START 3

Superfund Technical Assessment and Response Team 3 – Region 8

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WATER QUALITY REPORT
Four Mines Within Cement Creek Watershed

Silverton, San Juan County, Colorado

TDD No. 1008-01

August 27, 2012

URS
OPERATING SERVICES, INC.

In association with:
Garry Struthers Associates, Inc.
LT Environmental, Inc.
TechLaw, Inc.
Tetra Tech EMI
TN & Associates, Inc.

WATER QUALITY REPORT

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CEMENT CREEK WATERSHED
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WATER QUALITY REPORT

FOUR MINES WITHIN CEMENT CREEK WATERSHED
Silverton, San Juan County, Colorado

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1.0 INTRODUCTION

URS Operating Services, Inc. (UOS), was tasked by the Environmental Protection Agency (EPA), under Superfund Technical Assessment and Response Team 3 (START) contract # EP-W-05-050 Technical Direction Document (TDD) No. 1008-01, to provide technical support to the Region 8 On-Scene Coordinator (OSC) at an abandoned mine site near Silverton, San Juan County, Colorado. Specifically, START was tasked to review mine adit discharge data that had been obtained during several sampling events and to compile the data for review and analysis. This report focuses on four mine adits located in the headwaters of Cement Creek: the Red and Bonita, Mogul, Gold King 7 Level, and the American Tunnel. The flows from these adits have been substantially altered since the plugging of the American Tunnel, thus the reason for the focus on these adits. Another adit exists at the Grand Mogul mine upstream from the Mogul in the Cement Creek drainage above the other mines. However, it is not visible other than evidence of a waste dump, and there is no observable surface discharge.

Field data were obtained beginning in May 2009 and ending in October 2011. The mines are located within the Cement Creek drainage, approximately 10 miles north of the town of Silverton, Colorado (Figure 1). This information is intended to summarize several years of information regarding the flow and water quality for these major discharging adits and provide a base of comparison for potential changes resulting from actions that may be implemented.

2.0 SITE DESCRIPTION

Cement Creek originates high in the rugged San Juan Mountains of southwestern Colorado near the San Juan County and Ouray County line below the south flank of Brown Mountain, and southeast of Red Mountain Number 1. Cement Creek begins at an elevation of 13,000 feet above mean sea level (AMSL) and flows 7 miles southward to an elevation of 9,305 feet AMSL at its confluence with the Animas River at Silverton, Colorado (Colorado Department of Public Health and Environment [CDPHE] 1998). The name Cement Creek probably refers to the iron rich precipitates (ferricrete) that coat the stream bed materials (U. S. Geological Survey [USGS] 2007a). The Cement Creek watershed is a major tributary of the upper Animas River watershed. These watersheds were the focus of both large- and small-scale mining operations that flourished beginning in 1871 and lasting until as late as 1991.

Road access is via County Road (CR) 110 from the town of Silverton to CR53, accessed at the abandoned town site of Gladstone. CR53 continues northward up the Cement Creek valley to individual mine access points. The mines are accessible during non-snow months of the year, typically late June through early October.

2.1 GEOLOGY

The Cement Creek basin is located within the volcanic terrain of the San Juan Mountains. The area was a late Oligocene volcanic center where the eruption of many cubic miles of lava and volcanic tuffs covered the area to a depth of more than a mile (USGS 1969). The Cement Creek basin is composed of predominately intermediate to silicic composition lava flows. The flows include three distinct units: the upper-most crystalline rock Pyroxene Andesite Member – a porphyritic andesite; the Burns Member – a crystalline rock porphyritic andesite and rhyolite sequence that inter-fingers locally with the upper pyroxene andesite member; and the lower-most Henson Member – volcaniclastic sedimentary rocks that inter-finger with the Burns Member and the upper Pyroxene Andesite Member (USGS 2007a). The formation of the 10-mile diameter Silverton caldera produced faults that are generally circular and concentric. The caldera collapse was followed by multiple episodes of hydrothermal activity that produced widespread alteration and mineralization of the rocks (USGS 2007b). Three major areas of post-caldera collapse mineralization and alteration have been identified in the Cement Creek drainage. One of them is the Eureka Graben area on the upper northeast side of the Cement Creek drainage, which is the site of 10- to 18-million-year-old emplacement of northeast-trending polymetallic veins of silver, lead, zinc, copper, and often gold that formed as fracture or fissure filling material (USGS 2007c).

Major faults in the area of interest are those that bound the Eureka Graben, a predominantly northeast to southwest oriented rectangular-shaped downthrown block approximately 1.5 miles wide and 4 miles long, located predominantly northeast of the mines discussed in this report. A northwestern-extending leg of the graben is indicated on Figure 2, and is formed by the Bonita and Ross Basin Faults. The Bonita Fault is east of and sub-parallel to Cement Creek and curves westward at the northern reaches of Cement Creek to form the western extent of the graben and its northwestern-extending leg. The American Tunnel, Red and Bonita, and Upper Gold King mines are respectively located within approximately 5,000, 4,000, and 3,000 feet west of this fault. The target of those mines was likely minor/normal faulting associated with the Bonita Fault. The Mogul and Grand Mogul mines are located along the upper reaches of Cement Creek within approximately 2,000 feet northeast of the Bonita Fault where it curves westward and, respectively, 600 to 400 feet south of the Ross Basin Fault, which forms the northern edge of the

Eureka Graben (USGS 2007a). Mineralization associated with the Ross Basin fault was likely the target of the Mogul and Grand Mogul mines.

Joints and flow structure (crude bedding) were identified and measured at surface on cliff faces and at the portals of prospects and mines adjacent to the Red & Bonita mine. The structural data was analyzed using Rock Pack III software at the Colorado Geological Survey. Two preferential joint trends were detected: a joint set trending roughly east-west, with dips of 60 to 89 degrees to the north; and a joint set striking roughly northeast-southwest, dipping steeply southeast (Colorado Division of Reclamation, Mining and Safety [DRMS] 2007). These orientations are similar to the dominant northeast-southwest anisotropy observed at the Sunnyside mine located 2 miles west. Permeability was observed at the Sunnyside mine to be greater in the northeast-southwest direction due to the dominant fracture orientation within that section of the Eureka Graben. Also, the structural discontinuities measured by the DRMS tend to agree with the direction of structural anisotropy as shown on published geologic maps and reports for this area near the Eureka Graben. Flow structure (crude bedding) in the andesite strikes southeast and dips gently southwest (DRMS 2007).

2.2 HYDROLOGY

The drainage area of Cement Creek is 20.1 square miles (USGS 2007d). Cement Creek flows through the middle of the caldera, with the period of high flow being May, June, and July in response to snowmelt in the San Juan Mountains. Periods of low flow occur in late summer and winter. The average annual flow measured by the USGS on Cement Creek at Silverton before the confluence with the Animas River (station number 09358550, also known as CC48) between 1992 and 2008 (excluding 1994) was 38.3 cubic feet per second (cfs) (17,190 gallons per minute [gpm]). The highest average annual flow on Cement Creek was 56.3 cfs (25,269 gpm) during 1995, and the lowest was 17 cfs (7,630 gpm) during the drought of 2002 (USGS 2009).

Groundwater occurs in the bedrock formations that underlie the Cement Creek watershed. Groundwater occurrence and flow is controlled by the distribution and orientation of secondary porosity and permeability associated with fractures, faults, and zones of highly altered rock. Groundwater discharge to Cement Creek accounts for the base flow in the stream. Groundwater recharge is primarily from infiltration of rain and snow, but also includes infiltration of mine waters.

Rock exposed in adjacent mine workings and prospect adits is highly jointed near the portals, becoming tighter with increased distance from the surface. This is common in hard rock workings in the San Juan Mountains and effects groundwater flow through the rock. Rock near the surface is subjected to severe chemical and physical weathering (freeze-thaw, surface infiltration). Release of overburden pressure through erosion, coupled with glacial scouring effects, normally increases fracturing and jointing of the rock mass near the ground surface. As distance from the ground surface increases, joints generally become fewer and tighter due to overburden pressure (DRMS 2007).

2.3 MINE SITES

This report is focused on four mine sites determined to be major sources of water contamination within the Cement Creek watershed. The mines are accessed by four wheel drive roads. Road access to the Gold King Mine has been truncated by drainage from the North Fork stream which has eroded the road immediately below the mine, making it impassable by vehicle at that point.

2.3.1 American Tunnel

The American Tunnel is the lower-most mine. The portal is located in the abandoned town site of Gladstone at 10,540 feet AMSL. A series of three concrete bulkhead plugs were installed in the tunnel in 1997, 2001, and 2002. However, discharge still occurs from the tunnel via a culvert near the adit location. This discharge flows into a lined channel, through a flume, and into Cement Creek. Since 2009, flow rates have been observed to range from 80 to 143 gpm. The pH range of the discharge is 4.5 to 5.4 standard units (SU). The discharge contributes significant amounts of metals to Cement Creek that include aluminum, iron, manganese, and zinc.

2.3.2 Gold King Mine - 7 Level

The Gold King 7 Level portal is located approximately 0.75 mile northeast of Gladstone in the watershed of the North Fork of Cement Creek at 11,386 feet AMSL. Adit discharge is channeled into a cement culvert, through a flume, and into the North Fork of Cement Creek. The North Fork of Cement Creek joins with the main stem of Cement Creek downstream of the Red and Bonita Mine. Since 2009, discharge rates from the adit have been observed to range from 134 to 252 gpm. The discharge water pH ranges from

2.3 to 5.1 SU. Discharge from the Gold King adit contains high concentrations of copper, aluminum, iron, manganese, and zinc.

2.3.3 Mogul Mine

The Mogul mine portal is located approximately 1.5 miles north of Gladstone at an elevation of 11,376 feet AMSL. Adit discharge from the Mogul Mine passes through a weir located at the portal inside the adit, then through a wetland area before it enters Cement Creek. A concrete bulkhead was installed in the adit in 2003. Since 2009, flow rates from the adit have been observed to range from 40 to 116 gpm. The pH range of the adit discharge water is 3.1 to 3.7 SU. The adit discharge contains high concentrations of aluminum, iron, manganese, and zinc.

2.3.4 Red and Bonita Mine

The Red and Bonita mine portal is approximately 0.5 mile north of Gladstone at 10,893 feet AMSL. Adit discharge was through a collapsed portal until a new portal structure was installed in October 2011. Initial breach of the portal collapse into the adit occurred on September 15, 2011. The adit has been exposed to ambient conditions since that time, although air flow was blocked by a brattice cloth that was placed over the portal during the 2011-2012 winter months to inhibit freezing effects in the adit. Adit discharge flows overland approximately 200 feet across and down a mine dump face before being channelized at the toe of the dump. The channel directs flow into an iron bog en route to Cement Creek approximately 500 feet down gradient from the toe of the dump. Since 2009, adit discharge rates have been observed to range from 181 to 336 gpm. The pH range of portal discharge water is 5.4 to 6.5 SU. The adit discharge water contains high concentrations of aluminum, iron, manganese, and zinc. Because of diffused flow through the portal collapse, field observations included in this report are primarily based upon sampling performed at the toe of the dump within the channelized flow, with the exception of isotope samples obtained at the mine adit.

3.0 SAMPLING ACTIVITIES

Water quality sampling was performed on 17 occasions during a 28-month period. Not all locations were accessible for each sampling event. Sample collection for metals analysis, field parameter measurements, and stream gauging was performed by the EPA, with laboratory analysis performed by the EPA Region 8

Laboratory in Golden, Colorado. Sample collection for stable water isotope and tritium analysis was performed by START. Tritium laboratory analysis was performed at the USGS Stable Isotope and Tritium Laboratory in Menlo Park, California (tritium analysis), and stable water isotope analysis was performed at the Institute of Arctic and Alpine Research Laboratory in Boulder, Colorado (oxygen-18 and deuterium). An attempt to obtain automated field parameter data was pursued through the deployment of dedicated probes within stilling wells attached to flumes at each mine adit. At the Red and Bonita mine the probe was deployed in a well which was completed within the mine adit behind the collapsed portal. All resulting data is of poor quality due to freezing conditions, animal interference, and precipitation of yellowboy (ferric iron hydroxide) onto the probes. This data is displayed in Appendix B.

4.0 OBSERVATIONS

4.1 MINE ADIT FLOW RATES

Table A below presents mine adit discharge rates for individual months in 2005 and 2006, and average discharge rates for the years 2010 (five to seven measurements) and 2011 (five to six measurements). Discharge rates since 2009 are also presented on Figure A. Flow from the American Tunnel appears to have remained stable since 2005. Note that it received three bulkheads that influence flow from the adit; one each in 1997, 2001, and 2002 (Animas River Stakeholders Group [ARSG] 2003). Flow from the Mogul has essentially doubled since 2005. Flow from the Red and Bonita mine appears to have increased by 1/3 since 2005. Adit discharge from the Gold King 7 Level appears to be somewhat erratic, however predictable in the fact that flow appears to have increased since 2005, although additional data would be warranted.

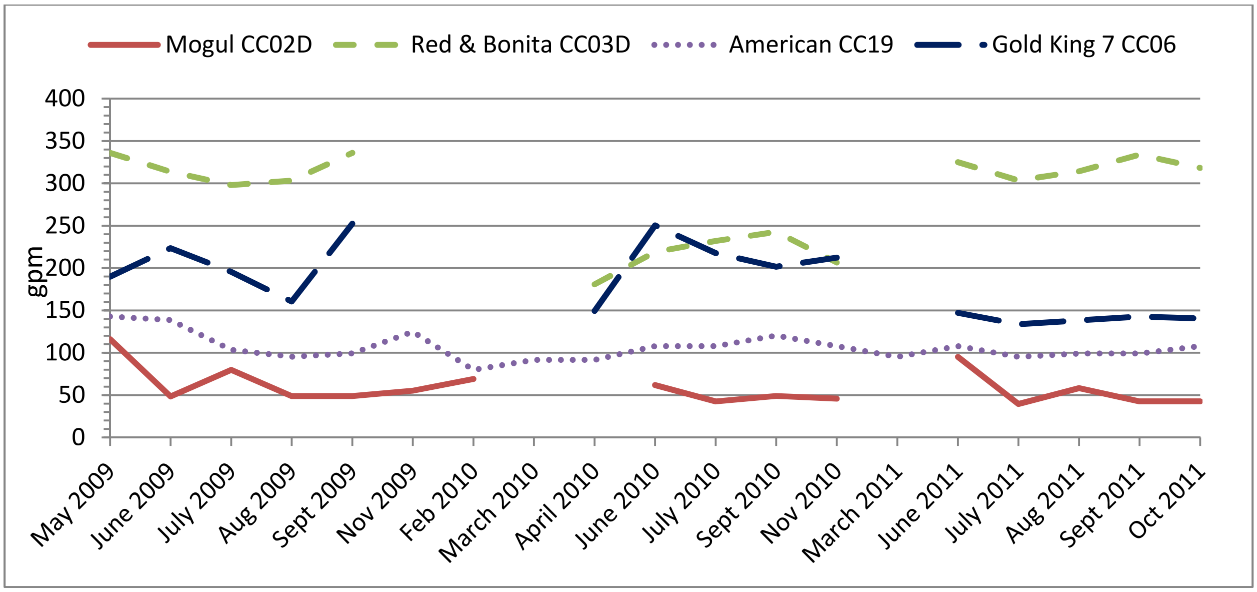
TABLE A
Mine Adit Discharge 2005 to 2011

Mine	Elevation (feet AMSL)	Bulkhead Install	Flow Rate (gpm)				
			July 2005	September 2005	October 2006	Average 2010	Average 2011
Mogul	11,376	2003	21	27	11	54	56
Gold King 7 Level	11,386	None	42	135	314	206	140
Red & Bonita	10,893	None	210	224	233	216	319
American Tunnel	10,540	1997 2001 2002	95	90	84	101	101

gpm – Gallons per minute.
AMSL – Above mean sea level.

Mine portal discharge rates appear to be fairly consistent during the observation period of May 2009 to August 2011 (Figure A). Due to extreme winter conditions it is not possible to obtain flow measurements during the December to March period. As shown in Figure A, the Mogul mine exhibited the lowest discharge rate of approximately 50 gpm, while the Red and Bonita exhibited the greatest flow volume at approximately 330 gpm. Flow from the Red and Bonita portal was significantly lower in 2010 when compared to 2009 and 2011.

Figure A
Mine Discharge Rates in Gallons per Minute (gpm)

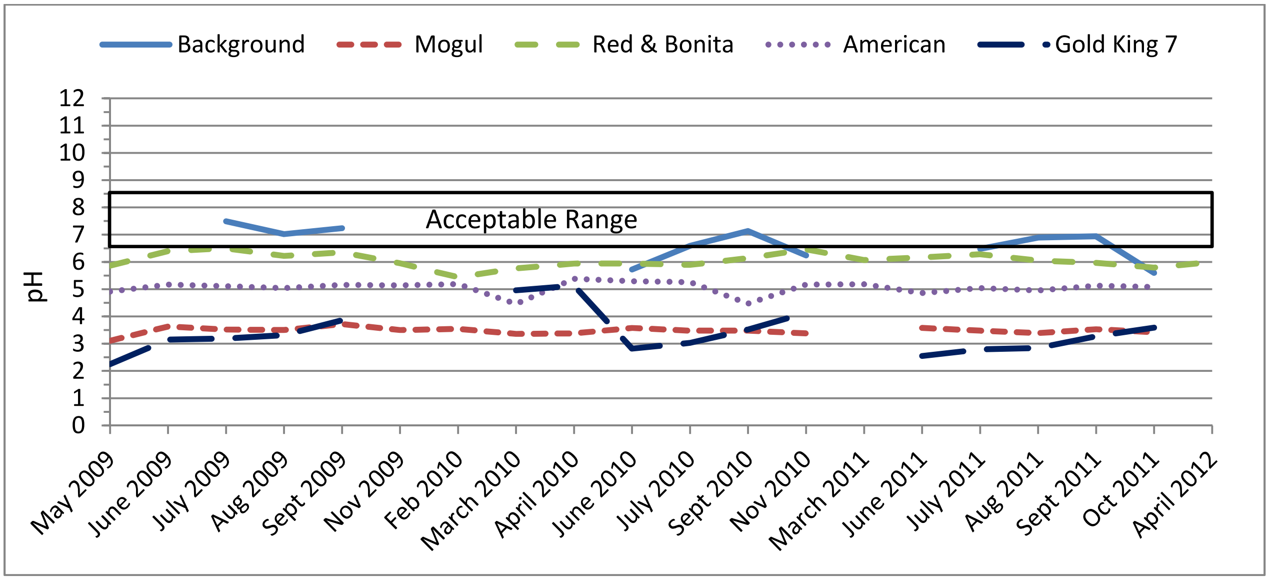


4.2 ACIDITY pH

Mine discharge water exhibited varying pH levels (Figure B). The pH values for samples collected from the American Tunnel were consistent and averaged 5 SU. Samples from the Mogul and the Gold King had lower pH values, each averaging 3.5 and 3.4 SU, respectively; however, the pH range at the Mogul is observed to be relatively narrow, between 3.1 to 3.72 SU, while the range observed at the Gold King varied more widely between 2.3 to 5.1 SU. The Red and Bonita exhibited a fairly consistent pH averaging 6.1 SU. Note that an independent pH measurement of 6.0 SU was obtained at the Red & Bonita in April 2012 when a light yellow-orange precipitate was observed to be releasing from the adit drainage (Sorenson 2012). A red-colored precipitate has been typical during site activities, although some lighter-colored precipitate is observed on the adit walls and on the mine dump.

All pH measurements from the adits were below an acceptable range of approximately 6.5 to 8.5 SU required for aquatic organisms to thrive. For comparison, results from a background sample (sample location CC01F) located above the Grand Mogul mine in upper Ross Basin was included on Figure B. Samples from that location averaged 6.7, within the acceptable pH range.

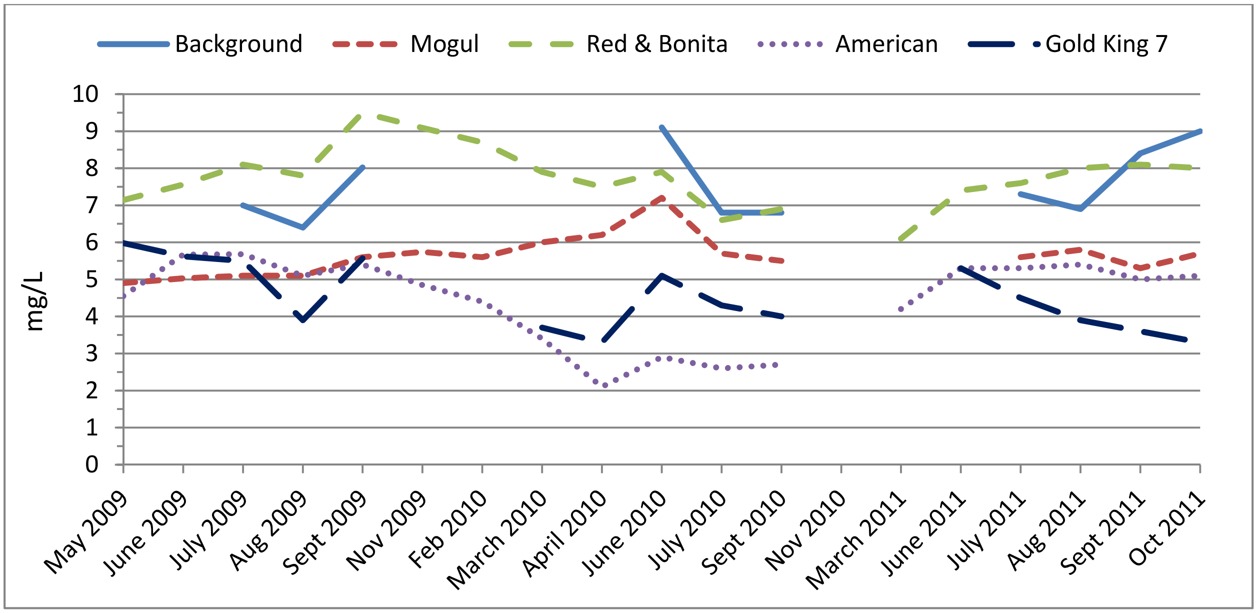
Figure B
Mine Discharge pH Values



4.3 DISSOLVED OXYGEN

Concentrations of dissolved oxygen (DO) from mine discharge water are shown in Figure C. It is important to note that DO was measured in channels near the mine adits that transport the mine discharge to Cement Creek. The mine discharge water will mix with air along the channel route to Cement Creek, thus the values are not representative of in situ conditions. The distance traveled and the amount of turbulence will vary for each site. This makes it difficult to interpret the data. However it should be noted that the four different mine discharges do vary in concentration of DO. Also, for illustration, a healthy stream will typically have a minimum DO amount of 4 to 5 milligrams per liter (mg/L) and, as shown in Figure C, the DO values are below 5 mg/L for the American Tunnel and Gold King 7 Level discharge. The “background” sample is location CC01F located above the Grand Mogul mine in upper Ross Basin.

Figure C
Dissolved Oxygen in Milligrams per Liter (mg/L)



4.4 METALS LOADING RATES

Metal loading from mine discharge waters into Cement Creek is presented in charts included in Appendix A. Loading charts for aluminum, cadmium, copper, iron, lead, manganese, nickel, and zinc were prepared, as these appeared to be the most egregious metals within the data sets provided for this investigation. Common among the charts is the observation that the Upper Gold King 7 Level mine appears to contribute the most metals overall to the Cement Creek drainage. However, the Red and Bonita mine contributes more lead and manganese than the Gold King.

4.5 STABLE WATER ISOTOPE AND TRITIUM ANALYSIS

Stable water isotope and tritium analysis was performed on mine discharge and Cement Creek samples to help characterize the sources of water and the flow paths, and provide an estimation of the age of the water. Isotopes are atoms of the same chemical element having the same number of protons but differing numbers of neutrons. They are alike chemically, but differ in mass. For this study, 30 water samples were analyzed for the presence of tritium (^{3}H), and stable water isotopes [oxygen-18 (^{18}O), and deuterium (^{2}H)]. These samples were collected from five different mine discharges (American Tunnel, Red and Bonita, Gold King 7 Level, Mogul, and Grand Mogul) and five different Cement Creek locations (Figure 2). Samples were collected in October 2010, March 2011, June 2011, September 2011 and October 2011.

4.5.1 Oxygen 18 (^{18}O), and Deuterium (^{2}H)

Analysis of ^{18}O and ^{2}H involves measuring the fractionation (isotope partitioning) of these stable isotopes that has occurred as a result of natural meteorological processes. The meteoric relationship of ^{18}O and ^{2}H arises from fractionation during condensation from the vapor mass. During phase changes of water between liquid and gas, the heavier water molecules tend to concentrate in the liquid phase, which fractionates the hydrogen and oxygen isotopes. Water that evaporates from the ocean, for example, is isotopically lighter than the water remaining behind. And precipitation is isotopically heavier; i.e., it contains more ^{2}H and ^{18}O than the vapor left behind in the atmosphere (Fetter 1988). Isotope ratios are expressed in delta units (δ) as *per mille* (parts per thousand, or ‰) differences relative to a standard. Fresh waters correlate on a global scale; therefore, a global meteoric water line (GMWL) or "standard mean ocean water line" was developed (Figure D). Continental precipitation will tend to group close to the GMWL while oceanic water will fall below the GMWL, as it is isotopically enriched. Figure D illustrates tight groupings of water samples from the collective mine adits, as well as a tight grouping of individual mines, with the exception of the Mogul mine.

The ^{18}O values observed at the site indicate that the mine adit discharges are very similar and dominated by infiltrated snowmelt that has been in residence in the subsurface for 5-15 years. The ^{18}O values for the Mogul were more enriched, suggesting some rain input. Water samples from Cement Creek vary widely in ^{18}O values, suggesting poorly mixed waters that are probably affected by the time of year the samples were obtained. Samples collected in June are more depleted in ^{18}O than samples collected in March, September and October, probably indicating a significant snowmelt component, which could be due to a recharge from infiltration of current years' snowmelt forcing older more depleted (-17δ to -18δ) water out into the stream; i.e., a "piston flow" concept that is common in the mountains. The more enriched values of ^{18}O (-14δ to -16δ) may indicate some contribution from monsoon rain. Samples collected in October are more enriched, perhaps indicating a large amount of rain input.

4.5.2 Tritium (^{3}H)

Tritium, ^{3}H, is an unstable isotope of hydrogen with a half-life of 12.4 years. Tritium within the atmosphere enters the groundwater as recharging precipitation. Beginning in

1953, the manufacturing and testing of nuclear weapons increased the amount of ^{3}H in the atmosphere, resulting in an increase of ^{3}H in the groundwater. Therefore ^{3}H can be used to approximate ages of groundwater, although age predictions are not precise due to temporal and spatial variations in ^{3}H injected into the atmosphere since 1953 (Fetter 1988). Per Clark and Fritz (1997), tritium values between 5 and 15 are representative of residence times of 5 to 15 years, commonly thought of as modern or "new" water. Tritium values in new precipitation in the San Juan Mountains are currently about 6 to 7 tritium units (TU). In general, snow typically has a lower ^{3}H concentration than spring or summer rain.

Amounts of ^{3}H in waters sampled at the site area range from 4.4 TU to 9.7 TU (Table 3). Only two values at the site were below 5 TU; one from the Mogul and one from the American Tunnel. Both of those samples were collected during base flow (October). Those two samples may indicate some small amount of older water, although still less than a 50-year residence time. Figure E is a plot of ^{3}H vs. delta ^{18}O. The five samples in the upper left corner on Figure E are from stream locations in upper Cement Creek. Tritium values for these samples indicate that these waters may be older (probably have some nuclear weapon-spiked water) than the other samples which mostly fall between 6 and 8 TU, indicating newer water. However ^{18}O values for the five samples indicate that the water is mostly snowmelt. Overall, the adit discharge values are all similar and are lower in tritium than surface waters. The higher values for surface water probably indicate that Cement Creek has a significant amount of very recent water; i.e., from the last few years.

Figure D
Stable Isotope Comparison in Mine Discharge and Surface Waters

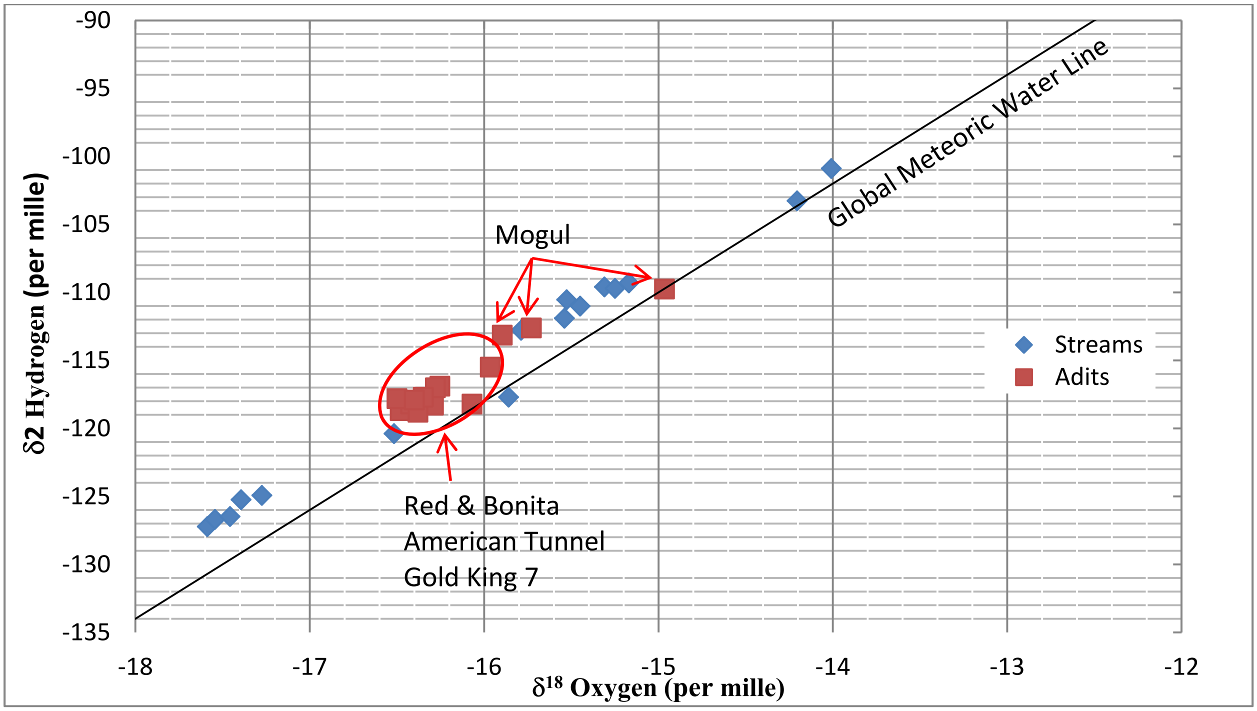
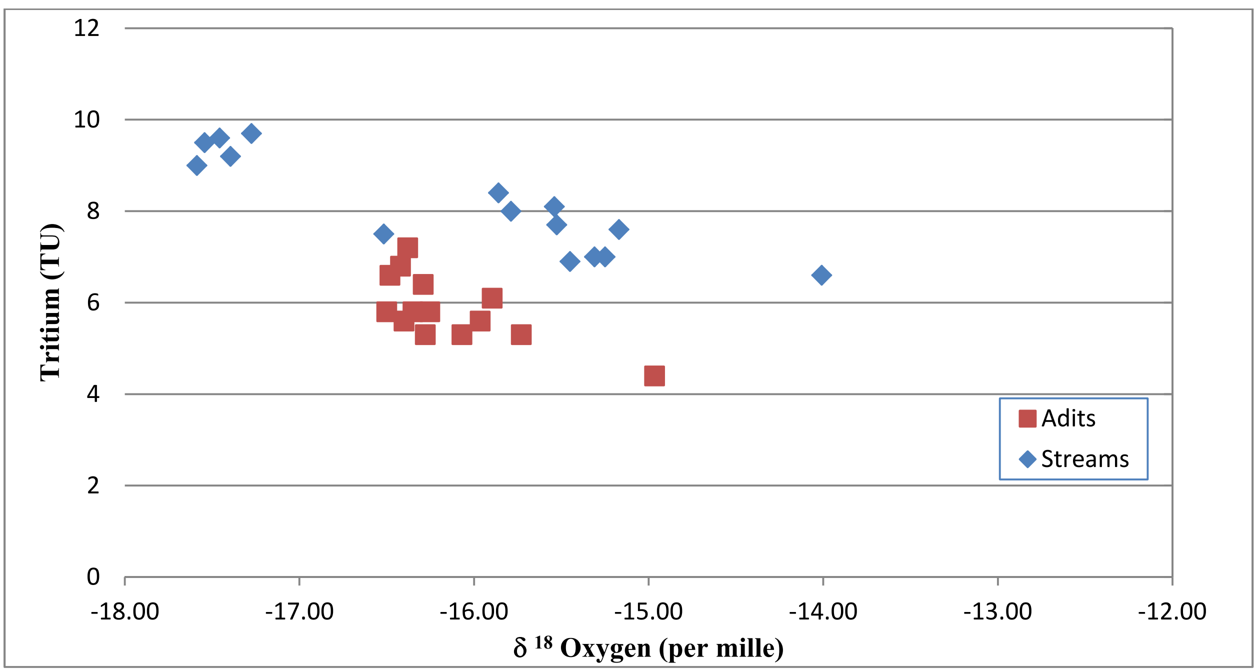


Figure E
Tritium vs. δ 18Oxygen – Mine Discharge and Cement Creek Waters



5.0 SUMMARY AND OBSERVATIONS

Infiltration of rain and snow are the primary sources of recharge in the upper Cement Creek watershed, with snowmelt being dominant over a multiple season basis. The late summer monsoon rains do provide recharge but not as much as snowmelt. As shown on Figures D and E, the samples from the American Tunnel, Red and Bonita, and the Gold King are tightly clustered, suggesting that they are similar and dominated by snowmelt. The samples from the Mogul are more enriched, suggesting more of a rain input. The residence time of water in the subsurface, from the time it enters as infiltrated snow/rain to the time it discharges via mine adits or to Cement Creek, is from 5 to 15 years. Water discharge from the adits is well-mixed, has a consistent signature, and is on average older than the water in Cement Creek, which indicates that the adit discharge water is from a mine pool and not from recent precipitation.

The period of greatest water flow at the site appears to be occurring during the May/June months when snow melt is most prevalent. The low flow period of the year appears to be around the month of August (Figures F and G). Metals loading to Cement Creek correlate with water flow amounts; i.e., as the water volume within Cement Creek changes, so does the relative amount of metals within the water. Therefore, a dilution effect does not seem to be occurring during high flow periods.

The aquifer at the site area is a fracture-controlled system that has been widely affected by mining activities during the past 141 years. Mine influences such as adits, tunnels, pits, etc., have provided preferential pathways for groundwater migration and have exposed minerals that chemically react with oxygen and water to produce acid mine drainage. A primary source for metals contamination in Cement Creek appears to occur via mine adit discharge while associated mine features, such as mine dumps, appear to contribute lesser amounts of metals loading. This scenario is observed at the Mogul Mine where water sampling indicated that contributions to the metals load in Cement Creek from the associated mine waste rock dump was small. As much as 95 percent of the load observed below the Mogul Mine appeared to be derived from the mine adit discharge (EPA 2012).

Chemical signatures among mine adit discharges sampled for this report varied with regard to the amount of metals being released; however, similar metals were observed at each adit. Metals loading graphs are included in Appendix A.

Mineralization that is present within typical mining regions promotes a commonly occurring red-colored ferric iron hydroxide and/or iron oxide precipitate known as “yellowboy.” Yellowboy is dropped from solution with pH changes, and as oxygen-deprived acidic water, rich in iron, oxidizes with newly available oxygen when exposed to atmospheric conditions. Red-colored yellowboy is observed at the Red and Bonita mine and, over many years, accumulated to an approximate 8-inch thickness on the top of the mine dump and precipitated onto the dump face. However, the yellowboy precipitate that was observed releasing from the adit drainage onto the mine dump face in the Spring of 2012 (post adit opening) had altered to a distinct light yellow-orange color. The Red and Bonita mine discharge water chemistry, however, appears to be consistent with prior years' observations (Tables 1 and 2). The reason for the color change is not fully understood at this time. Note, however, that iron hydroxide and iron oxide can be observed in color combinations of black, brown, red, and yellow varieties. Also of note is the presence of similar light yellow-orange colored precipitate observed by START on the dump face and within the adit, which was deposited prior to current activities at the site.

Typical red-colored yellowboy accumulation was observed to be as thick as approximately 3 feet within the mine adit as far back as 680 feet inby on June 6, 2012, the maximum adit distance explored by personnel to date. The adit was observed to continue for an undermined distance beyond 680 feet inby, and only one water inflow source was observed: 10 gpm at 283 feet inby. Therefore, the adit water chemistry does indicate a propensity to oxidize and precipitate available iron deep within the adit.

Figure F
Metals Loading & Flow Rate – Sample Location CC02D:
Mogul Mine Discharge Water

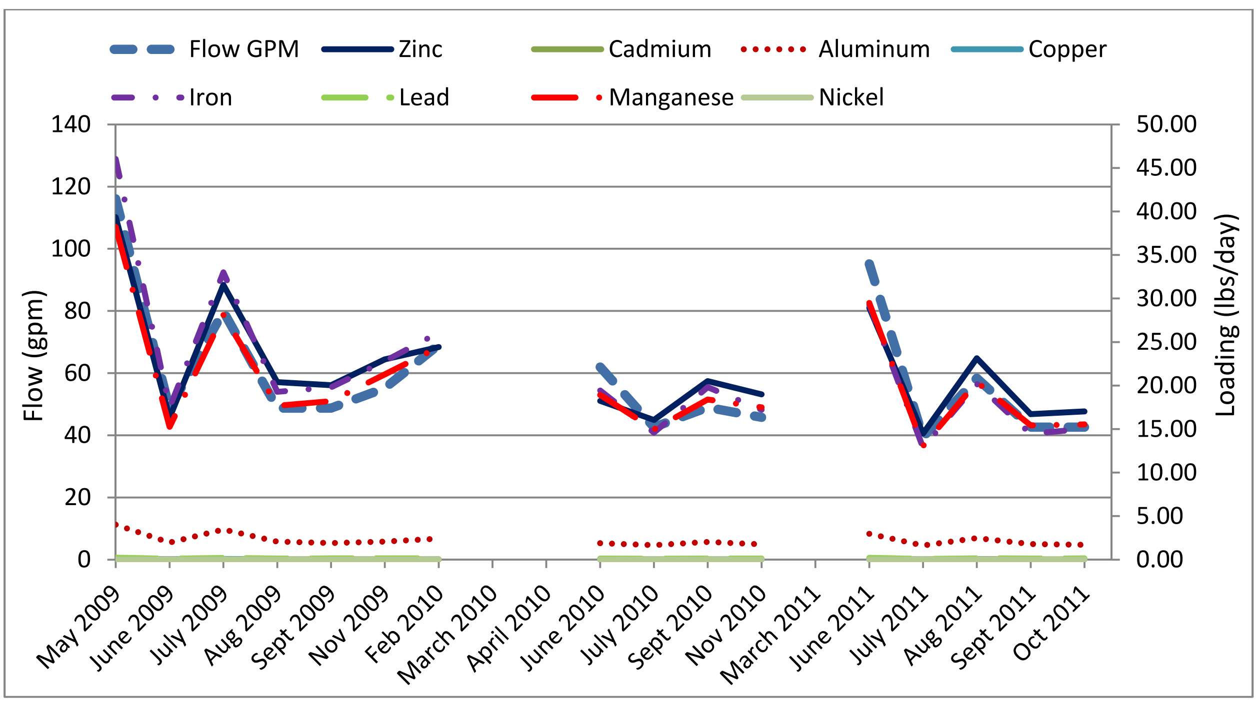
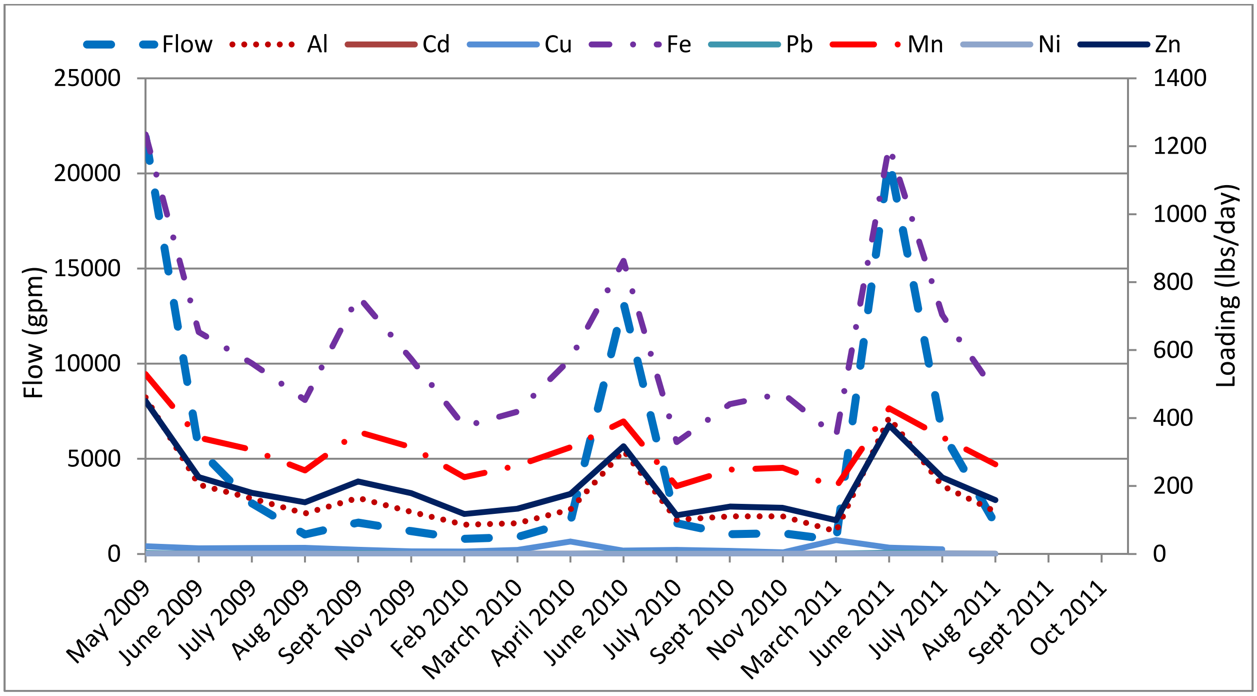


Figure G
Metals Loading & Flow Rate – Sample Location CC18:
Cement Creek above the South Fork Tributary, Below the Mine Site Area



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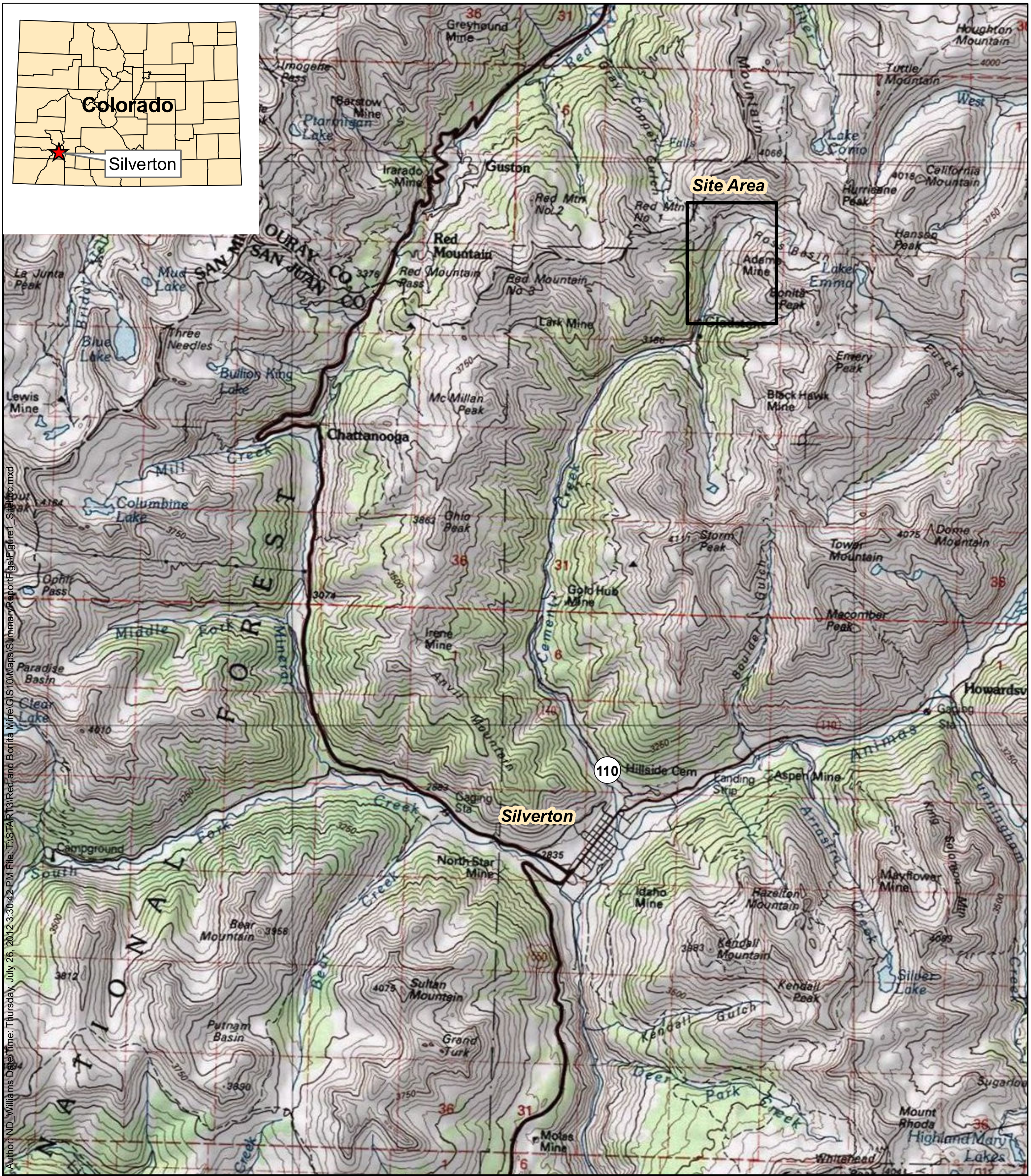


Projection System:
Universal Transverse
Mercator Zone 13 North
North American Datum 1983

NORTH

Miles

0 0.5 1 2

TDD Title: **Water Quality Report For Mines Within Cement Creek Watershed**

Figure: 1

Figure Title: Site Location Map

TDD County: San Juan

TDD State: CO

TDD: 1008-01

Date: 08/2012

URS
OPERATING SERVICES

Sources:
Arcservices World Topmap

Author: ND_Williams Date/Time: Thursday, August 23, 2012 11:04:51 AM File: T:\START3\Red and Bonita Mine\GIS10\Maps\SummaryReportFigs\Fig2_SummaryReport0312_11_17_2.mxd

TABLE 1
Field Data Parameters

	May 2009	Jun 2009	Jul 2009	Aug 2009	Sep 2009	Nov 2009	Feb 2010	Mar 2010	Apr 2010	Jun 2010	Jul 2010	Sep 2010	Nov 2010	Mar 2011	Jun 2011	Jul 2011	Aug 16 2011	Sep 13 2011	Oct 16 2011	May 16 2012
Background Station CC01F: Cement Creek upstream of Grand Mogul adit and tailings. Sample at start of steep uphill where grass border meets the scree of the Grand Mogul Mine. Called CCOPP-08 by EPA during July 2009 sampling event.																				
Flow (cfs)	--	--	1.11	0.101	0.200	--	--	--	--	4.61	0.389	0.075	--	--	--	3.6	0.384	0.110	0.101	--
Flow (gpm)	--	--	496.37	45.18	89.71	--	--	--	--	2068.97	174.58	33.66	--	--	--	1615.68	172.34	49.37	45.33	--
Temp (°C)	--	--	12.70	14.20	6.19	--	--	--	--	0.31	12.45	12.3	1.1	--	--	10.51	13.58	2.8	1.62	--
Cond (µS/cm)	--	--	257	365	327	--	--	--	--	129	282	332	276	--	--	221	362	365	293.2	--
pH (su)	--	--	7.49	7.02	7.24	--	--	--	--	5.72	6.59	7.13	6.24	--	--	6.48	6.89	6.94	5.6	--
DO (mg/l)	--	--	7.0	6.4	8.0	--	--	--	--	9.1	6.8	6.8	--	--	--	7.3	6.9	8.4	9	--
Acidity (mg/l)	--	--	<10	<10	<10	--	--	--	--	<10	<10	<10	<10	--	--	<10	<10	<10	<10	--
TSS (mg/l)	--	--	<20	<20	<20	--	--	--	--	<20	<20	<20	<20	--	--	<20	<20	<20	<20	--
TDS (mg/l)	--	--	44	250	220	--	--	--	--	85	190	200	180	--	--	150	270	240	190	--
Mogul Mine Adit Station CC02D: Mogul Mine adit. Collect sample downstream of the mine pool at the 3-inch Parshall Flume.																				
Flow (cfs)	0.259	0.108	0.178	0.109	0.109	0.123	0.154	--	--	0.138	0.095	0.109	0.102	--	0.212	0.088	0.13	0.095	0.095	0.231
Flow (gpm)	116.06	48.47	79.84	48.74	48.74	55.16	69.12	--	--	61.93	42.64	48.92	45.78	--	95.15	39.49	58.34	42.64	42.64	103.67
Temp (°C)	5.19	4.92	5.31	5.23	4.95	4.86	4.76	5.13	5.08	4.38	5.33	5.3	5.1	--	4.99	5.42	5.3	5.26	5.11	4.58
Cond (µS/cm)	1,274	1,254	1,296	1,344	1,347	1,365	1,345	1,327	1,322	785	1,315	1,357	1,364	--	1,172	1,255	1,338	1,419	1,388	1,113
pH (su)	3.11	3.63	3.52	3.50	3.72	3.50	3.54	3.36	3.38	3.58	3.48	3.48	3.38	--	3.58	3.48	3.39	3.53	3.42	3.53
DO (mg/l)	4.9	5.0	5.1	5.1	5.6	5.7	5.6	6	6.2	7.2	5.7	5.5	--	--	--	5.6	5.8	5.3	5.7	6.5
Acidity (mg/l)	--	130	160	170	150	140	130	160	--	140	140	160	140	--	120	130	150	170	150	--
TSS (mg/l)	--	22	26	<20	25	<20	<20	<20	--	<20	<20	24	<20	--	<20	<20	<20	<20	<20	--
TDS (mg/l)	--	1,100	1,100	1,200	1,200	1,100	1,100	1,100	--	1,000	1,300	1,100	1,000	--	960	1,100	1,200	1,100	1,200	--
Red & Bonita Culvert Station CC03D: Red and Bonita mine adit. Collect sample at culvert that goes under the road.																				
Flow (cfs)	0.749	0.699	0.664	0.676	0.749	--	--	--	0.403	0.488	0.517	0.541	0.46	--	0.724	0.676	0.7	0.744	0.709	--
Flow (gpm)	336.06	313.71	298.00	303.30	336.06	--	--	--	180.87	219.01	232.03	242.80	206.45	--	324.93	303.39	314.16	333.91	318.20	--
Temp (°C)	9.17	8.28	8.15	6.08	3.89	2.09	3.22	6.85	9.4	6.83	16.78	14.2	6.4	8.94	8.06	9.59	8.26	--	--	8.40
Cond (µS/cm)	2,074	2,051	2,090	2,098	2,114	2,169	2,181	2,207	2,288	2,207	2,173	2,188	2,164	2,244	2,026	2,028	2,076	--	--	2,220
pH (su)	5.86	6.40	6.50	6.22	6.35	5.95	5.44	5.76	5.94	5.94	5.89	6.14	6.46	6.07	6.17	6.28	6.05	5.96	5.79	6.23
DO (mg/l)	7.1	7.6	8.1	7.8	9.5	9.1	8.7	7.9	7.5	7.9	6.6	6.9	--	6.1	7.4	7.6	8	8.1	8	7.9
Acidity (mg/l)	--	200	220	233	250	210	200	240	--	240	230	190	220	250	230	170	190	180	180	--
TSS (mg/l)	--	33	23	27	28	23	22	22	--	28	24	25	27	33	25	32	110	54	51	--
TDS (mg/l)	--	2,000	2,000	2,100	2,100	2,000	2,100	2,200	--	2,100	2,100	2,000	2,000	2,100	2,000	2,000	2,100	2,100	2,200	--

TABLE 1, cont.
Field Data Parameters

	May 2009	Jun 2009	Jul 2009	Aug 2009	Sep 2009	Nov 2009	Feb 2010	Mar 2010	Apr 2010	Jun 2010	Jul 2010	Sep 2010	Nov 2010	Mar 2011	Jun 2011	Jul 2011	Aug 16 2011	Sep 13 2011		Oct 16 2011	May 16 2012
American Tunnel Station CC19: American Tunnel mine adit. Sample where flow comes out of the ground.																					
Flow (cfs)	0.318	0.309	0.231	0.212	0.221	0.278	0.178	0.204	0.204	0.24	0.24	0.268	0.24	0.212	0.24	0.212	0.221	0.221		0.24	--
Flow (gpm)	142.72	138.68	103.45	95.33	99.36	124.72	79.89	91.56	91.56	107.71	107.71	120.28	107.71	95.15	107.71	95.15	99.18	99.18		107.71	--
Temp (°C)	7.56	7.66	7.71	7.70	7.69	7.65	7.63	7.62	7.61	7.52	7.78	7.8	7.7	7.63	7.48	7.65	7.68	7.68		7.69	8.86
Cond (µS/cm)	2,338	2,426	2,445	2,425	2,409	2,511	1,957	2,428	2,450	1,430	2,352	2,451	2,386	2,395	2,308	2,389	2,409	2,379		2,385	2,399
pH (su)	4.91	5.17	5.11	5.04	5.16	5.14	5.19	4.46	5.38	5.29	5.26	4.47	5.17	5.18	4.86	5.04	4.95	5.13		5.08	5.01
DO (mg/l)	4.6	5.7	5.7	5.1	5.4	4.9	4.4	3.4	2.1	2.9	2.6	2.7	--	4.2	5.3	5.3	5.4	5		5.1	6.8
Acidity (mg/l)	--	360	380	390	380	350	360	380	--	380	380	360	340	350	330	360	320	320		350	--
TSS (mg/l)	--	24	26	<20	<20	<20	<20	<20	--	<20	<20	<20	27	<20	28	31	82	<20		28	--
TDS (mg/l)	--	2,600	2,900	2,400	2,600	2,400	2,300	2,300	--	2,400	2,500	2,300	2,300	2,500	2,500	2,500	2,100	2,500		2,600	--
Upper Gold King 7-Level Adit Station CC06: 7-Level mine adit upstream of the confluence with the North Fork of Cement Creek. Sample where flow comes out of the mine tunnel.																					
Flow (cfs)	0.423	0.498	0.436	0.358	0.562	--	--	--	0.333	0.558	0.485	0.449	0.473	--	0.328	0.298	0.308	0.318		0.313	0.278
Flow (gpm)	189.80	223.50	195.49	160.51	252.42	--	--	--	149.45	250.43	217.67	201.51	212.28	--	147.21	133.74	138.23	142.72		140.47	124.76
Temp (°C)	8.76	8.24	8.20	8.11	8.04	--	--	7.96	7.98	8.5	8.19	8	8	--	8.56	8.42	8.13	8.02		7.95	7.96
Cond (µS/cm)	3,076	2,481	2,476	2,381	2,175	--	--	1,953	1,955	3,084	2,443	2,250	2,064	--	3,060	2,835	2,546	2,326		2,147	2,116
pH (su)	2.25	3.15	3.19	3.31	3.86	--	--	4.96	5.13	2.82	3.03	3.52	4.13	--	2.55	2.79	2.84	3.27		3.59	3.25
DO (mg/l)	6.0	5.6	5.5	3.9 **	5.6	--	--	3.7	3.3	5.1	4.3	4	--	--	5.3	4.5	3.9	3.6		3.3	4.8
Acidity (mg/l)	--	470	440	410	330	--	--	170	--	1,000	420	310	250	--	1,100	850	550	410		320	--
TSS (mg/l)	--	29	30	<20	20	--	--	<20	--	<20	26	23	<20	--	<20	28	<20	<20		28	--
TDS (mg/l)	--	2,300	2,200	2,300	2,100	--	--	1,700	--	3,100	2,500	1,900	1,900	--	3,500	2,900	2,500	2,300		2,200	--
Red & Bonita Adit Station CC03C: Red and Bonita mine adit at the portal. Do not take flow measurements at this site.																					
Flow (cfs)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Portal collapse opened 9-15-11	--	--
Temp (°C)	--	--	--	--	--	--	--	--	--	--	--	6.2	5.9	--	--	6.05	6.15	6.12		6.05	6.08
Cond (µS/cm)	--	--	--	--	--	--	--	--	--	--	--	2,201	1,578	--	--	2,069	2,083	2,088		2,104	2,235
pH (su)	--	--	--	--	--	--	--	--	--	--	--	5.97	5.86	--	--	6.06	5.99	5.73		5.65	5.68
DO (mg/l)	--	--	--	--	--	--	--	--	--	--	--	6.9	--	--	--	7	7	3.7		6.9	6.6
Acidity (mg/l)	--	--	--	--	--	--	--	--	--	--	--	210	220	--	--	200	200	210		180	--
TSS (mg/l)	--	--	--	--	--	--	--	--	--	--	--	<20	<20	--	--	<20	<20	21		51	--
TDS (mg/l)	--	--	--	--	--	--	--	--	--	--	--	2,000	2,000	--	--	2,100	2,100	2,200		2,200	--

cfs – cubic feet per second
°C – degrees centigrade
su – standard units
< - less than
gpm – gallons per minute
µS/cm – microsiemens per centimeter
mg/l – milligrams per liter
-- - no sample data

TABLE 2
Laboratory Metals Sample Data

	May 2009	Jun 2009	Jul 2009	Aug 2009	Sep 2009	Nov 2009	Feb 2010	Mar 2010	Apr 2010	Jun 2010	Jul 2010	Sep 2010	Nov 2010	Mar 2011	Jun 2011	Jul 2011	Aug 16 2011	Sep 13 2011	Oct 16 2011	May 16 2012
Background Station CC01F: Cement Creek upstream of Grand Mogul adit and tailings. Sample at start of steep uphill where grass border meets the scree of the Grand Mogul Mine. Called CCOPP-08 by EPA during July 2009 sampling event.																				
Al (T) (µg/l)	--	--	204	226	243	--	--	--	--	248	154	261	294	--	--	166	179	151	224	--
Al (D) (µg/l)	--	--	180	204	181	--	--	--	--	<100	137	151	<25.0	--	--	<100	116	<100	<100	--
Al Load (lb/day)	--	--	1.22	0.123	0.262	--	--	--	--	6.2	0.3	0.1	--	--	--	3.2	0.4	0.1	0.1	--
Cd (T) (µg/l)	--	--	1	1.2	1.5	--	--	--	--	2.1	1	1.6	3.1	--	--	1.2	1.1	1.1	2.6	--
Cd (D) (µg/l)	--	--	0.9	1.2	1.6	--	--	--	--	1.9	1	1.7	3.2	--	--	1.1	1.1	1.1	2.7	--
Cd Load (lb/day)	--	--	0.01	0.001	0.002	--	--	--	--	0.1	0.002	0.001	--	--	--	0.02	0.002	0.00	0.001	--
Cu (T) (µg/l)	--	--	25.4	25.6	28.3	--	--	--	--	44.2	24.4	34.4	46.4	--	--	26.1	23.5	20.4	36.5	--
Cu (D) (µg/l)	--	--	19.7	20.4	18	--	--	--	--	27.2	17.1	19.8	26.8	--	--	<20.0	<20.0	<20.0	22.9	--
Cu Load (lb/day)	--	--	0.15	0.014	0.031	--	--	--	--	1.1	0.1	0.01		--	--	0.5	0.05	0.01	0.02	--
Fe (T) (µg/l)	--	--	<100	<100	<100	--	--	--	--	<100	<100	<10.0	<10.0	--	--	<100	<100	<100	<100	--
Fe (D) (µg/l)	--	--	<100	<100	<100	--	--	--	--	<100	<100	<10.0	<10.0	--	--	<100	<100	<100	<100	--
Fe Load (lb/day)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pb (T) (µg/l)	--	--	3.3	1.5	1.9	--	--	--	--	11.5	2.5	1.8	1.4	--	--	7.1	1.9	1.6	1.5	--
Pb (D) (µg/l)	--	--	2.3	<1.0	<1.0	--	--	--	--	<1.0	1.2	<0.2	<0.2	--	--	3.5	<1.0	<1.0	<1.0	--
Pb Load (lb/day)	--	--	0.02	0.001	0.002	--	--	--	--	0.3	0.01	0.001		--	--	0.1	0.004	0.001	0.001	--
Mn (T) (µg/l)	--	--	48	36.1	66	--	--	--	--	157	42	72.1	132	--	--	75.8	45.4	50	121	--
Mn (D) (µg/l)	--	--	47.0	35.6	66.1	--	--	--	--	148	40.5	73	125	--	--	73.6	45.1	55.9	120	--
Mn Load (lb/day)	--	--	0.29	0.020	0.071	--	--	--	--	3.9	0.1	0.0	0.0	--	--	1.5	0.1	0.0	0.1	--
Ni (T) (µg/l)	--	--	<2	<2.0	<2.0	--	--	--	--	<4.0	<4.0	<0.7	<0.7	--	--	<4.0	<4.0	<4.0	<4.0	--
Ni (D) (µg/l)	--	--	<2.00	<2.0	<2.0	--	--	--	--	<4.0	<4.0	<0.7	<0.7	--	--	<4.0	<4.0	<4.0	<4.0	--
Ni Load (lb/day)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zn (T) (µg/l)	--	--	193	185	279	--	--	--	--	379	180	262	661	--	--	238	179	188	505	--
Zn (D) (µg/l)	--	--	175	179	259	--	--	--	--	370	179	276	604	--	--	233	177	196	492	--
Zn Load (lb/day)	--	--	1.15	0.100	0.301	--	--	--	--	9.4	0.4	0.1	0.0	--	--	4.6	0.4	0.1	0.3	--
Mogul Mine Adit Station CC02D: Mogul Mine adit. Collect sample downstream of the mine pool at the 3-inch Parshall Flume.																				
Al (T) (µg/l)	2,880	3,360	3,610	3,530	3,250	3,130	2,910	2,720	2,420	2,520	3,250	3,440	3,180	--	2,600	3,420	3,530	3,490	3,330	2,960
Al (D) (µg/l)	2,850	3,150	3,630	3,580	3,320	3,140	2,910	2,610	2,510	2,390	3,110	3,700	3,230	--	2,610	3,400	3,690	3,480	3,340	2,840
Al Load (lb/day)	4.02	1.96	3.46	2.07	1.90	2.07	2.4	--	--	1.9	1.7	2.0	1.7	--	3.0	1.6	2.5	1.8	1.7	--
Cd (T) (µg/l)	41.3	57.2	62.1	60.8	58.4	50.1	43.2	40.8	41.4	40.3	54.3	57.6	54	--	36.8	50.1	60.4	58.4	54.1	35.5
Cd (D) (µg/l)	40.6	51.8	63	61.8	58.5	52.5	43.5	39.3	41	38.9	56.3	55.7	54.2	--	37.5	51.7	63.6	60.3	51.4	36.9
Cd Load (lb/day)	0.06	0.03	0.06	0.04	0.03	0.03	0.0	--	--	0.03	0.03	0.03	0.03	--	0.04	0.02	0.04	0.03	0.03	--
Cu (T) (µg/l)	33.9	50.4	45.5	31.4	30.9	21.6	16.9	17.9	19.7	22.6	31.6	23.8	14.7	--	24.6	35.2	29.9	29.5	<20.0	19.2

TABLE 2, cont.
Laboratory Metals Sample Data

	May 2009	Jun 2009	Jul 2009	Aug 2009	Sep 2009	Nov 2009	Feb 2010	Mar 2010	Apr 2010	Jun 2010	Jul 2010	Sep 2010	Nov 2010	Mar 2011	Jun 2011	Jul 2011	Aug 16 2011	Sep 13 2011	Oct 16 2011	May 16 2012
Cu (D) (µg/l)	32.5	54.2	44.1	31.7	29.1	24	16.2	18.3	19.9	22.3	32.2	22.1	14.5	--	24.3	33.3	30.8	30.4	<20.0	22.1
Cu Load (lb/day)	0.05	0.03	0.04	0.02	0.02	0.01	0.0	--	--	0.02	0.02	0.01	0.01	--	0.03	0.02	0.02	0.02	--	--
Fe (T) (µg/l)	33,000	30,000	34,400	32,900	33,800	34,400	31,400	33,000	29,500	26,100	28,500	33,700	31,300	--	25,600	27,100	28,800	28,200	29,300	29,700
Fe (D) (µg/l)	28,800	24,800	29,200	30,100	31,000	30,300	30,800	27,500	27,400	22,000	26,000	30,200	29,600	--	23,700	24,700	27,000	26,200	27,700	23,200
Fe Load (lb/day)	46.03	17.48	33.01	19.27	19.80	22.80	26.1	--	--	19.4	14.6	19.8	17.2	--	29.3	12.9	20.2	14.4	15.0	--
Pb (T) (µg/l)	147	174	202	212	238	213	184	189	181	168	193	232	231	--	170	189	229	235	254	188
Pb (D) (µg/l)	142	160	207	227	241	219	189	182	178	153	186	219	238	--	174	186	228	236	242	179
Pb Load (lb/day)	0.21	0.10	0.19	0.12	0.14	0.14	0.2	--	--	0.1	0.1	0.1	0.1	--	0.2	0.1	0.2	0.1	0.1	--
Mn (T) (µg/l)	27,400	26,200	29,300	30,200	31,100	32,100	29,400	30,800	29,200	25,400	29,200	31,300	31,800	--	25,800	27,500	29,100	30,100	30,300	24,500
Mn (D) (µg/l)	26,700	24,200	28,200	30,300	31,600	31,000	31,100	29,100	29,100	24,100	28,500	33,100	32,900	--	26,000	27,200	29,100	29,900	30,700	24,500
Mn Load (lb/day)	38.22	15.26	28.11	17.69	18.22	21.28	24.4	--	--	18.9	15.0	18.4	17.5	--	29.5	13.1	20.4	15.4	15.5	--
Ni (T) (µg/l)	12	13.3	14	13.7	14.5	14.5	14.2	12.9	11.9	12.2	12.4	12.8	13.7	--	11.2	12	12.2	13	12	10.5
Ni (D) (µg/l)	11.8	11	13.2	13.5	15.1	14.2	14.7	13.3	12.4	8.8	10.2	14.1	13.1	--	10.8	12.6	12.6	12.5	12.3	9.36
Ni Load (lb/day)	0.02	0.01	0.01	0.01	0.01	0.01	0.0	--	--	0.0	0.01	0.01	0.01	--	0.0	0.0	0.009	0.007	0.006	--
Zn (T) (µg/l)	28,200	28,000	32,900	34,800	34,200	34,700	29,400	29,200	27,800	24,500	31,300	34,900	34,500	--	25,300	30,500	33,000	32,600	33,200	28,100
Zn (D) (µg/l)	26,400	25,100	31,600	33,600	34,700	32,200	31,200	28,500	25,800	22,900	29,800	36,700	37,800	--	25,600	29,800	32,800	32,900	33,700	28,800
Zn Load (lb/day)	39.33	16.31	31.57	20.38	20.03	23.00	24.4	--	--	18.2	16.0	20.5	19.0	--	28.9	14.5	23.1	16.7	17.0	--
Red & Bonita Culvert Station CC03D: Red and Bonita mine adit. Collect sample at culvert that goes under the road.																				
Al (T) (µg/l)	4,030	3,040	3,380	3,500	3,520	3,780	4,410	3,960	3,820	3,890	4,050	3,920	3,990	3,790	4,130	3,750	3,360	--	--	4,800
Al (D) (µg/l)	3,320	1,840	2,000	2,640	2,440	3,270	3,920	2,690	2,280	2,770	4,050	2,970	2,000	2,440	2,890	2,240	2,450	--	--	2,750
Al Load (lb/day)	16.3	11.5	12.1	12.8	14.2	No Flow	--	--	8.3	10.2	11.3	11.4	9.9	--	16.1	13.7	12.7	--	--	--
Cd (T) (µg/l)	33.3	34.8	34.9	34.6	35.9	37.7	37.5	37.6	37.3	40.4	35.5	35.5	38	33	31.8	30	29	--	--	14.7
Cd (D) (µg/l)	33.1	34.4	34.5	34.5	37.5	37.3	38.1	36.5	40.9	39.3	37.2	34.1	38	34	33.2	28.6	29.6	--	--	33.2
Cd Load (lb/day)	0.1	0.1	0.1	0.1	0.1	No Flow	--	--	0.1	0.1	0.1	0.1	0.1	--	0.1	0.1	0.1	--	--	--
Cu (T) (µg/l)	50.6	4.5	6.2	6.9	4.1	8.6	47.1	14.2	18	14.3	<10.0	17.8	11.3	16.7	38.2	<20.0	<20.0	--	--	<5.00
Cu (D) (µg/l)	41.1	<3.0	3.5	4.5	<3.0	8.9	41.8	11.2	13.8	11.4	<10.0	13.6	<4.0	11.5	30.3	<20.0	<20.0	--	--	<5.00
Cu Load (lb/day)	0.2	0.0	0.0	0.0	0.0	No Flow	--	--	0.04	0.04	--	0.1	0.03	--	0.1	--	--	--	--	--
Fe (T) (µg/l)	86,700	76,700	87,700	88,000	96,700	96,100	82,300	93,500	97,600	89,400	79,900	81,600	96,500	87,400	88,000	84,200	78,800	--	--	96,800
Fe (D) (µg/l)	80,500	81,200	85,800	85,800	94,100	91,600	83,100	85,600	87,100	83,100	84,000	86,100	92,700	88,800	82,800	76,900	82,300	--	--	87,900
Fe Load (lb/day)	350.2	289.2	314.1	320.8	390.6	No Flow	--	--	212.2	235.3	222.8	238.1	239.4	--	343.6	307.0	297.5	--	--	--
Pb (T) (µg/l)	71.2	39.5	36.5	34	41.4	37.2	47.2	58.7	55.3	57.7	40	38.4	60.7	63.2	76.8	46.2	36.7	--	--	88.7
Pb (D) (µg/l)	8.1	4.1	7.6	9.1	15.4	4.6	4.3	3.6	2.1	9	10.7	6.2	7.9	3.9	7.3	5.3	6.9	--	--	5.05
Pb Load (lb/day)	0.3	0.1	0.1	0.1	0.2	No Flow	--	--	0.1	0.2	0.1	0.1	0.2	--	0.3	0.2	0.1	--	--	--
Mn (T) (µg/l)	33,200	27,900	32,300	32,500	34,600	35,700	34,100	35,100	36,300	33,200	31,500	32,700	35,300	32,900	31,800	31,400	29,900	--	--	36,300
Mn (D) (µg/l)	32,300	30,800	32,100	32,700	33,700	35,000	35,200	32,900	32,500	31,700	32,900	35,700	34,100	34,400	31,700	30,400	30,500	--	--	34,200

TABLE 2, cont.
Laboratory Metals Sample Data

	May 2009	Jun 2009	Jul 2009	Aug 2009	Sep 2009	Nov 2009	Feb 2010	Mar 2010	Apr 2010	Jun 2010	Jul 2010	Sep 2010	Nov 2010	Mar 2011	Jun 2011	Jul 2011	Aug 16 2011	Sep 13 2011	Oct 16 2011	May 16 2012
Mn Load (lb/day)	134.1	105.2	115.7	118.5	139.7	No Flow	--	--	78.9	87.4	87.8	95.4	87.6	--	124.2	114.5	112.9	--	--	--
Ni (T) (µg/l)	52	44.1	50	52.5	53.8	57.1	56.9	59.1	56.5	55.1	52.3	53.2	56.9	55.4	51.3	50.6	48.9	--	--	51
Ni (D) (µg/l)	51.9	47.7	47.9	50.4	55.5	57.3	59.4	55.9	54.7	52	49.5	56.6	57.1	56	50.9	49.2	49.5	--	--	52.1
Ni Load (lb/day)	0.2	0.2	0.2	0.2	0.2	No Flow	--	--	0.1	0.1	0.15	0.16	0.14	--	0.2	0.2	0.2	--	--	--
Zn (T) (µg/l)	15,600	13,600	15,500	15,800	16,400	17,400	16,000	16,500	17,500	15,500	14,500	15,300	16,600	15,500	14,800	14,500	13,400	--	--	17,900
Zn (D) (µg/l)	14,300	13,600	15,000	15,000	16,100	16,400	16,900	15,500	14,200	14,900	14,800	16,500	17,200	15,500	14,600	13,600	14,200	--	--	16,800
Zn Load (lb/day)	63.0	51.3	55.5	57.6	66.2	No Flow	--	--	38.0	40.8	40.4	44.6	41.2	0.0	57.8	52.9	50.6	--	--	--
American Tunnel Station CC19: American Tunnel mine adit. Sample where flow comes out of the ground.																				
Al (T) (µg/l)	5,680	5,520	5,510	5,380	5,510	5,470	5,480	4,960	5,100	5,070	5,310	4,970	5,360	4,840	5,160	5,180	4,850	4,750	4,690	5,350
Al (D) (µg/l)	5,360	5,530	5,250	5,240	5,280	4,830	5,180	4,810	4,710	4,200	5,310	4,930	4,660	4,870	4,810	4,900	4,870	4,680	4,660	4,890
Al Load (lb/day)	9.74	9.20	6.85	6.16	6.58	8.20	5.3	5.5	5.6	6.6	6.9	7.2	6.9	5.5	6.7	5.9	5.8	5.7	6.1	--
Cd (T) (µg/l)	2.6	2.5	2.5	2.5	2.5	2.3	2.3	2.3	2.4	2.3	2.1	2.1	2.3	2	2.3	2.2	2.2	2.1	2.1	2.14
Cd (D) (µg/l)	2.6	2.5	2.4	2.3	2.4	2.4	2.2	2.3	2.5	2.2	2.2	2	2.5	1.9	2.2	2	2.2	2.1	2	2.55
Cd Load (lb/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.003	0.003	0.003	0.003	0.003	0.002	0.003	0.003	0.003	0.003	0.003	--
Cu (T) (µg/l)	7.9	7	6.2	6.3	6.6	6.5	5.9	8.9	6.6	<10.0	<10.0	<4.0	<4.0	<10.0	<10.0	<20.0	<20.0	<20.0	<20.0	<5.00
Cu (D) (µg/l)	7.3	6.4	6.1	6	6.6	5.4	5.7	8.3	6.2	<10.0	<10.0	<4.0	<4.0	<10.0	<10.0	<20.0	<20.0	<20.0	<20.0	<5.00
Cu Load (lb/day)	0.01	0.01	0.01	0.01	0.01	0.01	0.0	0.0	0.0	--	--	--	--	--	--	--	--	--	--	--
Fe (T) (µg/l)	142,000	133,000	144,000	141,000	152,000	155,000	143,000	143,000	161,000	150,000	148,000	147,000	148,000	144,000	141,000	138,000	138,000	132,000	142,000	140,000
Fe (D) (µg/l)	139,000	135,000	143,000	141,000	144,000	129,000	148,000	145,000	159,000	136,000	157,000	164,000	142,000	135,000	134,000	135,000	139,000	129,000	136,000	134,000
Fe Load (lb/day)	243.56	221.67	179.03	161.53	181.52	232.33	137.3	157.3	177.2	194.2	191.6	212.5	191.6	164.7	182.5	157.8	164.5	157.3	183.8	--
Pb (T) (µg/l)	4.7	3.9	3.3	3.2	3.6	3.3	3.4	5.4	4.1	4.2	4	3.6	3	3	3.8	3.2	2.9	2.7	2.9	3.51
Pb (D) (µg/l)	2.3	1.9	2	1.8	1.9	1.7	1.4	1.8	2	2.2	2.5	2.5	1.5	1.3	2	1.2	1.7	1.3	1.3	1.26
Pb Load (lb/day)	0.01	0.01	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.01	0.01	0.01	0.004	0.003	0.005	0.004	0.003	0.003	0.004	--
Mn (T) (µg/l)	49,400	46,600	49,800	52,000	50,700	52,000	46,400	48,300	50,400	47,800	47,800	47,400	50,400	48,800	48,400	49,500	47,000	46,900	49,000	47,800
Mn (D) (µg/l)	48,900	47,200	49,200	48,800	49,200	44,900	49,500	50,300	49,700	44,500	49,900	51,400	49,100	47,500	47,700	47,800	47,600	47,200	46,500	47,200
Mn Load (lb/day)	84.73	77.67	61.91	59.57	60.55	77.94	44.5	53.1	55.5	61.9	61.9	68.5	65.2	55.8	62.7	56.6	56.0	55.9	63.4	--
Ni (T) (µg/l)	66	61.7	66	70.4	69.1	69.7	67.7	60.8	66.4	63.5	66.4	64.1	69.6	68	62.7	67.4	65.7	64.3	63.1	57.9
Ni (D) (µg/l)	64.1	61.5	64.6	63.2	69	60	69.7	67.2	67.8	56.7	65.2	71.5	66.8	64.4	62.6	66.5	63.2	62.8	60.9	58.8
Ni Load (lb/day)	0.11	0.10	0.08	0.08	0.08	0.10	0.1	0.1	0.1	0.1	0.09	0.09	0.09	0.1	0.1	0.1	0.1	0.1	0.1	--
Zn (T) (µg/l)	19,200	17,900	19,900	19,600	20,500	21,400	19,000	19,700	20,600	18,700	18,300	17,800	21,000	20,500	19,100	19,700	19,000	18,500	20,800	20,900
Zn (D) (µg/l)	19,500	17,800	20,000	19,500	20,100	17,400	19,900	20,600	18,400	17,600	19,700	20,400	21,400	18,500	18,900	19,900	19,500	18,200	19,300	20,800
Zn Load (lb/day)	32.93	29.83	24.74	22.45	24.48	32.08	18.2	21.7	22.7	24.2	23.7	25.7	27.2	23.4	24.7	22.5	22.6	22.1	26.9	--

TABLE 2, cont.
Laboratory Metals Sample Data

	May 2009	Jun 2009	Jul 2009	Aug 2009	Sep 2009	Nov 2009	Feb 2010	Mar 2010	Apr 2010	Jun 2010	Jul 2010	Sep 2010	Nov 2010	Mar 2011	Jun 2011	Jul 2011	Aug 16 2011	Sep 13 2011	Oct 16 2011	May 16 2012
Upper Gold King 7-Level Adit Station CC06: 7-Level mine adit upstream of the confluence with the North Fork of Cement Creek. Sample where flow comes out of the mine tunnel.																				
Al (T) (µg/l)	58,300	32,900	31,800	28,500	21,500	--	8,310	8,240	7,840	61,600	30,200	24,200	18,600	--	57,400	53,500	36,700	28,700	21,000	21,200
Al (D) (µg/l)	59,000	33,400	31,900	28,600	21,600	--	7,670	8,040	7,220	57,700	30,200	25,700	17,300	--	60,000	52,200	39,200	28,300	21,700	21,000
Al Load (lb/day)	133.0	88.4	74.7	55.0	65.2	--	--	--	14.1	185.4	79.0	58.6	47.5	--	101.5	86.0	61.0	49.2	35.5	--
Cd (T) (µg/l)	111	59.9	61.4	66.2	64.4	--	38.3	37.7	41.4	136	61.5	57.5	52.9	--	136	61.1	69.3	55.7	58.7	56.4
Cd (D) (µg/l)	110	71.6	60.8	66.6	62.7	--	35.9	36.1	41	133	63.2	56.9	53.3	--	138	62.2	72.2	60.3	58.8	57.1
Cd Load (lb/day)	0.3	0.2	0.1	0.1	0.2	--	--	--	0.1	0.4	0.2	0.1	0.1	--	0.241	0.098	0.115	0.096	0.099	--
Cu (T) (µg/l)	10,600	5,680	5,710	7,150	5,630	--	2,430	2,410	4,060	12,300	5,360	5,480	4,020	--	12,400	9,930	8,330	6,420	5,220	3,730
Cu (D) (µg/l)	10,100	5,520	5,520	7,310	5,440	--	2,450	2,620	2,690	12,100	4,970	5,540	3,900	--	11,900	9,490	8,370	6,350	4,950	3,800
Cu Load (lb/day)	24.2	15.3	13.4	13.8	17.1	--	--	--	7.3	37.0	14.0	13.3	10.3	--	21.9	16.0	13.8	11.0	8.8	--
Fe (T) (µg/l)	244,000	107,000	101,000	96,700	86,000	--	55,300	56,200	54,000	243,000	87,400	72,100	67,600	--	254,000	188,000	123,000	89,200	81,200	50,300
Fe (D) (µg/l)	240,000	102,000	91,900	90,400	80,800	--	52,300	54,000	47,400	213,000	81,900	75,200	65,800	--	257,000	175,000	123,000	83,800	72,500	46,800
Fe Load (lb/day)	556.6	287.4	237.3	186.5	260.9	--	--	--	97.0	731.4	228.6	174.6	172.5	--	--	--	--	153.0	137.1	--
Pb (T) (µg/l)	24.7	18.1	21.5	24.9	16.3	--	1.9	1.8	1.8	21.3	19.6	21.8	6.9	--	23.6	19.1	29.1	23.2	17.1	15.1
Pb (D) (µg/l)	25.3	19.7	22.6	26.1	14.6	--	1	1	<1.0	20.7	18.9	21.1	6.5	--	23.7	18.1	29	23.9	15	14.9
Pb Load (lb/day)	0.1	0.0	0.1	0.0	0.0	--	--	--	0.0	0.1	0.1	0.1	0.02	--		0.03	0.05	0.04	0.03	--
Mn (T) (µg/l)	30,200	28,700	32,200	34,400	34,900	--	28,000	28,400	26,700	29,500	29,500	29,300	31,000	--	27,000	29,500	31,600	34,400	33,500	26,900
Mn (D) (µg/l)	30,200	27,700	31,800	34,200	33,900	--	26,500	27,400	26,200	27,100	29,600	31,700	30,700	--	28,100	28,900	30,900	33,600	32,000	26,000
Mn Load (lb/day)	68.9	77.1	75.7	66.4	105.9	--	--	--	48.0	88.8	77.2	71.0	79.1	--	47.8	47.4	52.5	59.0	56.6	--
Ni (T) (µg/l)	90	60.8	65	59.1	55.5	--	38	37.1	35	95.1	57.6	52.6	46.7	--	94.1	85.8	68.5	60	51.9	37.3
Ni (D) (µg/l)	91.1	57.6	63.8	59.9	55.6	--	36.4	38.1	37.4	94	53.7	55.2	47.7	--	93.2	86.2	68.2	59.6	49.9	39.7
Ni Load (lb/day)	0.2	0.2	0.2	0.1	0.2	--	--	--	0.1	0.3	0.2	0.1	0.1	--	0.2	0.1	0.1	0.1	0.1	--
Zn (T) (µg/l)	40,300	23,800	24,800	26,300	23,000	--	15,200	16,000	14,500	44,700	23,500	19,500	20,000	--	40,200	33,400	27,500	24,600	24,400	19,700
Zn (D) (µg/l)	40,200	21,900	24,000	24,800	22,400	--	15,500	15,600	13,000	39,300	22,500	21,700	20,700	--	41,900	32,900	28,600	23,900	21,100	19,100
Zn Load (lb/day)	91.9	63.9	58.3	50.7	69.8	--	--	--	26.0	134.5	61.5	47.2	51.0	--	--	--	--	--	--	--
Red & Bonita Adit Station CC03C: Red and Bonita mine adit at the portal. Do not take flow measurements at this site.																				
Al (T) (µg/l)	--	--	--	--	--	--	--	--	--	--	--	3,310	3,130	--	--	4,170	3,290	4,040	4,010	4,750
Al (D) (µg/l)	--	--	--	--	--	--	--	--	--	--	--	3,470	3,060	--	--	4,080	3,480	3,840	4,050	4,370
Al Load (lb/day)	--	--	--	--	--	--	--	--	--	--	--			--	--	--	--	--	--	--
Cd (T) (µg/l)	--	--	--	--	--	--	--	--	--	--	--	31.3	32.3	--	--	32.7	28	32.9	50.6	32.1
Cd (D) (µg/l)	--	--	--	--	--	--	--	--	--	--	--	30.2	32.3	--	--	32.8	28.2	33.9	50.3	33.6
Cd Load (lb/day)	--	--	--	--	--	--	--	--	--	--	--			--	--	--	--	--	--	--
Cu (T) (µg/l)	--	--	--	--	--	--	--	--	--	--	--	<4.0	<4.0	--	--	<20.0	<20.0	<20.0	29.6	<5.00

Portal collapse opened 9-15-11

TABLE 2, cont.
Laboratory Metals Sample Data

	May 2009	Jun 2009	Jul 2009	Aug 2009	Sep 2009	Nov 2009	Feb 2010	Mar 2010	Apr 2010	Jun 2010	Jul 2010	Sep 2010	Nov 2010	Mar 2011	Jun 2011	Jul 2011	Aug 16 2011	Sep 13 2011		Oct 16 2011	May 16 2012
Cu (D) (µg/l)	--	--	--	--	--	--	--	--	--	--	--	<4.0	<4.0	--	--	<20.0	<20.0	<20.0	Portal collapse opened 9-15-11	29.9	<5.00
Cu Load (lb/day)	--	--	--	--	--	--	--	--	--	--	--			--	--	--	--	--		--	--
Fe (T) (µg/l)	--	--	--	--	--	--	--	--	--	--	--	106,000	98,700	--	--	93,000	89,100	97,400		84,100	96,100
Fe (D) (µg/l)	--	--	--	--	--	--	--	--	--	--	--	106,000	103,000	--	--	91,400	93,500	89,900		78,200	88,700
Fe Load (lb/day)	--	--	--	--	--	--	--	--	--	--	--			--	--	--	--	--		--	--
Pb (T) (µg/l)	--	--	--	--	--	--	--	--	--	--	--	86	88.1	--	--	84.2	163	101		134	79.8
Pb (D) (µg/l)	--	--	--	--	--	--	--	--	--	--	--	71.1	88.5	--	--	75.9	75.7	34.9		38.8	19.8
Pb Load (lb/day)	--	--	--	--	--	--	--	--	--	--	--			--	--	--	--	--		--	--
Mn (T) (µg/l)	--	--	--	--	--	--	--	--	--	--	--	35,900	33,800	--	--	31,100	29,800	31,200		32,300	35,900
Mn (D) (µg/l)	--	--	--	--	--	--	--	--	--	--	--	36,200	35,000	--	--	30,600	31,400	30,800		31,500	33,100
Mn Load (lb/day)	--	--	--	--	--	--	--	--	--	--	--	0.0	0.0	--	--	--	--	--		--	--
Ni (T) (µg/l)	--	--	--	--	--	--	--	--	--	--	--	54.1	56.4	--	--	51.5	51.5	51.4		52.2	48.2
Ni (D) (µg/l)	--	--	--	--	--	--	--	--	--	--	--	55.9	55.5	--	--	51.3	49.4	51.3		50.9	51.3
Ni Load (lb/day)	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	--	--	--	--	--		--	--
Zn (T) (µg/l)	--	--	--	--	--	--	--	--	--	--	--	16,600	15,200	--	--	14,800	13,400	14,600		16,100	17,900
Zn (D) (µg/l)	--	--	--	--	--	--	--	--	--	--	--	16,300	16,800	--	--	14,700	14,200	14,000		14,600	16,300
Zn Load (lb/day)	--	--	--	--	--	--	--	--	--	--	--	0.0	0.0	--	--	0.0	0.0	--		--	--

'-- - data not available or not sampled.
µg/l – micrograms per liter.
lb/day – pounds per day

TABLE 3
Water Stable Isotope and Tritium Sample Data
18-Oxygen and 2-Hydrogen (deuterium)

Sample ID	Description	October 2010			March 2011			June 2011			September 2011			October 2011		
		$\delta^{18}O$ per mille	$\delta^{2}H$ per mille	D-excess	$\delta^{18}O$ per mille	$\delta^{2}H$ per mille	D-excess	$\delta^{18}O$ per mille	$\delta^{2}H$ per mille	D-excess	$\delta^{18}O$ per mille	$\delta^{2}H$ per mille	D-excess	$\delta^{18}O$ per mille	$\delta^{2}H$ per mille	D-excess
CC01F	Ross Basin drainage above Grand Mogul	-15.31	-109.6	12.9	Snow - No Sample			Too much snow - No Sample			-15.45	-111.0	12.5	Not Sampled		
CC01C	Stream at toe of Grand Mogul pile	-16.52	-120.4	11.8	Snow - No Sample			-17.59	-127.2	13.5	-15.86	--	--	Not Sampled		
CC01CL	Stream location below toe of Grand Mogul pile	Not Sampled			Not Sampled			-17.54	-126.7	13.7	Not Sampled			Not Sampled		
USCC02D CC01U (CC01U was obtained in March 2011)	Cement Creek above Mogul Mine	-14.21	-103.3	10.4	-15.53	-110.5	13.7	-17.39	-125.2	--	--	--	12.4	Not Sampled		
CC02D	Mogul Mine adit	-14.97	-109.8	10.0	No Access			-15.90	-113.1	14.0	-15.73	--	--	Not Sampled		
UASW020	Cement Creek below Mogul Mine and Mogul Mine wetlands	Not Sampled			-15.79	-112.8	13.5	-17.46	-126.5	13.2	-15.25	--	--	Not Sampled		
CC03C	Red and Bonita adit	-16.29	-118.3	12.0	-16.48	-118.7	13.2	-16.42	-118.2	13.2	-16.38	-118.8	12.2	Data Pending		
CC04	Stream above Gold King #7	-14.01	-100.9	11.2	No Access			-17.28	-124.9	13.3	-15.17	-109.3	12.1	Not Sampled		
CC08/CC06	Gold King #7 adit	-15.97	-115.5	12.2	No Access			-16.25	-116.9	13.1	-16.28	-117.0	13.2	Not Sampled		
CC19	American Tunnel adit	-16.07	-118.2	10.3	-16.40	-117.9	13.3	-16.5/-16.4 dup.	-117.8/-118.0 dup.	13.9/12.8 dup.	-16.35	--	--	Not Sampled		

$\delta\ ^{18}O$ per mille – Difference of ^{18}O per thousand.
$\delta\ ^{2}H$ per mille – Difference of ^{2}H per thousand.

TABLE 3, cont.
Water Stable Isotope and Tritium Sample Data
3-Hydrogen (tritium)

Sample ID	Description	October 2010		March 2011		June 2011		September 2011		October 2011	
		TU	Error +/-	TU	Error +/-	TU	Error +/-	TU	Error +/-	TU	Error +/-
CC01F	Ross Basin drainage above Grand Mogul	7	0.4	--	--		--	6.9	0.4	Not Sampled	
CC01C	Stream at toe of Grand Mogul pile	7.5	--		--	9	--	8.4	0.4	Not Sampled	
CC01CL	Stream location below toe of Grand Mogul pile	Not Sampled		--		--		--	--	Not Sampled	
USCC02D CC01U (CC01U was obtained in March 2011)	Cement Creek above Mogul Mine	No results/not analyzed		7.7		--		--	0.4	Not Sampled	
CC02D	Mogul Mine adit at Portal	4.4	0.3	--	--	6.1	--	5.3	0.4	Not Sampled	
UASW020	Cement Creek below Mogul Mine and Mogul Mine wetlands.	Not Sampled		8		--		--	0.4	Not Sampled	
CC03C	Red and Bonita adit at (collapsed) portal	6.4	0.4	6.6	--	6.8	--	7.2	0.4	6.2	0.4
CC04	Stream above Gold King #7	6.6	0.4	--	--	9.7	--	7.6	0.4	Not Sampled	
CC08/CC06	Gold King #7 adit at Portal	5.6	0.4	--	--	5.8	--	5.3	0.6	Not Sampled	
CC19	American Tunnel adit at Portal	5.3 (dupe = 4.9)	0.3	5.6 (dupe = 6.3)	--	5.8	--	5.8 (dupe = 5.9)	0.4	Not Sampled	

TU – Tritium units

TABLE 4
Sample Locations

Sampling Location Upper to Lower	Latitude	Longitude	Elevation (HAE)	Description
CC01F	37 54 33.64 N	107 37 47.46 W	11781	Cement Creek upstream of Grand Mogul adit and tailings. Sample at start of steep uphill where grass border meets the scree of the Grand Mogul Mine. Called CCOPP-08 by EPA during July 2009 sampling event.
CC01C	37 54 35.72 N	107 37 51.66 W	11682	Grand Mogul adit at toe of waste pile. Take flow measurements further downstream and just upstream of confluence with Cement Creek.
CC01CL				Stream location below toe of Grand Mogul pile
USCC02D / CC01U (labeled CC01U for March 2011)				Cement Creek above Mogul Mine
CC02D	37 54 36.14 N	107 38 17.26 W	11376	Mogul Mine adit. Collect sample downstream of the mine pool at the 3-inch Parshall Flume.
UASW020				Cement Creek below Mogul Mine and Mogul Mine wetlands.
CC03C	37 53 50.16 N	107 38 37.90 W	10893	Red and Bonita mine adit at the portal. Do not take flow measurements at this site.
CC03D	37 53 48.46 N	107 38 41.61 W	10776	Red and Bonita mine adit. Collect sample at culvert that goes under CR53.
CC04	37 53 38.82 N	107 38 15.42 W	11313	North Fork of Cement Creek upstream of confluence with the 7-Level mine adit. Sample upstream of the road switchback and upstream of the 7-Level flow that comes down the hill. Site was called CCOPP02 by EPA during May, June, and July 2009 sampling events.
CC06 / CC08	37 53 40.50 N	107 38 18.09 W	11386	7-Level mine adit upstream of the confluence with the North Fork of Cement Creek. Sample where flow comes out of the mine tunnel.
CC19	37 53 27.50 N	107 38 54.39 W	10540	American Tunnel mine adit. Sample where flow comes out of the ground.
CC-18	37 53 28.57 N	107 38 57.07 W	10514	Cement Creek upstream of South Fork but downstream of American Tunnel confluence. Sample upstream of road crossing in Gladstone. Site was called CCOPP-01 by EPA in May, June, and July 2009 sampling events.

APPENDIX A

Metals Loading Charts

Figure A-1
Aluminum Loading (pounds per day)

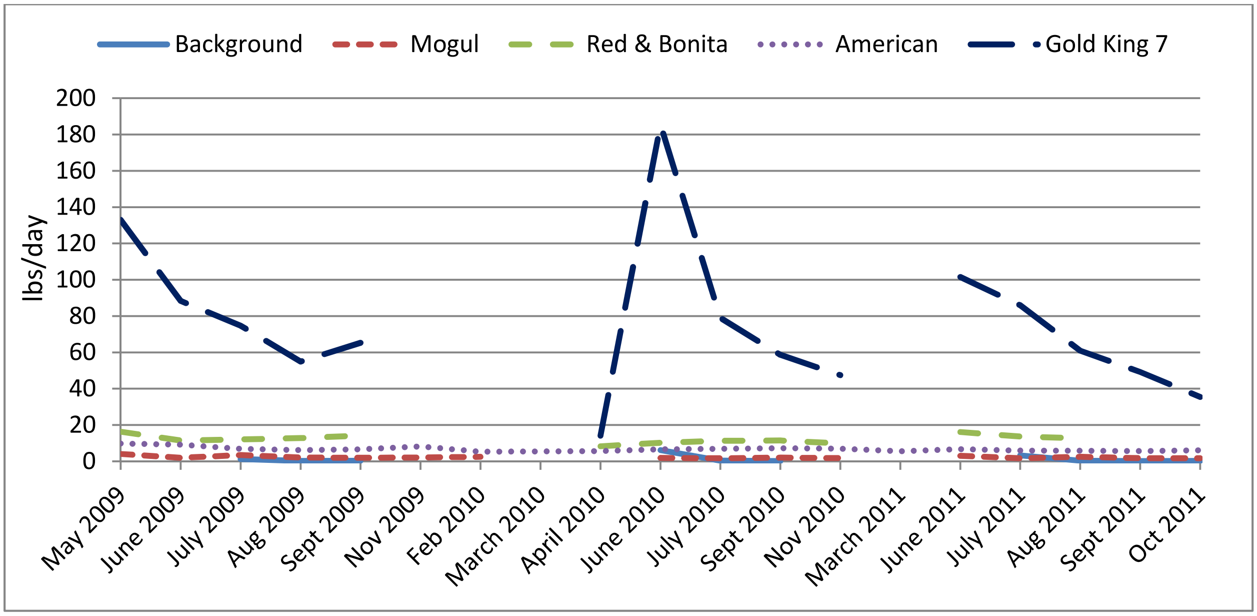


Figure A-2
Cadmium Loading (pounds per day)

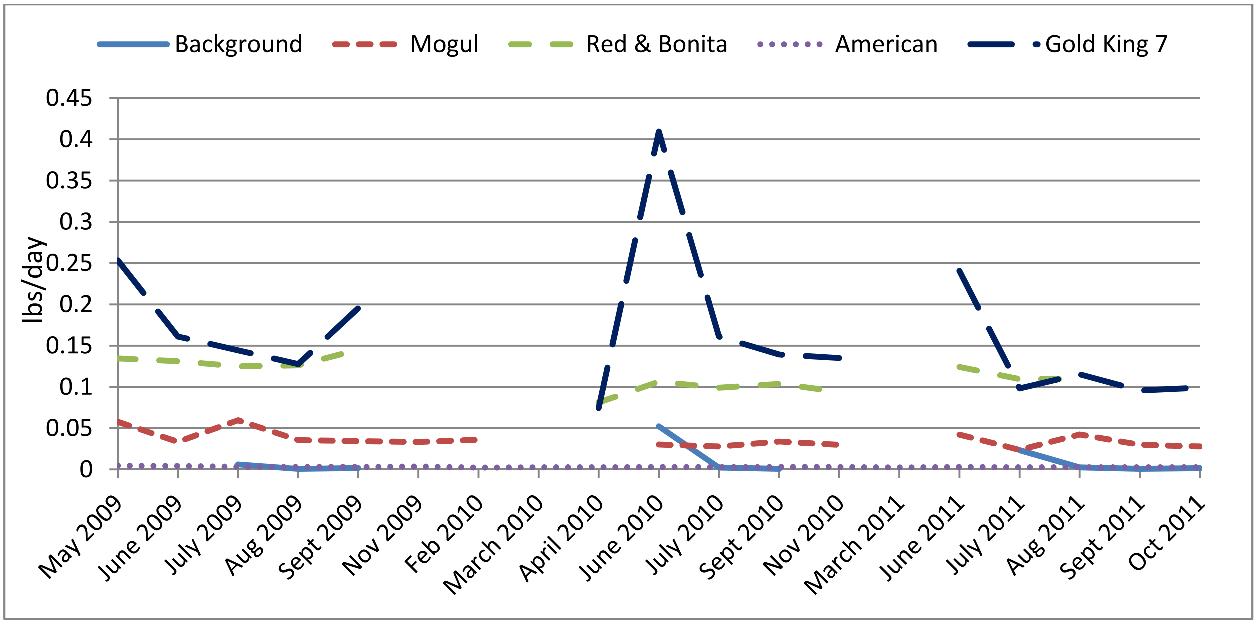


Figure A-3
Copper Loading (pounds per day)

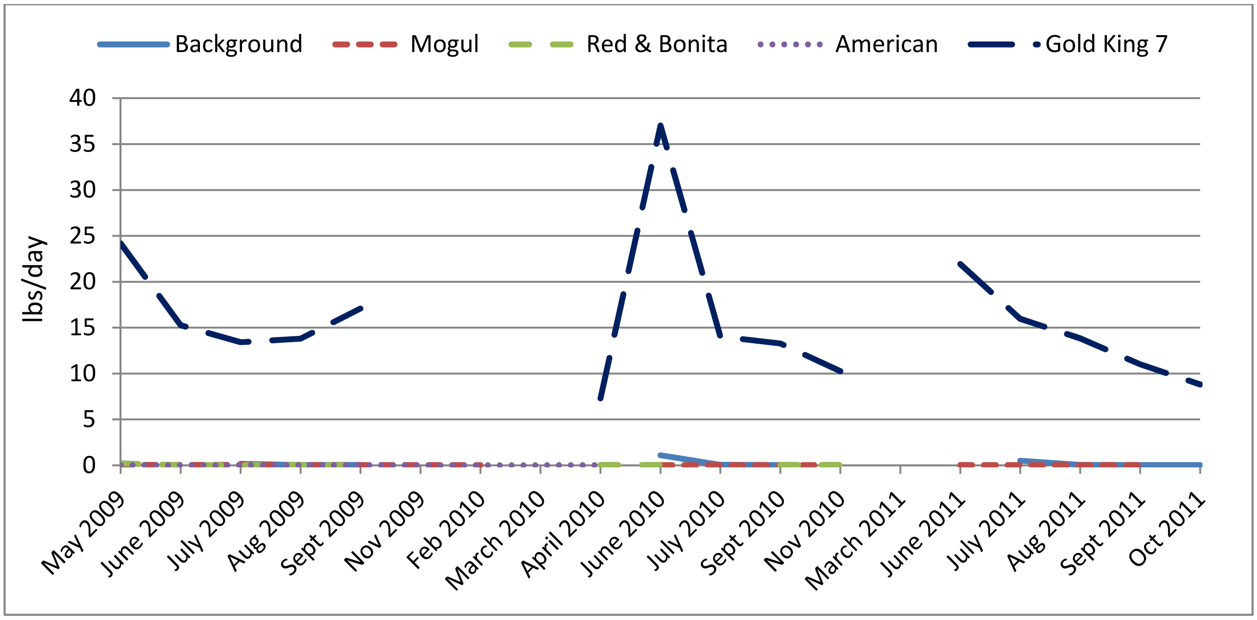
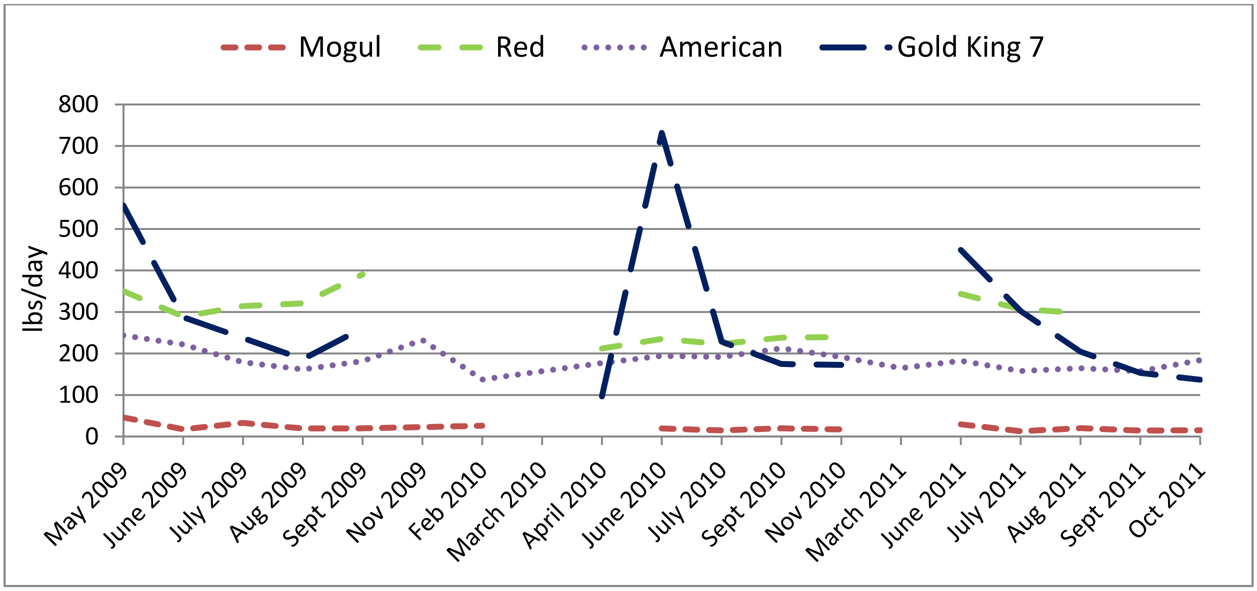


Figure A-4
Iron Loading (pounds per day)



Background graph is not included because content was below laboratory detection limit.

Figure A-5
Lead Loading (pounds per day)

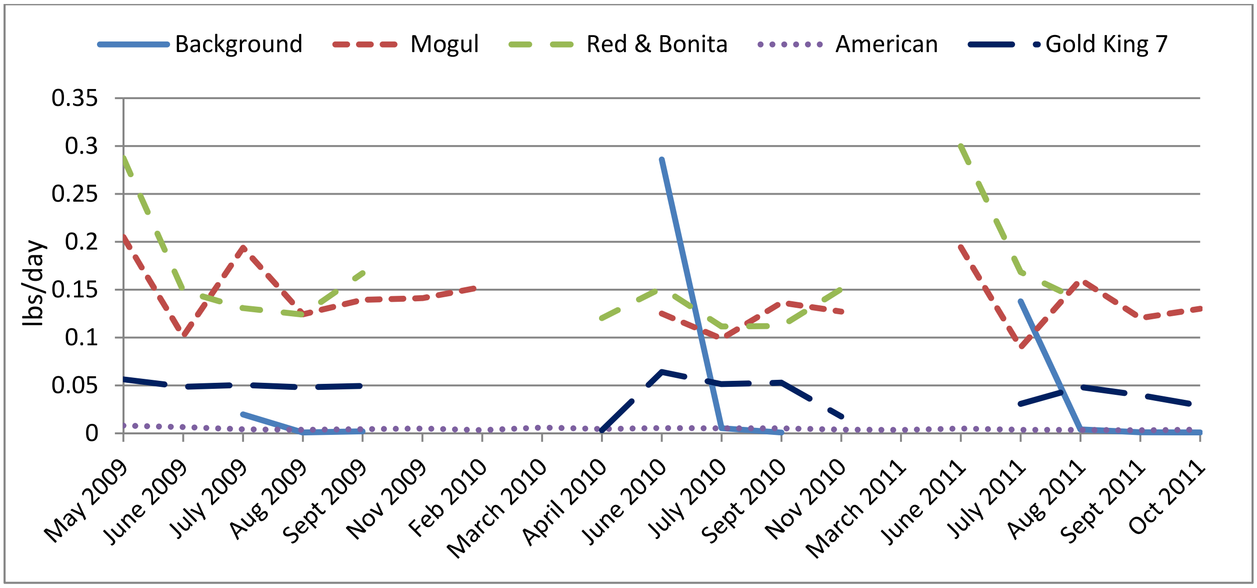


Figure A-6

Manganese Loading (pounds per day)

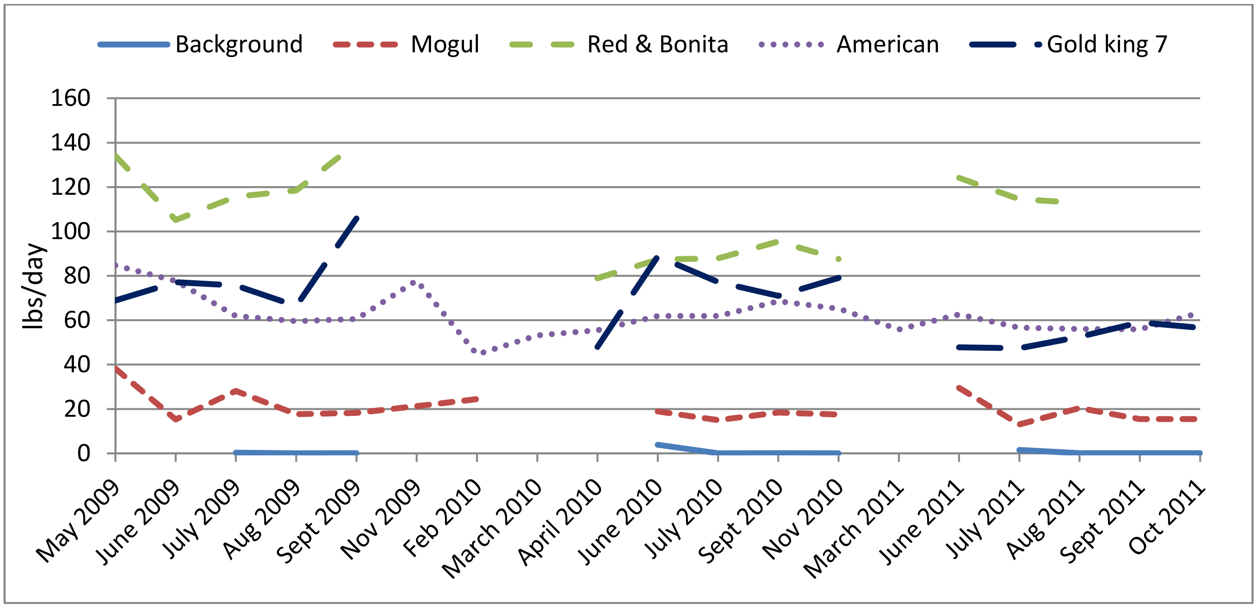
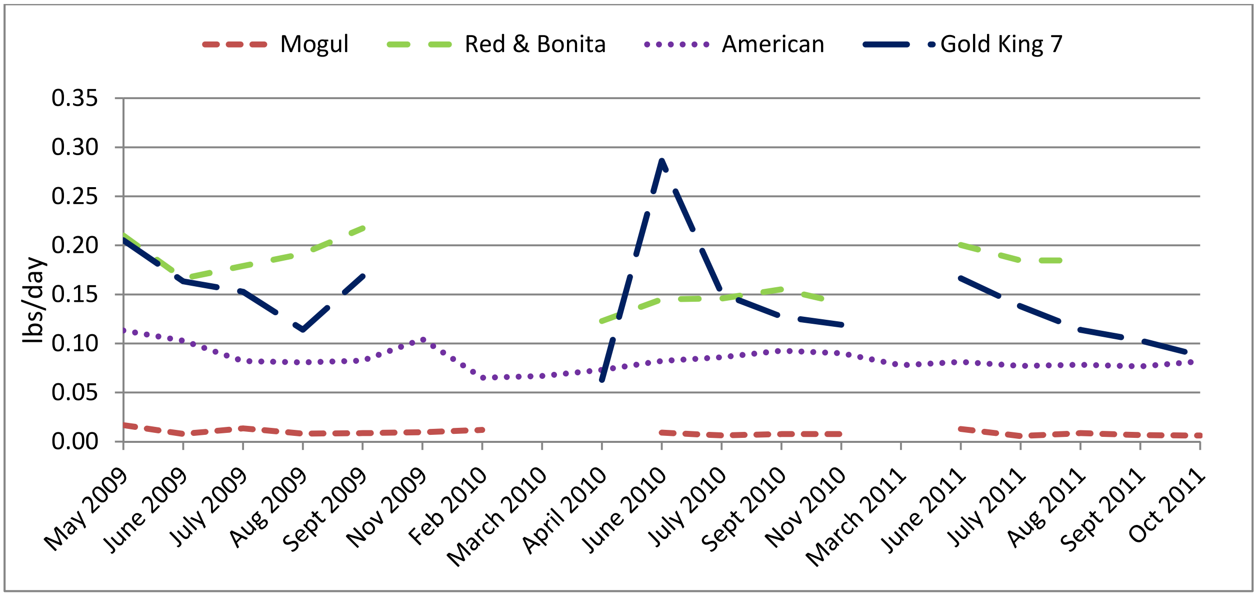
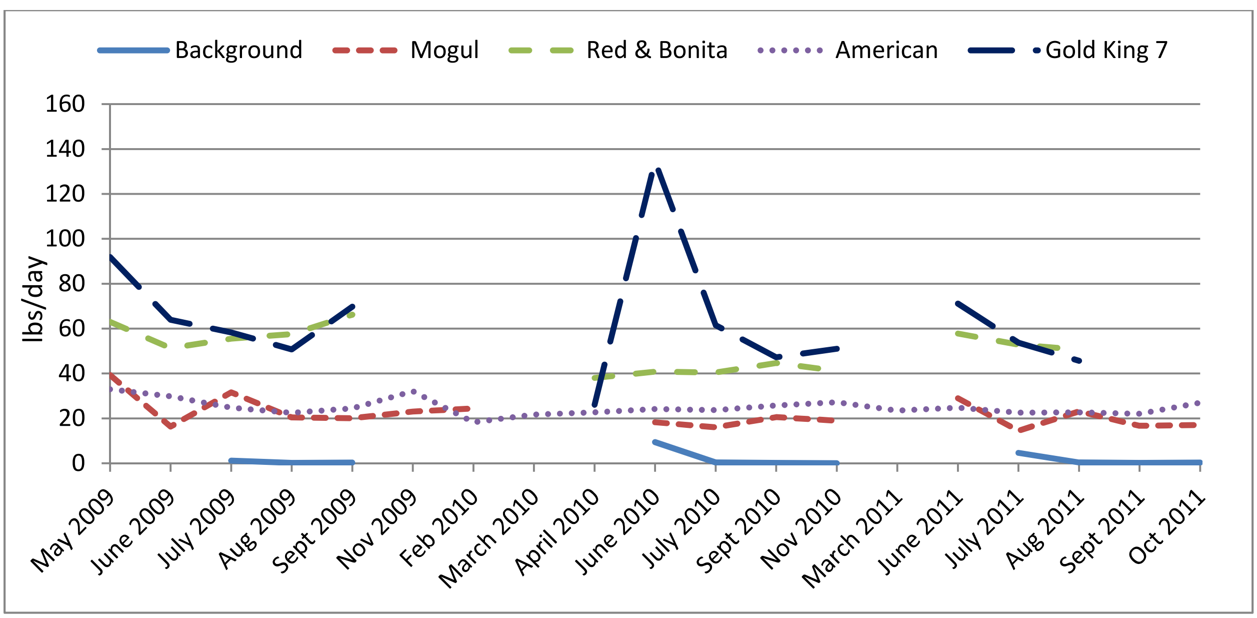


Figure A-7
Nickel Loading (pounds per day)



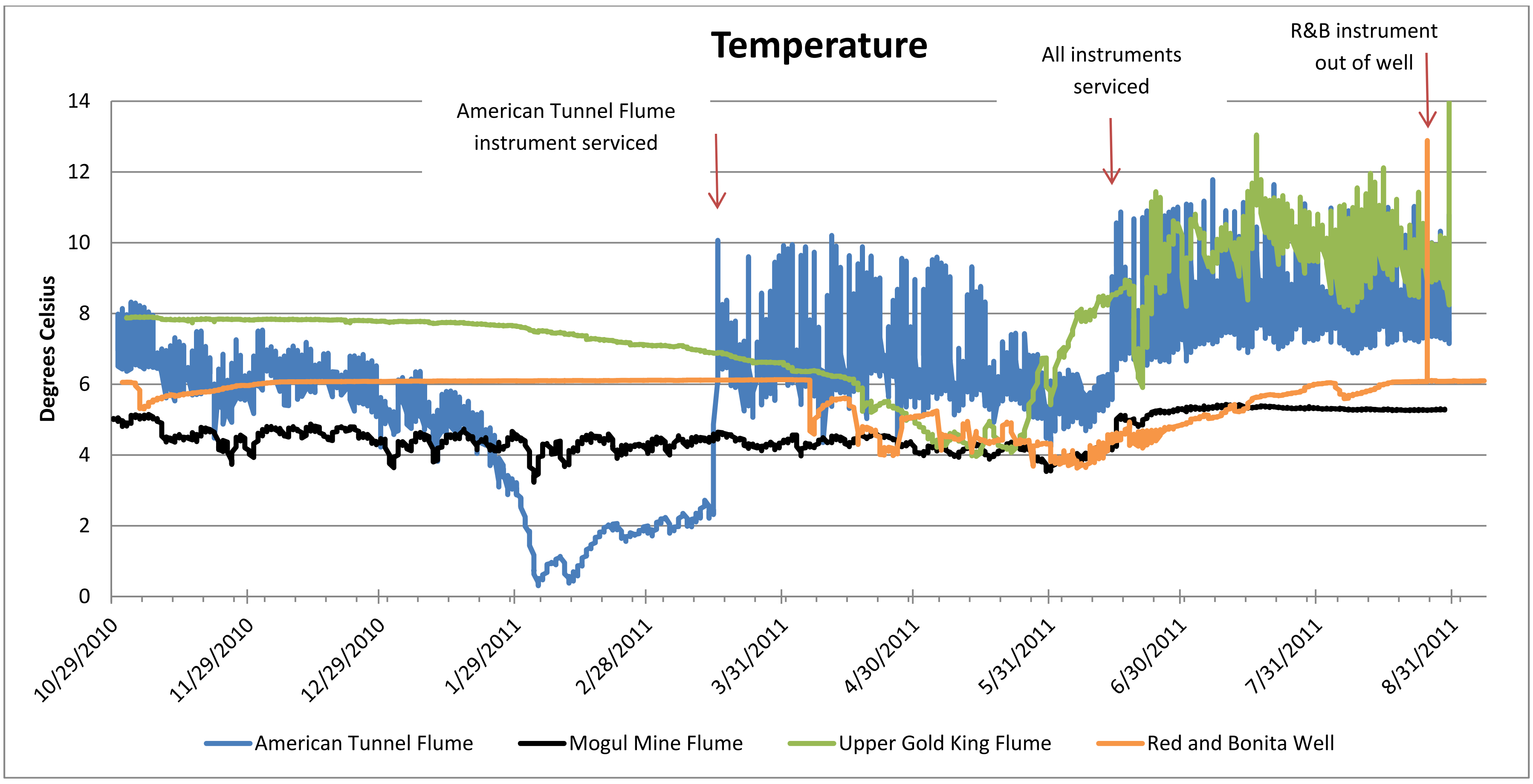
Background graph is not included because content was below laboratory detection limit.

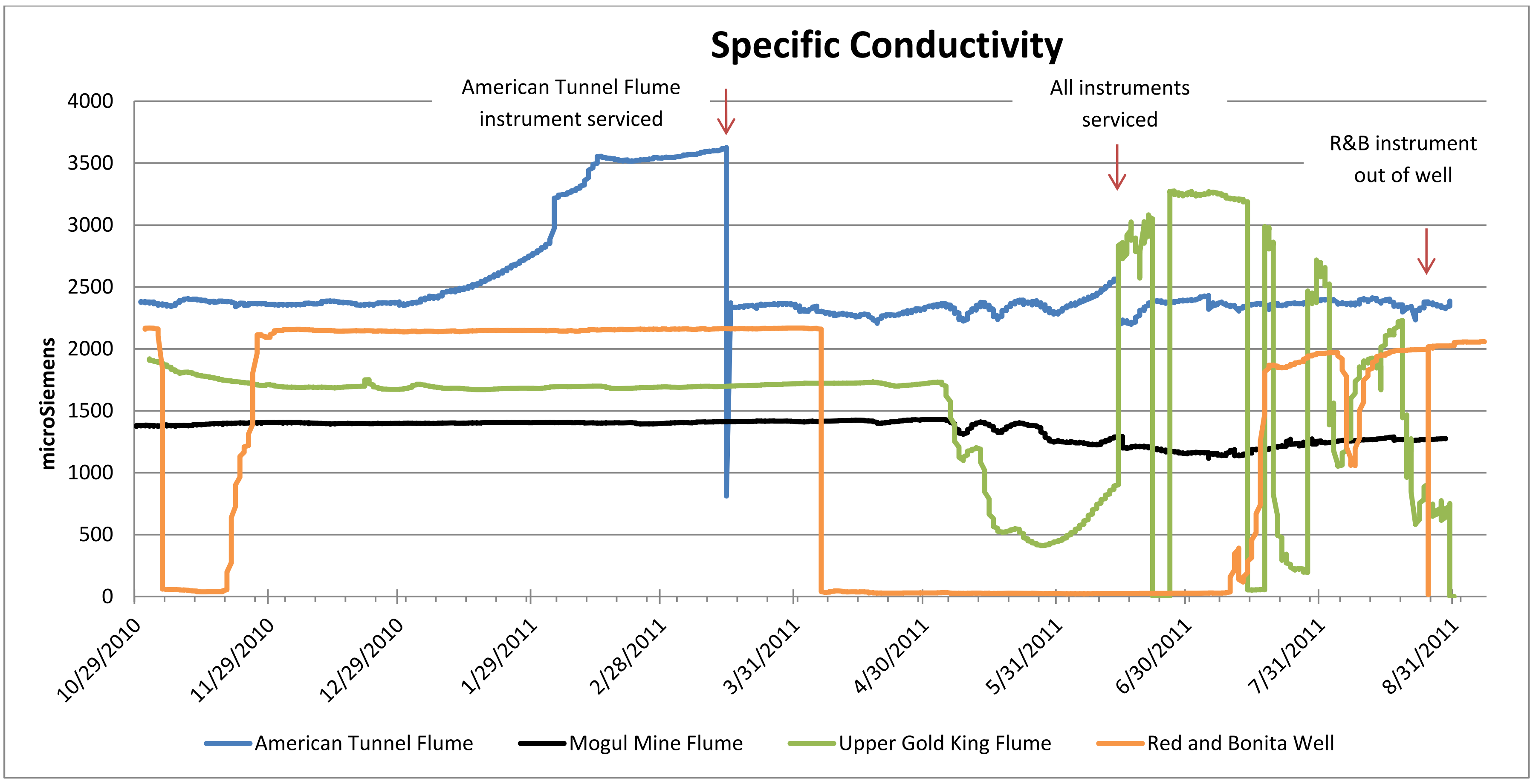
Figure A-8
Zinc Loading (pounds per day)



APPENDIX B

Data Charts of Mine Adit Effluent from Pressure Transducer and Water Parameter Probes





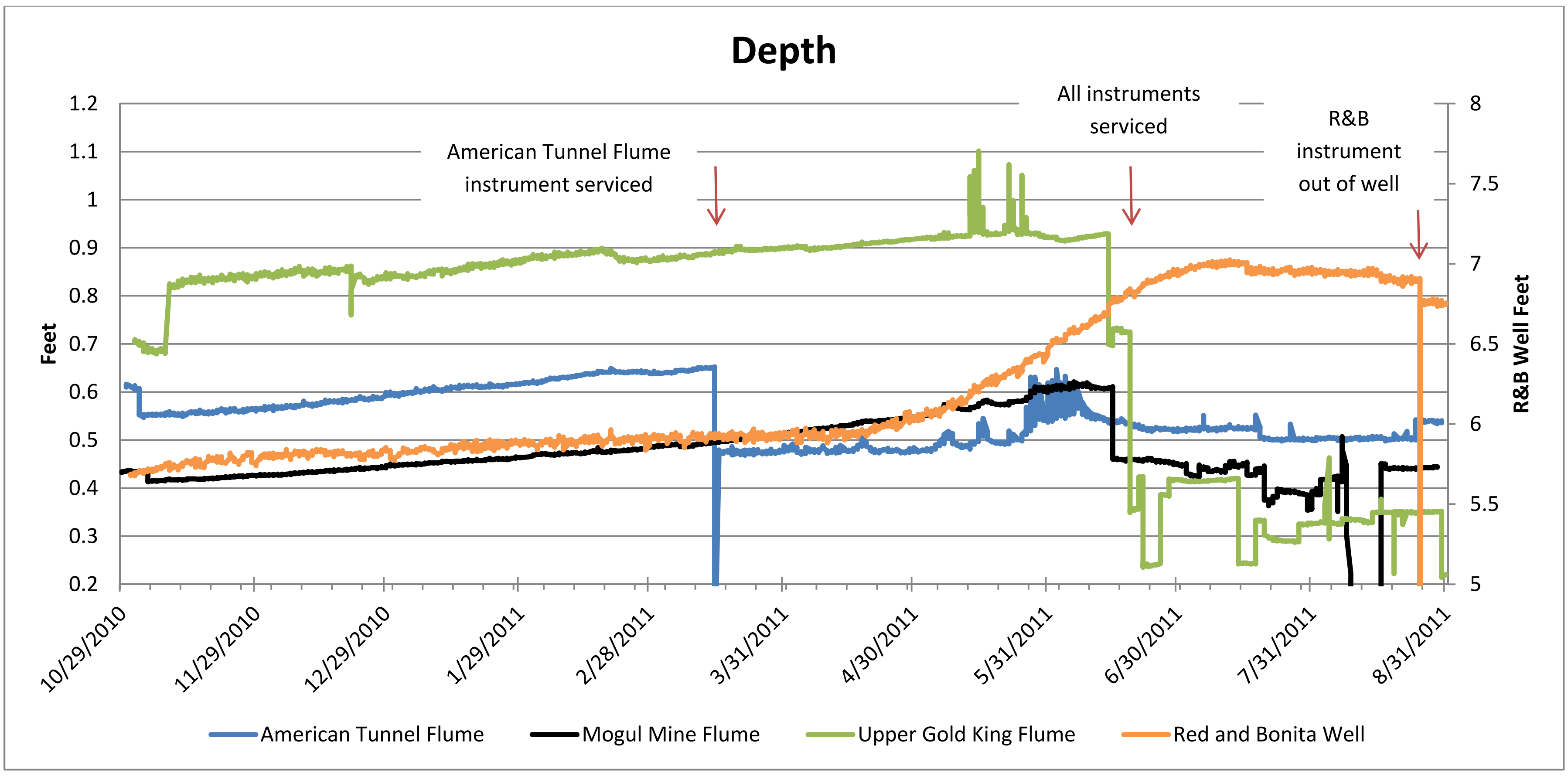


CHART 1

Upper Animas River, Cement Creek Watershed Mine Adit Effluent

October 29, 2010 to September 7, 2011