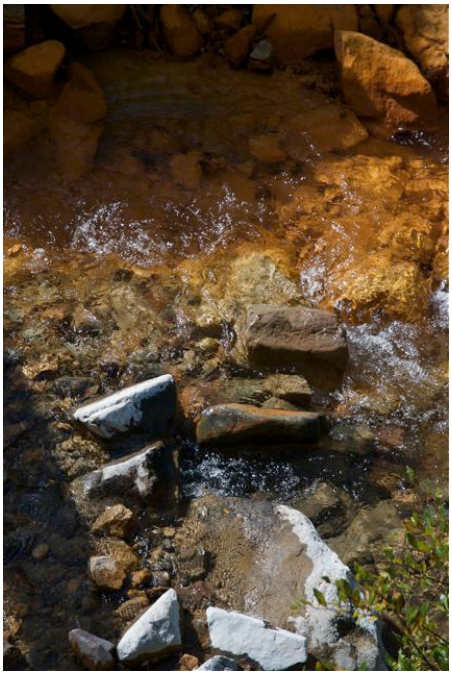
Sampling and Analysis Plan for Surface Water and Waste Rock Sampling

South Platte Watershed



Upper South Platte Mine Assessment Project

Coalition for the Upper South Platte

2010

Table of Contents

1.0 Introduction…….page 3

2.0 Surface Water Monitoring…….page 4

2.1 Surface Water Monitoring Schedule and Locations……..page 4

2.2 Sample Collection Procedures……page 5

2.2 Laboratory Analytical Parameters…….page 6

1.0 Introduction

This document presents the Sampling and Analysis Plan (SAP) for surface water monitoring and waste rock sampling conducted within the Upper South Platte watershed, Colorado. This SAP will apply for all sampling activities within the 2010 field season.

Monitoring and assessment activities will be performed by the Coalition for the Upper South Platte (CUSP), a watershed group that brings together a diverse group of stakeholders ranging from local governments to Front Range water providers, state and federal agencies, other nonprofits and interested citizens. CUSP is interested in developing a mine-specific planning project. The project will collect mine data, map mines (both abandoned and active) and, ultimately, develop restoration strategies for addressing problems from mining across both public and private lands. This CUSP project will look at the entire watershed and will particularly focus on mining effects in the Hall Valley and around South Mosquito Creek which are not attaining water quality standards for metals. While some mine data has been gathered on National Forest Service and other public lands, there is a significant lack of information for mines on private lands, as well as a lack of detailed information on areas mentioned above. Ultimately, the information gathered through this assessment will facilitate the next step: fundraising and implementation of on-the-ground mine reclamation projects.

Mining, traditionally an important economic engine within the Upper South Platte Watershed, has left its mark: runoff from tailings and acid mine drainage carries heavy metals and results in acidicification of streams. Located in the headwaters, the mines, mostly abandoned, negatively impact not only area residents, but also the entire state, as this watershed provides drinking water to three quarters of Colorado's residents. As a result, mine issues were ranked as an "issue of high priority" in the Coalition for the Upper South Platte's (CUSP's) overall strategic plan (originally completed in 2000 and updated in 2006).

This SAP describes sampling procedures that will be used to effectively collect data at the selected sites. The goals of this study are to:

- Form an advisory committee of appropriate agency and entity personnel, local citizens, etc., including but not limited to USFS, BLM, OSM, CDPHE, EPA, DRMS.
- Pull together a what-do-we-already-know document that gathers the available data from various advisory group members, including such information as hydrogeological characterizations, information on historical uses, contaminant loading data, etc.
- Visit mines and mining areas in order to ground-truth and/or collect more accurate GPS readings at the mines, including documenting significant features, such as extent and placement of tailings piles, draining tunnels, etc, and to use field monitoring equipment to rank mines requiring further study.

- Establish and map ownership information for problem mines on private lands.
- Develop a monitoring strategy to enable us to fill in critical data gaps that will follow EPA approved monitoring and analysis protocols at sample sites.
- Develop a prioritization matrix that facilitates the identification of priority remediation projects based on the severity of environmental and safety hazards.
- Create conceptual remediation plans for the highest priority projects that include a preferred alternative approach.
- Provide outreach to interested parties on findings and opportunities.
- Create a potential funding matrix to allow us to pursue funding for on-the-ground project implementation in the coming years.
- At the end of this assessment project, a comprehensive document will be created to include the most recent and accurate AML assessment information.

This SAP is organized into separate sections that discuss surface water monitoring and waste rock sampling procedures.

2.0 Surface Water Monitoring

Waterbodies, discharging adits and mine drainage will be sampled by professionally trained personnel. Volunteer assistants will be used on occasion, but will remain under the direct supervision of the project supervisor or designated professional.

Surface water sampling locations, sample collection procedures and analytical parameters for the proposed surface water monitoring events are detailed in this section. The surface water sampling schedule and locations are discussed in Section 2.1, field data and sample collection procedures are presented in Section 2.2 and analytical parameters are described in Section 2.3. Any deviations from the defined procedures, due to field conditions or other parameters, will be noted in the field logbook.

2.1 Surface Water Monitoring Schedule and Locations

Surface water samples will be taken during the summer and fall months of 2010. It is acknowledged that initial sampling conducted during the 2010 field season is a snapshot in time and concentrations or mass loadings may not represent the maximum contaminant loading events.

Sampling locations include stations downstream of mine sites, at the mine site, and upstream of mine sites. Synoptic sampling will occur throughout each subbasin of interest to insure that all sampling is representative of the contaminant loading conditions existing at the time of sampling.

2.2 Sample Collection Procedures

Surface water field procedures consist of 1) stream-flow (discharge) measurements, 2) documentation of site conditions, 3) measurements of field water quality parameters, and 4) collection of water quality samples for laboratory analysis.

2.2.1 Discharge Measurements

Velocity measurements will be taken using a Pygmy flow meter. The flow meter will provide accurate feet per second measurements which will be used to determine discharge. Exact discharges will be calculated by creating a stream profile and taking velocity measurements at ten points across the stream's width. Discharge measurements will be taken at each site where a water sample is collected.

2.2.2 Collection of Water Samples for Metals Analysis

As noted earlier, water samples will be taken at each mine site as well as downstream and upstream of the site on the same day to minimize the environmental effects on the samples. Samples will be stored in bottles provided by Denver Water's certified Drinking Water laboratory (Lab ID #CO00023). Bottles used for total metal analysis will be prepped by Denver Water. When applicable, samples will be refrigerated at 4°C at Denver Water's laboratory. See the Quality Assurance Project Plan for the Mine Assessment Project for quality control requirements and checks.

Two water samples will be taken at each sample point. A larger, two liter sample will be filtered within 24 hours of collection, while the other, smaller sample will remain unfiltered. These samples will provide information about the state and mobility of any contamination. Samples to be filtered will be filtered using a portable peristaltic pump (GeoPump) which filters water samples for specific tests like UV-254, NH3-COND or ICPMS-DISS. Samples will be filtered using guidelines determined by Denver Water. Once collected, both samples will be sent to Denver Water's laboratory for analysis. Denver Water will analyze for total and dissolved metal content and will include a full sweet of metals including; Al, Ag, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Si, Tl, U, V, and Zn.

Supplementary tests will be run in the field using a Hach DR 2800 portable spectrophotometer. The spectrophotometer, using Hach reagents, will test total alkalinity, Cadmium, Nitrate, Nitrite, Ammonia, Copper, Sulfate, Zinc and Manganese. Spectrophotometer tests will be run using manufacturer's instructions.

Each sample will be labeled at the time of collection with:

- sample location
- date and time of collection
- Remarks- special processing such as filtration; split sample etc.
- Sampler's initials

All water samples will be accompanied by a Chain of Custody form to ensure proper sample management.

2.2.3 Field Measurements

In order to provide complete data, pH/ORP, EC, DO and temperature will be recorded at each site using a Hanna HI 98280 meter with a HI 769828 multisensor probe. Manufacturer's instructions will be followed while using the probe.

2.3 Laboratory Analytical Parameters

Denver Water's certified Drinking Water laboratory (ID #CO00023) will run the water samples from this project and the laboratory staff will provide any addition training needed. Laboratory analysis is addressed in Denver Water's SOP.

Coalition for the Upper South Platte
Mine Assessment Project (USP-MAP)

QUALITY ASSURANCE PROJECT PLAN

prepared by:

Jara Johnson
Habitat and Monitoring Coordinator,
Coalition for the Upper South Platte

January 24, 2011

A1:Quality Assurance Approval Form

This document has been prepared by:

_____

Jara Johnson **Date**

_____

Carol Ekarius, Executive Director **Date**

A2: TABLE OF CONTENTS

SECTION		PAGE
PROJECT MANAGEMENT		
A3	Initial Distribution List	4
A4	Project/Task Organization	4
A5	Problem Definition/Background	4
A6	Project/Task Description	5
A7	Data Quality Objectives for Measurement Data	7
A8	Special Training Requirements/Certification	7
MEASUREMENT/DATA ACQUISITION		
B1	Sampling Process Design	8
B2	Sampling Methods Requirements	8
B3	Sample Handling and Custody Requirements	8
B4	Quality Control Requirements and Checks	9
B5	Instrument Calibration and Frequency	10
ASSESSMENT/OVERSIGHT		
C1	Assessments and Response Actions	11
DATA VALIDATION AND USABILITY		
D1	Data Review, Validation, and Verification Requirements	12
D2	Validation and Verification Methods	12
D3	Reconciliation with Data Quality Objectives	13

A3 Initial Distribution List

CUSP executive staff (Carol Ekarius and Jonathan Bruno)
CUSP field staff (Jara Johnson, Lauren Barrows OSM intern)
Laboratory staff at Denver Water (Steve Lohman/Linda Rosales)
USP-MAP Leadership Team Committee (USFS: John Neubert; Denver Water: Steve Lohman; CWCB: Chris Sturm; CGS: Matthew Sares; CDPHE: Mark Rudolph; DRMS: Jeff Graves, Al Amundson; DOW: Barb Horn)

A4 PROJECT/TASK ORGANIZATION

The Coalition for the Upper South Platte (CUSP) is a nonprofit watershed group, that works with a wide variety of stakeholders to *protect the water quality and ecological health of the Upper South Platte Watershed through the cooperative efforts of stakeholders with emphasis on community values and economic sustainability.* To meet that mission, CUSP helps coordinate on-the-ground restoration projects, and facilitates the efforts of others to accomplish such projects.

The Mine Assessment Project (MAP) will require collaboration from various agencies. Approximately 50 percent of the land is in the watershed is managed by the US Forest Service, and numerous mines are on their land, so collaboration with the USFS is critical. Collaboration with other agencies such as the Colorado Division of Reclamation, Mining, & Safety, the Colorado Division of Wildlife, the Colorado Department of Public Health and Environment, the Colorado Geological Survey, and the Bureau of Land Management will be necessary due to the reclamation and water quality monitoring activities being conducted by these agencies.

CUSP will be the lead organization in coordinating the proposed project. The USP-MAP requires not only collaboration with agencies, but also with private mine owners and patent holders. CUSP's unique position and capabilities enhances the chance for this project to lead to implementable reclamation projects in the future.

A comprehensive USP-MAP plan and monitoring strategy will be delivered to the above advisory panel in the f late 2010, including all data collected during the 2010 summer filed session.

A5 PROBLEM DEFINITION/BACKGROUND

The Upper South Platte Watershed is a high-priority watershed (encompassing two hydrologic units, numbers 10190001 and 10190002). for federal and state agencies and local partners. It covers 2,600 square miles southwest of Denver and ranges in elevation from 6,000, to over 14,000 feet above sea level. The watershed is an important source water area for Front Range cities, providing municipal water for 3/4's of the state's population. Portions of the Upper South Platte River convey both native flows and transmountain diversion water. The watershed is a major recreational area, with over 3,000,000 visitor-days per year; it accounts for 25% of all fisherman days in the state, and includes miles of "Gold-medal" fishing streams and half a dozen reservoirs. Several stream segments are listed on the 303(d) list for for metals/acid mine drainage.

Mining, traditionally an important economic engine within the Upper South Platte Watershed, has left its mark: runoff from tailings and acid mine drainage carries heavy metals and results in acidicification of streams. Located in the headwaters, the mines, mostly abandoned, negatively impact not only area residents, but also the entire state, as this watershed provides drinking water to three quarters of Colorado's residents. As a result, mine issues were ranked as an "issue of high priority" in the Coalition for the Upper South Platte's (CUSP's) overall strategic plan (originally completed in 2000 and updated in 2006).

With aid of the Colorado Healthy Rivers' fund and the Hillsdale Fund, CUSP will collect data, map mines (abandoned, active, and inactive), and develop restoration strategies for addressing problems from mining across both public and private lands. Our efforts will look at the entire watershed, but will particularly assess the mining effects in the Hall Valley and around South Mosquito Creek, both of which are segments that are not attaining water quality standards for metals. While some mine data has been gathered on National Forest Service and other public lands, there is a significant lack of information for mines on private lands, as well as a lack of detailed information on areas mentioned above. Ultimately, the information gathered through this assessment will facilitate the next step: fundraising and implementation of on-the-ground mine reclamation projects.

A6 PROJECT/TASK DESCRIPTION

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Mining played a very important role in the history of this basin, with many mining operations having been worked — and later abandoned. These mines extracted silver, lode and placer gold, aggregate/sand, coal, gemstones, and peat. The heaviest concentrations of mines occurred in three major locations within the Upper South Platte Watershed:

1.) The Mosquito and South Mosquito Creek subbasins of the Middle Fork (north and west of Alma and Fairplay) have had very heavy mining in the past. The London Mine is one of the major mines in this area. (It has active treatment following a CDPHE/EPA/CDRMS project that was implemented in 2002. This project did improve water quality on South Mosquito Creek; however, other mine features in the watershed are still causing reduced water quality the mainstem of Mosquito Creek.)
2.) Downstream of Fairplay along the Middle Fork was heaviliy placer mined.
3.) The upper reaches of the North Fork, especially in the Geneva Creek, Handcart Gulch, and Hall Valley areas.

Some mining still occurs within the watershed. These operations are primarily for sand/gravel, though small-scale mining for gemstones, gold, and silver is on the rise. In-situ uranium mining is also under consideration for the South Park area of the watershed, as is oil and gas drilling.

Problems found in mining areas include metal leaching and erosion from waste rock piles and tailings, as well as acid drainage. These result in mild-to-severe degradation to water quality and decreases in overall stream health. This project will develop an assessment plan that will provide, for the first time, a comprehensive picture of the mining issues in

the watershed across all land ownership boundaries, and will provide information for pursuing funding for mine reclamation in environmentally affected areas.

Goals/Outcomes

1. Form an advisory committee of appropriate agency and entity personnel, local citizens, etc., including but not limited to USFS, BLM, OSM, CDPHE, EPA, DRMS.
2. Pull together a what-do-we-already-know document that gathers the available data from various advisory group members, including such information as hydrogeological characterizations, information on historical uses, contaminant loading data, etc.
3. Visits to mines and mining areas in order to ground-truth and/or collect more accurate GPS readings at the mines, including documenting significant features, such as extent and placement of tailings piles, draining tunnels, etc, and to use field monitoring equipment to rank mines requiring further study.
4. Establish and map ownership information for problem mines on private lands.
5. Develop a monitoring strategy to enable us to fill in critical data gaps that will follow EPA approved monitoring and analysis protocols at sample sites.
6. Develop a prioritization matrix that facilitates the identification of priority remediation projects based on the severity of environmental and safety hazards.
7. Create conceptual remediation plans for the highest priority projects that include a preferred alternative approach.
8. Provide outreach to interested parties on findings and opportunities.
9. Create a potential funding matrix to allow us to pursue funding for on-the-ground project implementation in the coming years.
10. At the end of this assessment project, a comprehensive document will be created to include the most recent and accurate AML assessment information.

Project Timetable

- Train staff in use of field sampling and analysis equipment for quick field study. (Spring/Summer 2010)
- Create a technical advisory committee to help us identify the what-do-we-already know information, and later to develop a monitoring plan and review the final mining plan. (Spring 2010)
- Obtain permission from private landowners to access their land to conduct site visits and collect samples. (Spring 2010)
- Recruit volunteers to assist with field scoping and preliminary assessment work (GPS and preliminary data gathering) (Spring 2010)
- Conduct field assessment (Summer 2010)
- Data analysis (Summer-Fall 2010)
- Create comprehensive MAP Plan and Monitoring Strategy and finalize grant report (Fall-Winter 2010)

A7 DATA QUALITY OBJECTIVES FOR MEASUREMENT DATA

The objective of quality assurance for the measurement data is to insure confidence in the data used to target source water quality problems and establish synoptic evidence needed by CUSP and our partner agencies to identify potential remedial project areas. Sample

site selection, analytical methods, and QA activities are designed to support project objectives that are detailed in the SAP.

Data Precision and Accuracy: Analytical goals for the precision and accuracy of samples analyzed by Denver Water are addressed in the Laboratory SOP. Analytical goals for samples analyzed in the field using the Hach Spectrophotometer, associated Hach reagents, and a HANNA HI9828 multiparameter meter with GPS are addressed in the individual instrument manuals and specifications. These manuals also specify measurement range for each water quality parameter. Precision is expressed as relative standard deviation and accuracy as absolute biases as percentage.

Representativeness:Sampling should be conducted to ensure that data accurately and precisely represent the area being studied. Sampling is intended to represent the concentrations and mass loading of each draining mine adit, mine dump pond, and nearest tributary in relation to sampling date and storm event influences. It is acknowledged that initial sampling conducted during the 2010 field season is a snapshot in time and concentrations or mass loadings may not represent the maximum contaminant loading events. Synoptic sampling will occur throughout each subbasin of interest to insure that all sampling is representative of the contaminant loading conditions existing at the time of sampling.

Completeness and Comparability Completeness is the percentage of all data collected which is acceptable. Experience gained during previous nonpoint source assessment suggests that 90 percent completeness or better is attainable (CDPHE, 1994). Comparability is the degree of confidence that data sets are comparable with each other. This is ensured by using standard procedures and standard reporting of data.

A8 SPECIAL TRAINING REQUIREMENTS/CERTIFICATIONS

CUSP is staffed by professional personnel having at least the following types of qualifications:

- Sufficient professional and supervisory stature to deal effectively with program participants and professional contacts.
- Knowledge gained through a combination of training and experience in a scientific analytical discipline and a knowledge of data validation, quality assurance procedures, and problem solving.
- Knowledge of appropriate Federal laws, Environmental Protection Agency regulations and policies, and State Water Quality programs.

Denver Water operates a certified Drinking Water laboratory, Lab ID #CO00023. Denver Water's laboratory staff will provide any required training for specific sampling procedures prior to initiation of sampling.

B1 SAMPLING PROCESS DESIGN

The SAP will be developed by representatives from CUSP and our partners, including Denver Water, the USFS and others, and submitted as addendum to this document.

Rational for selecting the targeted sampling sites includes; previous listing of the mine site within the USFS AML project; DRMS, CDPHE, USGS, CGS or BLM listing of the site as having potential environmental degradation or risk to human health and the environment; and discussion with Town of Alma administration and Mosquito Range Heritage Initiative members, regarding mining impacted waters within the Mosquito Creek drainage and Buckskin Creek watershed.

B2 SAMPLING METHODS REQUIREMENT

Waterbodies, discharging adits, and mine drainage are sampled by professionally trained personnel. Volunteer assistants are used on occasion, but remain under the immediate supervision of the project supervisor or designated professional.

Specific sample collection procedures will be described in the SAP.

B3 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

The laboratory provides bottles and labels. Bottles used for collection of total metal analysis will be prepped by the laboratory and contain the designated preserving agents such as nitric acid. Containers are labeled in the field at the time of sample collection. Information included on the identification labels include at a minimum:

- sample location
- date and time of collection
- Remarks - special processing such as filtration; split sample, etc.
- Samplers' initials

A chain of custody (CoC) form accompanies all samples. Samplers verify the bottle labels matches the CoC before submitting samples. The chain of custody is signed and sealed in the shipping container by the responsible sending party before transport to the analytical lab. Upon receipt of the container, the receiver signs the chain of custody and returns it CUSP. A copy of the completed chain of custody form accompanies the data results in the report from the lab.

Samples that require refrigeration are maintained at 4° C. If samples are not shipped immediately to the analytical laboratory, refrigeration will be provided at CUSPs offices. CUSPs refrigerator temperature is checked and recorded monthly. For shipment, sample bottles are placed in a cooler with ice to maintain proper temperature and sealed with

appropriate shipping tape. Upon receipt by the contract lab the cooler temperature is recorded on the chain of custody papers.

Sample handling and preservation techniques are per: Standard Methods, 17th edition, Pg 1-37. All procedures for analytical determinations will be EPA approved methodologies from 40 CFR part 136 and/or Standard Methods for the Examination of Water and Wastewater, 17th Edition.

B4 QUALITY CONTROL REQUIREMENTS AND CHECKS

Generally, unless otherwise specified in project plans, 10% of the analytical samples and 5% of the field samples are devoted to quality control requirements. Quality Control for field sampling and analysis, laboratory procedures and data management have been discussed throughout this document. Internal checks will be set up by someone other than the person or persons performing the analytical work. The CUSP field coordinator is responsible for ensuring that samples are collected and preserved properly.

FIELD CHECKS

Field Duplicate Samples - Samples collected in two sample containers at the same time and the same site.

Check Frequency - Once during each sampling event.

Acceptance Criteria - Duplicate samples must have a relative percent difference of <20% from the mean for each analyte.

Corrective Action - If duplicates do not have an RPD of <20%, the results for each analyte not meeting this criteria shall be qualified as "questionable". If the 2 or more analytes from the same container do not meet this criteria, all results from that container will be disallowed. If any results from 2 or more containers do not meet this criteria, the sample will be disallowed. Repeat samples cannot be collected, as they represent a specific event. Additionally, perform audit of the sampling and chain of custody process.

Field Blank Samples – samples prepared on site using water known to be free from the potential toxics of concern. Field blanks measure sample contamination due to sampling equipment and field procedures.

Check Frequency – At first sampling and then at least once per month.

Acceptance Criteria – A zero laboratory analysis reading (below MDL).

Corrective Action - If analyte is detected in the field blank, contamination sources should be investigated. Background contamination in the blank will be reported with laboratory data.

Calibration Checks Check equipment performance against commercially prepared standards for accuracy.

Check Frequency - Once for every 20 samples analyzed.

Acceptance Criteria - Results of calibration must fall within acceptable ranges identified in the monitoring equipment specifications and manual.

Corrective Action - Follow manufacturers suggestions for trouble shooting and calibration procedures. Re-calibrate. Sample analysis should not proceed until acceptance criteria have been achieved.

LABORATORY CHECKS

Laboratory split sample Divide one sample into equal amounts and analyze separately.

Check Frequency - Once per sample batch.

Acceptance Criteria - Duplicate splits must have a relative percent difference of <20%.

Corrective Action - Results not meeting this criteria are marked as 'questionable'.

B5 INSTRUMENT CALIBRATION AND FREQUENCY

Multiparameter meter readings will not be collected until the meter has stabilized as identified by a decrease in parameter fluctuation. Calibration procedures are specified in each analytical SOP, adopting manufacturer's recommendations as minimum criteria.

Parameters which are tested for in the field, and corresponding type of instrumentation, are listed below:

1. stream flow --- pigmy flow meter
2. pH/ORP, EC, DO, and temperature --- Hanna HI 98280 meter with HI 769828 multisensor probe
3. Total alkalinity --- TNTplus chemistry reagent and Hach DR 2800 portable spectrophotometer
4. Cadmium --- TNTplus chemistry reagent and Hach DR 2800 portable spectrophotometer
5. Nitrate --- TNTplus chemistry reagent and Hach DR 2800 portable spectrophotometer
6. Nitrite --- TNTplus chemistry reagent and Hach DR 2800 portable spectrophotometer
7. Ammonia --- TNTplus chemistry reagent and Hach DR 2800 portable spectrophotometer
8. Copper --- CuVer® 1 reagent and Hach DR 2800 portable spectrophotometer
9. Sulfate --- SulfaVer® 4 reagent and Hach DR 2800 portable spectrophotometer
10. Zinc --- ZincoVer® 5 reagent and Hach DR 2800 portable spectrophotometer

11. Manganese --- Hach reagent and Hach DR 2800 portable spectrophotometer

SECTION C ASSESSMENT/OVERSIGHT

C1 ASSESSMENTS AND RESPONSE ACTIONS

Audits for work performed by CUSP employees or partners will be performed by the project manager at least once during the project. Results of these audits will be included in the employees' performance evaluations.

Any analyses conducted for this project by a contract lab, or subcontracted lab, may at any time during the length of this project be inspected at the discretion of CUSP, or stakeholder partners. This includes any type of systems audit, procedural or performance evaluations.

Assessment and response to data generated by the Denver Water Laboratory is determined by the analyst and/or the QA officer in accordance with Denver Water SOP.

Data which is determined to be unacceptable shall result in one or more of the following corrective actions:

1. check for transcription of math error
2. review analysis with the chemist/technician responsible for generating the data in question
3. identify measures to prevent future problems such as training in sample collection, preservation, or crosschecking on analysts

Corrective actions and follow-up from these activities will be the responsibility of the CUSP field coordinator.

SECTION D DATA VALIDATION AND USABILITY

D1 DATA REVIEW, VALIDATION, AND VERIFICATION REQUIREMENTS

Unless otherwise specified, acceptable precision for duplicate samples shall be <30% expressed as relative percent difference (RPD). Where:

Precision = RPD= (C-C/[(C+C)/2)]) x 100
In the event split sample pairs are > 30% data from that site. Time will be considered qualified and will be interpreted with caution. Qualified data will be clearly denoted in the database.

Estimates of overall precision of a parameter will be derived from the pooled standard deviations form all individual duplicate pairs. The pooled standard deviation statistic is termed the root mean square (RMS) and is calculated:

Percent relative standard deviation = %RSD = 100 (SD/mean)

Root mean square = RMS = $\%RSD_1 + \%RSD_2 \ldots + \%RSD_n$

Unless otherwise specified, acceptable RMS for each parameter is <30%. If RMS is >30% than the analysis for that parameter will be considered as qualified data and interpreted with caution.

Data from field blanks will be tabulated, reviewed, and interpreted in project reports. If contamination of field blanks occurs, corrective action will be initiated.

D2 VALIDATION AND VERIFICATION METHODS

It is the responsibility of the project manager to evaluate raw data generated by the contract lab and the lab for appropriate numeric reduction, data quality, and accuracy. All data will be reviewed and reported in units specified at the detection level of the analytical methods used.

There is a common problem in all programs in which analytical data is evaluated with data that is reported as being in concentrations less than the detection limit for a particular parameter. Data that is reported as "less than" the detection limit may be considered at ½ the detection limit value, considered as a zero (0) value, or omitted from the statistical data evaluation.

Data will be compiled on computer spreadsheets. During this data transfer, the information will be reviewed and verified in accordance with the information in §D3, as well as other validation checks, storage, chain of custody records and evaluation of calibration information to ensure that equipment was operating properly at the time data was generated.

Data units will routinely be reported in milligrams per liter (unless otherwise noted) for all elements except pH and conductivity. Scientific notation will be used when appropriate and the number of significant figures reported will depend directly on the detection levels of the analytical method used. Raw data will be available to partner organizations upon request.

D3 RECONCILIATION WITH DATA QUALITY OBJECTIVES

Precision is defined as "a measure of mutual agreement among individual measurements of the same property usually under prescribed similar conditions," and is usually expressed in terms of standard deviation (SD). To insure precision, the following steps will be taken by samplers and analytical labs:

* instrument maintenance and calibration check records
* laboratory replicate records
* field duplicates records

Accuracy is the agreement between the measured amount of constituent and the amount of that constituent actually present in the sample. Checks to insure accuracy include:

* reagent blanks

* instrument calibration records, as per SOP

Accuracy is usually expressed as a percentage of known value (also called relative error).

Representative is the expression of the "degree to which data accurately and precisely represents a characteristic of a population, parameter variation at a sampling point, a process condition, or an environmental condition."

Comparability is the confidence with which one data set can be compared to another. Consistency of reporting units, standardized analytical methods, and standardized data formatting will insure comparability. Additionally, sampling will be conducted in a synoptic manor within a sub watershed to ensure that all samples taken in a sub watershed are representative of the same temporal and environmental influences.

Detection levels will be reported as specified for each analytical method. The method used will be EPA approved from 40 CFR part 136 or Standard Methods 17th Edition.

USFS-AMLI FIELD DATA FORM

LOCATION AND IDENTIFICATION

(1) **ID#:** 02- 08-_____-_____- _____/_____-_____
rgn st fst rd xutm yutm area#

(2) **Site name:** _____

(3) **Other name/reference:** _____

_____ (4) **Highest priority Environmental Degradation occurring in this area:**
1=extreme; **2**=significant; **3**=potentially significant; **4**=slight; **5**=none

_____ (5) **Highest priority Mine Hazard noted in this area:**
E=emergency; **1**=extreme danger; **2**=dangerous; **3**=potentially dangerous;
5=no significant hazard

_____ (6) **Commodity: C**=coal; **U**=uranium; **M**=metals; **I**=industrial material.
(Metal or Indust. material type: _____)

(7) **Quad name and date:**_____

(8) **County:** _____

(9) **2° map:** _____

(10) **Water Cataloguing Unit #:** _____

(11) **Mining district/coal field:** _____

(12) **Land survey location:** _____-_____-_____sec_____,T_____,R_____

(13) **Receiving stream:** _____flowing into_____
nearest named stream next named stream

(14) **Elevation** (ft): _____

_____ (15) **General Slope: 1**=0-10°; **2**=11-35°; **3**=greater than 35°

_____ (16) **Regional terrain: R**=rolling or flat; **F**=foothills; **T**=mesa; **H**=hogback;
M=mountains; **S**=steep/narrow canyon

_____ (17) **Type of access: N**=no trail; **T**=trail; **J**=jeep road; **G**=gravel road;
M=paved road; **P**=private/restricted road

_____ (18) **Quality of access for construction vehicles: G**=good; **M**=moderate; **P**=poor;
X=very poor

(19) **Nearest town on map:** _____

_____ (20) **Road distance from nearest town** (#.# miles)

(21) **Nearest road** (name and/or #): _____
FR=forest rd; **CR**=county rd; **SH**=state highway; **I**=interstate

Distance to following types of public uses (#.# miles):

_____ (22) Road _____ (25) Marked trail

_____ (23) Dwelling (year-round) _____ (26) Other public use (explain)

_____ (24) Campground/picnic area _____

ENVIRONMENTAL INFORMATION

_____ (27) **Vegetation density adjacent to site: D**=dense; **M**=moderate; **S**=sparse;
B=barren

_____ (28) **Vegetation type adjacent to site**: **B**=barren; **W**=weeds; **G**=grass; **R**=riparian
S=sagebrush/oakbrush/brush; **J**=juniper/piñon; **A**=aspen; **P**=pine/spruce/fir;
T=tundra

_____ (29) **Evidence of intentional reclamation: Y**=yes; **N**=no (if yes, use comments)

_____ (30) **Size of disturbed area in acres**

_____ (31) **Potential historical structures in area: Y**=yes; **N**=no (if yes, use comments)

_____ (32) **Positive evidence of BATS: G**=guano; **I**=insect remains; **B**=bat sighting;
O=other(use comments); **N**=no (use comments to expand on any positive evidence;
"No" only indicates absence of positive evidence, **not** absence of bats)

_____ (33) **Recorded by/date:** _____

ADITS, SHAFTS, AND OPENINGS													
Feature Nos.		100	101	102	103	104	105	106	107	108	109	110	111
Type of Feature													
Opening Size (ft)	H												
	W												
Depth (ft)													
Condition													
Drainage													
Access Deterents													
Deterent Condition													
Ratings	Env. Deg.												
	Hazard												
Photo	Roll No.												
	Frame No.												
Comments?													

DUMPS, TAILINGS, AND SPOIL BANKS										
Feature No.		200	201	202	203	204	205	206	207	208
Type of Feature										
Plan view Dimension(ft.)	L									
	W									
Volume (yds)										
Steepest Slope Angle (dgr)										
Steepest Slope Length (ft)										
Size of Materials										
Cementation										
Vegetation Type										
Vegetation Density										
Drainage										
Stability										
Water Erosion	of Feature									
	Storm Runoff									
Wind Erosion										
Radiation Count										
Access Deterents										
Deterent Condition										
Ratings	Env. Deg.									
	Hazard									
Photo	Roll No.									
	Frame No.									
Comments?										
Soil Sample No.										

DRAINAGE/WATER SAMPLES						
Item Nos.	300	301	302	303	304	305
Adit/Shaft/Dump No./Other=0 (If other location, describe in comments)						
pH (standard units)						
Conductivity (uS)						
Flow (gpm)						
Method of Flow Measure						
Date Flow/Sample (m/d/y)						
Location of Sample/Flow						
Evidence of Toxicity in Site Drainage						
Evidence of Toxicity in Receiving Stream						
Distance from Stream (ft)						
Comments?						
Lab Water Sample No.						

GPS READINGS	
Ftr. No.	Location
	Lat. Long.
	Lat. Long.
	Lat. Long.
	Lat. Long.
	Lat. Long.
	Lat. Long.
	Lat. Long.
	Lat. Long.
	Lat. Long.
	Lat. Long.
	Lat. Long.

DIAGRAM OF PROBLEM AREA (Locate all adits, shafts, dumps, prospects, etc. on topo map.)

Check off upon completion: __ north arrow; __ scale bar or general size noted; __ direction to nearest trail/road/town noted; __ significant mine features numbered

Adit shaft prospect hole building dump or tailings collapsed adit and shaft fence

•81. Local person interviewed _____
Name Address

•82. Name and address of person desiring a copy of this form:_____

_____

•83. Describe the minimum work needed to mitigate any public health, safety, welfare, or environmental problems observed at the site. Note specific reclamation activities along with an estimated cost and time period to implement each activity described. Code costs as: 1= less $10,000; 2= $10,000 to $100,000; 3= $100,000 to $500,000; 4= more than $500,000. Code estimated time to complete the activity as: 1= less than 1 month; 2= 1 to 12 months; 3= 1 to 3 years; 4= over 3 years

Cost	Time	Recommended reclamation activity

•84. Comments relating to geology, health, safety, welfare, environmental, or restoration problems of a certain feature. All comments must be keyed to mine feature # or drainage/water sample item #.

Ftr.# _____

_____-if more comments use back of page →

General Comment (on whole inventory area or group of mine features):_____

_____-if more comments use back of page →

OFFICE/LITERATURE INFORMATION

•41. Owner of surface _____
•42. Last known operator _____
•43. Estimated production _____
•44. Dates of production _____
•45. Literature not cited in comments_____
•46. Citation of any historical register listing _____ _____

CODES FOR TABULAR INFORMATION

ALL TABLES: If appropriate code is not listed, use: **N** = none or no; **N/A** = not applicable; **UNK** = unknown; **O** = other, explain in #84

ADITS, SHAFTS, & OPENINGS

- Type of feature: **A** = adit; **S** = vertical shaft; **I** = incline shaft; **P** = prospect hole; **ST** = stope; **G** = glory hole; **SU** = subsidence feature; **PT** = open pit; **O** = other, explain in #84.
- Condition: **I** = intact; **P** = partially collapsed or filled; **F** = filled or collapsed; **N** = feature searched for but not found (mine symbol on map)
- Drainage: **N** = no water draining; **W** = water draining; **S** = standing water only (note at what depth below grade)
- Access deterrents: **N** = none; **S** = sign; **F** = fence; **C** = sealed or capped; **D** = open door or hatch; **L** = locked door or hatch; **G** = open grill; **O** = other, explain in #84.
- Deterrent condition: **P** = prevents access; **D** = discourages access; **I** = ineffective
- Ratings: Hazard: **E** = emergency; **1** = extreme danger; **2** = dangerous; **3** = potential danger; **5** = no significant hazard
  Env. Deg.: **1** = extreme; **2** = significant; **3** = potentially significant; **4** = slight; **5** = none
- Comments?: **Y** = yes; **N** = no

DUMPS, TAILINGS, AND SPOIL AREAS

- Type of feature: **D** = mine dump; **T** = mill tailings; **W** = coal waste bank; **S** = overburden or development spoil pile; **DS** = dredge spoil; **HD** = placer or hydraulic deposit; **H** = highwall; **P** = processing site
- Size of materials: **F** = fine; **S** = sand; **G** = gravel; **L** = cobbles; **B** = boulders
- Cementation: **W** = well cemented; **M** = moderately cemented; **U** = uncemented
- Vegetation Type: **G** = mixed grass; **S** = sagebrush/oakbrush/brush; **J** = juniper/piñon; **A** = aspen; **P** = pine/spruce/fir; **T** = tundra; **R** = riparian; **F** = tilled crops; **B** = barren/no vegetation; **W** = weeds
- Vegetation Density: **D** = dense; **M** = moderate; **S** = sparse; **B** = barren
- Drainage: **N** = no water draining; **W** = water draining across surface; **S** = standing water only; **SP** = water seeping from side of feature
- Stability: **U** = unstable; **P** = potentially unstable; **S** = stable
- Water erosion: of Feature: **N** = none; **R** = rills; **G** = gullies; **S** = sheet wash
  Storm Runoff: **C** = in contact with normal stream; **S** = near stream or gully, but only eroded during storm or flood; **N** = no storm/flood runoff erosion
- Wind erosion: **N** = none; **D** = dunes; **B** = blowouts; **A** = airborne dust
- Radiation Count: **N** = none taken; record value of reading if taken
- Access deterrents: **N** = none; **S** = sign; **F** = fence; **O** = other, explain in #84
- Ratings: Hazard: **E** = emergency; **1** = extreme danger; **2** = dangerous; **3** = potential danger; **5** = no significant hazard
  Env. Deg.: **1** = extreme; **2** = significant; **3** = potentially significant; **4** = slight; **5** = none
- Comments?: **Y** = yes; **N** = no

DRAINAGE/WATER SAMPLES

- Adit/Shaft/Dump No./Other: Indicate Feature No. associated with water information; **0** = other, explain in comments
- Flow (gpm): record unestimatable seeps as 0.1 gpm
- Method of flow measure: **E** = estimate; **T** = bobber/stopwatch/x-section; **W** = weir; **D** = catchment; **F** = flow meter
- Location of sample and flow: **A** = immediately adjacent to adit/shaft; **B** = below dump/tailings; **C** = immediately above confluence with receiving stream; **SW** = standing water in/on feature; **RU** = receiving stream upstream of feature; **RD** = receiving stream downstream of feature;
- Evidence of toxicity: **N** = none; **A** = absence of benthic organisms; **W** = opaque water; **P** = yellow or red precipitate; **S** = suspended solids; **D** = salt deposits
- Comments?: **Y** = yes; **N** = no

FIELD GUIDE

FOR THE USFS ABANDONED MINE LAND INVENTORY PROJECT

-general guidelines for the field geologist-

Mine Openings - record all features shown on the topographic map if they are on, or affect, public land. Features that are identified by literature search or field reconnaissance should be recorded, depending on size and other factors, as detailed in the following paragraphs.

Prospect pits and exploratory holes are not typically recorded because their environmental degradation potential is usually negligible. Exceptions are made for any workings shown on topographic maps, and for deep pits or exploratory shafts that could be a physical hazard. A quantitative guideline would be a hole or pit less than 10' in depth will not be recorded. This guideline is adaptable to accommodate site-specific conditions such as steepness of sidewalls, ability to climb out of a hole, public access, interaction with surface- or ground water, etc.

Dumps, Tailings, and Spoils Piles

Generally dumps, tailings, or spoils piles less than 50 cubic yards in volume do not need to be recorded as their environmental degradation and physical hazard potential are usually negligible. Piles less than this size may be recorded according to the discretion of the field geologist. One important exception is that any mine waste interacting with flowing water should be recorded.

Determining When a Site Needs to be Visited

DON'T JUDGE A MINE OPENING BY ITS DUMP! Some shafts, mine vents, etc. will not have large dumps associated with the hole, but will still be very deep. The waste rock may have been taken out an adit at a lower mine level, leaving very little dump material around the mine opening. The geometry of nearby adits and shafts can give clues to the probability of a feature being a vent or a connecting shaft. The general rule is -- if you're not sure it's just a prospect pit or a shallow exploratory hole, go to the site.

If there is a shaft, adit, or quarry indicated on the topographic quadrangle, you must go to the site and record data for it, even if it is collapsed, filled, overgrown with vegetation, etc. Information that a mine feature is not a problem at all is just as useful to the USFS as information about problem sites.

GUIDE FOR USING THE USFS-AMLI FIELD DATA FORM

LOCATION AND IDENTIFICATION

(1) ID# - a numeric code used for location information and for linking all the database files together. It is important for this number to be correct.

fst = two digit code for the specific National Forest

rd = two digit code for the specific ranger district

xutm,yutm = Universal Transverse Mercator coordinates, shown on the map edge. This defines a 1000 square meter cell. The coordinates are taken from the bottom left-hand corner of the utm cell containing the inventory area (the smallest x,y coordinates defining the cell).

area# = number assigned to differentiate between more than one inventory area within a utm cell. Number sequentially from 1, 2, 3, etc.

(2) Site name – Name of the mine or workings from the map or from literature. Cite the literature source if appropriate. If a proper name is unknown, the name of a nearby geographical feature may be used.

(3) Other name/reference – as above if more than one name.

(4) Environmental Degradation – Environmental Degradation Ratings (EDRs) are somewhat subjective. This is necessary, and even desirable, so that the field geologist can take into account site-specific conditions such as geology, effluent discharge volume, placement of the feature in the drainage basin, surface water interactions, precipitation, etc. Numerical pH and conductivity values are useful tools. Natural waters from alpine basins generally have conductivities of less than 100 μS, and streams at lower elevations often have conductivities of 100-300 μS. In areas of intensely altered rock, natural waters can have low pH and high conductivity. In addition, conductivity may be elevated in areas underlain by limestone, gypsum, or other easily soluble rocks. Mine effluent pH and conductivity should be compared to background values when assessing the environmental degradation. Conductivity and pH values, as well as the other criteria listed on the following table are general guidelines, and should not be considered absolutes. Ratings are usually based on combinations of listed characteristics, but occasionally one aspect of a feature may fully justify a rating. (See table 1).

Table 1. General guidelines for assigning Environmental Degradation Ratings (EDR).

Rating (EDR)	Feature usually displays one or more of the following characteristics:
1=EXTREME	• Contamination offsite is severe. • Receiving stream is "dead" or sterile at the mine and downstream. • Effluent has extremely low pH (<4). • Effluent has extremely high conductivity (>1500 μS; >1000 μS in alpine areas). • High flows of poor-quality water, relative to the receiving stream. • Abundant precipitate at the mine and in the receiving stream. • Very large dumps or tailings piles with evidence of severe erosion, especially if they have abundant sulfides.
2=SIGNIFICANT	• Receiving stream is significantly or obviously adversely affected, but not "dead" or sterile. • Effluent has low pH (<5). • Effluent has high conductivity (>1000 μS; >500 μS in alpine areas). • Moderate flows of poor-quality water, relative to the receiving stream. • High flows of moderate-quality water, relative to the receiving stream. • Moderate to abundant precipitate at the mine and/or in the receiving stream. • Large sulfide-rich dumps or tailings piles with evidence of moderate erosion. • Large dumps with sparse or no sulfides, but evidence of significant erosion.
3=POTENTIALLY SIGNIFICANT	• Evidence of degraded water quality, but serious effects are not obvious or detected. • Effluent has low pH (<5.5). • Effluent has moderate conductivity (>800 μS; >150 μS in alpine areas). • Poor-quality water with low or no flow (standing water). • Moderate to low flows of moderate-quality water, relative to the receiving stream. • Minor amounts of precipitate. • Very large dumps with little or no evidence of erosion and sparse or no sulfides. • Small and moderate-sized sulfide-rich dumps or tailings piles with evidence of moderate erosion.
4=SLIGHT	• Effluent with slightly acidic pH (<6.5). • Effluent with slightly elevated conductivity (600-800 μS; 100-150 μS in alpine areas). • Low flow volume with sparse or no precipitate. • Small to moderate-sized sulfide-rich dumps or tailings piles with little evidence of erosion.
5=NONE	• No effluent. • Effluent of high quality water. • Small dumps distant from surface water with little or no evidence of erosion.

(5) Mine Hazards – Features are given Physical Hazard Ratings (PHRs) based on definitions shown below.

> **E = EMERGENCY** - This will seldom be noted on the data form since it reflects a "sudden danger or impairment that presents a high probability of substantial physical harm to the health, safety, or general welfare of people before the danger can be abated under normal program operation procedures" [Office of Surface Mining Rules and Regulations, Section 872.5(c)]. An emergency involves a sudden and recent change on which immediate action should be taken.

1 = EXTREME DANGER - This means a "condition that could reasonably be expected to cause substantial physical harm to persons, property....and to which persons or improvements on real property are currently exposed" [OSM Rules and Regulations 872.5(e)]. Sites falling in this category will generally have a high degree of exposure to the chance of injury or damage. A high degree of peril coupled with a high degree of jeopardy being placed on persons or property, either knowingly or unknowingly, is generally involved. Easy access to the general public is a factor. Situations involving open vertical shafts, unstable adits (incompetent rock), very high highwall, or collapsed stopes near roads or towns would fall into this category.

2 = DANGEROUS - The specific mining feature may be as perilous as in a #1 situation, but may be less likely to cause injury or damage because of the remoteness of the site or other constraints on uncontrolled access to the site.

3 = POTENTIALLY DANGEROUS - any open or partially filled adit, moderate height highwall, etc. that is not close to a road or town and would be infrequently accessed by people. This includes situations where the exact hazard is unknown, but could involve a degree of risk at certain times or under certain conditions.

4= (not used during this inventory) - In order to maintain some degree of consistency, this Mine Hazard rating system is based on one used by Colorado Division of Minerals and Geology during an earlier, less detailed inventory. In the earlier inventory, a rating of "4" indicated possible environmental degradation, rather than physical hazard. The "4" rating is not applicable for physical hazards in this inventory.

5 = NO SIGNIFICANT HAZARD - includes collapsed or filled features that are being naturally or intentionally reclaimed, stable mine dumps, and mine sites where all physical hazards have been effectively mitigated.

(7) Quad name and date - write in the name and the last USFS revision or modification date (including "USFS correction guides") listed in the bottom left-hand corner of the PBS quad.

(10) Water Cataloguing Unit # - the number assigned to the drainage basins in Colorado according to the "Hydrologic Unit Map 1974–State of Colorado" published by the USGS.

ENVIRONMENTAL INFORMATION

(28) Vegetation type adjacent to site - use more than one category if appropriate.

(29) Evidence of intentional reclamation - evidence of reclamation includes re-grading, replacing topsoil, seeding, erosion control, fencing, sealing of mine openings.

(30) Size of disturbed area in acres - always give an estimate. Helpful rules of thumb: an acre =

43,560 ft^2 which is about equal to a football field playing area; a city block is about 5 to 6 acres.

TABULAR INFORMATION - pages 2-3 on the data form

Refer to the "Codes for Tabular Information" on page 5 of the data form. If the mine and dump features are associated, they should have the same last digit (i.e. dump #201 is related to adit #101, dump #202 to shaft #102). If an opening has no related dump, the corresponding dump # should be left blank and vise versa.

ADITS, SHAFTS, AND OPENINGS - all recorded mine openings must have an EDR and PHR.

Depth - For shafts (or pits), this means vertical distance from ground surface to the bottom of the shaft. For adits, this means horizontal distance from the portal to the back of the mine. If unknown, note the visible distance and add a "+" to the number.

Access deterrents - Indicates man-made access deterrents; use only those codes listed. More than one may be used if appropriate. A collapsed or filled mine opening is not used as a deterrent here.

Deterrent condition - Indicate the condition if there is an actual deterrent. If there is no deterrent (access deterrents=N) leave this item blank.

DUMPS, TAILINGS, AND SPOIL BANKS

Steepest slope angle - use the clinometer on the Brunton compass to determine this. Often these angles will be around 35 degrees.

Size of materials - Fine= powdery or silty, gravel= larger than sand up to about 3 inches diameter or "throwing rocks," cobbles are brick size, boulders are over 12 inches in diameter.

Stability - Unstable slopes show evidence of past failure, potentially unstable slopes appear to be likely to fail due to high slope angles and/or undercutting or removal of toe material by a stream.

Water erosion of feature - Rills are under 9" across and gullies are over 9" across. Sheet wash shows even overall erosion, but fines are absent.

Access deterrents/Deterrent condition - as above in ADITS, SHAFTS, & OPENINGS

DRAINAGE/WATER SAMPLES

Distance from stream - the distance from the sample location to the receiving stream.

Lab water sample No. - indicate the number given to water samples taken for laboratory analysis. When labeling the sample, use the inventory area id# (top page 1) appended with the water sample item # (300 series) for both the preserved (acidized) and neutral sample bottles.

GPS READINGS - if Global Positioning System equipment is used, record the entire latitude and longitude displayed on the GPS recorder and the mine feature.

DIAGRAM OF PROBLEM AREA - always sketch a detailed map of the inventory area. Locate and label all mine features and water test/sample locations along with roads, trails, streams, mine drainage, buildings, structures, fences, etc. It is sometimes helpful to outline patented land inholdings within the inventory area if pertinent. A separate larger scale sketch of important mine features is sometimes warranted.

COMMENTS - These may include anything the field geologist deems worth mentioning about the mine feature. Usually, comments will expand on any associated environmental degradation, physical hazards, historical structures, machinery, relation to other features, etc. Include identifiable mineralogy of dump (or vein) material, especially any acid-forming minerals (mainly sulfides, sulfosalts). Also note the presence of any neutralizing host or country rock (limestone, dolomite, marble, or other carbonate).

GUIDELINES FOR WATER AND SOIL SAMPLING FOR LAB ANALYSIS

Water Sampling

Water samples for laboratory analysis should be taken at sites that have very significantly degraded water. These will generally be sites with "Environmental Degradation (E.D.) Ratings" of 1 or 2. All sites with an E.D. rating of 1 (and water associated with it) should be sampled for lab analysis. Most sites with an E.D. rating of 2 should be sampled, but the field geologist may use discretion based on the site conditions.

Water Sampling Procedures:

1 a) All water samples to be analyzed for dissolved constituents will be filtered with a disposable 0.45-micron filter attached to the 60-cc syringe. The disposable filter should be rinsed by forcing 20 cc of sample water through it, **before** dispensing filtrate into the sample bottle. (i.e. the filtered acidified (FA) and filtered unacidified (FU) subsample bottles)

b) Samples to be analyzed for total recoverable constituents are unfiltered raw water. (i.e. raw acidified (RA) subsample bottle)

2) All sample bottles must be **filled** to the bottom of the neck of the bottle. This insures there is enough sample to do the analyses needed.

3) Required analyses for water samples are:

Metals, Dissolved Phase:("FA" Bottle)
Aluminum
Cadmium
Calcium
Chromium (total)
Copper
Iron
Lead
Magnesium
Manganese
Nickel
Potassium
Silver
Sodium
Zinc

Metals, Total Recoverable Phase:("RA" Bottle)
Antimony
Aluminum
Arsenic
Iron
Thallium
Zinc

Anions (dissolved phase):("FU" Bottle)
Chloride
Fluoride
Sulfate
Dissolved Oxygen (done in field)
Alkalinity (done in field)

Other water sample analyses which may be requested on a site-specific basis are:

Barium (Trec)
Beryllium (TRec)
Mercury (Diss)
Molybdenum(TRec)
Selenium (Diss)
Uranium (Diss)

4) Analyses for total recoverable metals, dissolved metals, and total hardness are performed on the preserved (HNO3 acidized) FA and RA subsamples. Samples should be acidified to pH=< 2.

5) Analyses for total alkalinity, sulfate, or other anions are performed on the neutral (unpreserved) sample. These have a 14-day holding time including delivery to the lab.

6) If water samples for cyanide analysis are needed, bottles with NaOH preservative must be ordered from the CDPHE Inorganic Lab. If water samples for mercury are needed, glass bottles with nitric acid must be ordered from the CDPHE Inorganic Lab.

7) All water samples should be refrigerated, but not frozen. Use a cooler in the field.

8) A Health Dept. **"Water Quality Data" form** which lists constituents for analysis must accompany every water sample we send them. The **constituents you want analyzed from a certain sample must be circled or highlighted** on the form. I've indicated our required analyses above. Optional analyses can be added - you may want data for other constituents that apply to specific sites (some likely ones are listed).

8) A **chain of custody form** must accompany any set of samples sent to the lab.

9) Samples should be sent by UPS or dropped off to:

Sherri Alexander/Inorganic Lab
Colorado Dept. of Health
Room 153
4210 East 11th Street
Denver, CO 80220

Dump, Tailings, or Spoils Sampling

Sampling of dumps, tailings, or spoils piles will generally be rare. Samples should only be taken if there is evidence of: 1) extreme erosion into a perennial receiving stream, 2) significant amounts of material becoming airborne (aided by vehicles, machinery etc.), or 3) very frequent visitation/recreation at the site (possibility of frequent ingestion episodes). Sites where tailings are well impounded and/or "high and dry" will not be sampled.

Dump, Tailings, or Spoils Sampling Procedures:

1) Samples should be of the "composite" type. The composite sample should be taken from 10 different subsample locations, equally spaced on the top and slopes of the dump. Try to obtain material from the surface to 6 inches below the surface. Each subsample should be approximately 100 cubic centimeters. Attempt to collect material that is sand size or less. (Smaller grain sizes have larger surface areas for water-rock interaction and there are no lab grinding fees!) Take the sample from material that has not been in contact with your digging tool to avoid contamination. The sample can be put into a 1-gallon heavy-duty zip-lock type bag. Label with the date, time, site ID#, and the sampler's name. Indicate the subsample locations on a large-scale field sketch of the dump.

2) Soil samples must be analyzed for concentrations of the following constituents:

Aluminum	Iron	Silver
Arsenic	Lead	Zinc
Cadmium	Manganese	Paste pH
Chromium	Mercury	Acid-base potential
Copper	Nickel	Neutralization potential

⇒ Site-specific constituents such as barium, beryllium, selenium, uranium, or radionuclides (gross alpha, gross beta) may also be analyzed.

3) A **chain of custody form** must accompany any set of samples sent to the lab.

4) Samples should be sent by UPS or dropped off to:

Sherri Alexander/Inorganic Lab
Colorado Dept. of Public Health and Environment
Room 153
4210 East 11th Street
Denver, CO 80220

Table A
Aquatic Life Use Standards Calculated using Sample Hardness

		Standards Based on Sample Hardness as $CaCO_3$															
	Hardness as	Cd (ug/l)		Cu (ug/l)		Pb (ug/l)		Mn (ug/l)		Ni (ug/l)		Ag (ug/l)		Zn (ug/l)		U (ug/l)	
Sample #	$CaCO_3$ (mg/L)	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic
1	38.99	1.21	0.21	5.53	4.00	22.85	0.89	2181.67	1205.38	211.06	23.44	0.40	0.06	64.23	55.69	850.76	531.41
2	7.49	0.28	0.06	1.17	0.98	3.52	0.14	1259.03	695.62	52.24	5.80	0.02	0.00	15.73	13.64	138.00	86.20
3	12.45	0.44	0.09	1.89	1.51	6.30	0.25	1491.50	824.05	80.34	8.92	0.06	0.01	24.27	21.04	241.73	150.99
4	12.86	0.46	0.09	1.95	1.55	6.54	0.25	1507.74	833.03	82.58	9.17	0.06	0.01	24.95	21.63	250.55	156.50
5	50.97	1.52	0.26	7.12	5.04	30.79	1.20	2385.38	1317.93	264.77	29.41	0.64	0.10	80.71	69.98	1143.08	714.00
6	24.05	0.79	0.14	3.51	2.65	13.29	0.52	1857.26	1026.14	140.23	15.58	0.17	0.03	42.54	36.88	499.43	311.96
7	17.00	0.58	0.11	2.53	1.97	8.98	0.35	1654.65	914.19	104.57	11.61	0.10	0.02	31.65	27.44	340.79	212.87
8	55.96	1.65	0.27	7.78	5.45	34.14	1.33	2460.76	1359.57	286.54	31.83	0.75	0.12	87.40	75.78	1267.00	791.41
9	139.13	3.65	0.54	18.34	11.88	92.35	3.60	3332.85	1841.40	619.15	68.77	3.58	0.56	189.97	164.72	3456.83	2159.23
10	46.42	1.40	0.24	6.52	4.65	27.75	1.08	2312.20	1277.49	244.63	27.17	0.54	0.09	74.53	64.62	1031.11	644.06
11	57.17	1.68	0.28	7.94	5.55	34.96	1.36	2478.31	1369.27	291.76	32.41	0.78	0.12	89.01	77.17	1297.16	810.24
12	57.99	1.70	0.28	8.04	5.62	35.52	1.38	2490.14	1375.80	295.31	32.80	0.80	0.13	90.10	78.12	1317.75	823.10
13	68.33	1.97	0.32	9.39	6.47	42.56	1.66	2629.98	1453.07	339.27	37.68	1.05	0.17	103.62	89.84	1578.87	986.20
14	73.29	2.09	0.34	10.03	6.87	45.97	1.79	2692.13	1487.41	360.01	39.99	1.19	0.19	110.00	95.38	1705.71	1065.43
15	79.03	2.23	0.36	10.77	7.32	49.93	1.95	2760.51	1525.19	383.69	42.62	1.35	0.21	117.29	101.70	1853.30	1157.63
16	110.50	2.99	0.46	14.77	9.75	71.99	2.81	3086.68	1705.39	509.52	56.59	2.41	0.38	156.10	135.35	2681.77	1675.11
17	57.53	1.69	0.28	7.98	5.58	35.20	1.37	2483.46	1372.12	293.31	32.58	0.78	0.12	89.48	77.58	1306.10	815.83
18	115.52	3.11	0.47	15.40	10.13	75.54	2.94	3132.67	1730.80	529.02	58.76	2.60	0.41	162.12	140.57	2816.26	1759.12
19	44.31	1.35	0.23	6.24	4.47	26.35	1.03	2276.64	1257.85	235.19	26.12	0.50	0.08	71.63	62.10	979.56	611.86
20	105.90	2.88	0.44	14.19	9.41	68.74	2.68	3043.22	1681.38	491.50	54.59	2.24	0.35	150.54	130.52	2558.86	1598.33
21	102.61	2.80	0.43	13.77	9.16	66.42	2.59	3011.39	1663.79	478.54	53.15	2.12	0.33	146.54	127.06	2471.36	1543.68
22	145.16	3.79	0.56	19.09	12.31	96.66	3.77	3380.33	1867.64	641.80	71.28	3.85	0.61	196.98	170.79	3622.47	2262.69
23	56.29	1.66	0.28	7.82	5.48	34.37	1.34	2465.59	1362.24	287.97	31.99	0.76	0.12	87.84	76.16	1275.26	796.56
25	41.90	1.28	0.22	5.92	4.26	24.76	0.96	2234.55	1234.59	224.30	24.91	0.45	0.07	68.29	59.21	920.91	575.22
26	39.40	1.22	0.21	5.59	4.04	23.12	0.90	2189.31	1209.60	212.94	23.65	0.41	0.06	64.80	56.19	860.65	537.59
27	84.51	2.37	0.37	11.47	7.76	53.74	2.09	2822.88	1559.64	406.09	45.10	1.52	0.24	124.20	107.68	1995.49	1246.44
28	46.86	1.42	0.24	6.58	4.69	28.04	1.09	2319.45	1281.50	246.58	27.39	0.55	0.09	75.12	65.14	1041.84	650.76

Table A
Aquatic Life Use Standards Calculated using Sample Hardness

		Standards Based on Sample Hardness as $CaCO_3$															
	Hardness as	Cd (ug/l)		Cu (ug/l)		Pb (ug/l)		Mn (ug/l)		Ni (ug/l)		Ag (ug/l)		Zn (ug/l)		U (ug/l)	
Sample #	$CaCO_3$ (mg/L)	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic
29	40.22	1.24	0.21	5.70	4.11	23.66	0.92	2204.43	1217.95	216.70	24.07	0.42	0.07	65.96	57.19	880.48	549.97
30	41.90	1.28	0.22	5.92	4.26	24.76	0.96	2234.55	1234.59	224.30	24.91	0.45	0.07	68.29	59.21	920.91	575.22
31	38.99	1.21	0.21	5.53	4.00	22.85	0.89	2181.67	1205.38	211.06	23.44	0.40	0.06	64.23	55.69	850.76	531.41
34	45.88	1.39	0.24	6.45	4.60	27.39	1.07	2303.11	1272.47	242.19	26.90	0.53	0.08	73.78	63.97	1017.76	635.72
034 dup	46.70	1.41	0.24	6.56	4.67	27.93	1.09	2316.79	1280.03	245.86	27.31	0.55	0.09	74.90	64.95	1037.89	648.29
36	126.98	3.37	0.51	16.83	10.98	83.68	3.26	3232.91	1786.19	573.08	63.65	3.06	0.48	175.73	152.37	3125.58	1952.32
37	58.92	1.73	0.28	8.16	5.70	36.15	1.41	2503.37	1383.11	299.31	33.24	0.82	0.13	91.33	79.19	1341.06	837.66
38	36.08	1.13	0.20	5.14	3.75	20.96	0.82	2126.09	1174.67	197.67	21.96	0.35	0.06	60.12	52.13	781.14	487.92
39	34.44	1.08	0.19	4.92	3.60	19.89	0.78	2093.30	1156.55	190.02	21.11	0.32	0.05	57.78	50.10	741.97	463.46
40	36.49	1.14	0.20	5.20	3.78	21.22	0.83	2134.14	1179.11	199.58	22.17	0.36	0.06	60.71	52.64	790.96	494.05
41	38.52	1.19	0.21	5.47	3.96	22.55	0.88	2172.97	1200.57	208.93	23.21	0.39	0.06	63.57	55.12	839.58	524.42
42	34.77	1.09	0.19	4.97	3.63	20.10	0.78	2099.97	1160.24	191.56	21.28	0.33	0.05	58.25	50.51	749.83	468.36
50	25.28	0.83	0.15	3.68	2.77	14.06	0.55	1888.48	1043.39	146.29	16.25	0.19	0.03	44.39	38.49	527.75	329.65
51	44.70	1.36	0.23	6.29	4.50	26.60	1.04	2283.20	1261.47	236.91	26.31	0.51	0.08	72.16	62.56	988.94	617.72
52	50.07	1.50	0.25	7.00	4.96	30.18	1.18	2371.22	1310.10	260.80	28.97	0.62	0.10	79.49	68.92	1120.77	700.06
53	158.95	4.10	0.60	20.80	13.31	106.55	4.15	3484.07	1924.95	693.01	76.97	4.50	0.71	212.82	184.53	4003.50	2500.70
54	110.09	2.98	0.46	14.71	9.72	71.70	2.79	3082.85	1703.28	507.92	56.41	2.39	0.38	155.61	134.92	2670.77	1668.24
55	54.62	1.62	0.27	7.60	5.34	33.24	1.30	2440.95	1348.63	280.72	31.18	0.72	0.11	85.61	74.23	1233.57	770.52
56	106.36	2.89	0.44	14.24	9.44	69.06	2.69	3047.66	1683.84	493.32	54.79	2.26	0.36	151.10	131.01	2571.25	1606.07
57	263.67	6.37	0.88	33.50	20.51	182.25	7.10	4123.82	2278.41	1063.37	118.11	10.75	1.70	327.63	284.08	6993.14	4368.11

TABLE III METAL PARAMETERS (Concentration in ug/l)						
METAL[1]	AQUATIC LIFE[1][3][4][J]		AGRICULTURE[2]	DRINKING WATER-SUPPLY[2]	WATER + FISH[7]	FISH INGESTION[10]
	ACUTE	CHRONIC				
Aluminum	750 (tot.rec.)	87 (tot.rec.)[11]			---	---
Antimony				6.0 (30-day)	5.6	640
Arsenic	340	150	100[A] (30-day)	0.02 – 10[13] (30-day)[14]	0.02	7.6
Barium				1,000[E](1-day) 490 (30-day)	---	---
Beryllium			100[A,B] (30-day)	4.0 (30-day)	---	---
Cadmium	(1.136672-[ln(hardness) x (0.041838)])x $e^{0.9151[\ln(hardness)]-3.1485}$ (Trout)=(1.136672-[ln(hardness)x (0.041838)])x $e^{0.9151[\ln(hardness)]-3.6236}$	(1.101672-[ln(hardness) x(0.041838)] x $e^{0.7998[\ln(hardness)]-4.4451}$	10[B] (30-day)	5.0[E] (1-day)	---	---
Chromium III[5]	$e^{(0.819[\ln(hardness)]+2.5736)}$	$e^{(0.819[\ln(hardness)]+0.5340)}$	100[B] (30-day)	50[E] (1-day)	---	---
Chromium VI[5]	16	11	100[B] (30-day)	50[E] (1-day)	100(30-day)	---
Copper	$e^{(0.9422[\ln(hardness)]-1.7408)}$	$e^{(0.8545[\ln(hardness)]-1.7428)}$	200[B]	1,000[F] (30-day)	1,300	---
Iron		1,000(tot.rec.)[A,C]		300(dis)[F] (30-day)	---	---
Lead	(1.46203-[(ln(hardness)* (0.145712)])*$e^{(1.273[\ln(hardness)]-1.46)}$	(1.46203-[(ln(hardness)* (0.145712)])*$e^{(1.273[\ln(hardness)]-4.705)}$	100[B] (30-day)	50[E] (1-day)	—	---
Manganese	$e^{(0.3331[\ln(hardness)]+6.4676)}$	$e^{(0.3331[\ln(hardness)]+5.8743)}$	200[B] (30-day)[12]	50(dis)[F] (30-day)	—	---
Mercury	1.4	0.77 FRV(fish)[6] = 0.01 (Total)		2.0[E] (1-day)	—	---
Nickel	$e^{(0.846[\ln(hardness)]+2.253)}$	$e^{(0.846[\ln(hardness)]+0.0554)}$	200[B] (30-day)	100[E] (30-day)	610	4,600

TABLE III METAL PARAMETERS (Concentration in ug/l)						
METAL[1]	AQUATIC LIFE[1][3][4][J]		AGRICULTURE[2]	DRINKING WATER-SUPPLY[2]	WATER + FISH[7]	FISH INGESTION[10]
	ACUTE	CHRONIC				
Selenium[9]	18.4	4.6	20[B,D] (30-day)	50[E] (30-day)	170	4,200
Silver	$\frac{1}{2}e^{(1.72[\ln(hardness)]-6.52)}$	$e^{(1.72[\ln(hardness)]-9.06)}$ (Trout) = $e^{(1.72[\ln(hardness)]-10.51)}$		100[F] (1-day)	—	---
Thallium		15[C]		0.5 (30-day)	0.24	0.47
Uranium	$e^{(1.1021[\ln(hardness)]+2.7088)}$	$e^{(1.1021[\ln(hardness)]+2.2382)}$		30	---	---
Zinc	$0.978\ e^{(0.8525[\ln(hardness)]+1.0617)}$	$0.986\ e^{(0.8525[\ln(hardness)]+0.9109)}$	2000[B] (30-day)	5,000[F] (30-day)	7,400	26,000
NOTE: Capital letters in parentheses refer to references listed in section 31.16(3); Numbers in parentheses refer to Table III footnote						

Table III – Footnotes

(1) Metals for aquatic life use are stated as dissolved unless otherwise specified.

Where the hardness-based equations in Table III are applied as table value water quality standards for individual water segments, those equations define the applicable numerical standards. As an aid to persons using this regulation, Table IV provides illustrative examples of approximate metals values associated with a range of hardness levels. This table is provided for informational purposes only.

(2) Metals for agricultural and domestic uses are stated as total recoverable unless otherwise specified.

(3) Hardness values to be used in equations are in mg/l as calcium carbonate and shall be no greater than 400 mg/l. For permit effluent limit calculations, the hardness values used in calculating the appropriate metal standard should be based on the lower 95 per cent confidence limit of the mean hardness value at the periodic low flow criteria as determined from a regression analysis of site-specific data. Where insufficient site-specific data exists to define the mean hardness value at the periodic low flow criteria, representative regional data shall be used to perform the regression analysis. Where a regression analysis is not possible, a site-specific method should be used, e.g., where hardness data exists without paired flow data, the mean of the hardness during the low flow season established in the permit shall be used. In calculating a hardness value, regression analyses should not be extrapolated past the point that data exist. For determination of standards attainment, where paired metal/hardness data is available, attainment will be determined for individual sampling events. Where paired data is not available, the mean hardness will be used.

(4) Both acute and chronic numbers adopted as stream standards are levels not to be exceeded more than once every three years on the average.

(5) Unless the stability of the chromium valence state in receiving waters can be clearly demonstrated, the standard for chromium should be in terms of chromium VI. In no case can the sum of the instream levels of Hexavalent and Trivalent Chromium exceed the water supply standard of 50ug/l total chromium in those waters classified for domestic water use.

(6) FRV means Final Residue Value and should be expressed as "Total" because many forms of mercury are readily converted to toxic forms under natural conditions. The FRV value of 0.01 ug/liter is the maximum allowed concentration of total mercury in the water that will present bioconcentration or bioaccumulation of methylmercury in edible fish tissue at the U.S. Food and Drug Administration's (FDA) action level of 1 ppm. The FDA action level is intended to protect the average consumer of commercial fish; it is not stratified for sensitive populations who may regularly eat fish.

A 1990 health risk assessment conducted by the Colorado Department of Public Health and Environment indicates that when sensitive subpopulations are considered, methylmercury levels, in sport-caught fish as much as one-fifth lower (0.2 ppm) than the FDA level may pose a health risk.

In waters supporting populations of fish or shellfish with a potential for human consumption, the Commission can adopt the FRV as the stream standard to be applied as a 30-day average. Alternatively, the Commission can adopt site-specific ambient based standards for mercury in accordance with section 31.7(1)(b)(ii) and (iii). When this option is selected by a proponent for a particular segment, information must be presented that (1) ambient water concentrations of total mercury are detectable and exceed the FRV, (2) that there are detectable levels of mercury in the

proponent's discharge and that are contributing to the ambient levels and (3) that concentrations of methylmercury in the fish exposed to these ambient levels do not exceed the maximum levels suggested in the CDH Health Advisory for sensitive populations of humans. Alternatively or in addition the proponent may submit information showing that human consumption of fish from the particular segment is not occurring at a level which poses a risk to the general population and/or sensitive populations.

(7) Applicable to all Class 1 aquatic life segments which also have a water supply classification or Class 2 aquatic life segments which also have a water supply classification designated by the Commission after rulemaking hearing. These Class 2 segments will generally be those where fish of a catchable size and which are normally consumed are present, and where there is evidence that fishing takes place on a recurring basis. The Commission may also consider additional evidence that may be relevant to a determination whether the conditions applicable to a particular segment are similar enough to the assumptions underlying the water plus fish ingestion criteria to warrant the adoption of water plus fish ingestion standards for the segment in question.

(8) The use of 0.1 micron pore size filtration for determining dissolved iron is allowed as an option in assessing compliance with the drinking water standard.

(9) Selenium is a bioaccumulative metal and subject to a range of toxicity values depending upon numerous site-specific variables.

(10) Applicable to the following segments which do not have a water supply classification: all Class 1 aquatic life segments or Class 2 aquatic life segments designated by the Commission after rulemaking hearing. These class 2 segments will generally be those where fish of a catchable size and which are normally consumed are present, and where there is evidence that fishing takes place on a recurring basis. The Commission may also consider additional evidence that may be relevant to a determination whether the conditions applicable to a particular segment are similar enough to the assumptions underlying the fish ingestion criteria to warrant the adoption of fish ingestion standards for the segment in question.

(11) Where the pH is equal to or greater than 7.0 and the hardness is equal to or greater than 50 ppm as $CaCO_3$ in the receiving water after mixing, the 87 µg/L chronic total recoverable aluminum criterion will not apply, and aluminum will be regulated based on compliance with the 750 µg/L acute total recoverable aluminum criterion.

(12) This standard is only appropriate where irrigation water is applied to soils with pH values lower than 6.0.

(13) Whenever a range of standards is listed and referenced to this footnote, the first number in the range is a strictly health-based value, based on the Commission's established methodology for human health-based standards. The second number in the range is a maximum contaminant level, established under the federal Safe Drinking Water Act that has been determined to be an acceptable level of this chemical in public water supplies, taking treatability and laboratory detection limits into account. Control requirements, such as discharge permit effluent limitations, shall be established using the first number in the range as the ambient water quality target, provided that no effluent limitation shall require an "end-of-pipe" discharge level more restrictive than the second number in the range. Water bodies will be considered in attainment of this standard, and not included on the Section 303(d) List, so long as the existing ambient quality does not exceed the second number in the range.

(14) Applies at the point of water supply intake.