Upper Slate River

RESTORATION OF ABANDONED MINE SITES PROJECT

FINAL REPORT

Prepared by

U.S. Army Corps of Engineers

Omaha District

Omaha, Nebraska

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1 Introduction

The U.S. Army Corps of Engineers (USACE) has been provided authority for Restoration of Abandoned Mine Sites (RAMS) by Section 560 of the 1999 Water Resource Development Act. The RAMS program is a regionally focused and stakeholder responsive program for the restoration of abandoned and inactive non-coal mines where water resources (ecosystem/habitat) have been degraded by past mining practices. This authority is intended to allow the USACE to provide support to agencies that manage lands impacted by past mining. The USACE coordinated in advance to obtain stakeholder buy-in on all work proposed to be performed by Corps Districts to ensure that the proposed work is supportive of the stakeholders' efforts in the area.

The USACE Omaha District is working in coordination with the U.S. Forest Service (USFS), the Bureau of Land Management (BLM), and the Colorado Division of Minerals and Geology (CDMG) on the Upper Slate River RAMS project. The USFS, BLM, and CDMG identified the data needs for the upper Slate River and Washing Gulch that supply the Slate River above Crested Butte, Colorado. The USACE obtained the necessary right-of-entry (ROE) to the identified locations. USACE Omaha District personnel performed the fieldwork from August 6 through 9 and August 21, 2002.

The purpose of this report is to submit documentation of the field activities and analytical results obtained from this fieldwork to the USFS, BLM, and CDMG in the form of a data summary report. This report includes the methods and procedures used for collecting surface water quality samples, stream flow measurements and calculations, field measurements, analytical results, and the data quality evaluation. The scope of work for this project did not require interpretation of these results or preparation of conclusions or recommendations regarding future actions for the site. The data is being provided to the stakeholders for their interpretation.

2 Project Information

2.1 Site Description

The investigation area is the upper Slate River located in Gunnison County, Colorado. The investigation area is north of Crested Butte in the Slate River watershed both upstream and downstream of abandoned silver mines. The area is largely undeveloped mountainous terrain used extensively for outdoor recreation and moderately for residences and livestock grazing. Much of the area investigated is on U.S. Bureau of Land Management or Gunnison National Forest property, although some private landowners allowed access to the field team to perform the investigation.

Known former mines in the area include Daisy Mine in Redwell Basin, Smith Hill Mine and Peanut Mine in Slate River Valley, Pittsburg Mine near Pittsburg, Agusta Mine in Poverty Gulch, and Painter Box Mine in Washington Gulch. Evidence of former mining activity is everywhere. Cables, pieces of machinery, large concrete blocks, and large piles of broken rock mine tailings are present on the land surface. Most of the roads used for access to the sample locations are former mine roads built on top of rock tailings from the mines.

During the summer of 2002 the region was experiencing extreme drought, lowering water levels and flow in all creeks and rivers in the Slate River area.

2.2 Project Goals

The goal of the investigation is to collect data from the Slate River and tributaries in northern Gunnison County, Colorado, as part of Restoration of Abandoned Mines Sites investigations to identify and remedy contamination in surface water related to silver mining in the area. Data collected will be added to a database maintained by the U.S. Forestry Service.

3 Field Investigation

3.1 Field Investigation Activities

Seventeen locations from the 20 proposed in the Site Specific Addendum (SSA) to the Final RAMS Work Plan (USACE, July 2002) were sampled. Coordinates for the sampling locations are provided in table 1. SW02 and SW03 are located on land administered by the Bureau of Land Management. SW07 is located on privately owned property for which USACE obtained permission to sample. SW04 through SW16 except SW07 are located on Gunnison National Forest. SW19 and SW20 are located on the County Road 317 (Gothic Road) right-of-way. Sampling location latitude, longitude, and altitude were obtained from a hand-held Garmin e-Trex Global Positioning Satellite (GPS) device and recorded in the field logbook. The coordinate system used is the 1984 World Geodetic System. The GPS has an approximate accuracy of plus-or-minus 20 feet, though could be as much as 90 feet. Sampling locations are also shown on figure 1. Some sample locations are only a few hundred feet apart, and overlap on the figure.

The sampling locations are upstream and downstream from potential contamination sources and spatially distributed throughout the upper Slate River and Washington Gulch watersheds. At each sample location water quality was checked, water samples were collected for laboratory analysis, and stream flow rate was measured.

Table 1 Slate River surface water sample locations

Sample location		Coordinates (WGS 84)	Altitude (above mean sea level)
SW02	Oh-Be-Joyful Creek downstream of Wolverine Creek	N38° 54' 37.5" W107° 01' 56.0"	8930 ft
SW03	Wolverine Creek above Oh-Be-Joyful Creek	N38° 54' 22.6" W107° 03' 00.9"	9442 ft
SW04	Redwell Basin above Oh-Be-Joyful Creek	N38° 54' 22.6" W107° 03' 00.9"	9442 ft
SW05	Unnamed tributary west of Redwell Basin	N38° 54' 22.7" W107° 03' 17.5"	9480 ft
SW06	Oh-Be-Joyful Creek upstream of unnamed tributary	N38° 54' 22.8" W107° 03' 17.5"	9476 ft
SW07	Slate River below Poverty Gulch	N38° 56' 40.3" W107° 03' 38.0"	9253 ft
SW08	Poverty Gulch above Slate River	N38° 57' 06.0" W107° 04' 04.9"	9357 ft

SW09	Baxter Basin above Poverty Gulch	N38° 57' 27.1" W107° 05' 06.9"	9615 ft
SW10	Poverty Gulch below Cascade Mountain	N38° 57' 33.1" W107° 05' 13.5"	9675 ft
SW11	Unnamed tributary west of Baxter Basin above Poverty Gulch	N38° 57' 44.6" W107° 05' 21.6"	9837 ft
SW12	Poverty Gulch above unnamed tributary west of Baxter Basin	N38° 57' 44.8" W107° 05' 19.5"	9938 ft
SW13	Poverty Gulch above last road crossing	N38° 58' 01.7" W107° 05' 21.1"	10,217 ft
SW14	Slate River above Poverty Gulch	N38° 57' 29.2" W107° 03' 44.5"	9458 ft
SW15	Slate River about 1.5 miles above Poverty Gulch Rd	N38° 58' 20.5" W107° 03' 56.0"	9684 ft
SW16	Washington Gulch Below mining	N38° 57' 01.3" W107° 01' 47.6"	10,003 ft
SW19	Coal Creek above Slate River	N38° 52' 37.7" W106° 58' 37.9"	8903 ft
SW20	Slate River above Coal Creek	N38° 52' 38.6" W106° 58' 38.3"	8918 ft

3.2 Surface Water Samples

Water parameters were measured in the field with a Horiba U-10 water quality checker at each sample location. The U-10 is a hand-held type water quality checker that measures acidity, conductivity, turbidity, dissolved oxygen, temperature, and salinity levels simply by immersing the analysis device directly in water. These measurements cannot be duplicated in a laboratory because the water conditions change after the sample is collected.

Stream water was collected by dipping a disposable plastic cup into the stream and pouring water into a sample bottle. A total of 17 surface water samples plus one Quality Control (QC) sample were collected at the locations identified in table 1. The QC sample consisted of a second sample identical to the primary sample and was collected at sampling location SW13 Poverty Gulch above last road crossing.

A sample consisted of three 500-milliliter bottles. One was used to measure alkalinity and sulfate and chloride concentrations, another for total metals, and the third for dissolved metals. The only difference between the total metals and dissolved metals analysis is sample preservation. The total metals samples were collected in bottles that contained about six drops of concentrated laboratory-grade nitric acid, to prevent changes in water chemistry between the time of collection and the time of analysis. The dissolved metals samples were collected into empty bottles and sent to the laboratory, where they were filtered with a 0.45 micron filter to remove suspended solids then preserved with nitric acid, two or three days after sample collection.

3.3 Stream Flow Rate Equipment and Procedures

Flow rates were measured at each sampling location using an FP201 Global Flow Probe hand-held flow meter. This flow meter has a 2-inch propeller sensor that rotates freely on a bearing shaft with no mechanical interconnections. Magnetic material in the propeller passes a pickup coil in the housing, producing electrical impulses. The electrical impulses are then carried by wire to a readout display located on top of the handle, which amplifies and converts the signal into velocity readings measured in feet per second. The range of the flow meter is 0 to 25 feet per second, with accuracies of plus-or-minus 0.01 feet per second for average and maximum velocity.

A cross section of the stream channel at the sample location was drawn on paper, and conceptually divided into three or four sections depending on the width and pattern of the streambed. The flow rate, width, and height were measured for each section. Flow rates were measured by holding the probe in the center of each section and moving up and down vertically for one minute. The shape of the stream and average and maximum flow velocities for each sampling location were recorded on a diagram.

The channel area in square feet (ft^2), the discharge rate in cubic feet per second (ft^3/s), and discharge rate if gallons per minute (gpm) are provided in table 3. Channel area is the sum of the cross-sectional area of each segment, and discharge rate is the product of the channel area and the average flow rate measured. Flow was not observed at locations SW19 and SW20 and no flow is calculated.

Table 2 Flow Rates

Location	Channel area (ft^2)	Discharge rate (ft^3/s)	Discharge rate (gpm)
SW02 Oh-Be-Joyful Creek below Wolverine Creek	14.58	2.38	1,069
SW03 Wolverine Creek above Oh-Be-Joyful Creek	10.50	3.22	1,445
SW04 Redwell Basin above Oh-Be-Joyful Creek	2.18	2.10	942
SW05 Unnamed tributary west of Redwell Basin	4.45	2.97	1,333
SW06 Oh-Be-Joyful Creek above unnamed tributary	63.08	36.80	16,516
SW07 Slate River below Poverty Gulch	5.08	11.12	4,989
SW08 Poverty Gulch above Slate River	6.00	19.68	8,833
SW09 Baxter Basin above Poverty Gulch	2.04	2.90	1,301
SW10 Poverty Gulch below Cascade Mountain	9.41	20.60	9,248
SW11 Unnamed tributary west of Baxter above Poverty Gulch	1.70	2.54	1,139
SW12 Poverty Gulch above unnamed tributary west of Baxter	1.25	3.27	1,468
SW13 Poverty Gulch above last road crossing	1.80	2.87	1,287
SW14 Slate River Road 0.2 miles above Poverty Gulch	6.08	8.25	3,704
SW15 Slate River about 1.5 miles above Poverty Gulch	3.67	4.20	1,887
SW16 Washington Gulch below mining	0.58	1.36	610

4 Sample Results

4.1 Data Quality Objectives

The data quality objectives are those in the General Work Plan (USACE, 2002). The analytical results provide information about presence and extent of mine-related contamination. The criteria in order to attain these goals are given in the General Work Plan, 2002 and this section. Method detection limit (MDL), method reporting limit (MRL), and Quality Control (QC) criteria that will meet the data objectives for metals are given in table 6-6 of the General Work Plan. The MDL, MRL, and QC criteria for sulfate, alkalinity, and chloride are given in table 6-7 of the General Work Plan.

4.2 Field Measurements

Field measurement data was collected with a Horiba U-10 portable water quality checker at each sample location. Five parameters were checked and observations are recorded in table 3. Acidity is the concentration of hydrogen ion in the water and is measured in pH. Conductivity is a measure of the amount of dissolved minerals in the water capable of conducting electrical current, measured in milliSiemens per second (mS/s). The amount of particles, silt, and suspended matter in the water is turbidity, measured in nephelometric turbidity units (NTU). Dissolved oxygen is measured in milligrams of oxygen per liter of water (mg/L). The water's temperature was recorded in degrees Celsius (°C). The measurements were collected by immersing the U-10's probe in a pooled or slow-flowing part of the stream and recording observations from its display in the field log book. The U-10 was calibrated at least twice daily, and before checking stream water at most sample locations.

Table 3 Field Measurements

Sample location		pH	Conductivity (mS/s)	Turbidity (NTU)	Dissolved oxygen (mg/L)	Temperature (°C)
SW02	Oh-Be-Joyful Creek downstream of Wolverine Creek	4.55	0.201	0.88	9.58	14.5
SW03	Wolverine Creek above Oh-Be-Joyful Creek	5	0.160	5	10.68	10.5
SW04	Redwell Basin above Oh-Be-Joyful Creek	4.11	1.24	5	9.16	11.5
SW05	Unnamed tributary west of Redwell Basin	7.84	0.107	10	10.15	10.9
SW06	Oh-Be-Joyful Creek upstream of unnamed tributary	7.98	0.085	6	10.38	13.0
SW07	Slate River below Poverty Gulch	3.78	0.126	6	10.52	10.9
SW08	Poverty Gulch above Slate River	3.58	0.106	10	10.10	12.4
SW09	Baxter Basin above Poverty Gulch	7.98	0.099	5	10.26	12.1

Sample location		pH	Conductivity (mS/s)	Turbidity (NTU)	Dissolved oxygen (mg/L)	Temperature (°C)
SW10	Poverty Gulch below Cascade Mountain	8.07	0.142	6	10.28	12.7
SW11	Unnamed tributary west of Baxter Basin above Poverty Gulch	7.99	0.249	6	9.91	11.6
SW12	Poverty Gulch above unnamed tributary west of Baxter Basin	7.72	0.73	6	10.74	12.0
SW13	Poverty Gulch above last road crossing	7.84	0.073	5	10.45	10.8
SW14	Slate River above Poverty Gulch	3.99	0.212	5	9.84	13.9
SW15	Slate River about 1.5 miles above Poverty Gulch Rd	5.20	0.306	10	11.87	14.4
SW16	Washington Gulch Below Mining	6	0.244	4	9.60	13.2
SW19	Coal Creek above Slate River	6.60	0.352	1	7.99	14.6
SW20	Slate River above Coal Creek	6.76	0.143	2	7.25	16.7

4.3 Analytical Results

ECB Laboratory in Omaha, Nebraska, analyzed water samples for chemical concentration of metal and anions that could be found both naturally and as contamination from mine wastes. Table 4 identifies the methods ECB Laboratory used for each chemical.

Table 4 Chemical analyses and methods

Target Constituent	Analytical Method
Metals	
Antimony	EPA SW-846 6010B Inductively Coupled Plasma - Trace
Arsenic	EPA SW-846 6010B Inductively Coupled Plasma – Trace
Cadmium	EPA SW-846 6010B Inductively Coupled Plasma – Trace
Chromium	EPA SW-846 6010B Inductively Coupled Plasma – Trace
Copper	EPA SW-846 6010B Inductively Coupled Plasma – Trace
Iron	EPA SW-846 6010B Inductively Coupled Plasma – Trace
Lead	EPA SW-846 6010B Inductively Coupled Plasma – Trace
Manganese	EPA SW-846 6010B Inductively Coupled Plasma – Trace
Mercury	EPA SW-846 7470 Cold Vapor Atomic Absorption
Nickel	EPA SW-846 6010B Inductively Coupled Plasma – Trace
Selenium	EPA SW-846 6010B Inductively Coupled Plasma – Trace
Silver	EPA SW-846 6010B Inductively Coupled Plasma – Trace

Target Constituent	Analytical Method
Zinc	EPA SW-846 6010B Inductively Coupled Plasma – Trace
Chloride	EPA M325.2 Colorimetry
Sulfate	EPA M375.3 Colorimetry
Alkalinity	EPA M310.2 Titrimetry

Results from the laboratory analysis are in table 5. The sample numbers contain the sample location number for reference. For example, "CO-USR-SW-02" is the sample number for the bottles filled at location SW02 Oh-Be-Joyful Creek downstream of Wolverine Creek.

The results are expressed in concentration units of either micrograms of chemical per liter of water (ug/L) for total and dissolved metals or milligrams of chemical per liter of water (mg/L) for chloride, sulfate, and alkalinity. Every analysis has a result listed, although some chemicals were not detected. The non-detected results are indicated in table 5 with a less than symbol (<) and the method detection limit. Some laboratory results are qualified with a "J". The J indicates the chemical is definitely identified but its concentration is considered estimated. Some laboratory results are qualified with a "B". The B indicates some of the chemical measured in the sample may be the result of contamination during sample collection, transportation, laboratory preparation, or laboratory analysis. Some laboratory results contain both a J and a B, indicating the value is both estimated and the sample may have been contaminated after it was collected. The Chemical Data Quality Assessment Report is attached to this report and contains more information about data qualifiers.

Table 5 Laboratory Measurements

	Aluminum	Arsenic	Cadmium	Calcium	Chromium	Copper	Iron	Lead	Magnesium	Manganese	Potassium	Silver	Zinc	Sulfate	Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Chloride
	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L
CO-USR-SW-02	33	< 3	1.7 J	13700	< 2	3.7J	< 40	10.7 J	1170	21.5	416	< 1	181	10 J	45	45	<7	<1
CO-USR-SW-02 (dissolved)	< 30	< 3	1.5 J	13600	< 2	3.3 J	< 40	7.6 J	1160	22.8	403	< 1	175					
CO-USR-SW-03	< 30	< 3	0.54 J	14300	< 2	130	< 40	< 2	1980	< 1	558	< 1	151	29	38	38	< 7	< 1
CO-USR-SW-03 (dissolved)	< 30	< 3	0.53 J	14300	< 2	< 2	< 40	< 2	1980	< 1	558	< 1	149					
CO-USR-SW-04	1550	< 3	36.3	7440	< 2	113	< 40	580	1760	1030	682	< 1	4600	42	<7	<7	<7	< 1
CO-USR-SW-04 (dissolved)	1550	< 3	36.1	7430	< 2	113	< 40	578	1770	1030	681	< 1	4580					
CO-USR-SW-05	< 30	< 3	< .5	17200	< 2	< 2	44	< 2	1340	1.3 J	391	< 1	5.3 JB	10 J	47	47	< 7	< 1
CO-USR-SW-05 (dissolved)	< 30	< 3	< .5	17500	< 2	< 2	44	< 2	1360	3.1 J	393	< 1	6.3 JB					
CO-USR-SW-06	< 30	< 3	< .5	14300	< 2	< 2	152	< 2	1120	10.7	366	< 1	< 3	8 J	39	39	<7	<1
CO-USR-SW-06 (dissolved)	< 30	< 3	< .5	14400	< 2	< 2	128	< 2	1120	9.67	368	< 1	< 3					
CO-USR-SW-07	< 30	< 3	< .5	20500	< 2	< 2	< 40	< 2	1410	1 J	423	< 1	21.9	28	43	43	< 7	< 1
CO-USR-SW-07 (dissolved)	< 30	< 3	< .5	20500	< 2	< 2	< 40	< 2	1410	1 J	417	< 1	7.8 J					
CO-USR-SW-08	< 30	< 3	< .5	16900	< 2	< 2	78 J	< 2	1220	5.08	342	< 1	9.7 J	27	39	39	< 7	< 1
CO-USR-SW-08 (dissolved)	< 30	< 3	< .5	16900	< 2	< 2	60 J	< 2	1210	4.4 J	341	< 1	7.9 J					

	Aluminum	Arsenic	Cadmium	Calcium	Chromium	Copper	Iron	Lead	Magnesium	Manganese	Potassium	Silver	Zinc	Sulfate	Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Chloride
	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L
CO-USR-SW-09	< 30	< 3	< .5	17000	< 2	< 2	40	< 2	1310	2.4 J	371	< 1	21 B	20 J	43	43	<7	<1
CO-USR-SW-09 (dissolved)	< 30	< 3	< .5	16900	< 2	< 2	55	< 2	1300	3.7 J	381	< 1	14.5 B					
CO-USR-SW-10	< 30	< 3	< .5	23300	< 2	< 2	< 40	< 2	1540	< 1	270 J	< 1	18.7	40	40	40	< 7	< 1
CO-USR-SW-10 (dissolved)	< 30	< 3	< .5	23200	< 2	< 2	< 40	< 2	1530	< 1	240 J	< 1	8.6					
CO-USR-SW-11	< 30	4.7 J	< .5	41200	< 2	< 2	< 40	< 2	3050	1.4 J	337	< 1	22	76	55	55	< 7	< 1
CO-USR-SW-11 (dissolved)	< 30	5.2 J	< .5	41500	< 2	< 2	< 40	< 2	3070	1.2 J	337	< 1	21.8					
CO-USR-SW-12	< 30	< 3	< .5	12100	< 2	< 2	47 J	< 2	609	< 1	180 J	< 1	11	20 J	28	28	< 7	< 1
CO-USR-SW-12 (dissolved)	< 30	< 3	< .5	12000	< 2	< 2	197	< 2	608	1.5	180 J	< 1	< 3					
CO-USR-SW-13	< 30	< 3	< .5	12200	< 2	< 2	< 40	< 2	614	< 1	180 J	< 1	< 3	20 J	40	40	< 7	< 1
CO-USR-SW-13 (dissolved)	< 30	< 3	< .5	12100	< 2	< 2	< 40	< 2	613	< 1	180 J	< 1	< 3					
CO-USR-SW-13-02	< 30	< 3	< .5	12000	< 2	< 2	< 40	< 2	604	< 1	170 J	< 1	< 3	20 J	26	26	< 7	< 1
CO-USR-SW-13-02 (dissolved)	< 30	< 3	< .5	12000	< 2	< 2	< 40	< 2	600	< 1	200 J	< 1	< 3					
CO-USR-SW-14	< 30	< 3	< .5	36800	< 2	< 2	< 40	< 2	2260	< 1	728	< 1	3.6 J	52	60	60	< 7	< 1
CO-USR-SW-14 (dissolved)	< 30	< 3	< .5	37200	< 2	< 2	< 40	< 2	2280	< 1	734	< 1	< 3					
CO-USR-SW-15	< 30	< 3	< .5	38500	< 2	< 2	< 40	< 2	1560	< 1	779	< 1	< 3	50	67	67	<7	<1
CO-USR-SW-15 (dissolved)	< 30	< 3	< .5	37700	< 2	< 2	< 40	< 2	1530	< 1	769	< 1	< 3					

	Aluminum	Arsenic	Cadmium	Calcium	Chromium	Copper	Iron	Lead	Magnesium	Manganese	Potassium	Silver	Zinc	Sulfate	Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Chloride
	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L
CO-USR-SW-16	31 J	< 3	< .5	33700	< 2	< 2	443	< 2	9160	18.1	726	< 1	12.6	20 J	130	130	< 7	< 1
CO-USR-SW-16 (dissolved)	< 30	< 3	< .5	33800	< 2	< 2	97	< 2	9330	3.9	702	< 1	3.2					
CO-USR-SW19-01	< 30	< 3	1 J	51100	< 2	< 2	161	< 2	5430	344	1620	< 1	130	110	86	86	< 7	3 J
CO-USR-SW19-01 (dissolved)	< 30	< 3	0.88 J	50700	< 2	< 2	< 40	< 2	5420	310	1620	< 1	153					
CO-USR-SW20-01	< 30	< 3	< .5	23700	< 2	< 2	150	2.1 J	2850	37	861	< 1	28.9	32	56	56	< 7	1 J
CO-USR-SW20-01 (dissolved)	< 30	< 3	< .5	23900	< 2	< 2	44	2.1 J	2860	34.2	856	< 1	35.9					

5 Quality Control Review

Quality control review consists of an evaluation of the field procedures and analytical procedures and a review of the data to ensure appropriate QC compliance were met.

5.1 Field Quality Control

The USACE project team for completeness reviewed all field documents including logbooks. A review of the placement or coordinates of the sample was performed to ensure that this correlates to sample nomenclature. Placement and frequency of the quality control samples were reviewed to ensure compliance to set criteria. Location coordinates, flow rate measurements, cross-sectional area calculations, and discharge calculations were reviewed for completeness and accuracy by the project technical team.

5.2 Laboratory Quality Control

The analytical program for this project conformed to the general Restoration of Abandoned Mines Sites Work Plan prepared by the U.S. Army Corps of Engineers, July 2002 and the Upper Slate River Site Specific Addendum to the Work Plan, 30 July 2002. ECB Laboratory performed sample analyses in accordance with the procedures prescribed in the general Work Plan using definitive quality control and quality assurance procedures.
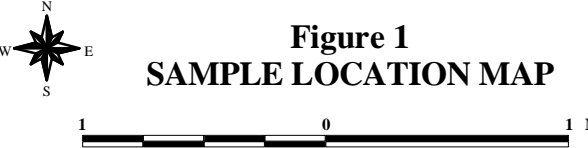
5.3 Data Evaluation

The reviewed data are usable and are suitable for addressing the overall objective of this investigation. The detailed Chemical Data Quality Assessment Report (CDQAR) identifies the procedures used to ensure definitive quality data was obtained from the water samples. The CDQAR is attached to this report.

6 Summary

Samples of water were collected from the Slate River and its tributaries in August 2002 and analyzed for chemical concentrations of several metals as part of on-going investigations into effects from former mining operations in the area. Samples were collected from seventeen discreet locations on the Slate River, Oh-Be-Joyful Creek, Poverty Gulch, Wolverine Creek, Washington Gulch, and unnamed streams in northern Gunnison County, Colorado. Stream flow rates were also measured, and water quality checks performed. Results are included in this report.
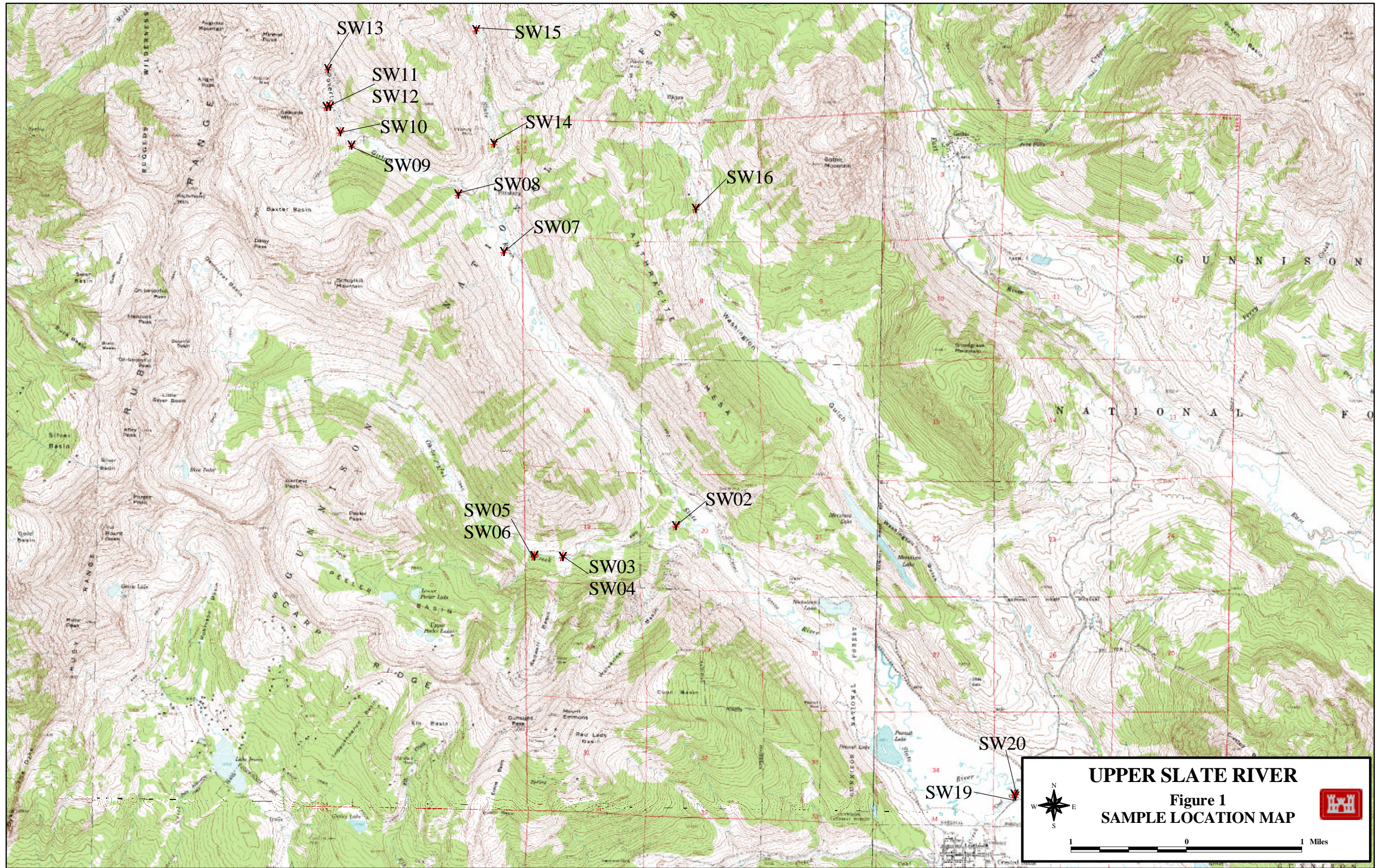
UPPER SLATE RIVER
Figure 1
SAMPLE LOCATION MAP
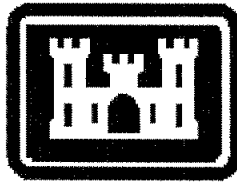
Attachment

Upper Slate River

RESTORATION OF ABANDONED MINE SITES PROJECT

CHEMICAL DATA QUALITY ASSESSMENT REPORT

Prepared by
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Omaha, Nebraska

November 2002

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LIST OF APPENDICES

A   Data Tables of validated data from the surface water samples

ABBREVIATIONS

ADP	Analytical Data Package
ASTM	American Standard Testing Materials
° C	Degrees Celsius
CDQAR	Chemical Data Quality Assessment Report
USACE	Corps of Engineers, Omaha District
COC	Chain-of-Custody
DQCR	Daily Quality Control Report
DQOs	Data Quality Objectives
DUP	Duplicate
ECB	Environmental Chemistry Branch
eV	Electron volt
EPA	Environmental Protection Agency
FSP	Field Sampling Plan
ft	Foot/Feet
HSA	Hollow Stem Auger
I.D.	Inner Diameter
IDW	Investigative Derived Waste
Kg	Kilogram
L	Liter
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LIMS	Laboratory Information Management System
MDL	Method Detection Limit
mg/kg	Milligrams per kilogram
mg/L	Milligrams per Liter
mg	Milligram
Min	Minute
ml	Milliliters
MS/MSD	Matrix Spike/Matrix Spike Duplicate

MSL	Mean Sea Level
MW	Monitoring Well
N/A	Not Applicable
ND	non-detect
ppb	Parts per Billion (measured in water as ug/L)
PQL	Practical Quantitation Limit
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RL	Reporting Limit
RPD	Relative Percent Difference
SSHP	Site Safety Health Plan
SOP	Standard Operating Procedure
μg/L	Micrograms per Liter
U.S.	United States
USACE	United States Army Corps of Engineers

1 INTRODUCTION

1.1 QUALITY CONTROL SUMMARY

This Chemical Data Quality Assessment Report (CDQAR) describes the operations and procedures to evaluate the usability of surface water sample data obtained from the Upper Slate River and Washington Gulch, Colorado. Fieldwork was performed by Omaha District U.S. Army Corps of Engineers (USACE) personnel. Analytical services were provided by a US Army Corps of Engineers laboratory, the Environmental Chemistry Branch (ECB) Laboratory located in Omaha, Nebraska.

The field and sample analyses were performed in accordance with the general Site Work Plan for the Restoration of Abandoned Mines prepared by Omaha District USACE, July 2002 and the Site-Specific Addendum to Restoration of Abandoned Mines Site Work Plan, Upper Slate River, 30 July, 2002.

This CDQAR includes a summary of the quality assurance (QA) and quality control (QC) procedures and an evaluation of data quality and data usability with respect to Data Quality Objectives (DQOs) established for this field investigation.

1.2 REPORT ORGANIZATION

Section 2 of this report provides a discussion of project objectives. Procedures used to control and evaluate the sample collection, transportation, storage, and analysis quality are presented in Section 3. Section 4 discusses data evaluation, and the results of QC evaluations are in Section 5. Conclusions and recommendations are presented in Section 6.

2   PROJECT DESCRIPTION

2.1   PROJECT PURPOSE

The purpose of this investigation is to sample surface water from the upper Slate River and tributaries, Colorado to determine the presence of mine wastes in surface water.

2.2   ANALYTICAL SERVICES

The ECB Laboratory provided the analytical services for this project. The ECB Lab provided analytical services for total and dissolved metals, sulfate, alkalinity, and chloride. Field measurements of pH, specific conductance, temperature, dissolved oxygen, and turbidity were obtained with a Horiba U-10 water quality probe. Laboratory address is given below:

US Army Corps of Engineers
Environmental Chemistry Branch Laboratory
420 South 18th Street
Omaha, NE 68102-2501

2.3   DATA QUALITY OBJECTIVES

The DQOs for this site are based on the objective of the investigation, which is to collect surface water data to assess effect of former mine operations at this area.

2.3.1   Data Collected

The data collected at the Upper Slate River site were from samples obtained from surface water in the Slate River, Wolverine Creek, Oh-Be-Joyful Creek, Poverty Gulch, Washington Gulch, Redwell Basin, Baxter Basin, and Coal Creek in northern Gunnison County, CO. The data collected included both field measurements (field screening data) and off-site analysis of samples (definitive data).

2.3.1.1   Field Measurements (Field Screening Data)

A Horiba U-10 was used to measure water quality parameters in the field. The Horiba U-10 measured pH, specific conductance, temperature, dissolved oxygen, and turbidity. A flow meter was used to record flow rates. Measurements were recorded in the field logbook.

2.3.1.2   Off-Site Analysis (Definitive Level Data)

Definitive level data was obtained from twenty (17) surface water samples. All of these samples were analyzed for total and dissolved metals, alkalinity, chloride, and sulfate.

3   FIELD QUALITY CONTROL PROCEDURES

3.1   PROJECT PLANNING

The field investigation was conducted as described in the Site Specific Addendum to the Restoration of Abandoned Mines Sites Work Plan for Upper Slate River, July 2002. The plan was written by USACE to ensure the quality of data derived from the investigation. The plan provides a discussion of the project work scope and procedures to be followed for field activities. Work planning for laboratory activities and Data Quality Objectives are documented in the Restoration of Abandoned Mines Sites Work Plan Quality Assurance Project Plan written by USACE, June 2002.

3.2   DOCUMENTED FIELD ACTIVITIES

This section summarizes the equipment, procedures, and methods undertaken to insure quality sample collection activities. Investigation activities and QC procedures were recorded and documented in the field using appropriate field forms. Field equipment was decontaminated before sample collection as well as between sample locations.

3.2.1   Surface Water Samples

A total sixteen surface water samples were obtained by USACE personnel on August 6, 7, 8, and 21, 2002.

3.2.2   Management of Investigation Derived Waste (IDW)

Disposable sampling equipment was disposed in municipal dumpsters. Decontamination consisted of distilled water rinsing. IDW water was disposed at sampling locations.

3.2.3   Decontamination Procedures

The field instruments were decontaminated in the field by distilled water rinsing.

3.2.4   Other Documentation and Reporting of Field Activities

All field activities were thoroughly documented in indelible ink using the following forms:

- Field Notebook
- Chain of Custody Record
- Daily Quality Control Report (DQCR)

USACE field personnel initiated Chain of Custody (COC) documentation as samples were collected and selected for laboratory analysis. Sample custody was maintained from sample collection through the completion of the laboratory analysis.

3.2.5   Sample Labeling, Handling, and Shipping

The sampling team performed sample collection, sample labeling, and sample shipping. Samples were collected in the appropriate sample containers provided by ECB Lab. The

sample containers were identified with waterproof labels and all writing was completed in indelible ink.

Labeled samples were placed in sealed closeable freezer bags and packed in plastic ice chests with sufficient packaging material placed around and between the sample jars. Ice was double bagged and placed on the bottom of the cooler, and around the sample containers, and on top of the sample containers to achieve and maintain preservation at 4° C from the time of collection until receipt by the laboratory. Sample containers, preservatives, and holding times used for this project are shown in Table 3-1.

Every cooler contained a COC form that identified all of the sample containers, analytical requirements, time and date sampled, preservatives, and other pertinent field data. Samples were shipped overnight by FedEx to ECB Laboratory the day after collection. Upon receipt in the laboratory, the Sample Custodian opened the shipping containers, compared the contents with the COC record, ensured that the document control information was accurate and complete, and dated the form. A Sample Receipt Form was used by the laboratory to log in samples and document their condition at arrival. These forms are provided in the Analytical Data Packages.

3.3 FIELD QUALITY CONTROL SAMPLES

Duplicate samples were analyzed at the rate of one every analytical batch. The results of the field QC samples and their impact on data quality are discussed in Section 4.0.

Table 3-1 Sample Containers, Preservation, and Holding Times for Surface Water Samples

Parameter	Container	Preservation	Maximum Holding Times:	
			Extraction	Analysis
Total Metals	1 - 500 ml plastic	HNO3 to pH<2 Ice to 4° C	6 months (Hg-28 days)	6 months (Hg-28 days)
Dissolved Metals	1 - 500 ml plastic	Ice to 4° C*	6 months (Hg-28 days)	6 months (Hg-28 days)
Alkalinity Chloride Sulfate	1- 500 ml plastic	Ice to 4° C		14 days 28 days 28 days

* Acid preserved by after filtration through 0.45 micron filter by ECB Lab

4   EVALUATION OF DATA QUALITY

The laboratory analytical data was reviewed and verified by ECB Laboratory and then evaluated by the USACE project chemist for compliance with project objectives.

The following section is a description of the laboratory review procedures used to ensure data quality and the project chemists' assessment of project deliverables. Data usability was determined by comparing the project DQOs against the quality of the final analytical results.

4.1   LABORATORY QUALITY CONTROL SAMPLES

This section provides a description of laboratory QC samples: laboratory control samples, method blanks, and matrix spike/matrix spike duplicate.

4.1.1   Laboratory Control Samples (LCS)

The laboratory analyzed a spike blank sample in duplicate to evaluate the precision and accuracy within an analytical batch. The nomenclature for these samples is a laboratory control sample (LCS). LCS sample pairs consisted of analyte-free water that was spiked with selected target compounds. LCS results are included in the QC section of each laboratory's data package, which are included in the Analytical Data Packages.

4.1.2   Method Blank Analyses

A laboratory method blank is a contaminant free matrix sample (e.g. a method blank is often a volume of distilled water carried through the entire analytical scheme) that is subjected to the same analytical procedures as the field samples. The method blank is used in all analyses to verify that the determined concentrations do not reflect contamination. One method blank is performed with every batch of samples (approximately 20 samples). If consistent high blank values are observed, laboratory glassware and reagents are checked for contamination and the analysis is halted until the system is brought under control.

4.1.3   Surrogate Spike Analyses

An organic surrogate compounds is spiked into all investigative samples for organic analyses. The surrogate is compared to QC limits to evaluate the matrix effect of each sample and monitor the overall system performance. Low surrogate recoveries are indicative of problems in instrument performance, extraction procedures, or severe matrix effects. Samples which have a surrogate recovery above the laboratory control limits typically do not demonstrate performance problems unless the recoveries are high enough to indicate double spiking of surrogate compounds or extremely low internal standard recoveries.

4.1.4   Matrix Spike/Matrix Spike Duplicate (MS/MSD)

The laboratory analyzed a spiked environmental sample and duplicate to evaluate the precision and accuracy within an analytical batch. The MS is used to assess the performance of the method as applied to a particular project matrix. A MS is an environmental sample in which known concentrations of certain target analytes have been added before sample manipulation from the preparation, cleanup, and determinative procedures have been implemented. The results of the MS are evaluated in conjunction with other QC information to determine the effect of the matrix

on the bias of the analysis.

4.2   LABORATORY DATA VALIDATION ACTIVITIES

All analytical data generated by ECB Lab was checked for completeness and evaluated for overall quality prior to final report generation as outlined in the QAPP and specified in the laboratory's Standard Operating Procedures (SOPs). This process consisted of data generation and reduction plus three levels of documented review. Each step of the review process involved evaluation of data quality based on QC data results and the professional judgment of the reviewers. All reviews were documented by the reviewer's signature and the date reviewed.

The first level review was performed by the analyst who generated the raw analytical data. Primary emphasis of the review was on correctness and completeness of the data set. All data were generated and reduced following method-specific laboratory SOPs. Each analyst reviewed the quality of the work based on the guidelines established in the SOP. The first review ensured that:

- Sample preparation and analysis information was correct and complete;
- The appropriate SOPs had been followed;
- QC parameters were within method control limits; and
- Documentation was complete

The second level review was structured so that all calibration data and QC sample results were reviewed and 10 percent of the analytical results were confirmed against the bench and instrument sheets. This included a complete review of instrument data scans to ensure accurate peaks and retention time, and correct peak integrations have been performed. If no problems were found with the data package, the review was considered complete. If any problems were found with the data package, an additional 10 percent of the samples were checked to the bench sheet. The process was continued for each batch until no errors were found or until each data package was reviewed in its entirety. All second level reviews were performed by a laboratory supervisor, data review specialist, or QA officer to ensure that:

- Calibration data were appropriate to the method and completely documented;
- QC sample results were within established guidelines;
- Qualitative identification of sample components was correct;
- Quantitative values were calculated correctly;
- Documentation was complete and correct;
- The data were ready for final reporting; and;
- The data package was complete and ready for data archive.

An important element of the second review was the documentation of any errors identified and corrected during the review process.

Before the final report was released, a third review was performed to check each data package for completeness and to ensure that the data met the overall objectives of the project. This review was done by the laboratory Program Administrator, as stated in the QAPP. The review was

performed to ensure that:

- Target analyte lists were complete as specified in the sampling and analysis plan;
- Data package checklist items were present;
- Case narratives accurately documented analytical conditions;
- All non-conformances were addressed and closed.

The Analytical Data Packages (ADPs) contain the following:

- Cover page, identifying project and remarks
- Summary and discussion of method QC and shipping and/or chain-of-custody errors
- Sample receipt information including copies of Cooler Receipt Forms
- Chain-of-Custody (COC) information including copies of COCs
- Analytical Test Results

ECB Lab applied data qualifiers as part of the review process to specific results to indicate usability and/or special analytical conditions. The following qualifiers were used to flag data:

B   The compound was also observed in the method blank.
J   Estimated concentration below the Reporting Limit.
u   The compound was not detected.
M   Reporting limit higher than normal due to matrix interferences.
D   Derived from a dilution of extract.

All investigative and QC sample summary results have been submitted in the Analytical Data Packages. ECB Lab reported all non-detect results as "u". The non-detect values are given in the data tables as 'u' less than the Method Detection limits (MDL). The MDL is the minimum concentration of a substance that can be measured and reported with 99 per cent confidence that the analyte concentration is greater than zero. The Reporting Limit (RL) is determined by the laboratory and takes into account impacts from sample matrix, sample preparation, and instrument limitations. The RL represents the concentration at which the laboratory can both determine the presence of an analyte and accurately quantify its concentration. The laboratory reported MDL as sample detection limit and RL as sample quantitation limit or laboratory reporting limit. For this report they can be used interchangeably. The laboratory reported detections below the RL and higher than the MDL with a "J" laboratory qualifier, which indicates positive detection with less than 99 per cent certainty associated with the quantitative result. The J values are considered valid and useable. Reporting limits may increase for an individual environmental sample due to high concentrations of target analytes, matrix effects, or other interferences.

4.3   USACE PROJECT CHEMIST QUALITY EVALUATION

In addition to the internal validation conducted by ECB Lab, the USACE project chemist performed data validation of the data set. This included an evaluation and validation of samples based on:

- Initial sample inspection and COC documentation;
- Holding Times;
- Field Duplicate Analyses;
- Laboratory Control Samples;
- Method Blank Analyses;
- Matrix Spike/Matrix Spike Duplicate recoveries;
- Surrogate recoveries;
- Precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters as they apply to this CDQAR; and
- An overall assessment of data compared to the project DQOs.

The USACE project chemist received data from the laboratory. The USACE Guidance for the Review of Performance-Based Definitive Chemical Data was used to perform the review and validation of the data.

The first step in evaluating and validating the data was to group the samples according to analytical batch or work group. A table was generated to show all analytical batches (project samples and laboratory QC samples). The batches are shown on Table 4-1. After analytical batching, the batches were reviewed to ensure that the proper QC (type and frequency) was analyzed according to the QAPP for each batch. Next, sample duplicate frequency was evaluated for compliance with the QAPP. Chain-of-custody forms and Cooler Receipt Forms were then reviewed. Any problems found were documented and the impact on sample results was determined and explained.

Holding times were evaluated for compliance with extraction and analysis holding time requirements. Matrix spike recoveries were evaluated for all samples. MS/MSD results were re-calculated on at least one sample per batch. Data qualifier flags were applied as appropriate. Surrogate spike recoveries were evaluated for all samples and surrogate recoveries were re-calculated on at least one sample per batch for organic analyses.

Next, LCS results were reviewed for all samples. LCS recoveries were re-calculated on one sample per batch. Relative Percent Differences (RPDs) for MS/MSD and LCS/LCSD pair calculations were verified for all batches. The 5× and 10× rule (as discussed in the Functional Guidelines for the Evaluation of Chemical Data) was used for evaluation of method blank results. The completeness percentage for surrogates, LCS, MS/MSD and holding times was then calculated.

Summaries of the data review and validation results are given in section 5.

As discussed previously, data qualifier flags were applied to out-of-control data as appropriate. The following qualifiers were used to indicate data usability:

u: The analyte was not detected relative to the method reporting limit.

UN: The result is reported as a tentative nondetection. There is uncertainty with whether or not the nondetection is valid at the stated method reporting limit.

X: The data is tentatively rejected because project-specific data quality objectives have not been met or have not been demonstrated.

J: The target analyte is positively identified but the quantitative result is an estimate and the direction of bias is unknown. The flag indicates a significant quantitative (rather than a qualitative) uncertainty exists.

J-:   The target analyte is present but the reported concentration is an estimated value that is believed to be biased low. (i.e. the actual concentration in the environmental sample believed to be higher than the reported concentration)

J+:   The target analyte is present but the reported concentration is an estimated value that is believed to be biased high. (i.e. the actual concentration in the environmental sample is believed to be lower than the reported concentration)

R: Data is rejected due to the serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified. The data is not useable.

Daily Quality Control Reports and COC documentation were compared against laboratory reports to check conformity of sample identification numbers. Analytical results were compared to daily activity logs to identify sampling procedures/activities that may have impacted data quality.

Table 4-1 Analytical Batches
Upper Slate River Surface Water Survey

Batch	Analyses	Sample ID
WG11003	Metals (water)	CO-USR-SW02 (diss)
		CO-USR-SW02
		CO-USR-SW15 (diss)
		CO-USR-SW15
		CO-USR-SW13-02 (diss)
		CO-USR-SW13-02
		CO-USR-SW03 (diss)
		CO-USR-SW03
		CO-USR-SW07 (diss)
		CO-USR-SW07
		CO-USR-SW08 (diss)
		CO-USR-SW08
		CO-USR-SW-14 (diss)
		CO-USR-SW-14
		Method Blank
		Laboratory Matrix Duplicate
		Matrix Spike (MS)/Matrix Spike Duplicate (MSD)
		Laboratory Control Sample (LCS)
WG11002	Metals (water)	CO-USR-SW04 (diss)
		CO-USR-SW04
		CO-USR-SW05 (diss)
		CO-USR-SW-05
		CO-USR-SW06 (diss)
		CO-USR-SW06
		CO-USR-SW09 (diss)
		CO-USR-SW09
		CO-USR-SW10 (diss)
		CO-USR-SW10
		CO-USR-SW11 (diss)
		CO-USR-SW11
		CO-USR-SW12 (diss)
		CO-USR-SW12
		CO-USR-SW13 (diss)
		CO-USR-SW13
		Method Blank
		Laboratory Matrix Duplicate
		MS/MSD
		LCS

Batch	Analyses	Sample ID
WG11019	Metals (water)	CO-USR-SW16 (diss)
		CO-USR-SW16
		Method Blank
		Laboratory Matrix Duplicate
		MD/MSD
		LCS
WG11100	Metals (water)	CO-USR-SW19 (diss)
		CO-USR-SW19
		CO-USR-SW20 (diss)
		CO-USR-SW20 (diss)
		Method Blank
		Laboratory Matrix Duplicate
		MS/MSD
		LCS
WG11082	Sulfate	CO-USR-SW02
		CO-USR-SW15
		CO-USR-SW04
		CO-USR-SW05
		CO-USR-SW06
		CO-USR-SW09
		CO-USR-SW10
		CO-USR-SW11
		CO-USR-SW12
		CO-USR-SW13
		CO-USR-SW13 -02 (dup)
		CO-USR-SW03
		CO-USR-SW07
		CO-USR-SW08
		CO-USR-SW14
		CO-USR-SW16
		Method Blank
		Laboratory Matrix Duplicate
		MS/MSD
		LCS
WG11133	Sulfate	CO-USR-SW19
		CO-USR-SW20
		Method Blank
		Laboratory Matrix Duplicate
		MS/MSD
		LCS

Batch	Analyses	Sample ID
WG11016	Alkalinity	CO-USR-SW02
		CO-USR-SW15
		CO-USR-SW04
		CO-USR-SW05
		CO-USR-SW06
		CO-USR-SW09
		CO-USR-SW10
		CO-USR-SW11
		CO-USR-SW12
		CO-USR-SW13
		CO-USR-SW13-02 (dup)
		CO-USR-SW03
		CO-USR-SW07
		CO-USR-SW08
		CO-USR-SW14
		CO-USR-SW16
		Method Blank
		Lab Matrix Dup
		MS/MSD
		LCS
WG11113	Alkalinity	CO-USR-SW19
		CO-USR-SW20
		Method Blank
		Lab Matrix Dup
		MS/MSD
		LCS
WG11000	Chloride	CO-USR-SW02
		CO-USR-SW15
		CO-USR-SW15
		CO-USR-SW04
		CO-USR-SW05
		CO-USR-SW06
		CO-USR-SW09
		CO-USR-SW10
		CO-USR-SW11
		CO-USR-SW12
		CO-USR-SW13
		CO-USR-SW13-02 (dup)
		CO-USR-SW03
		CO-USR-SW07
		CO-USR-SW08
		CO-USR-SW14
		CO-USR-SW16

Batch	Analyses	Sample ID
		Method Blank
		Lab Matrix Dup
		MS/MSD
		LCS
WG11127	Chloride	CO-USR-SW19
		CO-USR-SW20
		Method Blank
		Lab Matrix Dup
		MS/MSD
		LCS

5   RESULTS OF QUALITY CONTROL ACTIVITIES AND ANALYSES

Field QC activities consisted of collecting field QC samples (field duplicate and matrix spike samples), daily communication between the USACE field team and ECB Lab, and consistent interaction between the USACE field team and USACE Technical Manager.

5.1   FIELD QC PROCEDURES AND FIELD QC ANALYSES

5.1.1   Documentation of Field Quality Procedures

Daily Reports were completed to summarize daily investigation procedures and document QC activities. These reports summarize samples collected, environmental conditions, instrument problems, and any non-routine situations that may have impacted sample integrity. These reports were reviewed concurrently with the COC forms and the analytical results from the laboratory to identify potential sampling anomalies or confirm sample identifications.

5.1.2   Field Duplicate Analyses

Field duplicate samples were collected during the sampling event to evaluate sampling and laboratory precision. Each duplicate sample was analyzed for sulfate, alkalinity, and chloride and the analytical data agreed between the field sample and the field duplicate sample. No field duplicate sample was collected for metals; however, a matrix spike was sample was collected and analyzed and results agree with the field sample.

5.2   LABORATORY QC PROCEDURES AND LABORATORY QC ANALYSES

A review of laboratory QC procedures was conducted by the USACE project chemist. All issues identified, and their respective solutions are discussed below and required qualifications are discussed and are included in the data tables of Appendix A.

5.2.1   Initial Sample Inspection and COC Documentation

ECB Laboratory inspected all shipping containers and compared the contents with the appropriate COC documentation. Information from the sample check-in procedures was recorded on the Cooler Receipt Form. This form was used to document that samples listed on the COC forms agreed with samples contained in the coolers, COC forms were filled out properly, samples were not broken, custody seals were intact, and cooler temperatures were less than or equal to 4°C. These forms are included in the Analytical Data Packages. No problems or deficiencies were found with the sample shipments or COC documentation.

5.2.2   Holding Times

Samples were delivered daily by the overnight courier to ECB Laboratory to ensure all analyses were completed within the required holding times. Part of the USACE chemist evaluation included reviewing sample extraction and analysis dates to ensure holding times were met. Based on the USACE review of the laboratory data, all samples were extracted and analyzed within the required holding times.

5.2.3 Method Blank Analyses

Method blanks were analyzed to assess existence and magnitude of contamination problems and measure the representativeness of the analytical process. Blanks reflect the amount of contamination introduced into the environmental samples during sample collection, transfer from the site to the laboratory or analysis. In particular, method blanks reflect laboratory contamination from both the determinative and preparatory method. At least one method blank must be reported for each preparation batch of samples. All blanks were uncontaminated except in the following:

Analytical Batch: WG11100. This method blanks contained aluminum at 40 μg/L. but the samples had aluminum values of nondetect so no qualification was applied to the aluminum values.

5.2.4 Laboratory Control Samples

Laboratory control samples are evaluated to assess overall method performance and are the primary indicators of laboratory performance. Laboratory control samples are method blanks which are spiked typically with all target analytes of interest. The percent recovery is used as a measure of accuracy and bias. The relative percent difference (RPD) for duplicate LCS recoveries is normally used as a measure of precision. When both a laboratory control sample (LCS) and laboratory control sample duplicate (LCSD) are processed for a batch of samples, there is no significant physical distinction between the LCS and the LCSD. Both the LCS and the LCSD must satisfy the same recovery acceptance criteria. At least one LCS must be reported with each batch of samples. Multiple LCSs may be required to evaluate method precision. For example, a laboratory control sample and a laboratory control sample duplicate (LCSD) may be analyzed to provide information on the precision of the analytical method. The generation of control chart limits for precision via the analysis of LCS/LCSD pairs is an effective means to measure method precision. LCS and LCSD results are included in the QC section of the laboratory's data package.

Metals: An LCS was analyzed with each metals analytical batch. The % recovery was compared to set criteria for each analyte. The LCS % recoveries were all within set criteria so no qualifications were applied to metals results.

Sulfate: An LCS was analyzed as part of the cyanide quality control to determine precision. The RPD results met set criteria so no qualification was applied to the sulfate results.

Alkalinity: An LCS was analyzed as part of the alkalinity quality control to determine precision. The RPD results met set criteria so no qualification was applied to the alkalinity results.

Chloride: An LCS was analyzed as part of the chloride quality control to determine precision. The RPD results met set criteria so no qualification was applied to the chloride results.

5.2.5 Surrogate Recovery

Surrogates are organic compounds that are similar in chemical composition to the analytes of interest. Surrogates are spiked into environmental and batch QC samples prior to sample preparation and analysis. Surrogate recoveries for environmental samples are used to evaluate matrix interference on a sample-specific basis. High or low surrogate recoveries indicate problems in instrument performance, extraction procedures, or severe matrix effects. Samples for metals analysis are not spiked with surrogate analytes. No surrogate is added to samples for cyanide analysis.

5.2.6 MS/MSD Recovery

Matrix Spike (MS) and matrix spike duplicate (MSD) results are examined to evaluate the impact of matrix effects on overall analytical performance. A matrix spike is a representative environmental sample that is spiked with target analytes of interest prior to being taken through the entire analytical process in order to evaluate analytical bias for an actual matrix. A matrix duplicate is a collocated or a homogenized sample that is processed through the entire analytical procedure in order to evaluate overall precision for an actual matrix.

MS recovery failure and poor precision may arise because of (i) poor sampling technique, (ii) inadequate homogenization, or (iii) from matrix effects associated with the preparatory or determinative portion of an analytical method. Matrix interferences may be "positive" or "negative" in nature. Results of MS/MSD analyses are included in the Analytical Data Packages. The % recovery and RPD for the MS/MSD for the metals, sulfate, alkalinity, and chloride were within criteria so no qualification was applied to the data.

5.2.7 Completeness of Data Packages

The USACE Chemist reviewed the data package and confirmed the completeness of the data package. All the planned sampling activities were executed and all the laboratory analyses were performed.

5.3 PRECISION, ACCURACY, REPRESENTATIVENESS, COMPLETENESS AND COMPARABILITY (PARCC)

DQOs and their corresponding measurement indicators were specified in the QAPP. To achieve the project DQOs, specific PARCC goals are established for laboratory and field sampling procedures. These PARCC parameters are the measurement tools for determining the usability of generated data.

Precision and accuracy goals were based on knowledge of each analytical measurement system. For this CDQAR, precision was measured using the RPD between two replicated sample analyses. The precision evaluation encompassed laboratory precision (LCS samples), and combined field/laboratory precision (MS/MSD samples).

Accuracy was measured using the percent recovery of surrogates, MS/MSD samples, and

LCS sample pairs. Spike recoveries form field samples and laboratory QC samples are compared to established control limits to determine a laboratory's ability to accurately determine both qualitative and quantitative results.

Representativeness is the degree to which the data accurately and precisely portrayed the environmental conditions being studied. For the site investigation, sampling procedures and sample locations were selected to bias samples in areas of potential places of contamination. All sampling was conducted using known approved field procedures to minimize variability.

Completeness refers to the amount of valid data obtainable from a measurement system compared to the expected amount of data. The QAPP established a completeness goal of 90 percent for laboratory QC requirements. This goal was attained by the data for this project.

5.4   Data Tables

The qualified data is given in Appendix A.

5.5   Analytical Data package

Data Sheets as obtained from the ECB Lab are available upon request

6 CONCLUSIONS

This CDQAR presents, in specific terms, the quality control practices utilized to achieve the goals of the site investigation at Upper Slate River, Colorado. The analytical program for this project conformed to the general Site Work Plan for the Restoration of Abandoned Mines prepared by U.S. Army Corps of Engineers, July 2002 and the Site Specific Addendum to the Work Plan for the Upper Slate River areas, 30 July 2002.

Samples were collected and analyzed in accordance with EPA methods and laboratory specific QA/QC procedures were used. These procedures were followed to generate high quality data.

The quality issues addressed in this report do not impact the usability of the data. These issues have all been addressed on section 5 and the qualified data is given in Appendix A. The reviewed data are usable and are suitable for addressing the overall objective of this investigation.

Appendix A

Table 1, Upper Slate River Qualified Analytical Data

Sample ug/L	MDL	CO-USR-SW-02 (DISS)			CO-USR-SW-02			CO-USR-SW-15 (DISS)			CO-USR-SW-15		
Date Collected		08/08/02	RL	Qual	08/08/02	RL	Qual	08/08/02	RL	Qual	08/08/02	RL	Qual
Aluminum	30	< 30	90	u	33	90	J	< 30	90	u	< 30	90	u
Arsenic	3	< 3	15	u	< 3	15	u	< 3	15	u	< 3	15	u
Cadmium	0.5	1.5	2.5	J	1.7	2.5	J	< .5	2.5	u	< .5	2.5	u
Calcium	100	13600	300		13700	300		37700	300		38500	300	
Chromium	2	< 2	10	u	< 2	10	u	< 2	10	u	< 2	10	u
Copper	2	3.3	10	J	3.7	10	J	< 2	10	u	< 2	10	u
Iron	40	< 40	120	u	< 40	120	u	< 40	120	u	< 40	120	u
Lead	2	7.6	10	J	10.7	10		< 2	10	u	< 2	10	u
Magnesium	40	1160	120		1170	120		1530	120		1560	120	
Manganese	1	22.8	4		21.5	4		< 1	4	u	< 1	4	u
Potassium	100	403	300		416	300		769	300		779	300	
Silver	1	< 1	5	u	< 1	5	u	< 1	5	u	< 1	5	u
Zinc	3	175	10		181	10		< 3	10	u	< 3	10	u
Sulfate mg/L	6				10	20	J				50	20	
Alkalinity mg/L as CaCO3	7				45	20					67	20	
Bicarbonate Alk as CaCO3	7				45	20					67	20	
Carbonate Alk as CaCO3	7				<7	20	u				<7	20	u
Chloride mg/L	1				<1	5	u				<1	5	u

u = non detect above Method Detection Limits (MDL)

J = estimate value due to analyte detected between MDL and RL or data qualification

Table 1, Upper Slate River Qualified Analytical Data

Sample	MDL	CO-USR-SW-04 (DISS)			CO-USR-SW-04			CO-USR-SW-05 (DISS)			CO-USR-SW-05		
Date Collected		08/07/02	RL	Qual	08/07/02	RL	Qual	08/07/02	RL	Qual	08/07/02	RL	Qual
Aluminum	30	1550	90		1550	90		< 30	90	u	< 30	90	u
Arsenic	3	< 3	15	u	< 3	15	u	< 3	15	u	< 3	15	u
Cadmium	0.5	36.1	2.5		36.3	2.5		< .5	2.5	u	< .5	2.5	u
Calcium	100	7430	300		7440	300		17500	300		17200	300	
Chromium	2	< 2	10	u	< 2	10	u	< 2	10	u	< 2	10	u
Copper	2	113	10		113	10		< 2	10	u	< 2	10	u
Iron	40	< 40	120	u	< 40	120	u	44	120	J	44	120	J
Lead	2	578	10		580	10		< 2	10	u	< 2	10	u
Magnesium	40	1770	120		1760	120		1360	120		1340	120	
Manganese	1	1030	4		1030	4		3.1	4	J	1.3	4	J
Potassium	100	681	300		682	300		393	300		391	300	
Silver	1	< 1	5	u	< 1	5	u	< 1	5	u	< 1	5	u
Zinc	3	4580	10	B	4600	10	B	6.3	10	JB	5.3	10	JB
Sulfate	6				42	20					10	20	J
Alkalinity mg/L as CaCO3	7				<7	20	u				47	20	
Bicarbonate Alk as CaCO3	7				<7	20	u				47	20	
Carbonate Alk as CaCO3	7				<7	20	u				< 7	20	u
Chloride	1				< 1	5	u				< 1	5	u

u = non detect above Method Detection Limits (MDL)

J = estimate value due to analyte detected between MDL and RL or data qualification

Table 1, Upper Slate River Qualified Analytical Data

Sample	MDL	CO-USR-SW-06 (DISS)			CO-USR-SW-06			CO-USR-SW-09 (DISS)			CO-USR-SW-09		
Date Collected		08/07/02	RL	Qual	08/07/02	RL	Qual	08/07/02	RL	Qual	08/07/02	RL	Qual
Aluminum	30	< 30	90	u	< 30	90	u	< 30	90	u	< 30	90	u
Arsenic	3	< 3	15	u	< 3	15	u	< 3	15	u	< 3	15	u
Cadmium	0.5	< .5	2.5	u	< .5	2.5	u	< .5	2.5	u	< .5	2.5	u
Calcium	100	14400	300		14300	300		16900	300		17000	300	
Chromium	2	< 2	10	u	< 2	10	u	< 2	10	u	< 2	10	u
Copper	2	< 2	10	u	< 2	10	u	< 2	10	u	< 2	10	u
Iron	40	128	120		152	120		55	120	J	40	120	
Lead	2	< 2	10	u	< 2	10	u	< 2	10	u	< 2	10	u
Magnesium	40	1120	120		1120	120		1300	120		1310	120	
Manganese	1	9.67	4		10.7	4		3.7	4	J	2.4	4	J
Potassium	100	368	300		366	300		381	300		371	300	
Silver	1	< 1	5	u	< 1	5	u	< 1	5	u	< 1	5	u
Zinc	3	< 3	10	uB	< 3	10	uB	14.5	10	B	21	10	B
Sulfate	6				8	20	J				20	20	J
Alkalinity mg/L as CaCO3	7				39	20					43	20	
Bicarbonate Alk as CaCO3	7				39	20					43	20	
Carbonate Alk as CaCO3	7				<7	20	u				<7	20	u
Chloride	1				<1	5	u				<1	5	u

u = non detect above Method Detection Limits (MDL)
J = estimate value due to analyte detected between MDL and RL or data qualification

Table 1, Upper Slate River Qualified Analytical Data

Sample	MDL	CO-USR-SW-10 (DISS)			CO-USR-SW-10			CO-USR-SW-11 (DISS)			CO-USR-SW-11		
Date Collected		08/07/02	RL	Qual	08/07/02	RL	Qual	08/07/02	RL	Qual	08/07/02	RL	Qual
Aluminum	30	< 30	90	u	< 30	90	u	< 30	90	u	< 30	90	u
Arsenic	3	< 3	15	u	< 3	15	u	5.2	15	J	4.7	15	J
Cadmium	0.5	< .5	2.5	u	< .5	2.5	u	< .5	2.5	u	< .5	2.5	u
Calcium	100	23200	300		23300	300		41500	300		41200	300	
Chromium	2	< 2	10	u	< 2	10	u	< 2	10	u	< 2	10	u
Copper	2	< 2	10	u	< 2	10	u	< 2	10	u	< 2	10	u
Iron	40	< 40	120	u	< 40	120	u	< 40	120	u	< 40	120	u
Lead	2	< 2	10	u	< 2	10	u	< 2	10	u	< 2	10	u
Magnesium	40	1530	120		1540	120		3070	120		3050	120	
Manganese	1	< 1	4	u	< 1	4	u	1.2	4	J	1.4	4	J
Potassium	100	240	300	J	270	300	J	337	300		337	300	
Silver	1	< 1	5	u	< 1	5	u	< 1	5	u	< 1	5	u
Zinc	3	8.6	10	JB	18.7	10	B	21.8	10	B	22	10	B
Sulfate	6				40	20					76	20	
Alkalinity mg/L as CaCO3	7				40	20					55	20	
Bicarbonate Alk as CaCO3	7				40	20					55	20	
Carbonate Alk as CaCO3	7				< 7	20	u				< 7	20	u
Chloride	1				< 1	5	u				< 1	5	u

u = non detect above Method Detection Limits (MDL)

J = estimate value due to analyte detected between MDL and RL or data qualification

Table 1, Upper Slate River Qualified Analytical Data

Sample	MDL	CO-USR-SW-12 (DISS)			CO-USR-SW-12			CO-USR-SW-13 (DISS)			CO-USR-SW-13		
Date Collected		08/23/02	RL	Qual	08/07/02	RL	Qual	08/07/02	RL	Qual	08/07/02	RL	Qual
Aluminum	30	< 30	90	u	< 30	90	u	< 30	90	u	< 30	90	u
Arsenic	3	< 3	15	u	< 3	15	u	< 3	15	u	< 3	15	u
Cadmium	0.5	< .5	2.5	u	< .5	2.5	u	< .5	2.5	u	< .5	2.5	u
Calcium	100	12000	300		12100	300		12100	300		12200	300	
Chromium	2	< 2	10	u	< 2	10	u	< 2	10	u	< 2	10	u
Copper	2	< 2	10	u	< 2	10	u	< 2	10	u	< 2	10	u
Iron	40	197	120		47	120	J	< 40	120	u	< 40	120	u
Lead	2	< 2	10	u	< 2	10	u	< 2	10	u	< 2	10	u
Magnesium	40	608	120		609	120		613	120		614	120	
Manganese	1	1.5	4	J	< 1	4	u	< 1	4	u	< 1	4	u
Potassium	100	180	300	J	180	300	J	180	300	J	180	300	J
Silver	1	< 1	5	u	< 1	5	u	< 1	5	u	< 1	5	u
Zinc	3	< 3	10	uB	11	10	B	< 3	10	uB	< 3	10	uB
Sulfate	6				20	20	J				20	20	J
Alkalinity mg/L as CaCO3	7				28	20					40	20	
Bicarbonate Alk as CaCO3	7				28	20					40	20	
Carbonate Alk as CaCO3	7				< 7	20	u				< 7	20	u
Chloride	1				< 1	5	u				< 1	5	u

u = non detect above Method Detection Limits (MDL)
J = estimate value due to analyte detected between MDL and RL or data qualification

Table 1, Upper Slate River Qualified Analytical Data

Sample	MDL	CO-USR-SW-13-02			CO-USR-SW-03 (DISS)			CO-USR-SW-03			CO-USR-SW-07 (DISS)		
Date Collected		08/07/02	RL	Qual	08/08/02	RL	Qual	08/08/02	RL	Qual	08/08/02	RL	Qual
Aluminum	30	< 30	90	u	< 30	90	u	< 30	90	u	< 30	90	u
Arsenic	3	< 3	15	u	< 3	15	u	< 3	15	u	< 3	15	u
Cadmium	0.5	< .5	2.5	u	0.53	2.5	J	0.54	2.5	J	< .5	2.5	u
Calcium	100	12000	300		14300	300		14300	300		20500	300	
Chromium	2	< 2	10	u	< 2	10	u	< 2	10	u	< 2	10	u
Copper	2	< 2	10	u	< 2	10	u	130	10		< 2	10	u
Iron	40	< 40	120	u	< 40	120	u	< 40	120	u	< 40	120	u
Lead	2	< 2	10	u	< 2	10	u	< 2	10	u	< 2	10	u
Magnesium	40	604	120		1980	120		1980	120		1410	120	
Manganese	1	< 1	4	u	< 1	4	u	< 1	4	u	1	4	J
Potassium	100	170	300	J	558	300		558	300		417	300	
Silver	1	< 1	5	u	< 1	5	u	< 1	5	u	< 1	5	u
Zinc	3	< 3	10	u	149	10		151	10		7.8	10	J
Sulfate	6	20	20	J				29	20				
Alkalinity mg/L as CaCO3	7	26	20					38	20				
Bicarbonate Alk as CaCO3	7	26	20					38	20				
Carbonate Alk as CaCO3	7	< 7	20	u				< 7	20	u			
Chloride	1	< 1	5	u				< 1	5	u			

u = non detect above Method Detection Limits (MDL)

J = estimate value due to analyte detected between MDL and RL or data qualification

Table 1, Upper Slate River Qualified Analytical Data

Sample	MDL	CO-USR-SW-07			CO-USR-SW-08 (DISS)			CO-USR-SW-08			CO-USR-SW-14 (DISS)		
Date Collected		08/08/02	RL	Qual	08/08/02	RL	Qual	08/08/02	RL	Qual	08/23/02	RL	Qual
Aluminum	30	< 30	90	u	< 30	90	u	< 30	90	u	< 30	90	u
Arsenic	3	< 3	15	u	< 3	15	u	< 3	15	u	< 3	15	u
Cadmium	0.5	< .5	2.5	u	< .5	2.5	u	< .5	2.5	u	< .5	2.5	u
Calcium	100	20500	300		16900	300		16900	300		37200	300	
Chromium	2	< 2	10	u	< 2	10	u	< 2	10	u	< 2	10	u
Copper	2	< 2	10	u	< 2	10	u	< 2	10	u	< 2	10	u
Iron	40	< 40	120	u	60	120	J	78	120	J	< 40	120	u
Lead	2	< 2	10	u	< 2	10	u	< 2	10	u	< 2	10	u
Magnesium	40	1410	120		1210	120		1220	120		2280	120	
Manganese	1	1	4	J	4.4	4		5.08	4		< 1	4	u
Potassium	100	423	300		341	300		342	300		734	300	
Silver	1	< 1	5	u	< 1	5	u	< 1	5	u	< 1	5	u
Zinc	3	21.9	10		7.9	10	J	9.7	10	J	< 3	10	u
Sulfate	6	28	20					27	20				
Alkalinity mg/L as CaCO3	7	43	20					39	20				
Bicarbonate Alk as CaCO3	7	43	20					39	20				
Carbonate Alk as CaCO3	7	< 7	20	u				< 7	20	u			
Chloride	1	< 1	5	u				< 1	5	u			

u = non detect above Method Detection Limits (MDL)

J = estimate value due to analyte detected between MDL and RL or data qualification

Table 1, Upper Slate River Qualified Analytical Data

Sample	MDL	CO-USR-SW-14			CO-USR-SW-16 (DISS)			CO-USR-SW-16			CO-USR-SW19-001 (DISS)		
Date Collected		08/23/02	RL	Qual	08/23/02	RL	Qual	08/23/02	RL	Qual	08/21/02	RL	Qual
Aluminum	30	< 30	90	u	< 30	90	u	31	90	J	< 30	90	uB
Arsenic	3	< 3	15	u	< 3	15	u	< 3	15	u	< 3	15	u
Cadmium	0.5	< .5	2.5	u	< .5	2.5	u	< .5	2.5	u	0.88	2.5	J
Calcium	100	36800	300		33800	300		33700	300		50700	300	
Chromium	2	< 2	10	u	< 2	10	u	< 2	10	u	< 2	10	u
Copper	2	< 2	10	u	< 2	10	u	< 2	10	u	< 2	10	u
Iron	40	< 40	120	u	97	120	J	443	120		< 40	120	u
Lead	2	< 2	10	u	< 2	10	u	< 2	10	u	< 2	10	u
Magnesium	40	2260	120		9330	120		9160	120		5420	120	
Manganese	1	< 1	4	u	3.9	4	J	18.1	4		310	4	
Potassium	100	728	300		702	300		726	300		1620	300	
Silver	1	< 1	5	u	< 1	5	u	< 1	5	u	< 1	5	u
Zinc	3	3.6	10	J	3.2	10	J	12.6	10		153	10	
Sulfate	6	52	20					20	20	J			
Alkalinity mg/L as CaCO3	7	60	20					130	20				
Bicarbonate Alk as CaCO3	7	60	20					130	20				
Carbonate Alk as CaCO3	7	< 7	20	u				< 7	20	u			
Chloride	1	< 1	5	u				< 1	5	u			

u = non detect above Method Detection Limits (MDL)

J = estimate value due to analyte detected between MDL and RL or data qualification

Table 1, Upper Slate River Qualified Analytical Data

Sample	MDL	CO-USR-SW19-01			CO-USR-SW20-001 (DISS)			CO-USR-SW20-001		
Date Collected		08/21/02	RL	Qual	08/21/02	RL	Qual	08/21/02	RL	Qual
Aluminum	30	< 30	90	uB	< 30	90	uB	< 30	90	uB
Arsenic	3	< 3	15	u	< 3	15	u	< 3	15	u
Cadmium	0.5	1	2.5	J	< .5	2.5	u	< .5	2.5	u
Calcium	100	51100	300		23900	300		23700	300	
Chromium	2	< 2	10	u	< 2	10	u	< 2	10	u
Copper	2	< 2	10	u	< 2	10	u	< 2	10	u
Iron	40	161	120		44	120	J	150	120	
Lead	2	< 2	10	u	2.1	10	J	2.1	10	J
Magnesium	40	5430	120		2860	120		2850	120	
Manganese	1	344	4		34.2	4		37	4	
Potassium	100	1620	300		856	300		861	300	
Silver	1	< 1	5	u	< 1	5	u	< 1	5	u
Zinc	3	130	10		35.9	10		28.9	10	
Sulfate	6	110	20					32	20	
Alkalinity mg/L as CaCO3	7	86	20					56	20	
Bicarbonate Alk as CaCO3	7	86	20					56	20	
Carbonate Alk as CaCO3	7	< 7	20	u				< 7	20	u
Chloride	1	3	5	J				1	5	J

u = non detect above Method Detection Limits (MDL)

J = estimate value due to analyte detected between MDL and RL or data qualification