, Table 8). No biological data exist for the reach at Michael Breen site but macroinvertebrates were observed in 2010 further downstream, just above confluence with Red Mountain Creek (Rapid River Assessment 2010, observation). Macroinvertebrate sampling will be included in the SAPP for this project.

Data collected from the WQCD 2012 high and low flow sampling events showed increases in concentrations from directly above the Michael Breen adit and waste rock piles. Low flow values increased from 150 ug/L to 170 ug/L and high flow values increased from 89 ug/L to 110 ug/L. Additionally concentration values from the adit discharge were measured at 4,500 ug/L and 4,700 ug/L. Loadings values are less conclusive in stream. This may be due to variability of flow measurements and lack of flow measurements due to safety concerns. Additional biological and water quality sampling pre- and post-project implementation at

Michael Breen Mine as well as additional sampling in COGUUN02 tributaries, Poughkeepsie Gulch and Mineral Creek (part of headwaters assessment), will be incorporated into the SAPP.

2.3 – Type of Water Quality Problem including Sources

The overall water quality problem in the Upper Uncompahgre Watershed has been attributed to heavy metal loading and acid mine drainage from abandoned mine sites and natural processes (Uncompahgre Watershed Plan 2013). According to historical data summarized in the Uncompahgre River Water Quality Report (Woodling, 2102), mining activities contribute 44% of Cu, 23% of Cd, and 73% Zn loading (lbs/day) to segment COGUUN02 of the Uncompahgre River (WQCD 2009). During peak spring run-off (May-June) loads are typically higher than at low flows in August-October. The water bodies included in this project proposal are on the 303(d) and/or M&E list (see Table 1) and one water body has a completed TMDL.

An additional challenge for restoration planning in this region is a paucity of data. This project comes to fruition only because of additional characterization provided by CDPHE. The existing TMDL for Upper Uncompahgre watershed and historical data for the other segments are not of sufficient detail to direct restoration activities (prioritize sites, estimate load reductions and develop restoration plans). By working with the Water Quality Control Division Environmental Data Unit Staff, key water bodies and segments were identified but new questions were triggered. Therefore, this project budgets time and resources to perform headwaters characterization of additional sites throughout the Upper Uncompahgre headwaters area to continue restoration planning. Potential drainages to be sampled during the headwaters assessment of this PIP are noted in section 2.4, further discussed in Task 4 of Section 3.2 and will be characterized in the SAPP.

The three remediation sites selected for this first implementation focused project all contribute heavy metals to the respective 303(d)-listed waterbodies discussed above. Drainage from Atlas Mill waste piles and runoff from tailings drains across the valley and streambanks before entering Sneffels Creek. The Vernon Mine draining adits and waste rock piles in waterway contribute directly to Gray Copper Gulch. The collapsed adit at the Michael Breen mine drains through waste rock pile, crosses Ouray County Road 17 and flows through more waste rock before entering the Uncompahgre River. More detailed information on the water quality data and analysis for the three respective segments and abandoned sites is included below.

1. Sneffels Creek

<u>Water Quality Problem</u>

The Atlas Mill site is on Sneffles Creek above the confluence with Imogene Creek. Based on 2012 data, Sneffels Creek reference site above the Atlas Mill is in attainment of state water quality standards for Cd and Zn, while the segment below the mill fails to attain dissolved chronic and acute Zn and chronic Cd standards at high flows. This made

the mill of key interest as a potential loader of metals to the creek. Until the WQCD sampling in 2012 there was no data collected above the mill site.

Characterization of Water Quality Problems

Multiple government agencies have studied these drainages in limited degrees. Currently the Atlas Mill is the only identified abandoned feature. Data collected by the United States Geological Survey in 1997-1999 (USGS DDS-73 2002) indicates slight impacts above and below the Atlas Mill for Pb: <0.05 to 0.96 µg/l and Zn: 84 to 98 µg/l. Water quality data collected by the WQCD at the mouth of Sneffels Creek in 2009 and 2010 confirms the dissolved Zn and Cd non-attainment status.

The Atlas Mill tailings contained appreciable amounts of Pb and Zn when sampled in 1997-1999 (USGS DDS-73 2002). In 1999, CDPHE personnel also noted springs originating from the Atlas Tailings pile and most likely entering Sneffels Creek near the pile. Total metals analysis of water from one of these springs (Sample AM-SP-01) indicated presence of aluminum (497 µg/l), arsenic (11.70 µg/l), cadmium (5.90 µg/l), copper (42.9 µg/l), iron (2420 µg/l), lead (661µg/l), manganese (664 µg/l), silver (15.30 µg/l) and zinc (1170 µg/l) and that cadmium, copper, iron, lead, silver and zinc levels exceeded acute TVS established for downstream Canyon Creek (ARR Canyon Creek Watershed 2000). X-Ray Fluorescence (XRF) measurements taken in 2012 by DRMS confirmed elevated metals concentrations for Fe, Pb and Zn. Additionally, four tailings samples showed Cd levels of 1.3-13 mg/kg and Zn levels of 200-3,100 mg/kg (Appendix B, Table 9). Thus, removal of tailings should eliminate a potential source of metals at Atlas Mill. Furthermore, the braided stream section of Sneffels Creek currently flowing through the tailings and causing additional mobilization will be moved from the contaminated area during the project.

WQCD water quality data collected during the drought year of 2012 did not show appreciable increases in metals above vs. below the Atlas Mill site but several TVS standards were exceeded at both. The drought conditions of 2012 could possibly have affected the lack of a metals loading difference between the two sites. The springs noted in earlier reports were not present and the lack of runoff and/or low water conditions could have reduced runoff of metals in 2012. A map of WQCD sampled locations in 2012 is included in Appendix B, Figure 2. Table 3 (Appendix B) shows water sample results for Cd (µg/L) and TVS and loading values for Sneffels Creek. The Sneffels Creek reference site reflects background values for Sneffels Creek. Cadmium loading was slightly elevated below the Atlas Mill compared to above values and chronic Cd TVS were exceeded at both locations during high flow but not low flow periods. Both acute and chronic zinc TVS were exceeded above and below Atlas Mill during high flows but not low flows (Appendix B, Table 4). The chronic TVS was calculated for future reference purposes to allow comparisons when more sample values allow a more accurate chronic TVS value. Results (pending) from 2013 sampling event should further elucidate in-stream cadmium and zinc dynamics in reference to Atlas Mill.

2. Gray Copper Gulch

Water Quality Problem

The Gray Copper Gulch area lies on the flanks of Red Mountain and contains natural and mining-related sources of metal pollutants. The COGUUN07 segment is currently listed as impaired for not meeting the Aquatic Life Cold 2 standard for dissolved Cu and is on the M&E list for Fe(TREC) and pH. The Vernon Mine is located adjacent to the stream bank of Gray Copper Gulch adjacent to USFS lands on a private mining claim. Previous studies by the USGS indicated the Vernon Mine was a significant contributor of copper, which matched the impairment of the stream. Additionally there is a limited concentration of abandoned mines in this drainage. Gray Copper Gulch discharges into Red Mountain Creek below the Idarado mining area. The Vernon mine site contains two draining mine adits flowing through waste rock piles before discharging to Gray Copper Gulch (no flow was evident from adit #2 during drought conditions of the 2012 sampling event). There are two waste rock piles located directly in the Gray Copper Gulch channel adjacent to and below the two draining adits.

Characterization of Water Quality Problem

The limited 1997-1999 water quality data for the Vernon Mine draining adits (USGS DDS-73 2002) indicated low pH of 2.8 and elevated metals concentrations 360 µg/l of Cu and 6100 µg/l of Fe. In 2012, DRMS staff conducted initial analysis of the waste rock piles utilizing a XRF meter and collected waste rock pile samples for analysis. The XRF data indicated elevated Cu and Fe concentrations in both waste rock piles and two waste rock samples ranged at 13-58 mg/kg for Cu and 62-84 mg/kg for Fe (Appendix B, Table 10). Water quality data collected by WQCD in 2012 (Appendix B, Figure. 3) indicated Cu values in Gray Copper Gulch exceeded chronic and acute standards. Furthermore, Cu values increased appreciably below the draining adit during the low flow sampling event (see Appendix B, Table 5).

3. Upper Uncompahgre River

Water Quality Problem

The Uncompahgre River segment COGUUN02 extends approximately 2 miles in length from Como Lake to a point immediately above the confluence with Red Mountain Creek. This segment is currently listed as impaired for not meeting the applicable Aquatic Life Cold 2 Use or Mn(WS) Cd, Cu, and Zn standards. A TMDL was completed for this segment in 2011 (Appendix B, Table 6).

Many abandoned mine feature and draining adits are located in this portion of the Uncompahgre River drainage. The Michael Breen Mine has a fairly large waste rock pile located directly above the Uncompahgre River with access directly from Engineer Pass road. There are many smaller mine workings in both the Uncompahgre and Mineral Creek drainages. However, DRMS has assessed the area and few other mine sites are possibly impacting the water quality as directly as the Michael Breen site.

Characterization of Water Quality Problem

There are limited 2004 water quality data for the upper section of the Uncompahgre, (Appendix B, Table 7). These data indicate chronic TVS exceedances for Cd, Cu, and Zn.

The limited existing water quality data for the Michael Breen adit indicates elevated metals concentrations, especially Cd, Fe, Zn (USGS DDS-73 2002). The draining adit flows across and through a waste rock pile prior to discharge to the Uncompahgre River. In 2012, DRMS conducted XRF screening of the waste rock and detected elevated levels of Cu, Fe, Pb and Zn; two waste rock samples showed 15-17 mg/kg of Cu, 1 mg/kg of Fe, 200-700 mg/kg of Pb and 300-520 mg/kg of Zn (Appendix B, Table 11).

In 2012, WQCD also conducted water quality sampling of two major Uncompahgre tributaries, Poughkeepsie Gulch and Mineral Creek, and Uncompahgre River above and below the Michael Breen draining adit (Appendix B, Figure 4). TVS values were exceeded during the high flow event for Cd, Cu, and Zn for sites below the Michael Breen Mine (Appendix B, Table 8). Note that even though 2012 was one of the driest on record and snowpack levels were well below normal, a discharge measurement could not be collected at some of the lower Uncompahgre sites due to the narrow channel and dangerous currents. Furthermore, metals concentrations collected in 2012 were similar to the ranges documented in the 2009 Total Maximum Daily Load Report. The TMDL requires a load reduction of approvximately 80% to reach attainment of standards for segment COGUUN02. Based on the data the Michael Breen has not been ruled out as a potential loader of metals.

2.4 – Water Quality Priorities

This project is consistent with water quality priorities specified in the 2012 Colorado NPS Management Plan. Implementation of mining-related TMDLs and projects that address mining-related impairments are the top priority for 2012-2017. Furthermore, the Uncompahgre Watershed is in the target basin, Gunnison River Basin, prioritized for funding in the FY2013 funding rotation. The Uncompahgre Watershed Plan prioritizes improvements to water quality from mining related heavy metal and acid mine drainage impairments and removing impaired waterbodies off the 303(d) list (Executive Summary p. iii, Sec. 8, p.8-5 and Sec. 9, 10 http://www.uncompahgrewatershed.org/wp-content/uploads/2012/03/UncompahgrePlan-Jan2013.pdf). The UWP has identified legacy mining impacts in the Uncompahgre Watershed Plan (Sec. 7.5, p.7-4; Sec. 8, p.8-5). This project would address legacy mining impairments and heavy metal load reductions at three river segments, one of which has a completed TMDL (Upper Uncompahgre COGUUN02) and all are on the 303(d) list. These sites were selected based on 2012 WQCD water quality data. Future remediation sites will be evaluated based on data collected in the headwaters assessment of this project. These data are needed to assess other nonpoint sources and inform future restoration planning in the watershed.

This project is intended to help meet TMDL targets for Cd, Cu, Zn, reduce Mn and Pb loading reductions in Upper Uncompahgre River (COGUUN02). The two other proposed sites contribute to segments that do not have completed TMDLs but are on the 303(d) list

for Cu (Gray Copper Gulch, COGUUN07) or Cd and Zn (Sneffels Creek, COGUUN09). The three waterbodies were selected for remediation based on a statewide screening and loading data collected by WQCD in 2012. One sampling event was conducted in late May 2012 to characterize surface water quality during the high flow season when snow melt had saturated the drainage. The second sampling event was completed in September 2012 to characterize surface water quality at lower flow scenarios. Projects at the three sites should improve water quality and improve the waterbody trends toward water quality improvement and standards attainment.

The project will utilize mining best management practices (BMPs) to improve water quality in segments that have been degraded by legacy mining. Proposed techniques are consistent with those presented in *Best Practices in Abandoned Mine Reclamation* (Colorado DNR - Division of Minerals and Geology, 2002). The BMPs will include removal and consolidation of tailings and waste rock (BMP #2), vegetation of tailings and rock waste (BMP #6), and construction of diversion ditches (BMP #1). Although it is very challenging, load reduction targets were estimated. At Atlas Mill, we assumed 100% reduction from removal of tailings and re-routing of stream channel from tailings area based on CDPHE ARR Canyon Creek study instead of CDPHE WQCD 2012 data. The initial load reduction target is .8 lbs/day of zinc. At the Vernon Mine on Gray Copper Gulch the estimates were calculated by summing the differences in metals from above and below sites (WQCD 2012 data) at high flow and assuming a 50% reduction by either removing waste rock or re-routing adit drainage from draining through waste rock. This initial load reduction target is .65 lbs/day of copper and 20 lbs/day of iron. Estimated load reduction in Uncompahgre River (Michael Breen site) is not estimated at this time because of low stream flows at time of sampling in 2012 and inconclusive data.

All three sites are considered reasonable, initial remediation projects, in terms of cost, complexity, local support and reduction potential. Future analysis of metals load reduction and progress in meeting stream standards will be done in the sampling and analysis project plan and final report as well as the longer-term headwaters assessment. Although work at Vernon and Michael Breen sites has the potential for greater loads reduction than Atlas Mill, work at Atlas Mill is scheduled first because it an opportunity for unique collaboration with a local watershed group (UWP), local contractors, active mine willing to help in cleanup and tailings reprocessing, state agencies (DRMS, CDPHE), USFS, and EPA funding. Removal of contaminated materials at Atlas Mill would also be more extensive than at the two other mines (approximately 7 vs. 1 acre) resulting in more habitat restored. Local partners including commissioners and general public are very excited see successful completion of remediation at this site to demonstrate that mining and environmental interests can work together to clean-up mine waste and improve water quality. Furthermore, 83% of budgeted costs at Atlas Mill will be covered by in-kind or cash contributions ensuring adequate NPS funds for work at Vernon and Michael Breen sites.

<u>Justification for headwaters assessment:</u> Data are needed to assess other nonpoint sources for future mine remediation work in Uncompahgre River's tributaries. Additional sampling is needed in COGUUN02 tributaries (i.e. Poughkeepsie Gulch and Mineral Creek above the Michael Breen Mine, see Sec. 2.4 data on Waterbody COGUUN02 and Table 8). There are

elevated metals upstream of Vernon Mine in Gray Copper Gulch requiring additional source assessment and gap analysis (see Sec. 2.4 data on Waterbody COGUUN07 and Table 5). Additional characterization of Canyon Creek (COGUUN09) drainage would benefit determining sources of exceedances for Zn and Cd TVS values (see Sec. 2.4 data on Waterbody COGUUN09 and Table 3, 4). The sampling sites will be selected in the SAPP and samples collected as part of the headwaters assessment of this PIP.

2.5 - Map of Watershed Location *(see Appendix B)*

3.0 - Project Description: Includes expansion of the project via awarded (Fall 2013) WQIF funds.

3.1 - Environmental and Programmatic Goals

Environmental Goal 1

Reduce the level of heavy metal loading or acid mine drainage from three legacy mining sites: Vernon Mine, Michael Breen Mine, and Atlas Mill.

Programmatic Goal 1

Identify and implement appropriate restoration practices to reduce metals pollutant loading or acid mine drainage from Atlas Mill to Sneffels Creek, from Vernon Mine to Gray Copper Gulch and Michael Breen Mine to the Uncompahgre River.

Programmatic Goal 2

Monitor and report the effectiveness of BMPs implemented at Atlas Mill, Vernon Mine, and Michael Breen Mine. And, expand or refine water quality sampling at abandoned mine nonpoint sources to prioritize remediation sites for future restoration efforts in Upper Uncompaghre River Headwaters

Programmatic Goal 3

Conduct effective project administration and outreach. Inform and educate the public on the need for and progress of mine remediation projects in the Uncompahgre watershed through effective outreach and education activities.

3.2 - Objectives, Tasks and Products (*Note: Costs are calculated in the 2013 Budget Table)*

Funding from the WQIF will be used to expand and enhance tasks proposed in the original NPS project. The WQIF enhancements are included in this section.

Objective 1. Reduce metals loading to Sneffels Creek by addressing sources from Atlas Mill. *(Environmental & Programmatic Goal 1)*

Task 1.

A) Complete site investigation, cost estimate, permitting and design of remediation approach of tailings deposited along Sneffels Creek from the abandoned Atlas Mill. Determine boundaries of tailing deposits, tailings removal and repository protocols, as well as re-vegetation streambank stabilization and wetland creation methods.

B) Implement site remediation as determined by efforts in Task 1A: remove tailings, revegetate riparian zone and streambanks, reconstruct channel and stabilize streambanks, create small wetlands. **WQIF funds will be used to reconstruct and stabilize more length of streambanks, create small wetlands in areas where tailings will be removed and obtain appropriate US Army Corps of Engineers permit.** Water quality in Sneffels Creek, revegetated areas and channel geometry will be monitored and evaluated according to the SAPP (Task 4).

Products.

A) Design and cost estimate for implementation of tailings remediation and streambank restoration. Target metals load reduction estimate.

B) Removal of tailings to prevent entry into Sneffels Cr. and restoration of riparian habitats to proper condition and function. Target metals load reduction. **WQIF will facilitate construction of two small wetland areas and additional 200 ft. to original 100 ft of stabilized streambanks.**

Objective 2. Reduce metals loading and improve pH of mine drainage from Vernon Mine to Gray Copper Gulch. *(Environmental & Programmatic Goal 1)*

Task 2.

A) Complete site investigation, cost estimate, permitting and design of remediation approach at the Vernon Mine. Determine appropriate diversion of drainage waters, waste rock removal and repository, and possible revegetation approach (bedrock may be underlying the waste rock.)

B) Implement site remediation as determined by efforts in Task 2A: diversion, waste rock removal, and/or revegetation. **WQIF funds will be used for additional re-vegetation at the site.** Water quality will be monitored and evaluated according to the SAPP (Task 4). Re-vegetation and streambank stabilization efforts will be monitored.

Products.

A) Design and cost estimate for implementation of diversions and waste rock removal. Target metals load reduction estimate.

B) Improved pH and reduced metal loading to Gray Copper Gulch from Vernon Mine. Removal of waste rock from the stream channel and entry into Gray Copper Gulch. Target metal load reduction; **WQIF will reduce erosion after re-vegetation.**

Objective 3. Reduce metals loading from Michael Breen Mine to the Uncompahgre River. *(Environmental & Programmatic Goal 1)*

Task 3.

A) Complete site investigation, cost estimate, permitting and design of remediation approach at the Michael Breen Mine. Determine appropriate diversion of drainage waters, drainage design across Ouray County Road 17, potential removal of waste rock near load-out structure, and hillslope stabilization/vegetation.

B) Implement site remediation as determined by efforts in Task 3A: diversion, road drainage, and/or waste rock removal. **WQIF funds will be used to stabilize a load-out structure (must be completed for safe removal of waste), and additional improvements to enhance road drainage from runoff from the upslope mine site.** Water quality will be monitored and evaluated according to the SAPP (Task 4).

Products.

A) Design and cost estimate for implementation of diversions, road drainage and/or waste rock removal, hillslope and loadout structure stabilization. Target metals load reduction estimate.

B) Reduced metal loading to Uncompahgre River from Michael Breen mine. **WQIF will allow for stabilization of load-out structure.**

Objective 4. Collect pre- and post-project water quality to document and evaluate the effectiveness of mine remediation efforts. And, assess water quality at other abandoned mine sites in Uncompahgre River headwaters to prioritize future remediation efforts. *(Environmental & Programmatic Goal 2)*

Task 4.

A) Develop a SAPP in collaboration with NPS for pre- and post-project monitoring and evaluation of remediation efforts at three project sites (Atlas Mill, Vernon Mine, Michael Breen Mine) as well as for collection of baseline data at other sites in the Uncompahgre River headwaters. **WQIF funds will be used to expand water quality sampling and site assessments to more sites in the upper watershed.**

B) Collect water quality data, vegetation cover and channel geometry data where appropriate. Analyze and document results in final project report. Upload data for storage in EPA WQX/STORET database.

Products.

A) A NPS-approved SAPP which will address how data is managed by the organization for this project and all future projects. Details QA/QC programs, data storage, data transfer, and other components of data management.

B) Pre-project water quality report for three project sites and final project report documenting load reductions from implementation of BMPs at three project sites. Also, water quality report for assessment of other waterbodies and legacy mine sites and data storage in EPAWQX/STORET database. **WQIF will support an expanded headwaters water quality assessment and report to ID future sites for remediation.**

Objective 5. Communicate project implementation plan and outcomes with the public through community outreach and education activities. Enhance understanding of mine remediation by installing interpretive signs at two remediated sites. *(Programmatic Goal 3)*

Task 5.

A) Organize community presentations and site tours to inform the public on project goals and mine remediation approaches. Build an informed UWP stakeholder group on abandoned mine issues and mine remediation needs for improved water quality in the Uncompahgre watershed.

B) Install interpretive signs at Atlas Mill and Michael Breen Mine to enhance public awareness of abandoned mine reclamation. **WQIF funds will also be used for construction of the interpretive signs.**

Products.

A) Public Events: at least three public presentations related to the project (pre-implementation overview, progress updates during implementation, post-implementation overview). Presenters will discuss nonpoint source issues being addressed in the project, implementation approaches, and outcomes. UWP will also organize at least one field tour to a project site. Additionally, UWP has been coordinating the annual San Juan Mining Conference and during the annual 2015 and 2017 event we will highlight this project's progress and outcomes. Outreach Media: the public will be informed of the project through press releases, UWP newsletters, and UWP website updates.

B) Interpretive signs of sites and their remediation at Atlas Mill and Michael Breen Mine.

Objective 6. Conduct effective project administration and evaluation. *(Programmatic Goal 3)*

Task 6. The UWP will administer the project according to NPS programmatic and contractual requirements. **The WQIF funds will support project administration and management to ensure adequate and timely project reporting and invoicing.** This task covers Administrative components of contract management (reports, invoicing, etc.) and overhead costs (rent of office space, supplies etc.).

Products. Adminsitrative products include quarterly reimbursement requests, match reporting, semi-annual and final reports.

3.3 - Environmental Permits

Necessary permits will be identified and obtained during the site assessment and design tasks for each mine remediation site. DRMS will obtain letters of consent for BMP

implementation from landowners. Special use permits will be obtained from the BLM and USFS. The USFS will prepare a NEPA document at Atlas Mill as an in-kind service. DRMS will conduct resource and biological assessment including consultation with U.S. Fish and Wildlife at Vernon Mine and Michael Breen Mine sites. No species of concern (ESA) are known at the three remediation sites, however, they will be considered and identified during site assessments. Cultural resources at all sites will be assessed and permitted by USFS or DRMS during site assessments. US Army Corps of Engineers CWA Section 404 and 401 permits will be obtained for the Atlas Mill site during design of streambank stabilization protocols and wetland delineation. A CWA Section 404 permit may also be obtained for channel stabilization post waste rock removal at the Vernon Mine site. Road survey and county land use permission at the Michael Breen site will be conducted and obtained by the Ouray County Road and Bridge Department.

3.4 - Lead Project Sponsor Qualifications

The UWP will serve as the lead sponsor for this grant. The UWP was formed in 2007 as a community group dedicated to protecting and restoring the Uncompahgre River watershed. In 2012, the group completed the Uncompahgre River Watershed Plan which guides the organization's projects.

UWP's watershed coordinator, Agnieszka Przeszlowska, will lead and coordinate this project. She has a PhD in ecology and extensive experience in riparian ecology, watershed science, monitoring and project coordination. She has led the UWP since Apr. 2012, formed partnerships with numerous stakeholders and organizations, and coordinated several education and outreach initiatives. Ms. Przeszlowska will be directly supported by an OSM/VISTA Volunteer who will assist with water quality sampling, field events, and coordination of community outreach events. UWP's Steering Committee and future Board of Directors will contribute knowledge and volunteer time to the project to help ensure effective implementation. Members have expertise in mine remediation, BMP implementation, stream restoration, and water quality sampling. Jeff Litteral is a project manager for the DRMS and will provide in-kind services of technical support and coordination of BMP implementation.

3.5 - BMP Operation and Maintenance

The following Operations and Maintenance will be in-kind by responsible parties identified in parentheses:

Task 1 – Maintenance of erosion matting and/or browse fencing protecting re-vegetated streambanks at Atlas Mill Site (UWP) as well as 404 monitoring of constructed wetlands (Star Mine Operations).

Task 2 – Maintenance and monitoring of stream stabilization at Vernon Mine (UWP). Monitoring of revegetation/cap of waste rock repository (DRMS)

Task 3 – Maintenance of road drainage feature below Michael Breen Mine (Ouray County Road and Bridge Department).
Maintenance of erosion control mats and re-vegetated hillslope (DRMS, UWP)

Task 5 – Maintenance of interpretive signs at Atlas Mill site, load out structure and interpretive signs at Michael Breen site (Ouray County Historical Society)

4.0 - Coordination Plan

4.1 - Lead Project Sponsor and Cooperating Organizations (*see Appendix C)*

4.2 - Local Support

The public's interest and participation in UWP initiatives has grown since its inception in 2007. Involvement has especially increased in 2012 as the group transitioned from watershed planning to project implementation. Ouray County residents have participated in restoration activities, fundraisers, education and outreach events. Constituents have identified water quality impairments as highest priority at stakeholder meetings and in the watershed plan. They are eager to work on restoration efforts.

DRMS has been an involved partner and will contribute both cash match and in-kind services to this project by coordinating design and implementation of all BMPs. Various in-kind services will be provided by agencies and organizations listed in Appendix C and described in Sec. 4.3. Match support will be tracked in a database. In-kind time will be tracked through timesheets and in-kind services through accounting sheets distributed to each cooperator. Cash matches will be tracked with letters of commitment from contributing cooperators.

4.3 - Coordination with Other Projects and Organizations

The UWP has worked with Western Stream Works on a riparian restoration project in Ridgway in 2012 and will utilize its expertise for re-vegetation and wetlands work at Atlas Mill site in this project (Task 1). The UWP has partnered annually with the Ouray County Historical Society (OCHS) to organize mine tours. In this project, OCHS will assist UWP with stabilization of a historic load-out structure (Task 3) and installation of interpretive signs at project sites (Task 5). Lastly, UWP has been collaborating with Mountain Studies Institute to host the annual San Juan Mining Conference (Task 5).

4.4 - Similar Watershed Activities

The UWP is working in conjunction with DRMS and CDPHE to characterize abandoned mines in the watershed (Task 4). UWP also supports CPW's on-going River Watch sampling in the upper Uncompahgre watershed. In 2012 and 2013, UWP had assisted volunteers with River Watch sampling on the Red Mountain Creek and mainstem of Uncompahgre River from confluence with Red Mountain Creek to below Ridgway Reservoir (9 sites). In late 2013, UWP has assumed regular sampling of four downstream

sites. The River Watch sampling is complimentary to water quality sampling proposed in this PIP, Task 4.

Abandoned mine closures and BMPs are conducted in the watershed by DRMS. Their efforts as well as this project address water quality impairments from legacy mining operations primarily in drainages other than those contributing to Red Mountain Creek. Impairments to Red Mountain Creek are currently being addressed by Idarado Mine (Newmont Gold Company) through a CDPHE approved Remedial Action Plan (see Sec. 2.1). There are no plans by any other organization to perform BMP implementation, monitoring or design work on the three sites addressed by this project.

5.0 – Project Evaluation and Data Management

5.1 - SAPP Development

The SAPP and IMAP will be developed in collaboration with NPS program staff. No monitoring will take place until the SAPP is approved by NPS Project Manager. The sampling plan utilized by CDPHE and DRMS in 2012-2013 for water quality monitoring at high and low flows will be modified and adapted to meet NPS guidelines for repeat sampling in 2014. In addition, macroinvertebrate, vegetation sampling, and photo points will be collected using CDPHE accepted protocols. The SAPP will detail how historical data are handled and incorporated into current data collection efforts.

5.2 – Monitoring Strategy

The project sponsor and the CDPHE's Measurable Results Project (MRP) will coordinate to develop a SAPP for monitoring and evaluation of remediation efforts at the three project sites. The monitoring strategy will include data quality objectives, media and parameters to be measured (heavy metals, macroinvertebrates, vegetation success), methods to be used, and data analysis tools that are compatible with CDPHE regulations and protocols. Trending towards WQCD standards for respective WBIDs in Regulation #35 will be used as benchmarks for attainment of water quality improvements from BMP implementation at the three project sites. Increases in macroinvertebrate multi metiric indicies and % success rates for vegetation shall indicate success for the project. Table 12 in Appendix D summarizes how each project task will be monitored. The table contains several potential monitoring strategies based on the current level of knowledge of proposed restoration efforts. Strategies will be finalized in the SAPP after completion of project designs and before project implementation.

5.3 – Data Management

All water quality data will be uploaded through the Colorado Data Sharing Network for storage and automatic upload to EPA WQX/STORET. All other data (vegetation and channel surveys) will be managed in Excel spreadsheets and maintained by UWP. An IMAP will be developed to detail how data will be managed and stored.

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5.4 - Models

Use of models, if necessary, will be evaluated with assistance from the MRP during development of monitoring strategies. All model selection will be approved in the SAPP.

6.0 - Budget

6.1 - Budget Table *(Complete in the 2013 Budget Table)*

7.0 - Public Involvement

7.1 - Process for Public Involvement

The UWP holds monthly Board of Directors meetings that are open to the public. Additionally, the UWP holds quarterly stakeholder meetings which feature presentations or discussion forums on various watershed topics. To ensure public awareness and involvement in this project, the UWP will host at least 3 special public presentations to inform the community on this project, its progress and completion. UWP will also organize at least one field tour to a remediated site to discuss impairments and remediation approaches. Additionally, presentations pertaining to this project will be featured in the 2015 and 2017 San Juan Mining Conference. The public will be informed of the project through regular press releases, newsletters and website updates. Volunteers will be recruited at various events and through media outlets to help with field events and water quality sampling. The education, outreach and volunteer events will be organized by the UWP watershed coordinator and OSM/VISTA Volunteer.

Appendix Contents

A) 2013 Budget Table – *(Complete in the 2013 Budget Table)*

B) Figures (project and WQCD 2012 sampling maps) and Tables

C) Lead Project Sponsor and Cooperating Organizations

D) Section 5.2 Evaluation Table

Appendix B. Figures (project and WQCD 2012 sampling maps) and Tables.

Figure 1. Project Map: Upper Uncompahgre Watershed and locations of project sites**.**

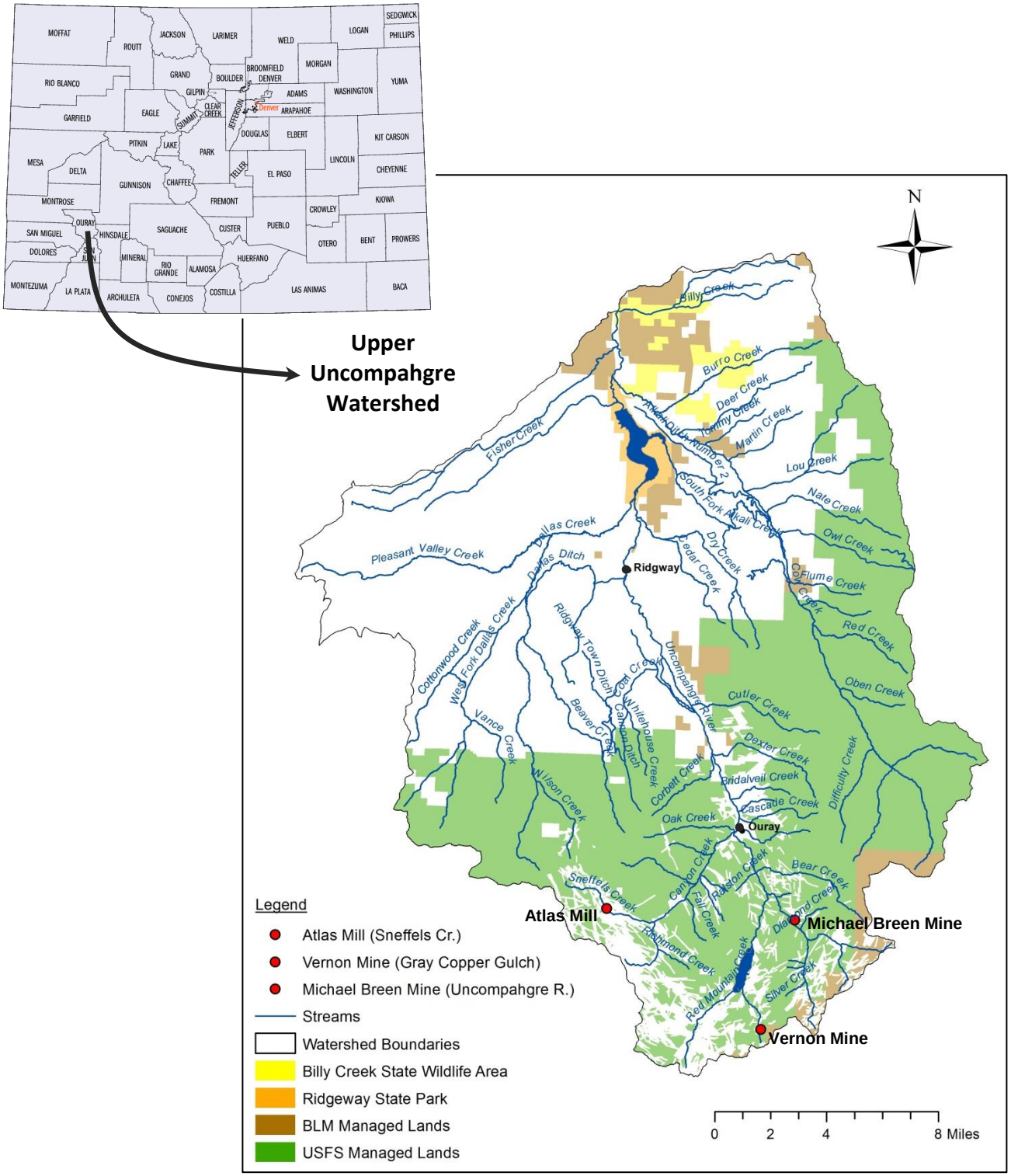

Figure 2. Locations of WQCD 2012 sampling in Sneffels Creek drainage.

Figure 3. Locations of WQCD 2012 sampling in Gray Copper Gulch.

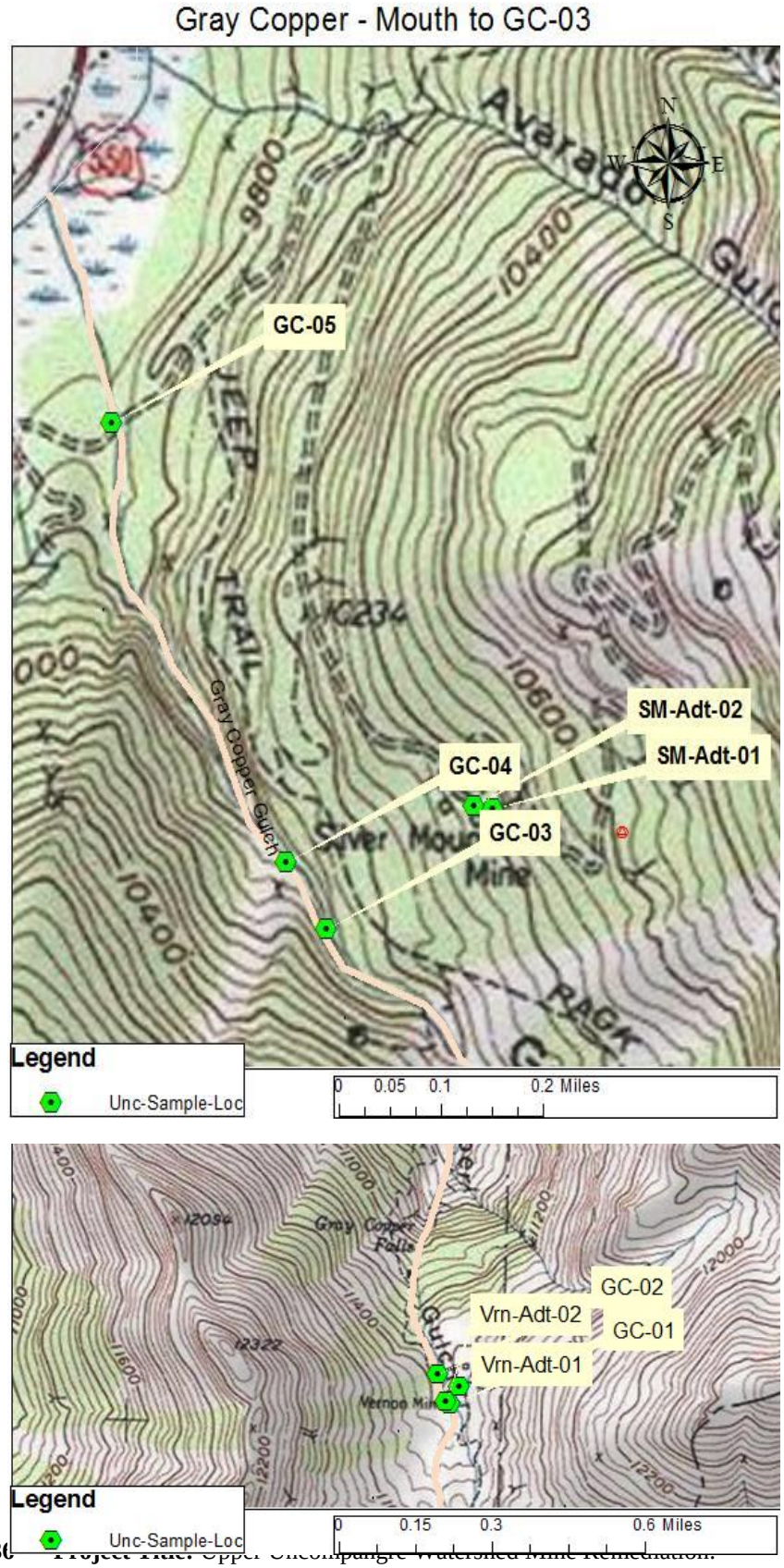

Figure 4. Locations of WQCD 2012 sampling in upper Uncompahgre River drainage.

Table 3. High and low flow (2012) cadmium concentrations and loading in Sneffels Creek (COGUUN09). Table Value Standards (TVS) are site-specific in-stream standards calculated using stream hardness.

Site Name	Site ID	Hardness Total	Cd, Dissolved (µg/L)	Chronic Cd TVS	> Chronic Cd TVS	Cd Loading (lb/day)	Flow (cfs)
Sneffels Cr reference	SC-01	37	<0.07	0.200338	no	< MDL	High 11.18
Sneffels Cr abv Atlas Mill	SC-02	38	0.48	0.204416	yes	0.114022	High 43.99
Sneffels Cr bel Atlas Mill	SC-03	36	0.55	0.196232	yes	0.122339	High 41.19
Canyon Cr @ Angel Cr	CC-02	74	0.29	0.33812003	no	No data	No data
Sneffels Cr, reference	SC-01	47	<0.07	0.240028	no	< MDL	Low 2.26675
Sneffels Cr abv Atlas Mill	SC-02	64	0.15	0.303037	no	0.004528	Low 5.59005
Sneffels Cr bel Atlas Mill	SC-03	63	0.20	0.299456	no	0.006237	Low 5.77525
Canyon Cr @ Angel Cr	CC-02	170	0.42	0.632786	no	0.26493	Low 116.81

Table 4. High and low flow (2012) zinc concentrations and loading in Sneffels Creek (COGUUN09). Table Value Standards (TVS) are site-specific in-stream standards calculated using stream hardness.

Site Name	Site	Hardness Total	Zinc, Diss. (µg/L)	Chronic Zn TVS	>Chronic Zn TVS	Acute Zn TVS	>Acute Zn TVS	Zn loading (lb/day)	Flow (cfs)
Sneffels Cr, reference	SC-01	37	14	53.26	no	61.42	no	0.85	High 11.18
Sneffels Cr abv Atlas Mill	SC-02	38	130	54.48	yes	62.83	yes	30.88	High 43.99
Sneffels Cr bel Atlas Mill	SC-03	36	120	52.03	yes	60.00	yes	26.69	High 41.19
Canyon Cr @ Angel Cr	CC-02	74	100	96.16	yes	110.90	no	No data	No data
Sneffels Cr, reference	SC-01	47	20	65.30391	no	75.31695	no	0.24481	Low 2.2668
Sneffels Cr abv Atlas Mill	SC-02	64	52	84.96581	no	97.9936	no	1.56969	Low 5.5901
Sneffels Cr bel Atlas Mill	SC-03	63	53	83.83272	no	96.68679	no	1.65288	Low 5.7753
Canyon Cr @ Angel Cr	CC-02	170	120	195.404	no	225.3653	yes	75.6944	Low 116.81

Table 5. High and low flow (2012) copper concentrations and loading in Gray Copper Gulch (COGUUN07). Table Value Standards (TVS) are site-specific in-stream standards calculated using stream hardness.

Site Name	Site ID	Hardness (mg/l)	Cu, Diss. (µg/L)	Chronic TVS	>Cu Chronic TVS	Cu Acute TVS	>Cu Acute TVS	Cu loading (lb/day)	Flow (cfs)
Gray Copper abv Vernon Mine	GC-01	5.1	38	0.704	yes	0.814	yes	1.150	High 5.60
Vernon adit #1	Vrn-Adt-01	50	580	4.953	yes	6.994	yes	0.049	High 0.016
Gray Copper bel Vernon Mine	GC-02	5.9	51	0.798	yes	0.933	yes	2.400	High 8.71
Gray Copper Gulch mouth	GC-05	74	33	6.924	yes	10.11	yes	2.708	High 15.20
Gray Copper abv Vernon Mine	GC-01	13	16	1.567	yes	1.965	yes	0.0010	Low 0.011
Gray Copper bel Vernon Mine	GC-02	15	390	1.770	yes	2.249	yes	0.0704	Low 0.033

Table 6. TMDL Table Value Standards and & Reductions* for Uncompahgre River. Table Value Standards (TVS) are site-specific in-stream standards calculated using stream hardness.

Hard ness mg/l	Cd-D, µg/L	Cd-D, TVS	Range of % Reduction	Cu-D µg/L	Cu-D TVS	Range of % Reduction	Zn-D, µg/l	Zn-D TVS	Range of % Reduction
111	0.7	0.3	0-81%	7.1	12.5	0-71%	99	21.3	0-81%

**Total Maximum Daily Load Assessment Red Mountain Creek/Uncompahgre River. San Juan/Ouray/Montrose County Colorado; Colorado Department of Public Health and Environment, Water Quality Control Division, November 2009 – Table 10.*

Table 7. Water quality in mainstem Uncompahgre River (COGUUN02) June 22, 2004. (from Uncompahgre River Water Quality Report, Woodling 2012).

Site	pH	Hardness	Al	Cd	Cu	Fe	Mn	Zn
Above Canadian Creek	7.2	68	350[a]	3.1*	23*	74	453	525*
Below Silver Creek		69	110	2.1*	17*	44	290	367*
Below Letcher Creek	6.9	68	88.4	1.9*	13*	95	262	341*
Below Old Lout Mine	7.2	77	68.4	2*	13.5*	99	276	339*
Above Mineral Creek	7.6	76	56	1.4*	10*	83	232	285*
Below Mineral Creek	7.1	56	85.7	1.1*	7.3*	249	148	211*
Above Michael Breen Mine	7.3	67	0	1.1*	13.4*	61	140	202*
Below Michael Breen Mine	7.6	61	0	0.95*	8.5*	64	118	177*
Above Red Mountain Creek	7.5	60	0	1*	8.7*	206	135	197*

Data from O'Grady, 2005. All metals in µg/L and reported in dissolved fraction, except Fe which is reported as total Fe. Hardness reported in mg/L as $CaCO_3$.
** = exceeded chronic table value stream standards as applied by WQCC.*
All Zn measurements also exceeded recalculated standards protective of some level of brown trout, except one mearurement at the "Below Michael Breen Mine."
Al standards are not applied by the WQCC in the Uncompahgre River, but "a" indicates the sample exceeded chronic Al criteria which was 288 µg/L at a hardness of 68 mg/L $CaCO_3$ which could be applied to the Uncompahgre River.

Table 8. High and low flow (2012) Cd, Cu, and Zn loading in Uncompahgre River (COGUUN02).

Site Name	Site ID	Flow (cfs)	Cd-dis (µg/L)	Cd-load (lb/day)	>Cd Chronic TVS	Cd Acute TVS	Cu-dis (µg/L)	Cu- load (lb/day)	>Cu Chronic TVS	Cu Acute TVS	Zn-dis (µg/L)	Zn-load (lb/day)	>Zn Chronic & Acute TVS
Uncompahgre above confluence with Red Mtn Cr	UNR-05	High flow: no data	0.66		yes	no	8		yes	no	140		yes
Michael Breen Adit	MB-Adt-01	High 0.017	19	0.0017	yes	yes	10	0.00091	no	no	4500	0.40824	yes
Uncompahgre bel Michael Breen	UNR-04	High flow: no data	0.83		yes	no	9		yes	yes	170		yes
Uncompahgre abv Michael Breen	UNR-03	High flow: no data	0.72		yes	no	9		yes	yes	150		yes
Uncompahgre bel Mineral Cr	UNR-02	High 3.7	0.79	0.0158	yes	yes	9	0.17982	yes	yes	160	3.1968	yes
Mineral Cr abv Unc R. confluence	MC-01	High 17.9255	0.23	0.0223	yes	no	8	0.77438	yes	yes	72	6.969434	yes
Poughkeepsie Glch abv Unc R. confluence	UNR-01	High 37.2125	1.1	0.2210	yes	yes	10	2.0095	yes	yes	200	40.1895	yes
Uncompahgre above confluence with Red Mt Cr	UNR-05	Low 5.64035	0.32	0.0098	no	no	<5	< MDL	no	no	87	2.649836	no
Michael Breen Adit	MB-Adt-01	Low 0.0168	16	0.0015	no	no	5.4	< MDL	no	no	4200	0.381024	no
Uncompahgre bel Michael Breen	UNR-04	Low 3.65	0.38	0.0075	no	no	<5	< MDL	no	no	110	2.1681	no
Uncompahgre abv Michael Breen	UNR-03	Low 4.63825	0.35	0.0088	no	no	<5	< MDL	no	no	89	2.229143	No

Table 9. Waste rock metal concentrations in mg/kg from waste rock and tailings piles near the Camp Bird Adit (CBA) #3 and the Atlas Mill (AM) site in 2012.

Waste Rock "Total" Metal Concentrations in mg/kg of material from TCLP Analysis																		
Site ID	Ag	Al	As	Cd	Cr	Cu	Fe	Hg	Pb	Mn	Mo	Ni	Se	SO_4^{2}	U	Zn	Alkalinity	Hardness
CBA #3 WR-01	<0.02	58.0	<0.02	4.4	0.2	53	0	<0.001	420	490	0.1	0.2	0.10	2,300	0.04	860	34,000	16,000
CBA #3 WR-02	<0.02	31.0	<0.02	3.8	0.2	34	0	<0.001	170	500	0.1	0.3	0.10	3,400	<0.02	700	50,000	23,000
CBA #3 WR-03	<0.02	66.0	<0.02	3.2	0.1	43	0	<0.001	500	360	0.1	0.2	0.08	1,200	<0.02	690	34,000	16,000
AM TA-01	<0.02	9.6	0.04	7.3	0.1	65	2	<0.001	3,500	390	0.0	0.2	0.07	380	0.03	1,700	30,000	9,200
AM TA-02	0.02	5.4	0.02	6.1	0.1	30	0	<0.001	2,700	440	0.0	0.2	0.07	1,000	<0.02	1,400	26,000	9,200
AM TA-03	0.04	2.0	0.08	1.3	0.0	1	0	<0.001	290	31	0.1	0.2	0.07	4,600	<0.02	200	24,000	3,800
AM TA-04	<0.02	4.2	0.03	13.0	0.1	44	0	<0.001	690	420	-0.1	0.2	0.08	220	<0.02	3,100	52,000	18,000

Table 10. Waste rock metal concentrations in mg/kg from waste rock piles near the Vernon Mine in 2012.

Waste Rock Total Metal Concentrations in mg/kg of material from TCLP Analysis																		
Site ID	Ag	Al	As	Cd	Cr	Cu	Fe	Hg	Pb	Mn	Mo	Ni	Se	SO_4^{2}	U	Zn	Alkalinity	Hardness
VM WR-01	<0.02	1.8	2.00	<0.02	0.0	58	84	<0.001	130	1	0.1	0.1	0.08	3,200	<0.02	0.4	11,400	110
VM WR-02	<0.02	3.9	0.15	0.1	0.0	13	62	<0.001	170	3	0.1	0.2	0.08	3,500	<0.02	15	12,800	190

Table 11. Waste rock metal concentrations in mg/kg from waste rock piles near the Michael Breen Adit in 2012.

Waste Rock Total Metal Concentrations in mg/kg of material from TCLP Analysis																		
Site ID	Ag	Al	As	Cd	Cr	Cu	Fe	Hg	Pb	Mn	Mo	Ni	Se	SO_4^{2}	U	Zn	Alkalinity	Hardness
MBA WR-01	<0.02	28.0	<0.02	3.0	0.1	17	1	<0.001	700	230	0.0	0.3	0.06	8,400	0.03	520	17,200	4,600
MBA WR-02	<0.02	26.0	<0.02	2.0	0.1	15	1	<0.001	200	180	0.0	0.2	0.04	7,500	<0.02	300	10,400	3,200

Appendix C. Lead Project Sponsor and Cooperating Organizations

Lead Sponsor			
Agency Name	Uncompahgre Watershed Partnership		
Agency Address	PO Box 392, Ridgway CO 81432		
Role/contribution	Lead project sponsor, project coordinator		
Contact Person	Agnieszka Przeszlowska	Telephone	970-416-5372
E-mail address	UWPcoordinator@gmail.com		

Cooperators			
Agency Name	Colorado Division of Reclamation Mining and Safety – Inactive Mines Reclamation Program		
Agency Address	PO Box 2058, Ridgway, CO 81432		
Role/contribution	Site assessments, design, reclamation oversight; financial contributor (cash & in-kind)		
Contact Person	Jeff Litteral	Telephone	970-216-1330
E-mail address	jeff.litteral@state.co.us		

Cooperators			
Agency Name	Mountain Studies Institute		
Agency Address	Fort Lewis College, Reed 130A, Durango, CO		
Role/contribution	San Juan Mining Conference partners, financial contributor (in-kind)		
Contact Person	Marcie Demmy Bidwell	Telephone	970-382-6908
E-mail address	marcie@mountainstudies.org		

Cooperators			
Agency Name	Ouray County Historical Society		
Agency Address	PO Box 151, 420 6th Avenue, Ouray, CO 81427		
Role/contribution	Site assessment, load out structure design, interpretive signs, financial contributor (in-kind)		
Contact Person	Don Paulson	Telephone	970-325-4576
E-mail address	drpaulson@ouraynet.com		

Cooperators			
Agency Name	Ouray County Road and Bridge Department		
Agency Address	PO Box 456, 115 Mall Rd, Ridgway, CO 81432		
Role/contribution	Road drainage design & survey, maintenance of features		
Contact Person	Chris Miller	Telephone	970-626-5391
E-mail address	cmiller@ouraycountyco.gov		

Cooperators			
Agency Name	Star Mine Operations, LLC		
Agency Address	1675 Larimer St, Ste 820, Denver CO 80202		
Role/contribution	Atlas Mill tailings removal/reprocessing, financial contributor (in-kind)		
Contact Person	John Trujillo	Telephone	303-534-6500, 970-596-4082
E-mail address	jrtrujillo@slvrstar.com		

Cooperators			
Agency Name	Trust for Land Restoration		
Agency Address	PO Box 743, 555 West Clinton Street, Ridgway, Colorado 81432		
Role/contribution	Site assessments and design, financial contributor (in-kind)		
Contact Person	Patrick Willits	Telephone	970-626-3236
E-mail address	willits@independence.net		

Cooperators			
Agency Name	US Bureau of Land Management – Tres Rios Field Office		
Agency Address	15 Burnett Court, Durango, CO 81301		
Role/contribution	Site assessment, special use permit		
Contact Person	Cathleen (Kay) Zillich	Telephone	970-247-4874
E-mail address	Cathleen_Zillich@blm.gov		

Cooperators			
Agency Name	US Forest Service - Minerals Program, Grand Mesa, Uncompahgre & Gunnison NF, Lands and Minerals Program		
Agency Address	Ouray Ranger District, 2505 S. Townsend, Montrose, CO 81401		
Role/contribution	Biological Evaluation, NEPA, special use permit, financial contributor (in-kind)		
Contact Person	Liz Mauch	Telephone	970-240-5405
E-mail address	lmauch@fs.fed.us		

Cooperators			
Agency Name	Western Stream Works		
Agency Address	1460 County Road 17, Ridgway, Colorado 81432		
Role/contribution	Wetland delineation, streambank stabilization		
Contact Person	Bill Coughlin	Telephone	970-708-2139
E-mail address	billcoughlin@westernstreamworks.com		

Appendix D. Section 5.2 Evaluation Table.

Table 12. Monitoring Strategy

Environmental Goal 1: Reduce the level of heavy metal loading or acid mine drainage from three legacy mining sites: Vernon Mine, Michael Breen Mine, and Atlas Mill.				
Programmatic Goal 1: Identify and implement appropriate restoration practices to reduce metals pollutant loading or acid mine drainage from Atlas Mill to Sneffels Creek, from Vernon Mine to Gray Copper Gulch and Michael Breen Mine to the Uncompahgre River.				
Programmatic Goal 2: Monitor and report the effectiveness of BMPs implemented at Atlas Mill, Vernon Mine, and Michael Breen Mine. And, expand or refine water quality sampling at abandoned mine nonpoint sources to prioritize remediation sites for future restoration efforts in Upper Uncompahgre River Headwaters.				
Programmatic Goal 3: Conduct effective project administration and outreach. Inform and educate the public on the need for and progress of mine remediation projects in the Uncompahgre watershed through effective outreach and education activities.				
Objective 1: Reduce metals loading to Sneffels Creek by addressing sources from Atlas Mill. *(Environmental & Programmatic Goal 1)*				
Task	**Responsible Party**	**Products & Outcomes**	**Evaluation Methods**	**Measure of Success**
Task 1: A) Atlas Mill site assessment and design B) Implement BMP at Atlas Mill	UWP, DRMS, TLR, WSW, Star Mine Operations	1. BMP design 2. BMP cost estimate 3. Estimated 20,000 cu.yd. of tailings removed 4. Estimated 7 ac. seeded 5. Estimated 300 ft streambank revegetated & stabilized 6. Estimated 2 acres wetlands created 7. Estimated metals removed	1. BMP protocols 2. Successfully executed contracts 3. Absence of approximately 20,000 cu.yd. tailings 4. Cover plots 5. Mortality measure of woody veg. established on streambank & channel cross-sections 6. 404 permit monitoring 7. Heavy metals sampling	1. Accepted design by all parties 2.Contracts completed on time and on budget 3. Approximately 20,000 cu.yd. tailings removed and water quality improved (see #7) 4. 40-60 % vegetation cover successfully established 5. Low measure of 30% mortality of woody veg. established on streambank &. 50-70 % channel stability 6. Army Corps of Engineers approval and low measure of 30% mortality of wetland vegetation 2 yrs. post project. 7. Increasing trend to metals load reduction for Zn at least

Objective 2: Reduce metals loading and improve pH of mine drainage from Vernon Mine to Gray Copper Gulch. *(Environmental & Programmatic Goal 1)*				
Task 2: A) Vernon Mine site assessment and design B) Implement BMP at Vernon Mine	UWP, DRMS, TLR	1. BMP design 2. BMP cost estimate 3. Estimated <1 cfs of discharge diverted 4. Estimated 1000 cu.yd. waste rock removed 5. Estimated 75 ft streambank revegetated & stabilized 6. Estimated metals removed	1. BMP protocols 2. Successfully executed contracts 3. BMP assessment 4. Absence of approximately 1,000 cu.yd. waste rock 5. Cover plots & mortality measure of woody veg. established on streambank 6. Heavy metals sampling	1. Accepted design by all parties 2. Contracts completed on time and on budget 3. Estimated <1 cfs of discharge diverted 4. Approximately 1,000 cu.yd. waste rock removed 5. 40-60 % vegetation cover successfully established & low measure of 30% mortality of woody veg. established on streambank 6. Increasing trend to metals load reduction for Cu and Iron
Objective 3: Reduce metals loading from Michael Breen Mine to the Uncompahgre River. *(Environmental & Programmatic Goal 1)*				
Task	**Responsible Party**	**Products & Outcomes**	**Evaluation Methods**	**Measure of Success**
Task 3: A) Michael Breen site assessment and design B) Implement BMP at Michael Breen	UWP, DRMS, TLR, OCRB	1. BMP design 2. BMP cost estimate 3. Road drainage design 4. Estimated <1 cfs discharge diverted 5. Estimated 1 ac revegetated hillslope 6. Estimated metals removed	1. BMP protocols 2. Successfully executed contracts 3. County protocols for road drainage construction assessment 4. BMP Assessment 5. Cover plots 6. Heavy metals sampling and other simple estimation/ modeling if possible	1. Accepted design by all parties 2. Contracts completed on time and on budget 3. Enhanced drainage routing across road 4. Estimated <1 cfs of discharge diverted 5. 40-60 % vegetation cover successfully established 6. Increasing trend to metals load reduction for Cd, Cu, Zn (per TMDL)

Objective 4: Collect pre- and post-project water quality to document and evaluate the effectiveness of mine remediation efforts. And, assess water quality at other abandoned mine sites in Uncompahgre River headwaters to prioritize future remediation efforts. *(Programmatic Goal 2)*				
Task 4: A) Develop SAPP and IMAP B) Implement SAPP: Pre- and post-project data collection and analysis. Headwaters water quality assessment.	UWP, CDPHE, DRMS	1. SAPP documents 2. Pre- and post-project and headwaters data sets 3. Documentation of water quality trends 4. Prioritization of sites for future restoration projects 5. Data storage in EPA WQX/STORET database 6. Improved understanding of BMP efficacy	1. CDPHE Approval of SAPP 2. CDPHE water quality tables 3. Completed Assessments 4. Completed prioritization list 5. Proof of upload to EPA WQX/STORET database 6. Reporting of findings to CDPHE MRP	1. SAPP implementation with minimal modification during project duration 2. Successful collection of water quality, vegetation, and channel data as outlined in SAPP 3. Assessments accepted by UWP, DRMS, CDPHE 4. Prioritization accepted by UWP, DRMS, CDPHE 5. Data upload to EPA WQX/STORET database prior to end of contract 6. CDPHE MRP acceptance of data and findings.

Objective 5. Communicate project implementation plan and outcomes with the public through community outreach and education activities. Enhance understanding of mine remediation by installing interpretive signs at two remediated sites. *(Programmatic Goal 3)*				
Task	**Responsible Party**	**Products & Outcomes**	**Evaluation Methods**	**Measure of Success**
Task 5: A) Community Outreach B) Interpretive signs at Atlas Mill and Michael Breen Mine, stabilize load out structure at Michael Breen Mine	UWP, MSI, OCHS	1. At least 3 public presentations and 1 site tour 2. At least 3 press releases, on-going newsletters & website updates 3. San Juan Mining Conference in 2015, 2017 4. Two interpretive signs at Atlas Mill, one at Michael Breen Mine and stabilized load out structure at Michael Breen Mine 5. Enhanced community awareness of abandoned mine remediation	1. Attendance at public meetings and mine tour 2. Placement in newspaper, website and newsletters 3. Attendance at San Juan Mining Conference 4. Installation of interpretive signs, stabilized structure. 5. Increased website and meeting attendance.	1. # meetings and 1 tour attended by public 2. Feedback from articles, newsletter & website updates 3. Increased collaboration for interested parties. 4. Anecdotal evidence of stoppage at the sign and structure sites. 5. Greater participation by the community in UWP activities.

Objective 6: Conduct effective project administration. *(Programmatic Goal 3)*				
Task 6: Project administration	UWP	1. Quarterly reimbursement requests 2. Match reporting 3. Semi-annual reports and final report per contract	1. Compliance with timelines in contract for invoicing 2. Accounting measures per contract 3. Completion of semi-annual and final reports per contract	1. Regular payment of invoices by CDPHE 2. Regular payment of invoices. 3. Acceptance of semi annuals and final reports by CDPHE. Final report submitted prior to the end of the contract.

Responsible Parties:

DRMS: Division of Reclamation Mining and Safety
OCRB: Ouray County Road and Bridge Department
OCHS: Ouray County Historical Society
MSI: Mountain Studies Institute
TLR: Trust for Land Restoration
UWP: Uncompahgre Watershed Partnership
WSW: Western Stream Works

Exhibit 3. Sampling Analysis Plan for mine remediation project (Project Implementation Plan).

TMDL Bridge to Restoration

Sampling and Analysis Plan

Colorado Department of Public Health and Environment

Colorado Department of Public Health and Environment
Water Quality Division
4300 Cherry Creek Drive South
Denver, CO 80246

April 2014

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Introduction

In the state of Colorado there are over 23,000 hazardous mines and 604 miles of streams impacted by past mining. Dissolved metals and acidity due to legacy mining and natural loading sources make up 51% of the impaired waters list and 89% of completed Total Maximum Daily Loads (TMDLs) in the State of Colorado. Historically, legacy mines or abandoned mine lands (AMLs) have lacked a financially viable "responsible party", making restoration efforts difficult. Because of the significant impacts on the state's waterways and lack of funding available for restoration projects, The Nonpoint Source (NPS) group within the Water Quality Control Division (Division) has made legacy mining a high priority for the next five years.

The Environmental Data Unit's (EDU) Measureable Results Program (MRP) has been tasked with measuring the water quality effects of point and nonpoint source pollution control activities in support of planning and prioritization of future resources to achieve the best possible water quality benefit for the state. EDU's MRP is assisting the NPS group in its goal to reduce the impact of legacy mines by providing water quality and site characterization to facilitate restoration planning.

There typically is not enough specific water quality information in Total Maximum Daily Loads (TMLDs) for a watershed group or the Division of Reclamation Mining and Safety (DRMS) to determine exact impairment sources or design a restoration plan. This project intends to address this issue by better characterizing water quality and measuring pollutant loadings from legacy mining features to facilitate restoration planning. Restoration plans may be used to apply for funds through section 319 and Clean Water State Revolving Funds (CWSRF). Through this project, the Division will assume greater control of directing restoration resources to watersheds where the greatest water quality benefit will be achieved.

1 Sampling Plan Design

This Sampling Analysis Plan (SAP) describes the procedures and methods utilized for the collection and analysis of water quality data for EDU's TMDL Bridge to Restoration initiative. The primary goal of this initiative is to facilitate restoration planning and projects for water bodies impaired by legacy mining pollution. These studies are designed to collect water quality and abandoned mine site data to support science-based decisions for remediation actions. To accomplish this, pollution sources will be documented and evaluated to determine loading contributions. These sources will be prioritized based on quantities of pollutants or loading contributions. Sources will be attributed to natural or anthropogenic causes.

Water quality samples will be collected above and below sources and if possible from the sources themselves. Laboratory analysis will determine concentrations of pollutants. Flow discharge will be measured at corresponding sampling locations. Loading contributions from individual sources will be derived from the pollutant concentrations and discharge volumes.

Historic data will be collected from and shared with interested agencies and stakeholders to produce as complete a dataset as possible. This data will be used to determine where data gaps exist. Additional monitoring efforts will be directed to complete site characterizations and determine pollution sources and loadings.

Each project is unique and requires a specific approach to site characterization. Specific study information such as, project description, environmental problem, sampling locations, project maps, constituents, frequencies, etc. are described on a project specific basis in Site Specific SAPs. Site Specific SAPs are documented in Section 4. Trip Safety and Planning Information Forms will be completed for each sampling event. An example form is available in Section 5.

2 Intended Use of Data

This information will have a wide readership and benefit the Division in several ways. First and foremost, this program will provide sufficient water quality data to facilitate the legacy mine restoration plans which seek to eliminate or reduce water quality impairment. These restoration plans will be utilized to solicit funds through the Clean Water State Revolving fund and the NonPoint Source (Section 319) programs. Approaches to these funding sources are explained in greater detail below. Secondly, all information collected during these studies will be used to help the division fulfill its requirements under Sections 303(d) and 305(b) of the Federal Clean Water Act (CWA). Optionally, the data from these restoration projects may be included in EDU's Measurable Results program to evaluate whether, and to what extent, the restoration project and associated BMPs have improved water quality.

Clean Water State Revolving Funds: Pollution source identification and loadings contributions will be documented at specific impairment sites. DRMS will utilize the site characterization to determine the most effective restoration activities in order to make the site "shovel ready" for construction. DRMS may seek funding for these projects through the CWSRF. This data is expected to provide DRMS with a significant cost savings for the initial site characterization and allow for additional monies to be dedicated to restoration.

319 Grant Monies: Pollution source identification and pollutant loadings will be documented at specific impairment sites. These impairment characterizations will be utilized to request restoration projects through the 319 grant funding program. This will follow the existing project solicitation process. Building upon these site characterizations, watershed groups will experience a significant cost savings that allow for additional monies to be dedicated to restoration.

Because of the intended use within the 319 grant program, the data collected within the TMDL Bridge to Restoration initiative must be compatible and comparable to data collected within the 319 Grant program. This is accomplished through field data collection and laboratory analysis quality control and quality assurance programs with equal levels of rigor. Section 3 of this SAP identifies the field and laboratory methods for use in this study. This section includes, by reference, sampling protocols and quality assurance guidance developed by the Division. These

protocols are designed to produce accurate, unbiased, representative and comparable data within the Watershed Program and the Division. These activities will include a combination of field and laboratory procedures that, when performed properly, will provide measurements that are of known quality, technically sound, statistically accurate, properly documented and representative of the media being measured. These same methods form the basis for sampling and analysis protocols used in the 319 Grant program. Therefore data collected through studies conducted for the 319 Grant program or the TMDL Bridge to Restoration initiative will be mutually comparable and can be used by either group.

Environmental Data Unit Assessments: The Environmental Data Unit exists to gather, assess and report data regarding the chemical, physical and biological integrity and quality of state surface waters as required through the CWA. Data collected during this study will be formatted appropriately to help EDU in its water quality assessments and 305(b) and 303(d) reporting requirements.

3 Field and Laboratory Methods

As mentioned above, the results of this study will have a wide readership. This data will be utilized by the Division to make important water quality decisions. All data collection and analysis will follow, or be comparable in nature to, Division protocols and methodologies. These protocols are designed to produce accurate, unbiased, representative and comparable data within the Watershed Program and the Division. These activities will include a combination of field and laboratory procedures that, when performed properly, will provide measurements that are of known quality, technically sound, statistically accurate, properly documented and representative of the media being measured. Division methods and protocols used in this initiative are:

Title	Date
Standard Operating Procedures for the Planning of and Field Procedures for Conducting Monitoring Activity	2007
Standard Operating Procedures for the Pebble Counts	2005
Standard Operating Procedures for the Assessment of Habitat – Physical Characterization and RBPs	2004
Standard Operating Procedures for the QUANTA water quality monitoring system	2002
Standard Operating Procedures for the Collection of Periphyton Samples	2006

Standard Operating Procedures for Collecting and Preserving Benthic Macroinvertebrate Samples	2004
Standard Operating Procedures for the Sampling Frame (Pebble Counts)	2004
Standard Operating Procedures for the Photo Documentation Establishing Permanent Photo Points	1999
Standard Operating Procedures for the Filtration of Water Samples	2003
Standard Operating Procedures for the Collection of Water Samples	2008
Standard Operating Procedures for the Operations of In-Situ Multi-parameter Meter	2011
Standard Operating Procedures for the Collection of Lakes Water 2011 Quality Information	
Standard Operating Procedures for the Establishment and Documentation of Sampling Site Location	2003
Procedures for Safety Planning in the Field	2009

4 Site Specific Sampling Plans

4.1 Illinois Gulch:

Blue River Segment 12 (COUCBL12) Illinois Gulch, is in nonattainment of Aquatic Life Use-based water quality standards for dissolved zinc and cadmium. Illinois Gulch is located near Breckenridge in Summit County, Colorado. Beneficial Uses applied to Illinois Gulch are Aquatic Life Cold 2, Recreation P, Water Supply and Agriculture.

4.1.1 Environmental Problem

Much of the heavy metal loading throughout the Blue River basin is the result of natural geologic conditions and historic mining activities. The Blue River watershed began experiencing widespread mining activity throughout the basin beginning in the 1870's. Several historical mine sites are located in the vicinity of Illinois Gulch. Commodities from these mine included gold, zinc, lead, silver, and copper. Mining operations resulted in residual levels of elevated

cadmium concentrations in Illinois Gulch. Discharge from the Puzzle/Willard Adit is the starting point for surface water in Iron Springs Gulch. Surface water from Iron Springs Gulch flows a few hundred feet before mixing with water seeping from several large waste rock piles. Iron Springs Gulch flows north through a wetland before taking shape in a channelized stream, eventually meeting with Illinois Gulch.

The Water Quality Control Division has a routine monitoring site on Illinois Gulch near the Breckenridge Ice Rink. This site provided water quality data from 2001 to 2007. In addition to the routing monitoring, the WQCD conducted synoptic sampling events; 2 during 2008 and 2 during 2010. Six sites were sampled: sample sites were located upstream from the Puzzle/Willard Mine (Illinois Gulch at Illinois Gulch Road), the Puzzle/Willard Mine seepage, Iron Springs Gulch upstream from the confluence with Illinois Gulch, Illinois Gulch upstream of the confluence with Iron Springs Gulch, Illinois Gulch downstream of the confluence with Iron Springs Gulch, and Illinois Gulch at the Breckenridge Ice Rink. These data were utilized in the development of the TMDL.

(TMDLs) for dissolved zinc and dissolved cadmium were approved in December 2009 and May 2011 respectively. The TMDL calculated load reductions required to attain chronic dissolved zinc and cadmium standards. The reductions were calculated for high flow and low flow conditions for Illinois Gulch below the confluence with Iron Springs Gulch. The high and low flow reduction requirements for dissolved cadmium are 72% and 71% respectively. The high and low flow reduction requirements for dissolved zinc are 59% and 76% respectively.

During the development of the TMDLs for (COUCBL12) four zinc results were recorded in 2008 on Illinois Gulch above the Iron Springs Gulch confluence. A mean hardness of 88.5 mg/L was used to calculate a chronic zinc Aquatic Life Use-based standard of 112.10, which when compared to 98.2 ug/L, the 85 % of zinc, shows attainment. Of these four sampling events, there were no exceedances of the zinc acute aquatic life standard. Six cadmium results were recorded on Illinois Gulch above the Iron Springs Gulch confluence between 2008 and 2010. All samples resulted in less than detectable levels of cadmium and attainment of chronic and acute Aquatic Life Use-based standards. While the portion of Illinois Gulch above the confluence with Iron Springs Gulch is attaining water quality standards, zinc levels equal 87% of the chronic standard for this portion. Abandoned mine waste-rock piles in close proximity to Illinois Gulch have been observed in this portion.

4.1.2 Characterization of Water Quality

Additional water quality information was collected in 2012 and 2013 to facilitate remediation decisions and provide a basis for remediation planning. This additional characterization will build on the information used to develop the Total Maximum Daily Load for Illinois Gulch. According to the TMDL the Puzzle/Willard Mine adit and nearby waste rock piles are estimated to be the most significant sources of metals to Iron Springs Gulch. Sampling locations in Iron Springs Gulch were positioned above and below known sources to measure zinc and cadmium

loading contributions per source. Water quality reporting is underway based on data collected during 2012 and 2013.

The collection of Macro Invertebrates was planned during sampling activities which occurred on August 28 2013. Unfortunately adequate resources to collect the samples were not available. This monitoring activity was postponed to a later date. However, unseasonably wet weather occurred directly after this monitoring event which resulted in unrepresentative conditions for the next month. When the wet weather subsided, it was outside of the recommended macro invertebrates sampling period of July through October. Therefore Macro Invertebrates were not collected in 2013.

4.1.3 2014 Sample Collection:

For the purpose of the Measurable Results Project initiative, the only monitoring efforts currently scheduled are the collection of macro invertebrates. Macro invertebrates will be collected during a low flow sampling event in 2014. The US Forest Service is conducting additional water quality monitoring and waste rock pile analysis in Illinois Gulch drainage. The Macro invertebrate sampling will be timed to coincide with these efforts.

4.1.4 Project Contact Information

DRMS:
Primary Contact: Allen Sorenson 303-866-8143 allen.sorenson@state.co.us

CDPHE:
Primary Contact: Skip Feeney 303-691-4928 Stanley.feeney@state.co.us

4.1.5 Monitoring Schedule

Monitoring Sites						
Estimated Dates: June 5, 2013 and September 18, 2013						
Site Description and DRMS Site Number	WQCD Site Number	Sample Suite	Responsible Party WQCD or DRMS		Lat (WGS 84)	Long (WGS 84)
			Sampling	Analysis		
Illinois Gulch at Ice Arena.	IG-1	Macro Invertebrates	WQCD	WQCD	39.472391	-106.039019
Illinois Gulch above Iron Springs Gulch Confluence.	IG-14	Macro Invertebrates	WQCD	WQCD	39.471250	-106.02862

4.1.6 Sample Locations Map

Legend

- 2013-loc

0 0.0750.15 0.3 Miles

4.1.7 Monitoring Parameter List

The WQCD is utilizing a standard parameter group for each of the surface water assessments. This list of parameters will meet the specific mining site characterization needs as well as supply data to other division programs. Optionally, DRMS can identify their own analysis suite based on their analytical budgets.

Parameter List						
EPA PARAMETER	METHOD #	PQL*	HOLDING TIME	SAMPLING CONTAINER **	PRESERVATIVE	Suite
Metals (dissolved and total recoverable)						
ALUMINUM	200.7	50	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
ARSENIC	200.8	1	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
CADMIUM	200.8	0.6	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
CHROMIUM	200.7	20	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
COPPER	200.7	5	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
IRON	200.7	10	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
LEAD	200.8	.8	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
MANGANESE	200.8	2	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
MERCURY	245.1	0.1	28 days	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
NICKEL	200.7	30	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
SELENIUM	200.8	.7	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
SILVER	200.8	0.6	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
URANIUM	200.8	1	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
ZINC	200.7	10	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
Minerals		mg/L				
ALKALINITY	310.1	10	14 days	P,G	Cool, 4°C	Standard
HARDNESS	200.7	1	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
Nutrients		mg/L				
AMMONIA	350.1	0.03	28 days	P,G	Cool, 4°C - H2SO4 to pH<2	Nutrients
KJELDAHL	351.2	0.5	28 days	P,G	Cool, 4°C - H2SO4 to pH<2	Nutrients
NITRATE/NITRITE	353.2	0.3	28 days	P,G	Cool, 4°C - H2SO4 to pH<2	Nutrients
TOTAL PHOSPHATE	365.1	0.01	28 days	P,G	Cool, 4°C - H2SO4 to pH<2	Nutrients
Miscellaneous		mg/L				
SULFATE	300.0	3	28 days	P,G	Cool, 4°C	Standard
Benthic Macroinvertebrates	Policy 10-1			P	95% Ethanol	Macro
*PQL=Practical Quantitation Level in Clean Matrix				**P=plastic		
ug/L=Micrograms per Liter				G=glass		
mg=Milligrams per Liter				S=sterile		
pCi/L=Picocurries per Liter				AW=acid washed		

Field Analysis	
Parameter	**Suite**
Dissolved O2 (mg/l)	standard
TEMP (c)	standard
pH (s.u)	standard
Conductivity (us/cm)	standard
Flow (feet per second)	standard

4.2 Waldorf Mine

The Waldorf Mine is located in the headwaters of Leavenworth Creek (COSPCL03b), a tributary to Clear Creek. This segment was previously listed as impaired for not meeting the applicable lead and zinc standards associated with its Aquatic Life Use classification.

A TMDL for lead and zinc was approved in September 2008. The TMDL calculated load reductions to attain chronic dissolved lead and zinc standards. The reductions are calculated on a monthly basis. Lead reductions on the segment range from 3% in December to as much as 98% in June. Load reductions during the rising and falling limbs of the hydrograph (May-July) are greater than 90%. Months of December and January require the lowest lead reductions at 3% and 8%, respectively. Load reductions for zinc are steadier year round (68%-98%) with the highest loading reductions occurring in May-June at 97% and 98%, respectively. During months of lower flow (i.e. September-April), zinc loading reductions fluctuate from 68% and 88%.

Subsequent to TMDL development for zinc and lead, Leavenworth Creek was determined to be impaired for dissolved copper and was included in the 2010 303(d) List.

4.2.1 Environmental Problem

The Waldorf Mine site contains a draining adit and a series of waste piles that encompass over 2 acres. The Waldorf Mine adit (a/k/a Waldorf Tunnel, a/k/a Wilcox Tunnel) continually drains and intermittently discharges large surges of contaminated water into a wetland area and Leavenworth Creek. The site is owned by private landowners and the United States Forest Service.

4.2.2 Summary of Adit Data Collected In 2011, 2012 and 2013

Sampling and analysis conducted at the Waldorf Mine adit from 2011 to 2013 demonstrates that the discharge from the adit carries a substantial load of heavy metals, as detailed in the following table.

Waldorf Mine Adit Discharge – Concentrations and Loading for Selected Dissolved Metals				
Date	Flow Rate (CFS)	Analyte	Concentration (ug/L)	Load (lbs./day)
6/28/11	0.143	Cadmium	21	0.016
6/28/11	0.143	Copper	550	0.42

6/28/11	0.143	Zinc	6300	4.9
6/19/12	0.20	Cadmium	14	0.015
6/19/12	0.20	Copper	110	0.12
6/19/12	0.20	Zinc	6000	6.47
9/26/13	0.227	Cadmium	32	0.04
9/26/13	0.227	Copper	290	0.355
9/26/13	0.227	Zinc	10,400	12.74

Consideration of how best to mitigate the impact to water quality in Leavenworth Creek by the Waldorf Mine adit discharge would be facilitated by a better understanding of the source and subsurface flow paths of the water, and the sources of the dissolved metals carried by the water.

U.S. Geological Survey Professional Paper 178 published in 1935 includes a map of the Waldorf Mine adit that also illustrates the adit's relationship to overlying mine workings, including level 5 of the of the Santiago Mine. Professional Paper 178 also includes a cross section of the Santiago Mine showing that the lowest level (the no. 7 level) of the Santiago Mine is approximately 250 feet above the elevation of the Waldorf Mine adit. These figures from Professional Paper 178 are reproduced below.

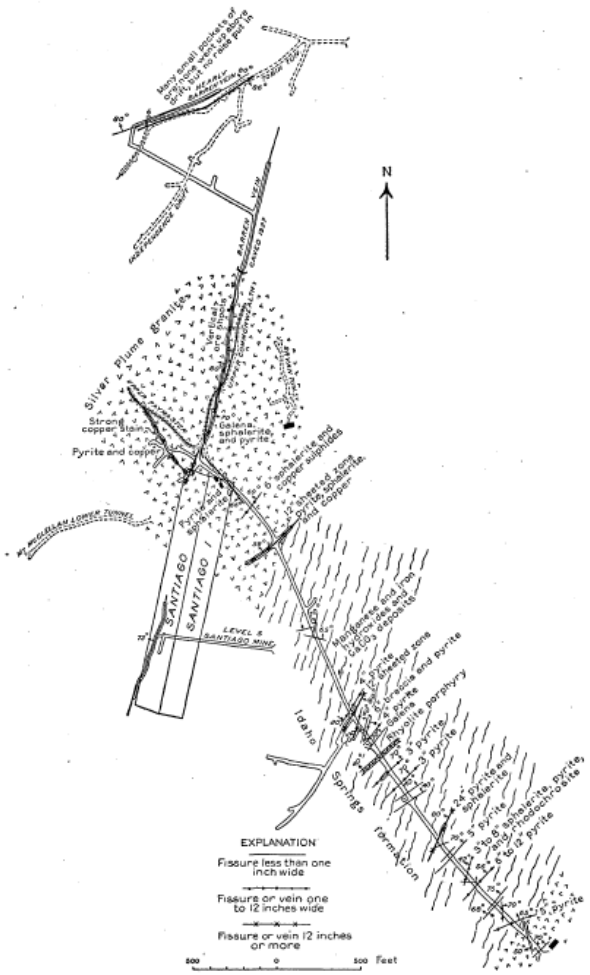


FIGURE 16.—General relations of Santiago, Commonwealth, Independence, Tobin, and Paymaster workings and geology of Waldorf tunnel.

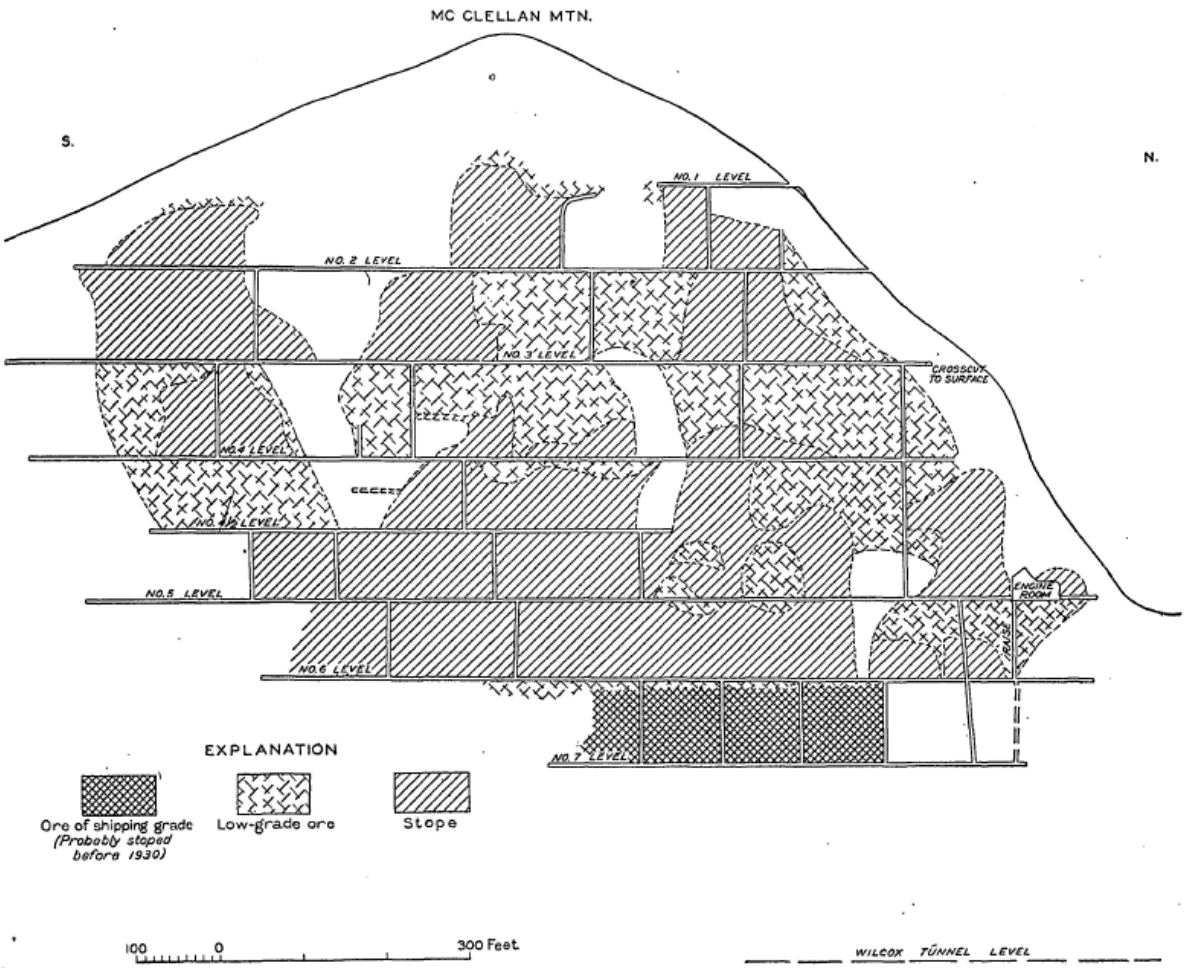


FIGURE 20.—Stope map of Santiago mine, looking west. (From map by F. Ricci.)

The Santiago Mine no. 5 level portal was examined by personnel from the Division of Reclamation, Mining and Safety (DRMS) in 2011. The mine appeared to be safely accessible for as far as a mine lamp could be shined in from the portal. No water was observed at the portal or within the mine at that time. In 2009, Cats International, through the owner of the Santiago Mine claims, filed a Notice of Intent to Conduct Prospecting at the Santiago Mine. It is stated in the Notice of Intent that the Santiago Mine below the no. 5 level is flooded, and would have to be dewatered by pumping in order to conduct prospecting in the lower levels.

It is not believed that the Santiago Mine and Waldorf Mine adit are interconnected via mine workings, but the Waldorf Mine adit may drain the Santiago Mine pool by flow through fractures that pass ground water through the rock between the mines. Reconnaissance of the underground workings of the Santiago Mine might allow for observation and testing for confirmation and measurement of ground water flow from the Santiago to the Waldorf. This will provide data to help in the determination of dissolved metal sources in the Waldorf Mine adit discharge.

Sampling locations cannot be preselected prior to entering the Santiago Mine therefore opportunistic sampling of water observed within the mine will be conducted. Six sample

bottles will be prepared for sample collection. Water sampling and flow measurement in the Santiago Mine will be conducted using the same procedures as surface water sampling under the Sampling and Analysis Plan.

4.2.3 Project Contact Information

DRMS:
Primary Contact: Allen Sorenson 303-866-8143 allen.sorenson@state.co.us

CDPHE:
Primary Contact: Skip Feeney 303-691-4928 Stanley.feeney@state.co.us

4.2.4 Monitoring Parameter List

The WQCD is utilizing a standard parameter group for each of the surface water assessments. This list of parameters will meet the specific mining site characterization needs as well as supply data to other division programs.

Parameter List						
EPA PARAMETER	METHOD #	PQL*	HOLDING TIME	SAMPLING CONTAINER **	PRESERVATIVE	Suite
Metals (dissolved and total recoverable)						
ALUMINUM	200.7	50	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
ARSENIC	200.8	1	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
CADMIUM	200.8	0.6	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
CHROMIUM	200.7	20	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
COPPER	200.7	5	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
IRON	200.7	10	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
LEAD	200.8	.8	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
MANGANESE	200.8	2	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
MERCURY	245.1	0.1	28 days	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
NICKEL	200.7	30	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
SELENIUM	200.8	.7	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
SILVER	200.8	0.6	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
URANIUM	200.8	1	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
ZINC	200.7	10	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
Minerals		mg/L				
ALKALINITY	310.1	10	14 days	P,G	Cool, 4°C	Standard
HARDNESS	200.7	1	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
Nutrients		mg/L				
AMMONIA	350.1	0.03	28 days	P,G	Cool, 4°C - H2SO4 to pH<2	Nutrients
KJELDAHL	351.2	0.5	28 days	P,G	Cool, 4°C - H2SO4 to pH<2	Nutrients

Parameter List						
EPA PARAMETER	METHOD #	PQL*	HOLDING TIME	SAMPLING CONTAINER **	PRESERVATIVE	Suite
NITRATE/NITRITE	353.2	0.3	28 days	P,G	Cool, 4°C - H2SO4 to pH<2	Nutrients
TOTAL PHOSPHATE	365.1	0.01	28 days	P,G	Cool, 4°C - H2SO4 to pH<2	Nutrients
Miscellaneous		mg/L				
SULFATE	300.0	3	28 days	P,G	Cool, 4°C	Standard
*PQL=Practical Quantitation Level in Clean Matrix				**P=plastic		
ug/L=Micrograms per Liter				G=glass		
mg=Milligrams per Liter				S=sterile		
pCi/L=Picocurries per Liter				AW=acid washed		

Field Analysis	
Parameter	**Suite**
Dissolved O2 (mg/l)	standard
TEMP (c)	standard
pH (s.u)	standard
Conductivity (us/cm)	standard
Flow (feet per second)	standard

4.3 Daisy Mine in the Redwell Basin:

The Daisy Mine is located in Redwell Basin which is a tributary to Oh-Be-Joyful Creek (COGUUG10), which in turn, is a tributary to the Slate River. The Daisy Mine complex is located in private lands. This segment is currently listed as impaired for not meeting the applicable Aquatic Life Use-based cadmium, copper, lead and zinc standards. A TMDL has been developed for Redwell Basin and is currently at public notice.

The TMDL study determined the contribution of metals from historic mining activity was approximately 97% for cadmium, 84% for copper, 93% for lead, and 96% for zinc. A 100% reduction in cadmium concentrations is required in order to meet the TMDL for Redwell Creek. Copper requires a 98% reduction, lead a 100% reduction, and zinc a 99% reduction.

4.3.1 Environmental Problem

Redwell Basin is a naturally mineralized basin, located 5 miles west of the Town of Crested Butte. Several anthropogenic and natural sources of acidic, metals laden waters exist within the Redwell Basin. The Daisy Mine and an artesian borehole (sample location RW-1) are the primary anthropogenic sources of metals and acidity in the Basin. The artesian borehole consistently emits 15-20 gallons per minute (gpm) of metals laden, pH 2.8 water.

4.3.2 Best Management Practice Implementation

In October 2012 the Division of Reclamation, Mining, and Safety (DRMS) grouted the artesian drill hole to seal and eliminate its discharge. The grouting project set a packer at a depth of 100 feet, and pumped 5 pallets of grout into the borehole. Due to unknown circumstances at depth, the grouting was unsuccessful at completely blocking the flow of water through the bore hole. Prior to demobilization of the grouting equipment, a valve was placed on the pipe. During the Fall of 2013, DRMS pressure grouted the entire length of the borehole. Approximately 20 pallets of grout were injected to refusal through the existing pipe. This implementation completely blocked the discharge of water from the artesian drill hole.

4.3.3 Sampling Procedure/Rational and Sample Locations

The purpose of this sampling activity is to measure water quality change in Redwell Basin as a result of the remediation project at the Artesian Drill hole. Previously collected data has provided a base line for this study. Post project water quality monitoring will occur in such a fashion to produce comparable results. Monitoring will occur at similar locations in the basin to produce spatially consistent data. Sample collection will be timed to capture high and low flow hydraulic scenarios consistent with previous studies. It should be noted that collecting data that mirrors previous hydraulic conditions exactly is not possible.

Samples will be analyzed for dissolved metals, total metals and in select locations nutrients. Field parameters will be Temp, Dissolved Oxygen, pH, Conductivity, and Flow.

4.3.4 Project Contact Information

DRMS:
Primary Contact: Tara Tafi 720-425-4122 Tara.Tafi@state.co.us

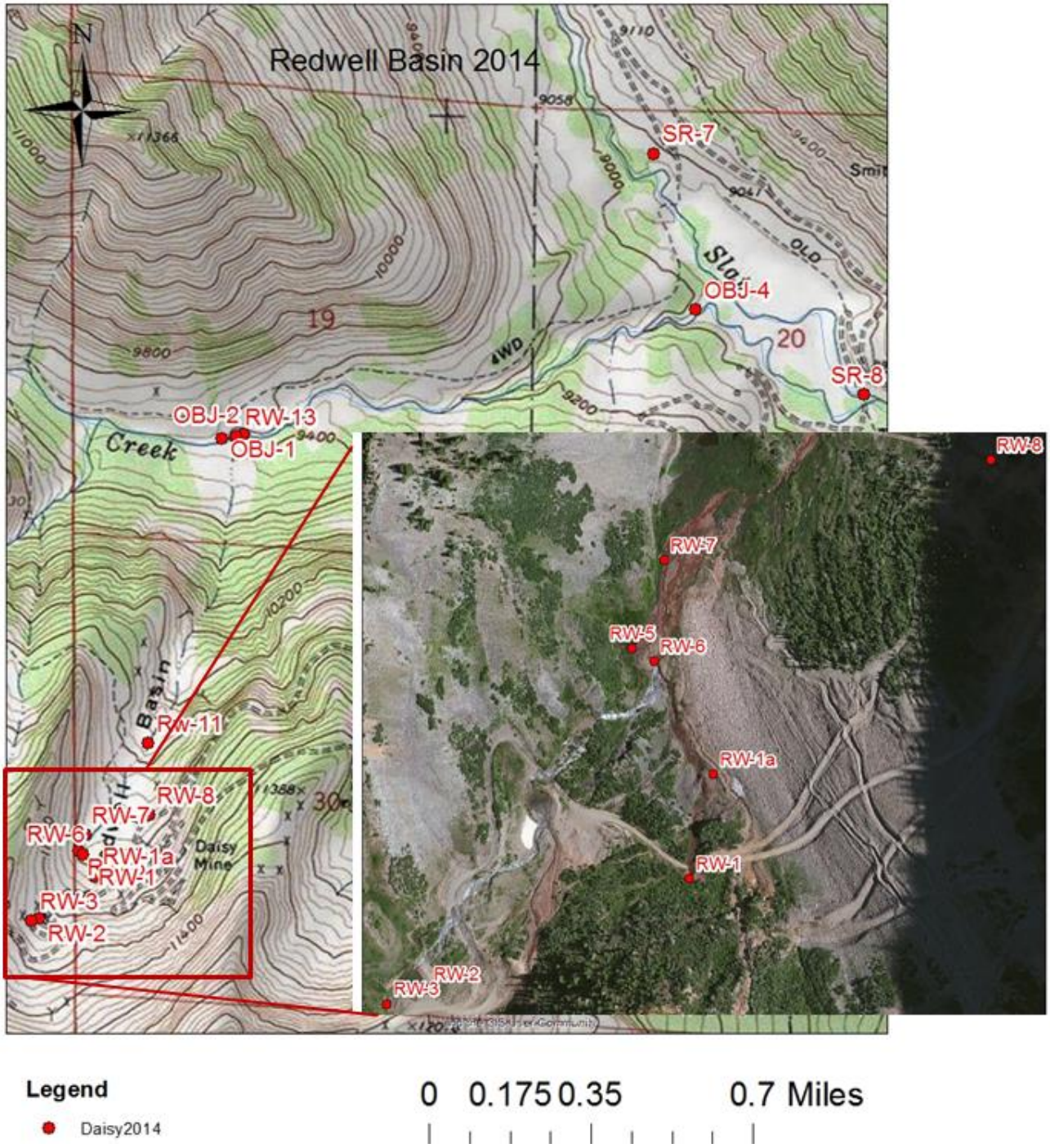
CDPHE:
Primary Contact: Skip Feeney 303-691-4928 Stanley.feeney@state.co.us

4.3.5 Monitoring Schedule

Monitoring Sites						
Estimated Dates: July 15th and Sept 3						
Site Description	Site Number	Sample Suite	Responsible Party WQCD or DRMS		Lat	Long
			Sampling	Analysis		
Artesian drill hole (not flowing)	RW-1	Standard	WQCD/ DRMS	WQCD	38.89188809	-107.0557712

Monitoring Sites						
Estimated Dates: July 15th and Sept 3						
Site Description	Site Number	Sample Suite	Responsible Party WQCD or DRMS		Lat	Long
Al pond outflow	RW-2	Standard/Nutrients	WQCD/ DRMS	WQCD	38.89117934	-107.0578076
Above Al pond	RW-3	Standard	WQCD/ DRMS	WQCD	38.89108124	-107.0581176
The Redwell	RW-5	Standard	WQCD/ DRMS	WQCD	38.89328591	-107.0562631
R.W. creek above the Redwell	RW-6	Standard	WQCD/ DRMS	WQCD	38.89321035	-107.0560874
R.W creek below the Redwell	RW-7	Standard	WQCD/ DRMS	WQCD	38.89382768	-107.0560246
Daisy Mine Drainage	RW-8	Standard	WQCD/ DRMS	WQCD	38.8944861	-107.053488
Redwell Creek below Daisy	RW-11	Standard	WQCD/ DRMS	WQCD	38.89671675	-107.0535767
Redwell Creek above OBJ	RW-13	Standard	WQCD/ DRMS	WQCD	38.90637841	-107.0503162
Toe of slope blow Artisan Drill Hole	RW-1a (RW-14)	Standard	WQCD/ DRMS	WQCD	38.89253	-107.0556
OBJ above Redwell Creek	OBJ-1	Standard/Nutrients	WQCD/ DRMS	WQCD	38.90631821	-107.0509004
OBJ below Redwell Creek	OBJ-2	Standard/Nutrients	WQCD/ DRMS	WQCD	38.90646017	-107.0500221
OBJ above Slate River	OBJ-4	Standard/Nutrients	WQCD/ DRMS	WQCD	38.9106750	-107.0319960
Slate River above OBJ and BLM Campground	SR-7	Standard/Nutrients	WQCD/ DRMS	WQCD	38.91553500	-107.0338416
Slate River below OBJ Creek and Gunsight Pass Footbrigde.	SR-8	Standard/Nutrients	WQCD/ DRMS	WQCD	38.9081450	-107.0251661

4.3.6 Sample Locations Map



4.3.7 Monitoring Parameter List

WQCD is utilizing a standard parameter group for each of the surface water assessments with the addition of molybdenum at this site. This list of parameters will meet the specific mining

site characterization needs as well as supply data to other division programs. Optionally, DRMS can identify their own analysis suite based on their analytical budgets.

Parameter List						
EPA PARAMETER	METHOD #	PQL*	HOLDING TIME	SAMPLING CONTAINER**	PRESERVATIVE	Suite
Metals (dissolved and total recoverable)		ug/L				
ALUMINUM	200.7	50	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
ARSENIC	200.8	1	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
CADMIUM	200.8	0.6	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
CHROMIUM	200.7	20	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
COPPER	200.7	5	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
IRON	200.7	10	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
LEAD	200.8	.8	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
MANGANESE	200.8	2	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
MOLYBDENUM	200.7	50	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
MERCURY	245.1	0.1	28 days	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
NICKEL	200.7	30	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
SELENIUM	200.8	.7	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
SILVER	200.8	0.6	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
URANIUM	200.8	1	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
ZINC	200.7	10	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
Minerals-Neutrals		mg/L				
ALKALINITY	310.1	10	14 days	P,G	Cool, 4°C	Standard
HARDNESS	200.7	1	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
Miscellaneous		mg/L				
SULFATE	300.0	3	28 days	P,G	Cool, 4°C	Standard
Benthic Macroinvertebrates				P	95% Ethanol	Macro
Nutrients		mg/L				
AMMONIA	350.1	0.03	28 days	P,G	Cool, 4°C - H2SO4 to pH<2	Nutrients
KJELDAHL	351.2	0.5	28 days	P,G	Cool, 4°C - H2SO4 to pH<2	Nutrients
NITRATE/NITRITE	353.2	0.3	28 days	P,G	Cool, 4°C - H2SO4 to pH<2	Nutrients
TOTAL PHOSPHATE	365.1	0.01	28 days	P,G	Cool, 4°C - H2SO4 to pH<2	Nutrients
*PQL=Practical Quantitation Level in Clean Matrix				**P=plastic		

Parameter List						
EPA PARAMETER	METHOD #	PQL*	HOLDING TIME	SAMPLING CONTAINER**	PRESERVATIVE	Suite
ug/L=Micrograms per Liter				G=glass		
mg=Milligrams per Liter				S=sterile		
pCi/L=Picocurries per Liter				AW=acid washed		

Field Analysis	
Parameter	
Dissolved O2 (mg/l)	standard
TEMP (c)	standard
pH (s.u.)	standard
Conductivity (uS/cm)	standard
Flow (feet per second)	standard

4.4 Canyon/Imogene/Sneffels Creeks:

Numerous abandoned mine features are located in the watersheds in Canyon Creek, Sneffels Creek, and Imogene Creek. These creeks and tributaries to these creeks comprise Colorado segment COGUUN09. Specifically, the lower portion of Sneffels Creek is not in attainment of Aquatic Life Use-based standards for dissolved zinc and cadmium. Additionally, Canyon Creek is on the Water Quality Control Commission's Monitoring and Evaluation (M&E) list for dissolved lead.

The Uncompahgre Watershed Partnership was awarded a Non-Point Source 319 grant in 2014 to include required monitoring of project remediation sites to measure the water quality changes derived from the remediation project and additional headwaters site assessment sampling to characterize other suspected sources in the watershed. Sampling sites associated with these initiatives are classified as NPS 319 and Headwater respectively within the monitoring schedule table.

In 2012 and 2013 WQCD, DRMS and the Uncompahgre Watershed Partnership conducted four sampling events in the Canyon Creek, Imogene Creek and Sneffels Creek as part of the TMDL Bridge to Restoration (TBR) initiative. This initiative provided DRMS and the Watershed Partnership with the data needed to select sites for remediation action. In conjunction with DRMS and the Uncompahgre Watershed Partnership, this study continues to study these watersheds. All data collected under this initiative will be classified as TBR within the monitoring schedule.

4.4.1 Environmental Problem

The Atlas Mill site has tailings directly on the banks of Sneffels Creek and is easily accessible via Camp Bird/Imogene Pass Road. The Atlas Mill site is at the junction of Segments COGUUN05 and COGUUN09. Sneffels Creek above the Atlas Mill is in attainment of state water quality standards, while the segment below fails to attain dissolved zinc and cadmium standards.

Sampling conducted by WQCD/DRMS in 2012 and 2013 indicated additional source(s) of zinc above and below the Atlas Mill site. Additional WQCD TBR sampling sites to investigate the distribution of zinc in the Sneffels Creek headwaters of Governor Basin and more detailed monitoring of the effect of the Atlas Mine draining adit will be conducted in 2014.

The Camp Bird #3 adit is located in the upper reaches of Imogene Creek and flows through waste rock and mill tailings prior to discharge into Imogene Creek. Water quality sampling conducted in 2012/2013 determined elevated cadmium and zinc mostly related to Hidden Treasure draining adit at site IC-02 - Imogene Creek below Camp Bird #3. NPS Headwaters sampling directly below the Camp Bird tailings will be added for 2014, due to elevated metals detected during 2012/2013 sampling of Camp Bird tailings/waste rock.

4.4.2 Characterization of Water Quality Problems

Sneffels Creek is use protected and classified as an Aquatic Life, Cold water Class 1, Recreation, Class P, Water Supply and agriculture. The stream is impaired by cadmium and zinc and 303(d)-listed because its water quality does not support aquatic life, cold water class 1 communities. Tailings from the Atlas Mill site are actively eroding into Sneffels Creek, elevated levels of cadmium and zinc were detected in 2012 tailings samples. Preliminary benthic macroinvertebrate sample analysis shows a declining trend in the Macroinvertebrate community below the mill site.

Two sampling events are planned for 2014. The first sampling event will occur in June to characterize the surface water quality during the high flow season when snow melt has saturated the drainage. The second is scheduled in September to characterize the surface water quality at lower flow scenarios.

Water quality chemistry and macroinverebrate samples will be collected above and below the Atlas Mill site, before and after project implementation to evaluate whether, and to what extent, the remediation project and associated BMPs have improved water quality at the site scale. Additional sites in the Canyon/Imogene/Sneffels Creek drainage will be sampled as part of the NPS 319 grant headwaters assessment. Samples will be taken above and below sources (Atlas Mine, Hidden Treasure Adit) and if possible from the sources themselves to determine loading contributions and to support future science-based decisions for remediation actions.

4.4.3 Project Contact Information

DRMS:
Primary Contact: Jeff Litteral 970-216-1330 Jeff.Litteral@state.co.us

CDPHE:
Primary Contact: Skip Feeney 303-691-4928 Stanley.feeney@state.co.us

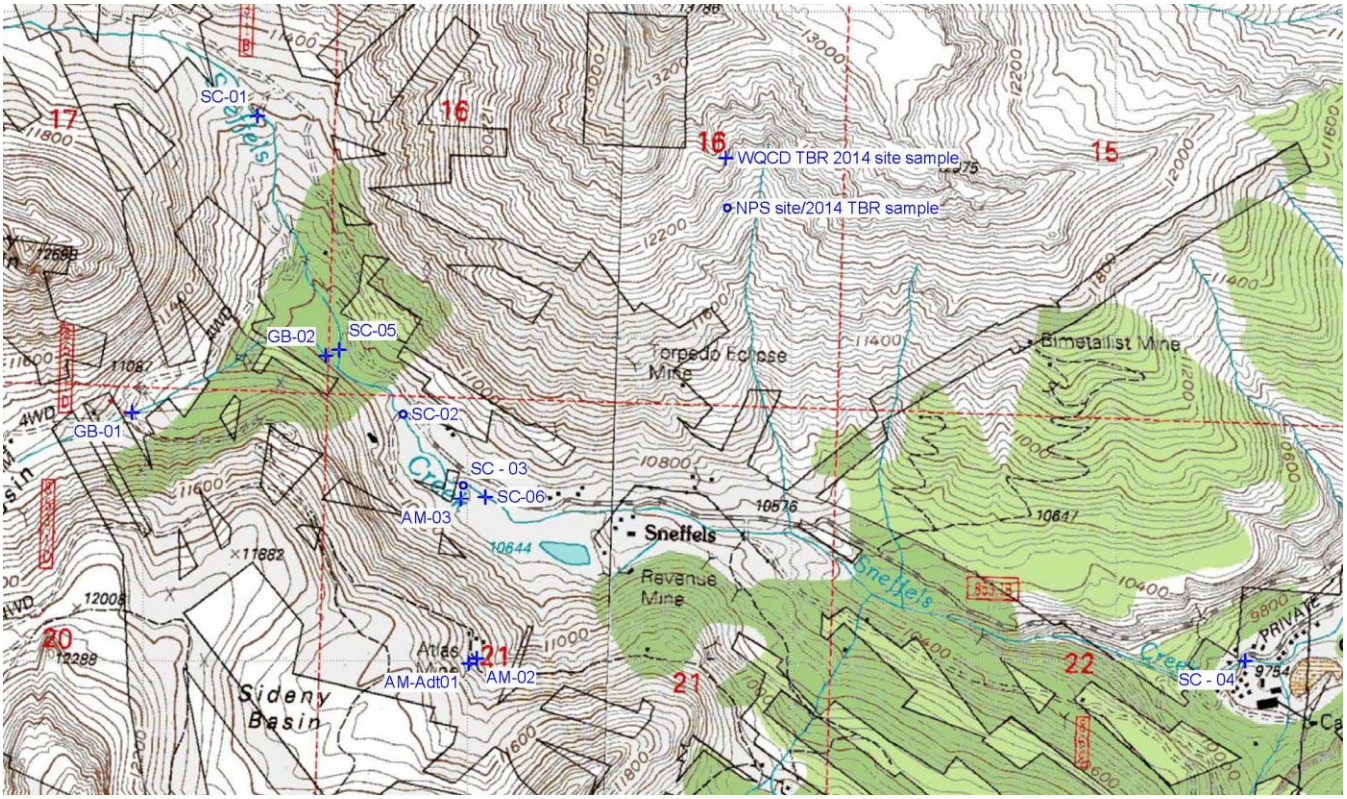
4.4.4 Monitoring Schedule

Monitoring Sites : Sneffels/Imogene\Canyon						
Estimated Dates: June 10, 11 and September 9,10						
Site Description and DRMS Site Number	WQCD Site Number (TBD)	Sample Suite	Monitoring Program and Analysis		Lat	Long
			Sampling	Analysis		
Sneffels Cr reference	SC-01	Standard/Nutrients	WQCD/ TBR	WQCD	37.986180	-107.763467
Sneffels Cr abv Atlas Mill	SC-02	Standard/Nutrients/ Macros	NPS 319/TBR Site	WQCD	37.978020	-107.758050
Sneffels Cr bel Atlas Mill	SC-03	Standard/Nutrients/ Macros	NPS 319/TBR Site	WQCD	37.976180	-107.755450
Sneffels Cr abv Canyon Cr @ Camp Bird	SC-04	Standard/Nutrients/ Macros	WQCD/ TBR	WQCD	37.971870	-107.728270
Governors Basin @ road	GB-01	Standard	WQCD/ TBR	WQCD	37.977848	-107.767554
Governors Basin @ mouth	GB-02	Standard	WQCD/ TBR	WQCD	37.979585	-107.760827
Sneffels cr abv Governors Basin	SC-05	Standard/Nutrients	WQCD/ TBR	WQCD	37.979757	-107.760364
Sneffels cr bel Atlas Mine Adit Confluence	SC-06	Standard/Nutrients	WQCD/ TBR	WQCD	37.975790	-107.755080
Atlas Mine Adit	AM-Adt-01	Standard	WQCD/ TBR	WQCD	37.971087	-107.754800

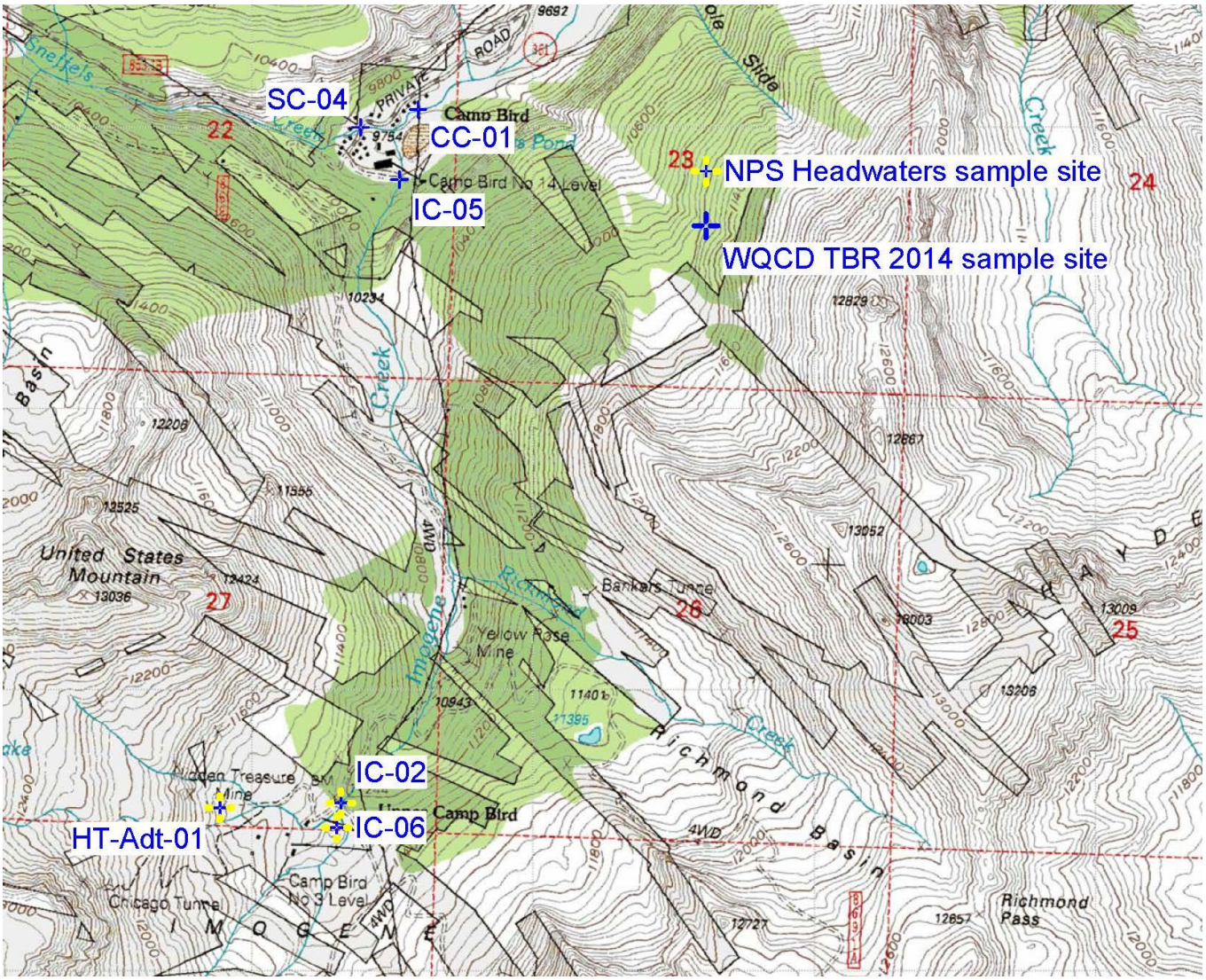
Monitoring Sites : Sneffels/Imogene\Canyon						
Estimated Dates: June 10, 11 and September 9,10						
Site Description and DRMS Site Number	WQCD Site Number (TBD)	Sample Suite	Monitoring Program and Analysis		Lat	Long
Atlas Mine Seep	AM-02	Standard	WQCD/ TBR	WQCD	37.971309	-107.755219
Atlas Mine Adit abv confluence with Sneffels Cr.	AM-03	Standard	WQCD/ TBR	WQCD	37.975729	-107.755939
Hidden Treasure Adit	HT-Adt-01	Standard	NPS/ Headwaters	ACZ	37.949954	-107.732646
Imogene Cr bel Camp Bird #3	IC-02	Standard	NPS/ Headwaters	ACZ	37.950214	-107.728375
Imogene Cr bel tailings	IC-06	Standard	NPS/ Headwaters	ACZ	37.949431	-107.728536
Imogene Cr abv Canyon Cr @ Camp Bird	IC-05	Standard/Nutrients/Macros	WQCD/ TBR/NPS headwaters	ACZ/Timberline	37.970221	-107.72675
Canyon Cr bel Sneffels and Imogene conf	CC-01	Standard/Nutrients	WQCD/ TBR	WQCD	37.975550	-107.720510

4.4.5 Sample Locations Map

SNEFFELS CREEK



IMOGENE/SNEFFELS CREEK



4.4.6 Monitoring Parameter List

WQCD is utilizing a standard parameter group for each of the surface water assessments. This list of parameters will meet the specific mining site characterization needs as well as supply data to other division programs.

Parameter List						
EPA PARAMETER	METHOD #	PQL*	HOLDING TIME	SAMPLING CONTAINER**	PRESERVATIVE	Suite
Metals (dissolved and total recoverable)		ug/L				
ALUMINUM	200.7	50	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
ARSENIC	200.8	1	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
CADMIUM	200.8	0.6	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
CHROMIUM	200.7	20	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
COPPER	200.7	5	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
IRON	200.7	10	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
LEAD	200.8	.8	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
MANGANESE	200.8	2	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
MERCURY	245.1	0.1	28 days	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
NICKEL	200.7	30	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
SELENIUM	200.8	.7	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
SILVER	200.8	0.6	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
URANIUM	200.8	1	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
ZINC	200.7	10	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
Minerals		mg/L				
ALKALINITY	310.1	10	14 days	P,G	Cool, 4°C	Standard
HARDNESS	200.7	1	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard
Nutrients		mg/L				
AMMONIA	350.1	0.03	28 days	P,G	Cool, 4°C - H2SO4 to pH<2	Nutrients
KJELDAHL	351.2	0.5	28 days	P,G	Cool, 4°C - H2SO4 to pH<2	Nutrients
NITRATE/NITRITE	353.2	0.3	28 days	P,G	Cool, 4°C - H2SO4 to pH<2	Nutrients
TOTAL PHOSPHATE	365.1	0.01	28 days	P,G	Cool, 4°C - H2SO4 to pH<2	Nutrients
Miscellaneous		mg/L				
SULFATE	300.0	3	28 days	P,G	Cool, 4°C	Standard
Benthic Macroinvertebrates				P	95% Ethanol	Macro
*PQL=Practical Quantitation Level in Clean				**P=plastic		

Parameter List						
EPA PARAMETER	METHOD #	PQL*	HOLDING TIME	SAMPLING CONTAINER**	PRESERVATIVE	Suite
Matrix						
ug/L=Micrograms per Liter				G=glass		
mg=Milligrams per Liter				S=sterile		
pCi/L=Picocurries per Liter				AW=acid washed		

Field Analysis	
Parameter	
Dissolved O2 (mg/l)	standard
TEMP (c)	standard
pH (s.u.)	standard
Conductivity (uS/cm)	standard
Flow (feet per second)	standard

4.5 Upper Uncompahgre:

The Uncompahgre River Segment COGUUN02 extends approximately 2 miles from Lake Como to a point immediately above the confluence with Red Mountain Creek. This segment is impaired for not meeting the applicable Aquatic Life Use-based cadmium, copper, and zinc standards as well as Mn (WS). Additionally, this segment is on the Monitoring and Evaluation (M&E) list for dissolved lead.

A TMDL was approved in November 2009 for cadmium, copper and zinc. The TMDL identified, on a monthly basis, load reductions required to attain chronic Aquatic Life Use-base standards. The reductions required to attain copper standards range from 61% to 71% in months April and May respectively. Reductions required for zinc range from 19% to 81% in months February through July. Reductions in cadmium are required in all months except August, October and November. Monthly reduction requirements range from 14% to 81% through the year. The greatest reduction requirements for all three parameters occur in months April and May during high or increasing hydrologic flow.

A TMDL summary table and percent reduction are illustrated below.

TMDL Study Table Value Standards and % Reductions*										
	Hardness, mg/L	Cd-D, ug/L	Cd-D, TVS	Range of % Reduction per month	Cu-D, ug/L	Cu-D, TVS	Range of % Reduction per month	Zn-D, ug/L	Zn-D, TVS	Range of % Reduction per month
Uncompahgre River	111	1.3	.3	0-81%	12.5	7.1	0-71%	99.0	213.0	0-81%

*Total Maximum Daily Load Assessment Red Mountain Creek/Uncompahgre River. Average hardness, chronic stream standards, and ambient eighty-fifth percentile stream concentrations for listed parameters on Segment 2 of the Uncompahgre River. Data are from the Colorado Department of Public Health and Environment (CDPHE), Colorado Parks and Wildlife (CPW), and U.S. Geological Survey (USGS). San Juan/Ouray/Montrose County Colorado; Colorado Department of Public Health and Environment, Water Quality Control Division, November 2009.

Mineral Creek (COGUUN08) from its source to the confluence with the Uncompahgre River is on the Water Quality Control Commission's Monitoring and Evaluation (M&E) list for dissolved cadmium and zinc. This segment is a tributary to the study being conducted on segment COGUUN02.

4.5.1 Environmental Problem

Water quality sampling conducted in 2012/2013 by WQCD determined water quality standards for cadmium and zinc were being exceeded for sample sites MC-01 at the mouth of Mineral Creek and at site PG-01 Poughkeepsie Gulch above the Old Lout mine.
The WQCDs 2012 and 2013 water quality study of the Uncompahgre River and Poughkeepsie Gulch was intended to determine the water quality impact of the Old Lout draining adit on the Uncompaghre River. It had recorded discharges of hundreds of gallons per minute. However, significant loading was not reflected in the water quality data collected in 2012/2013. The study showed water quality upstream of the Old Lout likely exceeded water quality standards for zinc and cadmium and the Old Lout was not a large contributor.

4.5.2 Characterization of Water Quality Problems

Sampling on Poughkeepsie Gulch below the Michael Breen adit will continue to monitor potential effects of Uncompahgre Watershed Partnership's NPS 319 project remediation work diverting the draining adit away from the existing waste rock pile, (elevated metals detected in the waste rock 2012 sampling). Standard water quality, nutrient, and macroinvertebrates samples will be collected above and below the Michael Breen site (macros below only), before

and after project implementation to evaluate whether, and to what extent, the remediation project and associated BMPs have improved water quality at the site scale.

The Headwaters study has selected 5 sampling locations in headwaters of Mineral Creek. This data will help identify sources and measure their pollution contributions in support of remediation decisions and planning.

Additional WQCD-TBR sampling will occur upstream of the Old Lout Mine in the mainstem of Poughkeepsie Gulch and major tributaries including the headwaters of Lake Como. This data will help identify sources and measure their pollution contributions in support of remediation decisions and planning.

Two sampling events are planned for 2014. The first sampling event is scheduled for mid-June to characterize the surface water quality during the high flow season when snow melt has saturated the watershed. The second is scheduled in September to characterize the surface water quality at lower flow scenarios.

4.5.3 Project Contact Information

DRMS:
Primary Contact: Jeff Litteral 970-216-1330 Jeff.Litteral@state.co.us

CDPHE:
Primary Contact: Skip Feeney 303-691-4928 Stanley.feeney@state.co.us

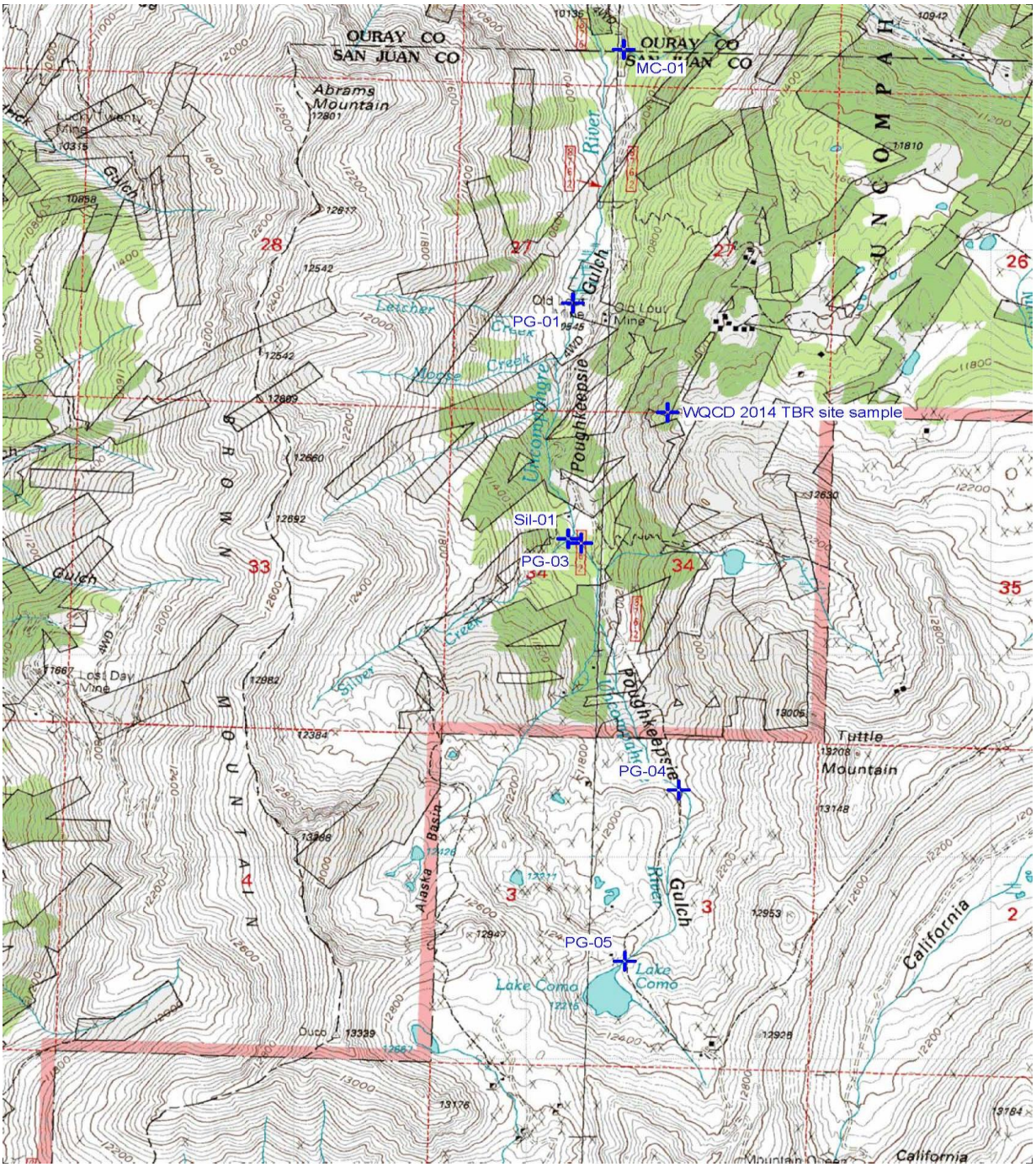
4.5.4 Monitoring Schedule

Monitoring Sites : Uncompahgre/Poughkeepsie/Mineral						
Estimated Dates: 6/10/2014 and 9/16/2014						
Site Description and DRMS Site Number	WQCD Site Number (TBD)	Sample Suite	Monitoring Program and Analysis		Lat	Long
			Sampling	Analysis		
Uncompahgre R abv Michael Breen	UNR-03	Standard/ Nutrients	NPS 319 Site	ACZ	37.97437	-107.63556
Uncompahgre R bel Michael Breen	UNR-04	Standard/ Nutrients/ Macros	NPS 319/Site	ACZ/ Timberline	37.974980	-107.635390
Poughkeepsie Gulch above the Old Lout Mine	PG-01	Standard/ Nutrients	WQCD/ DRMS	WQCD	37.953796	-107.62743
Michael Breen adit	MB-Adt-01	Standard	NPS 319 Site	ACZ	37.975059	- 107.635130

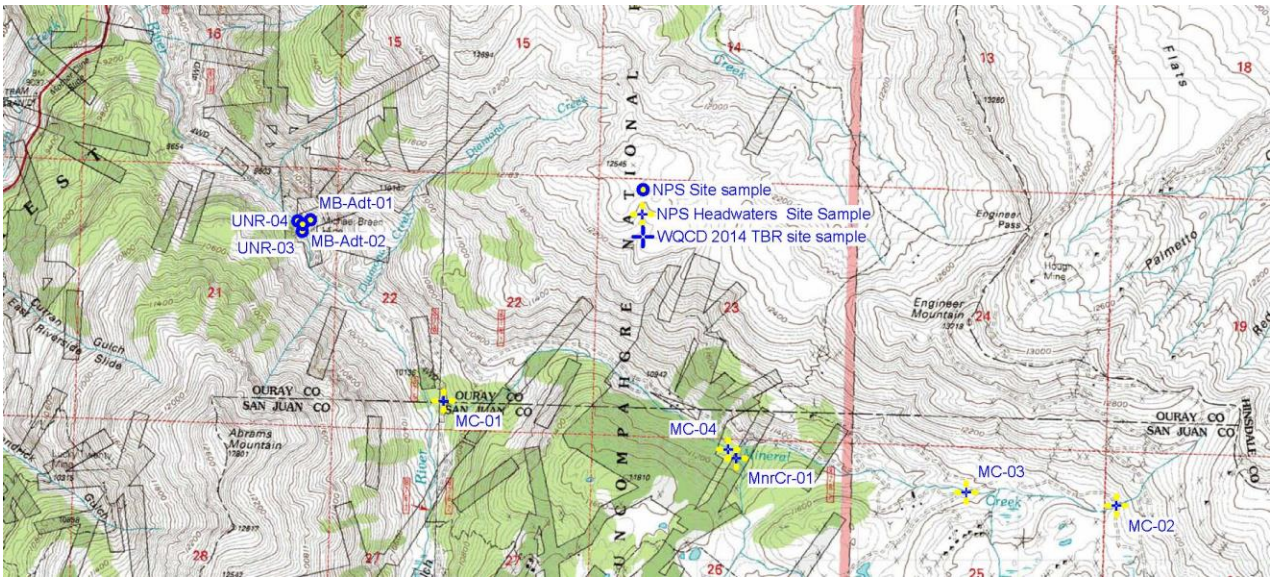
Monitoring Sites : Uncompahgre/Poughkeepsie/Mineral						
Estimated Dates: 6/10/2014 and 9/16/2014						
Site Description and DRMS Site Number	WQCD Site Number (TBD)	Sample Suite	Monitoring Program and Analysis		Lat	Long
Michael Breen adit below waste rock	MB-Adt-02	Standard	NPS 319 Site	ACZ	37.974800	- 107.635676
Silver Creek	Sil-01	Standard/ Nutrients	WQCD/ DRMS	WQCD	37.943295	-107.627286
Poughkeepsie abv Silver Cr	PG-03	Standard/ Nutrients	WQCD/ DRMS	WQCD	37.943112	-107.626641
Poughkeepsie Gulch above the Wall	PG-04	Standard/ Nutrients	WQCD/ DRMS	WQCD	37.932230	-107.621491
Lake Como Effluent Stream	PG-05	Standard/ Nutrients	WQCD/ DRMS	WQCD	37.924552	-107.623854
Mineral Cr abv Uncompahgre R	MC-01	Standard/Macros	NPS/ Headwaters	ACZ/ Timberline	37.965130	-107.625320
Mineral Creek bel Miners Cr.	MC-04	Standard	NPS/ Headwaters	ACZ	37.962,865	-107.605066
Miners Creek	MnrCr-01	Standard	NPS/ Headwaters	ACZ	37.962383	-107.604481
Mineral Creek bel San Juan Chief	MC-03	Standard	NPS/ Headwaters	ACZ	37.960827	-107.588120
Mineral Creek reference	MC-02	Standard	NPS/ Headwaters	ACZ	37.960319	-107.577451

4.5.5 Sample Locations Map

POUGHKEEPSIE GULCH



MINERAL CREEK



4.6 Gray Copper Gulch:

The Vernon mine is located in Gray Copper Gulch (COGUUN07) which is a tributary to Red Mountain Creek (COGUUN06b), which in turn, is a tributary to the Uncompahgre River. The Vernon Mine is located adjacent to the stream bank of Gray Copper Gulch.

The COGUUN07 segment is currently listed as impaired for not meeting the Aquatic Life Use-based standard for dissolved copper. Additionally this segment is on the Monitoring and Evaluation (M&E) list for total recoverable iron (Fe(Trec)) and pH.

4.6.1 Environmental Problem

The Gray Copper Gulch area lies on the flanks of Red Mountain and contains natural and mining-related sources of metals pollutants. The project goal is to isolate and quantify the sources of contaminants. The Vernon mine site contains two draining mine adits (one intermittent discharge) flowing through waste rock piles. The site is located near the upper reaches of Gray Copper Gulch.

4.6.2 Characterization of Water Quality Problems

Water quality sampling conducted in 2012/2013 documented increased metals loading in Gray Copper Gulch from below Vernon mine site compared to above. Continued monitoring will be conducted below the Vernon mine to assess the effects of removing the waste rock (which contained elevated metals from 2012 sampling) from the drainage and out of contact with the draining adit as part of Uncompahgre Watershed Partnership's NPS 319 project. Water quality chemistry, field parameters and macroinverebrate samples will be collected above and below Vernon Mine (macros below only), as well as water quality at the draining adit, before and after

project implementation to evaluate whether, and to what extent, the remediation project and associated BMPs have improved water quality at the site scale.

The 2012/2013 data revealed that site GC-01 slightly exceeded water quality standards for copper and iron and was of low pH. Additional headwaters sampling will be conducted in 2014 to include a draining adit above the Vernon mine (located on private property) and the Larsons Brothers mine which flows into Crystal Lake on the west side of Ironton Park. This sampling will be part of the NPS 319 grant headwaters assessment. Samples will be taken above and below these sources and if possible from the sources themselves to determine loading contributions, and to support future science-based decisions for remediation actions.

4.6.3 Project Contact Information

DRMS:
Primary Contact: Jeff Litteral 970-216-1330 Jeff.Litteral@state.co.us

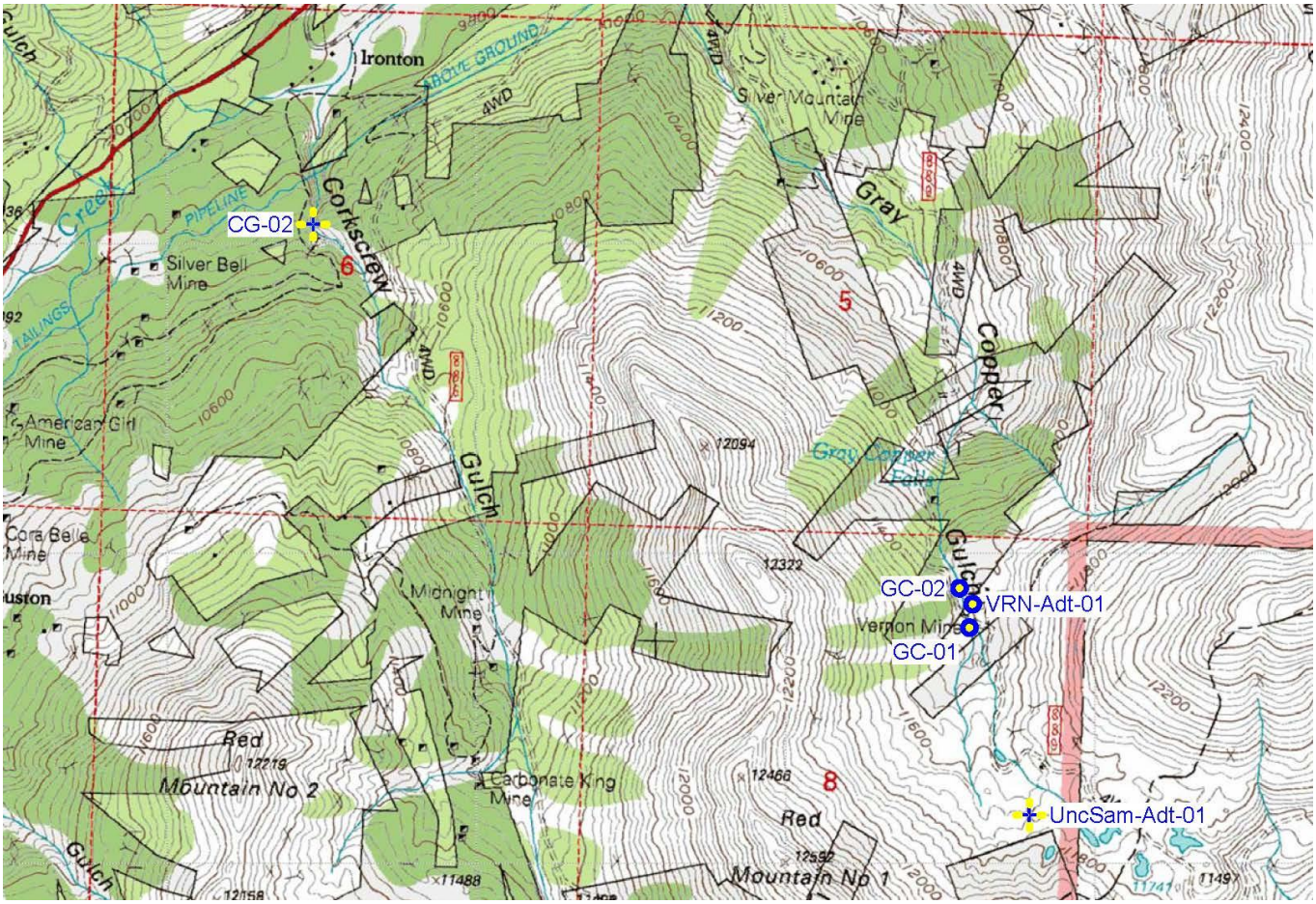
CDPHE:
Primary Contact: Skip Feeney 303-691-4928 Stanley.feeney@state.co.us

4.6.4 Monitoring Schedule

Monitoring Sites : Gray Copper Gulch						
Estimated Dates: 6/10/2014 and 9/16/20114						
Site Description and DRMS Site Number	WQCD Site Number (TBD)	Sample Suite	Monitoring Program and Analysis		Lat	Long
			Sampling	Analysis		
Vernon draining adit #1	Vrn-Adt-01	Standard	NPS 319/Site	ACZ	37.917805	-107.655264
Gray Copper Gulch abv Vernon mine and waste rock pile	GC-01	Standard/ Nutrient	NPS 319/Site	ACZ	37.917282	-107.655571
Gray Copper Gulch bel Vernon mine and waste rock pile	GC-02	Standard/ Nutrient/ Macro	NPS 319/Site	ACZ/Timberline	37.918443	-107.656176
Gray Copper Gulch mouth	GC-05	Standard/ Nutrient	NPS 319/Site	ACZ	37.937793	-107.668058
Uncle Sam draining adit	UncSam-Adt-01	Standard/ Nutrient	NPS 319/Headwaters	ACZ	37.911912	-107.653376
Larsons Brothers draining adit	LarBro-Adt-01	Standard/ Nutrient	NPS 319/Headwaters	ACZ	37.938422	-107.675555

4.6.5 Sample Location Map

GRAY COPPER GULCH



4.7 Evans Gulch:

Evans Gulch is a five mile long segment of the Upper Arkansas River basin in the historic mountainous "mineral belt" located near Leadville, Colorado in Lake County. Evans Gulch flows west from the base of Mount Evans through Mountain Lake and Diamond Lakes to the mainstem of the Arkansas River. Lincoln Gulch, South Evans Gulch and Little Evans Gulch are tributaries to Evans Gulch. The drainage serves as a municipal water supply for approximately 5,000 residents of Lake County and Leadville by way of Parkville Water District (PWD). Evans Gulch makes up the entire Colorado water body segment COARUR07. Beneficial Uses applied to Evans Gulch are Aquatic Life Cold 1, Recreation E (existing), Water Supply and Agriculture.

Directly south of Evans Gulch is the California Gulch Superfund site. This site was divided into 12 Operable Units (OU). The upper and lower portions of Evans Gulch are included in Operable Unit No. 6 (OU6). Within OU6 remediation work continues in Stray Horse and California Gulches. However no remediation work is planned for Evans Gulch. This ensures monitoring and remediation work within Evans Gulch will not interfere with the ongoing Superfund activities.

4.7.1 Environmental Problem

Historic mining operations within the Evans Gulch area have created the degraded landscape that visibly exists in the watershed today. Mine wastes and tailings piles are scattered throughout the riparian area with numerous piles coming in contact with Evans Gulch. During spring runoff and summer precipitation events these mine wastes directly interact with Evans Gulch stream flows causing a spike in metals loading and a low pH.

4.7.2 Characterization of Water Quality Problems

Evans Gulch first appeared on Colorado's 303(d) list of impaired waterways in 1998 for not attaining Chronic Aquatic Life Table Value Standards (TVS) for dissolved zinc. Subsequently a Total Maximum Daily Load (TMDL) was completed by the Colorado Department of Public Health and Environment and approved by the Environmental Protection Agency in 2009. Elevated concentrations of zinc were correlated with lower hardness values in those months with increased in flow. It is estimated that spring runoff may produce a flushing effect for zinc in Evans Gulch. Based on the water quality data used to create the TMDL, a 21% (May), 8% (July), and 3% (August) load reduction is necessary to achieve chronic zinc TVS.

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), Environmental Protection Agency (EPA), CDM Smith, Colorado State University (CSU), American Smelting and Refining Company (ASARCO), Colorado Mountain College (CMC), and Parkville Water District (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.

Based on these data, the dissolved zinc levels measured are typically well below TVS in the upper reaches of Evans Gulch. As Evans Gulch progresses down gradient, zinc levels increase. Most noticeable increase occurs below South Evans Gulch. Below Parkdale Water District the data is less consistent, but there are reasons to believe that sources may exist. In South Evans Gulch, dissolved zinc levels increase significantly below the IBEX waste rock pile. Lincoln Gulch has elevated zinc levels above TVS but only flows a few months per year.

4.7.3 Monitoring Strategy

The overall watershed monitoring strategy will be multi-phased. The first phase will diagnose areas and sources contributing to the degradation of water quality conditions in support of remediation decisions and planning. If remediation work is conducted, a follow up study will measure the water quality impacts. Monitoring activities are scheduled to occur in June to characterize the surface water quality when snow melt has saturated the watershed and in September to characterize water quality at lower flow scenarios. Additionally a subset of sampling locations will be monitored to characterize the metals load mobilized during wet weather events.

Specific sites along Evans Gulch from the source to the confluence of the Arkansas River were selected based on existing data and field reconnaissance with WQCD, DRMS, Colorado Mountain College, Trout Unlimited, and PWD officials. EG1, EG2, EG4 are positioned to characterize the middle and lower portions of Evans Gulch. EG 12 is positioned to characterize the influence of South Evans Gulch on Evans Gulch. EG13 and EG 14 will characterize the impact of two large wasterock piles positioned on either side of the Evans Gulch riparian area. LEG01 will characterize the metals contributions to Lincoln Gulch. SEG13 and SEG14 will characterize the contributions from the Ibex wasterock pile to South Evans Gulch. An additional ground truthing of sites for access and applicability to study goals will be conducted prior to sampling.

CMC and TU, using up to six auto-samplers with the capability of each taking 24 samples, will characterize the metals load mobilized during wet weather events. Flow will be captured at a downstream location and extrapolated for sites in the upper drainages. During high precipitation events stream conditions may be dangerous, so extreme caution will be used when collecting flow data. Flow data will be collected in a fashion not to disturb the sediment, which may mobilize metals, above active sampling locations. Both total-recoverable and dissolved fractions will be collected and analyzed using the laboratory at CMC. To ensure consistency between spring/fall events and summer storm sampling, all metals parameters listed in Section 4.7.7 will be analyzed during all events. A standard operating procedure (SOP) for the auto samplers is presented in Appendix A. The auto samplers have the ability to record continuous pH and specific conductance, and additional field parameters of dissolved oxygen and temperature can be recorded on-site upon collection of each sample. The total-recoverable portion of the samples will be essential in quantifying short-term increases in metal loading due to runoff.

4.7.4 Project Contacts

The Evans Gulch Restoration Project will be a joint partnership between Trout Unlimited, Bureau of Land Management, Colorado Nonpoint Source Program, Colorado Water Quality Control Division, Colorado Division of Reclamation, Mining and Safety, Parkville Water District, Freeport-McMoRan Copper and Gold, Colorado Mountain College (CMC), Collegiate Peaks Anglers Chapter of Trout Unlimited, local landowners and other local partners. For the monitoring portion of this project important contacts are listed below:

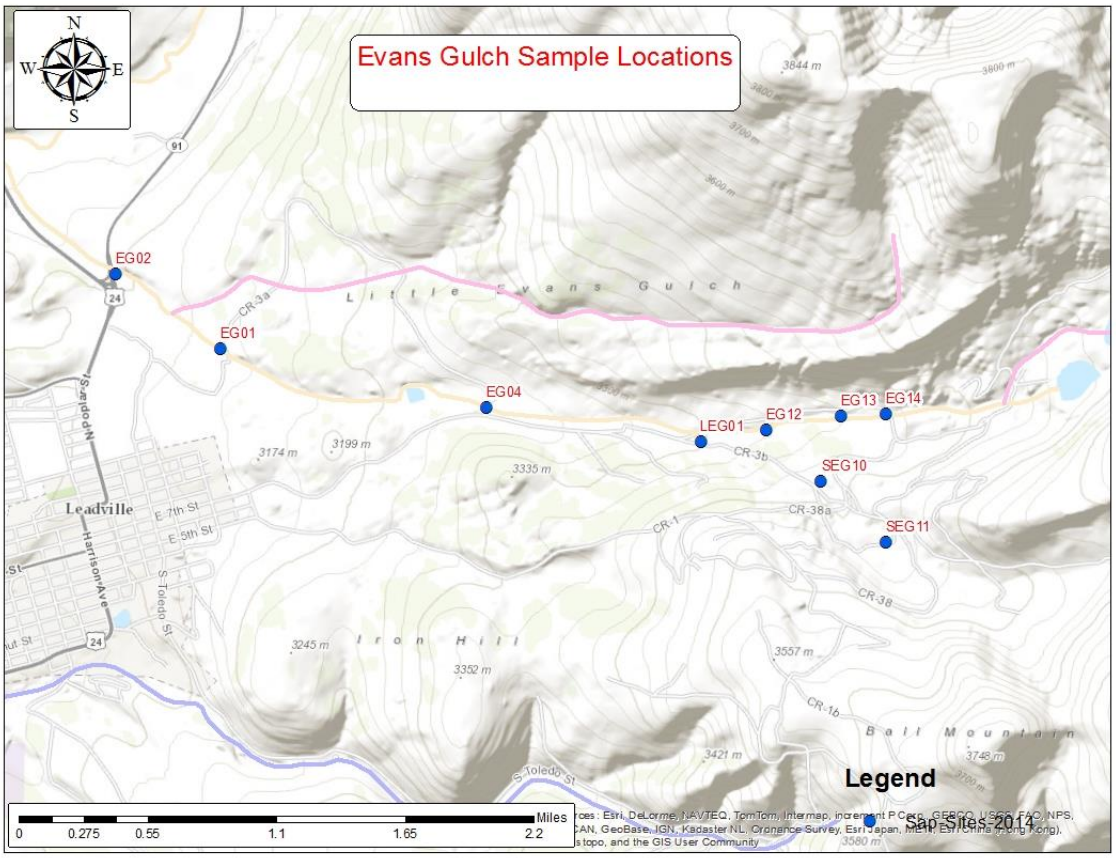
Name	Phone	Email	Organization
Skip Feeney	303-691-4928	Stanley.feeney@state.co.us	WQCD
Jason Willis	719- 221-0411	jwillis@tu.org	Trout Unlimited
Jenn Moore	315-322-1303	jlmoore@coloradomtn.edu	CMC
Craig Bissonnette		Craig.Bissonnette@state.co.us	DRMS

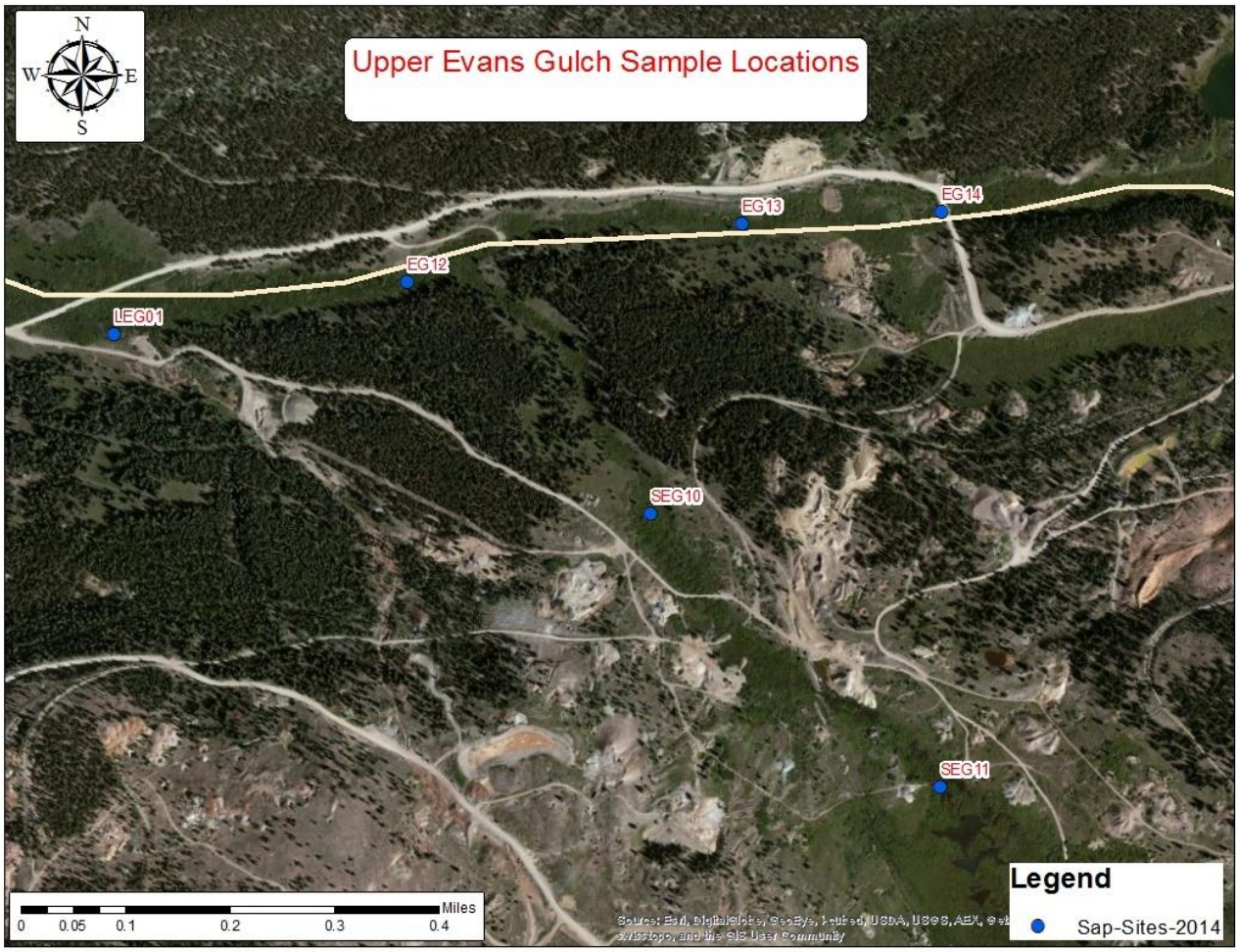
4.7.5 Monitoring Schedule

As mentioned above, this area has been monitored by many organizations over the years. Previously used sampling locations exist throughout the basin. Several of these historic sampling locations serve the objectives of this study very well. In those cases, the existing sampling site ID is used. Such as EG 01, 02, 04. Where new sampling locations were desired new sampling IDs were generated. To ensure the new site ids don't conflict with ones previously used, stream abbreviations and numbers greater than ten were uses. Examples of this naming convention are: EG- 10, 11, 12.

Monitoring Sites				
Estimated Dates: 6/3/2014, 9/3/2014 and Wet Weather Events				
WQCD Site Number (TBD)	Description	Sample Suite	Lat WGS 84	Long WGS 84
EG01	Evans Gulch just upstream of CR 3a, above confluence with Little Evans Gulch	Nutrient, Metals, Neutrals, Auto Sampler	39.2613310	-106.2817660
EG02	Evans Gulch at hwy 24 & 91	Nutrient, Metals, Neutrals, Macros, Auto Sampler, Pebble Counts	39.2658570	-106.2901850
EG04	Evans Gulch above Parkville settling pond	Nutrient, Metals, Neutrals, Auto Sampler	39.2579000	-106.2604750
EG12	Evans Gulch bel South Evans Gulch	Nutrient, Metals, Neutrals	39.2567690	-106.2381190
EG13	Evans Gulch 500 feet bel unnamed waste rock pile	Nutrient, Metals, Neutrals , Auto Sampler	39.2576340	-106.2321550
EG14	Evans Gulch abv un-named waste rock pile at CR 3 crossing	Nutrient, Metals, Neutrals	39.2578460	-106.2285770
LEG01	Lincoln Gulch abv Evans Gulch	Nutrient, Metals, Neutrals , Auto Sampler	39.2559770	-106.2433360
SEG10	South Evans Gulch bel Ibex Waste Rock Pile	Nutrient, Metals, Neutrals, Auto Sampler	39.2536050	-106.2337150
SEG11	South Evans Gulch abv Ibex Waste Rock Pile at road	Nutrient, Metals, Neutrals, Auto Sampler	39.2498550	-106.2284710

4.7.6 Estimated Sample Location Maps





4.7.7 Monitoring Parameter List

WQCD is utilizing a standard parameter group for each of the surface water assessments. This list of parameters will meet the specific mining site characterization needs as well as supply data to other Division programs. At six locations, an auto sampler will be deployed to collect wet weather water quality data. These samples will be analyzed for Total and Dissolved metals by the Colorado Mountain College laboratory. Data comparability will be ensured through the utilization of the same analytical methods.

Parameter List						
EPA PARAMETER	METHOD #	PQL*	HOLDING TIME	SAMPLING CONTAINER**	PRESERVATIVE	Suite
Metals (dissolved and total recoverable)		ug/L				
ALUMINUM	200.7	50	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard/auto Sampler
ARSENIC	200.8	1	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard/auto Sampler
CADMIUM	200.8	0.6	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard/auto Sampler
CHROMIUM	200.7	20	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard/auto Sampler
COPPER	200.7	5	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard/auto Sampler
IRON	200.7	10	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard/auto Sampler
LEAD	200.8	.8	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard/auto Sampler
MANGANESE	200.8	2	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard/auto Sampler
MERCURY	245.1	0.1	28 days	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard/auto Sampler
NICKEL	200.7	30	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard/auto Sampler
SELENIUM	200.8	.7	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard/auto Sampler
SILVER	200.8	0.6	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard/auto Sampler
URANIUM	200.8	1	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard/auto Sampler
ZINC	200.7	10	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard/auto Sampler
Minerals		mg/L				
ALKALINITY	310.1	10	14 days	P,G	Cool, 4°C	Neutral/auto Sampler
HARDNESS	200.7	1	6 months	P,G-AW	HNO3 to pH<2, w/in 10 days of sampling	Standard/auto Sampler
Nutrients		mg/L				
AMMONIA	350.1	0.03	28 days	P,G	Cool, 4°C - H2SO4 to pH<2	Nutrients
KJELDAHL	351.2	0.5	28 days	P,G	Cool, 4°C - H2SO4 to pH<2	Nutrients
NITRATE/NITRITE	353.2	0.3	28 days	P,G	Cool, 4°C - H2SO4 to pH<2	Nutrients
TOTAL PHOSPHATE	365.1	0.01	28 days	P,G	Cool, 4°C - H2SO4 to pH<2	Nutrients
Miscellaneous		mg/L				
SULFATE	300.0	3	28 days	P,G	Cool, 4°C	Neutral
Benthic Macroinvertebrates				P	95% Ethanol	Macro
Pebble Counts						Pebble
*PQL=Practical Quantitation Level in Clean Matrix				**P=plastic		

Parameter List						
EPA PARAMETER	METHOD #	PQL*	HOLDING TIME	SAMPLING CONTAINER**	PRESERVATIVE	Suite
ug/L=Micrograms per Liter				G=glass		
mg=Milligrams per Liter				S=sterile		
pCi/L=Picocurries per Liter				AW=acid washed		

Field Analysis	
Parameter	**Suite**
Dissolved O2 (mg/l)	standard
TEMP (c)	standard
pH (s.u.)	standard
Conductivity (uS/cm)	standard
Flow (feet per second)	standard

5 Trip Safety and Planning Information Forms

Brief description of daily itinerary:

Day	*Date*	*Travel*	*Location of Field Activity*	*Overnight Location*
1	*XX/XX/XX*	*From :*		
		To :		
		Departure :		
2		*From :*		
		To :		
		Departure :		
3		*From :*		
		To :		
		Departure :		
4		*From :*		
		To :		
		Departure :		
5		*From :*		
		To :		
		Departure :		

EMERGENCY CONTACTS

(Note: carry on person during field activity)

Prepared by

Name__ _____ Date _____

List Personal Contacts

Name	*Relationship*	*Home Phone*	*Cell phone*

WQCD – Environmental Data Unit Contacts

Name	*Position*	*Office Phone*	*Cell phone*
Aimee Konowal	*Unit Manager*	*303.692.3530*	
Chris Theel	*Work Group Leader*	*303.692.3558*	
Sarah Wheeler	*Work Group Leader*	*303.692.3436*	
Loralee Evans	*Administration*	*303.692.3601*	
Dick Parachini	*Section Manager*	*303.692.3516*	

Agency Emergency Contacts (or call 911)

Area	*Agency*	*Phone*
Animal Bites, Rabies, Snake Bites, Frostbite	*CDPHE/DCEED*	*303.692.2700*
Insect Bites	*CDPHE/DCEED*	*303.692.2628*
Community Public Health Emergency or Hazardous Spill Hotline	*CDPHE/DCED-EMP*	*877.518.5608*
	EPA	*800.442.8802*
Head Injury	*Head Injury Helpline*	*800.444.6443*
Poison Control	*Rky Mt. Poison Center*	*800.222.122*

Local Emergency Contacts

Area	*Agency*	*Phone*
Ouray, CO	*Ouray Co Police Department*	*Dept Phone: (970) 325-4225*
Ouray	*Telluride Medical Center*	*(970) 728-3848*
Ouray	*Mercy Urgent Care*	*(970) 385-2129*

(Note: carry on person during field activity)

Prepared by
Name_ _____ Date _____

List One or More Personal Doctors

Name	*Specialty*	*Office Phone*	*Cell phone*

Medical Conditions

Allergies and Other Medical Conditions	*Medications Being Taken*	*Medications to Avoid*

GEAR CHECKLIST

Communications and Instructions	*First Aid and Protective Equipment*
( ) Field folder (maps, emergency and medical information, contacts)	*( ) survival kit – keep in vehicle & available to be taken into field*
( ) cellular phone	*( ) first aid kit – portable & for vehicle*
( ) personal locator beacon (SPOT)	*( ) orange reflective vest*
( ) whistles or horns	*( ) change of dry clothes*
( ) flares	*( ) flashlight and extra batteries*
( ) mirror (or reflective device)	*( ) water and energy bars*
( ) portable weather radio	*( ) pepper spray*
	( ) insect repellent
	( ) traffic cones
Climatic and UV Protection	*Head, Hand, and Foot Protection*
( ) boots	*( ) hard hat*
( ) hat, wide-rimmed	*( ) safety glasses*
( ) rain gear	*( ) steel-toed safety shoes*
( ) sunglasses	*( ) work gloves* • *( ) disposable*

	• *( ) waterproof*
( ) sunscreen	*( ) extra shoes and socks*
( ) temperature-modifying clothing	
Special Electronic Equipment	*Other*
( ) GPS unit - hand held	*( ) tool kit*
( ) SPOT	*( ) Waders, wading boots*
	( ) PFD, Inflatable and Automatic
	( ) Duct tape

Appendix A - AutoSampler Standard Operating Procedure

Prepared for Water Quality Control Division (WQCD) by Trout Unlimited (TU)

Standard Operating Procedure (SOP) for a Hach Sigma 900 MAX Portable Sampler. For Evans Gulch monitoring we have the option to use up to six autosamplers to measure precipitation induced events. The location of these units will be determined during a field investigation day scheduled for 5/27/14. The six sites that provide the best chance for displaying load contributions to Evans Gulch will be selected for summer storm monitoring. Upon site selection, the autosamplers will be installed during August or early September using the specified technique:

1.0 Decontamination Equipment

Before any sampling begins, and between samples, all sample collection equipment shall be decontaminated. If dedicated equipment is used, it will be rinsed with deionized water. If non-dedicated equipment is used, it will be washed with Alconox Soap (or equivalent), rinsed with potable water, then rinsed with deionized water, dried with paper towels and placed in clean plastic bags. Mobile decontamination supplies will be provided so that equipment can be decontaminated in the field.

2.0 Instrument Calibration

Portable electronic equipment used during sampling may include a pH meter with temperature scale and a conductivity meter to coincide with autosamples. Before going into the field, a field crew member shall verify that all of these are operating properly. The pH and conductivity meters

require calibration prior to use every day. Calibration times and appropriate readings will be recorded in the field notebook.

3.0 Obtaining Water Samples With Autosampler Equipment

- The following procedures are to be used to collect surface water samples at up to six sites.

1. Make sure that the sample labels have been filled out for the sampling location. Assemble bottles for filling.
2. Autosamplers will be set up on the stream bank in a relatively level and secure position.
3. The units will then be leveled and secured with wire leashes.
4. GPS coordinates of each sampler will be recorded and synced with remote control.
5. Once a storm event is monitored by CMC staff a remote control will start the sampling event.
6. Multiple frequency rates are available with a maximum of 24 samples per event.
    a. An example would be samples taken every 5 minutes for 2 hours.
7. There will then be the option to either analyze each sample or combine them to a composite per each site.
    a. A composite sample will be utilized to quantify the storm total load as a whole compared to individual time samples.
8. Immediately following a storm event sample bottles will be collected and preserved according to industry standards.
9. Samples will be then analyzed using the Colorado Mountain College lab total and dissolved fraction.

- If taking field parameters adjacent to autosamplers during sample collection, stand downstream from collection point, avoid collecting items floating in the water, and disturbing bottom sediment. Field measurements should include time/date and be recorded on a Surface Water Data Collection Sheet for complete field documentation.

- Rinse sample collection and field analysis equipment with deionized water or distilled metal analyte free water after sample collection is complete at the site. Conduct decontamination of sampling equipment before reuse of equipment at another location.

3.1 Filtering Samples

Total metals, conductivity, pH, and solids analyses are performed on unfiltered samples. Dissolved Metals analysis requires the filtering of samples. Samples will be filtered in the field by using a disposable 0.45µm membrane filter apparatus and peristaltic or hand vacuum pump. Filtered samples will be collected according to the following procedure:

·Assemble filter device according to manufacturer's instructions.

·Filter sample either by pouring sample in the top portion of filter unit or pumping it through tubing and an in-line filter using a peristaltic pump. Composited sample remaining in the churn splitter may be used for filtered sample.

·Transfer filtered sample to appropriate preservative-containing sample bottles.

·Dispose of the used filter cartridge and tubing.

3.2 Field Sampling Data Collection Note

A field sampling data sheet will be completed at each sample location. Items not applicable to the sampling will be labeled as not applicable (NA). The information on the data sheet will include the following:

·Sampling location
·Date and time of sampling
·Persons performing sampling
·Conductivity, temperature, dissolved oxygen (if measured), and pH during sampling
·Color, odor, and cloudiness of the water
·Sample identification numbers
·Number of samples taken — note analytes and preservation methods
·Identification numbers of any QC samples from site
·Any irregularities or problems which may have a bearing on sampling quality

3.3 Field Notes

Field notes will also be kept during sampling activities. The following information will be recorded in the bound field notebook using waterproof ink or pencil:

·Names of personnel
·Weather conditions
·Date and time of sampling
·Location and sample station number
·Decontamination times
·Calibration information