

## Reclamation of Water Quality Impairments at High Priority Abandoned Hardrock Mine Sites in Colorado

### Workplan

Prepared by:

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for:

Colorado Department of Public, Health and the Environment,  
Water Quality Control Division (WQCD)

### Background

This list of priority AML sites proposed for characterization and remediation designs are currently included in WQCC Regulation #93 (CCR 1002-93) Colorado's Section 303(d) List of Impaired Waters and Monitoring and Evaluation List. This fulfills requirements of Section 303(d) of the federal Clean Water Act which requires that states submit to the U.S. Environmental Protection Agency a list of those waters for which technology-based effluent limitations and other required controls are not stringent enough to attain water quality standards. Dissolved metals and acidity (pH) from legacy mining (AML-Abandoned Mine Lands) and background sources comprise 89% of the total number of impaired stream segments in Colorado (Fig. 1). These impairments are considered nonpoint sources (NPS) because they are related to run-off and drainage from AML sites for which there is no remaining financially viable "responsible party".

All of the sites included in this proposed project scope of work (SOW) are located in stream segments that are impaired because of excessive heavy metals related to legacy mining. The sites identified in this SOW can be considered a high priority for reclamation because of being the primary pollutant source; a Total Maximum Daily Load (TMDL) analysis has been completed and approved; the severity of the problem that they represent; or the potential for de-listing a segment if the mining nonpoint source impact is mitigated through reclamation work. Some of the mine sites on the list and their related segments have already been evaluated and monitored by watershed groups, state, or federal agencies. In these cases, there are water quality data to locate the source of the WQ impairment and target the AML source. At other stream segments, there are water quality sampling data to indicate that water quality standards are not attained, but the loading sources have not been clearly identified or adequately characterized to determine the best reclamation alternative.

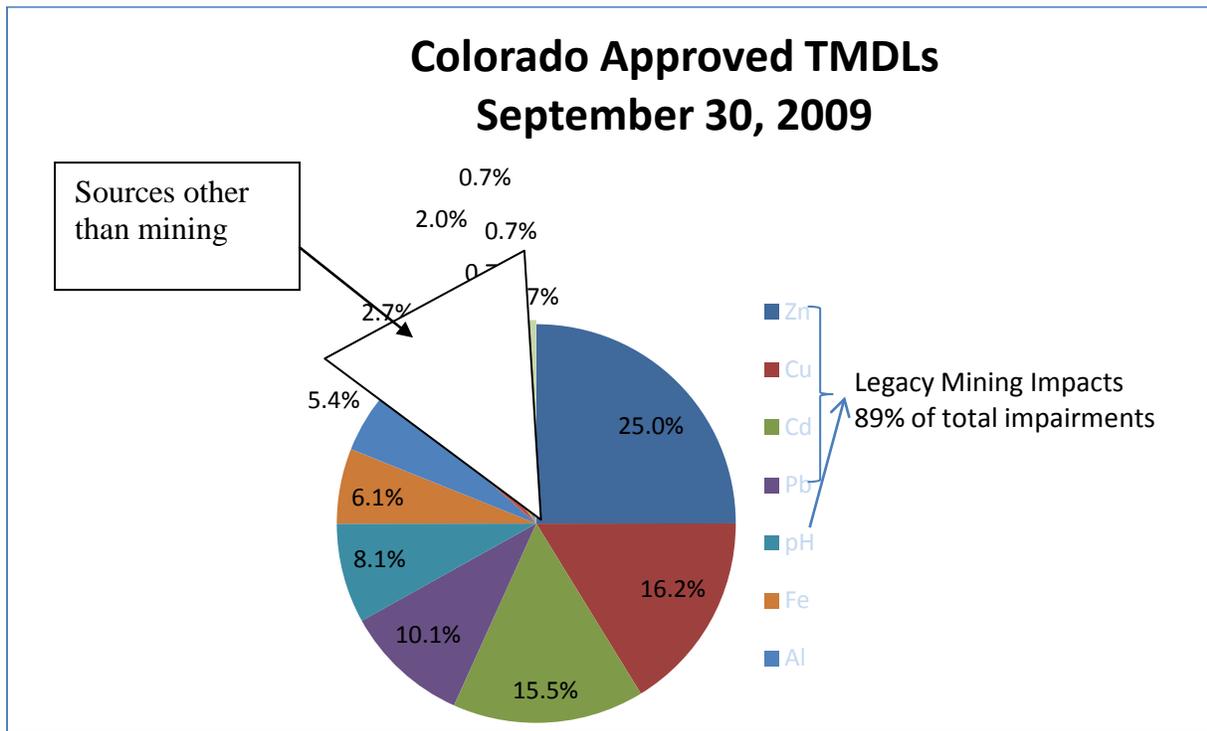
### Objective

This SOW is designed to bring priority AML mine sites to the point where they are "shovel ready" for the construction of the best management practices to eliminate or reduce the present water quality problems. This proposal also identifies potential funding costs for project implementation or construction. As mentioned, a portion of the impaired segments still require additional water quality monitoring in order to characterize the source of pollutants, identify the BMPs and prioritize the sites for funding. Other segments have been adequately characterized and priority metals loading sources have been identified for future action. In this case, funding for engineering and project design will move these sites to "ready for construction" status.

**The objective of this agreement is to fund the 2 initial steps of the overall work plan: a) stream characterization and water quality monitoring and/or b) engineering and design.** Because the first phase of this work (Site characterization) is exploratory in nature, DRMS and CDPHE will work together on adjusting the budget as needed. Most of the costs are estimated initially, and as more information becomes available, some of the scopes of work will have to be revised. No work will be conducted prior to CDPHE NPS program approval of budget modifications. Total budget modification will not exceed 20% of the total funds available.

**Project timeline**

The proposed performance period is for two years. Milestones for completion of site project objectives are specific to the project’s baseline data set on the continuum of characterization and design, as mentioned above. In general, any additional data collection and site characterization will take place during the first year, with engineering and design work completed by the end of the second year. For some sites, characterization is complete and engineering and design can proceed in the first year. (Fig. 1 from WQCD)



## **HIGH PRIORITY ABANDONED HARDROCK MINE SITES** **Workplan by Watershed**

### **I - South Platte Watershed**

#### **1) London Mine - Segment COSPUS02C**

The historic London Mine is located in the headwaters of South Mosquito Creek and encompasses approximately 40 acres. The stream is on the 303(d) list as impaired for not meeting the applicable standards for Zinc, Iron, Manganese and Cadmium. The classified use that is not protected is aquatic life. The mine is located on private land. Several reclamation projects have been conducted at the site over the past 15 years. The site is currently not actively permitted with DRMS and there is no existing reclamation responsibility for the site.

#### **Environmental Problem**

The site contains three significant sources of pollutants that negatively impact South Mosquito Creek and the wetlands associated with the creek:

1. Butte Mine waste and tailings - 25,000 Cubic Yards
2. Historic London Tailings - 20,000 Cubic Yards
3. Constructed Tailings Impoundment - 30,000 Cubic Yards

The tailings piles are immediately adjacent to South Mosquito Creek and have impacted the underlying wetlands. The stream is perennial and the tailings continually leach acidic metal-laden water into it. In the spring, the creek significantly erodes the tailings piles and contributes metal-laden sediment to the creek. The tailings impoundment was constructed in the 1980's and is beginning to breach in several areas. There are several significant acidic seeps near the toe of the impoundment.

#### **Past Characterization of Water Quality Problem**

Numerous watershed groups and government agencies have collected water quality data for South Mosquito Creek over the past decade. The problems are clearly identified and well documented. However, it is necessary to gather additional site-specific data on a small tributary, No Name Creek, to isolate and identify any ancillary sources of metals loading contamination and to sample the numerous springs and seeps originating from the tailings piles.

#### **Engineering and Design Activities**

The preferred reclamation alternative to reduce metals migration at the site is to consolidate the tailings piles from all three locations in an engineered upland repository. Test holes would be drilled into the tailings piles to determine their depth and physical characteristics in order to ascertain the approximate volumes of material and properly design the repository. Field and geologic surveying and reconnaissance will be required to identify the appropriate location for the repository and the need for a bottom liner.

In addition, it will be necessary to analyze the composition of the tailings to determine if any amendments will be required to neutralize the acid generating potential prior to depositing the tailings in the repository.

Following removal of the tailings to the repository, the original disturbed areas will be covered with stockpiled topsoil and revegetated with appropriate plant species. The riparian areas along

the creek will be re-established with native vegetation and the stream channel morphology will be restored.

#### Post Reclamation Water Quality

The historic tailings piles are the most significant remaining source of pollutants in South Mosquito Creek. The removal of the tailings piles from near the creek should reduce the metal loads by at least 60% over a period of five years. Additional improvements should be realized in the next ten years as the vegetation is established in the reclaimed areas along the creek.

#### Task Cost Estimates

Stream Characterization/Water Quality Monitoring	\$10,000
Engineering and Design	\$100,000
Construction	\$1,100,000
Post Reclamation Water Quality Monitoring and Maintenance	\$20,000
<b>Total project Cost</b>	<b>\$1,230,000</b>

## **2) Waldorf Mine - Segment COSPCL03b**

The Waldorf Mine is located in the headwaters of Leavenworth Gulch, a tributary to Clear Creek. The segment is listed as impaired for not meeting the applicable Lead and Zinc standards. The classified use that is not protected is aquatic life.

#### Environmental Problem

The Waldorf Mine site contains a draining adit and a series of waste piles that encompass over 2 acres. The adit continually drains and intermittently discharges large surges of contaminated water that erode the mine waste pile and transport the materials into the wetlands below the mine. The site is owned by private landowners and the United States Forest Service.

#### Characterization of Water Quality Problem

Numerous watershed groups and government agencies have collected water quality data for Clear Creek and its tributaries over the past decade. It is necessary to gather additional site-specific data on the chemical and physical properties of the waste piles and seasonal flow measurements of the drainage from the adit.

#### Engineering and Design

The proposed reclamation alternative for site includes creating a concrete lined stilling basin at the portal mouth to contain surge flows and installing rock-lined channels to permanently divert clean water flow around the waste piles. This phase of work does not include any remediation of the wetlands or waste rock removal.

#### Post Reclamation Water Quality

The erosion and subsequent deposition of the waste rock piles into the natural wetlands is a detriment to water quality in Leavenworth Gulch. The control of the flow path of the adit will eliminate further impacts to the wetlands and promote future recovery. This work will also

compliment additional project work at numerous other abandoned mine sites within the Clear Creek watershed.

### **Task Cost Estimates**

Stream Characterization/Water Quality Monitoring	\$5,000
Engineering and Design	\$5,000
Construction	\$50,000
Post Reclamation Operation and Maintenance/ Water Quality Monitoring	\$5,000
<b>Total project Cost</b>	<b>\$65,000</b>

## **II - Upper Colorado River Basin**

### **3) Saint Johns Mine - Segment COUCBLO6**

The historic Saint Johns Mine and Mill are located at the headwaters of Saint Johns Creek, a tributary to the Snake River. The mine was one of the first producing silver mines in Colorado. The segment is listed as impaired for not meeting the applicable Zinc, Copper, Lead and Cadmium standards. The classified use that is not protected is aquatic life.

#### **Environmental Problem**

The site contains multiple mine waste piles and mill tailings that continually erode into the creek during spring runoff and leach metals into the creek. It is estimated that the site contains about 65,000 cubic yards of waste rock and 15,000 cubic yards of mill tailings. There is also a draining adit on site that is discharging water onto the waste piles.

#### **Characterization of Water Quality Problem**

Numerous watershed groups and government agencies have collected water quality data for the Snake River and its tributaries over the past decade. However, it is necessary to gather some additional site-specific data on the chemistry of the various waste piles in the Saint Johns area as well as the draining adit.

#### **Engineering and Design**

The preferred reclamation alternative for the site is to consolidate the tailings/waste rock piles from all of the individual sites in an engineered upland repository. Test holes would be drilled into the piles to determine the depth and physical properties in order to ascertain the approximate volume of material. Field and geologic reconnaissance will be required to identify the appropriate location for the upland repository site and the need for a bottom liner. In addition, it will be necessary to analyze the composition of the tailings to determine if any amendments will be required prior to depositing the tailings at the consolidation site to neutralize the acid generating potential. The adit drainage will be diverted away from contact mine waste and mill tailing piles.

Following removal of the tailings from the stream channel, the original disturbed areas will be covered with stockpiled topsoil and revegetated with appropriate plant species. The riparian areas along the creek will be re-established with native vegetation and the stream channel morphology will be restored.

Post Reclamation Water Quality

The waste rock and tailing piles associated with the Saint Johns Mine are the most significant remaining source of pollutants. The removal of the tailings from the creek should significantly reduce the Zinc and Cadmium loads. This work will compliment additional project work at numerous other abandoned mine sites within the Snake River watershed.

**Task Cost Estimates**

Stream Characterization/Water Quality Monitoring	\$5,000
Engineering and Design	\$25,000
Construction	\$300,000
Post Reclamation Operation and Maintenance/ Water Quality Monitoring	\$5,000
<b>Total project Cost</b>	<b>\$335,000</b>

**III - Rio Grande River Basin****4) Kerber Creek Above Brewery Creek - Segment CORGCBO9a**Characterization of Water Quality Problems

This segment, located in the vicinity of the historic Rawley Mine complex, is listed as impaired for Zinc and Cadmium. The mining sites are located on private and public lands. Initial characterization studies of the mining related problems and water quality sampling in some of the tributaries in this segment have been conducted. However, there are remaining tributaries with numerous waste piles that need to be characterized. In particular, Squirrel Creek and Rawley Creek contain many waste piles to be sampled and analyzed. Sampling should include high and low flow stream data as well as waste rock and mine tailings analysis. These data will be used to identify the appropriate best management practices and prioritize the sites for funding.

**Task Cost Estimates**

Stream Characterization/Water Quality Monitoring	\$50,000
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**IV - Arkansas River Basin****5) Venture Mine Complex - Segment COARUA02b**

The Venture Mine is located in the Little Frying Pan drainage, a tributary to Colorado Gulch and the Lake Fork of the Arkansas. This segment is listed as impaired for not meeting the applicable Zinc and Cadmium standards. The classified use that is not protected is aquatic life. The waste piles are located on private and public lands. Numerous water quality improvement projects have been conducted in the watershed over the past decade. These include consolidation of the Dinero, Nelson and Tiger waste piles, and the installation of the Dinero Tunnel bulkhead. Remediation of the Venture Mine complex would complement the previous water quality projects.

Environmental Problem

The site contains numerous significant sources of metals. There are at least five discrete waste piles associated with the site with a total of 20,000 cubic yards of mine tailings and waste rock piles. The tailings piles are immediately adjacent to creek and continually leach acidic metal-

laden water. In the spring, the creek significantly erodes the waste rock piles, also contributing metal-laden sediment to the watershed.

#### Characterization of Water Quality Problem

Numerous watershed groups and government agencies have collected water quality data for the watershed over the past decade. The problems are clearly identified and well documented and no additional characterization is necessary.

#### Engineering and Design

The preferred reclamation alternative for the remediation of the site is to consolidate the waste rock piles from all three sites in an engineered upland repository. Test holes would be drilled into the tailings to determine their depth and physical properties in order to ascertain the appropriate volume of material and properly design the repository. Field and geologic reconnaissance will be required to identify the appropriate location for the repository and the need for a bottom liner. In addition, it will be necessary to analyze the composition of the tailings to determine if any amendments will be required to neutralize the acid generating potential prior to depositing the tailings in the repository.

Following removal of the tailings to the repository, the original areas will be covered with stockpiled topsoil and revegetated with appropriate plant species. The riparian areas along the creek will be re-established with native vegetation and the stream channel will be restored.

#### Post Reclamation Water Quality

The Venture Mine waste piles are some of the most significant remaining sources of pollutants in the Little Frying Pan drainage. The removal of the waste piles from the creek should significantly reduce the Zinc and Cadmium loads over the next five years and will complement the other work that has been completed in the watershed. Additional improvements should be realized in the next ten years as the vegetation is established in the reclaimed areas along the creek.

#### Task Cost Estimates

Stream Characterization/Water Quality Monitoring	\$0
Engineering and Design	\$55,000
Construction	\$500,000
Post Reclamation Operation and Maintenance/ Water Quality Monitoring	\$5,000
<b>Total project Cost</b>	<b>\$560,000</b>

#### **6) Champion Mine and Mill - Segment COARUA05**

The Champion Mine and Mill are located at the headwaters of Halfmoon Creek, a tributary to the Lake Fork of the Upper Arkansas. This segment is listed as impaired for not meeting the applicable standards for Zinc and Cadmium. The classified use that is not protected is aquatic life. The area is part of a pristine high altitude ecosystem near Mount Massive. Initial reconnaissance indicates that the Champion site is the only mine within the drainage. However, there has been limited investigation of the drainage.

Environmental Problem

The mine site contains an adit that drains directly into Half Moon Creek. The mill site is located about 1 mile downstream from the mine and contains a fairly significant waste pile that is located near the creek. The waste pile is eroded during high flow in the spring and continually leaches metals into the creek.

Characterization of Water Quality Problems

Very limited water quality data exist for this segment. Sampling will include high and low flow stream data as well as mine waste analysis of the Champion mill area. While it appears that the Champion is the only mine in the area, additional reconnaissance of the entire segment will be conducted to identify other possible sources of metals. The acidic drainage from the adit will be sampled. These data will be used to identify the appropriate best management practice to employ at the site.

Post Reclamation Water Quality

The Champion mine and mill waste/tailings piles appear to be the most significant source of pollutants in Half Moon Creek. Removing the tailings from the creek should significantly reduce the metal lodes to the creek and the Lake Fork of the Arkansas.

Task Cost Estimates

Stream Characterization/Water Quality Monitoring	\$25,000
Engineering and Design	\$55,000
Construction (TBD)	
<b>Total Proposed Cost</b>	<b>\$80,000</b>

**IV - Gunnison River Basin****7) Daisy Mine - Redwell Basin - Segment COGUUG10**

The Daisy Mine lies in Redwell Basin and impacts a tributary to the Slate River. The Slate River is listed as impaired for not meeting the applicable Cadmium, Copper, Lead and Zinc standards. The classified use that is not protected is aquatic life. The Daisy Mine complex is located in private lands.

Environmental Problem

The Redwell basin area contains natural and mining-related sources of metals pollutants. The project goal is to isolate and quantify the sources of contaminants. The site contains a draining mine adit, multiple waste rock piles with seeps, and an artesian drill hole with poor water quality.

Characterization of Water Quality Problems

Sampling was conducted at 17 sites along Redwell Creek in 2010 and additional data on the basin was collected in previous years. Additional high and low flow sampling of the area is necessary to determine the pollutant loading sources.

Task Cost Estimates

Stream Characterization/Water Quality Monitoring	\$24,605
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**SUMMARY PROJECT BUDGET ESTIMATE**

PROJECT  Watershed/River Basin – Project	CATEGORY		
	Characteri zation (Estimated Costs)	Engineering (Estimated Costs)	Future Reclamation (Estimated Costs)
<b><i>I - South Platte Watershed</i></b>			
1) London Mine - Segment COSPUS02C	\$10,000	\$100,000	\$1,100,000
2) Waldorf Mine - Segment COSPCL03b	\$5,000	\$5,000	\$50,000
<b><i>II - Upper Colorado River Basin</i></b>			
3) Saint Johns Mine - Segment COUCBLO6	\$5,000	\$25,000	\$300,000
<b><i>III - Rio Grande River Basin</i></b>			
4) Kerber Creek above Brewery Creek - Segment CORGCBO9a	\$50,000	TBD*	TBD*
<b><i>IV - Arkansas River Basin</i></b>			
5) Venture Mine Complex - Segment COARUAO2b		\$55,000	\$500,000
6) Champion Mine and Mill - Segment COARUAO5	\$25,000	\$55,000	TBD*
<b><i>V - Gunnison River Basin</i></b>			
7) Daisy Mine - Redwell Basin - Segment COGUUG10	\$24,605	TBD*	TBD*
	\$119,605	\$240,000	<b>\$1,950,000*</b>

\* TBD=Cost To Be Determined