RECLAMATION FEASIBILITY REPORT

HENSON CREEK WATERSHED

Paul Krabacher, Jim Herron, Jeff Graves, Kirstin Brown

Colorado Department of Natural Resources
Division of Minerals & Geology

In cooperation with the

Lake Fork Watershed Stakeholders

Funded through a Clean Water Act §319 Grant

RECLAMATION FEASIBILITY REPORT
HENSON CREEK WATERSHED

PREPARED BY

PAUL KRABACHER, PRINCIPLE EDITOR/PROJECT MANAGER
JIM HERRON, HYDROLOGIST
JEFF GRAVES, GEOLOGIST
KIRSTIN BROWN, GEOLOGIST

SPECIAL THANKS TO THE
LAKE FORK WATERSHED STAKEHOLDERS

COLORADO DEPARTMENT OF NATURAL RESOURCES
COLORADO DIVISION OF MINERALS AND GEOLOGY
1313 SHERMAN STREET, ROOM 215
DENVER COLORADO 80203

JUNE 2006

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

INTRODUCTION

This report is intended to be a guidance document for use by the Lake Fork of the Gunnison Watershed Group (LFWG) in prioritizing and planning water quality reclamation projects at Mine sites in Henson Creek above the confluence with the Lake Fork of the Gunnison River. The initial reconnaissance investigation of the basin was performed by the LFWG in September and October of 2004. The initial investigation included identification of potential sources of heavy metals and sampling of mining wastes that could be potential sources of heavy metals.

Investigation of the water quality of Henson Creek was initiated as part of the effort to improve the water quality in the Lake Fork of the Gunnison above Lake City. Henson Creek was targeted because previous investigations had shown that Palmetto Gulch was impacted by past mining, resulting in listing on the Clean Water Act 303(d) list of impaired waters for zinc and cadmium. In addition there was visual evidence of impairment in other portions of the Henson Creek Watershed.

The ultimate goal of this work is to assess and potentially improve the water quality and fisheries of the Lake Fork of the Gunnison River above Lake City. Additional investigations are planned for the Lake Fork of the Gunnison above the confluence with Henson Creek starting in 2006.

GENERAL SITE DESCRIPTION

LOCATION

Henson Creek is located in Hinsdale County in the San Juan Mountains in southwestern Colorado. The headwaters of Henson Creek begin near the top of Engineer Pass and flow eastward for approximately 17 miles towards Lake City, where Henson Creek joins the Lake Fork of the Gunnison River. **Figure 1** is a general location map of the area.

Prospecting began in Hinsdale County about 1860. With the discovery of the Ute-Ule veins, mining began shortly there after in 1871. There are numerous inactive and abandoned Mines and prospects in Henson Creek with the major concentrations in the headwaters, near Capitol City and in the lower section of Henson Creek. There are currently no operating mines in the Henson Creek Watershed above Lake City.

GEOLOGY

It is well documented that geology plays a critical role in overall water quality within a watershed. Specific geologic factors including structure, mineralogy, bedrock stratigraphy and hydrothermal alteration often result in both water quality degradation and improvement. The Henson Creek watershed like many others within the San Juan Mountains has shown through extensive water sampling that many water quality problems can be directly correlated to the general geologic factors listed above. Certain geologic factors like hydrothermal alteration and corresponding mineralization, typically play a greater role in the predictive influence of geology on in-stream water chemistry, but certainly are not exclusive of other factors that may contribute more greatly on a site to site basis.

The following section will explain the general geologic factors including bedrock stratigraphy, surficial geology, structural geology and hydrothermal alteration that influence water quality within Henson Creek. Geology specific to individual stream reaches will be described in more detail in following sections. Understanding the influence of geologic factors existent within the

Henson Creek watershed provides a framework for water quality analysis and more informed decision making regarding reclamation feasibility.

No new geologic mapping was conducted in conjunction with this project. Instead, field verification and interpretations of existing geologic knowledge were made. The geology referenced in this report has been observed and described by others including Irving and Bancroft in 1911, Burbank and Luedke in 1969, Lipman in 1976, and Hon in 1987 which was heavily relied upon. Recent work by Bove, Hon and others in 2001 has helped to more accurately pinpoint geologic evolution of rocks within the watershed through new K-Ar dating techniques, but has not substantially changed historical geologic understanding.

Detailed geologic mapping within the study area has been conducted by numerous parties and can be referenced in the following reports: Geology and Ore Deposits Near Lake City, Colorado. Irving and Bancroft, 1911; Geologic Map of the Handies Peak Quadrangle, San Juan, Hinsdale and Ouray Counties. Luedke, and Burbank, 1987; Geologic Map of the Lake City Caldera Area, Western San Juan Mountains, Southwestern Colorado. Lipman, 1976; Geologic, Alteration and Vein Maps of the Redcloud Peak (Lake City Caldera) and Handies Peak Wilderness Study Areas, Hinsdale County, Colorado. Hon, 1987.

Bedrock Stratigraphy

The Henson Creek watershed is situated within the San Juan volcanic field. Henson Creek flows along the northern margin of the Tertiary aged Lake City Caldera, which lies within the larger San Juan–Uncompahgre Caldera complex as shown in **Figure 2**. The San Juan volcanic field is a complex assemblage of interbedded volcanic tuffs, lavas and intrusives of Tertiary age overlying Paleozoic sedimentary and Precambrian basement rocks. There are no Paleozoic or Precambrian rocks exposed within the watershed.

The majority of rocks within the study area are related to the formation and collapse of numerous volcanic calderas including the San Juan, Uncompahgre, Silverton and Lake City. The eruption and subsequent collapse of these calderas resulted in the expulsion of voluminous amounts of ash, forming large ash-flow tuffs and breccias that blanket the underlying basement rock. During formation of these pyroclastic flow deposits, rhyodacitic to andesitic lavas were extruded from within the caldera margins resulting in a complex interfingering rock assemblage. Intrusion of rocks ranging in composition from granite to monzonite formed stocks, dikes, plugs and sills along caldera margins.

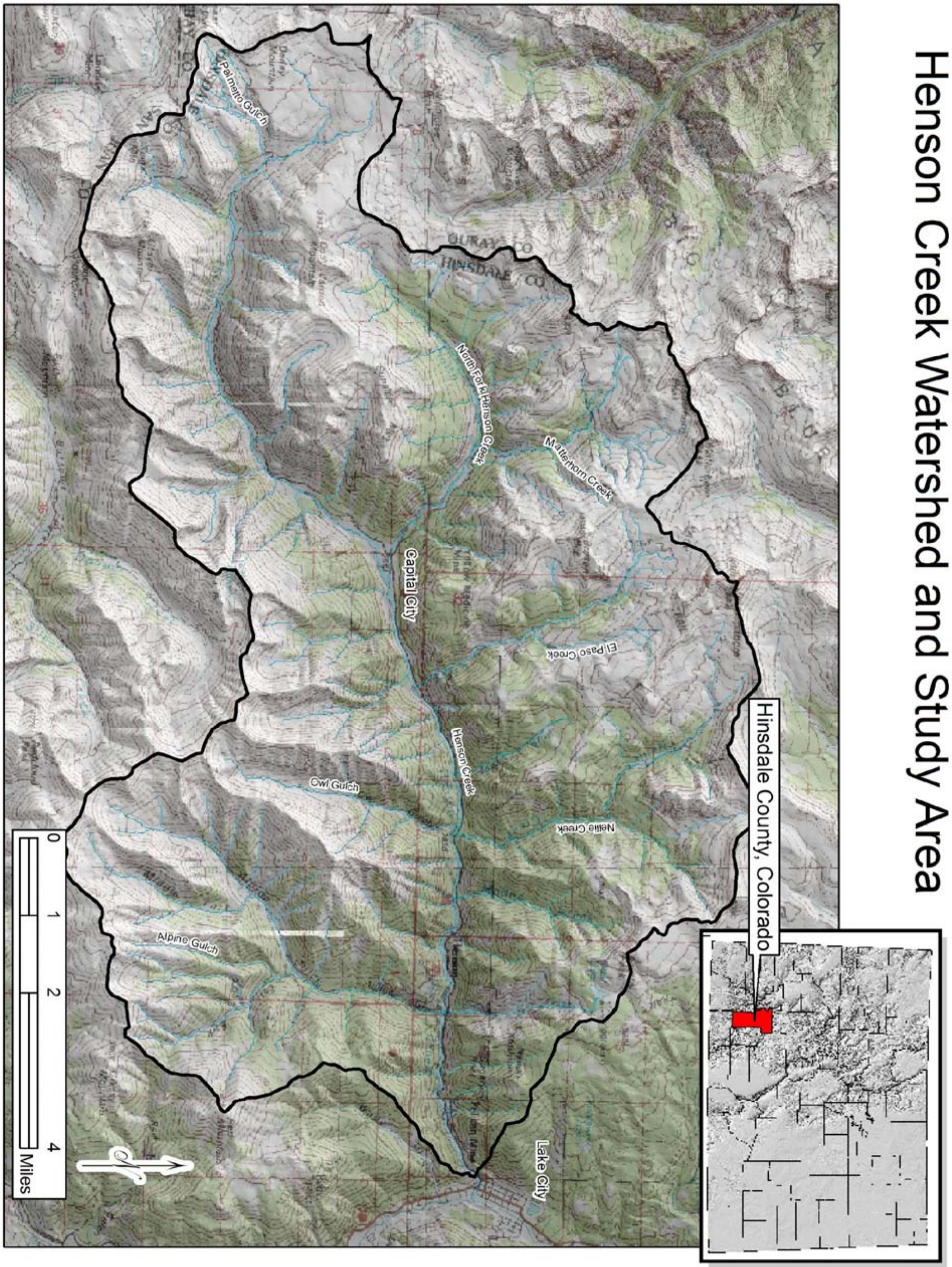
The following is a description of the complex sequence of rock units exposed within the study area, from oldest to youngest, and can be referenced for their location on the attached geologic map. (Irving and Bancroft, 1911, Lipman, 1976, Burbank and Luedke, 1989)

Tertiary Volcanic Rocks

Oligocene Lavas and Related Rocks Assemblage of andesite, rhyodacite and latite lava flows (Tef), dacitic and rhyodacitic breccias related to the Larsen and Cimarron volcanoes (Teb), and volcaniclastics associated with the above mentioned volcanics (Tec). Located along the northern margin of the study area outside the San Juan-Uncompahgre caldera boundary.

Ute Ridge Tuff (Tu) (Oligocene) Volcanic quartz latitic ash-flow sheet erupted from the Ute Creek caldera. Small areas of exposure in the northwestern part of the study area in upper Matterhorn Creek.

Figure 1. General Location Map - Henson Creek



Sapinero Mesa Tuff (Oligocene) Ash-flow sheet erupted from the San Juan-Uncompahgre caldera composed of numerous members. Outcrops along the stream channel and adjacent valley of mainstem Henson Creek from Lake City to its upper reaches.

Picayune Megabreccia Member (Tsm) Volcaniclastic of intermediate composition and large clast size underlying and interfingering with the Eureka Member. Typically brownish-gray in color, but often greenish-gray in appearance due to extensive propylitic alteration. Considered caldera collapse breccia from oversteepened walls of San Juan-Uncompahgre caldera (Lipman,1976).

Landslide Breccia Member (Tsl) Aerially limited landslide breccia, compositionally similar and transitional to the Picayune Megabreccia member. Typical clast size is small, less than one cm.

Eureka Member (Tse) Ash-flow tuff of quartz latitic to rhyolitic composition, moderately welded, with obvious eutaxitic structure (banding resulting in streaky or blotched appearance) located within the San Juan-Uncompahgre caldera. Typically gray to red-brown in color except were locally altered by propylitization to a greenish-gray appearance.

Silverton Volcanics (Oligocene) Lava flows and related volcaniclastics that collected within the San Juan-Uncompahgre caldera. Composition ranges from andesite to rhyolite. Large aerial exposure along the northern margin of the study area occupying Palmetto Gulch, North Fork Henson Creek, Matterhorn Creek and El Paso Creek.

Pyroxene Andesite Member (Tap) Porphyritic andesite lava flows commonly interfingering with the Burns and Henson members. Dark gray, tabular flows with amygdaloidal (cavities or vesicles containing zeolites, calcite and quartz) texture and containing 15-25% phenocrysts of plagioclase and augite.

Burns Member (Tbb) Lava flows and domes of silicic composition, generally biotite-quartz latite within the study area, that are complexly interfingered. Light- to dark-gray except were altered by propylitization to a greenish-gray color. Phenocrysts comprise 15-30% of the rock mass and consist of plagioclase, augite and biotite.

Rhyolite (Tbr) Rhyolitic lava flow, with few phenocrysts and well developed flow lamination, occurring locally within the study area on the northeast side of Sunshine Mountain.

Henson Member (Ths) Volcaniclastic tuffaceous sandstone, greenish-gray in color that intertongues with shaly tuffs and freshwater limestone. Complex interfingering of the Henson member with both the Pyroxene Andesite and Burns members is noted.

Fish Canyon Tuff (Tf) (Oligocene) Quartz-latitic ash-flow tuff erupted from the La Garita caldera that overlies both Silverton Volcanics and Sapinero Mesa Tuff. Light to dark gray, poorly to densely welded, with up to 50% phenocrysts of plagioclase, sanidine, biotite, quartz and hornblende. Outcrops within the San Juan-Uncompahgre caldera and occupies portions of the upper reaches of drainages north of Henson Creek.

Crystal Lake Tuff (Tcl) (Oligocene) Rhyolitic ash-flow tuff erupted from the Silverton caldera. Gray to reddish-brown, poorly to densely welded with few phenocrysts. Difficult to distinguish from Carpenter Ridge Tuff except for the abundance of small rock fragments. Generally, exposures are adjacent to and overlying the Fish Canyon Tuff.

Carpenter Ridge Tuff (Tcr) (Oligocene) Rhyolitic ash-flow tuff erupted from the Bachelor caldera. Similar in composition and appearance to the Crystal Lake Tuff except for the absence of small rock fragments and the presence of a basal vitrophyre (glassy) and lithophysal (bubble like structures) zone. Outcrops are similar to Crystal Lake and Fish Canyon Tuffs.

Volcaniclastic Sedimentary Rocks (Tvs) (Oligocene) Assemblage of tuffaceous sandstones and shale occurring in lenticular and cross-stratified beds. Similar in composition to the Henson member of the Silverton Volcanics. Occurrence within the study area is of limited aerial extent and corresponds to outcrops of Fish Canyon and Crystal Lake Tuffs.

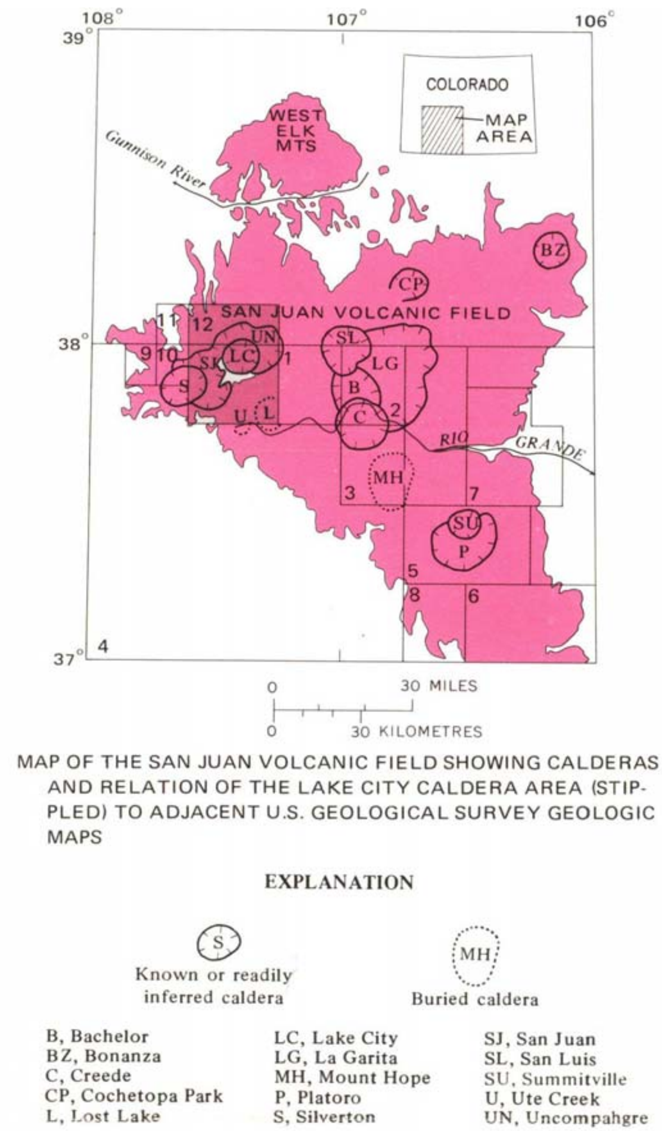


Figure 2. San Juan Volcanic Field (reprinted from Lipman, 1976)

.

Intrusives (Oligocene) Typically occur as stocks, plugs and dikes mostly along the northern margin of the Lake City caldera, specifically Capitol City and Matterhorn Creek.

> Monzonite (Tm) Poorly to slightly porphyritic intrusive rock, gray in color, occurring generally as stocks and plugs and grading to Monzonite porphyry.
>
> Monzonite Porphyry (Tmp) Moderately to coarsely porphyritic intrusive rock, gray in color.
>
> Porphyro-aphanitic rocks (Ti) Andesitic to rhyolitic, fine grained intrusive rocks occurring generally as dikes and small plugs.

Volcanics of Uncompahgre Peak (Oligocene) Lava flows and related volcaniclastic sediments of intermediate to silicic composition. Thick flows of porphyritic quartz latite (Tuq) outcrop on Uncompahgre Peak and portions of Broken Hill. Thick flows of light-tan to white rhyolite (Tur) which outcrop on Sunshine Mountain. Dark gray andesite (Tua) outcropping at the head of Modoc Creek. Localized volcaniclastic sedimentary rocks of varying composition (Tus).

Nelson Mountain Tuff (Tn) (Oligocene) Quartz latitic ash-flow sheet erupted from the San Luis caldera, and outcrops along the northern margin of the study area. Poorly to moderately welded, with 25-35% phenocrysts of plagioclase, sanidine, biotite, and augite. Mapped by Lipman (Lipman, 1976) in three separate subunits Upper (Tnu), Middle (Tnm) and Lower (Tnl) based on a successive sequence of zones similar in each unit.

Sunshine Peak Tuff (Miocene) Large rhyolitic ash-flow sheet and associated caldera collapse breccias erupted from the Lake City caldera that dominates the geology of the study area's southern boundary.

Ash-flow Member (Tsp) Silicic alkalic rhyolitic tuff extensively indurated and densely welded. Phenocrysts are quartz, sodic sanidine, and sparse biotite comprising approximately 25% of the rock mass. The majority of outcrop within the study area is intracaldera and as such is a single coherent rock unit with numerous xenolithic fragments and extensive propylitic alteration.

Landslide Breccia Member (Tspl) Landslide derived debris breccia, locally lensed and interfingering with the upper Ash-flow member. Fragments are relatively small in size and are consistent in composition to the caldera wall rock. This member grades into the Megabreccia member.

Megabreccia Member (Tspm) Assemblage of large and chaotically associated fragments of precaldera rock and underlying ash-flow sheets that interfinger with the Sunshine Peak Ash-flow member.

Post-Caldera-Collapse Lava Flows (Miocene) Accumulations of quartz latitic flows associated with eruptions along the perimeter of the Lake City caldera, isolated to the upper eastern reaches of Alpine Gulch within the study area.

Quartz Latite of Red Mountain (Tqr) Extensively altered porphyritic quartz latite flow and dome underlying the petrologically similar Quartz Latite of Grassy Mountain.

Quartz Latite of Grassy Mountain (Tqg) Thick unaltered flow of light-gray porphyritic quartz latite, with approximately 30% phenocrysts of plagioclase, sanidine, biotite, and augite.

Intrusives (Miocene) Typically occurring within the study area as plugs, sills, irregular intrusions and possibly batholiths of granitic, rhyolitic and quartz latitic compositions.

Granite (Tig) Typically occurring as porphyritic granite or quartz monzonite exclusively within the Lake City caldera. Phenocrysts are mostly K-feldspar and plagioclase in an aphanitic groundmass of quartz and alkali feldspar. Occurences within the study area are mostly discordant intrusive bodies such as ring dikes, but outside the study area, large concordant exposures suggest possible large batholic intrusions underlying large portions of the Lake City caldera.

Rhyolite (Tir) Silicic alkalic rhyolitic intrusions located along an easterly trending line from Engineer Pass to the upper reaches of Nellie Creek. Outcrops are buff, gray and white with 10-20% phenocrysts of quartz, sodic sanidine and sparse biotite.

Quartz Latite (Tiq) Gray porphyritic quartz latite intrusions occurring as plugs and irregular bodies, restricted to two outcrop locations within the study area, north of Engineer Pass and along a ridge west of Schafer Basin.

Surficial Geology

Morphology and surficial deposition have been extensively affected by both glacial and alluvial processes. Many of the upper valleys within the study area exhibit the classic glacial morphology of broad U-shaped valleys bounded by steep sidewalls. Much of the original glacial deposition within the watershed was Pleistocene in age, specifically Pinedale, and has been covered by more recent geologic activity or has been transported away through alluvial processes. The one mapped area of morainal material is located north of Capitol City along the southwestern flanks of Broken Hill. It is likely that some areas of glacial material have been classified as colluvium due to similar physical characteristics and composition.

Fluvial processes within the watershed have resulted in down-cutting and deposition of alluvial material along the existing stream courses. Fluvial action is obviously still a dominant erosional and depositional process within the watershed.

Surficial deposition within the upper reaches of Henson Creek and its tributaries are dominated by talus and scree aprons associated with erosion of steep cliffs and mountainsides. Numerous rock glaciers, lobate structures consisting of angular fragments and ice cores, are actively advancing in some upper tributaries like Horseshoe and Hurricane Basins. Large debris fans of coarse, cobbly and bouldery alluvium dominate the lower outwashes of side tributaries to Henson Creek.

Typical soil cover within the study area is thin to non-existent. Where existent, the soil is poorly developed and typically gravelly and sandy in texture with little organic material. The areas of thickest soil cover are below timberline and on heavily vegetated slopes of low to moderate angles. Sporadic beaver activity within the watershed has resulted in moderately thick alluvial deposits of sand, clay and organics along some tributaries and portions of Henson Creek.

Structural Geology

The formation and destruction of volcanic calderas was the dominant structural geologic process within the study area. At least two calderas, the Uncompahgre caldera and the Lake City caldera, formed and erupted within the Henson Creek watershed as shown in **Figure 3**. The eruption and subsequent collapse of the calderas resulted in extensive concentric ring faulting along their margin. The moats formed during caldera collapse and resurgence resulted in confinement and accumulation of vast quantities of volcanic strata up to 5,000 feet thick (Hon, 1987). Within the study area all Sunshine Peak Tuff is confined to the Lake City caldera, much like most Sapinero Mesa Tuff is confined to the San Juan-Uncompahgre caldera.

Following caldera eruption and collapse, a period of resurgence was typical. Resurgence is the doming of overlying strata, generally within the collapsed caldera, due to the movement of magma upward, but not reaching the surface. One of the most notable resurgences following the San Juan-Uncompahgre eruptive events resulted in the Eureka Graben. As magma moved upward within the collapsed calderas, overlying strata was stretched and eventually fractured resulting in a set of distentional, steeply dipping faults trending northeasterly. These steeply dipping faults are most notable in Palmetto, Redcloud and Schafer Gulches, and are typically mineralized. Resurgence also took place within the Lake City caldera resulting in distentional fracturing along the crest of the dome.

Within the project area, faulting generally trends northeast, and stratigraphic beds dip slightly to the north and northwest, due in part to resurgence. The vast majority of faulting unrelated to ring faults exhibit limited movement. One notable exception to the limited offset is the Alpine Gulch fault which shows a maximum offset of 4,000 feet (Hon, 1987). The Alpine Gulch fault appears to be related to resurgence along the eastern caldera margin. Within the study area, resurgence accounts for the majority of faulting.

Structural geology also greatly influences groundwater flow patterns. The faulting and fracturing associated with caldera collapse and resurgence will often form preferential flow patterns within the strata that can act to confine groundwater flow. These preferential flow pathways not only direct modern day groundwater flow, but enabled historic circulation of hydrothermal fluids and mineralization. Variations in welding of tuffs and density of fracturing within certain layers of stratigraphic units can also act to restrict groundwater flow. The outcrop of numerous springs along certain stratigraphic unit contacts also indicates that those contacts provide excellent pathways for flow.

Hydrothermal Alteration

Varying types and degrees of alteration are present within the Henson Creek watershed and are shown to have ongoing influences to in-stream water quality. The specific types of alteration vary from regional propylitization and solfataric alteration to localized silicification confined by veins. These altered mineral suites are often indicative and predictive of water quality not only in disturbed watersheds, but especially in undisturbed watersheds.

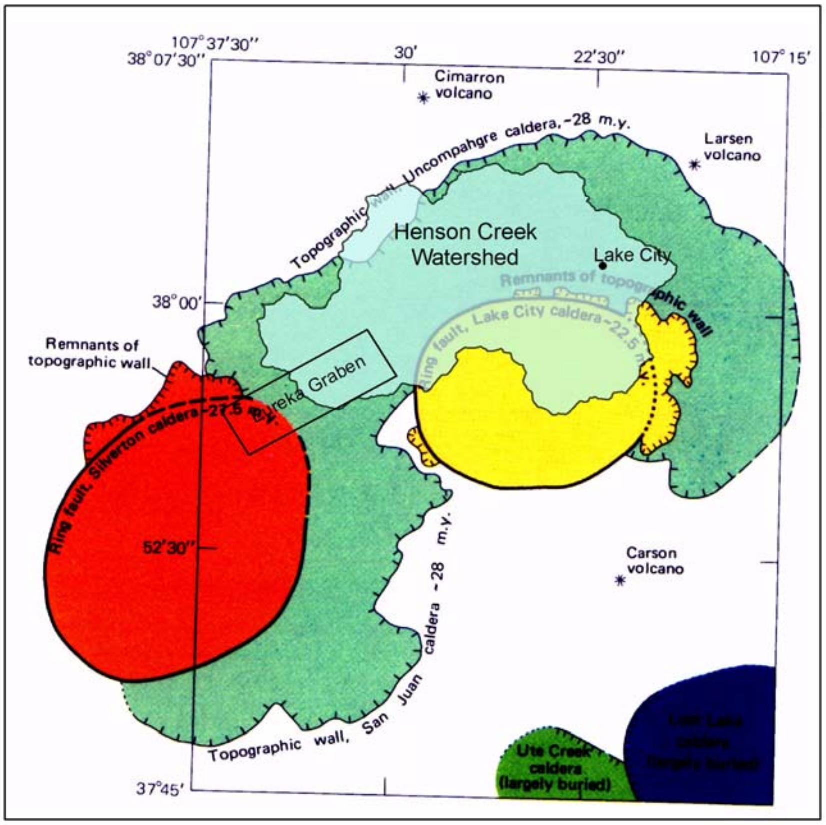
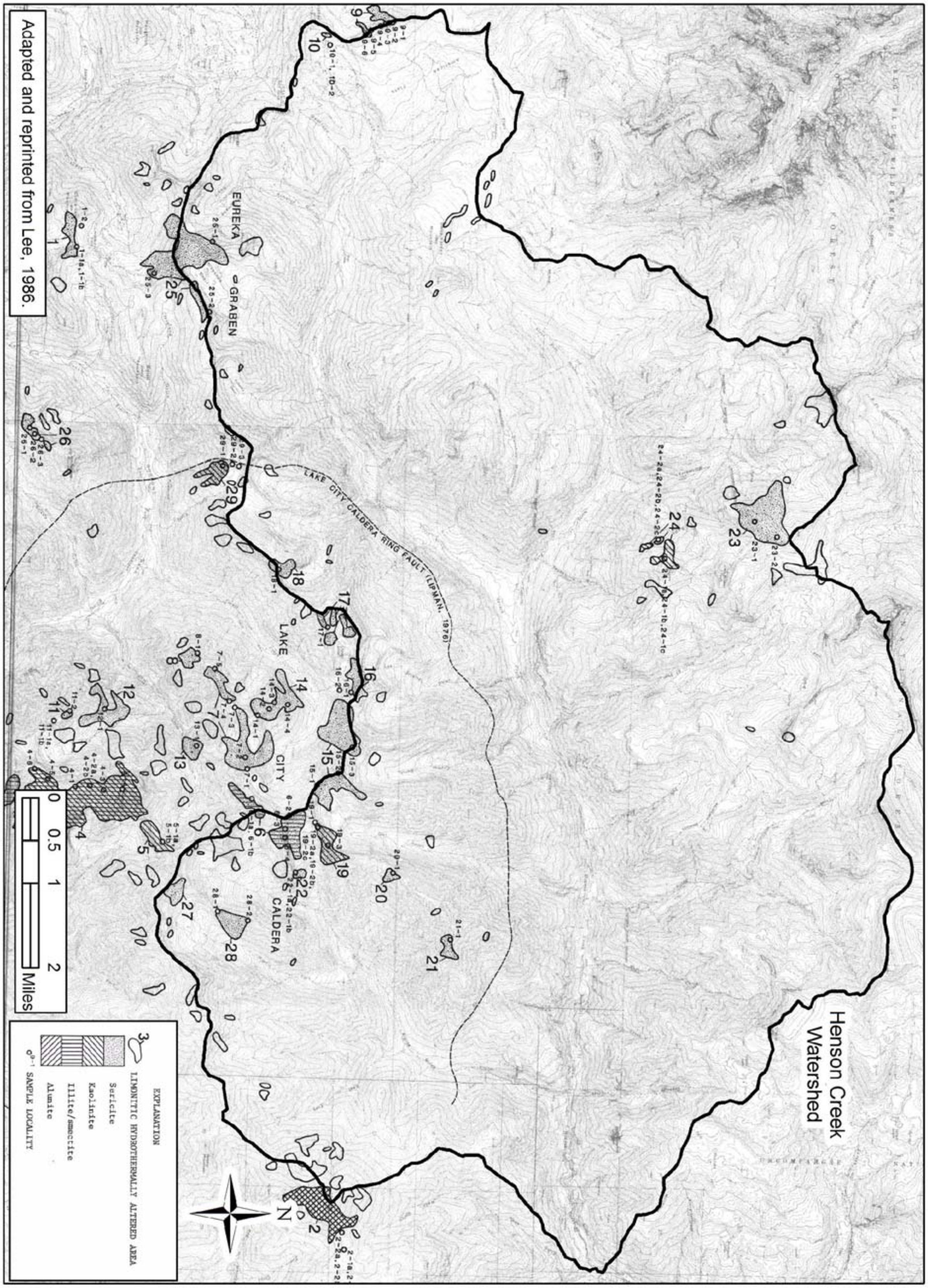


Figure 3. Calderas, Associated Structural Features and Study Area (modified from Lipman, 1976)

Propylitic alteration is probably the most common type of alteration within the study area. Propylitic alteration is a result from the addition of carbon dioxide and water to the rock mass through circulation of hydrothermal aqueous solutions. The suite of altered minerals typically produced during propylitization is chlorite, calcite, epidote, albite and varying clays, which result in a greenish-gray appearance to the rock mass. Propylitization appears to be confined within the project area to the intracaldera zone and specific geologic units. The units most heavily altered are the Sapinero Tuff, Silverton Volcanics and Sunshine Peak Tuff. Propylitic alteration was regional in scale and typically prior to ore deposition.

Figure 4. Limonitic Hydrothermal Alteration in the Lake City Caldera



Solfataric alteration within the study area is limited, and localized to faults and areas adjacent to intrusives. Circulation of hydrothermal solutions and gases saturated with sulphur (solfataric) in varying states of oxidation resulted in alteration of the rock mass to varying percentages of pyrite, kaolinite, alunite, sericite and silica. Areas that have been sofatarically altered will appear red, orange and often yellow due to the oxidation and subsequent staining of solfatarically deposited pyrite. The most prominent areas of solfataric alteration are the head of Palmetto Gulch, Redcloud Gulch, Horseshoe Basin, areas surrounding Broken Hill, Dolly Varden Mountain and a large portion of Red and Grassy Mountains.

Ring faulting along the perimeter of the Lake City caldera does not appear to have been a prominent pathway for solfataric alteration unlike the ring faults associated with the Silverton Caldera. Mapping of limonitic alteration in 1986 by Keenan (**Figure 4**) noted that alteration was more closely related to distentional faulting due to resurgence, than granitic or rhyolitic intrusions. Some areas like the Iron Beds (Broken Mountain) and Dolly Varden Mountain appear to have no extensive faulting and may be more closely tied to intrusions. The area of solfataric alteration at the head of Palmetto Gulch appears to be related to a breccia pipe located along the ridge north of Engineer Pass.

Veins within the study area have some variation, but are typically considered "simple" fissure type veins. Economically important veins varied in width from six inches to more than four feet and generally consisted of sulfide mineral suites with associated quartz and sericite. Typically, wallrock is altered, but localized along the vein. These veins are often correlative to areas of solfataric alteration but many areas do not lie in close proximity to large scale altered zones. Palmetto Gulch appears indicative of economic veins in close proximity to solfataric zones, unlike mineralization along the lower stretches of Henson Creek from Capitol City to Lake City which appear to be isolated veins from areas of extensive alteration. Heavily altered zones along Broken Mountain, Grassy Mountain and Red Mountain are widespread but resulted in no economically valuable mineralization. Veins on Red Mountain are typically barren quartz.

Based on water sampling within the study area, it is apparent that areas of extensive alteration, with little associated mining, contribute substantially to in-stream water quality changes. The areas of Henson Creek most likely affected by extensive alteration unrelated to mining are North Fork Henson Creek, specifically Matterhorn Creek, and lower Henson Creek below Capitol City, specifically Lee Smelter and Alpine Gulches. The tributaries that feed Henson Creek from Red and Grassy Mountains are extensively altered to sericites, kaolinites and illites and therefore are probably the source for much of the background loading. Water quality problems within Palmetto Gulch most certainly have a natural component due to widespread solfataric alteration, but are difficult to quantify in relation to mining related problems.

BASELINE DATA COLLECTION

Water, mill tailings and waste rock were sampled and analyzed to better understand the sources of heavy metals in Henson Creek. The initial reconnaissance of Henson Creek was completed by the LFWG in September and October 2004. Previous investigations had focused on Palmetto Gulch and the Ute-Ule Mine area. The Bureau of Land Management performed tracer studies on several sections of upper Henson Creek in 2000 (Palmetto Gulch) and 2001. Very little work has been completed on other portions of the Henson Creek Watershed.

Based on the reconnaissance investigations, water quality sampling was coordinated by the Division of Minerals and Geology (DMG) in June 2005 and September 2005. Mining waste sampling was conducted by the LFWG in September and October 2004. The locations of these sampling areas are shown on **Figures 5 - 13**. Location descriptions for each of the water and mine waste sites can also be found in subsequent tables and within the data lists in the Appendices.

WATER QUALITY SAMPLING

Sampling was performed along Henson Creek during the low-flow and high-flow regimes to determine the extremes in the amount of heavy metals contributed by various sources. Water samples were collected on Henson Creek below Capitol City on June 1 and 2, 2005 to obtain the high-flow data on the lower section of Henson Creek and June 28 and 29, 2005 above Capitol City to obtain the high-flow data on the upper section of Henson Creek. The high-flow sampling was done at two different times because the peak of snowmelt in the lower portion of Henson Creek occurred much earlier than the upper watershed. Two sampling sites (HC-5 and NFHC-3) were sampled during both periods. During both sampling periods, flows were too high in several locations to be safely measured.

Water samples were collected on Henson Creek on September 13 and 14, 2005 to obtain the low-flow data on Henson Creek below Redcloud Gulch and September 19 and 20, 2005 above Redcloud Gulch. The low-flow sampling had to be split because of potential contamination to Palmetto Gulch from a construction project on September 13. Two sampling sites (HC-5 and HC-3) were duplicated during both sampling events to serve as a basis for comparing the data. During both sampling periods, the draining mine adits were sampled on the first day followed by sampling of the stream sites on the second day.

Water samples were collected in Henson Creek above and below sites identified as potential sources during reconnaissance investigations. The DMG sampling plan included collecting dissolved metal, total recoverable metal, and major cation and anion samples at 67 different locations in Henson Creek. Two planned sampling sites were not sampled due to lack of flow. A list of the sampling sites, their locations and the time of year at which sampling was performed at that location is provided in **Table 1**. The locations of the sampling sites are shown on **Figures 5, 6, 7** and **8**.

Water samples were collected by teams composed of individuals from various government agencies and local volunteers. Raw depth and width integrated samples were taken in the stream. The total recoverable metals samples were then transferred directly to pre-cleaned pre-acidified 250 ml sample bottles; anion samples were transferred to pre-cleaned neutral 250 ml sample bottles; and dissolved metals samples were collected by filtering the raw water through a 0.45 micron filter into a pre-cleaned pre-acidified 250 ml sample bottle. After sampling, the samples were placed in coolers, and the anion samples were iced. All sampling activities were completed at the sampling site. Immediately after the sampling, pH, electrical conductivity and temperature were measured at a central location using one instrument.

During the low-flow sampling events, flow measurements were taken at the same time that the water quality samples were collected. Water quality sampling and flow measurements were taken by continually moving up the watershed during the day. During the high-flow sampling event, virtually all of the water quality samples at stream sites were taken during the period between 10:00 a.m. and 11:00 a.m. on June 1, 2005 and between 11:00 a.m. and 12:00 p.m. on June 29, 2005. This was done to limit the diurnal flow variations in the streams. On June 1, 2005, duplicate flow measurements were taken at stations NFHC-3 and HC-18 and pressure transducers were installed at stations HC-18, HC-17, HC-15, HC-9 and NFHC-3. On June 29, 2005, duplicate flow measurements were taken at sampling sites HC-5, HC-1, PG-10 and PG-1 plus a pressure transducer was installed at sampling site PG-10.

Figure 5. Upper Henson Creek Water Quality Sampling Sites

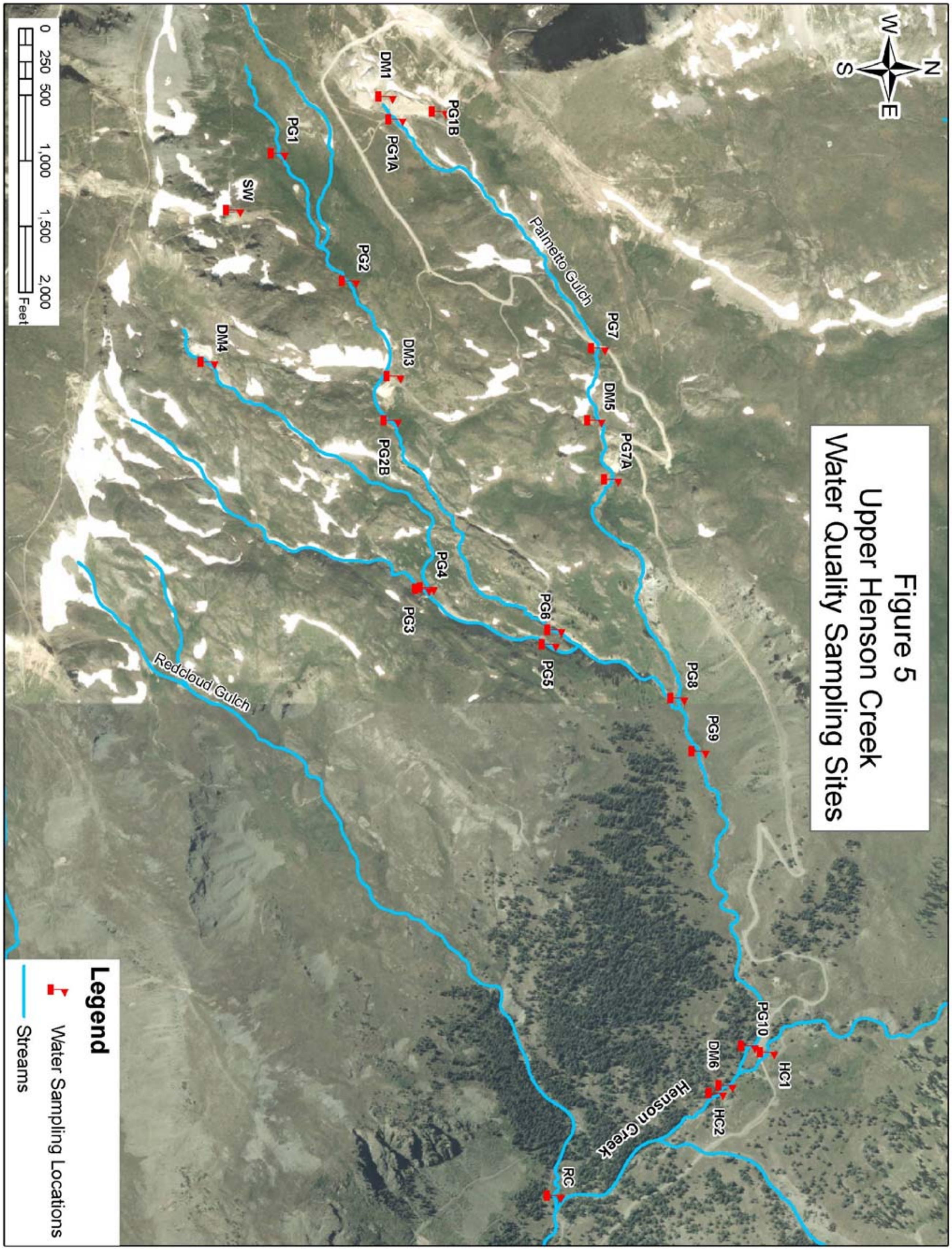


Figure 6. Henson Creek Above North Fork and North Fork Water Quality Sampling Sites

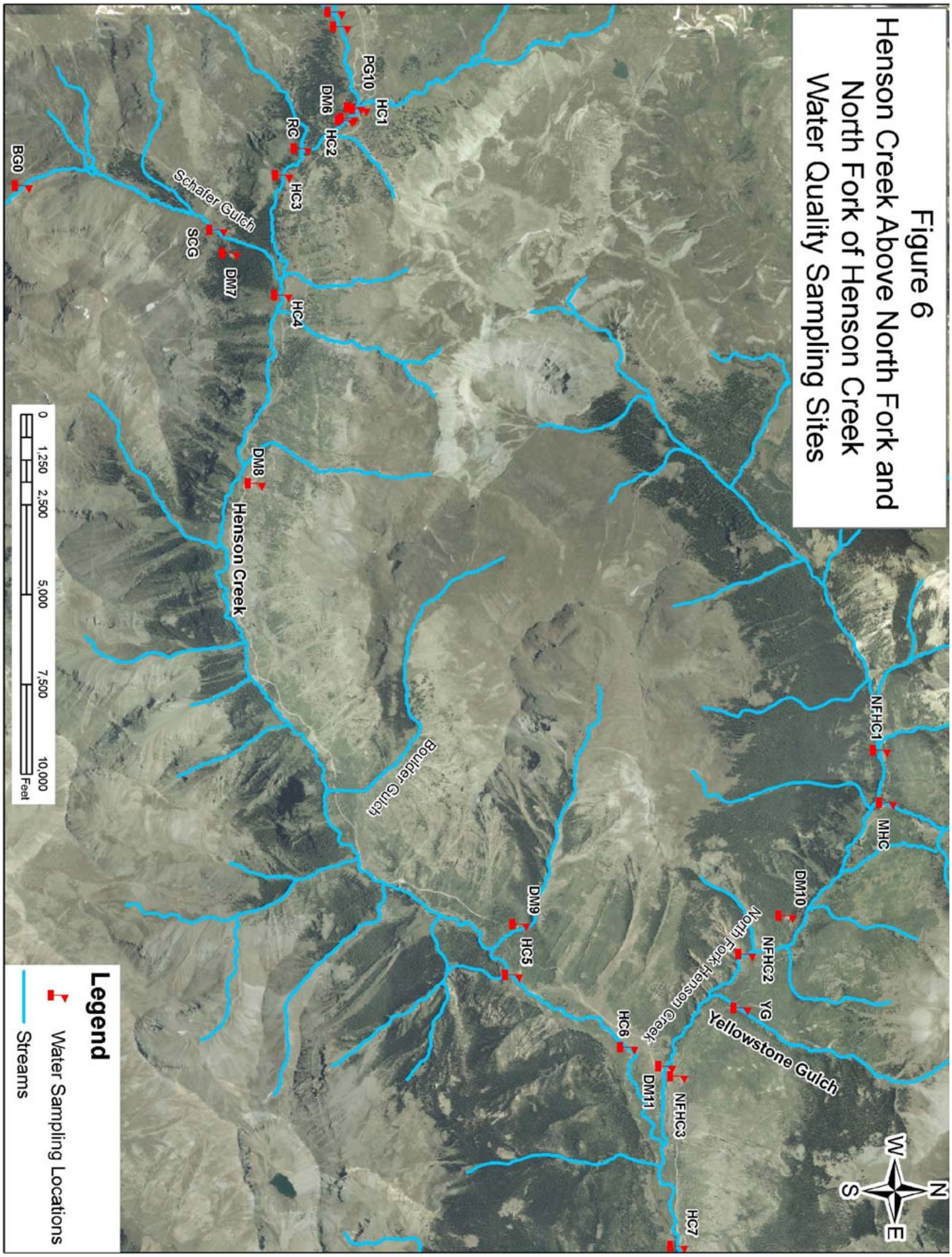


Figure 7. Henson Creek Below North Fork Water Quality Sampling Sites

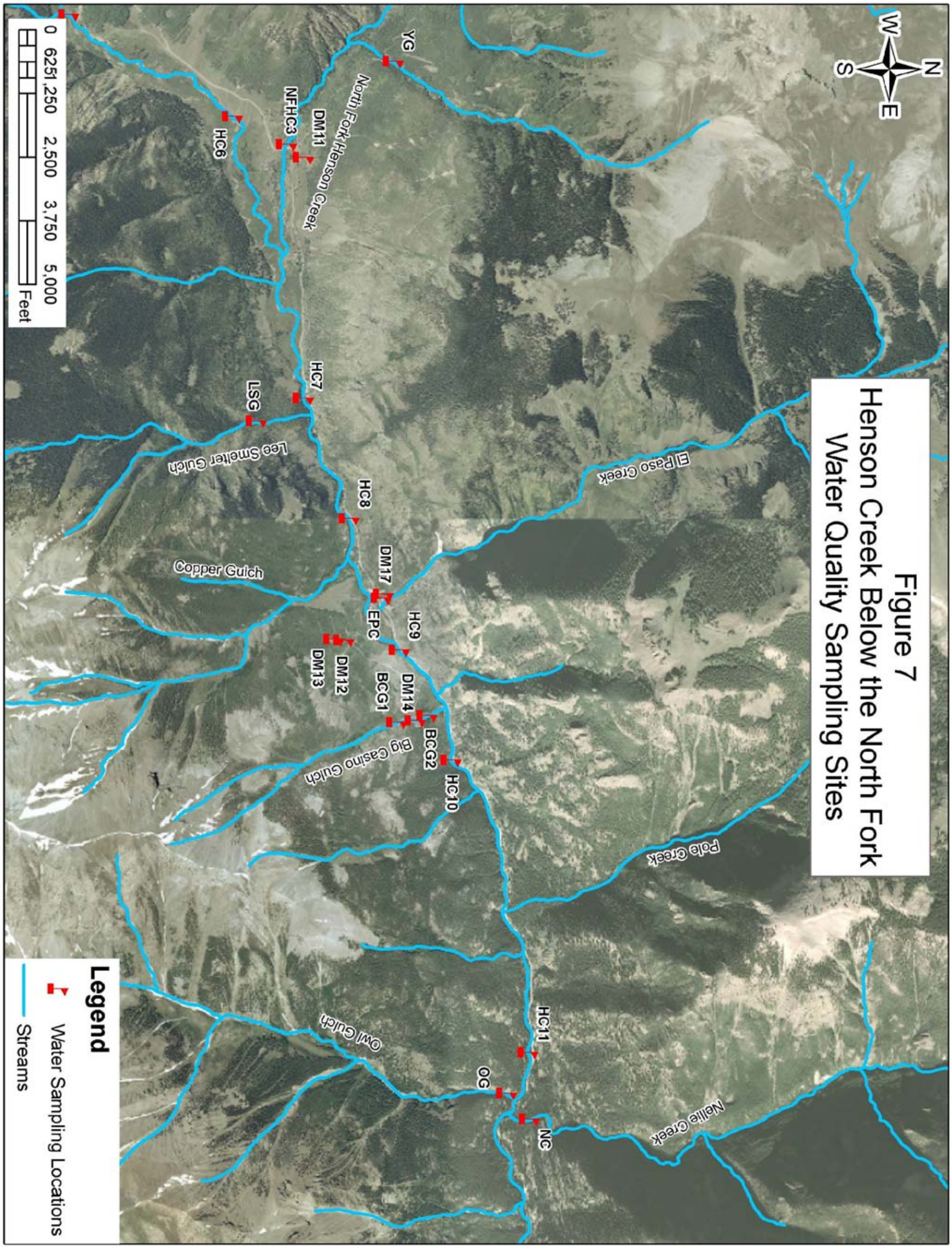
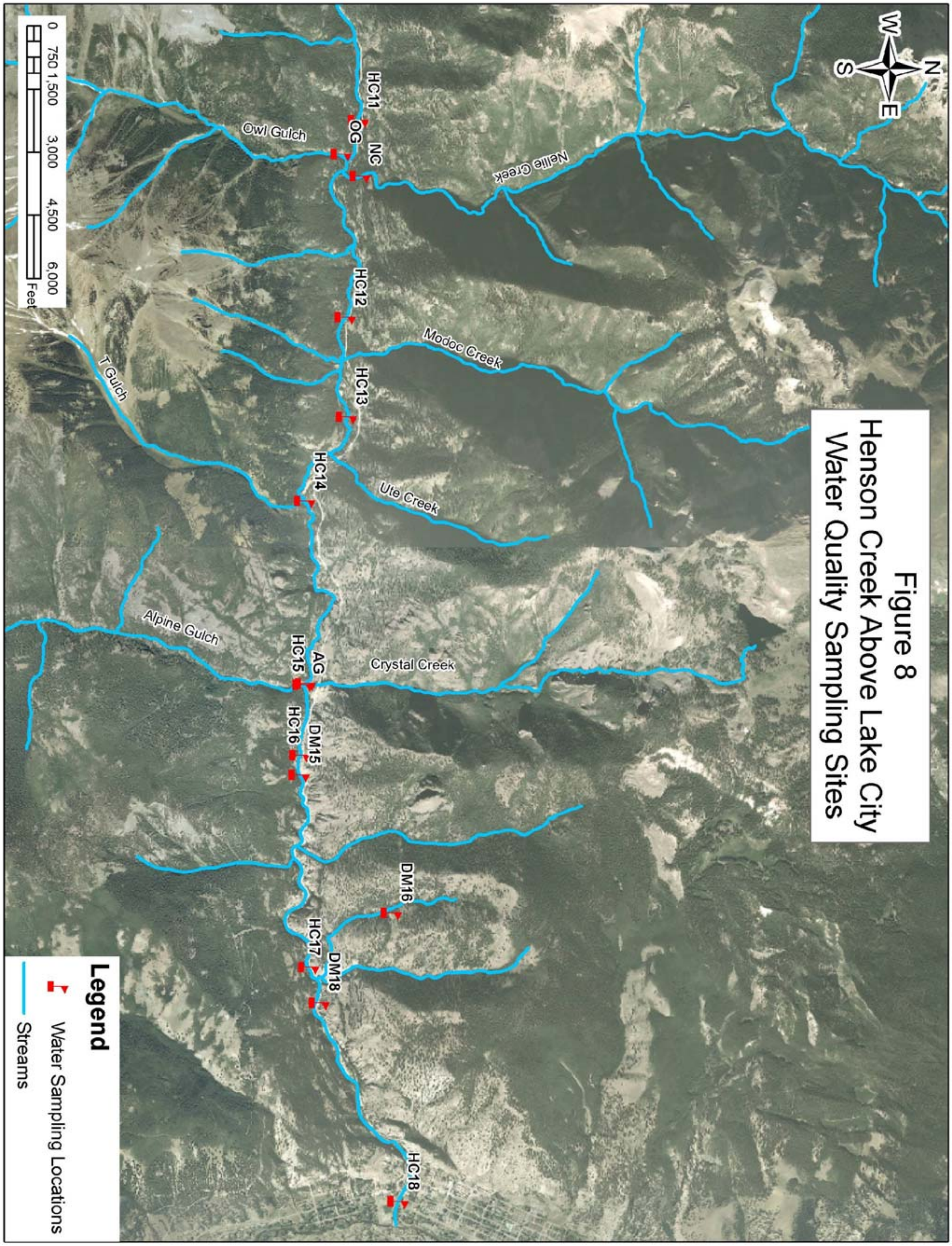


Figure 8. Henson Creek Above Lake City Water Quality Sampling Sites



The flow measurements at these sites plus duplicate measurements taken during the sampling period at other sites, were used to adjust the flow measurements taken later in the day.

The high-flow concentration data is presented in **Appendix 1**. High-flow loading data is presented in **Appendix 2.** The low-flow concentration data is presented in **Appendix 3** and low-flow loading data is presented in **Appendix 4**.

Table 1. Henson Creek Water Quality Sampling Sites

Sample No.	Location	June 2005	Sept. 2005	Comments
HC-1	Henson Headwaters	X	X	Headwaters
HC-2	Henson below Palmetto	X	X	
HC-3	Henson below Redcloud	X	X	
HC-4	Henson below Schafer	X	X	
HC-5	Henson above Hanna Mill	X	X	
HC-8	Henson above Copper	X	X	Flow too high to measure 6-1-2005
HC-5	Henson above Hanna Mill	X	X	
HC-6	Henson above North Fork	X	X	
HC-7	Henson above Lee Smelter	X	X	
HC-8	Henson above Copper	X	X	
HC-9	Henson above Big Casino	X	X	
HC-10	Henson below Big Casino Gulch	X	X	Flow too high to measure 6-1-2005
HC-11	Henson above Nellie and Owl Gulch	X	X	
HC-12	Henson above Ute-Ule Tailings	X	X	Flow too high to measure 6-1-2005 & 6-29-2005
HC-13	Henson below Ute-Ule Tailings	X	X	Flow too high to measure 6-1-2005 & 6-29-2005
HC-14	Henson below Ute-Ule	X	X	Flow too high to measure 6-1-2005 & 6-29-2005
HC-15	Henson above Alpine	X	X	Flow too high to measure 6-29-2005
HC-16	Henson below Alpine	X	X	Flow too high to measure 6-1-2005 & 6-29-2005
HC-17	Henson Below Pelican	X	X	
HC-18	Henson above Lake Fork	X	X	
PG-1A	Runoff from Hough Dump	X		Largest runoff channel from Hough Dump
PG-1B	Downstream of Hough Adit	X		Adit drainage could not be located under snow
PG-1	Palmetto Gulch Headwaters	X	X	Headwaters
SW	Sarah Woods Dump Drainage	X		No flow in September
PG-2	Palmetto below Sarah Woods	X	X	
PG-2A	Palmetto Gulch below Roy Pray		X	Immediately below Roy Pray
PG-3	South Trib to Palmetto	X	X	Includes effects from Engineer and Emperor Wilhelm Mines
PG-4	Palmetto Trib below Wyoming & Hoffman	X	X	Includes effects from Wyoming dump and drainage and Hoffman Mine dump
PG-4A	Palmetto Trib below Wyoming Adit	X		Adit drainage could not be located under snow

Sample No.	Location	June 2005	Sept. 2005	Comments
PG-5	Below Confluence of PG-3 and PG-4	X	X	
PG-6	Palmetto below Roy Pray	X	X	
PG-7	Palmetto below Hough	X	X	
PG-7A	Palmetto immediately below Palmetto Mine		X	Immediately below Palmetto Mine
PG-8	Palmetto below Palmetto Mine	X	X	Approximately ¼ mile downstream of Palmetto Mine
PG-9	Palmetto below Tributary Confluence	X	X	
PG-10	Palmetto above Henson	X	X	
AG	Alpine Gulch	X	X	
NC	Nellie Creek	X	X	
OG	Owl Gulch	X	X	
BCG-1	Big Casino Gulch above Pride of America	X	X	
BCG-2	Big Casino Gulch below Pride of America	X	X	Flow estimated
EPC	El Paso Creek	X	X	No flow measurement in September 2005
LSG	Lee Smelter Gulch	X	X	
CZ	Ephemeral Drainage below Czar & Czarina Mines			Dry in June and September. Flow observed in May 2005
YG	Yellowstone Gulch	X	X	
MHC	Matterhorn Creek	X	X	
NFHC-1	North Fork Henson Headwaters	X	X	
NFHC-2	North Fork Henson above Yellowstone	X	X	
NFHC-3	North Fork Henson above Henson	X	X	
SCG	Schafer Gulch	X	X	
BGO	Schafer Gulch below Golconda Mine		X	Inaccessible in June
RC	Redcloud Gulch	X	X	
DM-1	Hough Mine		X	Could not be located under snow in June
DM-2	Drainage above Roy Pray			Not sampled
DM-3	Roy Pray Mine		X	Not sampled in June
DM-4	Wyoming Mine		X	Could not be located under snow in June
DM-5	Palmetto Mine	X	X	
DM-6	BLM Adit below Confluence		X	Standing water in June
DM-7	Chicago Tunnel	X	X	
DM-8	Highland Chief Mine	X	X	
DM-9	Moro Tunnel	X	X	
DM-10	Vulcan Mine	X	X	
DM-11	Lucky Strike Mine	X	X	
DM-12	Four Aces Upper Adit	X		Standing water in September
DM-13	Four Aces Lower Adit			Standing water, no flow
DM-14	Pride of America Mine	X	X	
DM-15	Risorgimento Mine	X	X	
DM-16	Pelican Mine	X		No flow in September
DM-17	El Paso Creek Draining Mine	X		No flow in September
DM-18	Draining Mine below Pelican	X	X	

MINE WASTE SAMPLING

Mine waste samples were collected at 66 different locations in Henson Creek. The samples included 61 waste rock sites and five mill tailings sites. Iron bed soil in Matterhorn Creek was also sampled. The location of the sampling sites is shown on **Figures 9-13.** The mining wastes were investigated to provide information sufficient to allow the LFWG to prioritize mine sites for reclamation.

Waste rock and soil/outcropping samples were collected from a minimum of thirty locations at each site. New four oz. plastic Dixie cups and a rock from the mine dump were used to remove the top two inches of material. The 30+ sub-samples from each site were composited in a one-gallon re-closeable plastic bag.

After collection, the composited samples were thoroughly mixed by inverting the bag numerous times. After mixing, 150 ml of sample was removed and placed in a one liter plastic beaker along with 300 ml of deionized water. The wetted sample was then vigorously mixed for 15 seconds, plastic wrap was placed over the top, then left to settle for 90 minutes. It took 90 minutes for the clay fraction to settle to the bottom of the beaker.

Table 2. Mining waste physical ranking system

Erosion	Distance to channel	Vegetation On Pile	Kill Zone Below Pile
1=none	1=over 300 yds	1=lots	1=no kill zone
2=sheet wash	2=over 100 yds	2=yes	3=very little kill zone
3=rills less than 6” deep	3=over 100 ft	3=little	
4=rills 6” – 12” deep	4=less than 100 ft		4=trees but not underbrush
5=gullies over 12” deep	5=less than 10 ft	5=no	5=yes

After 90 minutes, the liquid was filtered through very fine grade soil filters (approximately two micron). A portion of the liquid was then used to measure the total acidity, pH, and specific conductance. The remaining liquid was filtered through a 0.45 micron filter and acidified with nitric acid for lab analysis. Total acidity was determined using an Hach digital titrator to reach a phenolphthalein end-point. Specific conductance and pH were measured with a standard calibrated instrument. The data from the waste rock sampling is presented in **Appendix 5**.

<u>Table 3</u>. Priority Mining Waste Sites in Henson Creek

Site #	Description	Chemical Rank	Physical Rank	Overall Ranking
2	Lower Hough Mine	1	1	1
1	Upper Hough Mine	2	1	2
5	Lower Sarah Woods Mine	5	1	3
48	Excelsior Lode	4	4	4
43	Yellowstone Mill Tailings West	6	4	5
55	Red Rover Tunnel/Little Hattie Lode	18	4	6
56	Pride of America Mine	14	9	7
42	Yellowstone Mill Tailings East	11	12	7
8	Miners Bank Mine	9	14	7
12	Upper Emporer. Wilhelm Mine	8	17	10
9	Wyoming Mine	13	14	11
15	Second Dump above Palmetto Mine	24	4	12
60	Hidden Treasure Tailings	15	14	13
11	Hofman Mine	22	9	14
54	Wave of the Ocean	10	21	14
61	Risorgimento Mine	3	28	14
47	Dump at gate below Czarina (Broker Lode)	7	28	17
14	Collapsed Adit between Palmetto and Roy Pray	28	9	18
17	Palmetto Mine	21	21	19
3	Backfilled shaft north of Sarah Woods	26	17	20
6	Dump East of lower Sarah Woods	24	21	21
27	Upper Golconda Mine	17	28	21
46	Mountain Belle Lode	19	28	23
45	Yellow Medicine Mine	27	21	24
40	Hanna Mill Tailings	23	28	25
50	Vermont Mine	36	17	26

The 66 mining sites that were sampled were prioritized on the basis of their chemical and physical characteristics, proximity to a stream course, vegetation on the waste pile, presence or absence of a vegetation kill zone and historic erosion. Chemical prioritization was done by ranking the sampling sites in progressive order for acidity, pH, specific conductance, and concentration of aluminum, arsenic, cadmium, copper, iron, manganese, lead and zinc in the leachate extraction, summing the individual rankings to determine a final ranking. Physical prioritization was done following the method developed by Wildeman, et. al. as shown in **Table 2.**

Table 4. Heavy Metals for which Henson Creek Mine Sites Ranked in the Top Ten

Site #	Description	Top 10 Metal
1	Upper Hough Mine	Al, As, Cd,Cu, Fe, Mn, S, Zn
2	Lower Hough Mine	Al, As, Cd,Cu, Fe, Mn, S, Zn
5	Lower Sarah Woods Mine	Al, As, Cu, Fe, S
6	Dump East of lower Sarah Woods Mine	Fe
8	Miners Bank Mine	Al, As
9	Wyoming Mine	Al
10	Engineer Mine	As
12	Upper Emporer. Wilhelm Mine	Al, Fe
15	Second Dump above Palmetto Mine	Fe
16	Dump across stream from Palmetto Mine	S
21	Mine Near Ridge on North Side of Schafer	As, Fe
27	Upper Golconda Mine	Al, Cd, Cu, Mn, S, Zn
35	Highland Mine	Mn, S
36	Schafer Basin Mine West Side	Cu, Pb
42	Yellowstone Mill Tailings East	Cd, Cu, Pb, Zn
43	Yellowstone Mill Tailings West	Cd, Cu, Pb, Zn
47	Dump at gate below Czarina (Broker Lode)	Al, Cd, Cu, Mn, Pb, Zn
48	Excelsior Lode	Al, Cd, Cu, Fe, S, Zn
52	Little Casino	Pb
53	Four Aces Lode	Cd, Pb
54	Wave of the Ocean	Cu, Mn, Pb
55	Red Rover Tunnel/Little Hattie Lode	S
56	Pride of America Mine	Cd, Mn, Pb, S, Zn
60	Hidden Treasure Tailings	Cd, Mn, Pb, Zn
61	Risorgimento Mine	Al, Fe, Mn, S, Zn
63	Mountain Chief Upper	Mn

The physical and chemical ranking of the mining waste pile is presented in **Appendix 6**. A listing of the 25 highest ranking waste pile is presented as **Table 3**, and a listing of the top ten sites for each of the heavy metals is presented as **Table 4**. In general, most of 25 highest ranking mining waste sites also were in the top 10 for each individual heavy metal.

No natural background samples were taken in Henson Creek. However, in comparison to natural background samples taken throughout the state, over half of the samples had total acidity similar to background soils. Many were also low in leachable heavy metals although most had higher concentrations of heavy metals in the leachate than natural background samples.

Figure 9. Upper Henson Creek Waste Rock Sampling Sites

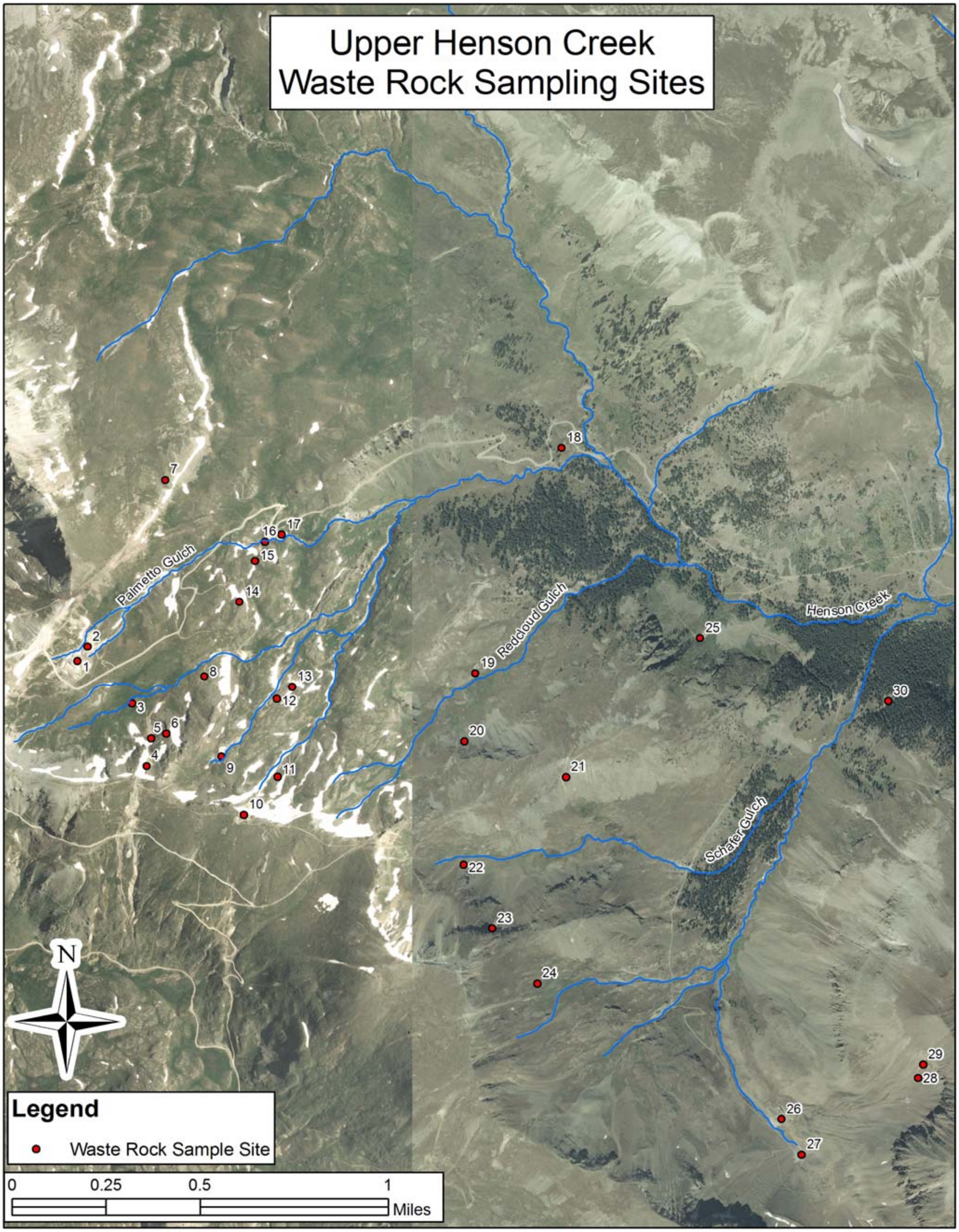


Figure 10. Henson Creek Above North Fork Waste Rock Sampling Sites

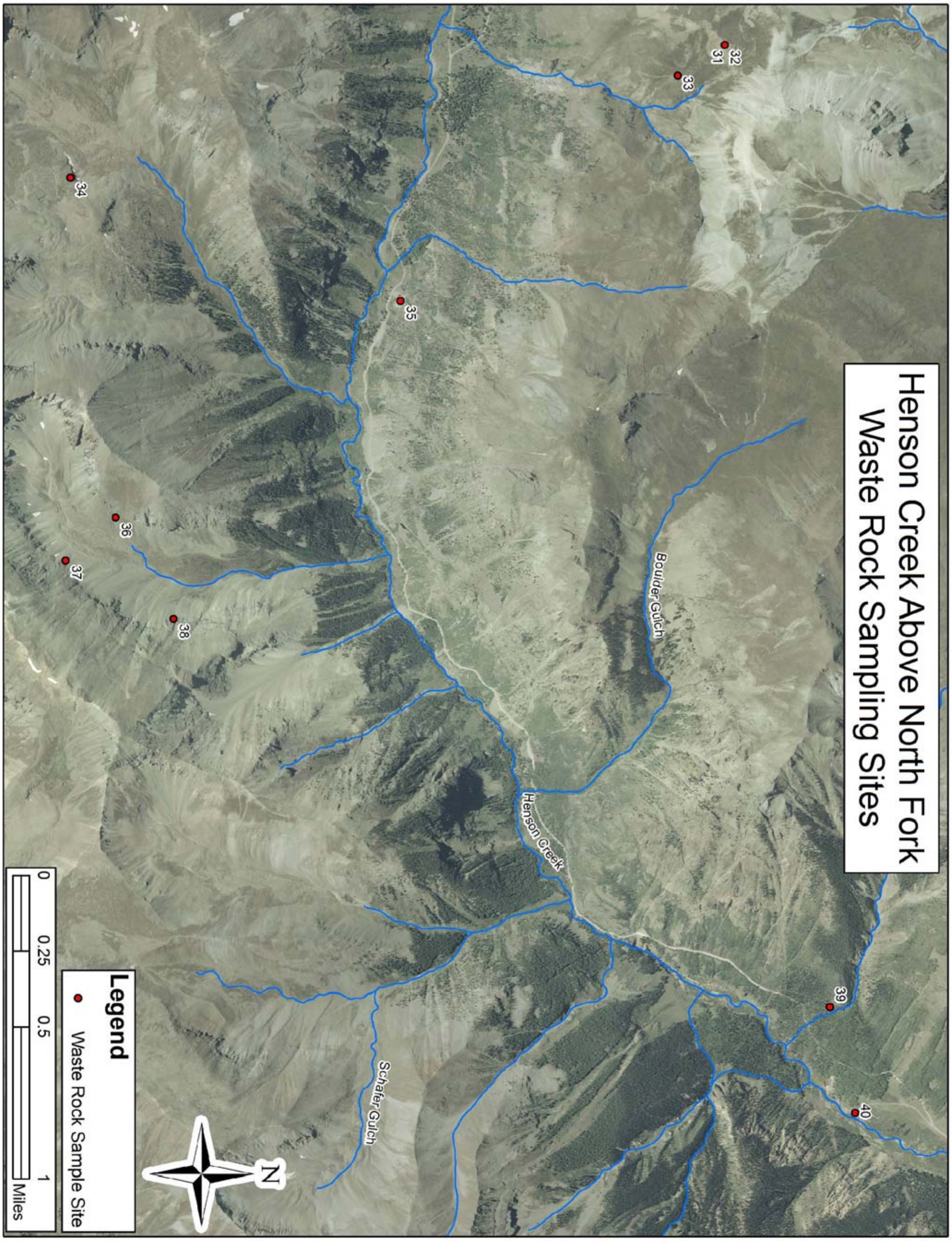


Figure 11. North Fork Henson Creek Waste Rock Sampling Sites

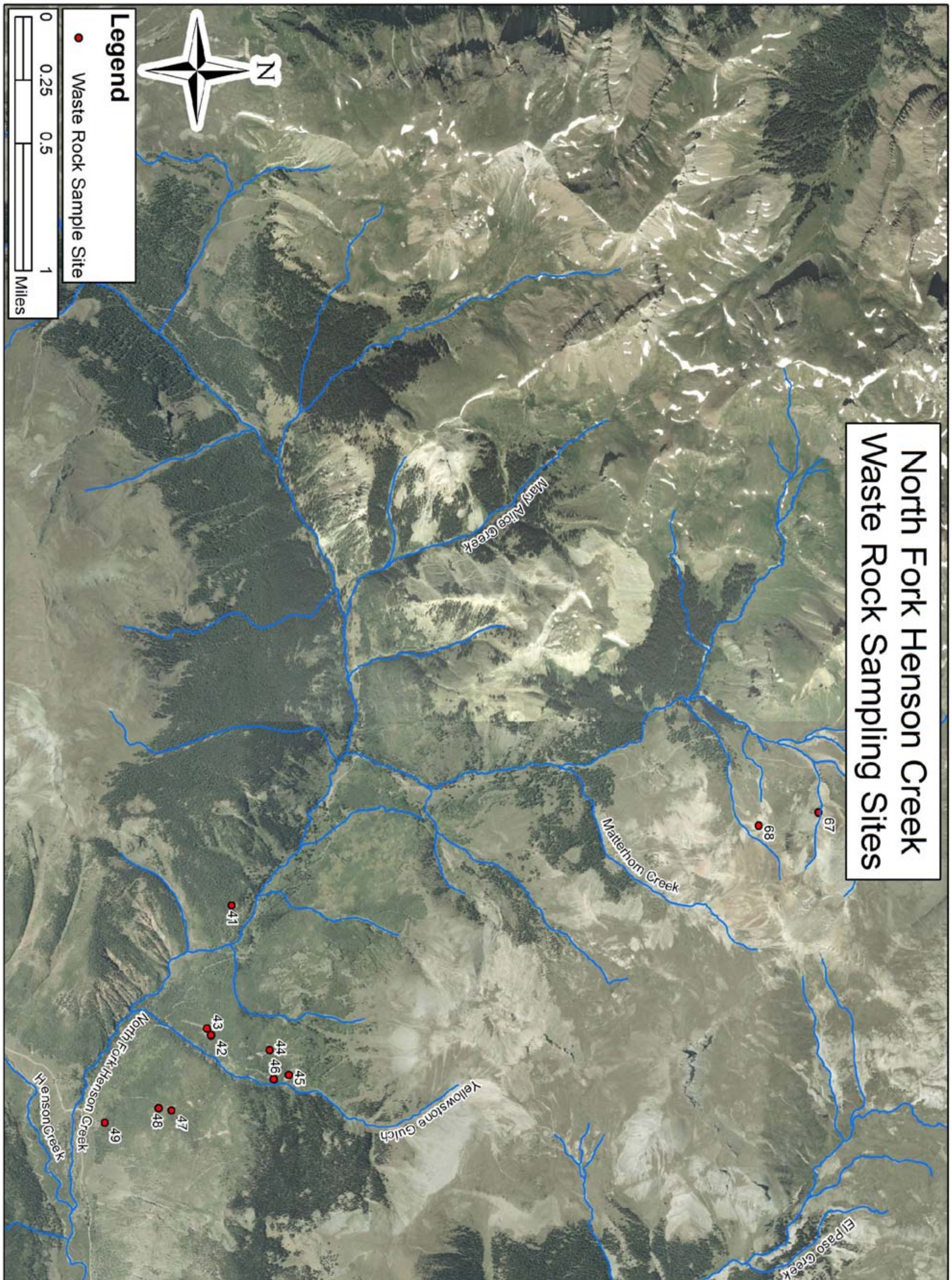


Figure 12. Henson Creek Below North Fork Waste Rock Sampling Sites

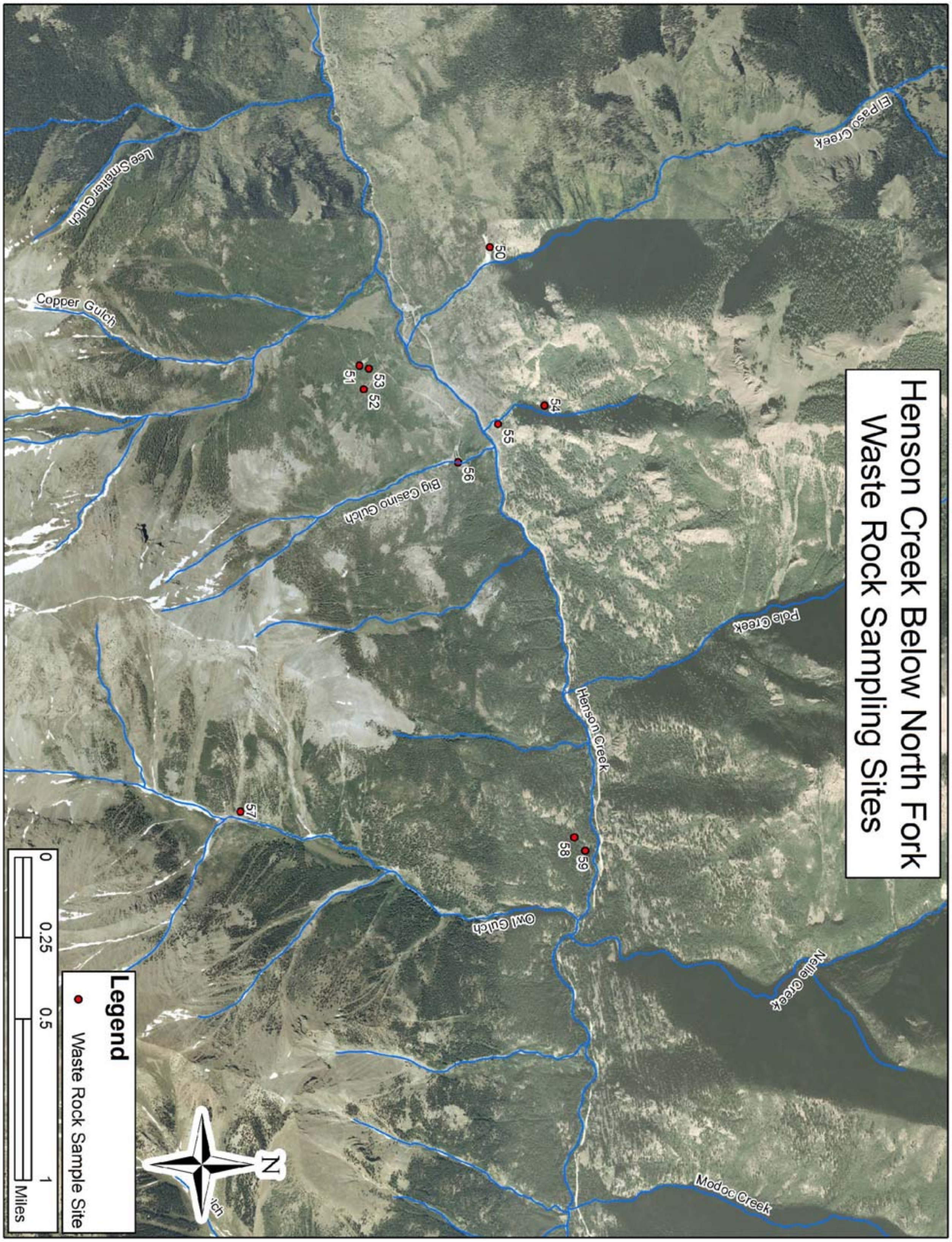
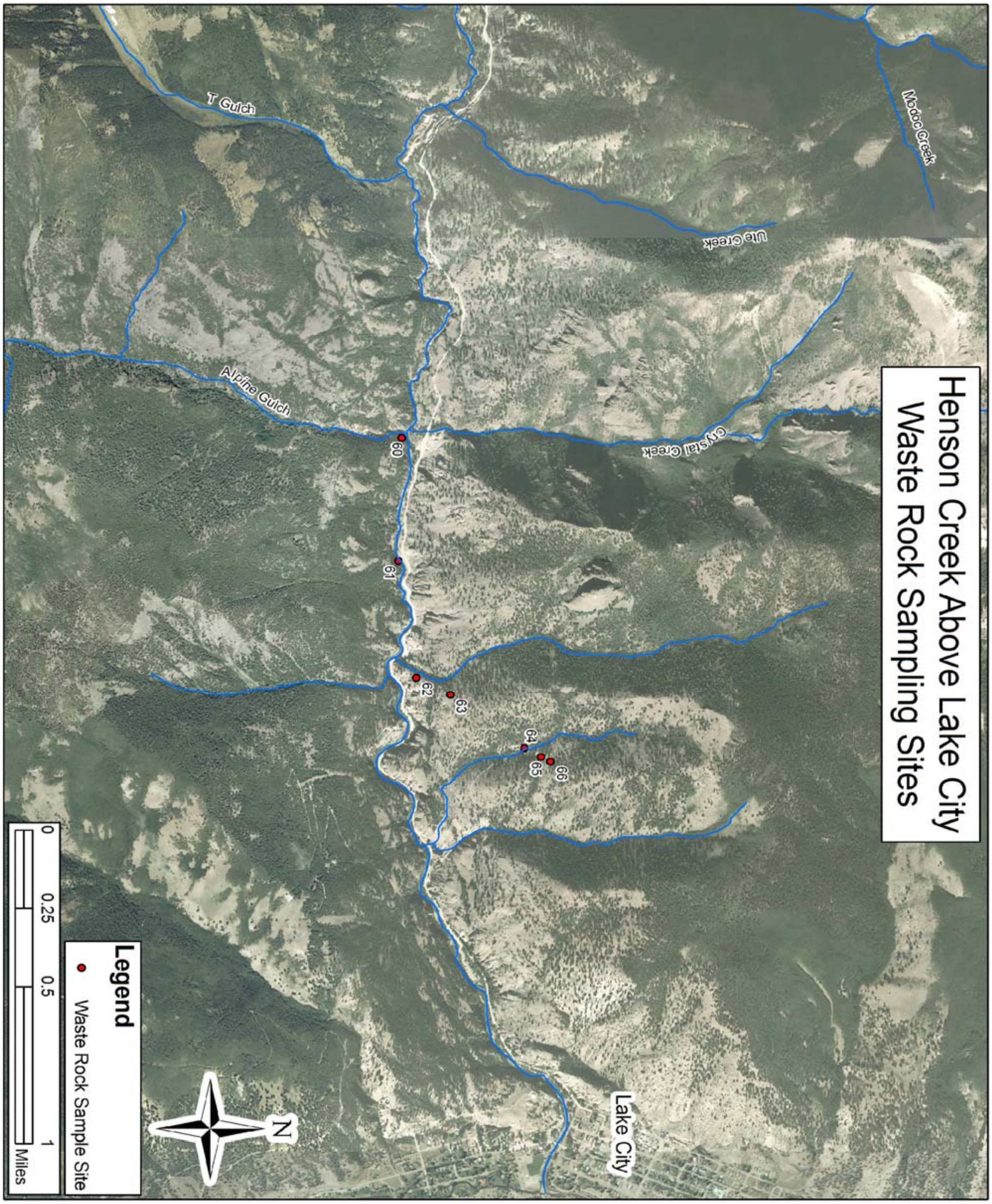


Figure 13. Henson Creek Above Lake City Waste Rock Sampling Sites



WATERSHED CHEMISTRY

The water chemistry in Henson Creek is very complex because there are both natural and mining-related metals loading affecting the streams. There are also some differences in speciation of metals due to the varying geology of the area.

Palmetto Gulch Chemistry

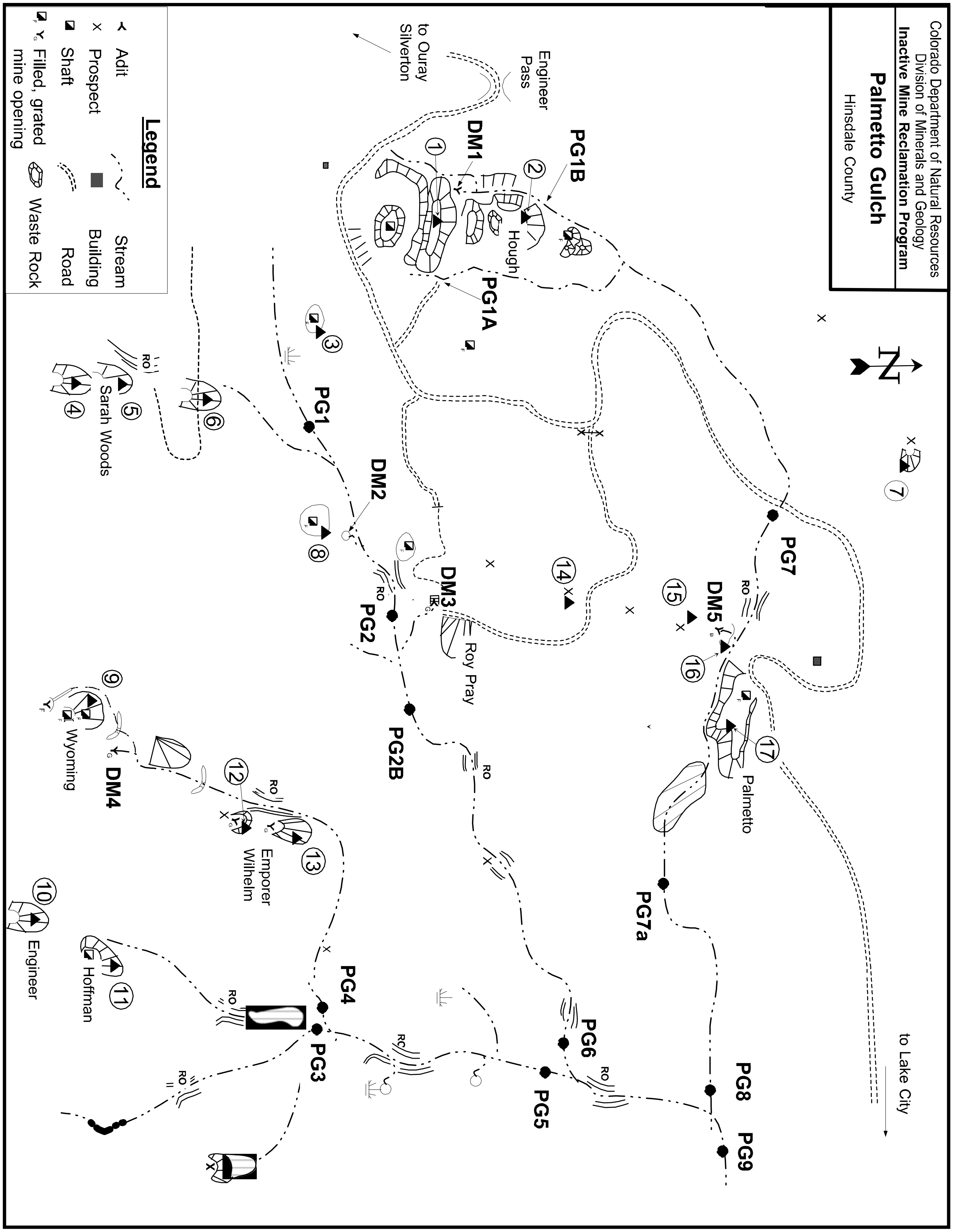
High Flow – Palmetto Gulch is actually comprised of four main tributaries that flow together at various points (**Figure 14**). For the purpose of this discussion, the tributary represented by sampling sites SW, DM-2, DM-3, PG-1, PG-2 and PG-6 will be referred to as Middle Palmetto Gulch. The tributary flowing past the Hough Mine and sampled as DM-1, DM-5, PG-1A, PG-1B, PG-7, PG-7A and PG-8 will be referred to as North Palmetto. The two drainages containing sampling sites DM-4, PG-3, PG-4, and PG-5 will be referred to as South Palmetto.

During high flow, the chemistry of Palmetto Gulch is dominated by nonpoint source of heavy metals (**Figure 15**). The draining mines only account for less than 5% of the heavy metals measured above the confluence with Henson Creek. Loading that is believed to be directly attributable to the Sarah Woods and Hough Mine dumps was measured directly and indirectly. The metal loads from these sites accounts for almost 40% of the zinc and 18% of the manganese, which are the most conservative of the metals measured. Leachate from the Sarah Woods and Hough Mine dumps also accounts for a large portion of the aluminum, copper and iron loading, but a large portion of these metals are naturally attenuated before the confluence with Henson Creek.

The major mines in the North Palmetto drainage are the Hough, near the headwaters and the Palmetto Mine. During high flow the Hough Mine has a major impact on North Palmetto. Direct impacts from the Hough Mine were measured at sampling sites PG-1A and PG-1B during high-flow and indirectly at sampling site PG-7. The majority of the metals load from high-flow is from leaching and runoff from the Hough waste rock pile. Runoff from the waste pile was sampled at site PG-1A. There were additional flow channels from the waste rock pile with the largest channel being sampled. Sampling site PG-1B is a mixture of Hough Mine drainage, runoff from above the Hough Mine and leachate and runoff from the Hough Mine. Total metals loading at sampling site PG-7 is over 70.5 pounds (32,000 grams) per day, including aluminum, arsenic, copper, cadmium, iron, lead, manganese and zinc. Between sampling sites PG-7 and PG-8, the metals load reduces from clean water inflows causing precipitation of the metals. This data indicates that there is minimal loading from the Palmetto Mine.

On Middle Palmetto, the total zinc load at sampling site PG-1 on Palmetto Gulch was below measurable quantities. Sampling site SW is directly below the lower Sarah Woods Mine and downstream of sampling site PG-1. The total zinc load measured at sampling site SW was only 0.4 grams per day. However, the total zinc load at sampling site PG-2, downstream of the Sarah Woods jumped to over 4.2 pounds (1900 grams) per day. Since there are virtually no other sources between PG-1 and PG-2, this load is directly attributable to the Sarah Woods Mine workings or to the Miners Bank vein that contains the Sarah Woods Mine workings. The majority of this load most likely enters Middle Palmetto Gulch as shallow ground water. Precipitate first forms on Middle Palmetto Gulch below the Sarah Woods.

Figure 14. Palmetto Gulch Sampling Sites



Below sampling site PG-2 is the Roy Pray Mine. This site was completely covered by snow during the high-flow sampling, so there was no direct measurement of the input from the draining mine between the inflows between the bulkhead seal and the portal. However, the zinc load increases to over 11 pounds (5,000 grams) per day at sampling site PG-6. An unknown portion of this load is attributable to the Roy Pray Mine, but also within this reach, the stream flows along a mineralized zone that could also be partially responsible for the loading.

Aluminum and manganese loading follows the same pattern as zinc. A small load was measured in flow from the Sarah Woods site, but a total aluminum load over 44 pounds (20,000 grams) per day and a total manganese load of over 11 pounds (5,000 grams) per day was measured at sampling site PG-2 immediately downstream. There also appears to be an increase in aluminum loading along with the manganese load doubling at sampling site PG-6 below the Roy Pray Mine. Again, a portion of the source is likely the Roy Pray inflow mine drainage and leaching of the waste rock, but the low-flow data indicates that the natural mineralization along the stream channel below the Roy Pray Mine may be the principal source of metals in this stream segment. The majority of the copper, cadmium and iron loading along Palmetto Gulch appears to originate from the Sarah Woods site.

The high-flow hydrology of South Palmetto is complex. Sampling site PG-3 measures impacts from the Engineer and Emperor Wilhelm Mines and sampling site PG-4 measures impacts from the Wyoming Mine, the Hoffman Mine and numerous prospects. The metals loading at both sampling sites is significant during high-flow. A large portion of this load can be attributed to leaching of the waste rock pile with a small portion of the load at PG-4 coming from the Wyoming Mine drainage. However, natural sources cannot be discounted as a loading source.

The only way to ascertain the contributions from each of the waste piles is to sample above and below each pile. Unfortunately, this could not be done during the high-flow synoptic sampling because snow depths were too great. Future investigators should consider an additional sampling during July when most of the snow is gone to further characterize the impacts of the waste rock piles. At sampling site PG-5, approximately 1,200 feet below the confluence of PG-3 and PG-4, the Al, Cd, Cu, Fe, Mn, and Zn load more than double. There are no significant mines in this stream stretch, but there are several springs.

Below the confluence of the three tributaries at sampling site PG-9, metals loading generally decreases. Below PG-9, there are no major inflows and no significant mining-related activity.

<u>Low-Flow</u> – Whereas the Hough Mine site is a dominant source of metals during high-flow, it is a minor source of metals during low-flow. During low-flow, there is very little impact to North Palmetto Gulch from the mine sites (**Figure 19**).

On Middle Palmetto Gulch, there is still some measurable impact from the Sarah Woods Mine, but quantifiable impacts are dominated by the Roy Pray inflow mine drainage. Below the Roy Pray, the aluminum, cadmium, copper, zinc and manganese loading more than doubles. The concentrations remain relatively stable while the flow more than doubles. This could indicate that there is communication from the bulkheaded Roy Pray reservoir and lower strata.

On South Palmetto Gulch, there is very little impact from the Wyoming and Hoffman Mines, but there is a detectable metals load at PG-3 from the Engineer and Emperor Wilhelm Mines. Below the confluence of PG-3 and PG-4, the flow more than doubles, but unlike at high-flow, there is a metal loading decrease indicating that the springs in this area supply relatively clean water. One possible explanation for the difference between high-flow and low-flow is that there

Figure 15. Upper Henson Creek-High-flow Loading Al, Cd, Cu, Fe and Zn

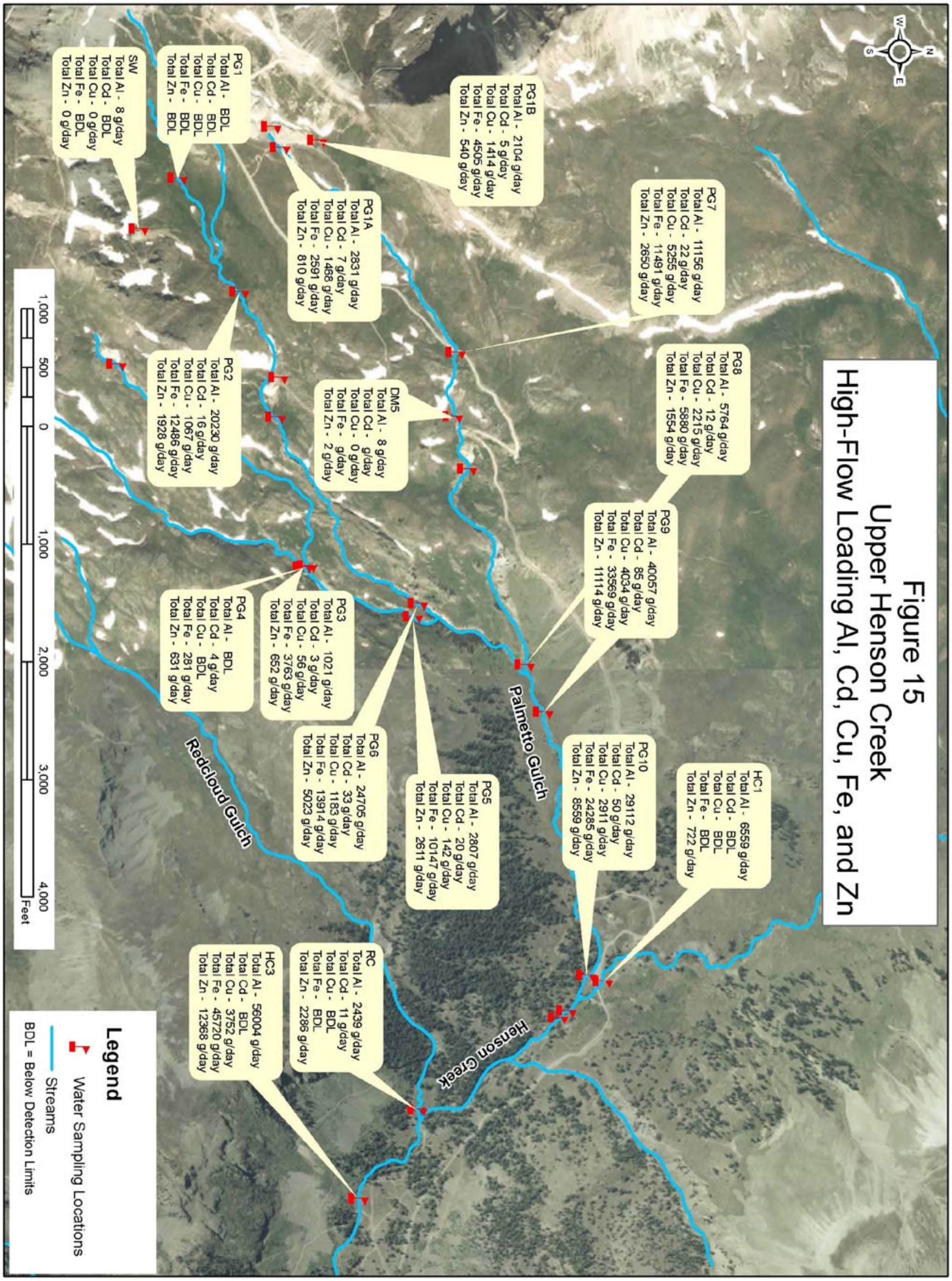


Figure 16. Henson Creek Above North Fork-High-flow Loading Al, Cu, Fe and Zn

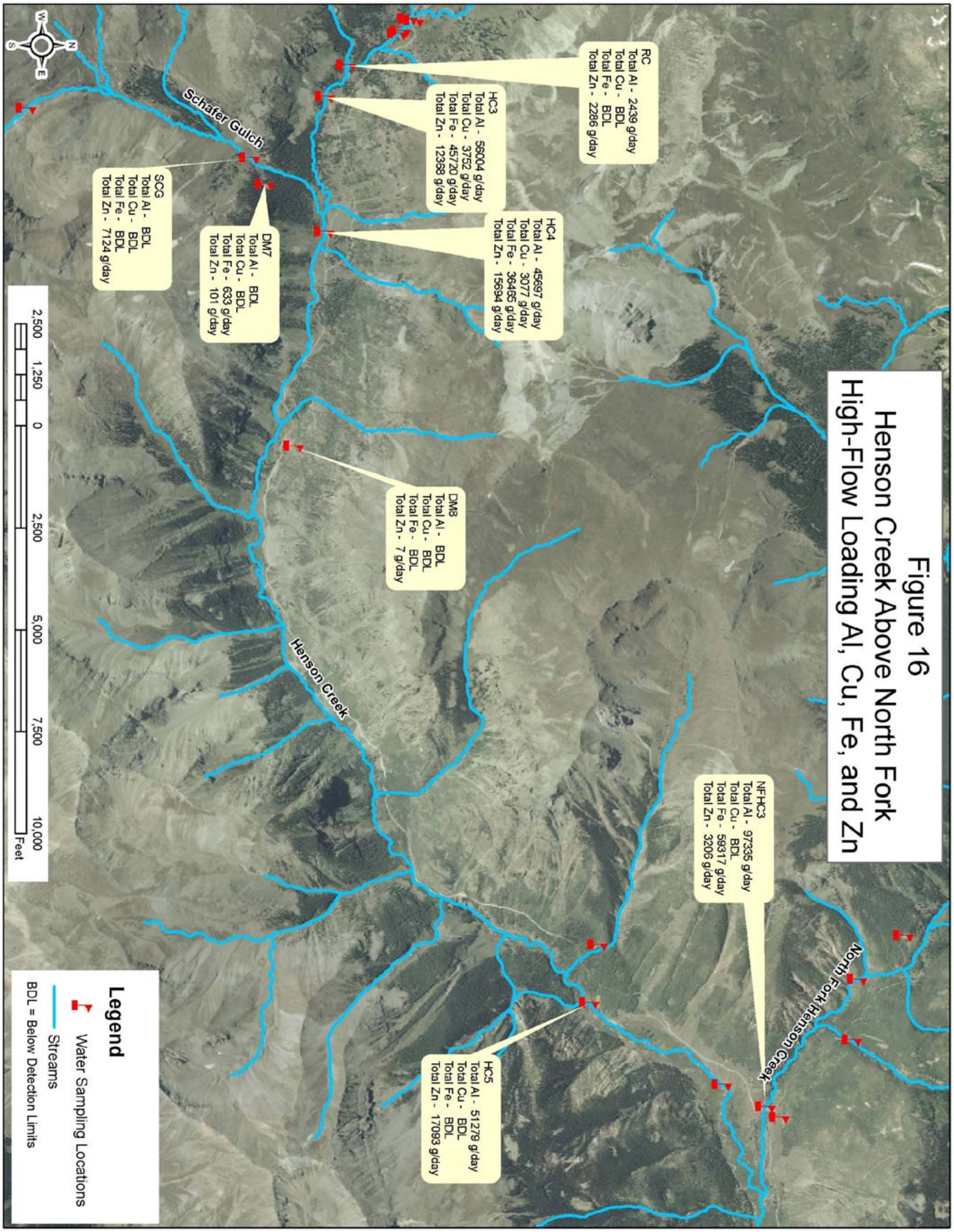


Figure 17. North Fork-High-flow Loading Al, Cu, Fe and Zn

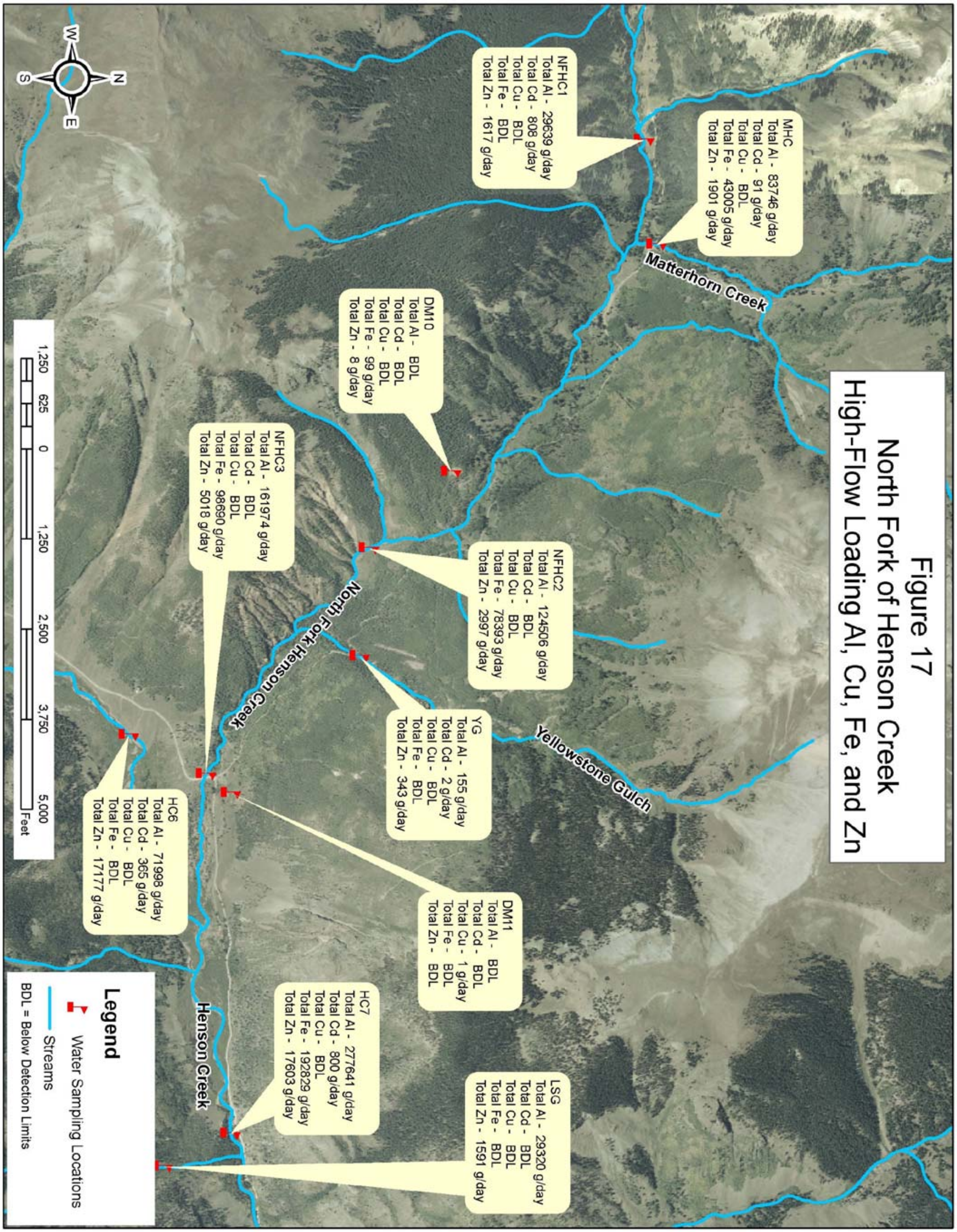


Figure 18. Henson Creek Below North Fork-High-flow Loading Al, Cu, Fe and Zn

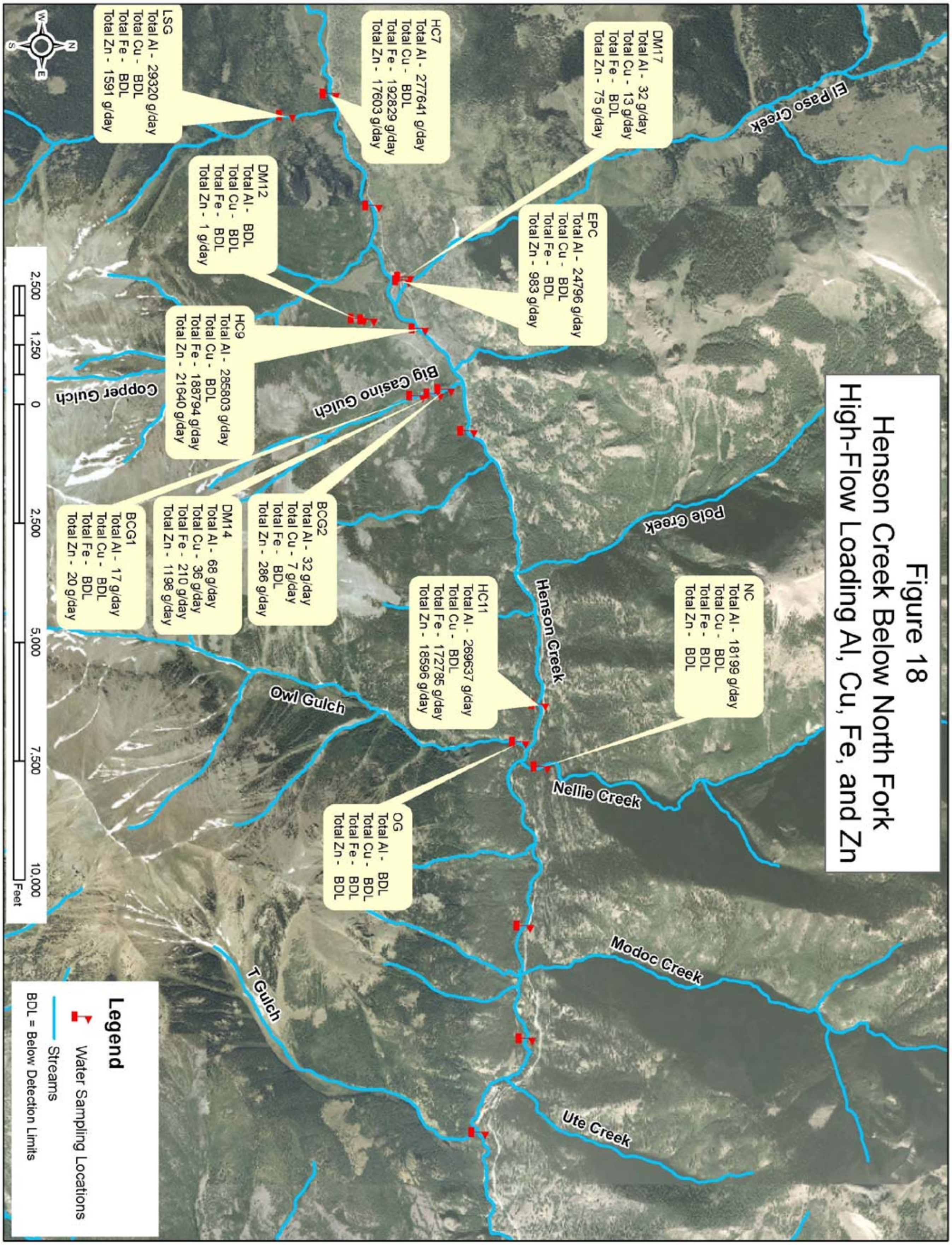
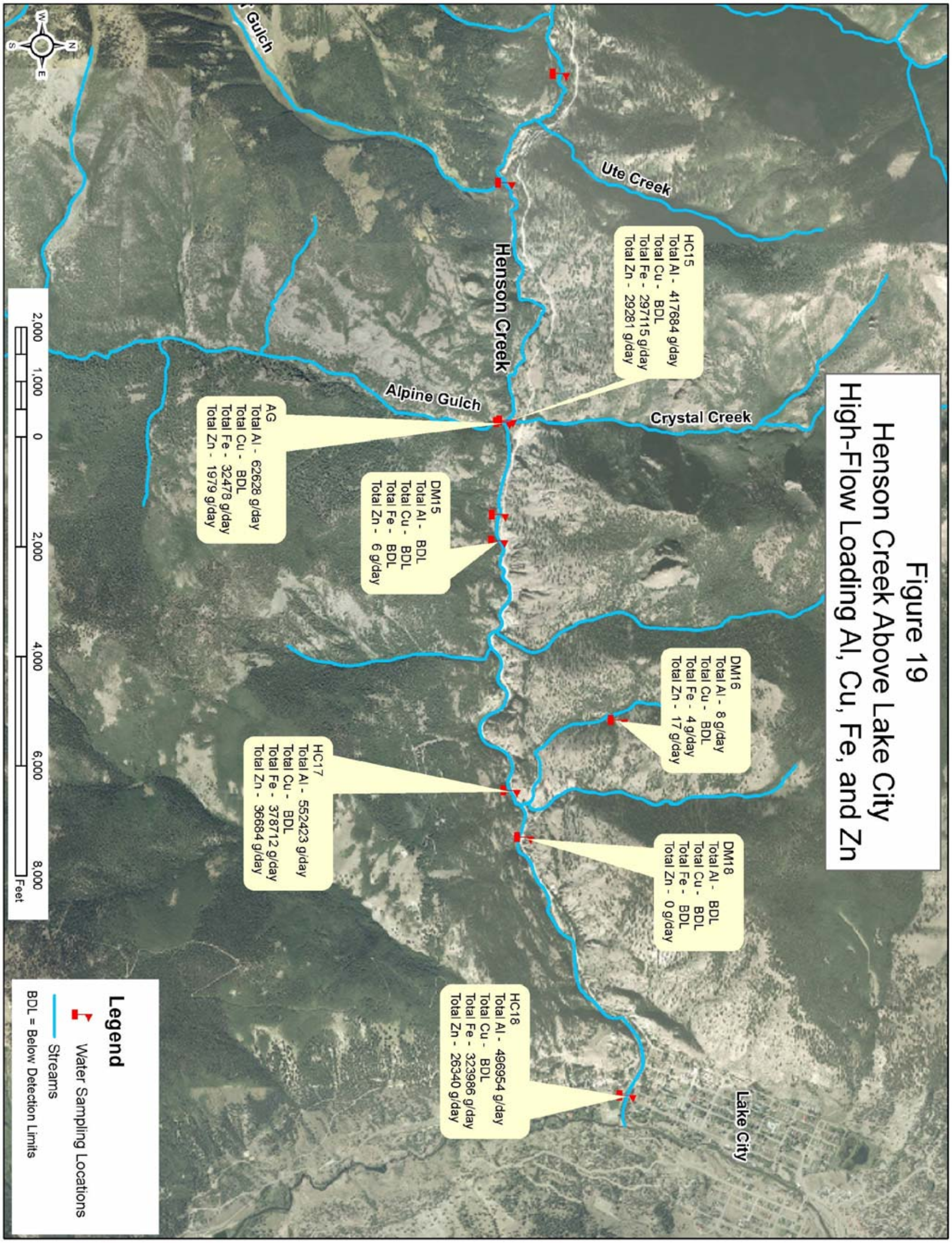


Figure 19. Henson Creek Above Lake City-High-flow Loading Al, Cu, Fe and Zn



are springs that produce metal laden water during snowmelt that dry up by the end of the summer.

North Fork of Henson Chemistry

High-Flow – During high-flow, dissolved zinc, aluminum and iron are below detection limits. Virtually all the zinc, aluminum and iron are in suspension (**Figure 17**). The largest measured source of total zinc, aluminum and iron in the North Fork of Henson Creek is Matterhorn Creek. Between sampling sites NFHC-2 and NFHC-3, there is an increased total zinc, aluminum, and iron loading of over 20%. A small part of this increase comes from Yellowstone Gulch, but the remainder most likely comes from natural sources in the mineralized zone of Sunshine Mountain.

Low-Flow – During low-flow, zinc, aluminum and iron concentrations and loading are relatively similar as found during high-flow (**Figure 21**). The major differences are that dissolved iron and zinc were measured in the mainstem. Matterhorn Creek continues to be the largest source of zinc, aluminum and iron. The large unmeasured increase in load between NFHC-2 and NFHC-3 found during high-flow was not present during low-flow. This indicates that the load is seasonal leaching of the naturally mineralized portion of Sunshine Mountain. During low-flow, there is a large increase in total zinc and iron loading that can be attributed to Yellowstone Gulch.

Henson Creek Mainstem Chemistry

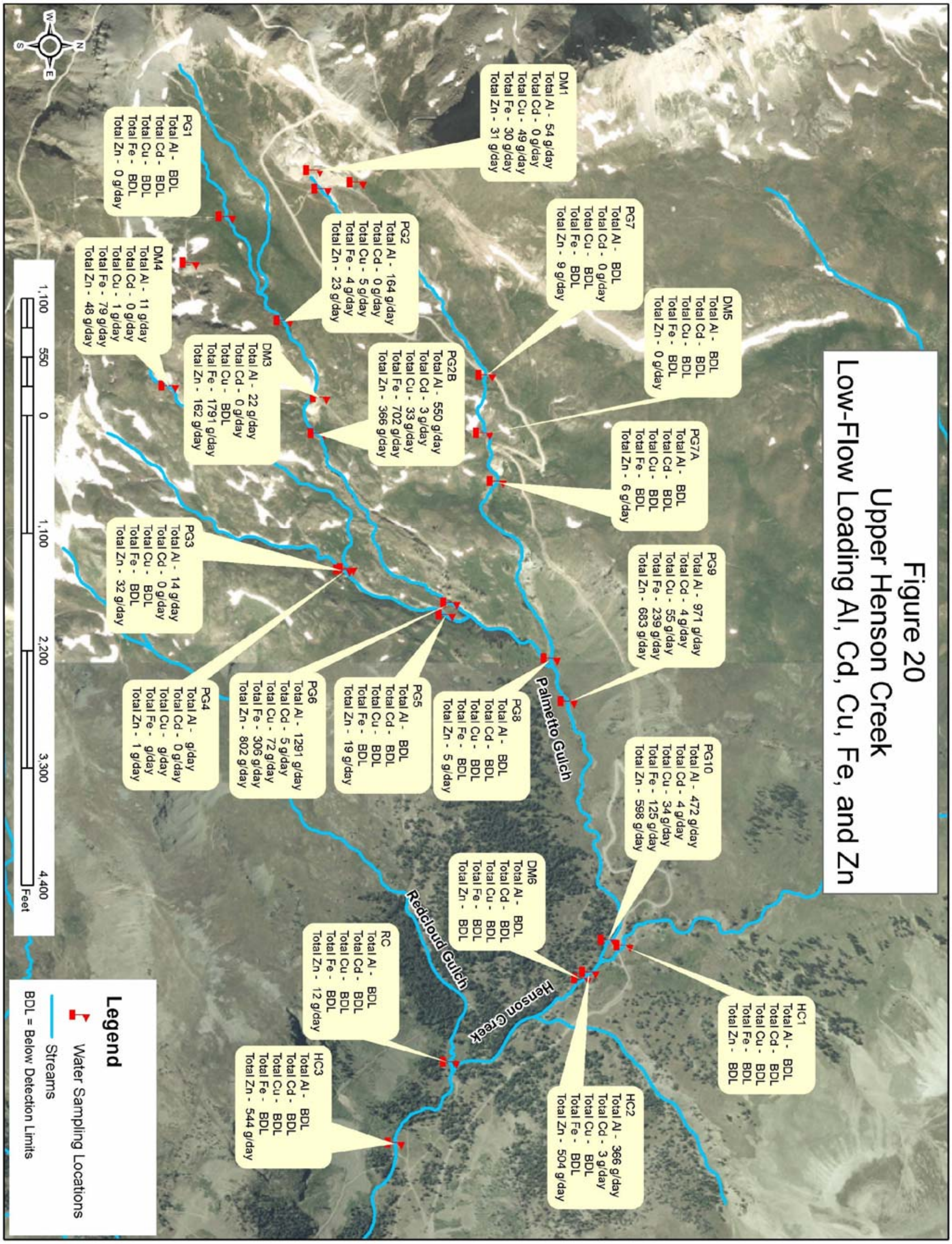
Aluminum, zinc, iron and copper are the principal metals impacting aquatic life in the mainstem of Henson Creek.

Iron plays a minor role in the water chemistry of the Henson Creek watershed, with the exception of Palmetto Gulch and the North Fork of Henson Creek. Iron may, however, play a significant role in removal of zinc. The lack of iron in most of the drainages means that there is very little zinc sorbed to precipitated iron. The majority of the iron in the Henson Creek watershed comes from Palmetto Gulch and Matterhorn Creek. The maximum in-stream iron concentration was found in Matterhorn Creek, while the highest iron concentration in a mine drainage was from the Roy Pray Mine.

High-Flow – During high-flow, most of the heavy metals progressively decrease in concentration downstream from the headwaters to below the no effect concentration by Capitol City (**Figure 16**). Total and dissolved zinc is the one exception. Zinc concentration increases below the confluence with Palmetto Gulch and continues to increase to sampling site HC-4 as Redcloud Gulch and Schafer Gulch join the mainstem. Manganese also increases when Redcloud Gulch enters the mainstem. Below Capitol City, there were no exceedances of the no effect concentration.

Low-Flow – Low-flow chemistry is much different than high-flow. During low-flow, heavy metal concentrations generally decline from the confluence with Palmetto Gulch to the Ute-Ule Mine, then increase to the confluence with the Lake Fork (**Figures 20 - 23**). Heavy metal loading generally remains constant from the confluence with Palmetto Gulch to the confluence with the North Fork (**Figure 20- 21**). Below the North Fork, heavy metal loading generally remains steady to the Ute-Ule Mine. At the Ute-Ule, there is a large increase in dissolved and total zinc and manganese. The zinc loading nearly triples and the manganese increases by approximately 50%. The zinc loading continues to increase to the confluence with the Lake Fork. Aluminum and iron loading increases when Alpine Gulch flows into Henson Creek.

Figure 20. Upper Henson Creek - Low-flow Loading Al, Cd, Cu, Fe and Zn



<u>Figure 21</u>. Henson Creek Above North Fork and North Fork - Low-flow Loading Al, Cu, Fe and Zn

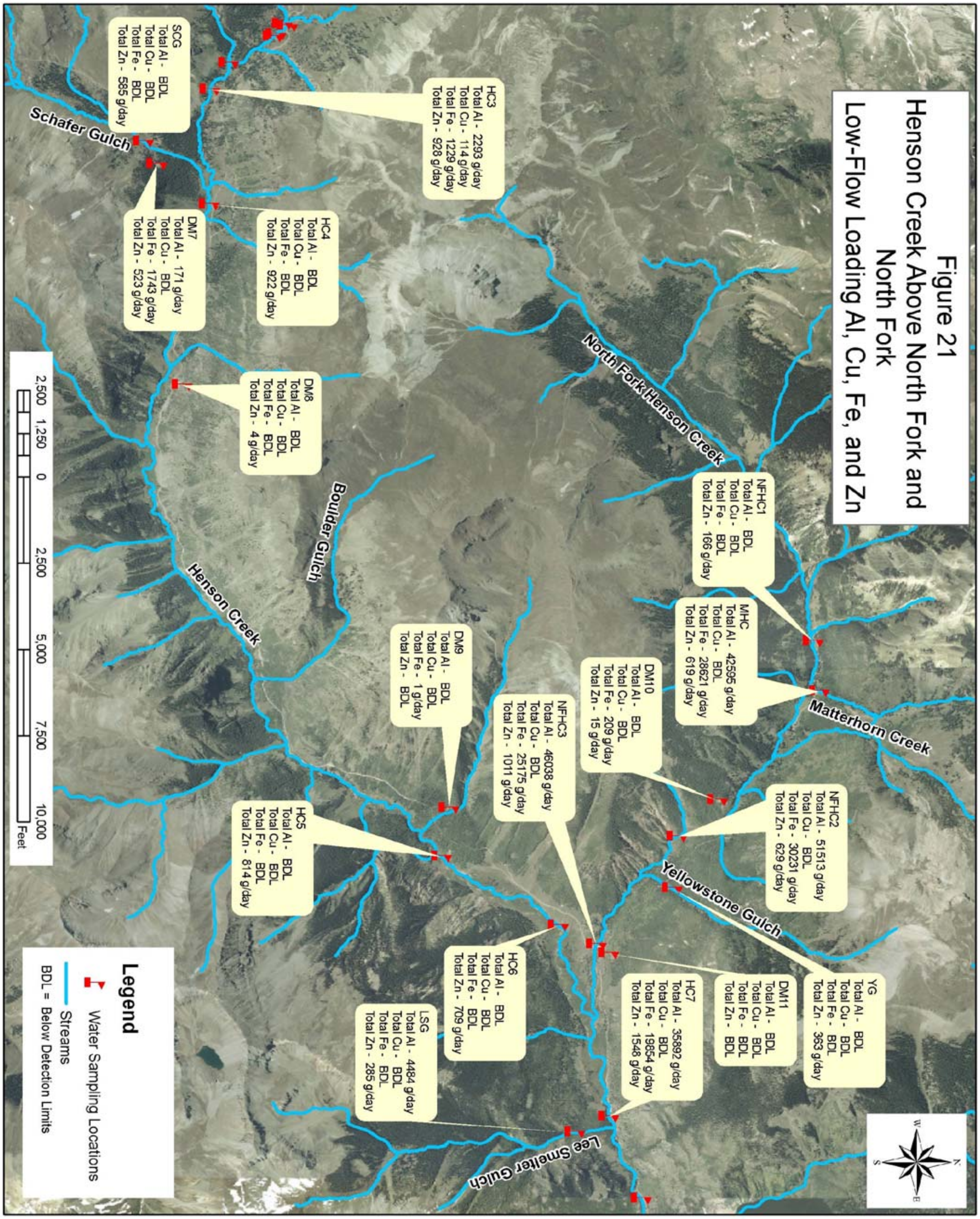


Figure 22. Henson Creek Below North Fork - Low-flow Loading Al, Cu, Fe and Zn

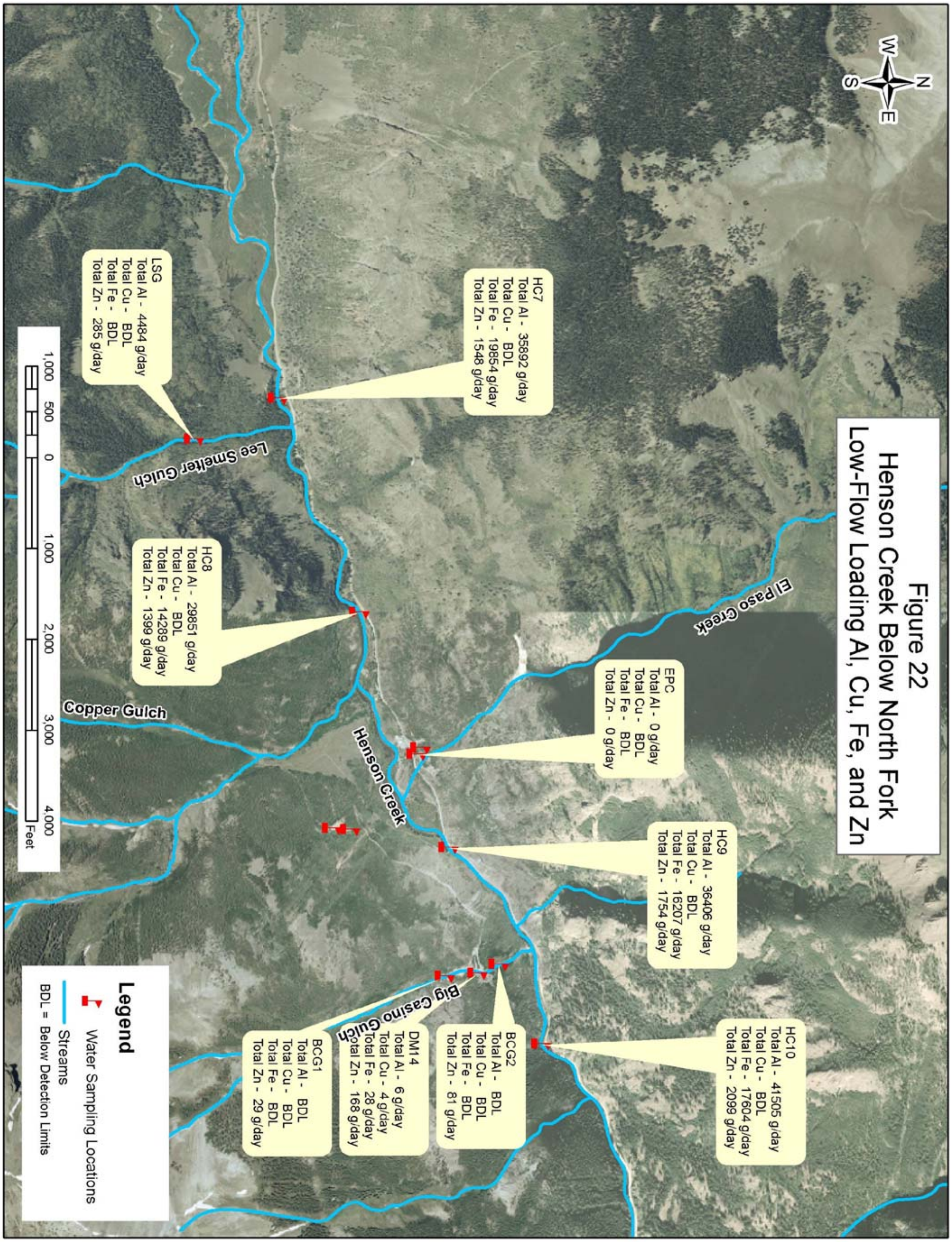
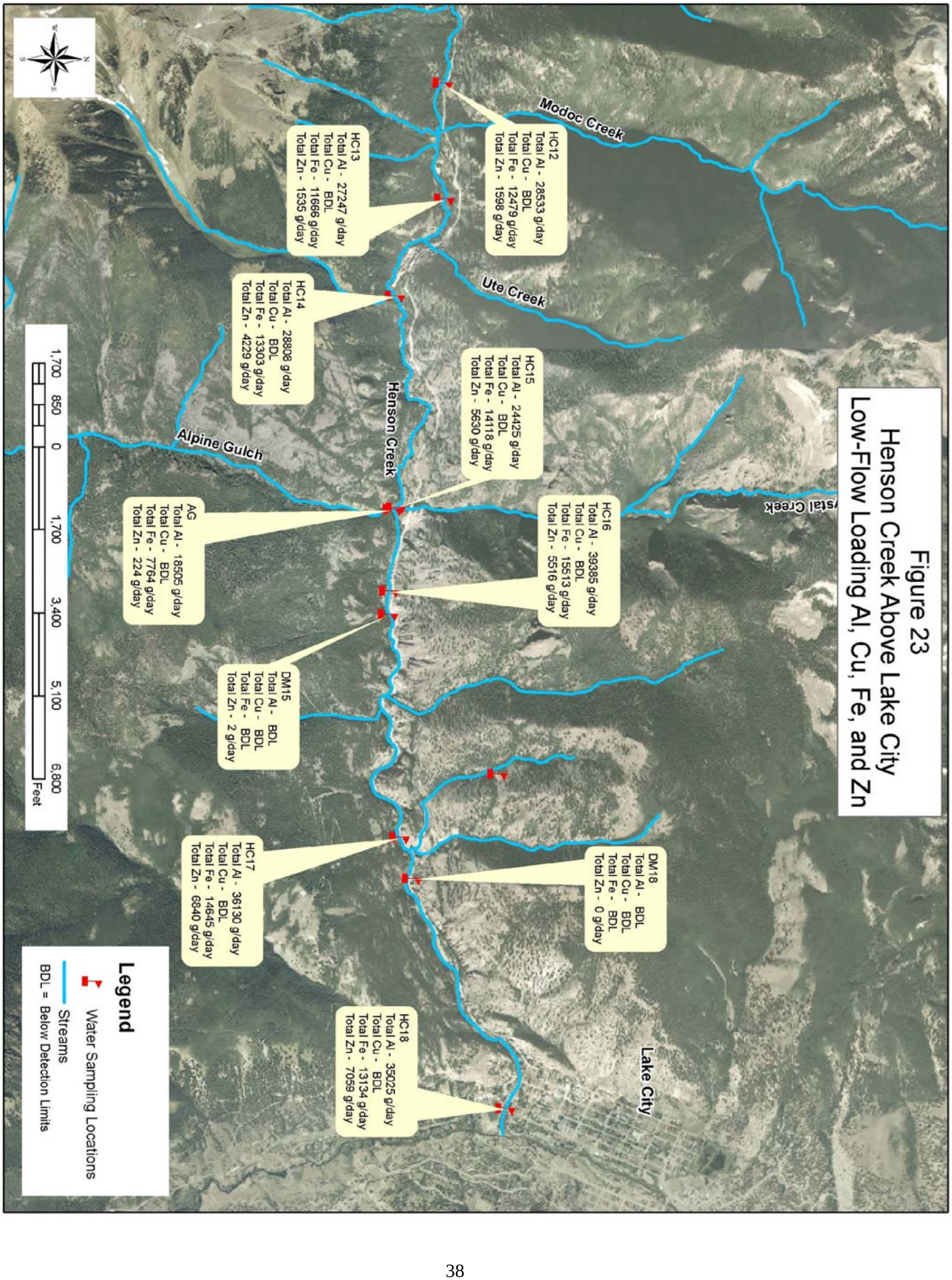


Figure 23. Henson Creek Above Lake City - Low-flow Loading Al, Cu, Fe and Zn



RECLAMATION OPTIONS

There are many different types of mining related disturbances in the Henson Creek watershed that affect water quality. A thorough understanding of the hydrologic system is necessary to determine which reclamation options would be best at a particular site. Reclamation of the watershed will be complicated and several reclamation options may be required at some sites to provide the most cost-effective cleanup.

One of the most complex alternatives involves the reclamation of adit discharges. These situations may involve collection and treatment of the mine drainage. In many cases, there is more water leaving the mine site than is measured at the mine adit. Some of the water flows underground through fracture systems into the stream. A groundwater-minepool interaction commonly exists because of the complex geology and extensive mining that has occurred. If a treatment system is contemplated to address a mine discharge, it will be necessary not only to understand the chemistry and hydrology of the adit discharge, but also to determine any potential groundwater loadings that leave the site through fractures or other geologic structures. The fractured, jointed, highly altered nature of the bedrock could be allowing seepage from the mine workings to enter the groundwater system. A treatment system could work well on the adit discharge, but would fail to meet metals removal goals in the stream due to unidentified groundwater pathways to the stream. In that case, simply sticking pipes into the adits would not be adequate to collect all the water that needs to be treated. It may be necessary to re-enter the adit to the point where contaminated flows can be collected and intercepted before they are lost to the groundwater system.

Reclamation and treatment methods considered in this feasibility investigation include:

1) <u>Surface Hydrologic Controls</u> (Preventative Measures); diversion ditches, mine waste removal and consolidation, stream diversion, revegetation.

2) <u>Passive Treatment</u> anoxic limestone drains, settling ponds, sulfate reducing wetlands, aqueous lime injection, limestone water jet, oxidation wetlands, aeration, powered mechanical neutralization systems, dilution, electro-kinetics, and land application.

3) <u>Subsurface Hydrologic Controls</u> (Preventive Measures); in-mine diversions of clean flows, bulkhead seals, pre-treatment of ore bodies or mined out areas, preventing subsurface flows from entering mine workings through mine openings, faults, and other geologic structures.

A short description of each method is given below.

SURFACE HYDROLOGIC CONTROLS

Most hydrologic controls are preventative measures in that they inhibit or prevent the process of acid formation and/or heavy metal dissolution. If it is possible to prevent water from entering a mine, or coming into contact with sulfide ores or wastes, this can be the best, most cost effective reclamation approach.

<u>Diversion ditches</u> are effective where run-on water is degraded by flowing over or through mine waste, or into mine workings. Diversion ditches can also be used to intercept shallow ground water that may enter mine waste. In some cases, mine discharge can be improved by flowing through the waste rock. Mine drainage must be sampled above and below a waste rock pile to determine whether the waste rock is actually degrading the water quality.

Mine waste removal and consolidation is effective where there are several small mining waste piles in an area, or where there is a large pile in direct contact with flowing water. The method is simply to move reactive material away from water sources.

Stream sealing or diversion involves moving the water sources away from reactive materials, or sealing/lining streams to prevent surface inflows into shallow mine workings through stopes, shafts, or fracture systems. It may include lining or grouting/sealing the stream bed or bedrock.

Revegetation is often used in combination with other hydrologic controls above. Revegetation by itself can be a very effective method of reducing heavy metals concentrations, particularly where much of the metals come from erosion of mining waste into a stream. Revegetation also reduces the amount of water that infiltrates a waste pile, thereby reducing leachate production. The roots of growing plants also have been shown to produce carbonates through respiration.

PASSIVE TREATMENT

Anoxic limestone drains are the simplest method of introducing alkalinity into mine discharges. Anoxic limestone drains (ALD) are constructed by placing coarse limestone (3/4" - 3") inside an adit or in a fully sealed trench outside a discharging mine. In order for an ALD to function properly, the mine discharge must be devoid of oxygen. In the absence of oxygen, limestone will not become coated by iron and other metal hydroxides, which can shorten the useful life of limestone. In addition, the mine drainage should be relatively low in dissolved aluminum. Aluminum has been shown to precipitate in ALDs, causing plugging. It is theorized that very coarse limestone (4-6") should provide large enough pore spaces to minimize or prevent clogging by aluminum. The disadvantage of using larger limestone is the reduced surface area to react with the mine drainage. After the mine drainage exits the ALD, aeration causes precipitation of metals. The increase in pH due to ALDs is site specific, but generally does not exceed two standard units.

Settling ponds are often overlooked as an effective treatment method. Settling ponds are particularly effective for treating near neutral mine drainages high in total suspended solids (TSS). Aeration of a near neutral pH mine drainage by means of a series of drops, followed by a settling pond can effectively remove iron and other metals that co-precipitate with the iron. Settling ponds should be designed for a 24-hour or greater retention time wherever possible.

Sulfate reducing wetlands are often called bioreactors. These systems treat water through bacterial reduction of heavy metals. Sulfate reducing bacteria (SRBs) utilize the oxygen in sulfates for respiration, producing sulfides. The sulfides then combine with heavy metals to form relatively insoluble metal sulfides. The bacteria derive their energy from a carbon source such as cow manure or mushroom compost. There are many other substrates that are an acceptable source of carbon, but most have a low hydraulic conductivity that can result in short circuiting of the system by the formation of preferential flow paths. Sulfate reducing bacteria cannot survive in a drainage with pH below 4.5. Highly acidic drainages will require a pH increase before the effluent enters the bioreactor.

Sulfate reducing wetlands should generally not be constructed near population centers. These systems commonly produce excess hydrogen sulfide, which can cause undesirable odors up to three miles from the system. When initially started, organics in the substrate discolor the treated water for several months, making water quality appear, to the layman, to be worse than that entering the system.

Aqueous lime injection is a passive method to introduce neutralizing agents into mine drainage. This system requires a clean water source. Clean water is passed through a pond containing neutralizing agent, then the high pH effluent is mixed with the mine drainage before it enters a settling pond. This system can be cost effective if alkaline wastes such as kiln dusts or fly ash are available. Although still in the experimental phase, the method holds promise for some mine sites. Neutralizing materials may also be injected into stopes and drifts, to prevent ARD.

Oxidation wetlands are what most people think of as "wetlands." They differ from sulfate reducing systems in that metals are precipitated through oxidation, and aquatic plants must be established. This treatment method is applicable where the pH of a mine drainage is approximately 6.5 or higher, and where metals concentrations in the drainage are primarily a problem during summer months. Aeration is an important part of this system. The plant materials provide aeration and, when they die, provide adsorption surfaces, along with sites for algal growth.

Aeration is best used where the mine drainage pH is about 6.5 or above. Aeration promotes metal precipitation through oxidation processes. Aeration can be accomplished by mechanical means, or simply by channeling the drainage over rough slopes. Mechanical methods require some source of power, which may be generated through wind, solar cells, or hydro-power. Aeration methods normally include a settling pond below the aeration component.

Mechanical injection of neutralizing agents involves a powered mechanical feeder/dosing system for dispensing neutralizing agents. This type of system requires frequent maintenance, may produce significant quantities of metal sludges, and should be considered "semi-passive." Power for the feeder can come from wind, solar, or hydro-power. At the Pennsylvania Mine in Summit County, a turbine running in the adit discharge stream demonstrated that hydro power is practical in some situations. Mechanical systems are generally considered only where there are no options for truly passive alternatives. Any high pH material can be used in this type of system. Because of cost effectiveness and sludge characteristics, the most common neutralizing agent used is finely ground limestone.

Dilution is often overlooked as a treatment method. It can be a cost effective method of treatment, because the neutralizing agent is simply uncontaminated water. Clean water is mixed with the mine drainage in a settling pond, and the resultant pH increase initiates precipitation of metals. A drawback to this method is that the percentage of metals precipitated is significantly less than most other methods. Metals removal is site specific, but generally less than 50%. This method is most effective in removing iron, aluminum, copper, cadmium, and lead, but has only slight effectiveness for zinc and manganese.

Electro-Kinetics is a newer semi-passive method to remove metals from mine drainage. There are several forms of this treatment currently being developed. The electro-kinetic method discussed in this report uses a low-maintenance, self-regenerating resin to remove metals from mine discharge. Different metals can be separated by using ion specific resins. Electricity is used to strip metals from the resins, producing a sludge, and allowing re-use of the resin.

Land Application is a method designed to use natural metals attenuation processes in soils and subsoils to remove metals. Plant uptake, evaporation and transpiration, and soil exchange capacity act to tie up and remove metals. This method is most effective where mine discharge can be spread over a large area to infiltrate into relatively thick soils or unconsolidated deposits. Drainage should be neutral or near neutral to avoid plant toxicity. This alternative is also effective for discharges with high iron and/or aluminum, and where pH is approximately 4.5 or above.

SUBSURFACE HYDROLOGIC CONTROLS

Subsurface Hydrologic Controls are in-mine measures that inhibit or prevent the process of acid formation and/or heavy metal dissolution into the ground or surface water system. If it is possible to prevent water from entering a mine, or from coming into contact with sulfide ores or wastes, or mixing with contaminated water plumes in the workings, this can be the best, most cost effective remediation approach, because it helps prevent the problem, rather than treating its symptoms in perpetuity. The success of most hydrologic controls depends on developing a geochemical and hydrologic understanding of the mine-groundwater interactions. Chemical characterization of inflows, and Isotopic and dye-tracer studies can be used to separate mine impacted waters from unimpacted water inflows; to determine travel times and pathways of infiltrated snowmelt and rainfall through ground-water flow systems; and to help develop conceptual understandings of geochemical processes which control the transport and fate of metals in the subsurface. These studies enhance the understanding of the sources and hydrologic pathways of waters that enter the mine workings and discharge from the mine workings through groundwater and surface pathways, and help determine how best to segregate or seal off particular water sources in the workings.

In-Mine Diversions are effective where clean groundwater inflows are degraded by flowing through drifts (veins) and stopes in the mine workings. The concept is to intercept the inflows before they come in contact with metals loading source areas in the mine, thus circumventing metals contaminant production in the mine workings/ore body. The “clean” inflows are then diverted to the surface stream through a collection and piping system. Though in many cases it may not be possible to intercept all inflows before they become contaminated through contact with the ore body, it is often possible to segregate and divert much of the groundwater inflow before it mixes with the contaminated plume. This can greatly reduce the overall quantity of polluted outflow. By significantly reducing mine discharge, it may then become cost-effective and feasible to treat the segregated contaminate plume through passive or semi-passive techniques; the effluent flow is minimized, and concentration may be adjusted for optimum system performance through dilution with part of the diverted clean flows.

Grout-sealing a fracture inflow zone at a discrete location can prevent groundwater from entering the workings, using proven, existing "ring-grouting" methods and technology. The concept for this technique is to seal water inflows through a grouting program, similar to those used to seal dam foundations, and control water inflows to active underground mining operations. Chemical or cement grout is pumped under pressure into an array of holes drilled radially out from the drift in and along the plane of the water bearing fracture or fracture zones. The grout enters and seals the fracture pathways that communicate with the mine opening. If engineered and executed correctly, the water is prevented from entering the excavation, and is forced far enough back into the rock away from the mine workings so that it resumes its pre-mining course, flowing around the grout “curtain.” Depending on conditions and the layout of the workings, care must be taken to ensure the inflows are not simply diverted to a point where they enter another part of the ore body. Ideally, the grout curtain would be in a position where no other lower or upper levels are nearby, and where numerous small fractures or one discrete structure is draining groundwater into the workings along a relatively short section of drift.

Bulkhead Seals are another type of preventive or “source control” measure. The concept is that geochemical and flow equilibrium will be reached in the groundwater, whereupon anoxic conditions in the flooded workings will prevent or reduce dissolution and transport of heavy metals. Bulkhead seals are designed to prevent discharge to surface water through the adit opening by blocking the flow with an engineered hydrologic plug, flooding the mine. For most inactive mines, bulkhead seals are expensive and require considerable geologic and engineering investigation and characterization. Sites that have simple geology, sound rock, and limited subsurface workings may be amenable to this approach.

MINE SITE CHARACTERIZATION

PALMETTO GULCH SITE DESCRIPTIONS

All the major mines in Palmetto Gulch were investigated. There are numerous prospects in Palmetto Gulch that were not investigated. The only prospect investigated that will not be discussed in detail is a small prospect above the Horsethief Trail, sampled as site #7. Leachate analysis shows that the waste rock pile has very little mineralization and is low in metal concentrations. All other sites investigated will be discussed in detail below.

Geologic Setting

The majority of surficial outcrop within Palmetto Gulch is composed of the Burns Member and Andesite Porphyry Member of the Silverton Volcanic Series. Outcrops of Fish Canyon Tuff, Sunshine Peak Tuff, and volcaniclastic sandstones from the Silverton Volcanic Series are also evident along the ridge bounding the western reach of the gulch. Several intrusions of porphyritic quartz latite are also exposed along the western ridge and may be associated with a zone of hydrothermal intrusion referred to as a breccia pipe near Engineer Mountain.

Structurally, Palmetto Gulch lies at the northeastern margin of the Eureka Graben and contains an extensive framework of northeasterly trending, steeply dipping normal faults. The majority of these faults resulted in little noticeable movement, but appears to have provided pathways for hydrothermal fluids. Foliations and bedding planes within the volcaniclastic sediments and lavas indicate a general northeast strike and low angle dip, 10° to 20°, to the northwest. The orientation of beds within the gulch is consistent with resurgence of the San Juan-Uncompahgre Caldera.

Widespread alteration within Palmetto Gulch is propylitic in nature and not solfataric, but characteristic red and yellow staining along the western and southern ridges indicate that some pyritic enrichment has occurred. Generally, the intense alteration is localized along geologic structures forming “halos” around faults and fractures. Many of the hydrothermally altered structures within the gulch were economically mineralized, and referred to as veins. The most prominent veins are the Polar Star/Miners Bank, Flower of San Juan, Emporer Wilhelm and Hoffman. The mineralization typically filled open fractures with minor wall rock alteration due to migration of ore fluids into the surrounding country rock. The breccia pipe located on Engineer Mountain is extensively altered but does not appear to have been economically mineralized.

Groundwater flow along mineralized veins may represent a large component of loading within Palmetto Gulch. Discharge from portals on the Hough, Roy Pray and Wyoming indicate that mineral laden water is currently flowing along many of the major veins. It is reasonable to assume that since many of the structures provided pathways for circulation of hydrothermal fluids in the past, those same pathways may still exist today for migration of meteoric waters. Groundwater flow within the gulch is most likely controlled by fractures and geologic contacts and not overall rock permeability, due to the lack thereof. Numerous springs outcrop within the watershed and in some locations appear to be consistent with the Burns-Andesite contact. Groundwater flow within the Andesite Member may be less restricted until encountering the lithologically different Burns Member resulting in discharge along the contact. Geologic mapping of the Roy Pray workings by Stover indicated a thick section (approximately 50 feet) of highly fractured and water-filled Andesite Porphyry at the surface. If this fracturing is regional and consistent, it may indicate an upper regime of groundwater flow isolated from deeper vein controlled flow. The complex nature of groundwater flow within Palmetto Gulch will require additional and more thorough investigations to determine its influence on loading to the watershed.

Surficial geology within Palmetto Gulch is dominated by glacially abraded bedrock outcrops. Soils are typically poorly developed or non-existent, with large areas of talus and scree in the upper reaches. Most of the veins outcrop to surface and are traceable by their distinct limonitic staining within the bedrock. Areas of exposed hydrothermally altered rock provide a highly leachable source of metals to Palmetto Gulch.

Hough Mine – Frank Hough Lode MS. #549

The Frank Hough Mine is located near the top of Engineer Pass at the headwaters of Palmetto Gulch. The elevation of the site is 12,680 feet. Access is via Engineer Pass road and the site is approximately 500 feet from the road with a well-traveled four-wheel drive access road. This site was bracketed by stream sampling site PG-1, background sample of Palmetto Gulch, PG-1a - the runoff from the Hough dump, PG-1b - downstream of the Hough Adit (mostly contained mine waste water, very little mine drainage), DM-1 - the Hough Mine drainage, and PG-7 – Palmetto Gulch below the Hough Mine. There are numerous sampling locations for the Hough Mine because during high-flow sampling the site was still buried under snow. Samples were taken from new locations that were exposed. Sampling site DM-1 was not sampled during high-flow because it was buried under snow. DM-1 may not have been contributing any mine drainage to the site during high-flow sampling, depending on whether the workings were frozen solid. The Hough Mine is located at N37° 58' 22.6", W107° 34' 58.1". The Hough Mine site contains a small standing log cabin near the access road, the remains of a loadout, and the remains of a shafthouse. The loadout and shafthouse are located on the Upper Hough Mine Waste Pile.

Geology and Mine Workings

The Frank Hough Mine develops a northeasterly trending, steeply dipping vein most likely associated with faulting of the Eureka Graben resulting from caldera resurgence. The mine is located in the Henson Member of the Silverton Volcanics (Ths), but some of the workings may also have developed ore within the Andesite Porphyry member (Tap). The mineralization appears to have been localized along the vein, which is common for many of the veins within the region.

The mine was the most productive mine in Palmetto Gulch with the richest ore. The shaft is 425 feet deep and has four short levels driven off of it, but is now partially collapsed. There is also an adit that connects to the shaft's workings. The mine may connect with the Frank Hough Tunnel, on the west side of Engineer Pass, which would have provided haulage of ore to the Silverton area and to railroad transportation. The Hough ore was high in copper, gold, and silver. Other ores in the area were also high in gold and silver, but usually had much more lead and zinc and proportionately less copper in comparison. The ore at the Hough mainly consisted of copper, copper pyrites, and iron pyrites.

Mine Waste

It is estimated that there are 21,000 cubic yards of mine waste at the Hough Mine Site. The waste rock sits near the top of Engineer Pass and has several small ephemeral drainages that run directly through or to the side of the mine waste piles. There is significant erosion at the site from the drainages that run through and past the mine waste pile. Leachate results showed that the Hough site, both the Upper and the Lower Hough piles ranked first and second in regards to heavy metals. Leachate results show the Hough pile to be high in aluminum, arsenic, cadmium, copper, iron, manganese, sulfur, and zinc. The only major heavy metal that the Hough Mine waste pile did not contain in large amounts was lead. Selected results from the leachate analysis are given below for the Lower and Upper Hough Mine waste pile.

Lower Hough Mine (Site #2)

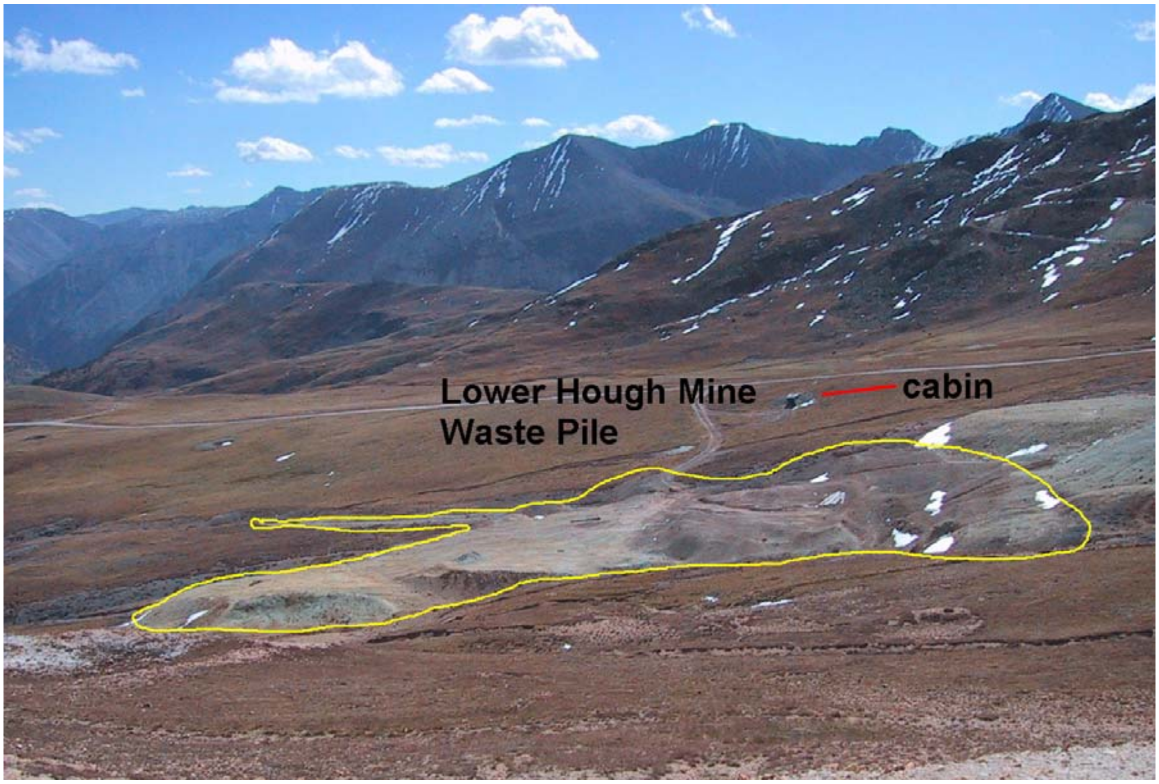
pH s.u.	Acidity mg/l	Diss Al ug/l	Diss As ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb ug/l	Diss Zn ug/l
2.4	3,750	148,703	26,698	528	102,097	688,856	11,961	619.2	63,968

Upper Hough Mine (Site #1)

pH s.u.	Acidity mg/l	Diss Al ug/l	Diss As ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb ug/l	Diss Zn ug/l
2.64	1,590	63,019	6,994	284	49,826	256,511	4,091	338	34,863

The location of the mine waste piles allows snow cover to build up consistently on the mine waste and then leach into the waste slowly over the course of the spring and summer months. The leaching from the mine waste pile is a more significant source of metals than the mine drainage from the Hough Adit. The Hough Adit drainage flows into a stream channel which bypasses the majority of the Hough dump, so the major source for leaching waters comes from snow melt and runoff. The Hough waste rock piles had the highest concentrations of aluminum, arsenic, copper, and iron and had the highest total acidity of all the piles sampled. Overall, the Hough waste rock piles ranked first and second out of the 66 dumps sampled.

Figure 24. Lower Hough Mine Waste Pile



Water Quality Impacts

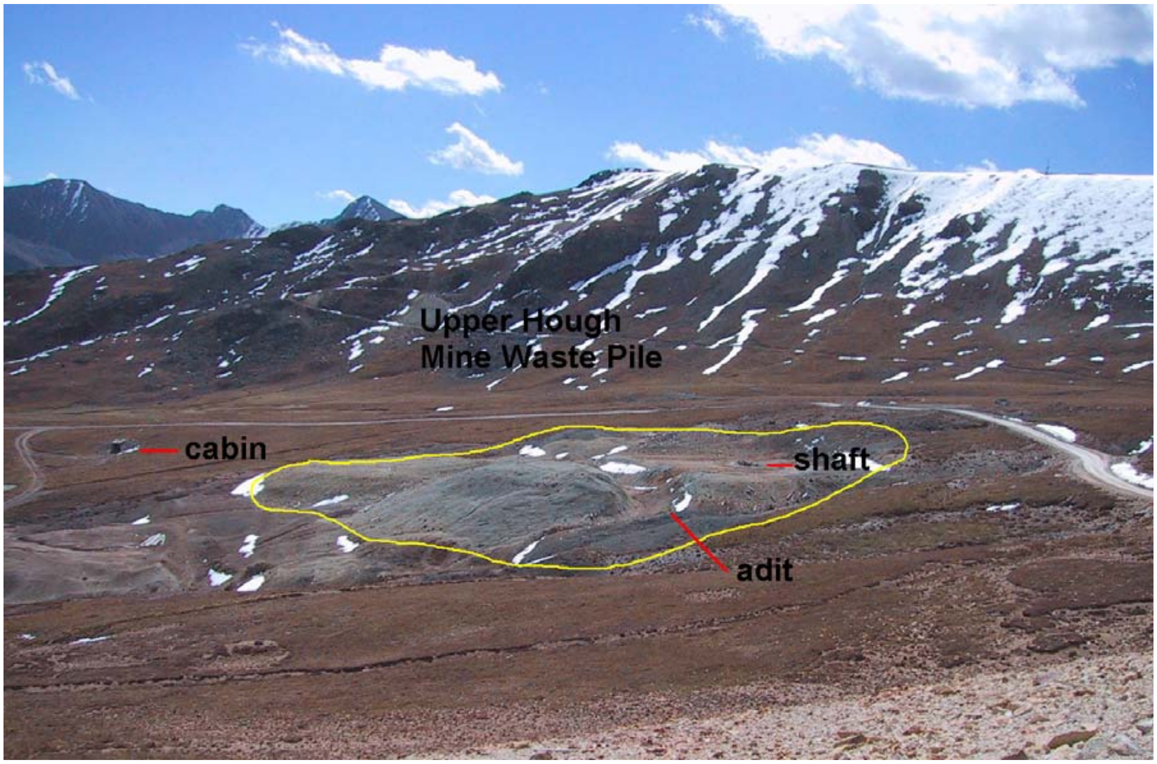
The water quality impacts from this site are from the waste pile and mine drainage combined. Sampling site PG-1 – the headwaters of Palmetto Gulch is the sampling site for background water quality data. During high flow sampling, PG-1a and PG-1b were sampled. PG-1a captured the runoff from the Hough dump and sampling site PG-1b was downstream of the Hough Adit. Sampling site PG-7 – Palmetto below the Hough, was also sampled during high flow sampling. Between the Hough and sampling site PG-7 there is an un-mineralized and un-Mined stretch of Palmetto Gulch, hence almost all the loading at site PG-7 can be attributed to the Hough Mine site. During high flow, the Hough Mine's impact is primarily attributed to the leaching of the mine waste pile. The mine drainage contributes relatively little metals loading in comparison to the impacts from the waste pile. The Hough Mine was the only major source for total arsenic during high flow sampling, present at sampling sites PG-1a, 1b, 7, and 8. The arsenic attenuated by the confluence with the mainstem of Palmetto Gulch at sampling site PG-9. During the low flow sampling event, the arsenic values for the entire Henson Creek watershed were below detection limits, indicating that the arsenic from the Hough Mine is due to the leaching of the mine waste pile, and not from the underground mine drainage.

A maximum of 26% of the total cadmium load seen at PG-9 can be attributed to the Hough Mine during high flow. During low flow, less than 5% of the total cadmium load can be attributed to the Hough Mine drainage. The Hough Mine drainage during low flow and the Hough Mine waste runoff during high flow had the highest concentrations of cadmium. The minimal flow from the Hough site rendered it a less significant contributor of total cadmium load to Palmetto Gulch, in comparison to other mine sites within the gulch during low-flow.

The Hough Mine area is the largest source of total copper during high flow, with 55% of the total copper load at sampling site PG-9 attributable to the Hough Mine waste pile during high flow, and roughly 40% of the total copper attributable to the Hough Mine drainage during low flow. The in-stream total copper in Palmetto Gulch attenuates rapidly as it progresses downstream. During high flow sampling, the Hough Mine drainage was not sampled, so it is difficult to determine the contribution of the mine drainage during high flow to the total copper load. The concentrations of copper during high flow are two orders of magnitude greater than the acute and chronic toxicity values. The high flow total copper concentration from the Hough dump runoff was 6740 ug/L and the runoff downstream of the adit was 1720 ug/L. During low flow, the Hough Mine drainage contributes a load of 49.3g/day of total copper, but all of the flow is attenuated to below detection limits of 10ug/L before reaching sampling site PG-7, approximately one half mile downstream of the adit.

The Hough Mine contributes a large portion of the total zinc loading to Palmetto Gulch with a maximum of 21% of the zinc load during high flow. Conversely, during low flow, the Hough Mine contributes less than 5% of the total zinc load seen at sampling site PG-10, the last sampling site before the confluence with Henson Creek. This switch in zinc loading from high flow to low flow indicates again that the leaching of the mine waste pile is a larger source of contamination than the mine drainage. The Hough Mine drainage does have the second highest zinc concentration in Palmetto Gulch, after the Roy Pray, but contributes relatively little to the total zinc loading.

Figure 25. Upper Hough Mine Waste Pile



After reviewing the metals loading it is apparent that the Hough Mine waste contributes significantly more metals during high flow, while the mine drainage impacts Palmetto Gulch more significantly during low flow. The Hough Mine site is the most significant source of metals during high flow in all of Palmetto Gulch.

<u>Reclamation Options</u>

The Hough Mine waste pile is the key source of several metals during high flow. The Hough Mine drainage does not contribute as high a load of metals as the mine waste pile, but does have extremely high concentrations of metals and plays a larger role during low flow. The Hough Mine waste pile is one of the most visible mine sites in Palmetto Gulch, and is located near the summit of Engineer Pass. The Hough Mine waste pile cannot be both historically preserved and reclaimed due to the characteristics and location of the mine waste. Since the mine waste pile is the largest source of metals loading at the Hough Mine site, the mine waste pile should be reclaimed first, then the mine drainage should be addressed. Reclamation options for the Hough Mine waste pile include: (1) to cap the Hough Mine waste pile in place with a geosynthetic liner and cover with soil and revegetate or other material such as tallus or; (2) completely remove the Hough Mine waste pile to a repository: (3) on-site amendment of the wastes through a paste technology. Capping of the waste pile would require consolidation of the piles into a minimal sloped mounded pile which could then either be capped with a geosynthetic liner or HDPE liner. Bedding material above the liner may have to come from an off-site source. Precautions for impacts from any sub-surface water flows will have to be undertaken. The other reclamation option for the mine waste pile is removal and re-location to the ridge near the Roy Pray Mine or to another possible repository location. On-site waste amendment could be achieved through a thorough acid-base testing program to determine quantities of cementatious mixing required. Final reclamation of the amended waste could include on-site burial or capping. Depending on the dissolved oxygen content of the mine water, an option for the underground mine drainage would be the construction of an anoxic limestone drain to increase the pH of the mine drainage, allowing for precipitation of metals once the drainage reaches the surface and becomes enriched with oxygen. Metals could then precipitate in a series of settling ponds. The settling ponds would have to be periodically cleaned out to remain effective.

Sarah Woods Mine (Polar Star MS. #289)

The Sarah Woods Mine is located near the headwaters of Palmetto Gulch, on the north-facing slope of the Palmetto Gulch amphitheater. This site is believed to be on the Polar Star Claim MS. #289 or on the Polar Star Extension MS. #7865. The elevation of the lowest Sarah Woods Mine workings is 12,800 feet and the highest working level of the Sarah Woods is 13,100 feet. Access is via Engineer Pass, which is a well-maintained four-wheel drive road. There is no access road from Engineer Pass to the Sarah Woods Mine site. The site is approximately 1,000 feet. off Engineer Pass. The Sarah Woods site is bracketed by sampling sites PG-1, Palmetto Gulch Headwaters and PG-2, Palmetto Below Sarah Woods. The SW (Sarah Woods dump drainage) sampling site was only sampled during high flow because the site was not flowing during low flow. The Lower Sarah Woods Mine waste pile is located at N37° 58' 18.4", W107° 34' 47.6". The Upper Sarah Woods Mine waste pile is located at N37° 58' 14.8", W107° 34' 47.7". The dump to the east of the Sarah Woods is located at N37° 58' 19.2", W107° 34' 45.1". Although the mine waste pile to the east of the lower Sarah Woods is not part of the same mine complex, it will be discussed with the Sarah Woods because of its proximity. Any reclamation of the lower Sarah Woods should include the mine waste pile to the east. The upper Sarah Woods Mine waste pile was sampled as site #4. The lower Sarah Woods was sampled as site #5 and the mine waste pile to the east of the Sarah Woods sampled as site #6.

Geology and Mine Workings

The Sarah Woods developed the northeasterly trending, steeply dipping Polar Star/Miners Bank vein, which is an extensively mineralized and mined vein system resulting from faulting related to caldera resurgence. All levels of the mine were driven in the Tertiary Andesite Porphyry member (Tap) of the Silverton Volcanics. Ore mineralization was generally confined to the vein, but extensive hydrothermal alteration is visible along the adjacent ridge. The Miners Bank is a typical quartz-sulfide fissure type vein with the chief gangue Mineral being massive white quartz with pyrite, spahlerite, galena and minor silver mineralization. Little is known of the exact ore material mined.

Three levels were mined along a vein outcrop that extends to the top of the ridge near Engineer Mountain. This mine is also known as the Polar Star Extension. The lowest working level is an adit. There is a spring located on the side of the lowest Sarah Woods Mine waste pile. The spring was sampled as site SW – Sarah Woods Mine waste pile drainage. The source of this water is not known. It may be drainage from the mine workings or surface flow from snowmelt immediately above the lower Sarah Woods. The mine workings extend through Engineer Mountain to the Mineral Creek drainage in Ouray and San Juan Counties. There is mine drainage from the workings into Mineral Creek. The Sarah Woods Mine was the second most productive mine in Palmetto Gulch after the Frank Hough Mine.

<u>Mine Waste</u>

There are three mine waste piles that comprise the Sarah Woods area and all three could be contributing to the metals load seen at sampling site PG-2. The upper Sarah Woods Mine waste pile contains approximately 1,900 cubic yards, the lower Sarah Woods Mine waste pile contains 2,700 cubic yards, and the mine waste pile east of the Sarah Woods contains 200 cubic yards of material. The upper Sarah Woods Mine waste pile has two working levels associated, but the two separate piles run together because of the steep slopes of the ridge.

The Sarah Woods Mine sits within the trace of the Miners Bank Vein. The vein runs up the side of the ridge and extends over the top into Ouray and San Juan Counties. There are three mine waste piles along the vein within the Palmetto Gulch drainage.

There is major erosion of the mine waste pile due to the steep terrain of the intermittent drainage from snowfields and the propensity for avalanches. Leachate results show this pile to be high in aluminum, arsenic, copper, iron, and sulfate. The mine waste pile to the east of the Sarah Woods is high in iron only. Based upon the metals concentration in the leachate, the lower Sarah Woods Mine ranked third out of 66 sites sampled. The dump east of the Sarah Woods ranked 21st out of the 66 sites sampled. Selected results from the leachate analysis are given below. The Upper Sarah Woods ranked 31st out of 66.

Lower Sarah Woods Mine Waste Pile (Site #5)

PH s.u.	Acidity mg/l	Diss Al ug/l	Diss As ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb ug/l	Diss Zn ug/l
2.49	1,204	34,537	4,473	21.5	5,693	493,957	1,331	181	1,296

East of Sarah Woods Mine Waste Pile (Site #6)

PH s.u.	Acidity mg/l	Diss Al ug/l	Diss As ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb ug/l	Diss Zn ug/l
3.2	34	124	BDL	BDL	81	829	138	BDL	137

Upper Sarah Woods Mine Waste Pile (Site #4)

PH s.u.	Acidity mg/l	Diss Al ug/l	Diss As ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb ug/l	Diss Zn ug/l
4.26	20	45.8	BDL	BDL	11	19.5	149.7	BDL	22.9

<u>Water Quality Impacts</u>
The water quality impacts from this site are seen at sampling site PG-2, in upper Palmetto Gulch northeast of the Sarah Woods. Sampling site SW has a distinct lack of high metals concentrations, which suggests that the near surface flow is not highly impacted by the waste rock pile or mine workings. The high metals concentrations at PG-2, indicate that the Sarah Woods Mine waste pile, or possible mine drainage, or combination infiltrates into the shallow groundwater system that exits just upstream of PG-2.

Within Palmetto Gulch, the Sarah Woods Mine area is the third largest contributor of mining related contamination. The Sarah Woods site contributes a higher percentage of the overall contamination during high flow, and is relatively unimportant during low flow. The contaminating metals of interest at the Sarah Woods Mine site are copper, zinc, and cadmium. There are also high concentrations of aluminum, arsenic, and cadmium. When the drainage from the Sarah Woods Mine area converges with Palmetto Gulch, an aluminum oxide precipitate becomes visible along the streambed, indicating that a pH change occurs with an associated precipitation of metals due to the mixing with cleaner waters. Immediately downstream from the aluminum oxide occurrence is the inflow of a spring which further mixes with the drainage and exhibits an iron oxide staining. (See **Figure 26** under the Miners Bank.)

The Sarah Woods Mine's total copper load at sampling site PG-2 during high flow is equal to the total copper load at PG-6, indicating that the Sarah Woods site exhibits significant copper loading during high flow. During low flow the Sarah Woods Mine area contributes a small portion of the total copper load, in comparison to the Roy Pray Mine area. The Sarah Woods contribution to total copper loading during low flow is also much less than the Hough Mine drainage. The concentration of total copper at sampling site SW during high flow is 11 ug/L, and jumps to 270 ug/L at sampling site PG-2, indicating that the impacts of the Sarah Woods Mine area are not seen in the surface runoff but are seen in the near surface groundwater. The water from the Sarah Woods Mine site as measured at station PG-2 is above the acute and chronic toxicity values for aquatic life with respect to copper. With respect to total copper, the Sarah Woods Mine area is the second most concentrated after the Hough Mine during high flow.

The total zinc contribution of the Sarah Woods Mine area is important during the high flow sampling event, and is contributing 4.25 pounds (1,928 g) per day, which is roughly 15% of the total zinc loading in Palmetto Gulch. During low flow the Sarah Woods Mine area contributes 5% or less of the total zinc found in Palmetto Gulch. The concentration of total zinc during low flow was 716 ug/L, a higher concentration than during high flow, which is expected due to the lower amount of flow and less dilution of the mining related pollution. The dissolved and total zinc concentrations at PG-2 are above the acute and chronic toxicity values for aquatic life.

The Sarah Woods Mine area is also a contributor of cadmium during high flow. The mine contributes 16 g/day of total cadmium during high flow and 0.2 g/day during low flow. The total and dissolved cadmium concentration during high flow was 4 ug/L, which is above the acute and chronic toxicity values standards for aquatic life. During low flow, the Sarah Woods Mine area does not contribute significantly to total cadmium. The Roy Pray contributes almost all of the total cadmium in Palmetto Gulch. The concentration of cadmium in Palmetto Gulch stays above the standards for aquatic life all the way to station PG-10 during high flow. The effects of cadmium are not seen in Henson Creek where the cadmium concentrations are below detection limits.

Sampling station SW does not show significant metals loading, indicating that it may be a shallow groundwater spring or cleaner mine drainage. Sampling site PG-2 does show significant metals loading of Cu, Zn, and Cd during high flow, indicating that it receives the bulk of the mining impacted waters. The water quality of PG-2 is contaminated either by the leaching of the Lower Sarah Woods Mine waste pile or through contamination of the groundwater by the mine workings. The high flow metals contribution of the Sarah Woods Mine site is much greater than the low flow metals contribution of the site. The high flow impact of the site indicates that most of the contamination is probably originating from the leaching of the Lower Sarah Woods Mine waste pile and not from underground mine drainage.

Reclamation Options

The data at this site suggests that the main contributor of contamination to Palmetto Gulch from the Sarah Woods Mine, is the lower Sarah Woods Mine waste pile. The constraints to reclamation at this site, are the steep slopes of the upper Sarah Woods Mine workings and the lack of an access road from Engineer Pass to the site. Access to the upper Sarah Woods site is from Ouray County, on the other side of the ridge extending from Engineer Mountain. There is a four-wheel drive road to within 100 feet of the upper mine waste pile. The most appropriate reclamation at this site would be the removal and relocation of the lower Sarah Woods Mine waste pile from the drainage to a repository location near the mine waste pile to the east. The repository would then be amended with limestone, capped with suitable topsoil or tallus material scavenged from nearby sources, and revegetated if possible. Capping material could also be imported from another area if suitable material was not available near the site. The mine waste leachate analysis of the upper Sarah Woods indicates that it is less of a heavy metal source than the lower waste pile. Before making a final decision on whether the upper Sarah Woods should be reclaimed, it is recommended that mine waste samples below the surface be analyzed, to make certain that preferential accumulation of metals on the surface of the lower waste pile is not taking place. Furthermore, it is recommended that the presence or absence of mine drainage be investigated. This can be accomplished through research and excavation of the collapsed portal at the Lower Sarah Woods Mine waste pile.

Miners Bank Mine

The Miners Bank Mine is located on the Miners Bank MS. #309 patented mining claim approximately 17.5 miles west of Lake City, Colorado in Hinsdale County. Located in the Galena Mining District at N37° 58' 20.900", W107° 34' 36.300", the elevation of the Mine site is 12,550 feet immediately southwest of the Roy Pray Mine site. Waste sample #8 is from the mine waste associated with the shaft. The shaft was backfilled within the Hinsdale AML hazard abatement project in 2002. The feature has since then settled to create a partial re-opening of the feature. Station DM-2 is a seep or spring flow which is immediately adjacent and south of the stream and is located on the Miners Bank vein.

Geology and Mine Workings

As mentioned under the Roy Pray section, a fairly exhaustive underground and surficial site-specific geologic investigative report of the Roy Pray site was prepared for the BLM by Bruce Stover of Hayward Baker in 2001. The Roy Pray crosscut intersects the Miners Bank vein at +232' from the portal. The Miners Bank Vein strikes roughly N20^{o}E, dipping from 80^{o} to 84^{o} east where it is surficially exposed. The mine is developed in the Tertiary Andesite Porphyry member of the Silverton Volcanics (Tap), with the vein trending generally parallel to the

Andesite Porphyry-Burns member (Tbb) contact. The Miners Bank Vein likely intersects the Burns member at a relatively shallow depth (150 feet), which may play a crucial role in groundwater hydrology. The Miners Bank is a typical quartz-sulfide fissure type vein with the chief gangue mineral being massive white quartz with pyrite, sphalerite, galena and minor silver mineralization. The vein width reportedly varies from three to 20 feet.

Mine Waste

The waste pile associated with the Miners Bank shaft was mostly eliminated for fill material during the 2002 AML shaft closure. The remnant pile contains less than 50 cubic yards of un-oxidized pyrite, galena and sphalerite. The historic impact from the pile however has created an approximate 2,000 square feet kill zone devoid of vegetation in an equal area to the previous pile footprint. Leachate results from dump sample #8 follow. The Miners Bank waste rock ranked 7th out of 66 dumps sampled.

Miners Bank Waste Pile (Site #8)

pH s.u.	Acidity mg/l	Diss Al ug/l	Diss As ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb ug/l	Diss Zn ug/l
3.05	148	3217.2	96.7	31.4	1151.6	5942.2	235.0	BDL	5494.7

Water Quality Impacts

The Miners Bank Mine was not sufficiently bracketed during high flow to make any detectable conclusions. The Miners Bank vein complicates interpretations made between PG-2, down stream impact monitoring station of the Sarah Woods, and PG-2B, down stream impact monitoring station of the Roy Pray site. Along the Miners Bank vein, spring DM-2 is located, which enters Palmetto Gulch immediately above PG-2. DM-2 could be associated with either the Roy Pray Mine workings or the Miners Bank Mine workings, both of which are along the vein. Due to insufficient flows, DM-2 was never sampled but was observed to contribute small amounts of flow to Palmetto Gulch. It is in this stretch that very visual evidence indicates a stream pH change as shown by the aluminum staining and partial iron staining on the stream bed adjacent to DM-2. During storm events or high flows, impacts from the Miners Bank dump could flow along vein towards where the change in staining appears. Additional sampling is needed to determine if there are impacts from the Miners Bank waste pile along the vein which could be related to DM-2.

Reclamation Options

Reclamation of the denuded area as well as limestone amendments to the remaining small mine waste could be performed. Measuring the improvement to water quality by reclaiming the Miners Bank waste rock pile would be difficult because most impacts occur during snowmelt, when the area is inaccessible. The re-opened shaft needs to be re-sealed and the remaining waste material could be utilized as backfill and mixed with cement to act as a neutralizing and strengthening agent or by applying limestone to reduce the acidity of the waste rock.

Figure 26. Palmetto Gulch crossing Miners Bank Vein – DM-2 area.

Roy Pray Mine

The Roy Pray Mine is located at N37° 58' 25.794", W107° 34' 31.940" on public lands approximately 17 miles west of Lake City, Colorado in Hinsdale County. Elevation of the site is 12,450 feet in the Galena Mining District. The adit was sealed with a grated door closure within the Henson Creek AML hazard abatement project in 2000.

Geology and Mine Workings

A fairly thorough underground and surficial site-specific geologic investigative report of the Roy Pray site was prepared for the Bureau of Land Management by Bruce Stover of Hayward Baker in 2001. The Roy Pray workings lie entirely within the Tertiary Porphyry Andesite (Tap) member of the Silverton Volcanics (Tap), and develop the Miners Bank Vein. The Miners Bank Vein strikes roughly N20^{o}E, dipping from 80^{o} to 84^{o} east where it is surficially exposed. The Miners Bank is a typical quartz-sulfide fault vein with chief gangue mineral being massive white quartz with pyrite, spahlerite, galena and minor silver mineralization. The vein width reportedly varies from three to 20 feet. The Miners Bank Vein likely intersects the Burns member (Tbb) at a relatively shallow depth (<150'), which may play a crucial role in groundwater hydrology.

The Roy Pray crosscut is driven entirely in andesite-porphyry rock on a N45^{o}W heading. The crosscut intersects the Miners Bank Vein at +232 feet from the portal. The workings along the Miners Bank Vein extend S30^{o}W off the crosscut for a distance of 970'. Amounts of sludge as a result of historic oxidation of vein material slowly increase as the back is approached to reach a maximum depth of over 48 inches.

Mine Waste

The waste pile associated with the Roy Pray adit was relocated in 2005 to prevent any hydrological impacts to the pile and to prevent the leaching of metals from the waste into the adjacent perennial stream. During removal, the sub-surface material proved to contain a large amount of suspected rock outcropping. What also was revealed was an indication of the original creek bed prior to the diversion created by the deposition of mine waste. A series of seeps were also encountered on the southern perimeter area after the mine waste was excavated. It is certain that the pre-mine flow path of the creek flowed to the north through the break in the outcrop. What remains uncertain is whether the creek flowed further to the north or where it currently has been redirected to the east. Subsurface material was not excavated in the buffer area between the relocated stream and the slope which leads to the existing sediment pond. Excavation would have allowed for the entire stream flow to be redirected to the sediment pond which is not desired at this point. Flows from spring snowmelt will show further indications of the original flow path of the creek.

Water Quality Impacts

The Roy Pray adit was further sealed with a concrete bulkhead to provide hydrologic collection and prevention of acid mine drainage at a location +140'. Seven days after the final grouting the valve was closed (October 22, 2003). Prior to construction, during the summers of 2001 and 2002, two separate engineering and geological investigative studies were performed. The Miners Bank Lode, MS. #309 is situated above the bulkhead location.

During the 2005 project, interim flows between the portal and the bulkhead required the installation of a permanent collection and diversion structure prior to the removal of the mine waste. An NDS system and HDPE apron is still being used to collect the adit flow and distinct inflow which is connected to 6' Schedule 40 PVC pipe to an outflow location 80' to the southeast of the portal. Sampling site DM-3 represents these collected in-flows.

Sampling Station DM-3 Concentrations

Flow Regime	Diss Al ug/l	Diss Cd Ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Pb ug/l	Diss Mn ug/l	Diss Zn ug/l
Low-Flow	927	15	<20	76800	13	27700	7110

None of the metals measured exceed aquatic life standards with respect to a measured total alkalinity of 81.8 mg/l.

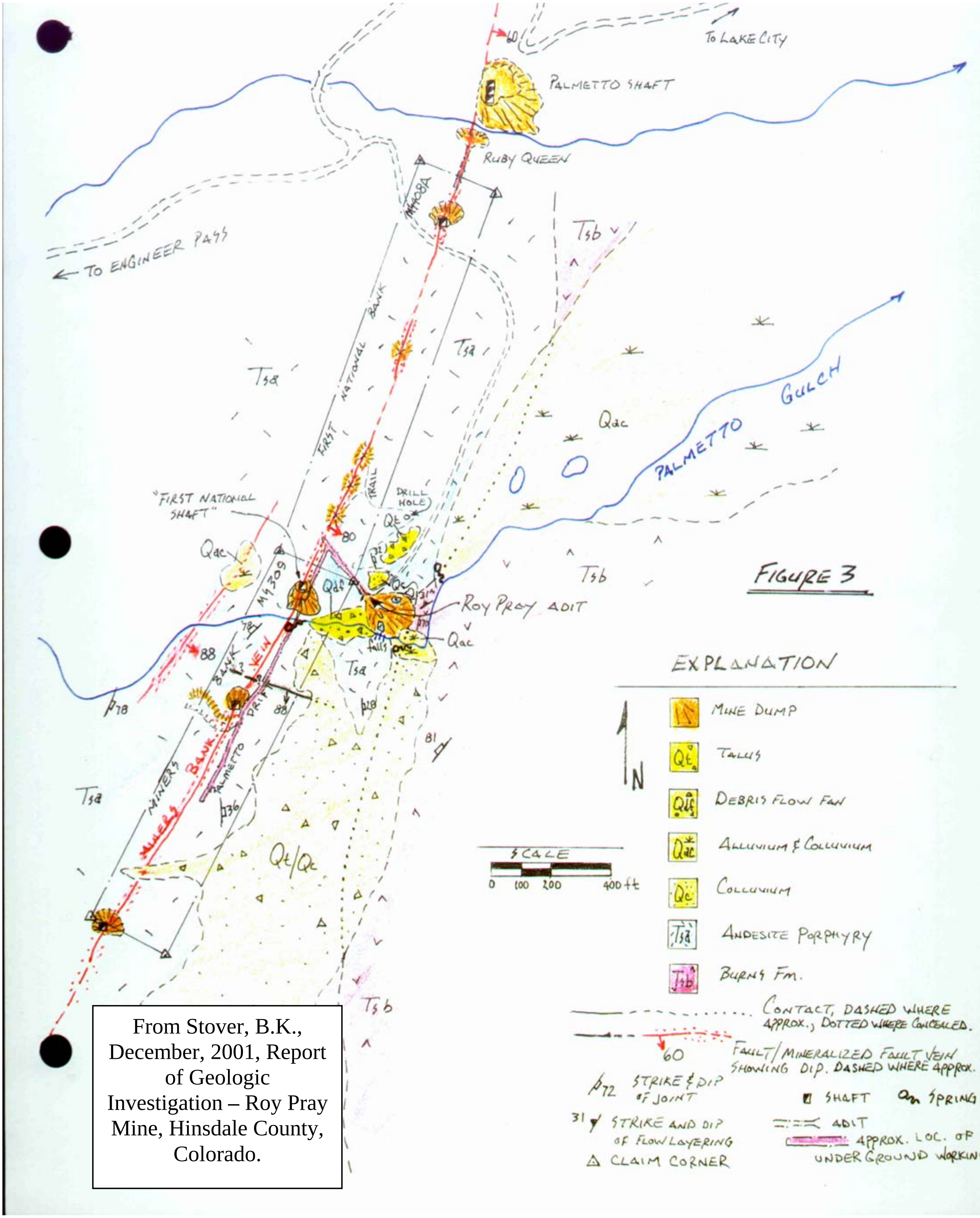
Sampling Station DM-3 Loading - Low-flow

	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
Dissolved	20.024	0.324	BDL	1658.959	0.281	598.349	153.583
Total	22.033	0.302	BDL	1790.726	0.281	611.309	161.576

Figure 27. Roy Pray Bulkhead - 137' location

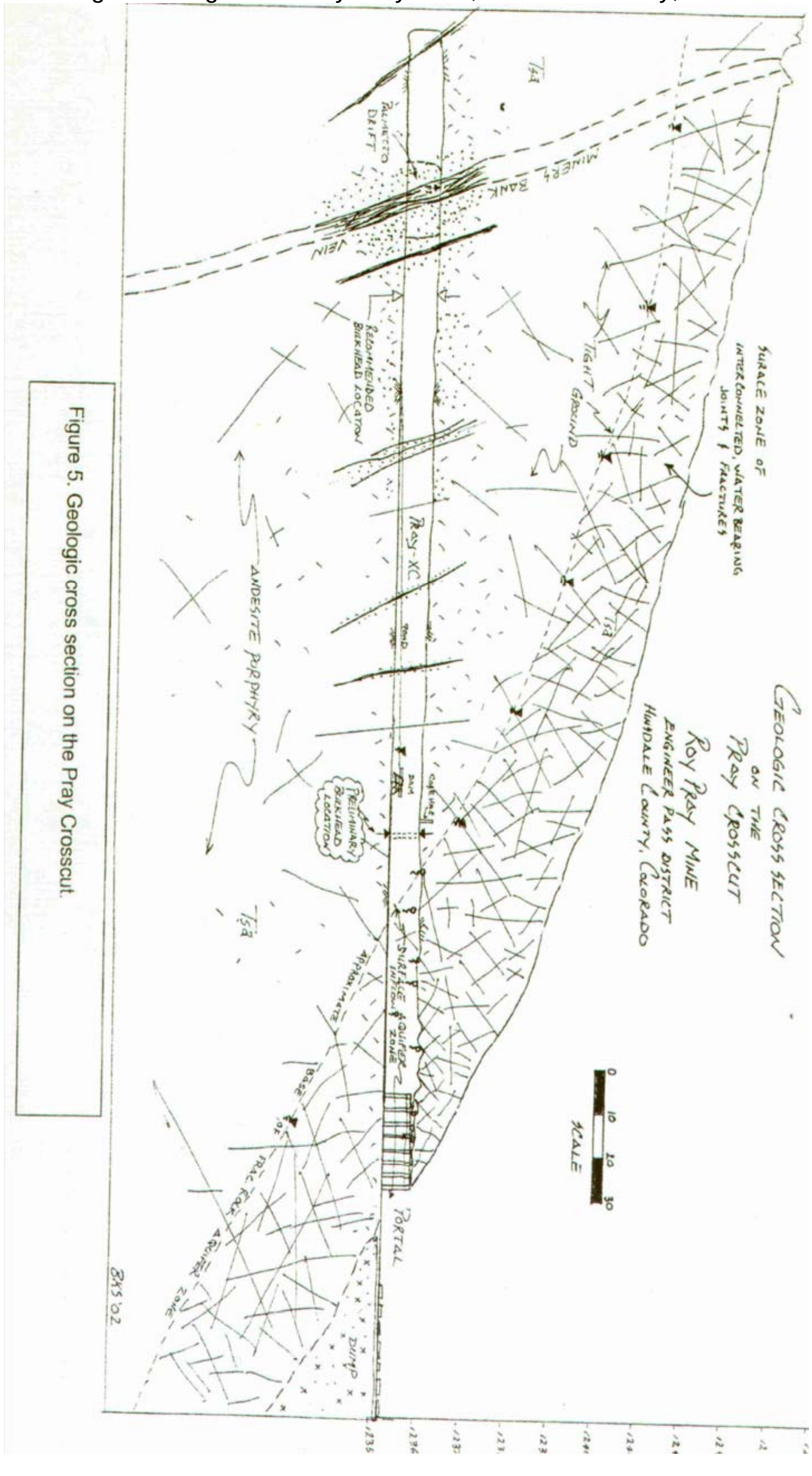
Stream stations PG-2 and PG-2B bracket the Roy Pray site including other seeps which have developed since the waste piles were removed from the drainage and relocated to the east. These seeps could be indicative of historic flows prior to the deposition of the mine waste into the hydrologic regime. Station PG-6 is located approximately 2,000 feet further downstream and further assesses the impact of the Roy Pray area.

Figure 28. Roy Pray Mine Geology and Miners Bank Vein Location



From Stover, B.K., December, 2001, Report of Geologic Investigation – Roy Pray Mine, Hinsdale County, Colorado.

Figure 29. Roy Pray Cross-section map - From Stover, B.K., December, 2001. Report of Geologic Investigation – Roy Pray Mine, Hinsdale County, Colorado



The low-flow loading shown during mine waste removal work at station PG-2b is not surprising considering that the short term liberation of metals as a result of waste removal is expected. Of note is that at station PG-2b there is very little difference between dissolved and total metal loading. One would expect a larger suspended or total load due to the recent reclamation work.

Sample PG-2 – Loading - Low-flow

	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
Dissolved	BDL	0.194	2.042	BDL	BDL	60.611	23.758
Total	163.683	0.194	5.218	3.987	BDL	53.481	23.207

Sample PG-2B - Loading - Low-flow

	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
Dissolved	342.459	2.283	32.757	662.087	1.390	657.124	352.385
Total	549.920	2.581	33.154	701.793	1.290	734.550	366.282

During low flow sampling, water quality measured at PG-6 indicates tremendous loading that occurs between station PG-2b and PG-6. There is a two to three times increase in aluminum, cadmium, copper, manganese and zinc loading in this reach. Not surprisingly, lead and iron are attenuating in this reach. There is notable rock outcropping which occurs in this section. The question that these observations raise is if there are impacts beyond the inflow drainage from DM-3 and the effects of post mine waste removal. One theory is that the Roy Pray reservoir behind the bulkhead is creating diffuse flows down gradient. It could be argued that the andesite porphyry is too tight at the reservoir and bulkhead location to allow diffuse flows to occur. On the other hand contact with the Burns formation down gradient could be providing a conduit for outflows.

Low flow Loading Difference Dissolved – PG-2 and PG-6

Station	Diss Al g/day	Diss Cd g/day	Diss Cu g/day	Diss Fe g/day	Diss Pb g/day	Diss Mn g/day	Diss Zn g/day
PG2	BDL	0.194	2.042	BDL	BDL	60.611	23.758
DM3	20.024	0.324	BDL	1658.959	0.281	598.349	153.583
PG2b	342.459	2.283	32.757	662.087	1.390	657.124	352.385
PG6	1190.417	4.914	73.033	236.743	BDL	1462.895	795.100

Low flow Loading Difference Total – PG-2 and PG-6

Station	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
PG2	163.683	0.194	5.218	3.987	BDL	53.481	23.207
DM3	22.033	0.302	BDL	1790.726	0.281	611.309	161.576
PG2b	549.920	2.581	33.154	701.793	1.290	734.550	366.282
PG6	1290.921	5.360	72.363	305.980	BDL	1514.264	801.801

Reclamation Options

The next phase of the project will be the covering of the mine waste material with a liner. Since a 3:1 (horozontal:vertical) slope was achieved, it is likely that a geosynthetic liner will be used. Additionally, the fracture in-flows between the bulkhead and Roy Pray portal and the upflow in front of the portal will be re-evaluated to determine which outflow path should be retained with the possibility of routing the outflows to the sediment pond. Discussions have also taken place regarding whether to leave or remove the sediment pond. If the pond is removed, a diversion will have to be constructed to collect the seeps which flow into the sediment pond and re-route them around the sediment pond. The sediment pond would then be dried up with the sediments being removed and enveloped into the relocated mine waste pile and covered with the chosen liner. Work is anticipated to be completed during the 2006 construction season.

To ascertain whether loading increases are potentially tied to the Roy Pray Mine reservoir behind the bulkhead seal, one method would be to drill into the reservoir from the top and add a tracer followed by intense monitoring down gradient from the portal within and below the Burns formation. It is recommended not to perform this until any effects from the mine waste reclamation can be eliminated as being accountable for the increases in loading within this stretch of stream.

Prospects Between the Roy Pray and Palmetto Mines

These sites are located between the Roy Pray Mine and the Palmetto Mine at an elevation range of 12,300 to 12,450 feet. There are three distinct prospects along the Mine's Bank Vein that are included in this grouping. The uppermost waste rock pile, sampled as site #14, is located west of the access road to the Roy Pray Mine at N37° 58' 31.6", W107° 34' 30.5". The middle prospect sampled as waste site #15 is located southwest of the Palmetto Mine at N37° 58' 37.5" W107° 34' 28.0". The lowermost prospect was not sampled, but is located immediately southwest of the Palmetto Mine above the draining mine sampled as water quality site DM-5. The lowermost site is located at N37° 58' 39.0", W107° 34' 27.2".

All three prospect sites are accessible to heavy equipment although the lower prospect site is on a steep slope that will make any reclamation difficult.

Geology and Mine Workings

All three prospect adits are developed along the Miners Bank vein system within the Andesite Porphyry (Tap) member of the Silverton Volcanics. The prospect adits are all collapsed. Based upon the size of the waste rock piles, the upper prospect has less than 100 linear feet of workings, the middle prospect has less than 45 feet of workings, and the lower prospect has less than 350 feet of workings.

Mine Wastes

Two of the three waste rock piles were sampled. Photos of the waste piles are shown in **Figures 30, 31**, and **32**. The upper pile was sampled as site #14 and the middle pile was sampled as site #15. The lower pile was similar to the middle pile. The upper and lower piles appeared to have seasonal drainage from the collapsed adits or there is leaching of the waste rock during snowmelt that has resulted in iron staining of the rock below the waste piles. There is a large kill zone below the upper and lower piles. Runoff from the middle pile flows to the lower pile. The middle pile blocks a small drainage. The blockage has resulted in erosion of the waste rock and increases leaching of heavy metals from the pile. Selected results from the waste rock leachate testing are given below.

Upper Prospect (Site #14)

pH s.u.	Acidity mg/l	Diss Al ug/l	Diss As ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb ug/l	Diss Zn ug/l
3.77	54	76	BDL	BDL	28	329	103	BDL	211

Middle Prospect (Site #15)

pH s.u.	Acidity mg/l	Diss Al ug/l	Diss As ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb ug/l	Diss Zn ug/l
3.32	38	124	BDL	1.3	45	562	75	BDL	466

Water Quality Impacts

Water quality impacts from these sites are seasonal. There were no measurable in-stream impacts from these sites, although these sites were not bracketed. Visual evidence shows that there is probably some seasonal drainage from the collapsed adits at the upper and lower sites. This is probably water that enters the near surface mine workings during spring snowmelt. The middle waste rock pile blocks a small stream channel, which intuitively would result in water quality degradation and definitely results in erosion of waste rock into Palmetto Gulch. The upper waste rock pile is not in a stream channel, so there is no impact from erosion, but leachate and/or seasonal mine drainage does enter a small ephemeral channel. The toe of the lower waste rock pile is in the same small ephemeral channel that flows through and over the middle waste rock pile. There is some erosion of the lower waste rock into Palmetto Gulch.

Figure 30. Upper Prospect on Miners Bank Vein

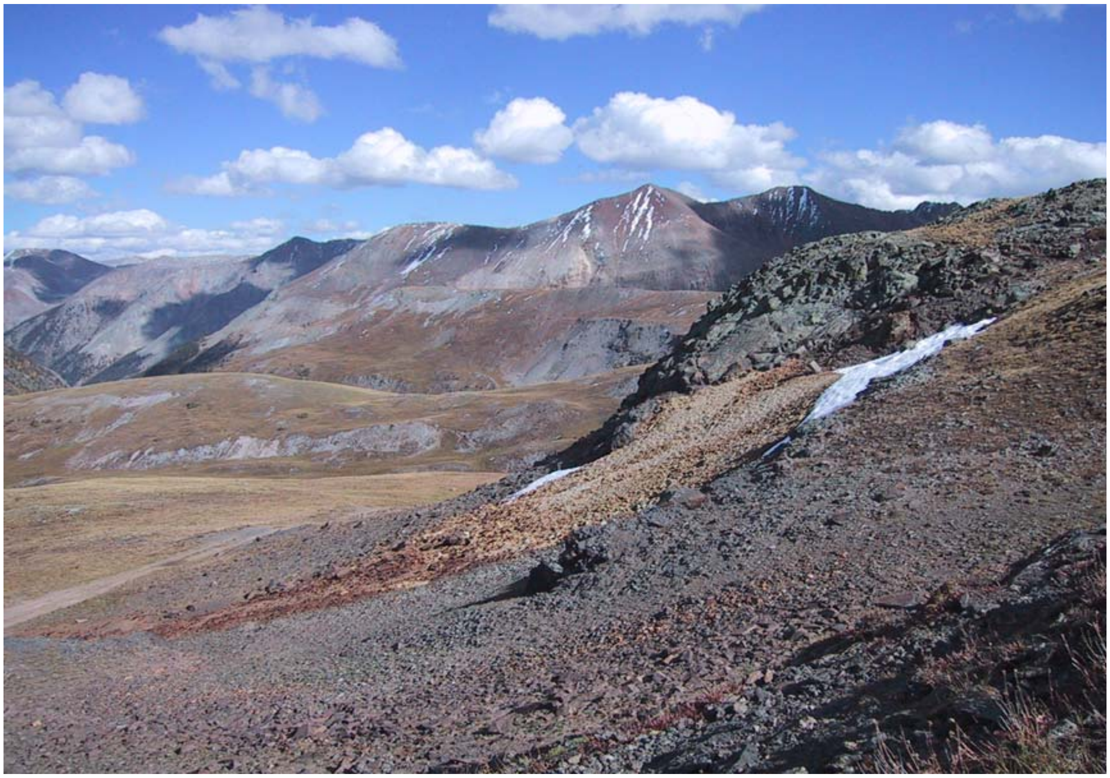


Figure 31.

Middle Prospect on Miners Bank Vein

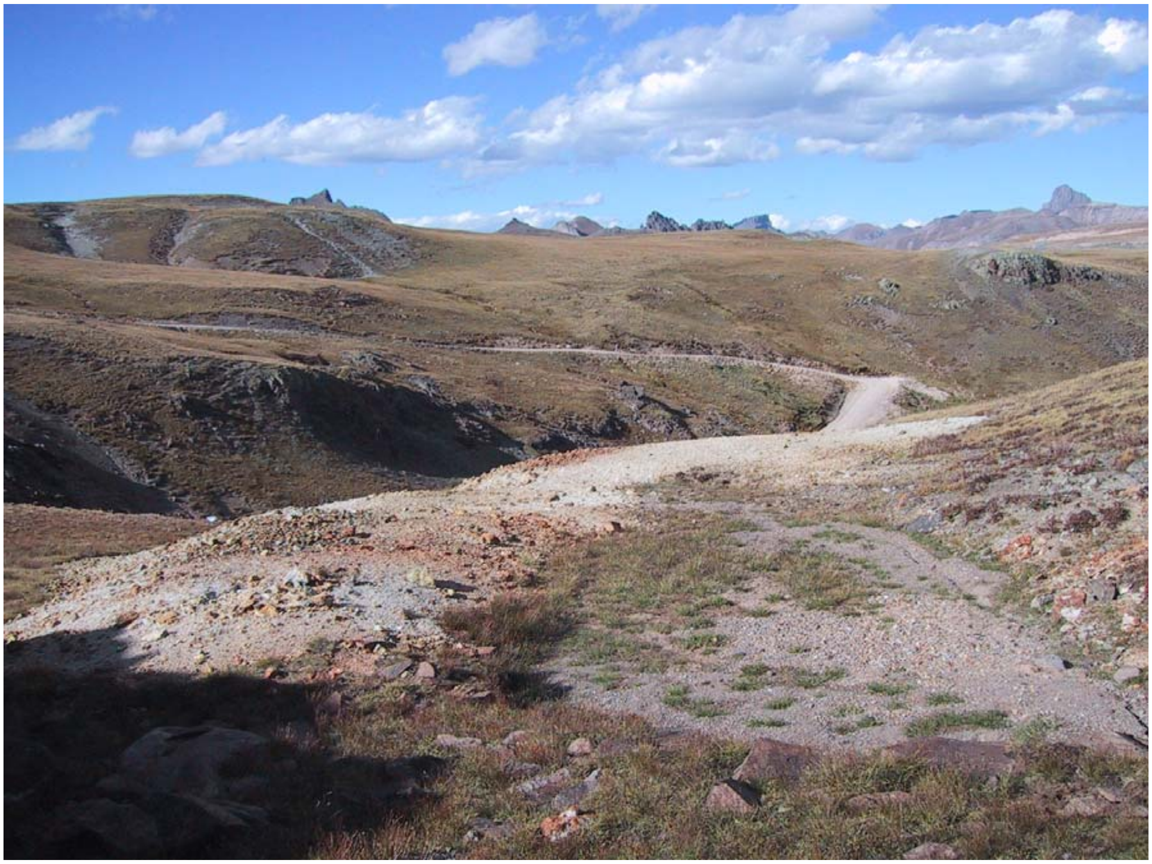


Figure 32. Lower Prospect on Miners Bank Vein

Reclamation Options

Degradation of water quality from the waste rock piles and possible mine drainages is seasonal. The upper waste rock pile probably has the least effect on in-stream water quality although it has the largest vegetation kill zone. The middle waste pile probably has the largest effect on water quality because of leaching of the waste rock where the pile blocks the drainage. The lower waste pile is the closest to the perennial receiving stream, so any leachate or eroded material will readily enter Palmetto Gulch.

At a minimum, the waste rock at the middle and lower piles should be pulled away from the stream channel. Eventually, the lower and middle piles should be removed and disposed of in a relatively high and dry location. The upper waste rock pile and the vegetation kill zone should have ground limestone applied to neutralize the acidity and reduce heavy metal mobilization.

Wyoming Mine

The Wyoming Mine is in the Galena Mining District located on public lands approximately 17 miles west of Lake City, Colorado in Hinsdale County. Elevation of the site is 12,900 feet in a hanging basin southeast of the top of Engineer Pass. Waste sample #9, located at N37° 58' 9.623", W107° 34' 32.881", was from the upper pile which has had hydrological run-on control ditch work completed. Sample DM4 is from the draining adit. There are two shafts related to the upper workings which contain a large amount of debris from a collapsed shaft building. There is evidence of a collapsed adit immediately to the south of the shaft surface level. The shafts were sealed with a polyurethane closure within the Henson Creek AML hazard abatement project in 2000. There was also a related small mine building to the west of the site which was totally knocked over by an avalanche in 2004.

Geology and Mine Workings

The Wyoming Mine develops a fissure type vein, the Emperor Wilhelm, that strikes N40°E, and dips 72°SE. The shafts and adit all lie within the Burns member (Tbb) of the Silverton Volcanics, but underground workings may intersect the Andesite Porphyry member at depth due to the proximity of the contact. The Emperor Wilhelm vein within the Wyoming Mine was reported to have a five foot wide fissure with an eighteen inch "paystreak" composed of solid galena and iron pyrites. During the 1883 Mining Directory report (A. Von Schulz), after sorting, ore grade showed 200 ounces per ton from one ninety-foot shaft. Since the report, another shaft and adit were put into development with very little information available as to connections, drift lengths or maps.

Mine Waste

Two waste piles exist at the Wyoming Mine. As a result of reclamation efforts, the lower pile was removed out of the drainage and was surficially amended with limestone. The results below (#9) are from the upper waste pile which has had hydrological control work performed to route run-on flows around the west side of the pile. Additionally, a sediment pond was retained immediately below the pile which catches any precipitates from any high flows which may occur. The mine flow from station DM-4 which is located between the two waste piles at present flows to the east and does not come in contact with the lower pile. Leachate results show the waste to have a slightly elevated level of aluminum. Overall, the Wyoming waste rock pile ranked 11th out of 66 sites sampled.

Wyoming Mine Waste Pile (Site #9)

pH s.u.	Total Acidity mg/l	Al ug/l	Cd ug/l	Cu ug/l	Fe ug/l	Mn ug/l	Pb ug/l	Zn ug/l
3.23	78	583.1	40.4	179.5	302.3	138.9	BDL	6613.9

<u>Water Quality Impacts</u>
An attempt was made to reopen the draining adit to assess the potential for hydrologic collection and prevention of acid mine drainage. The project was initiated during the fall 2002 and was completed in 2004. The adit was shown to have been completely packed with cementitious sludge which was impossible to excavate even with the combination of hydro-jetting. One theory proposed which could explain the tightness of the waste or sludge material was that the feature could have been the recipient of mine waste from the upper level workings. The adit was sealed with a grated HDPE culvert closure with a door to provide future access. Two sediment control ponds remain within the drainage. Seasonal flows from the upper level collapsed adit have been collected and are re-routed to the run-on diversion ditch to the northwest around the upper waste pile.

The adit was inaccessible after an attempt was made to locate the feature during the high-flow sampling event due to snow conditions. Water quality impacts from this site are hard to assess due to the disappearance of most of the annual flows into the channel material.

Sample DM-4 - Concentration - Low-flow

Flow Regime	Diss Al ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Pb ug/l	Diss Mn ug/l	Diss Zn ug/l
Low-Flow	320	10	43	1270	10	551	2060

Sample DM-4 - Loading - Low-flow

	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
Dissolved	7.67	0.24	1.03	30.45	0.24	13.21	49.39
Total	11.10	0.24	1.24	79.36	2.32	12.85	48.43

At station PG-4, which is the measurable outflow from the Wyoming drainage, all metals from DM=4 are shown to have decreased significantly if not entirely.

Sample PG-4 - Loading - Low-flow

	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
Dissolved	BDL	BDL	BDL	BDL	BDL	BDL	1.499
Totals	BDL	0.006	BDL	BDL	BDL	BDL	1.481

During high flow, there are considerably more impacts from the Wyoming and Emperor Wilhelm waste rock piles. It is assumed that the majority of the metals measured at sampling site PG-4 come from leaching of the waste rock piles. Concentrations and loading from this area are shown below. The data shows that the waste rock in this area is principally a source of zinc, although cadmium concentrations are elevated. Approximately 5% of the zinc loading in Palmetto Gulch occurs in this area.

Sample PG-4 - Concentration - High-flow

Flow Regime	Diss Al ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Pb ug/l	Diss Mn ug/l	Diss Zn ug/l
High-Flow	BDL	3	BDL	BDL	BDL	88	537

Sample PG-4 - Loading - High-flow

	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
Dissolved	BDL	3.6	BDL	BDL	BDL	107.0	653.0
Total	BDL	3.6	BDL	280.9	BDL	109.4	631.1

Reclamation Options
The reclamation at the Wyoming site has been completed. There is still an interest in accessing the mine workings related to the draining adit from above. The thought is that mine working voids could be determined with investigatory drilling.

Emperor Wilhelm MS. #1309

The Emperor Wilhelm Mine is located on the Emperor Wilhelm MS. #1309 patented mining claim in Palmetto Gulch approximately 17.5 miles west of Lake City, Colorado in Hinsdale County. Located at N37° 58' 17.538", W 107° 34' 23.658", the elevation of the mine site is 12,400 feet east of the Roy Pray Mine in the Galena Mining District. Both upper and lower mine features were sealed within the Hinsdale County AML hazard abatement project in 2002.

Geology and Mine Workings
The Emperor Wilhelm lies on the same vein (Emperor Wilhelm) as the Wyoming and has been referenced as an extension of the Wyoming Mine. The five foot wide fissure vein contains galena and iron pyrites in a quartz gangue. The tunnel in 1883 was reported to be over 160 feet deep with an associated 20 feet deep shaft (A. Von Schulz).

Mine Waste
Mine waste sample #12 is from the upper workings while sample #13 is from the lower workings. An approximate 500 feet distance separates the portals. A small width denuded drainage path from the upper pile extends downslope most of the way towards the lower pile. The mine waste pile associated with the upper workings is approximately 750 cubic yards in size. Mineralization as seen in the field is more evident on the upper dump than the lower dump. This is also shown in the leachate results which follow. The Upper Emperor Wilhelm ranked 10th and the lower waste pile ranked 34th out of 66 sites sampled.

Upper Emperor Wilhelm Waste Pile (Site #12)

pH s.u.	Acidity mg/l	Diss Al ug/l	Diss As ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb ug/l	Diss Zn ug/l
3.0	106	593.1	BDL	26.6	246.8	1343.1	1400.4	88.2	4158.6

Lower Emperor Wilhelm Waste Pile (Site #13)

pH s.u.	Acidity mg/l	Diss Al ug/l	Diss As ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb ug/l	Diss Zn ug/l
3.85	22	45.0	BDL	3.6	56.5	12.0	320.6	BDL	555.1

Water Quality Impacts
Water quality impacts from the vein related to the Emperor Wilhelm workings are difficult to establish. A large wetland area exists at the base of the slope that contains the mine. Any impacts from storm events or spring snowmelt is ameliorated within these wetlands. Storm water impacts from the dumps would flow along the vein towards PG-4. Results of PG-4 also shown under the Wyoming Mine narrative show evidence of negligible impacts during low flow.

Sample PG-4 - Loading - Low-flow

	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
Dissolved	BDL	BDL	BDL	BDL	BDL	BDL	1.499
Total	BDL	0.006	BDL	BDL	BDL	BDL	1.481

During high flow, there are considerably more impacts from the Wyoming and Emperor Wilhelm waste rock piles. It is assumed that the majority of the metals measured at sampling site PG-4 come from leaching of the waste rock piles. Concentrations and loading from this area are shown below. The data shows that the waste rock in this area is principally a source of zinc, although cadmium concentrations are elevated. Approximately 5% of the zinc loading in Palmetto Gulch occurs in this area.

Sample PG-4 - Concentration - High-flow

Flow Regime	Diss Al ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Pb ug/l	Diss Mn ug/l	Diss Zn ug/l
High-Flow	BDL	3	BDL	BDL	BDL	88	537

Sample PG-4 - Loading - High-flow

	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
Dissolved	BDL	3.6	BDL	BDL	BDL	107.0	653.0
Total	BDL	3.6	BDL	280.9	BDL	109.4	631.1

Reclamation Options
Reclamation of the upper waste pile is possible with limestone amendments and/or sub-surface burial. Any attempts to reclaim the lower pile would be costly due to the steep slope and machine access restrictions. The measurability of water quality improvement from this endeavor would probably not be cost effective.

Hoffman MS. #538 and **Engineer MS. #860**

The Hoffman Mine is located on the Hoffman MS. #538 patented mining claim within the furthest east tributary of Palmetto Gulch. The Engineer Mine is located on the Engineer MS. #860 patented mining claim at the top of the ridge headwater area to the same tributary. Both mines are approximately 16.5 miles west of Lake City, Colorado in Hinsdale County. The Hoffman is located at N 37° 58' 7.000", W 107° 34' 23.000", at an elevation of 12,650 feet. The Engineer is located at N37° 58' 1.461", W 107° 34' 28.713" at an elevation of 12,900 feet. All mine features related to both mines are collapsed.

Geology and Mine Workings
The Hoffman and Engineer Mines develop the Hoffman vein which strikes N30°E and dips nearly vertically. The Hoffman vein is likely associated with the caldera resurgence and development of the Eureka Graben. Both mines are located within the Burns member (Tbb) of the Silverton Volcanics. Extensive hydrothermal alteration along the ridge top near the Engineer Mine is likely associated with ore deposition.

The Hoffman Mine reportedly contains two fissure veins one to two feet in width accessed by a 55 foot shaft and a 40 foot drift. The vein accessed by the Engineer Mine contains quartz carrying native, brittle, and ruby silver with assay reports from 59 to 137 ounces silver per ton. In 1883 a 32 foot shaft was reported (A. Von Schulz).

Mine Waste
Mine waste sample #11 is from the Hoffman Mine while sample #10 is from the Engineer. The mines are approximately 900' apart. A small width denuded drainage path from the upper pile extends downslope most of the way towards the lower pile. The mine waste pile associated with the Hoffman Mine is approximately 1,200 cubic yards in size. The waste pile at the Engineer site is estimated to be 3,000 cubic yards. Mineralization as seen in the field is more evident on the upper dump than the lower dump. This is also shown in the leachate results which follow.

Engineer Mine Waste Pile (Site #10)

pH s.u.	Acidity mg/l	Diss Al ug/l	Diss As ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb ug/l	Diss Zn ug/l
3.3	38	152.4	BDL	1.6	16.7	213.8	1023.5	BDL	372.0

Hoffman Mine Waste Pile (Site #11)

pH s.u.	Acidity mg/l	Diss Al ug/l	Diss As ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb ug/l	Diss Zn ug/l
6.58	100	16.8	44.4	BDL	11.9	BDL	14.7	BDL	46.9

The sample from the Engineer Mine is questionable in its true representation of the overall dump. Visually the dump shows similarities with the other highly mineralized mine dumps in the Palmetto area. Regardless, the potential of remediating any impacts from the dump is very low due to its location and inaccessibility. Overall, the Engineer waste rock pile ranked 39th and the Hoffman ranked 14th out of 66 sites sampled.

Water Quality Impacts
The first sampling station measuring impacts from this tributary is PG-3. Many outcrops exist between the mines and PG-3 including mineralized zones which cross the drainage. During the low flow sampling, station PG-3 is a short distance down from where water flows were even measurable. There is visual evidence of iron staining up drainage from this location in the area where the drainage crosses the cliff outcrop. Results of PG-3 are shown below.

Sample PG-3 - Loading Dissolved

Flow Regime	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
Low-Flow	BDL	0.11	BDL	BDL	BDL	20.88	31.99
High-Flow	BDL	3.1	BDL	BDL	BDL	157.1	672.1

Sample PG-3 - Loading Total

Flow Regime	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
Low-Flow	14.026	0.11	BDL	BDL	BDL	20.88	32.153
High-Flow	1020.6	3.1	55.8	3763.3	BDL	1657.1	652.0

During High flow, these sites are a source of principally zinc and cadmium. Approximately 5% of the total zinc loading in Palmetto Gulch comes from this area. Most of the impact is probably due to leaching of the waste rock piles, but there is considerable mineralization in the area. Additional water sampling below these sites is needed to ascertain the actual amount of loading attributable to the waste rock piles.

Reclamation Options

Due to the inaccessibility of both dumps relative to road access, reclamation of the two waste piles is questionable. The Hoffman site would require crossing an expanse of tundra while the Engineer site could be accessed from above. Both dumps could be reclaimed with limestone amendments and or sub-surface burial. The Engineer dump would require extensive up-slope handling with a dragline. The measurability on water quality from this endeavor would not be cost effective.

Palmetto Mine MS. #233

The Palmetto Mine is located on both the Palmetto MS. #233 patented mining claim and public lands managed by the BLM. The mine is immediately adjacent to CR-20, the Engineer Pass road, approximately 17 miles west of Lake City, Colorado in Hinsdale County. Located at N37° 58' 41.387", W 107° 34' 23.491", the elevation of the mine site is 12,160 feet in the Galena Mining District. A shaft feature exists on-site with related shaft house debris and a boiler. The shaft is filled with trash and standing water.

Geology and Mine Workings

The Palmetto Mine exploits the northern extension of the Miners Bank Vein which strikes N10°E and dips to the east at 76° in the vicinity of the mine. Most, if not all of the workings are developed in Tertiary Andesite Porphyry (Tap) of the Silverton Volcanics, with the possibility of intersection with the Burns member (Tbb) at depth. The fissure type vein is located in a fine-grained porphyry between two to five feet in width containing sulphides of iron, zinc, and copper mixed with ruby and native silver. The main shaft is located off the vein to the east, intersecting and developing the vein at depth. The main twin compartment shaft was reported to be over 350 feet in depth with drifts aggregating over 1,650 feet in development. Production reported in the 1883 report was 15 tons per day (A. Von Schulz).

Mine Waste
Mine waste sample #17 is from the mine site. The dump is situated immediately adjacent to perennial water flows in Palmetto Gulch with portions of the pile actively eroding into the drainage. Sloughed material is aggrading in the flatter portion of the drainage approximately 300' down stream. The central portion of the dump exhibits a fair amount of alpine grass species wherever a small veneer of cover material is present. The mine waste pile is approximately 3,500 cubic yards in size. The Palmetto waste rock pile ranked 19th out of 66 sites sampled. The leachate results follow.

Palmetto Mine Waste Pile (Sample #17)

pH s.u.	Acidity mg/l	Diss Al ug/l	Diss As ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb ug/l	Diss Zn ug/l
4.8	38	393.9	BDL	5.7	96.6	47.6	1597.0	BDL	879.1

Water Quality Impacts
Sampling stations PG-7 and PG-7a, less the impacts from DM-5, bracket the impacts to Palmetto gulch from the mine site during low-flow sampling. During high-flow sampling, sampling stations PG-7 and PG-8, less the impacts from DM-5, bracket the mine site. As shown below with the data tables, water quality is not impacted from the Palmetto site even though there is active erosion on the mine dump. The trend still shows with the high flow total values. Metal fallout may be happening within the aggrading section between the sampling stations. More importantly, during low flows a significant dilution source occurs from seeps and small flows from the northeast area of the mine.

Low-flow - Loading - PG-7 and PG-7a - Dissolved

Station	Diss Al g/day	Diss Cd g/day	Diss Cu g/day	Diss Fe g/day	Diss Pb g/day	Diss Mn g/day	Diss Zn g/day
PG7	BDL	0.099	BDL	BDL	BDL	8.040	10.125
PG7a	BDL	BDL	BDL	BDL	BDL	6.077	6.280

Low-flow - Loading – PG-7 and PG-7a - Total

Station	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
PG7	BDL	0.099	BDL	BDL	BDL	8.437	8.834
PG7a	BDL	BDL	BDL	BDL	BDL	5.875	6.483

High-flow - Loading – PG-7 and PG-8 - Dissolved

Station	Diss Al g/day	Diss Cd g/day	Diss Cu g/day	Diss Fe g/day	Diss Pb g/day	Diss Mn g/day	Diss Zn g/day
PG7	BDL	BDL	3469.7	1896.6	BDL	1857.6	2755.7
PG8	BDL	BDL	661.0	BDL	BDL	1252.5	1403.2

High-flow - Loading – PG-7 and PG-8 - Total

Station	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
PG7	11156.5	22.3	5254.7	11491.2	BDL	1846.4	2649.7
PG8	5763.7	11.6	2215.0	5879.6	BDL	1322.0	1554.0

Reclamation Options

The BLM currently has a task order for reclamation of the Palmetto site with DMG. The alternatives for reclamation include the removal and placement of the waste at either the Roy Pray site, the upper BLM tailings location above the Ute-Ule, or reclamation on-site. Reclamation on-site is the preferred alternative. The mine waste would be excavated from the high water mark of the perennial stream flow. The final excavated grade would not impact the shaft. Permanent up-slope run-on diversions would need to be constructed to route perennial flows diverted from CR-20 around the site further to the northeast. The area for the relocated mine waste currently exhibits saturated soils. The vegetation and soils would be excavated and separately stockpiled for later re-distribution. After the up-slope diversions and placement area was excavated, mine waste would be placed, contoured, amended with limestone pending acid/base test results, and capped with the stockpiled soils and vegetation. If more mineralized material was encountered during the mine waste excavation, options could include isolating the mine waste with geofabric or capping the waste with a geotextile liner.

HENSON CREEK ABOVE CAPITOL CITY SITE DESCRIPTIONS

Mine sites in this area chosen for reclamation feasibility studies include: the Golconda Mine, the Chicago Tunnel, and the Hanna mill tailings. Smaller sites discussed below include: DM-6 - unnamed mine below the confluence with Palmetto Gulch, the Highland Chief Mine, the Moro Tunnel, the Mill across from Thoreau's Cabin, two small mines in Redcloud Gulch, six mines in Schafer Gulch, two mines on Dolly Varden Mountain, one mine in Horseshoe Basin, three mines in Schafer Basin, and one mine in Henson Creek. These smaller sites were not researched to determine the name of the mine, so they will be briefly discussed according to their descriptive location name below (see **Figures 6 -13** for locations).

BLM Adit Below the Confluence of Palmetto Gulch

DM-6 is located along Henson Creek at creek level, at an elevation of 11,320 feet. This adit was not sampled during high flow sampling because the flow was not consistent enough to sample. The site was sampled during low flow, and had a flow of .001 cfs. All of the major metals concentrations (Zn, Cu, Cd, Mn) were below detection limits from this site, and the sulfate concentration at this site was less than the Henson Creek Headwaters sampling site HC-1. The mine drainage from this site is in general cleaner than the water in Henson Creek at HC-2. No reclamation action is recommended at this site, other than a safety closure, to prevent access to the workings.

Mill Across from Thoreau's Cabin

This site is located near the confluence of Palmetto Gulch and Henson Creek at an elevation of 11,450 feet at N37° 58' 54.8" W107° 33' 34.7". The volume of tailings at this site is estimated to be less than 50 cubic yards. The mill tailings at this site were sampled as site #18. Overall, the mill tailings ranked 28th out of 66 waste rock piles sampled.

Mine Near Stream in Redcloud

This site is located in Redcloud Gulch at an elevation of 11,950 feet at N37° 58' 54.8" W107° 33' 34.7". The waste rock pile at this site is estimated to contain 150 cubic yards. The waste rock pile was sampled as site #19. This waste rock pile had very low concentrations of heavy metals. Overall, this waste rock pile ranked 49th out of 66 waste rock piles sampled. The heavy metals from Redcloud Gulch are principally from natural sources.

Mine on Southwest side of Redcloud

This site is located in Redcloud Gulch at an elevation of 12,050 feet at N37° 58’ 12.7” W107° 33’ 50.3”. The waste rock pile at this site is estimated to contain 150 cubic yards. The waste rock pile was sampled as site #20. This waste rock pile had very low concentrations of heavy metals and is far above any receiving stream. Overall, this waste rock pile ranked 58th out of 66 waste rock piles sampled. The heavy metals from Redcloud gulch are though to be principally from natural sources.

Mine on South Side of Henson Between Redcloud and Schafer

This site is located at an elevation of 11,400 feet at N37° 58’ 28.7” W107° 33’ 9.5”. The waste rock pile at this site is estimated to contain 500 cubic yards. The waste rock pile was sampled as site #25. This waste rock pile had moderately high concentrations of heavy metals. This mine site is located on a talus slope near the Schafer Gulch access road crossing of Henson Creek. The talus provides a pathway to Henson Creek for any leachate, but impacts from this site are thought to be minimal. Overall, this waste rock pile ranked 26th out of 66 waste rock piles sampled.

Mine Near Ridge on North Side of Schafer

This site is located in Schafer Gulch at an elevation of 12,300 feet at N37° 58’ 8.1” W107° 33’ 32.4”. The waste rock pile at this site is estimated to contain 700 cubic yards. The waste rock pile was sampled as site #21. This waste rock pile had very low concentrations of heavy metals. Overall, this waste rock pile ranked 55th out of 66 waste rock piles sampled.

North Mine at Headwaters of Northwest Schafer Trib

This site is located in Schafer Gulch at an elevation of 12,240 feet at N37° 57’ 55.1” W107° 33’ 49.9”. The waste rock pile at this site is estimated to contain 500 cubic yards. The waste rock pile was sampled as site #22. This waste rock pile had very low concentrations of heavy metals. Overall, this waste rock pile ranked 56th out of 66 waste rock piles sampled.

South Mine on Southwest side of Northwest Schafer Trib

This site is located in Schafer Gulch at an elevation of 12,360 feet at N37° 57’ 46.2” W107° 33’ 44.5”. The waste rock pile at this site is estimated to contain 1,000 cubic yards. The waste rock pile was sampled as site #23. This waste rock pile had relatively low concentrations of heavy metals but exhibited severe erosion and a large vegetation kill zone below the waste pile. However, the waste pile is distant from any stream to transport eroded or leached metals. In addition the entire basin between the site and the main stem of Schafer Gulch contains significant wetlands to ameliorate any further affects. Overall, this waste rock pile ranked 37th out of 66 waste rock piles sampled.

Golconda Mine

The Golconda Mine is located near the headwaters of Schafer Gulch in Hurricane Basin. The mine is located on public lands managed by BLM. The mine is approximately 17 miles west of Lake City, Colorado in Hinsdale County via CR20 for 15 miles turning onto the Schafer Gulch road just past Rose’s Cabin. At an elevation of 12,360 feet, the Golconda site (mine dump sample #26) is located at N37° 57' 19.615", W107° 32' 50.826". The site has a collapsed adit with related collapsing structures immediately in front of the feature. A well preserved unique boarding house is a short distance to the north. The BLM performed a stabilization project on this structure several years ago. Mine dump sample #27 is located at N37° 57' 15.000", W107° 32' 48.900" approximately 600 feet to the south of sample #26 at an elevation of 12,400 feet. The upper site mine feature was sealed with a grate within the Henson Creek AML hazard abatement project in 2000. The adit was draining approximately 10 gpm during the September reconnaissance. Sample station BGO picks up the water quality impacts from the site.

Geology and Mine Workings

The Golconda Mine lies within an area of highly faulted and hydrothermally altered Eureka member (Tse) rocks of the Sapinero Mesa Tuff. The mine appears to develop a set of veins consistent with the northern extension of the Denver Fault. The Denver Fault is a normal fault, striking northeast and dipping to the northwest, and is one of the major faults within the Eureka Graben.

The Golconda Mine appears to consist of two separate levels, one associated with older workings closer to the vein, and the other level being a cross-cut drift. Based on mine inspector reports from the 1920's, the Golconda Tunnel (cross-cut drift) was driven below the old workings and intercepted the main vein at 1,000 feet. Drifts totaling at least 2,000 feet were driven both east and west along the vein, with two raises driven nearly 500 feet upward to intersect the old workings. The cross-cut drift was continued another 700 feet but does not appear to have intercepted any additional veins. Inspector reports indicated that the vein was approximately 18 inches wide and was mined for both gold and silver within a quartz gangue. Work in the early 1980's was conducted to intercept the Golconda Tunnel through another cross-cut due to impassable ice within the main tunnel.

Mine Waste

The Mine waste pile associated with sample #26 is fairly extensive exhibiting a large amount of country rock and/or tallus material. The country rock or and or tallus is hard to differentiate within the approximate 5,000 cubic yards of Mine waste.

Lower Goldonda Waste Pile (Site #26)

pH s.u.	Acidity mg/l	Diss Al ug/l	Diss As ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb ug/l	Diss Zn ug/l
4.16	28	12.3	BDL	1.4	14.7	13.7	221.0	29.3	290.5

The upper Golconda site (#27) exhibits significantly elevated levels of cadmium, copper, lead, manganese and zinc. In addition to sulfur concentrations, all these metals exhibit concentrations that rank in the top ten dumps of the entire Henson watershed. The site has more recently been worked which could contribute to these high concentrations. This could be related to relatively newer unoxidized vein material encountered during the movement of waste material. The size of the upper waste pile is scattered and has been thinly bladed. Color differentiation is evident between the tallus and relatively un-oxidized mine waste. Leachate results from sample #27 follow.

Lower Golconda Waste Pile (Site #27)

pH s.u.	Acidity mg/l	Diss Al ug/l	Diss As ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb ug/l	Diss Zn ug/l
4.87	20	808.1	BDL	826.9	10925.2	69.2	3297.3	2935.9	120377.2

Overall, the lower waste rock pile ranked 46th and the upper waste pile ranked 21st out of the 66 sites sampled.

Water Quality Impacts
The first sampling station measuring impacts from the Golconda site is station BGO. Even though the upper Golconda waste pile has considerable elevated metals, stations BGO and SCG exhibit insignificant loading. By the time flows reach lower Schafer Gulch, much dilution occurs from side tributaries and from the Chicago Tunnel (DM-7). In addition to dilution, significant oxidation occurs from water falls between the stations BGO and SCG.

Reclamation Options
Access to the Golconda site is fairly treacherous although there does exist a passable four-wheel drive road to the site. The lower dump does not justify any reclamation work to be completed. The upper dump however should be prioritized for reclamation. An acid/base accounting should be completed to determine what neutralization amounts will be required to ameliorate the acid production over time. Once the calcium carbonate equivalence amounts have been determined, the entire dump should be excavated, amended with limestone, placed higher out of the drainage and capped with on-site tallus. Shorter downstream distance water quality sampling should show impacts from the site which station SCG does not. Even though longer distance impacts are not seen, reclamation should be justified with closer examination. In addition to the mine waste reclamation, the draining adit should be sampled.

Mine Below Siegel Mountain in Schafer Gulch

This site is located in Schafer Gulch at an elevation of 12,420 feet at N37° 57’ 28.3” W107° 33’ 9.5”. The small waste rock pile at this site is estimated to contain 250 cubic yards. The waste rock pile was sampled as site #24. This waste rock pile had very low concentrations of heavy metals. Overall, this waste rock pile ranked 52 out of 66 waste rock piles sampled.

Lower Mine on Northwest Side of Gravel Mountain

This site is located in Schafer Gulch at an elevation of 12,900 feet at N37° 57’ 26.6” W107° 33’ 29.1”. The waste rock pile at this site is estimated to contain 700 cubic yards. The waste rock pile was sampled as site #28. This waste rock pile had very low concentrations of heavy metals. Overall, this waste rock pile ranked 64 out of 66 waste rock piles sampled.

Upper Mine on Northwest Side of Gravel Mountain

This site is located in Schafer Gulch at an elevation of 13,000 feet at N37° 57’ 28.6” W107° 33’ 28.3”. The waste rock pile at this site is estimated to contain 500 cubic yards. The waste rock pile was sampled as site #29. This waste rock pile had very low concentrations of heavy metals. Overall, this waste rock pile ranked 59th out of 66 waste rock piles sampled.

Chicago Tunnel

The Chicago Mine site is located to the southeast where Schafer Gulch enters Henson Creek. The mine is located on the Dorchester MS. #20145 patented mining claim. The site is approximately 16.5 miles west of Lake City, Colorado in Hinsdale County via CR-20 for 15 miles turning onto the Schafer Gulch road just past Rose’s Cabin. The Chicago site (dump sample #30) is located at N 37° 58' 19.233", W 107° 32' 39.119", at an elevation of 11,200 feet. The site has a draining adit (station DM-7) with flows that range from 95.15 gpm during the high flow sampling to 128 gpm during the low flow sampling. This lower flow measured during the high flow event compared to the higher flow during the low flow sampling event could indicate that the source of the drainage is deeper ground water. The adit was sealed with a grate within the Henson Creek AML hazard abatement project in 2000.

Geology and Mine Workings

The Chicago Tunnel lies within the Burns member (Tbb) of the Silverton Volcanic series at the northeastern extent of the Eureka Graben. No obvious surficial expressions of a vein have been documented by previous field mapping, so the exact feature mined is unclear. Most likely the Chicago Tunnel was driven as a cross-cut to intersect a northeasterly trending mineralized structural feature associated with the Eureka Graben. No mapping or description of the underground workings was discovered during completion of this report.

Mine Waste

The mine waste pile associated with sample #30 is fairly extensive exhibiting a large amount of country rock and/or tallus material. The Chicago tunnel was a cross-cut tunnel accessing the Chicago patented mining claims to the south. The entire mine bench in front of the adit consists of this country rock excavated for the tunnel. The total volume is estimated to be approximately 3,500 cubic yards of material. As would be expected, the high content of country rock resulted in low metal concentrations from the waste rock leachate as shown below. The Chicago Tunnel waste rock pile ranked 53rd out of 66 sites sampled.

Chicago Tunnel Waste Rock (Site #30)

pH s.u.	Acidity mg/l	Diss Al ug/l	Diss As ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb ug/l	Diss Zn ug/l
5.58	18	27.6	BDL	BDL	BDL	54.5	8.7	BDL	35.1

Water Quality Impacts

The Chicago tunnel drainage is station DM-7. The mine drainage flows over the mine dump and shows visual armoring of dark oxides assumed to be manganese and iron. The flow continues into the forest creating significant marshy vegetation and substrate conditions prior to entering into Schafer Gulch and beaver ponds in and along Henson Creek. Sampling site SCG on Schafer Gulch is above the mine drainage and the mine drainage and Schafer Gulch are bracketed by sampling sites HC-3 and HC-4. Between HC-3 and HC-4 metal concentration and loading decreases for all constituents except for zinc during low flow and high flow. Virtually all the increase in zinc load between HC-3 and HC-4 can be accounted for by the Chicago Tunnel Mine drainage and Schafer Gulch. The natural bog and beaver ponds apparently removes most of the metals from Schafer Gulch and the Chicago Tunnel. Loading results from DM-7 follows.

Sample DM-7 - Loading - Dissolved

Flow Regime	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
Low-Flow	BDL	3.486	BDL	381.413	BDL	1255.106	573.862
High-Flow	BDL	BDL	BDL	BDL	BDL	278.5	101.1

Sample DM-7 - Loading - Totals

Flow Regime	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
Low-Flow	170.834	3.486	BDL	1743.203	BDL	1262.079	522.961
High-Flow	BDL	BDL	BDL	632.7	BDL	340.7	101.1

Reclamation Options

Because of the natural amelioration which occurs from DM-7, no reclamation or treatment of water draining from the Chicago tunnel is recommended at this time. Zinc removal could be increased through the addition of limestone to the bog/beaver pond area. Because of poor access, this would have to be done by hand or by helicopter. The potential negative impacts to the biology of the bog area outweigh any potential benefits to water quality.

Upper Dolly Varden

This site is located on Dolly Varden Mountain at an elevation of 12,500 feet at N37° 59' 21.7" W107° 32' 14.6". The waste rock pile at this site was split into two separate samples due to color. The waste rock pile was sampled as sites #31 and #32. The pile is estimated to contain 700 cubic yards. This waste rock pile had very low concentrations of heavy metals. Overall, this waste rock pile ranked 64th and 66th out of 66 waste rock piles sampled. No reclamation is recommended at this time.

Lower Dolly Varden

This site is located on Dolly Varden Mountain at an elevation of 12,220 feet at N37° 59' 13.8" W107° 32' 7.7". The waste rock pile at this site is estimated to contain 500 cubic yards. The waste rock pile was sampled as site #33. This waste rock pile had low to moderate concentrations of heavy metals. Overall, this waste rock pile ranked 45th out of 66 waste rock piles sampled. No reclamation is recommended at this time.

Highland Chief Mine

This draining adit is located above Engineer Pass Road to the north of Henson Creek. The dump has a large mill building located on it and the waste pile is estimated to be 5,500 cubic yards in size. The adit is driven into the cliffs behind the building and has a DMG mine closure on it. The coordinates of the Highland Chief Mine are N 37° 58' 35.0", W 107° 31' 18.8".

The mine drainage is contributing generally cleaner water to Henson Creek and the mine waste pile ranked 31st out of 66 mine waste piles sampled, making the site a low priority.

Horseshoe Basin Mine West

This site is located in Horseshoe Basin at an elevation of 12,450 feet at N37° 57' 30.7" W107° 31' 41.9". The waste rock pile at this site is estimated to contain 450 cubic yards. The waste rock pile was sampled as site #34. This waste rock pile had low concentrations of heavy metals. Overall, this waste rock pile ranked 56th out of 66 waste rock piles sampled. No reclamation is recommended.

Schafer Basin Mine West Side

This site is located in Schafer Basin at an elevation of 12,300 feet at N37° 57' 39.9" W107° 30' 28.3". The waste rock pile at this site is estimated to contain 250 cubic yards. The waste rock pile was sampled as site #36. This waste rock pile had high concentrations of heavy metals, particularly copper and lead. The waste rock had a chemical rank of 12 and an overall rank of 37th out of 66 waste rock piles sampled. Access to this site is by foot only, so any remediation of the waste pile would be costly. No reclamation is recommended.

Schafer Basin Mine East Side Upper

This site is located in Schafer Basin at an elevation of 12,400 feet at N37° 57' 31.6" W107° 30' 18.6". The small waste rock pile at this site is estimated to contain 200 cubic yards. The waste rock pile was sampled as site #37. This waste rock pile had the lowest overall concentrations of heavy metals of all the dumps sampled. Overall, this waste rock pile ranked 60th out of 66 waste rock piles sampled. No reclamation is recommended

Schafer Basin Mine East Side Lower

This site is located in Schafer Basin at an elevation of 12,100 feet at N37° 57' 50.3" W107° 30' 6.5". The waste rock pile at this site is estimated to contain 1,000 cubic yards. The waste rock pile was sampled as site #38. This waste rock pile had low to moderate concentrations of heavy metals. Overall, this waste rock pile ranked 47th out of 66 waste rock piles sampled. No reclamation is recommended

Moro Tunnel

This draining adit (DM-9) is located along the mainstem of Henson Creek, approximately 1.5 miles from Capitol City, and the North Fork of Henson Creek. The access to the site is along Engineer Pass, and then up an abandoned four-wheel drive road. The site is 2/10 of a mile off of Engineer Pass Road. The coordinates of this location are N 37° 59' 50.9", W 107° 28' 48.2"

The flow during both high and low-flow sampling events was .001 cfs, a very small amount of flow. Along with minimal flow, the site also had generally low metals concentrations in the mine drainage. The waste rock pile was sampled as site #39. The leachate results show that the waste rock has very low concentrations of heavy metals. The waste rock pile ranked 51st out of 66 sites sampled.

The minimal flow combined with the low metals concentrations from the Moro Tunnel, make this site an insignificant draining mine impact to Henson Creek. In general the mine drainage from the Moro Tunnel is less contaminated than the Henson Creek water just downstream of the site. The recommended reclamation at this site is no action.

Hanna Mill Tailings

This site is located west of Capitol City, along the mainstem of Henson Creek, about one mile upstream of the North Fork of Henson Creek confluence. The elevation of the site is 9,700 feet, and the coordinates are N 37° 59' 55.3", W 107° 28' 25.0". There is an access road to the site off of Engineer Pass, which is passable by four-wheel drive vehicles. The road is blocked by wooden barriers part way, where the land changes from public land to private land. This site was sampled as waste rock sampling site #40, and was bracketed by water quality sites HC-5 and HC-6. The historic Hanna Mill building is located adjacent to the tailings spill site. The building is mainly a foundation, with few standing walls. The mill building ran from the 1890's through the 1920's, and was used to mill the ore from the Moro Mine. The remnants of a tramway from the Moro Mine to the mill is still visible from the site. Presently, the landowner is planning to remove the historic structure and use the site as a building platform for a cabin. The reclamation on the Hanna Mill Tailings Spill did not affect any historic structures.

<u>Geology and Mine Workings</u>
There are no mine workings associated with the Hanna Mill Tailings, because the site was used as a milling location only. There is a small prospect shaft immediately above the mill building, which was approximately 50 feet deep, based upon the amount of waste rock. The ore that was milled at this site came primarily from the Moro Mine, which is located to the north of the Hanna Mill.

The site sits in a wide section of the Henson Creek Valley, the underlying material is a combination of alluvial and glacial material. Henson Creek becomes very sinuous in the area and has multiple flow channels.

<u>Mine Waste</u>
The waste at this site is comprised of mill tailings and waste rock, processed from the Moro Mine. The mill tailings are about 1/8 of a mile from the mill building to the east. The mill building is privately owned and the mill tailings spill is on BLM land. The tailings material is sand sized particles of crushed ore. There is some waste rock material underneath the mill building along with a small prospect with approximately 500 cubic yards of material located to the north of the mill building.

The tailings spill was thought to have occurred during operation of the mill in the 1920's, but after reclamation of the site in 2005, and the discovery of plastic materials within the spilled tailings, the spill is now thought to have occurred after 1950, and may have been caused by a large storm event. The estimated amount of spilled mine waste was 1,500 cubic yards.

The mill tailings spill was sampled as waste rock sampling site #13. The Hanna mill tailings sit above Henson Creek along the flood plain of the river. The tailings are never submerged in the stream, but are subject to erosion during storm events. The mill tailings ranked 23rd out of the 66 mine waste piles sampled. Selected results from the waste rock leachate testing are given below.

Hanna Mill Tailings Spill (Site #13)

pH s.u.	Acidity mg/l	Diss Al ug/l	Diss As ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb ug/l	Diss Zn ug/l
5.58	44	59.7	BDL	56.5	1594.9	38.3	153.5	1071	8919.4

The largest concern for the Hanna Mill Tailings spill was the ability of the tailings to wash into the stream during storm events. The sand-size particles along with the location near Henson Creek and within the floodplain made the Hanna Tailings a priority for the BLM and DMG when they reclaimed the site in September of 2005 (see **Figure 33** below).

This site is located in a flat valley near the confluence with the North Fork of Henson Creek. This site is subject to flooding during storm events. The waste rock beneath the Hanna Mill building sits well above the creek level, but the spilled tailings sat right near Henson Creek, and were partially in Henson Creek during high-flow storm events. During the summer of 2005, the same year as the Hanna Mill Tailings Spill Removal Project, a portion of the spilled tailings within Henson Creek were washed away, along with some of the other spilled tailings material that sat higher above the creek. It is estimated that approximately 200 cubic yards of material may have been lost during this storm event, mostly from the main spill area. Below the mill tailings and the spill is alluvial material consisting of large boulders and cobbles. There is plenty of topsoil material in this broad valley and reclamation and revegetation was simple, because of the broad flat nature of the valley and ease of access.

Figure 33. Hanna Mill Tailings during reclamation in September 2005

Water Quality Impacts
The only areas of concern at this site are the mill tailings spill and the small waste rock pile. There was no vegetation growing on the mill tailings spill, or the small prospect's mine waste. The site was bracketed by sample sites HC-5 and HC-6. The effects of the tailings spill were not detected in Henson Creek during high or low-flow sampling events. The Hanna Mill Tailings most likely played a larger role in contaminating Henson Creek during extremely high flows and storm events, due to the leaching and sheet washing of the sand-sized particles. The reclamation at the Hanna Mill Tailings Spill began after the low-flow sampling event in September of 2005.

Reclamation Options
The Hanna Mill Tailings site is mixed ownership between a private landowner and the BLM. The private landowner controls most of the Hanna Mill Tailings site along with the mill building. The BLM owns the tailings spill and the small prospect shaft above the mill building. In 2005 the BLM funded the Hanna Mill Tailings Spill Removal Project located on BLM land and the DMG designed and managed the project. The project started in September of 2005 and was completed at the end of October 2005. The project consisted of relocating the spilled tailings material and revegetation. The spilled tailings material was moved to the BLM's Ute-Ule repository site, approximately four miles down Engineer Pass from the Hanna Mill site. After the

material was removed, the site was regraded to a stable configuration and straw wattles were placed along contour. The site was also mulched with straw, but was not crimped due to time constraints and inclement weather. Most of the spilled tailings were relocated, but there were several small pockets of material that were not reclaimed, due to the difficulty of access through large stands of willows. The original estimate of spilled tailings material was 1,500 cubic yards, but during the project in 2005, only 500 cubic yards of tailings were found and relocated to the repository. It is estimated that another 50 cubic yards of spilled tailings were left in place.

The Hanna Mill site has not been reclaimed because it is on private land. The current landowner has chosen not to reclaim the site because the site is slated to be the location of a mountain cabin. The landowner plans to use the flat area of the mill building foundation and associated waste rock as a foundation. The foundation will be poured concrete, which should help to immobilize some of the metals in the waste rock pile. If land ownership changes, recommended reclamation for this site would either be to remove the waste rock to the Ute-Ule repository or to create an on-site repository and revegetate.

In 2006 the BLM plans to fund the relocation of the small prospect shaft's mine waste pile to the Ute-Ule repository and then revegetate the disturbed area. The recommended course of reclamation for this site, is to continue with the plans to remove the prospect shaft's mine waste pile to the Ute-Ule Repository and revegetate. For the mill tailings spill site, reclaimed in 2005, the recommended course of reclamation is to monitor the vegetation growth at the site and possibly fertilize the site again and crimp the mulch if necessary in the Spring of 2006. For the waste rock below the Hanna Mill Building, the recommendation for reclamation is no action, due to the private landowners plans to cap the site with a concrete foundation.

NORTH FORK OF HENSON CREEK SITE DESCRIPTIONS

Mine sites in this area chosen for reclamation feasibility studies include: The Vulcan Mine, Broker Lode, the Excelsior Lode, Yellow Medicine Mine, Mountain Belle Lode, and a mill tailings site in Yellowstone Gulch referred to as the Yellowstone Mill Tailings. The Capitol City Mine, the Czar, and the Czarina Mine were investigated and determined to be insignificant sources. Each of the sites chosen for reclamation feasibility studies will be discussed below. The Czar, Czarina and Capitol City Mines are discussed briefly.

North Fork Henson Creek

Geologic Setting

North Fork Henson Creek drains two distinct geologic areas, outside the San Juan-Uncompahgre caldera and intracaldera. Within the caldera outcrops are generally from the Silverton Volcanic series with numerous tertiary intrusives of Oligocene and Miocene age. Lavas and volcaniclastics of early Oligocene age and Ute Ridge Tuff dominate the bedrock outcrops outside the caldera margin. Intrusives are rhyolitic to monzonitic in composition and confined to the intracaldera zone, specifically Capitol City and Broken Hill. The sharp contact between older Oligocene Tuffs and lavas with younger volcanics highlights the thickness of volcaniclastic and extrusive accumulations within the down-dropped intracaldera zone.

No major mapped faults are noted within the North Fork area, but some minor faulting and fracturing has been observed. Faulting along the caldera margin appears confined to the actual ring fault resulting from collapse, with little visible propagation into the surrounding rock. Lamination and bedding planes within the volcaniclastics are erratically oriented probably due to proximity to the caldera margin. Near the caldera margin volcaniclastics, specifically Henson Formation, strike tangential to the margin and dip inward from the caldera walls.

Alteration within the North Fork Henson Creek is isolated to Yellowstone Gulch, Matterhorn Creek and Broken Hill. These areas of hydrothermal alteration exhibit extensive limonitic staining indicative of hydrothermal pyrite mineralization resulting from solfataric processes. Along with pyritic mineralization, hydrothermal processes have altered much of the feldspathic minerals within the rock mass to sericite and kaolinite. The areas of most intense hydrothermal alteration appear to be associated with intrusions of monzonite in Yellowstone Gulch and rhyolite on Broken Hill. This association is tenuously based on proximity and not actual geochemical analysis. Numerous iron springs outcrop within upper Matterhorn Creek and are assumed to be a product of the extensive limonitic alteration within upper Matterhorn Creek and Broken Hill.

Mineralization of economic importance is confined to areas surrounding Yellowstone Gulch and Capitol City. The veins are simple fissure type, composed mainly of quartz, galena and sphalerite. When compared with other mineralized areas of Henson Creek, the Capitol City assemblage is distinct suggesting a unique source or mineralization process. There is no known economically valuable mineralization associated with the hydrothermal alteration in Matterhorn Creek and Broken Hill. High concentrations of aluminum and iron within Matterhorn Creek can be correlated to leaching of hydrothermally altered rock within the drainage.

Vulcan Mine

The Vulcan Mine is located to the northwest of Capitol City along the North Fork of Henson Creek. The mine is located on the public lands boundary between USFS and BLM managed land. The site is approximately 10.5 miles west of Lake City, Colorado in Hinsdale County via CR20 for 9.5 miles turning onto the forward North Fork of Henson Creek road in Capitol City. An abandoned road accesses the site from the four-wheel drive North Fork of Henson Creek road. There is a multiple story loadout-milling structure on site which is deteriorating from the lack of a roof. Concrete foundations also exist to the east of the loadout-milling structure. The Vulcan site (dump sample #41) is located at N 38° 0' 57.086", W 107° 28' 51.215", at an elevation of 10,300 feet. The collapsed adit is draining with flows that range from 17.9 gpm during the high flow sampling to 40 gpm during the low flow sampling. There are a series of ponds that intercept the adit flow prior to its confluence with the North Fork of Henson Creek.

Geology and Mine Workings

The Vulcan Mine is located within the Eureka Member (Tse) of the Sapinero Mesa Tuff, but appears to intersect both the Andesite Porphyry Member of the Silverton Volcanic series (Tap) and Monzonite Porphyry (Tmp) at depth. The mine developed a vein striking N7°-15°W and dipping between 50° and 80° to the southwest. The vein appears to trend roughly perpendicular to the Lake City caldera, and lies at the northern margin of an extensively hydrothermally altered region associated with monzonitic intrusions to the Capitol City area.

The vein is accessed by an 800 foot crosscut, with about 1,000 feet of development along the vein. Reports indicated that the vein is a simple fissure type, with some evidence of movement along the dip. The vein is irregular in width, and is composed of mostly quartz, galena, sphalerite and pyrite, with minor amounts of chalcopyrite, gray copper, hessite, sylvanite, native silver, native tellurium and native gold (Irving and Bancroft, 1911). Extensive oxidation within the ore body was observed to a depth of 400 feet by Irving and Bancroft.

Mine Waste

The mine waste pile associated with sample #41 is fairly extensive exhibiting a large amount of country rock and/or tallus material. The Vulcan tunnel was a cross-cut tunnel accessing the Vulcan patented mining claims to the west. The total volume is estimated to be approximately 4,000 cubic yards of material. A small amount of tailings exists under the loadout-milling structure. The isolated tailings pile was not part of this sampling effort. The Vulcan waste rock pile exhibits relatively low metal concentrations. The waste rock ranked 42nd out of 66 sites sampled.

Vulcan Mine Waste Rock (Site #41)

pH s.u.	Acidity mg/l	Diss Al ug/l	Diss As ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb ug/l	Diss Zn ug/l
4.87	20	173.2	BDL	13.1	128.0	47.7	24.0	539.6	888.4

Water Quality Impacts
The Vulcan drainage is station DM-10. The drainage exhibits a dense moss community along the immediate exit pathway from the adit along with algae growth within the drainage. Any impacts from the site enter into the North Fork of Henson Creek and were measured at station NFHC-2. The drainage from the adit flows over the mine dump then continues into a series of ponds. These ponds could be effectively removing much of the metal loading, particularly iron. There is a significant increase in metal loading from sampling site NFHC-1 to NFHC-2. Virtually all this increase can be accounted for from Materhorn Creek. When taking the upper North Fork chemistry into consideration, during low flow it appears that manganese potentially is passing through any amelioration that the settling ponds may have. In comparison to the Vulcan Mine drainage, the impacts from Matterhorn Creek are magnitudes higher in concentrations and in loading on station NFHC-2. Loading results from both DM-10 and NFHC-2 follow.

Sample DM-10 - Loading - Totals

Flow Regime	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
Low-Flow	BDL	BDL	BDL	209.160	BDL	164.688	14.824
High-Flow	BDL	BDL	BDL	98.8	BDL	77.1	7.7

Sample NFHC-2 - Loading - Totals

Flow Regime	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
Low-Flow	34513.901	BDL	BDL	20254.637	BDL	2965.279	421.296
High-Flow	124506.5	BDL	BDL	78393.0	BDL	10375.5	2997.4

Reclamation Options
Except for manganese, natural amelioration appears to be cleaning any impacts the site may have from iron and zinc. Due to the complex treatment necessary for manganese removal and due to the fairly remote access restrictions which the site has, treatment options are extremely limited. The flows could be routed within a more defined channel around the waste piles for a more permanent route towards the settling ponds.

Capitol City Mine

The Capitol City Mine is located on the west side of Yellowstone Gulch at an elevation of 10,650 feet at N38° 01’ 6.6” W107° 28’ 14.2”. The Capitol City Mine waste rock was sampled as site #44. There is no mine drainage from the site, and there is no indication of water quality impacts from the waste rock pile. The waste rock pile at this site is estimated to contain 3,700 cubic yards. This waste rock pile had moderate concentrations of heavy metals. Overall, this waste rock pile ranked 29th out of 66 waste rock piles sampled.

Yellow Medicine Mine

This site is located at N38° 1' 10.786", W107° 28' 7.793" along the southern flanks of Broken Hill in the Yellowstone Gulch drainage, approximately 3,100 feet. northeast of the confluence with the North Fork of Henson Creek. The Yellow Medicine Mine lies on two privately held lode mining claims, Yellow Medicine and Mountain Belle, and consists of at least two distinct mine waste piles. A four-wheel drive road from the North Fork Henson Creek road provides access to the lower waste pile located at approximately 10,700 feet. The two waste piles were sampled as waste rock sampling sites #45 (Yellow Medicine), and #46 (Mountain Belle). Both sites #45 and #46 have various amounts of historic debris including wood, metal and glass. Historical records indicate that structures existed on both the upper and lower dumps during periods of mining prior to 1900, and during the early 1940’s. The upper dump, site #45, has foundations and collapsed structure debris indicating that some type of structure was associated with the upper portal. Little historical evidence, other than portions of a loadout, remain intact on the lower dump, site #46, probably due to construction of the existing residence.

Geology and Mine Workings

The Yellow Medicine Mine developed a “simple fissure” type vein that strikes N13°W, and dips 79°NE. Investigations of the vein in a 1911 report by Irving and Bancroft indicate that the vein lays in contact with pyroxene andesite flows (Tap) and a monzonite porphyry intrusion (Tmp). More recent surficial geologic mapping of the area by Lipman in 1976, appear to indicate that the vein may lie in contact with the biotite quartz latites of the Burns (Tbb) formation instead of pyroxene andesite flows. Regardless, substantial hydrothermal alteration, both propylitic and solfataric, has rendered much of the rock surrounding the vein undistinguishable.

The vein is developed on three levels, each separated by approximately 150 feet vertically. At the time of site inspections, both the lowest level (1st) and middle level (2nd) were inaccessible due to collapsed portals. The upper level (3rd) was open, but no underground investigations were conducted. No map of the workings was available for the mine. Mine inspection reports between 1948 and 1951 indicate that most of the stoping was conducted on the 2nd and 3rd levels, Mountain Belle and Yellow Medicine respectively. The vein on levels one and three was 1-4 feet wide and consisted of galena, sphalerite, pyrite, chalcopyrite and quartz.

Mine Wastes

The mine waste associated with the Yellow Medicine Mine is located at two discreet waste piles associated with two different levels of mining at the site. The upper waste pile, sampled as site #45, is located on a steep slope directly below the upper mine portal. This waste pile is approximately 40 feet wide and 150 feet long, with an estimated volume of 1,300 cubic yards. Much of the waste pile is moderately cemented and aggrades from fine to coarse material from top to bottom. Few erosional features are located on the pile, but the lower portion of the pile lies within the high water channel of Yellowstone Gulch. There is some vegetation located on the waste pile, and no kill zone was noticed below the site. The lower waste pile, sampled as site #46, is composed of two lobes. The eastern lobe extends eastward from the adit toward Yellowstone Gulch. This lobe is relatively steep, well cemented, with few erosional features, and has an estimated volume of 8,300 cubic yards. The upper lobe is located directly above a private residence, and appears to have been graded relatively flat to provide additional storage space. The volume associated with the upper lobe is estimated to be 3,000 cubic yards, bringing the total volume of mine waste for site #46 to 11,300 cubic yards. Aspen trees and other vegetation cover portions of both lobes. Site #45 ranked 33rd out of 66 waste rock sites sampled, and site #46 ranked 36th out of 66 waste rock sites sampled.

Mineralogy of both sites #45 and #46 were very similar in composition and consisted of pyrite, sphalerite and galena. Selected leachate results from the mine waste piles are shown below, and indicate elevated levels of zinc and lead. Much of the waste is heavily oxidized with extensive limonitic staining. Observed Mineralogy of the Yellow Medicine Mine is consistent with the quartz-galena-sphalerite grouping of Mines within the Capitol City area.

Yellow Medicine - Yellow Medicine Mine 3rd Level (Site #45)

pH s.u.	Acidity mg/l	Diss Al ug/l	Diss As ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb ug/l
4.32	20	117	8	156	74	138	720	1,657

Mountain Belle - Yellow Medicine Mine 2nd Level (Site #46)

pH s.u.	Acidity mg/l	Diss Al ug/l	Diss As ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb ug/l
5.2	54	158	49	156	74	573	138	6,029

Water Quality Impacts

Water quality impacts related to the Yellow Medicine Mine are difficult to quantify due to the lack of bracketing along Yellowstone Gulch, but it is a possible source based on mineralogy, physical characteristics and proximity to the stream. Portions of both the upper and lower waste dumps, site #45 and #46 respectively, lay within the stream channel of Yellowstone Gulch. In-field testing of pH during field reconnaissance above and below the mine sites indicated no pH change across the waste piles though. Both waste piles have elevated levels of leachable zinc, but are not ranked very high when compared to other dumps in the area. Regardless, the possibility exists that some waste is being leached during high flow events along the toe of both waste piles, and can account for some of the elevated zinc and other trace metal loading in Yellowstone Gulch.

Figure 34. Yellow Medicine Mine, Upper Dump (Site #45)

. Reclamation Options

Construction of surface hydrologic controls is the recommended method for reclamation at both sites. The lower dump, site #46, is easily accessible for heavy equipment and poses the least difficulty for reclamation. The eastern lobe of the waste pile should be pulled back from the stream channel and consolidated onto the upper lobe of the pile near the collapsed portal. Some minor road building onsite will be required to accomplish the waste removal and consolidation. The lack of erosional features on the waste dump indicate that overland flow is probably not a major water quality problem, but the construction of diversion channels above the site would be relatively inexpensive, and could prove beneficial in the long run.

The upper waste pile, site #45, poses a much greater challenge to reclamation due to the inaccessibility of the site. The access road was heavily overgrown and probably too narrow in some locations for heavy equipment to travel. Additionally, access to the toe of the dump would be extremely difficult for heavy equipment due to the steepness of the hill. Some work to move waste away from the stream channel could be accomplished by hand or with the assistance of a slusher/dragline type device, but probably at a very high cost. The limited water quality impact, coupled with the high potential cost suggests that reclamation on the site should not be a priority.

Due to the low total acidities of both sites a minimal amount of limestone amendment would be necessary for reclamation. Both waste piles appear to be naturally revegetating where slopes are stable enough for plants to establish. Specific topsoil addition and seeding could be helpful in accelerating vegetative coverage if desired, but does not appear necessary to address water quality concerns.

Figure 35. Yellow Medicine Mine, Lower Dump (Site #46)

.**Yellowstone Mill**

This site is located along the southern flanks of Broken Hill in the Yellowstone Gulch drainage, approximately 1,600 feet. northeast of the confluence with North Fork Henson Creek. The site consists of two distinct mill tailings piles located on BLM administered land at an elevation of 10,320 feet. A four-wheel drive road from the North Fork Henson Creek road provides access to the mill. The sites were sampled as waste rock sampling sites #42 (eastern pile) and #43 (western pile). Site #42 is located at N38° 0' 53.963", W107° 28' 17.568", while site #43 is located at N38° 0' 53.054", W107° 28' 19.299". The Yellowstone Mill began operation in 1897. "It contained a boiler, engine, crusher, three sets of rolls, revolving screen from each roll, set of revolving screens which went to four Harz jigs, and three buddle tables" (Irving and Bancroft, 1911). Most of the structures mentioned above have long since collapsed, been dismantled and hauled off. One Harz jig remains mostly intact (**Figure 36** below), with portions of a buddle table below it. Foundations for much of the milling equipment still remain, with wood and metal debris scattered throughout the site.

Mine Waste

The mill tailings, consisting of both the east and west piles, cover an area of approximately 1½ acres. The eastern pile is oval in shape and covers approximately 26,000 square feet, at an average estimated depth of one foot. Portions of the pile near the millsite foundations are thicker and consist of unprocessed ore material/mine waste. Below the foundation a mixture of tailings and mine waste persist for approximately 200 feet, and appear to be a product of primary ore crushing. The western pile covers an area of approximately 38,000 square feet at an average estimated depth of one foot. The tailings extend in a narrow "tongue" over 1,000 feet down the hillside from the processing point. The particle size is small and relatively homogeneous due to the milling process. Both piles exhibit extensive salt formation and moderate cementation due to evaporation and leaching.

Figure 36. Remains of a Harz jig at Yellowstone Mill (above western pile).

The Yellowstone Mill processed ores from the Yellowstone Gulch area, specifically the Yellow Medicine Mine, which was predominately a quartz-galena-sphalerite vein. The mill tailings in each pile are very high in leachable cadmium, copper, lead and zinc. The mill tailings from site #42 ranked 7th and the mill tailings from site #43 ranked 5th out of 66 sites sampled. Selected leachate results for both piles are listed below.

Yellowstone Mill – Eastern Pile (Site #42)

pH s.u.	Total Acidity mg/l	Al ug/l	Cd ug/l	Cu ug/l	Fe ug/l	Mn ug/l	Pb ug/l	Zn ug/l
5.19	94	169	309	3362	394	1151	5029	49,854

Yellowstone Mill - Western Pile (Site #43)

pH s.u.	Total Acidity mg/l	Al ug/l	Cd ug/l	Cu ug/l	Fe ug/l	Mn ug/l	Pb ug/l	Zn ug/l
3.69	90	582	181	4105	312	346	4676	30,490

Water Quality Impacts

Water quality impacts of the Yellowstone Mill tailings to adjacent streams are difficult to determine due to its location. Yellowstone Gulch flows within 150 feet of the lower end of the western tailings pile, but no bracketing of Yellowstone Gulch was done to determine possible impacts. It is likely that during spring melt and storm events, runoff from the site reaches Yellowstone Gulch. Tailings appear to be migrating downhill as evidenced by recent tree and vegetation kills. Some small areas of vegetation exist on the eastern pile, while both piles are covered with extensive deadfall. Few erosional features were noted on either tailing piles. Due to the small particle size and high concentrations of numerous leachable metals the Yellowstone Mill tailings have the potential for impacting the water quality within Yellowstone Gulch.

Figure 37. Yellowstone Mill looking down western pile

Reclamation Options
Reclamation of the Yellowstone Mill tailings could be most easily accomplished through the use of hydrologic controls. Some combination of run-on diversion ditches, mine waste consolidation, capping and revegetation could be implemented at the site. The large aerial extent of the tailings lends itself to consolidation at one or two locations which would reduce erosion and leaching. Tailings could be consolidated at the top of each pile (east and west), or at the top of the eastern pile with the use of a bulldozer. Once consolidated, the piles and the historic location of the piles could be amended, capped and revegetated to reduce leaching and establish a vegetation cover. A small amount of limestone would probably be needed based upon the low acidity of the waste material. Finally, run-on diversion ditches could be placed above the consolidated piles to divert overland flow away from the sites. Complete removal of the mill tailings is an option, but does not appear necessary based on the potential water quality impacts of the site.

Broker Lode

The Broker Lode is located on the east side of Yellowstone Gulch at N38° 00’ 45.9” W107° 27’ 57.7” at an elevation of 10,340 feet. The mine is accessed off the road to the Czar Mine immediately below the locked gate. The waste rock pile was samples as site #47.

Geology and Mine Workings
The Broker Lode is located in the Eureka Member (Tse) of the Sapinero Mesa Tuff. The vein developed by the mine strikes generally N10°W, and dips to the east between 60° and 80°. The vein appears to run perpendicular to the Lake City caldera, and is located well within an area of extensively hydrothermally altered rock associated with monzonitic intrusion. The vein as observed within the Excelsior Mine averages nine inches in width and is composed mainly of quartz, sphalerite, chalcopyrite and some galena.

The Broker Lode was mined through a shaft on vein. The mine workings connect with the Excelsior located downhill from the Broker. The connection was evidently done to allow ventilation of both contiguous mines. The size of the waste rock pile indicates that there are approximately 500 feet of drift and shaft workings. Records show that the connection with the Excelsior was at the main level of the Excelsior approximately 100-130 feet below the Broker. It is unknown whether the shaft extended below that level.

Mine Wastes
The waste rock pile contains approximately 1,000 cubic yards of waste rock. The toe of the waste rock pile is directly in an ephemeral drainage. There is minor erosion on the pile. Leachate results show this pile to be high in aluminum, cadmium, copper, manganese, lead, and zinc. Based upon the metals concentration in the leachate, the Broker ranked seventh out of 66 sites sampled and ranked 17th overall. The lower overall ranking was due to the lack of erosion by runoff and by the ephemeral stream channel. Installation of the shaft grate in 2002 may have resulted in repair of any historic erosion. Selected results from the leachate analysis are given below.

Broker Lode Waste Rock (Site #47)

pH s.u.	Total Acidity mg/l	Al ug/l	Cd ug/l	Cu ug/l	Fe ug/l	Mn ug/l	Pb ug/l	Zn ug/l
3.80	46	767	87.6	3,854	85	10,311	2,331	13,620

Water Quality Impacts
Water quality impacts from this site are thought to be minor. There is very little water from the slopes above that enters this site. The access road effectively acts as a run-on control. The major potential impact is from erosion of the waste by the ephemeral stream. However, there has been only minor erosion of the toe of the waste pile over the 100+ years since mining started.

Reclamation Options
The Broker waste rock pile is thought to be a minor source of metals. There are no signs of erosion into the ephemeral channel adjacent to the waste rock pile. However, if the Excelsior is reclaimed, it is recommended that the toe of the waste rock pile be removed and riprap armoring be placed at the toe of the pile.

Excelsior Lode MS. #5184

The Excelsior Lode is located on the east side of Yellowstone Gulch at N38° 00' 43.2" W107° 27' 58.3" at an elevation of 10,220 feet. The mine is accessed off the road to the Czar Mine. A spur road leads directly to the mine. The waste rock pile was sampled as site #48. The water quality of drainage from this site was planned to be sampled as site #CZ. However, there was no visible flow during the high-flow sampling. There had been flow two weeks prior to the sampling, but the all drainage was subsurface at the time of the first high-flow sampling. The remains of one structure is located near the backfilled mine adit.

Geology and Mine Workings

The geology associated with the Broker Lode is the same as that of the Excelsior Mine. The Excelsior was mined through a 100 foot crosscut to the vein. The mine workings connect with the Broker located uphill from the Excelsior. The connection was evidently done to allow ventilation of both contiguous mines. In 1911, the Excelsior had approximately 500 feet of workings along vein, including 160 vertical feet of stoping. The ore minerals are reported to be sphalerite with a good showing of chalcopyrite, some galena, and much pyrite.

Figure 38. View down the drainage below the Excelsior waste rock pile

Mine Wastes

The waste rock pile contains approximately 2,000 cubic yards of waste rock directly in an ephemeral stream channel (**Figures 38, 39**). The volume of the waste rock pile is difficult to estimate because of the irregular surface. The waste rock pile is directly in an ephemeral drainage. There is minor erosion of the pile, but this is likely from regrading of the pile during closure of the mine adit in 2002. Leachate results show this pile to be high in aluminum, cadmium, copper and zinc. Based upon the metals concentration in the leachate, the Excelsior ranked 4^{th} out of 66 sites sampled. Selected results from the leachate analysis are given below.

Excelsior Lode Waste Rock (Site #48)

pH s.u.	Total Acidity mg/l	Al ug/l	Cd ug/l	Cu ug/l	Fe ug/l	Mn ug/l	Pb ug/l	Zn ug/l
2.84	81	3,337	153	10,694	1,952	426	1,386	29,081

.

Figure 39. View of Ephemeral drainage above Excelsior with Broker waste rock pile in the background

Based upon the amount of sulfur in the leachate, the total acidity would be expected to be much higher than measured. This indicates that there is some buffering mineral such as calcite in the waste rock pile. Blockage of the ephemeral drainage has resulted in a large vegetation kill zone below the pile. The ephemeral drainage is devoid of any vegetation for over 1,000 feet and can be seen down to near the junction with Henson Creek near the Lucky Strike Mine.

Water Quality Impacts

There is no apparent mine drainage from the backfilled adit, although there may be a minor amount of seepage of water through fractures in the bedrock during spring snowmelt. Water quality impacts from this site are seasonal, occurring principally during spring snowmelt and summer thunderstorms. The small watershed that drains to the ephemeral channel blocked by the waste rock is well vegetated, so runoff during thunderstorms is probably minimal. However, it is evident that at some times of the year, water flows to Henson Creek as evidenced by the vegetation kill zone. Snowmelt on this south facing slope occurs early in the spring, before the peak flow in Henson Creek. This site may have a measureable effect on Henson Creek water quality during snowmelt. It is recommended that a water quality sample be collected during snowmelt in May to determine whether leaching of the waste pile is a significant problem.

Reclamation Options

The Excelsior waste rock pile is a seasonal source of heavy metals to Henson Creek. The recommended site reclamation is to remove the waste from the drainage, and dispose of the material in an excavated area on the slope west of the mine. As an alternative, the ephemeral stream channel can be routed around the mine waste pile. However, there will probably continue to be some leaching of the waste rock by subsurface water following the old flow path.

The stream channel below the waste rock pile probably contains considerable precipitated heavy metals that can be flushed by seasonal drainage and secondary sulfides that will lower the pH and dissolve heavy metals. To minimize the amount of dissolved metals entering Henson Creek, it is recommended that the vegetation kill zone be amended with ground limestone and revegetated.

Czar and Czarina Mines

The Czar Mine is located on the east side of Yellowstone Gulch. The site consists of two adits. The lower adit is located at N38° 00' 53.6" W107° 27' 53.3" at an elevation of 10,750 feet. The upper adit is located at N38° 00' 56.5" W107° 27' 51.8" at an elevation of 10,920 feet. The Czarina Mine is located on the east side of Yellowstone Gulch southwest of the Czar Mine. The site consists of two shafts. The lower shaft is located at N38° 00' 50.3" W107° 27' 58.9" at an elevation of 10,580 feet. The main or upper shaft is located at N38° 00' 52.4" W107° 28' 0.1" at an elevation of 10,550 feet. The Czar and Czarina waste piles were not sampled because they exhibited very few signs of water quality impacts.

Lucky Strike Mine

The Lucky Strike Mine is located north of the confluence of the North Fork of Henson Creek with the mainstem of Henson Creek, just to the north of the bridge that crosses over the North Fork of Henson Creek, within the historic town of Capitol City. The Lucky Strike Mine is visible from Engineer Pass Road where the road forks at the North Fork. The elevation of the Lucky Strike Mine is 9,720 feet. The coordinates of this location are N39° 0' 35.4", W107° 27' 56.9".

In general the water coming from the Lucky Strike Mine (DM-11) is less contaminated than the water in Henson Creek and the North Fork of Henson Creek. The flow from the site is also minimal, rendering the load as insignificant. The flow during both sampling events was .03 cfs. During high flow, the mine drainage had higher concentrations of copper, manganese, and sulfate, with a higher conductivity than the Henson Creek water at HC-6. The pH of the mine drainage was slightly less than Henson Creek but the alkalinity of the mine drainage was also higher, allowing for more buffering capacity. The aluminum, iron, and zinc of the mine drainage were all below detections limits during high flow.

During the low flow sampling event, the Lucky Strike Mine drainage had higher manganese and sulfate concentrations, along with higher conductivity and a slightly lower pH than Henson Creek. The alkalinity of the mine drainage was also higher, allowing for a greater buffering capacity. The iron, aluminum, copper, and zinc concentrations were all below detection limits.

The mine waste pile at this site ranked 56th out of 68 mine waste piles sampled. Hence, the recommended reclamation plan for this site is no action, due to the minimal amount of flow, generally clean nature of the water, and minimal impact of the mine waste pile.

HENSON CREEK BELOW CAPITOL CITY SITE DESCRIPTIONS

Mine sites in this area chosen for reclamation feasibility studies include: the Ocean Wave, the Red Rover Tunnel, the Four Aces Mine, the Pride of America Mine, the Risorgimento Mine, the Hidden Treasure mill tailings, and the Pelican Mine. Those mine sites will be discussed below.

The Vermont Mine, Little Casino Mine, Yellow Jacket Mine, Unnamed Owl Gulch Mine and Mountain Chief Mine were investigated and found to be minor sources of heavy metals. Those mine sites plus the Ute-Ule will be briefly discussed below.

Vermont Mine

This site is located in El Paso Creek at an elevation of 10,290 feet at N38° 0' 57.5" W107° 26' 21.7". The waste rock pile at this site is estimated to contain 9,000 cubic yards. The waste rock pile was sampled as site #50. This waste rock pile had moderate concentrations of heavy metals. The waste rock pile extends approximately 600 feet down a steep slope to El Paso Creek. There are undoubtedly impacts from erosion and leaching of the waste rock pile, but access to the site is by foot only. There are very few options for reclaiming this site. Overall, this waste rock pile ranked 26th out of 66 waste rock piles sampled.

Vermont Tunnel Draining Mine

The Vermont Tunnel is located in El Paso Creek, approximately 750 feet from the confluence of El Paso Creek and Henson Creek. Access is along Engineer Pass Road. The mine is located 250 feet off the road on the north side. The elevation of the site is 9,600 feet. The coordinate location is N38° 0' 53.1", W107° 26' 10.3".

The mine was sampled during the high flow sampling event on June 2, 2005, and due to lack of flow during the low flow sampling event, it was not sampled. The site is not bracketed within El Paso Creek. The El Paso Creek sampling location is downstream of the mine drainage input. El Paso Creek is bracketed by Henson Creek sampling sites HC-8 and HC-9. The flow out of the mine during high flow was .012 cfs.

The mine drainage from this mine does contain high levels of aluminum, cadmium, copper, lead, manganese, and zinc. The lead concentration of the mine drainage is 62 ug/L, and the El Paso Creek lead concentrations are below detections limits. The pH of the mine drainage is higher, with a value of 7.7, than the pH of the water in El Paso Creek. Although the concentrations of metals are high in the mine drainage, the minimal flow lessens the impacts seen in El Paso Creek, and lessens the impacts seen in Henson Creek. Since the site was not bracketed within El Paso Creek, it is difficult to determine whether the site is impacting the water quality within the tributary, but the minimal flow once again suggests that the impacts from the mine drainage are not great. The flow in El Paso Creek was 30.9 cfs in June, which is 2,500 times greater than the flow out of the draining mine.

The mine waste pile at this site was not sampled because it had been recently disturbed by the landowner. The mine workings at this site connect the Vermont shaft with the Vermont tunnel with approximately 2,000 horizontal feet of mine workings to the shaft and approximately 500 vertical feet. Although the mine waste was not sampled, the Henson Creek data at sites HC-8 and HC-9 suggest that the mine waste pile is not affecting Henson Creek. The recommended reclamation for this site is no action.

Little Casino Mine

This site is located between Big Casino and Copper Gulches on the south side of Henson Creek at an elevation of 9,700 feet at N38° 0' 38.0" W107° 25' 51.9". The waste rock pile at this site is estimated to contain 900 cubic yards. The waste rock pile was sampled as site #52. This waste rock pile had the highest lead concentration of all the waste piles sampled. Overall, this waste rock pile ranked 29th out of 66 waste rock piles sampled.

Four Aces Mine

The Four Aces Mine is located on the south side of Henson Creek between Big Casino Gulch and Copper Gulch at N38° 00’ 38.7” W107° 25’ 56.2” at an elevation of 9,650 feet. A road leads directly to the mine site. The waste rock pile was sampled as site #53. The apparent mine drainage was sampled as site DM-12.

Geology and Mine Workings
The Four Aces Mine developed a small set of fissure type veins located within the Eureka member (Tse) of the Sapinero Mesa Tuff along the margin of the collapsed Lake City caldera. The mine was accessed through a 5’ x 6’ adit on vein. The adit is currently open. Based upon the size of the waste rock pile, it is estimated that there are about 750 feet of mine workings. The most prevalent minerals on the waste rock pile are pyrite, galena, sphalerite and quartz.

Mine Wastes
The waste rock pile contains approximately 1,100 cubic yards of waste rock. There is some vegetation on the outslope of the waste pile where soil was pushed over and mixed with the waste rock during construction of the access road. Leachate results show this pile too high in cadmium and lead. Based upon the metals concentration in the leachate, the Four Aces ranked 16th out of 66 sites sampled and ranked 31st overall. Selected results from the leachate analysis are given below.

Four Aces Waste Rock (Site #53)

pH s.u.	Total Acidity mg/l	Al ug/l	Cd ug/l	Cu ug/l	Fe ug/l	Mn ug/l	Pb ug/l	Zn ug/l
3.84	38	85.1	80.7	48.7	160	679	6,317	9,810

Water Quality Impacts
The apparent mine drainage was sampled as site DM-12 during high-flow, but was not sampled during low-flow. There is a small stream of water from a spring above the adit that flows along the east side of the adit. It was unknown at the time how much of the water flowing from the collapse debris in front of the adit was from mine drainage and how much was from the spring above. Because of the collapse debris, the water flowing down the face of the adit flowed into the mine. Based upon the results of water quality analysis, it appears that most if not all of the water draining from this mine comes from the spring. All dissolved constituents except for zinc were below detection limits.

The drainage flows from the adit onto the waste rock pile, then quickly infiltrates. There are indications that the flow is larger than measured during some part of the year, because there is iron staining and an erosion channel along the flow path. The relatively clean water flowing onto the waste rock pile is probably the major impact from this site. The drainage surfaces as a seepage zone below the waste rock pile. In the absence of the drainage, the waste rock pile is thought to be a very minor source of heavy metals because it is located on a relatively dry slope far away from Henson Creek.

Reclamation Options
The only reclamation recommended for this site is to divert the drainage from the spring above by constructing a ditch around the waste rock pile. This can probably be accomplished by hand methods.

Pride of America Mine

The Pride of America Mine is located along the mainstem of Henson Creek, at an elevation of 9,950 feet. The mine is situated on a north-facing slope and is approximately 500 vertical feet above Henson Creek, and 1,000 horizontal feet from Henson Creek. The area consists of near vertical cliffs along the river, grading to extremely steep terrain comprised of talus and colluvium. Access is along Engineer Pass, and across the Big Casino Bridge. It is approximately three-fourths of a mile from the bridge to the mine site along a well-maintained four-wheel drive road. This site was bracketed by sampling site HC-9 and HC-10. The site was also bracketed within Big Casino Gulch, by BCG-1 and BCG-2. A sampling site was also taken at DM-14 – the Pride of America Mine drainage and the mine waste pile was sampled as site #56. Sampling sites BCG-1 and BCG-2 were difficult to obtain flows from because they flow through talus material. BCG-1 was sampled at both high and low flow, but BCG-2 was not sampled during low flow because the flow infiltrated into the talus and did not resurface until the cliffs just above Henson Creek. The flow at BCG-2 for low flow was approximated by the addition of BCG-1 and DM-14. The Pride of America Mine is located at N38° 0' 53.4, W107° 25' 37.7". The Pride of America Mine is located in an avalanche prone area that consists of steep talus slopes, vegetated slopes at the angle of repose, and bedrock cliffs. There is a lack of suitable topsoil materials on site and there is a lack of abundant space within the narrow Big Casino Gulch drainage. A small amount of space exists to the east of Big Casino Gulch, which has shallower slopes.

Geology and Mine Workings

The Pride of America Mine located within the Picayune megabreccia member (Tsm) of the Sapinero Mesa Tuff lies along the margin of the Lake City caldera. The mine develops at least two major fissure type veins, one that strikes east and dips 60° to the south, while the other strikes N45°E and dips likewise. The main vein, striking east, is roughly tangential to the collapsed margin of the Lake City caldera suggesting some possible association with development or collapse of the caldera structure, yet little widespread hydrothermal alteration is visible near the mine. Reports indicate that the major vein was approximately two feet wide and consisted of galena-freibergite ores. Previous owners of the mine indicated assays ranging from 200 to 412 ounces of silver per ton.

The mine workings at the Pride of America Mine consist of one shaft and two adits. The shaft and one adit have been safeguarded by the DMG and have grated closures on them. The shaft was sunk first to at least a depth of 60 feet and the adits were driven later. The Pride of America Mine was worked in the late 1800's into the early 1900's and then was reopened in the 1960's, at which point the two adits were driven. Mining continued through the late 1960's and then ceased. The two adits are most likely not connected to the shaft, because the shaft is water-filled at a depth of four feet below the collar, and the draining adit, DM-14, is lower in elevation than the shaft. The other collapsed adit below sampling site DM-14 is not draining (**Figure 40**).

Mine Waste

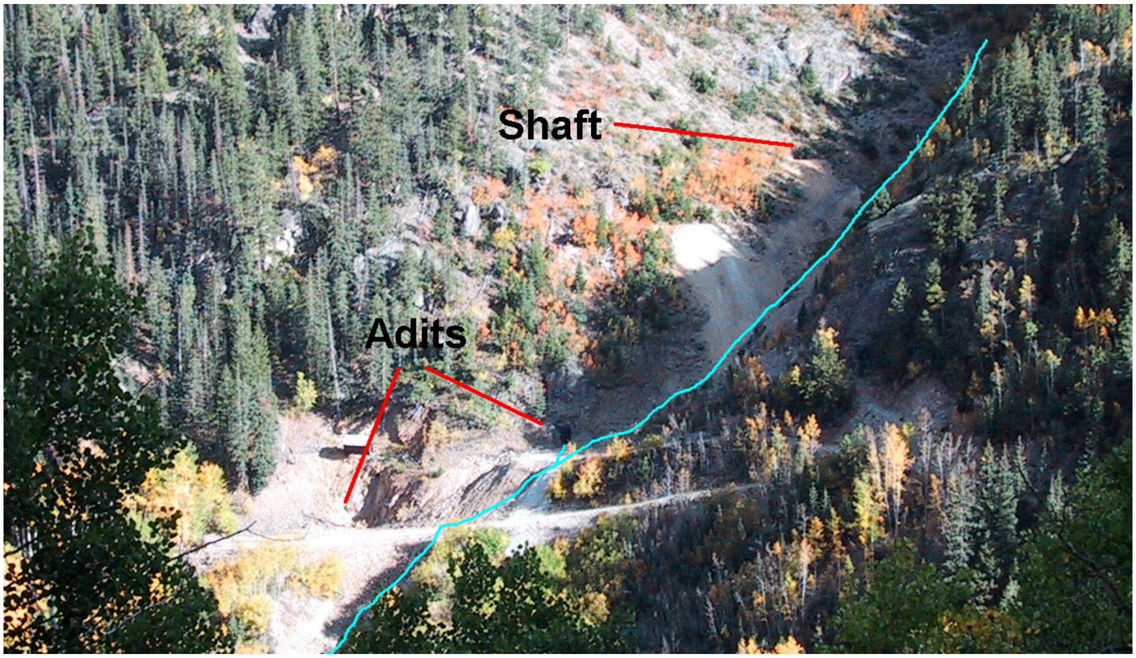
The waste rock pile contains approximately 2,700 cubic yards of material that is situated directly in Big Casino Gulch (**Figures 41 and 42**). There is major erosion of the mine waste pile due to the steep terrain of Big Casino Gulch. The mine waste pile has also been disturbed recently by prospecting using trenching methods and by the use of the road to the mine. Leachate results show this pile to be high in cadmium, manganese, lead, sulfate, and zinc. Based upon the metals concentration in the leachate and the physical characteristics of the mine waste, the Pride of America Mine ranked seventh out of 66 sites sampled. Selected results from the leachate analysis are given below.

Figure 40. Pride of America Mine Drainage and DMG Closure

Pride of America Mine Waste Pile (Site #56)

pH s.u.	Total Acidity mg/l	Al ug/l	Cd ug/l	Cu ug/l	Fe ug/l	Mn ug/l	Pb ug/l	Zn ug/l
2.07	74	13	392	124	7	4,192	1,828	22,942

Figure 41. Pride of America Mine Waste Piles - showing Big Casino Gulch and Mine Openings



Water Quality Impacts

The Pride of America Mine drainage has some of the highest concentrations of metals in all of the Henson Creek Watershed, but the flow is so minimal that the impacts from the drainage are not detectable within Henson Creek. The impacts of the mine drainage can be seen in Big Casino Gulch at BCG-2. Most of the metals concentrations increase from BCG-1 to BCG-2. There is a component of this increase, which can be attributed to the mine waste pile. The background water sampling location, BCG-1 does have inputs from other smaller mine workings located above DM-14.

The Pride of America Mine had the highest zinc concentration of any draining mine site during high and low flow, the second highest concentration of copper during low flow, after the Hough Mine drainage, and the highest concentration of cadmium during high and low flow sampling events.

Figure 42. Pride of America Mine Waste Pile Showing Location for an on-site repository

The total zinc concentration from the mine drainage during low flow was 21,500 ug/L, which was two orders of magnitude above the acute and chronic toxicity values for aquatic life. The zinc concentration just above the Pride of America Mine drainage at sampling site BCG-1 was 917 ug/L. Some of the total zinc seen at BCG-1 could be coming from seepage from the water-filled shaft. Because of the steep topography, sampling site BCG-1 was situated well below the shaft collar. The water quality at sampling site BCG-2, just below the DM-14 drainage, has a concentration of 2,060 ug/L. This increase in total zinc concentration from BCG-1 to BCG-2 indicates that the Pride of America Mine drainage affects the concentrations in Big Casino Gulch, but it also indicates that there is a background source for zinc above the Pride of America Mine drainage. The Henson Creek Headwaters and Palmetto Gulch Headwaters had zinc concentrations below detection limits, so we would have expected to see the Big Casino Gulch above the Pride of America Mine to have lower concentrations of metals, similar to headwaters type areas.

During high flow sampling, the total zinc concentration from BCG-1 to BCG-2 increases eight fold, and during low flow sampling, the total zinc concentration increases only two fold. The total zinc concentration increasing more during high flow sampling may indicate that the Pride of America Mine waste pile has a larger effect during high flow conditions, and the mine drainage effects Big Casino Gulch more during low flow.

Reclamation Options

The source of metals within Big Casino Gulch is the Pride of America Mine waste pile and the mine drainage. The mine drainage contributes less contamination to Big Casino Gulch than the mine waste pile. The flow from the adit is low during most of the year, so does not have a major effect on Henson Creek and should be a secondary priority after the mine waste pile.

The best reclamation option for the mine waste pile is relocation to an on-site repository out of the Big Casino Gulch drainage. There is a lack of suitable topsoil materials on site and there is a lack of abundant space within the narrow Big Casino Gulch. A small area exists to the east of the Pride of America which exhibits a more shallow slope where the mine waste could be relocated to, capped, and revegetated (**Figure 42**). The stream channel in Big Casino Gulch would then be restored and lined with riprap to slow down the turbulent flows of storm events and prevent erosion. After the mine waste pile is moved out of the drainage and capped and revegetated, the mine drainage could then be conveyed over to Big Casino Gulch. The metals could then attenuate as they flow through Big Casino Gulch, instead of flowing through waste rock.

For the mine drainage to be addressed, further investigations will have to be completed, including the investigation of underground source controls. The mine drainage could be treated by passing the relatively clean drainage from upstream through a limestone filled pond, then mixing the mine drainage with the high pH effluent in a settling pond. The pond would have to be constructed in the waste rock pile requiring a geosynthetic liner. Another alternative would be to install an anoxic limestone drain in the adit and precipitate the metals in a settling pond. Except for the possibility of source control, these options would require continual operation and maintenance.

Lellie Mine (Wave of the Ocean)

This site is located at N38° 0' 38.7" W107° 25' 56.2" in a steep, narrow ephemeral drainage north of Henson Creek approximately 1,800 feet east of El Paso Creek. The waste pile sampled as site #54 appears to be located on the Wave of the Ocean lode claim, but actually develops a vein located on the Lellie lode claim. A number of individual piles have coalesced to comprise the site. The waste pile is located at an elevation of 10,100 feet and can be accessed by an old mining road a few 100 yards east of El Paso Creek. The Lellie Minesite is covered with wood, metal and other mining related debris, but has no standing historic structures. The remains of a possible bunkhouse and blacksmith shop are located adjacent to the collapsed portal.

Geology and Mine Workings

The Lellie Mine worked a northeasterly trending vein system that dipped from 65°NW near the surface to 45°N at depth. The vein is referred to as the Lellie Vein and is described as a fissure type vein that varies in width from eight inches up to four feet. The vein is located in the Picayune Megabreccia Member (Tsm) of the Sapinero Mesa Tuff, which is a chaotic assemblage of precaldera rocks most likely related to slumping and weathering of the Uncompahgre-San Juan caldera walls.

As with many veins of the Henson Creek area the majority of high grade ore material was developed near the surface and died out with depth. The Lellie Mine was opened originally, by a crosscut adit (site #54) and shaft that accessed the upper portion of the vein. The crosscut adit was approximately 200 feet long and was driven N43°W, perpendicular to the strike of the vein. The Lellie Mine was also developed by a 1,140 feet crosscut located 500 feet below the upper crosscut, and is referred to as the Red Rover Tunnel. The lower and upper crosscuts are connected by a raise, which also develops at least three intermediate levels along the vein. The vein is classified as a Tetrahedrite-Rhodochrosite bearing vein, filled with quartz, rhodochrosite, barite, pyrite, galena, sphalerite and tetrahedrite, with some chalcopyrite (Irving and Bancroft, 1911). The silver was developed from argentiferous galena and tetrahedrite.

Mine Wastes

The mine waste sampled as site #54, is an aggregate of material located below the upper crosscut of the Lellie Mine. The waste pile is moderately steep (30°), and is approximately 200 feet x 200 feet with an average depth of 15 feet. The estimated volume of the waste pile is 22,000 cubic yards of fine to medium textured waste. The waste pile has some erosional features, but is located directly adjacent to an ephemeral or intermittent drainage. Much of the pile is well cemented with some areas of less cementation.

The observed mineralogy of the waste pile consisted of sphalerite, galena. pyrite and quartz. Selected leachate results from the mine waste piles are shown below, and indicate very high levels of lead, with high levels of zinc, manganese, copper and cadmium. Much of the waste is heavily oxidized with extensive limonitic staining.

Lellie Mine – Upper Crosscut (Site #54)

pH s.u.	Total Acidity mg/l	Al ug/l	Cd ug/l	Cu ug/l	Fe ug/l	Mn ug/l	Pb ug/l	Zn ug/l
3.63	66	359	54	3,235	119	2,823	6,343	6,872

Figure 43. Lellie Mine (Site #54) and adjacent drainage

Water Quality Impacts

Water quality impacts related to the Lellie Mine are probably limited to spring runoff and storm events. No water sampling was done above or below the mine since no water was flowing in the ephemeral drainage. Based on the waste rock leachate tests there is a high probability that during storm events and spring runoff, some metals loading to Henson Creek is occurring as a result of the Lellie Mine, but that loading is probably minimal and short in duration.

Reclamation Options

Construction of surface hydrologic controls is the recommended method for reclamation at the site. Access to the site will pose the biggest challenge to performing any reclamation activities. Currently the access is by an old mining road, which is very narrow and overgrown in many locations. If access can be achieved by heavy equipment then the eastern edge of the waste pile should be pulled back from the drainage and consolidated on the existing pile. Run-on controls above the waste pile could also be implemented to direct overland flow around the pile. Additional reclamation including amendment and revegetation is not necessary for water quality purposes, but could be performed by hand for aesthetic reasons if desired.

Red Rover Tunnel

The lower Red Rover Tunnel, also known as the Lellie is located on the Little Hattie Lode on the north side of Henson Creek across from Big Casino Gulch approximately 260 feet above Henson Creek. The bulkheaded adit is located at N38° 00' 59.6" W107° 25' 45.5" at an elevation of 9,650 feet. There is no equipment access to the mine because of the steep cliffs in the area. The waste rock pile at the lower tunnel was samples as site #55. The upper tunnel was not sampled. The remains of a historic structure are located near the mine adit, and the remains of a flume or tram system are located on the cliffs above this site.

Geology and Mine Workings

The geology associated with the Red Rover Tunnel is very similar to that of the Lellie Mine. The lower Red Rover Tunnel is a 1,140 foot long crosscut to the Vermont-Wave of the Ocean-Ocean Wave vein and the Lellie vein. A second 200-foot long tunnel, 500 feet above the lower tunnel, accessed the Lellie vein and was connected to the lower tunnel by a 500 foot raise. There were three intermediate levels between the two crosscut tunnels. In 1911, drifts had been driven on both tunnel levels for about 700 feet. The veins contain quartz, rhodochrosite, barite, pyrite, galena, sphalerite and tetrahedrite, with some chalcopyrite.

Mine Wastes

The waste rock pile contains approximately 16,000 cubic yards of waste rock. The waste rock pile is mostly country rock, but does contain sulfides, including galena, pyrite, tetrahedrite, and sphalerite along with some chalcopyrite. The western portion of the waste rock pile is in an ephemeral or intermittent drainage. A gully over 20 feet in depth has been cut through the waste rock (**Figure 44**).

Leachate results show this pile to have moderate levels of heavy metals, but a high sulfate content. The high sulfate content evidently comes from gypsum, since the pH of the leachate is relatively high and calcium concentration is similar to the sulfur concentration. Based upon the metals concentration in the leachate, the Red Rover Tunnel ranked 18th out of 66 sites sampled and ranked 22nd overall. Selected results from the leachate analysis are given below.

Red Rover Tunnel (Site #55)

pH s.u.	Total Acidity mg/l	Al ug/l	Cd ug/l	Cu ug/l	Fe ug/l	Mn ug/l	Pb ug/l	Zn ug/l
4.81	44	117	73.3	188	BDL	2,178	1,481	6,816

Figure 44. Red Rover Tunnel in lower right and Ocean Wave Mine in upper middle of picture

Water Quality Impacts

Water quality impacts from this site are seasonal. There is probably some leaching of the waste rock by spring snowmelt and summer thunderstorms, but the principal impact is erosion of waste rock into Henson Creek. Eroded waste rock is visible down to the Henson Creek road. This site is bracketed by water quality sampling sites HC-9 and HC-10. There were no significant increases in heavy metal concentrations between the sampling sites during high-flow and low-flow. The size of the drainage area indicates that there probably is some base flow following snowmelt, although there was no visible flow in early June of 2005 during the high-flow sampling. A flow of approximately ten gallons per minute was observed at the top of the waste rock pile in September of 2004, but there was no visible flow at the bottom of the pile.

Reclamation Options

The lack of access to this site severely reduces the options to reduce impacts from this site. As discussed above, the principle impact to Henson Creek is probably through waste rock erosion. To reduce erosion, some type of conveyance needs to be constructed from the top of the waste pile to the Henson Creek road. Possible options would include a culvert, or a concrete lined channel. Both options would require an energy dissipater at the bottom, and construction of thrust blocks to hold the conveyance on the steep slope. As an alternative, a sediment trap could be constructed at road level and maintained by the Hinsdale County Road Department.

Reclamation at this site should be considered a low priority, because of the high construction cost relative to the impact to Henson Creek. A water quality sample should be collected and analyzed when the drainage is flowing. Because the drainage is principally south facing, an early May sampling is recommended.

Owl Gulch Mine

This site is located approximately one mile south of Henson Creek on the west side of Owl Gulch at an elevation of 10,500 feet at N38° 0' 20.0" W107° 24' 25.2". The waste rock pile at this site is estimated to contain 700 cubic yards. The waste rock pile was sampled as site #57. This waste rock pile had very low heavy metal concentrations in the leachate. Overall, this waste rock pile ranked 54th out of 66 waste rock piles sampled. No reclamation is recommended for these waste piles at this time.

Yellow Jacket Mine

This site is located on the south side of Henson Creek west of the Owl Gulch confluence with Henson Creek. The mine site consists of two levels. There is no Mine drainage from this site. The lower level is at an elevation of 9,425 feet at N38° 1' 13.6" W107° 24' 21.8". The upper level is at an elevation of 9,500 feet at N38° 1' 15.4" W107° 24' 19.0". The lower waste rock pile, sampled as site #58, is estimated to contain 750 cubic yards and the upper pile, sampled as site #59 is estimated to contain 500 cubic yards. Both waste rock piles had low heavy metal concentrations in the leachate, but the lower pile had a low pH. Overall, the lower waste rock pile ranked 43rd and the upper waste rock pile ranked 62nd out of 66 waste rock piles sampled.

Mountain Chief Mine

This site is located on the south side of Henson Creek east of the Ute-Ule Mine, apparently on the same vein as the Pelican Mine. The mine site consists of two levels. There is no mine drainage from this site. The upper level is at an elevation of 9,200 feet at N38° 1' 15.5" W107° 20' 34.0". The lower level is at an elevation of 9,000 feet at N38° 1' 6.9" W107° 21' 2.0". The lower waste rock pile, sampled as site #62, is estimated to contain 1,200 cubic yards and the upper pile, sampled as site #63 is estimated to contain 1,500 cubic yards. Both waste rock piles had low heavy metal concentrations in the leachate, with the exception of manganese. Both waste rock piles were high in manganese concentrations. Overall, the lower waste rock pile ranked 34th and the upper waste rock pile ranked 40th out of 66 waste rock piles sampled. There currently is no reclamation recommended for this site.

Ute-Ule Mine

The Ute-Ule Mine was not investigated because of the exhaustive environmental assessment work that has been contracted out by the Bureau of Land Management. During high-flow, there were no major changes in Henson Creek heavy metal concentrations between the upstream and downstream sites. During low-flow, there was a large increase in manganese and zinc concentration and loading below the mine.

Hidden Treasure Tailings

The Hidden Treasure tailings pile is located near the junction of Alpine Gulch and Henson Creek. The mine is located on public lands managed by BLM. The tailings area is located approximately 2.5 miles west of Lake City, Colorado in Hinsdale County via CR-20 approximately one mile downstream from the Ute-Ule Mine/mill complex.   The Hidden Treasure tailings site (mine dump sample #60) is located at N38° 1' 7.536", W107° 21' 25.625", at an elevation of 8,910 feet. The site is bracketed between sample stations HC-15 and HC-16 subtracting the impacts from Alpine Gulch (station AG).

The Hidden Treasure mill was equipped with a 100 ton concentrating mill erected in 1898, a water driven compressor, and a 50 horsepower electric hoist. The mill was connected to the Hidden Treasure Mine with a 3,800 long, Bleichert wire-rope tram with twenty-five 450-500 pound buckets. The tram had a capacity of 12 tons per hour. The first ore was taken from the mine in June 1897 and was worked continuously until 1908. The mine associated with the mill had produced ore worth at least $700,00 by 1911 (Irving and Bancroft, 1911, p. 89).

Mine Waste
Located on the south side of Henson Creek, the predominate tailings pile associated with sample #60 is approximately 1,500 cubic yards in size. The area around the tailings contains additionally scattered amounts mixed among alluvial material. The tailings were once contained by wooden cribbing which has fallen over on the downstream side. Currently, the tailings are somewhat contained within a rock berm located approximately 50 feet from river bank right. The tailings are not in direct contact with Henson Creek flows although there are minor erosional features which bisect the area showing evidence of flows during high flow or storm events. Sparse grasses are present along the perimeter of the tailings pile. The Hidden Treasure tailings ranks the highest of all dumps sampled for manganese. The tailings also rank high in cadmium, lead and zinc. Previous sampling efforts performed by Harding ESE for the Bureau of Land Management showed concentrations in exceedance of PRG values at depths up to two feet. Depth of the main tailings could be up to four feet. Overall, the mill tailings ranked 13th out of 66 sites sampled. Leachate results from sample #60 follow.

Hidden Treasure Tailings (Site #60)

pH s.u.	Acidity mg/l	Diss Al ug/l	Diss As ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb Ug/l	Diss Zn ug/l
4.67	80	116.0	BDL	365.5	132.4	BDL	38469.1	4354.7	26528.6

Water Quality Impacts
As stated above, the first station downstream from the Hidden Treasure tailings location is HC-16. Due to extreme flows, high flow data was not obtained at this location. Impacts from the Hidden Treasure Tailings site seem to be insignificant compared to the loading which comes in from Alpine Gulch within this bracketed reach. Interestingly, manganese drops within this reach where dissolved concentrations from the leachate extraction are relatively high within the tailings.

Low-flow Dissolved Loading

Station	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
HC15	BDL	BDL	BDL	BDL	BDL	2959.62	3655.99
Alpine G	847.72	BDL	BDL	3281.300	BDL	311.41	173.00
HC16	BDL	BDL	BDL	BDL	BDL	3118.05	3579.98

Low-flow Total Loading

Station	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
HC15	16364.95	BDL	BDL	9459.17	BDL	3365.84	3772.06
Alpine G	12398.58	BDL	BDL	5201.64	BDL	311.40	149.94
HC16	26387.91	BDL	BDL	10393.48	BDL	3233.53	3695.46

Sample AG - Loading - High-flow

	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
Dissolved	BDL	BDL	BDL	BDL	BDL	3841.5	2211.8
Total	62628.2	BDL	BDL	32478.2	BDL	4190.7	1979.0

The increase in dissolved aluminum, iron and manganese loading between stations HC-15 and HC-16 could easily be attributed to Alpine Gulch during low-flow.

Reclamation Options
Due to the excessively high concentrations of manganese and to some extent, lead, cadmium and zinc, the tailings should be excavated out of the flood plain. There is very little on-site space to accommodate the tailings above the flood plain. A logical location for placement would be the BLM upper tailings location west of the Ute-Ule complex. Temporary road construction would be necessary to access Henson Creek. During the low-flow of Henson Creek, access to the Hidden Treasure tailings area could be easily reached with a variety of compact panel, military or other type of temporary bridge arrangements. Precautions would be essential for sediment control through the use of excelsior, straw and/or fabric fencing around the area to be impacted. Sediment pond construction may be necessary if the water table is intersected during excavation. Once all the tailings are excavated, revegetation should include riparian shrub species as well as future hedge brush layering with endemic willow species along streamside contact.

Risorgimento (Grand La Plata) Mine

The Risorgimento Mine is between the junction of Alpine Gulch and the town of Lake City. According to a mine map produced by Rehn and Carey, 1983, the main workings are actually the Grand La Plata Mine with the Risorgimento Mine positioned to the west on the Risorgimento MS. 17676 patented claim. Most of the mine is located on public lands managed by BLM. The mine is located approximately 0.3 miles downstream from the Hidden Treasure site, just over two miles west of Lake City, Colorado in Hinsdale County via CR20. The Risorgimento (Grand La Plata) Mine site (mine dump sample #61) is located at N38° 1' 6.837", W107° 21' 1.983", at an elevation of 8,860 feet. The site is bracketed between sample stations HC-16 and HC-17. The mine has several draining adits (station DM-15).

Geology and Mine Workings
The Risorgimento Mine is located within the Eureka member (Tse) of the Sapinero Mesa Tuff, a volcaniclastic sedimentary assemblage formed during collapse of the San Juan-Uncompahgre caldera complex. The mine appears to develop a vein that strikes generally N20°W and dips to the NW at 85°. The vein is a simple fissure type vein that varies in width from three inches to six inches. Hydrothermal alteration appears confined to the vein along with ore deposition.

The mine mapping produced by Rehn and Carey, 1983, show the Grand La Plata Mine having three levels. Contrary to mining classification, Rehn and Carey label tunnel #1 at the lowest portion of the workings which is at creek level. This was the location of the low-flow sampling for station DM-15. The workings associated with tunnel #1 extend over 250 feet in a southwest direction under tunnel #3 workings. tunnel #3 is 42 feet above the tunnel #1 workings. During high flow sampling tunnel #3 was sampled as DM-15.

Mine Waste
Mine waste from the Grand La Plata has been predominately overcast from the terrace above Henson Creek to stream level. A bench has been created over time from the mine waste. The waste pile is approximately 2,500 cubic yards in size. The area around the mine waste on the bench contains additionally scattered amounts of mine waste mixed with alluvial material. Currently, the mine waste is buffered from Henson Creek with a fairly dense population of willow. Mine waste could be in contact with Henson Creek during extreme high-flow events which flow over the bench. Mine waste sample #61 shows relatively high concentrations of aluminum, iron and manganese from the leachate tests. Behind the Hidden Treasure tailings, sample #61 ranks second of all dumps sampled for manganese. Overall, the waste rock ranked 14th of the 66 sites sampled. Leachate results from sample #61 follow.

Risorgimento Waste Rock (Site #61)

pH s.u.	Acidity mg/l	Diss Al ug/l	Diss As Ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb ug/l	Diss Zn ug/l
2.73	370	10612.3	BDL	50.2	1610.4	27776.2	13916.4	BDL	13103.6

Water Quality Impacts
As stated above, the site is bracketed by station HC-16 and HC-17. High flow data was not obtained at HC-16. Except for a slight increase in zinc, water quality improves between stations HC-16 and HC-17.

Low-flow Dissolved Loading

Station	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
HC16	BDL	BDL	BDL	BDL	BDL	3118.05	3579.98
DM15	BDL	BDL	BDL	BDL	BDL	2.13	1.67
HC17	BDL	BDL	BDL	BDL	BDL	2878.98	3995.31

Low-flow Total Loading

Station	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
HC16	26387.91	BDL	BDL	10393.48	BDL	3233.53	3695.46
DM15	BDL	BDL	BDL	BDL	BDL	2.10	1.62
HC17	24206.91	BDL	BDL	9812.02	BDL	3113.99	4582.86

Sample DM-15 - Loading

	Al g/day	Cd g/day	Cu g/day	Fe g/day	Pb g/day	Mn g/day	Zn g/day
Dissolved	BDL	BDL	BDL	BDL	BDL	3841.5	2211.8
Total	62628.2	BDL	BDL	32478.2	BDL	4190.7	1979.0

Reclamation Options

Due to the relatively high concentrations of aluminum, iron, manganese and to some extent, zinc, the mine waste should be excavated out of the flood plain. An alternative location for placement would be immediately to the south. Placement would require preparation work including tree, vegetation and soil removal prior to relocation. Sediment control measures would be needed through the use of excelsior, straw and/or fabric fencing along Henson Creek between the area to be excavated. Sediment pond construction may be necessary if the water table is intersected during excavation. After relocation of the waste, the pile would then be amended with limestone per acid/base calculations, covered with the previously excavated soils and revegetated. Drainage occurs out of the tunnel #3 adit. Waste under-drains would need to be constructed if placement was to impact this adit. Regardless, run-on controls would be constructed to divert upslope flows around the area to the northwest down the historic access route. Caution would be needed to maintain the relocation of mine waste well off of the Risorgimento patented claim to the west. Current access per historic road beyond the tunnel #3 location may be needed to be maintained. Construction access to the site across Henson Creek could be minimized under this option. Once all the mine waste was excavated, revegetation should include riparian shrub species as well as future hedge brush layering with endemic willow species along streamside contact.

Another option for re-locating the waste is for placement at the BLM upper tailings location west of the Ute-Ule complex. If this work was performed in concert with the removal of the Hidden Treasure tailings, unit costs would be competitive. Temporary road construction would be necessary to access the site as well as temporary crossing measures for Henson Creek. During the low-flow of Henson Creek, access to the area could be easily reached with a variety of compact panel, military or other type of temporary bridge arrangements. Sediment control measures would be needed through the use of excelsior, straw and/or fabric fencing along Henson Creek. Sediment pond construction may be necessary if the water table is intersected during excavation. Once all the mine waste was excavated, revegetation should include riparian shrub species as well as future hedge brush layering with endemic willow species along streamside contact.

Pelican Mine

The Pelican Mine is located approximately 2.0 miles west of Lake City, Colorado in Hinsdale County via CR-20. The Mine is on the Pelican MS. #464 and Pelican No. 1 MS. #1700A patented mining claims. The Pelican Mine site exhibits three levels of workings. There are piles of collapsed debris on the lower pile. A small ‘A’ frame structure is situated on the middle level at the base of the second waste pile. This is the location of the backfill closure within the Lake

City AML hazard abatement project in 1996. The backfilled adit is seeping with most of the water visible at the site coming from a spring which has been piped and directed into a 55 gallon drum structure. Sampling station DM-16 is located on this bench where flows were barely collected during the high-flow event. Within less than 100 feet downflow from the sampling location, the flow disappeared into the colluvial material. The site is located at N38° 1' 28.175", W107° 20' 22.646", at an elevation of 9,520 feet. The mine had three mine dump samples taken from each level #64, #65 and #66.

Geology and Mine Workings

The Pelican Mine, much like the Risorgimento, is driven entirely within the Eureka member (Tse) of the Sapinero Mesa Tuff. The mine develops a vein that strikes N30°E and dips to the SE at 70°. Reports indicate that extensive brecciation and replacement occurred along the vein, yet alteration appears confined to the fissure and local country rock.

The Pelican Mine produced silver ore intermittently from 1891 to 1960. The ore minerals apparently were freibergite (argentiferous tetrahedrite), pyragyrite and galena (Irving and Bancroft, 1911) contained in a three foot wide fissure type vein. Initial development was by a 50 foot deep shaft later accessed by a lower adit and drift.

Mine Waste

The upper mine waste pile at the Pelican Mine is predominately country rock with signs of calcite and manganese. Sample #66 was from this pile which contains approximately 700 cubic yards. The middle pile, sample #65 contains minor amounts of pyrite with predominately country rock. The middle pile contains approximately 1,700 cubic yards of waste. The lower pile (#64) is the largest waste pile containing approximately 7,000 cubic yards of mostly benign material consisting of country rock with minor amounts of pyrite. The intermittent drainage bisects the waste pile. As shown by the leachate results for the waste piles which follow, all three piles are not detrimental. Overall, waste pile #66 ranked 50th, #65 ranked 48th and #64 ranked 36th out of 66 sites sampled.

Pelican Mine Waste Dump Sample Concentrations

Sample #	pH s.u.	Acidity mg/l	Diss Al ug/l	Diss As ug/l	Diss Cd ug/l	Diss Cu ug/l	Diss Fe ug/l	Diss Mn ug/l	Diss Pb ug/l	Diss Zn ug/l
# 66	4.68	16	214.4	BDL	BDL	8.3	435.3	200.1	90.4	187.4
# 65	4.59	14	33.5	BDL	7.2	89.1	12.2	351.9	201.0	1038.6
# 64	4.44	26	42.2	BDL	13.3	15.2	18.4	2730.7	BDL	1917.1

Water Quality Impacts

As stated above, a high flow sample was taken from the draining adit and spring seep flows as station DM-16. Low flow data was not obtained due to very shallow standing seep water which exhibited extremely minor flow movement. As shown by the high-flow loading and the waste leachate results, this site is a minor source of heavy metals.

Reclamation Options

There are no reclamation recommendations for the Pelican Mine.

DM-18 - Draining Mine Below Pelican

This adit is located approximately one mile from the town of Lake City, on the north side of Engineer Pass Road behind a wooden fence storage area, owned by a local construction contractor. The elevation of the site is 8,800 feet. The coordinate location of this site is N38° 1' 20.1", W107° 19' 59.9".

The draining mine is bracketed by stream sampling locations HC-17 and HC-18. The effects of the draining mine cannot be seen in Henson Creek due to the minimal amount of flow. During high flow sampling, the flow out of the mine was .001 cfs. During low flow sampling the, the flow out of the mine was .002 cfs. The water from DM-18 is generally less contaminated than the water in Henson Creek at HC-18. The recommended reclamation is no action at this site, because the mine drainage is generally cleaner water than Henson Creek and the flows are minimal.

RECOMMENDATIONS FOR FURTHER INVESTIGATIONS

Several unanswered questions remain about some of the mining sites investigated. These issues were discussed in the narrative for each individual site in this report. In most cases, the unanswered question must be investigated prior to a final decision on the best reclamation option. In many cases, the answer to the question may simply involve a water sample, while in other cases, it may take additional work to better understand the site hydrology. For reference, these questions are consolidated and reviewed in Table 5 below.

CONCLUSIONS

Table 5. Summary of Reclamation Actions Recommended at This Time

Site	Recommended Action			
	Adit Discharge Reclamation	No Action at this time	Waste Rock Reclamation	Further Investigate
HEADWATERS AND BURROWS CREEK SITES				
Hough Mine	X		X	X
Sarah Woods Area			X	X
Miners Bank Mine			X	
Hoffman, Engineer and Emporer Wilhelm Mines		X		
Group of Dumps above Palmetto			X	X
Palmetto Mine			X	
Golconda Mine			X	X
Hanna Mill Tailings		Reclamation in Progress		
Yellowstone Mill Tailings			X	
Yellow Medicine Mine			X	
Mountain Belle Lode			X	
Broker Lode (Dump at gate below Czarina)		X		
Excelsior Lode			X	
Wave of the Ocean		X		
Red Rover Tunnel/Little Hattie Lode		X		
Pride of America Mine	X		X	X
Hidden Treasure Tailings			X	
Risorgimento Mine	X		X	
Roy Pray		Reclamation in Progress		X
Chicago Tunnel		X		
Vulcan Mine	X			X
Four Aces Mine		X		
Pelican Mine		X		

ANALYSIS OF RESULTS

Both natural and mining related metals loading affect water quality in Henson Creek. This investigation was designed to quantify the relative contribution of surface mine waste and mine portal discharge sources to Henson Creek. A simple model was used to provide some indication of the potential water quality improvement which might be expected if surface wastes and portal discharges were addressed. Because of the minimal loading measured in Henson Creek, this model was only used for Palmetto Gulch.

To do this, total zinc and manganese were selected as the parameters to be used to determine the relative percentage of metals loading that can be attributed to adit discharges. Manganese and zinc were chosen because they are found in all the adit discharges in Henson Creek, because there is a high correlation between manganese and zinc and other heavy metals of concern, and because it is a “conservative” metal, meaning that it is not readily precipitated. The assumption is that measured total load from the adit discharges will be approximately equal to the total manganese load measured in the stream below the sources if there are no natural manganese sources or inflows of mining impacted groundwater. In Palmetto Gulch, the percentages of the metal loading attributable to mining sources was similar using zinc and using manganese as the tracing parameters. During high-flow, zinc appeared to be more conservative while manganese appeared to be more conservative during low-flow.

Using this model, it was determined that a maximum of 35% and 6% of the zinc load measured at the mouth of Palmetto Gulch could be attributed to mining waste and draining mines respectively during high-flow. During low-flow, a maximum of 3% and 30% of the manganese load could be attributed to mining waste and draining mines, respectively. This indicates that the majority of the metal loading from Palmetto Gulch may be from natural sources. Further sampling would be required to ascertain whether water quality standards can be met if all the mining related sources are eliminated.

REFERENCES

A. Von Schulz,1883, Colorado Mining Directory and Mining Laws.

Bove, Dana J., Kurtz, Jeffrey P., Wright, Winfield G., 2002, Geology, Mineralization, and hydrothermal alteration and relationships to acidic and metal-bearing surface waters in the Palmetto Gulch area, southwestern Colorado: U.S. Geological Survey Open-File Report 02-275.

Bove, Dana J., Hon, Ken, Budding, Karin E., Slack, John F., Snee, Lawrence W., Yeoman, Ross A., 2001, Geochronology and geology of late Oligocene through Miocene volcanism and Mineralization in the Western San Juan Mountains, Colorado: U.S. Geological Survey Professional Paper 1642.

Burbank, Wilbur S., Luedke, Robert G., 1969, Geology and ore deposits of the Eureka and adjoining districts, San Juan Mountains, Colorado: U.S. Geological Survey Professional Paper 535, p. 5-43.

Hon, Ken, 1987, Geologic, alteration and vein maps of the Redcloud Peak (Lake City caldera) and Handies Peak Wilderness Study Areas, Hinsdale County, Colorado: U.S. Geological Survey Miscellaneous Field Studies Map MF-1949.

Irving, John Duer, Bancroft, Howland, 1911, Geology and ore deposits near Lake City, Colorado: U.S. Geological Survey Bulletin 478, p. 11-98.

Lee, Keenan, 1986, Map showing areas of limonitic hydrothermal alteration in the Lake City caldera area, western San Juan Mountains, Colorado: U.S. Geological Survey Miscellaneous Field Studies Map MF-1868.

Lipman, P. W., 1976, Geologic map of the Lake City caldera area, western San Juan Mountains, southwestern Colorado: U.S. Geological Survey Miscellaneous Investigations Map I-962, scale 1:48,000.

Luedke, Robert G., Burbank, Wilbur S., 1987, Geologic map of the Handies Peak Quadrangle, San Juan, Hinsdale and Ouray Counties, Colorado: U.S. Geological Survey Geologic Quadrangle Map GQ-1595.

Morse, M.Z., Bielser, F. 2000; A brief history of mining Hinsdale County: A compilation of information abut geology and Mineralogy; their relqation to the mining history of Colorado, Hinsdale County and Lake City, Colorado.

Sanford, Richard F, Kramer, Ann M, and O'Brien, Hugh, 1986; Geology, Mineralogy and paragenesis of the Pride of America Mine, Lake City, Hinsdale County, Colorado.

Sanford, R.F., Rehn, Patty, Kirk, A.R., Slack, J.F., Bove, Dana, 1991, Mine maps of silver-lead-zinc epithermal deposits in the Lake City area, Hinsdale County, San Juan Mountains, southwestern Colorado: U.S. Geological Survey Miscellaneous Field Studies Map MF 2152.

Stover, 2001.Report of Geologic Investigation – Roy Pray Mine, Hinsdale County, Colorado

APPENDIX 1

High-Flow Concentration Data

Site #	Description	Sample	Sample	Flow	Flow	Adjusted Flow	Diss. Al	Diss. As	Diss. Cd	Diss. Ca
		Date	Time	Time	cfs	cfs	ug/l	ug/l	ug/l	ug/l
HC-1	Henson Headwaters	6/29/2005	1115	1000	26.81	26.81	<100	<10	<1	8070
HC-1	Henson Headwaters	6/29/2005		1115	26.81	26.81				
HC-1	Henson Headwaters	6/29/2005		1315	30.24	30.24				
HC-2	Henson below Palmetto	6/29/2005	1145				<100	<10	<1	11100
HC-3	Henson below Redcloud	6/29/2005	1148	1500	69.02	56.8	<100	<10	<1	11900
HC-4	Henson below Schafer	6/29/2005	1100	1315	62.888	62.888	<100	<10	<1	12600
HC-4 DUP	Henson below Schafer	6/29/2005	1100	1315	62.888	62.888	<100	<10	<1	12500
HC-5	Henson above Hanna Mill	6/1/2005	1037	1200	150.34	150.34	<100	<10	<1	13100
HC-5	Henson above Hanna Mill	6/29/2005	1130	1045	135.27	135.27	<100	<10	<1	14000
HC-5	Henson above Hanna Mill	6/29/2005		1215	136.99	136.99				
HC-5	Henson above Hanna Mill	6/29/2005		1330	136.6	136.6				
HC-5	Henson above Hanna Mill	6/29/2005		1445	144.05	144.05				
HC-5 DUP	Henson above Hanna Mill	6/1/2005	1037	1200	150.34	150.34	<100	<10	<1	13100
HC-6	Henson above North Fork	6/1/2005	1008	1315	149.38	149.38	<100	<10	<1	13500
HC-7	Henson above Lee Smelter	6/1/2005		1425	327.033	327.033				
HC-7	Henson above Lee Smelter	6/1/2005	1000	1430	254.429	254.429	<100	<10	<1	13500
HC-8	Henson above Copper	6/1/2005	1050				<100	<10	<1	13600
HC-8	Henson above Copper	6/29/2005	1157	1250	184.087	184.087	<100	<10	<1	14400
HC-9	Henson above Big Casino	6/1/2005	1020	1300	305.004	305.004	<100	<10	<1	13700
HC-10	Henson below Big Casino Gulch	6/1/2005	1030				<100	<10	<1	13700
HC-10	Henson below Big Casino Gulch	6/29/2005	1230	1245	225.786	225.786	<100	<10	<1	13900
HC-11	Henson above Nellie and Owl Gulch	6/1/2005	1050	1100	316.692	316.692	<100	<10	<1	13600
HC-12	Henson above Ute-Ule Tailings	6/1/2005	1000				<100	<10	<1	13400
HC-12	Henson above Ute-Ule Tailings	6/29/2005	1135				<100	<10	<1	13300
HC-13	Henson below Ute-Ule Tailings	6/1/2005	1021				<100	<10	<1	13000
HC-13	Henson below Ute-Ule Tailings	6/29/2005	1125				<100	<10	<1	13400
HC-14	Henson below Ute-Ule	6/1/2005	1045				<100	<10	<1	13100
HC-15	Henson above Alpine	6/1/2005	1055	1045	352	352	<100	<10	<1	13000
HC-15	Henson above Alpine	6/29/2005	1145				238	<10	<1	13500
HC-16	Henson below Alpine	6/1/2005	1037				<100	<10	<1	13000
HC-16	Henson below Alpine	6/29/2005	1130				<100	<10	<1	13700

Site #	Description	Sample	Sample	Flow	Flow	Adjusted Flow	Diss. Al	Diss. As	Diss. Cd	Diss. Ca
		Date	Time	Time	cfs	cfs	ug/l	ug/l	ug/l	ug/l
HC-17	Henson Below Pelican	6/1/2005	1017		441	441	<100	<10	<1	12900
HC-17	Henson below Pelican	6/29/2005	1105	1355	268.095	268.095	<100	<10	<1	13600
HC-18	Henson above Lake Fork	6/1/2005		820	498.99	498.99				
HC-18	Henson above Lake Fork	6/1/2005	1000	1315	358.87	358.87	<100	<10	<1	13000
HC-18	Henson above Lake Fork	6/29/2005	1030	1030	355.751	355.751	<100	<10	<1	13600
SW	Sara Woods Dump Drainage	6/29/2005	1112	1130	0.0098	0.0098	224	<10	<1	5280
PG-1	Palmetto Gulch Headwaters	6/29/2005		1125	0.333	0.333				
PG-1	Palmetto Gulch Headwaters	6/29/2005		1205	0.333	0.333				
PG-1	Palmetto Gulch Headwaters	6/29/2005		1245	0.35	0.35				
PG-1	Palmetto Gulch Headwaters	6/29/2005	1115	1417	0.421	0.421	<100	<10	<1	30000
PG-1A	Runoff from Hough Dump	6/29/2005	1240	1325	0.1051	0.089	7630	<10	32	33600
PG-1B	Downstream of Hough Adit	6/29/2005	1240	1310	0.382743	0.336	828	<10	5	11600
PG-2	Palmetto below Sara Woods	6/29/2005	1115	1145	1.615	1.615	1420	<10	4	33700
PG-3	South Trib to Palmetto	6/29/2005	1125	1150	0.633	0.633	<100	<10	2	23300
PG-4	Palmetto Trib below Wyoming	6/29/2005	1100	1120	0.497007	0.497007	<100	<10	3	18400
PG-5	Below Confluence of PG-3 and PG-4	6/29/2005	1100	1150	2.765	2.765	<100	<10	2	21700
PG-6	Palmetto below Roy Pray	6/29/2005	1100	1135	2.239	2.239	2290	<10	6	31800
PG-6 DUP	Palmetto below Roy Pray	6/29/2005	1100	1135	2.239	2.239	2250	<10	6	31600
PG-7	Palmetto below Hough	6/29/2005	1140	1235	2.427	2.28	<100	<10	4	16400
PG-8	Palmetto below Palmetto Mine	6/29/2005	1115	1320	5.325	4.74	<100	<10	1	13600
PG-9	Palmetto below Tributary Confluence	6/29/2005	1105	1015	11.53	11.53	<100	<10	3	20700
PG-10	Palmetto above Henson	6/29/2005	1100	1040	9.94	9.94	<100	<10	2	19700
PG-10	Palmetto above Henson	6/29/2005		1150	10.17	10.17				
PG-10	Palmetto above Henson	6/29/2005		1345	13.02	13.02				
RC	Redcloud Gulch	6/29/2005	1157	1545	5.779	4.47	<100	<10	1	20300
SCG	Schafer Gulch	6/29/2005	1132	1415	18.831	16	<100	<10	<1	14100
NFHC-1	North Fork Henson Headwaters	6/1/2005	1025	1200	55.066	55.066	<100	<10	<1	7640
NFHC-1 DUP	North Fork Henson Headwaters	6/1/2005	1025	1200	55.066	55.066	<100	<10	<1	7660
NFHC-2	North Fork Henson above Yellowstone	6/1/2005	1000	1300	94.24	94.24	<100	<10	<1	11600
NFHC-3	North Fork Henson above Henson	6/1/2005	1000	915	115.38	115.38	<100	<10	<1	12200
NFHC-3	North Fork Henson above Henson	6/1/2005		1015	113.948	113.948				
NFHC-3	North Fork Henson above Henson	6/29/2005	1315	1500	93.609	93.609	<100	<10	<1	12400

Site #	Description	Sample	Sample	Flow	Flow	Adjusted Flow	Diss. Al	Diss. As	Diss. Cd	Diss. Ca
		Date	Time	Time	cfs	cfs	ug/l	ug/l	ug/l	ug/l
YG	Yellowstone Gulch	6/1/2005	1030	1030	0.477	0.477	<100	<10	2	23100
MHC	Matterhorn Creek	6/1/2005	1050	1130	37.005	37.005	<100	<10	<1	16100
LSG	Lee Smelter Gulch	6/1/2005	1015	1000	9.29	9.29	169	<10	<1	18800
EPC	El Paso Creek	6/1/2005	1108	1145	30.899	30.899	<100	<10	<1	9100
BCG-1	Big Casino Gulch above Pride of America	6/1/2005	1230	1230	0.045	0.045	<100	<10	2	15700
BCG-2	Big Casino Gulch below Pride of America	6/1/2005	1130	1130	0.08	0.08	<100	<10	16	15500
NC	Nellie Creek	6/1/2005	1055	1145	25.918	25.918	<100	<10	<1	5870
OG	Owl Gulch	6/1/2005	1002	1000	16.374	16.374	<100	<10	<1	15100
AG	Alpine Gulch	6/1/2005	1058	1003	47.58	47.58	<100	<10	<1	12300
DM-2	Wyoming Mine	6/28/2005	1240		0.0828	0.0828	<100	<10	<1	22000
DM-5	Palmetto Mine	6/28/2005	1330		0.00605	0.00605	<100	<10	<1	23700
DM-7	Chicago Tunnel	6/28/2005	1420		0.211968	0.211968	<100	<10	<1	50700
DM-7 DUP	Chicago Tunnel	6/28/2005	1430		0.211968	0.211968	<100	<10	<1	50500
DM-8	Highland Chief Mine	6/28/2005	1330		0.0722	0.0722	<100	<10	<1	32500
DM-9	Moro Tunnel	6/2/2005	1000		0.001	0.001	<100	<10	<1	91100
DM-10	Vulcan Mine	6/2/2005	1058		0.04	0.04	<100	<10	<1	101000
DM-11	Lucky Strike Mine	6/2/2005	1105		0.031	0.031	<100	<10	<1	309000
DM-11 DUP	Lucky Strike Mine	6/2/2005	1120		0.031	0.031	<100	<10	<1	310000
DM-12	Adit between Copper & Big Casino	6/2/2005	945		0.024	0.024	<100	<10	<1	34000
DM-14	Pride of America Mine	6/1/2005	1204	1200	0.067	0.067	<100	<10	65	16600
DM-16	Pelican Mine	6/2/2005	915		0.00125	0.00125	<100	<10	18	84100
DM-17	El Paso Gulch Draining Mine	6/2/2005	845		0.012	0.012	<100	<10	28	81800
DM-18	Brown Adit	6/2/2005	1110		0.00125	0.00125	<100	<10	<1	42500
BK-7	blank	6/1/2005	1500				<100	<10	<1	<200
BLK-1	blank	6/1/2005	1415				<100	<10	<1	<200
BLK-1	blank	6/29/2005	1207				<100	<10	<1	<200
BLK-2	blank	6/29/2005	1215				<100	<10	<1	<200

Site #	Description	Diss. Cu	Diss. Fe	Diss. Pb	Diss. Mg	Diss. Mn	Diss. Ni	Diss. K	Diss. Na	Diss. Zn
		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
HC-1	Henson Headwaters	<10	<200	<5	855	<4	<3	<1000	1140	<10
HC-1	Henson Headwaters									
HC-1	Henson Headwaters									
HC-2	Henson below Palmetto	12	<200	<5	1210	146	<3	<1000	1060	70
HC-3	Henson below Redcloud	12	<200	<5	1250	161	<3	<1000	1060	76
HC-4	Henson below Schafer	<10	<200	<5	1480	116	<3	<1000	925	94
HC-4 DUP	Henson below Schafer	<10	<200	<5	1490	115	<3	<1000	920	93
HC-5	Henson above Hanna Mill	<10	<200	<5	1170	6	<3	<1000	986	34
HC-5	Henson above Hanna Mill	<10	<200	<5	1300	26	<3	<1000	903	48
HC-5	Henson above Hanna Mill									
HC-5	Henson above Hanna Mill									
HC-5	Henson above Hanna Mill									
HC-5 DUP	Henson above Hanna Mill	<10	<200	<5	1180	6	<3	<1000	977	35
HC-6	Henson above North Fork	<10	<200	<5	1210	5	<3	<1000	1030	29
HC-7	Henson above Lee Smelter									
HC-7	Henson above Lee Smelter	<10	<200	<5	1520	14	<3	<1000	1610	17
HC-8	Henson above Copper	<10	<200	<5	1510	19	<3	<1000	1580	20
HC-8	Henson above Copper	<10	<200	<5	1640	28	<3	<1000	1560	25
HC-9	Henson above Big Casino	<10	<200	<5	1470	17	<3	<1000	1640	39
HC-10	Henson below Big Casino Gulch	<10	<200	<5	1480	16	<3	<1000	1650	20
HC-10	Henson below Big Casino Gulch	<10	<200	<5	1540	26	<3	<1000	1560	23
HC-11	Henson above Nellie and Owl Gulch	<10	<200	<5	1480	14	<3	<1000	1680	22
HC-12	Henson above Ute-Ule Tailings	<10	<200	<5	1420	12	<3	<1000	1740	31
HC-12	Henson above Ute-Ule Tailings	<10	<200	<5	1470	20	<3	<1000	1640	20
HC-13	Henson below Ute-Ule Tailings	<10	<200	<5	1410	11	<3	<1000	1720	16
HC-13	Henson below Ute-Ule Tailings	<10	<200	<5	1470	20	<3	<1000	1620	17
HC-14	Henson below Ute-Ule	<10	<200	<5	1410	14	<3	<1000	1730	22
HC-15	Henson above Alpine	<10	<200	<5	1410	13	<3	<1000	1810	40
HC-15	Henson above Alpine	<10	<200	<5	1480	28	<3	<1000	1640	30
HC-16	Henson below Alpine	<10	<200	<5	1460	15	<3	<1000	1740	20
HC-16	Henson below Alpine	<10	<200	<5	1540	22	<3	<1000	1700	23

Site #	Description	Diss. Cu	Diss. Fe	Diss. Pb	Diss. Mg	Diss. Mn	Diss. Ni	Diss. K	Diss. Na	Diss. Zn
		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
HC-17	Henson Below Pelican	<10	<200	<5	1450	14	<3	<1000	1740	34
HC-17	Henson below Pelican	<10	<200	<5	1540	22	<3	<1000	1660	24
HC-18	Henson above Lake Fork									
HC-18	Henson above Lake Fork	<10	<200	<5	1470	13	<3	<1000	1730	24
HC-18	Henson above Lake Fork	<10	<200	<5	1550	24	<3	<1000	1690	32
SW	Sara Woods Dump Drainage	12	<200	<5	532	88	3	<1000	<500	27
PG-1	Palmetto Gulch Headwaters									
PG-1	Palmetto Gulch Headwaters									
PG-1	Palmetto Gulch Headwaters									
PG-1	Palmetto Gulch Headwaters	<10	<200	<5	2930	5	<3	<1000	1310	<10
PG-1A	Runoff from Hough Dump	6410	991	<5	5820	1580	17	<1000	<500	3710
PG-1B	Downstream of Hough Adit	1600	1200	<5	1140	327	4	<1000	579	671
PG-2	Palmetto below Sara Woods	228	<200	<5	4420	1270	12	<1000	882	478
PG-3	South Trib to Palmetto	<10	<200	<5	1930	1070	4	<1000	886	434
PG-4	Palmetto Trib below Wyoming	<10	<200	<5	1130	88	<3	<1000	730	537
PG-5	Below Confluence of PG-3 and PG-4	<10	<200	<5	1650	623	3	<1000	840	387
PG-6	Palmetto below Roy Pray	200	383	<5	4880	1820	14	<1000	694	921
PG-6 DUP	Palmetto below Roy Pray	194	387	<5	4860	1810	15	<1000	680	905
PG-7	Palmetto below Hough	622	340	<5	1790	333	3	<1000	631	494
PG-8	Palmetto below Palmetto Mine	57	<200	<5	1520	108	<3	<1000	756	121
PG-9	Palmetto below Tributary Confluence	36	<200	<5	2450	678	5	<1000	782	386
PG-10	Palmetto above Henson	19	<200	<5	2240	592	4	<1000	801	304
PG-10	Palmetto above Henson									
PG-10	Palmetto above Henson									
RC	Redcloud Gulch	<10	<200	<5	1750	424	3	<1000	1160	206
SCG	Schafer Gulch	<10	<200	<5	2230	66	<3	<1000	<500	189
NFHC-1	North Fork Henson Headwaters	<10	<200	<5	890	<4	<3	<1000	2500	<10
NFHC-1 DUP	North Fork Henson Headwaters	<10	<200	<5	891	<4	<3	<1000	2500	<10
NFHC-2	North Fork Henson above Yellowstone	<10	<200	<5	1930	37	<3	<1000	2410	<10
NFHC-3	North Fork Henson above Henson	<10	<200	<5	1940	32	<3	<1000	2390	<10
NFHC-3	North Fork Henson above Henson									
NFHC-3	North Fork Henson above Henson	<10	<200	<5	1940	29	<3	<1000	2530	<10

Site #	Description	Diss. Cu	Diss. Fe	Diss. Pb	Diss. Mg	Diss. Mn	Diss. Ni	Diss. K	Diss. Na	Diss. Zn
		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
YG	Yellowstone Gulch	<10	<200	<5	2040	<4	<3	<1000	2690	308
MHC	Matterhorn Creek	<10	<200	<5	3440	107	<3	<1000	2270	13
LSG	Lee Smelter Gulch	<10	<200	<5	1810	202	<3	<1000	1140	66
EPC	El Paso Creek	<10	<200	<5	994	9	<3	<1000	2250	10
BCG-1	Big Casino Gulch above Pride of America	<10	<200	30	1040	<4	<3	<1000	1070	185
BCG-2	Big Casino Gulch below Pride of America	31	<200	40	1050	28	<3	<1000	1110	1620
NC	Nellie Creek	<10	<200	<5	852	<4	<3	1000	2710	<10
OG	Owl Gulch	<10	<200	<5	1040	<4	<3	<1000	914	<10
AG	Alpine Gulch	<10	<200	<5	1900	33	<3	<1000	1780	19
DM-2	Wyoming Mine	<10	<200	<5	1890	33	<3	<1000	<500	192
DM-5	Palmetto Mine	15	<200	<5	2980	144	<3	<1000	1030	122
DM-7	Chicago Tunnel	<10	<200	<5	4400	537	<3	1630	3020	195
DM-7 DUP	Chicago Tunnel	<10	<200	<5	4310	547	<3	1680	3030	197
DM-8	Highland Chief Mine	<10	<200	<5	1660	<4	<3	<1000	2600	34
DM-9	Moro Tunnel	<10	<200	<5	8200	475	<3	<1000	7660	<10
DM-10	Vulcan Mine	<10	907	<5	9480	802	<3	<1000	5310	51
DM-11	Lucky Strike Mine	21	<200	<5	6990	287	<3	<1000	11300	<10
DM-11 DUP	Lucky Strike Mine	21	<200	<5	6940	286	<3	<1000	11300	<10
DM-12	Adit between Copper & Big Casino	<10	<200	<5	1800	<4	<3	<1000	2350	18
DM-14	Pride of America Mine	55	<200	5	1150	306	<3	<1000	1260	7220
DM-16	Pelican Mine	<10	<200	<5	15200	130	<3	3100	22300	5870
DM-17	El Paso Gulch Draining Mine	191	<200	19	3600	1110	<3	1330	12600	2460
DM-18	Brown Adit	<10	<200	<5	5690	<4	<3	1460	9080	43
BK-7	blank	<10	<200	<5	<200	<4	<3	<1000	<500	<10
BLK-1	blank	<10	<200	<5	<200	<4	<3	<1000	<500	<10
BLK-1	blank	<10	<200	<5	<200	<4	<3	<1000	<500	<10
BLK-2	blank	<10	<200	<5	<200	<4	<3	<1000	<500	<10

Site #	Description	Tot. Al	Tot. As	Tot. Cd	Tot. Cu	Tot. Fe	Tot. Pb	Tot. Mg	Tot. Mn	Tot. Ni
		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l	ug/l	ug/l
HC-1	Henson Headwaters	100	<10	<1	<10	<200	<5	851	5	7
HC-1	Henson Headwaters									
HC-1	Henson Headwaters									
HC-2	Henson below Palmetto	397	<10	<1	30	334	<5	1240	152	<3
HC-3	Henson below Redcloud	403	<10	<1	27	329	<5	1300	178	<3
HC-4	Henson below Schafer	297	<10	<1	20	237	<5	1520	124	<3
HC-4 DUP	Henson below Schafer	288	<10	<1	21	234	<5	1530	125	<3
HC-5	Henson above Hanna Mill	207	<10	1	<10	<200	<5	1220	17	<3
HC-5	Henson above Hanna Mill	153	<10	<1	<10	<200	<5	1360	33	<3
HC-5	Henson above Hanna Mill									
HC-5	Henson above Hanna Mill									
HC-5	Henson above Hanna Mill									
HC-5 DUP	Henson above Hanna Mill	339	<10	<1	<10	284	<5	1270	25	<3
HC-6	Henson above North Fork	197	<10	1	<10	<200	<5	1250	15	<3
HC-7	Henson above Lee Smelter									
HC-7	Henson above Lee Smelter	347	<10	1	<10	241	<5	1540	23	<3
HC-8	Henson above Copper	400	<10	<1	<10	261	<5	1590	30	<3
HC-8	Henson above Copper	296	<10	<1	<10	<200	<5	1700	33	<3
HC-9	Henson above Big Casino	383	<10	<1	<10	253	<5	1520	28	<3
HC-10	Henson below Big Casino Gulch	410	<10	<1	<10	267	<5	1510	29	<3
HC-10	Henson below Big Casino Gulch	341	<10	<1	<10	<200	<5	1600	33	<3
HC-11	Henson above Nellie and Owl Gulch	348	<10	<1	<10	223	<5	1490	24	<3
HC-12	Henson above Ute-Ule Tailings	591	<10	<1	<10	405	<5	1520	32	<3
HC-12	Henson above Ute-Ule Tailings	315	<10	<1	<10	<200	<5	1530	27	<3
HC-13	Henson below Ute-Ule Tailings	486	<10	<1	<10	332	<5	1480	26	<3
HC-13	Henson below Ute-Ule Tailings	326	<10	<1	<10	<200	<5	1530	27	<3
HC-14	Henson below Ute-Ule	466	<10	<1	<10	302	<5	1490	30	<3
HC-15	Henson above Alpine	485	<10	<1	<10	345	5	1490	30	<3
HC-15	Henson above Alpine	<100	<10	<1	<10	<200	<5	1450	21	<3
HC-16	Henson below Alpine	381	<10	<1	<10	243	<5	1480	28	<3
HC-16	Henson below Alpine	304	<10	<1	<10	<200	<5	1530	29	<3

Site #	Description	Tot. Al	Tot. As	Tot. Cd	Tot. Cu	Tot. Fe	Tot. Pb	Tot. Mg	Tot. Mn	Tot. Ni
		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l	ug/l	ug/l
HC-17	Henson Below Pelican	512	<10	<1	<10	351	<5	1550	31	<3
HC-17	Henson below Pelican	353	<10	<1	<10	<200	<5	1580	31	<3
HC-18	Henson above Lake Fork									
HC-18	Henson above Lake Fork	566	<10	<1	<10	369	<5	1550	31	<3
HC-18	Henson above Lake Fork	320	<10	<1	<10	<200	<5	1540	28	<3
SW	Sara Woods Dump Drainage	342	<10	<1	11	<200	<5	565	92	<3
PG-1	Palmetto Gulch Headwaters									
PG-1	Palmetto Gulch Headwaters									
PG-1	Palmetto Gulch Headwaters									
PG-1	Palmetto Gulch Headwaters	<100	<10	<1	<10	<200	<5	2940	7	<3
PG-1A	Runoff from Hough Dump	13000	78	33	6740	11900	100	6740	1680	16
PG-1B	Downstream of Hough Adit	2560	105	6	1720	5480	19	1320	361	3
PG-2	Palmetto below Sara Woods	5120	<10	4	270	3160	<5	4550	1320	11
PG-3	South Trib to Palmetto	659	10	2	36	2430	<5	1910	1070	4
PG-4	Palmetto Trib below Wyoming	<100	<10	3	<10	231	<5	1130	90	<3
PG-5	Below Confluence of PG-3 and PG-4	415	<10	3	21	1500	<5	1710	651	<3
PG-6	Palmetto below Roy Pray	4510	<10	6	216	2540	<5	4970	1870	13
PG-6 DUP	Palmetto below Roy Pray	4420	<10	6	219	2570	<5	4990	1840	14
PG-7	Palmetto below Hough	2000	36	4	942	2060	<5	1840	331	5
PG-8	Palmetto below Palmetto Mine	497	10	1	191	507	<5	1550	114	<3
PG-9	Palmetto below Tributary Confluence	1420	<10	3	143	1190	<5	2400	679	6
PG-10	Palmetto above Henson	1170	<10	2	117	976	<5	2280	589	4
PG-10	Palmetto above Henson									
PG-10	Palmetto above Henson									
RC	Redcloud Gulch	223	<10	1	<10	<200	<5	1800	444	<3
SCG	Schafer Gulch	<100	<10	<1	<10	<200	<5	2270	71	<3
NFHC-1	North Fork Henson Headwaters	220	<10	6	<10	<200	<5	945	6	<3
NFHC-1 DUP	North Fork Henson Headwaters	289	<10	<1	<10	242	<5	948	8	<3
NFHC-2	North Fork Henson above Yellowstone	540	<10	<1	<10	340	<5	1990	45	<3
NFHC-3	North Fork Henson above Henson	581	<10	<1	<10	354	<5	1980	41	<3
NFHC-3	North Fork Henson above Henson									
NFHC-3	North Fork Henson above Henson	425	<10	<1	<10	259	<5	1980	34	<3

Site #	Description	Tot. Al	Tot. As	Tot. Cd	Tot. Cu	Tot. Fe	Tot. Pb	Tot. Mg	Tot. Mn	Tot. Ni
		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l	ug/l	ug/l
YG	Yellowstone Gulch	133	<10	2	<10	<200	<5	2070	4	<3
MHC	Matterhorn Creek	925	<10	1	<10	475	<5	3520	114	<3
LSG	Lee Smelter Gulch	1290	<10	<1	<10	<200	<5	1850	207	3
EPC	El Paso Creek	328	<10	<1	<10	<200	<5	1020	20	<3
BCG-1	Big Casino Gulch above Pride of America	154	<10	2	<10	<200	53	1070	7	<3
BCG-2	Big Casino Gulch below Pride of America	164	<10	15	37	<200	75	1040	29	<3
NC	Nellie Creek	287	<10	<1	<10	<200	<5	883	10	<3
OG	Owl Gulch	<100	<10	<1	<10	<200	<5	1050	<4	<3
AG	Alpine Gulch	538	<10	<1	<10	279	<5	1840	36	<3
DM-2	Wyoming Mine	<100	<10	<1	<10	289	<5	1930	44	<3
DM-5	Palmetto Mine	562	<10	<1	23	<200	<5	2980	162	<3
DM-7	Chicago Tunnel	<100	<10	<1	<10	1220	<5	4370	657	<3
DM-7 DUP	Chicago Tunnel	<100	<10	<1	<10	1260	<5	4320	677	<3
DM-8	Highland Chief Mine	<100	<10	<1	<10	<200	<5	1670	<4	<3
DM-9	Moro Tunnel	<100	<10	<1	<10	<200	<5	8160	713	<3
DM-10	Vulcan Mine	<100	<10	<1	<10	1010	<5	9430	788	<3
DM-11	Lucky Strike Mine	<100	<10	<1	17	<200	<5	7050	317	<3
DM-11 DUP	Lucky Strike Mine	<100	<10	<1	18	<200	<5	6960	301	<3
DM-12	Adit between Copper & Big Casino	<100	<10	<1	<10	<200	<5	1770	4	<3
DM-14	Pride of America Mine	417	<10	67	221	1280	49	1180	308	<3
DM-16	Pelican Mine	2460	<10	19	<10	1310	27	15400	468	<3
DM-17	El Paso Gulch Draining Mine	1090	<10	26	442	<200	62	3500	1060	<3
DM-18	Brown Adit	<100	<10	<1	<10	<200	<5	5670	<4	<3
BK-7	blank	<100	<10	<1	<10	<200	<5	<200	<4	<3
BLK-1	blank	<100	<10	<1	<10	<200	<5	<200	<4	<3
BLK-1	blank	<100	<10	<1	<10	<200	<5	<200	<4	<3
BLK-2	blank	<100	<10	<1	<10	<200	<5	<200	<4	<3

Site #	Description	Tot. K	Tot. Zn	SO4	Total Alkalinity	Cond.	pH
		ug/l	ug/l	mg/l	mg/l	umhos/cm	s.u.
HC-1	Henson Headwaters	<1000	11	5.3	22.8	65.5	7.89
HC-1	Henson Headwaters						
HC-1	Henson Headwaters						
HC-2	Henson below Palmetto	<1000	83	16.2	19.9	73.0	7.63
HC-3	Henson below Redcloud	<1000	89	18.9	20.1	78.1	7.53
HC-4	Henson below Schafer	<1000	102	22.4	17.9	83.8	7.47
HC-4 DUP	Henson below Schafer	<1000	102	22.5	17.8		
HC-5	Henson above Hanna Mill	<1000	43	16.4	23.2	76.8	7.56
HC-5	Henson above Hanna Mill	<1000	51	22.4	20.6	86.8	7.58
HC-5	Henson above Hanna Mill						
HC-5	Henson above Hanna Mill						
HC-5	Henson above Hanna Mill						
HC-5 DUP	Henson above Hanna Mill	<1000	45	16.4	23.2	77.8	7.57
HC-6	Henson above North Fork	<1000	47	17.1	23.2	80	7.53
HC-7	Henson above Lee Smelter						
HC-7	Henson above Lee Smelter	<1000	22	18.3	24.6	91	7.55
HC-8	Henson above Copper	<1000	25	19.5	24.1	107	7.55
HC-8	Henson above Copper	<1000	29	23.5	23.4	98.1	7.60
HC-9	Henson above Big Casino	<1000	29	19.4	24.2	102	7.56
HC-10	Henson below Big Casino Gulch	<1000	26	18.7	24.1	92.4	7.45
HC-10	Henson below Big Casino Gulch	<1000	28	23.3	22.8	98.1	7.31
HC-11	Henson above Nellie and Owl Gulch	<1000	24	18.5	24.8	101	7.58
HC-12	Henson above Ute-Ule Tailings	<1000	28	17.5	24.5	124	7.56
HC-12	Henson above Ute-Ule Tailings	<1000	23	21.7	22.9	93.6	7.56
HC-13	Henson below Ute-Ule Tailings	<1000	21	17.5	24.7	85.1	7.7
HC-13	Henson below Ute-Ule Tailings	<1000	24	21.7	23.1	93.2	7.64
HC-14	Henson below Ute-Ule	<1000	29	17.4	24.7	90.3	7.64
HC-15	Henson above Alpine	<1000	34	17.2	25.0	86.2	7.76
HC-15	Henson above Alpine	<1000	28	21.7	23.0	90.4	7.40
HC-16	Henson below Alpine	<1000	38	18.3	23.6	96.9	7.47
HC-16	Henson below Alpine	<1000	29	22.9	22.1	91.8	7.47
HC-17	Henson Below Pelican	<1000	34	18.1	23.7	103	7.58
HC-17	Henson below Pelican	<1000	31	22.7	22.1	93.2	7.63

Site #	Description	Tot. K	Tot. Zn	SO4	Total Alkalinity	Cond.	pH
		ug/l	ug/l	mg/l	mg/l	umhos/cm	s.u.
HC-18	Henson above Lake Fork						
HC-18	Henson above Lake Fork	<1000	30	18.3	23.6	97.8	7.5
HC-18	Henson above Lake Fork	<1000	33	22.5	22.2	92.6	7.52
SW	Sara Woods Dump Drainage	<1000	17	15.3	<5.00	42.8	6.09
PG-1	Palmetto Gulch Headwaters						
PG-1	Palmetto Gulch Headwaters						
PG-1	Palmetto Gulch Headwaters						
PG-1	Palmetto Gulch Headwaters	<1000	<10	52.9	38.3	189	7.05
PG-1A	Runoff from Hough Dump	2030	3720	163	<5.00	339	4.22
PG-1B	Downstream of Hough Adit	1590	657	43.8	<5.00	113	4.70
PG-2	Palmetto below Sara Woods	<1000	488	113	<5.00	247	5.02
PG-3	South Trib to Palmetto	<1000	421	64.8	6.62	163	6.12
PG-4	Palmetto Trib below Wyoming	<1000	519	44.1	9.66	122	6.65
PG-5	Below Confluence of PG-3 and PG-4	<1000	386	54.2	11.3	145	6.82
PG-6	Palmetto below Roy Pray	<1000	917	121	<5.00	258	4.93
PG-6 DUP	Palmetto below Roy Pray	<1000	917	121	<5.00		
PG-7	Palmetto below Hough	1180	475	41.2	10.4	116	6.26
PG-8	Palmetto below Palmetto Mine	<1000	134	24.5	19.0	93.6	7.13
PG-9	Palmetto below Tributary Confluence	<1000	394	57.3	9.49	148	6.86
PG-10	Palmetto above Henson	<1000	344	50.1	12.0	131	7.35
PG-10	Palmetto above Henson						
PG-10	Palmetto above Henson						
RC	Redcloud Gulch	<1000	209	45.7	16.2	135	7.34
SCG	Schafer Gulch	<1000	182	38.2	8.25	104	7.11
NFHC-1	North Fork Henson Headwaters	<1000	12	2.6	27.0	51	7.65
NFHC-1 DUP	North Fork Henson Headwaters	<1000	<10	2.6	27.2		
NFHC-2	North Fork Henson above Yellowstone	<1000	13	16.3	25.8	96.8	7.62
NFHC-3	North Fork Henson above Henson	<1000	18	16.7	26.9	87.7	7.74
NFHC-3	North Fork Henson above Henson						
NFHC-3	North Fork Henson above Henson	<1000	14	16.8	29.1	89.3	7.64
YG	Yellowstone Gulch	<1000	294	12.2	60.9	130	7.85
MHC	Matterhorn Creek	<1000	21	38.9	19.0	126	7.53
LSG	Lee Smelter Gulch	<1000	70	52.6	<5.00	129	6.41
EPC	El Paso Creek	<1000	13	9.7	23.2	62.7	7.66

Site #	Description	Tot. K	Tot. Zn	SO4	Total Alkalinity	Cond.	pH
		ug/l	ug/l	mg/l	mg/l	umhos/cm	s.u.
BCG-1	Big Casino Gulch above Pride of America	<1000	186	18.3	26.6	92.5	7.65
BCG-2	Big Casino Gulch below Pride of America	<1000	1460	20.6	25.4	97.3	7.47
NC	Nellie Creek	1050	<10	2.6	23.9	51.7	7.62
OG	Owl Gulch	<1000	<10	20.3	22.6	92	7.56
AG	Alpine Gulch	<1000	17	27.9	13.3	92	7.49
DM-2	Wyoming Mine	<1000	188	43.4	20.5	139	7.01
DM-5	Palmetto Mine	1070	127	53.3	20.2	165	6.86
DM-7	Chicago Tunnel	1690	195	83.5	78.3	315	7.05
DM-7 DUP	Chicago Tunnel	1720	204	83.7	78.3		
DM-8	Highland Chief Mine	<1000	37	27.5	70.1	193	7.68
DM-9	Moro Tunnel	<1000	<10	195	93.5	553	7.76
DM-10	Vulcan Mine	<1000	79	217	103	581	7.19
DM-11	Lucky Strike Mine	<1000	<10	818	98.1	1450	7.42
DM-11 DUP	Lucky Strike Mine	<1000	<10	820	98.1		
DM-12	Adit between Copper & Big Casino	<1000	17	41.6	54.8	189	7.65
DM-14	Pride of America Mine	<1000	7310	35.8	24.0	124	7.21
DM-16	Pelican Mine	4620	5590	189	156	612	7.38
DM-17	El Paso Gulch Draining Mine	1240	2550	172	93.8	478	7.7
DM-18	Brown Adit	1550	51	14.2	138	274	7.93
BK-7	blank	<1000	<10	<1.0	<5.00		
BLK-1	blank	<1000	16	<1.0	<5.00		
BLK-1	blank	<1000	<10	<1.0	<5.00		
BLK-2	blank	<1000	<10	<1.0	<5.00		

APPENDIX 2

High-Flow Loading Data

Site #	Description	Sample	Sample	Flow	Flow	Adjusted Flow	Diss. Al	Diss. As	Diss. Cd
		Date	Time	Time	cfs	cfs	g/day	g/day	g/day
HC-1	Henson Headwaters	6/29/2005	1115	1000	26.81	26.81	BDL	BDL	BDL
HC-2	Henson below Palmetto	6/29/2005	1145				No Data	No Data	No Data
HC-3	Henson below Redcloud	6/29/2005	1148	1500	69.02	56.8	BDL	BDL	BDL
HC-4	Henson below Schafer	6/29/2005	1100	1315	62.888	62.888	BDL	BDL	BDL
HC-4 DUP	Henson below Schafer	6/29/2005	1100	1315	62.888	62.888	BDL	BDL	BDL
HC-5	Henson above Hanna Mill	6/1/2005	1037	1200	150.34	150.34	BDL	BDL	BDL
HC-5	Henson above Hanna Mill	6/29/2005	1130	1045	135.27	135.27	BDL	BDL	BDL
HC-5 DUP	Henson above Hanna Mill	6/1/2005	1037	1200	150.34	150.34	BDL	BDL	BDL
HC-6	Henson above North Fork	6/1/2005	1008	1315	149.38	149.38	BDL	BDL	BDL
HC-7	Henson above Lee Smelter	6/1/2005	1000	1430	254.429	254.429	BDL	BDL	BDL
HC-8	Henson above Copper	6/1/2005	1050				No Data	No Data	No Data
HC-8	Henson above Copper	6/29/2005	1157	1250	184.087	184.087	BDL	BDL	BDL
HC-9	Henson above Big Casino	6/1/2005	1020	1300	305.004	305.004	BDL	BDL	BDL
HC-10	Henson below Big Casino Gulch	6/1/2005	1030				No Data	No Data	No Data
HC-10	Henson below Big Casino Gulch	6/29/2005	1230	1245	225.786	225.786	BDL	BDL	BDL
HC-11	Henson above Nellie and Owl Gulch	6/1/2005	1050	1100	316.692	316.692	BDL	BDL	BDL
HC-15	Henson above Alpine	6/1/2005	1055	1045	352	352	BDL	BDL	BDL
HC-17	Henson Below Pelican	6/1/2005	1017		441	441	BDL	BDL	BDL
HC-17	Henson below Pelican	6/29/2005	1105	1355	268.095	268.095	BDL	BDL	BDL
HC-18	Henson above Lake Fork	6/1/2005	1000	1315	358.87	358.87	BDL	BDL	BDL
HC-18	Henson above Lake Fork	6/29/2005	1030	1030	355.751	355.751	BDL	BDL	BDL
SW	Sara Woods Dump Drainage	6/29/2005	1112	1130	0.0098	0.0098	5.371	BDL	BDL
PG-1	Palmetto Gulch Headwaters	6/29/2005	1115	1417	0.421	0.421	BDL	BDL	BDL
PG-1A	Runoff from Hough Dump	6/29/2005	1240	1325	0.1051	0.089	1661.413	BDL	6.968
PG-1B	Downstream of Hough Adit	6/29/2005	1240	1310	0.382743	0.336	680.664	BDL	4.110
PG-2	Palmetto below Sara Woods	6/29/2005	1115	1145	1.615	1.615	5610.788	BDL	15.805
PG-3	South Trib to Palmetto	6/29/2005	1125	1150	0.633	0.633	BDL	BDL	1.549
PG-4	Palmetto Trib below Wyoming	6/29/2005	1100	1120	0.497007	0.497007	BDL	BDL	3.648
PG-5	Below Confluence of PG-3 and PG-4	6/29/2005	1100	1150	2.765	2.765	BDL	BDL	13.530
PG-6	Palmetto below Roy Pray	6/29/2005	1100	1135	2.239	2.239	12544.477	BDL	32.868
PG-6 DUP	Palmetto below Roy Pray	6/29/2005	1100	1135	2.239	2.239	12325.359	BDL	32.868
PG-7	Palmetto below Hough	6/29/2005	1140	1235	2.427	2.28	BDL	BDL	22.313
PG-8	Palmetto below Palmetto Mine	6/29/2005	1115	1320	5.325	4.74	BDL	BDL	11.597

Site #	Description	Sample	Sample	Flow	Flow	Adjusted Flow	Diss. Al	Diss. As	Diss. Cd
		Date	Time	Time	cfs	cfs	g/day	g/day	g/day
PG-9	Palmetto below Tributary Confluence	6/29/2005	1105	1015	11.53	11.53	BDL	BDL	84.628
PG-10	Palmetto above Henson	6/29/2005	1100	1040	9.94	9.94	BDL	BDL	48.638
RC	Redcloud Gulch	6/29/2005	1157	1545	5.779	4.47	BDL	BDL	10.936
SCG	Schafer Gulch	6/29/2005	1132	1415	18.831	16	BDL	BDL	BDL
NFHC-1	North Fork Henson Headwaters	6/1/2005	1025	1200	55.066	55.066	BDL	BDL	BDL
NFHC-1 DUP	North Fork Henson Headwaters	6/1/2005	1025	1200	55.066	55.066	BDL	BDL	BDL
NFHC-2	North Fork Henson above Yellowstone	6/1/2005	1000	1300	94.24	94.24	BDL	BDL	BDL
NFHC-3	North Fork Henson above Henson	6/1/2005	1000	915	115.38	115.38	BDL	BDL	BDL
NFHC-3	North Fork Henson above Henson	6/29/2005	1315	1500	93.609	93.609	BDL	BDL	BDL
YG	Yellowstone Gulch	6/1/2005	1030	1030	0.477	0.477	BDL	BDL	2.334
MHC	Matterhorn Creek	6/1/2005	1050	1130	37.005	37.005	BDL	BDL	BDL
LSG	Lee Smelter Gulch	6/1/2005	1015	1000	9.29	9.29	BDL	BDL	BDL
EPC	El Paso Creek	6/1/2005	1108	1145	30.899	30.899	BDL	BDL	BDL
BCG-1	Big Casino Gulch above Pride of America	6/1/2005	1230	1230	0.045	0.045	BDL	BDL	0.220
BCG-2	Big Casino Gulch below Pride of America	6/1/2005	1130	1130	0.08	0.08	BDL	BDL	3.132
NC	Nellie Creek	6/1/2005	1055	1145	25.918	25.918	BDL	BDL	BDL
OG	Owl Gulch	6/1/2005	1002	1000	16.374	16.374	BDL	BDL	BDL
AG	Alpine Gulch	6/1/2005	1058	1003	47.58	47.58	BDL	BDL	BDL
DM-2	Wyoming Mine	6/28/2005	1240		0.0828	0.0828	BDL	BDL	BDL
DM-5	Palmetto Mine	6/28/2005	1330		0.00605	0.00605	BDL	BDL	BDL
DM-7	Chicago Tunnel	6/28/2005	1420		0.211968	0.211968	BDL	BDL	BDL
DM-7 DUP	Chicago Tunnel	6/28/2005	1430		0.211968	0.211968	BDL	BDL	BDL
DM-8	Highland Chief Mine	6/28/2005	1330		0.0722	0.0722	BDL	BDL	BDL
DM-9	Moro Tunnel	6/2/2005	1000		0.001	0.001	BDL	BDL	BDL
DM-10	Vulcan Mine	6/2/2005	1058		0.04	0.04	BDL	BDL	BDL
DM-11	Lucky Strike Mine	6/2/2005	1105		0.031	0.031	BDL	BDL	BDL
DM-11 DUP	Lucky Strike Mine	6/2/2005	1120		0.031	0.031	BDL	BDL	BDL
DM-12	Adit between Copper & Big Casino	6/2/2005	945		0.024	0.024	BDL	BDL	BDL
DM-14	Pride of America Mine	6/1/2005	1204	1200	0.067	0.067	BDL	BDL	10.655
DM-16	Pelican Mine	6/2/2005	915		0.00125	0.00125	BDL	BDL	0.055
DM-17	El Paso Gulch Draining Mine	6/2/2005	845		0.012	0.012	BDL	BDL	0.822
DM-18	Brown Adit	6/2/2005	1110		0.00125	0.00125	BDL	BDL	BDL

Site #	Description	Diss. Ca	Diss. Cu	Diss. Fe	Diss. Pb	Diss. Mg	Diss. Mn	Diss. Ni	Diss. K
		g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day
HC-1	Henson Headwaters	529,338	BDL	BDL	BDL	56,082.3	BDL	BDL	BDL
HC-2	Henson below Palmetto	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
HC-3	Henson below Redcloud	1,653,706	1,667.6	BDL	BDL	173,708.6	22,373.7	BDL	BDL
HC-4	Henson below Schafer	1,938,658	BDL	BDL	BDL	227,715.4	17,848.0	BDL	BDL
HC-4 DUP	Henson below Schafer	1,923,272	BDL	BDL	BDL	229,254.1	17,694.1	BDL	BDL
HC-5	Henson above Hanna Mill	4,818,466	BDL	BDL	BDL	430,351.6	2,206.9	BDL	BDL
HC-5	Henson above Hanna Mill	4,633,322	BDL	BDL	BDL	430,237.1	8,604.7	BDL	BDL
HC-5	Henson above Hanna Mill	7,692,658	BDL	BDL	BDL	1,332,478.2	361,738.1	BDL	BDL
HC-5 DUP	Henson above Hanna Mill	4,818,466	BDL	BDL	BDL	434,029.8	2,206.9	BDL	BDL
HC-6	Henson above North Fork	4,933,887	BDL	BDL	BDL	442,222.5	1,827.4	BDL	BDL
HC-7	Henson above Lee Smelter	8,403,561	BDL	BDL	BDL	946,178.7	8,714.8	BDL	BDL
HC-8	Henson above Copper	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
HC-8	Henson above Copper	6,485,576	BDL	BDL	BDL	738,635.1	12,610.8	BDL	BDL
HC-9	Henson above Big Casino	10,223,252	BDL	BDL	BDL	1,096,947.5	12,685.8	BDL	BDL
HC-10	Henson below Big Casino Gulch	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
HC-10	Henson below Big Casino Gulch	7,678,472	BDL	BDL	BDL	850,708.4	14,362.6	BDL	BDL
HC-11	Henson above Nellie and Owl Gulch	10,537,534	BDL	BDL	BDL	1,146,731.6	10,847.5	BDL	BDL
HC-15	Henson above Alpine	11,195,642	BDL	BDL	BDL	1,214,296.5	11,195.6	BDL	BDL
HC-17	Henson Below Pelican	13,918,463	BDL	BDL	BDL	1,564,478.4	15,105.3	BDL	BDL
HC-17	Henson below Pelican	8,920,529	BDL	BDL	BDL	1,010,118.7	14,430.3	BDL	BDL
HC-18	Henson above Lake Fork	11,414,147	BDL	BDL	BDL	1,290,676.7	11,414.1	BDL	BDL
HC-18	Henson above Lake Fork	11,837,173	BDL	BDL	BDL	1,349,089.6	20,889.1	BDL	BDL
SW	Sara Woods Dump Drainage	127	0.3	BDL	BDL	12.8	2.1	0.1	BDL
PG-1	Palmetto Gulch Headwaters	2,314,651	BDL	BDL	BDL	362,130.9	5,413.3	BDL	BDL
PG-1	Palmetto Gulch Headwaters	30,901	BDL	BDL	BDL	3,018.0	5.2	BDL	BDL
PG-1A	Runoff from Hough Dump	7,316	1,395.8	215.8	BDL	1,267.3	344.0	3.7	BDL
PG-1B	Downstream of Hough Adit	9,536	1,315.3	986.5	BDL	937.1	268.8	3.3	BDL
PG-2	Palmetto below Sara Woods	133,157	900.9	BDL	BDL	17,464.6	5,018.1	47.4	BDL
PG-3	South Trib to Palmetto	18,042	BDL	BDL	BDL	1,494.5	828.6	3.1	BDL
PG-4	Palmetto Trib below Wyoming	22,374	BDL	BDL	BDL	1,374.1	107.0	BDL	BDL
PG-5	Below Confluence of PG-3 and PG-4	146,797	BDL	BDL	BDL	11,162.0	4,214.5	20.3	BDL
PG-6	Palmetto below Roy Pray	174,198	1,095.6	2,098.1	BDL	26,732.3	9,969.8	76.7	BDL

Site #	Description	Diss. Ca	Diss. Cu	Diss. Fe	Diss. Pb	Diss. Mg	Diss. Mn	Diss. Ni	Diss. K
		g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day
PG-6 DUP	Palmetto below Roy Pray	173,103	1,062.7	2,120.0	BDL	26,622.8	9,915.1	82.2	BDL
PG-7	Palmetto below Hough	91,483	3,469.7	1,896.6	BDL	9,985.1	1,857.6	16.7	BDL
PG-8	Palmetto below Palmetto Mine	157,718	661.0	BDL	BDL	17,627.3	1,252.5	BDL	BDL
PG-9	Palmetto below Tributary Confluence	583,932	1,015.5	BDL	BDL	69,112.8	19,125.9	141.0	BDL
PG-10	Palmetto above Henson	479,088	462.1	BDL	BDL	54,475.0	14,397.0	97.3	BDL
RC	Redcloud Gulch	222,007	BDL	BDL	BDL	19,138.5	4,637.0	32.8	BDL
SCG	Schafer Gulch	551,953	BDL	BDL	BDL	87,294.7	2,583.6	BDL	BDL
NFHC-1	North Fork Henson Headwaters	1,029,295	BDL	BDL	BDL	119,904.8	BDL	BDL	BDL
NFHC-1 DUP	North Fork Henson Headwaters	1,031,989	BDL	BDL	BDL	120,039.5	BDL	BDL	BDL
NFHC-2	North Fork Henson above Yellowstone	2,674,584	BDL	BDL	BDL	444,995.4	8,531.0	BDL	BDL
NFHC-3	North Fork Henson above Henson	3,443,922	BDL	BDL	BDL	547,640.1	9,033.2	BDL	BDL
NFHC-3	North Fork Henson above Henson	2,839,895	BDL	BDL	BDL	444,306.1	6,641.7	BDL	BDL
YG	Yellowstone Gulch	26,958	BDL	BDL	BDL	2,380.7	BDL	BDL	BDL
MHC	Matterhorn Creek	1,457,637	BDL	BDL	BDL	311,445.3	9,687.4	BDL	BDL
LSG	Lee Smelter Gulch	427,304	BDL	BDL	BDL	41,139.3	4,591.2	68.2	BDL
EPC	El Paso Creek	687,937	BDL	BDL	BDL	75,143.9	680.4	BDL	BDL
BCG-1	Big Casino Gulch above Pride of America	1,729	BDL	BDL	3.3	114.5	BDL	BDL	BDL
BCG-2	Big Casino Gulch below Pride of America	3,034	6.1	BDL	7.8	205.5	5.5	BDL	BDL
NC	Nellie Creek	372,222	BDL	BDL	BDL	54,026.2	BDL	BDL	63,411.0
OG	Owl Gulch	604,915	BDL	BDL	BDL	41,663.1	BDL	BDL	BDL
AG	Alpine Gulch	1,431,834	BDL	BDL	BDL	221,177.5	3,841.5	BDL	BDL
DM-2	Wyoming Mine	4,457	BDL	BDL	BDL	382.9	6.7	BDL	BDL
DM-5	Palmetto Mine	351	0.2	BDL	BDL	44.1	2.1	BDL	BDL
DM-7	Chicago Tunnel	26,293	BDL	BDL	BDL	2,281.8	278.5	BDL	845.3
DM-7 DUP	Chicago Tunnel	26,189	BDL	BDL	BDL	2,235.2	283.7	BDL	871.2
DM-8	Highland Chief Mine	5,741	BDL	BDL	BDL	293.2	BDL	BDL	BDL
DM-9	Moro Tunnel	223	BDL	BDL	BDL	20.1	1.2	BDL	BDL
DM-10	Vulcan Mine	9,884	BDL	88.8	BDL	927.8	78.5	BDL	BDL
DM-11	Lucky Strike Mine	23,436	1.6	BDL	BDL	530.2	21.8	BDL	BDL
DM-11 DUP	Lucky Strike Mine	23,512	1.6	BDL	BDL	526.4	21.7	BDL	BDL
DM-12	Adit between Copper & Big Casino	1,996	BDL	BDL	BDL	105.7	BDL	BDL	BDL

Site #	Description	Diss. Ca	Diss. Cu	Diss. Fe	Diss. Pb	Diss. Mg	Diss. Mn	Diss. Ni	Diss. K
		g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day
DM-14	Pride of America Mine	2,721	9.0	BDL	0.8	188.5	50.2	BDL	BDL
DM-16	Pelican Mine	257	BDL	BDL	BDL	46.5	0.4	BDL	9.5
DM-17	El Paso Gulch Draining Mine	2,402	5.6	BDL	0.6	105.7	32.6	BDL	39.0
DM-18	Brown Adit	130	BDL	BDL	BDL	17.4	BDL	BDL	4.5

Site #	Description	Diss. Na	Diss. Zn	Tot. Al	Tot. As	Tot. Cd	Tot. Cu	Tot. Fe	Tot. Pb
		g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day
HC-1	Henson Headwaters	74,776.4	BDL	6,559.3	BDL	BDL	BDL	BDL	BDL
HC-2	Henson below Palmetto	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
HC-3	Henson below Redcloud	147,304.9	10,561.5	56,003.7	BDL	BDL	3,752.1	45,720.1	BDL
HC-4	Henson below Schafer	142,322.1	14,463.0	45,696.9	BDL	BDL	3,077.2	36,465.2	BDL
HC-4 DUP	Henson below Schafer	141,552.8	14,309.1	44,312.2	BDL	BDL	3,231.1	36,003.7	BDL
HC-5	Henson above Hanna Mill	362,672.3	12,505.9	76,139.1	BDL	367.8	BDL	BDL	BDL
HC-5	Henson above Hanna Mill	298,849.3	15,885.7	50,635.6	BDL	BDL	BDL	BDL	BDL
HC-5 DUP	Henson above Hanna Mill	359,361.9	12,873.8	124,691.6	BDL	BDL	BDL	104,461.4	BDL
HC-6	Henson above North Fork	376,437.3	10,598.7	71,998.2	BDL	365.5	BDL	BDL	BDL
HC-7	Henson above Lee Smelter	1,002,202.4	10,582.3	216,002.6	BDL	622.5	BDL	150,019.1	BDL
HC-8	Henson above Copper	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
HC-8	Henson above Copper	702,604.1	11,259.7	133,314.6	BDL	BDL	BDL	BDL	BDL
HC-9	Henson above Big Casino	1,223,805.4	29,102.7	285,803.3	BDL	BDL	BDL	188,794.4	BDL
HC-10	Henson below Big Casino Gulch	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
HC-10	Henson below Big Casino Gulch	861,756.5	12,705.4	188,371.1	BDL	BDL	BDL	BDL	BDL
HC-11	Henson above Nellie and Owl Gulch	1,301,695.3	17,046.0	269,636.9	BDL	BDL	BDL	172,784.6	BDL
HC-15	Henson above Alpine	1,558,777.8	34,448.1	417,683.6	BDL	BDL	BDL	297,115.1	4,306.0
HC-17	Henson Below Pelican	1,877,374.0	36,684.3	552,422.7	BDL	BDL	BDL	378,711.7	5,394.8
HC-17	Henson below Pelican	1,088,829.2	15,742.1	231,540.2	BDL	BDL	BDL	BDL	BDL
HC-18	Henson above Lake Fork	1,518,959.6	21,072.3	496,954.4	BDL	BDL	BDL	323,986.2	BDL
HC-18	Henson above Lake Fork	1,470,942.9	27,852.2	278,521.7	BDL	BDL	BDL	BDL	BDL
SW	Sara Woods Dump Drainage	BDL	0.6	8.2	BDL	BDL	0.3	BDL	BDL
PG-1	Palmetto Gulch Headwaters	472,263.5	BDL!	79,332.8	BDL	BDL	BDL	BDL	BDL
PG-1	Palmetto Gulch Headwaters	1,349.3	BDL	BDL	BDL	BDL	BDL	BDL	BDL
PG-1A	Runoff from Hough Dump	BDL	807.8	2,830.7	17.0	7.2	1,467.6	2,591.2	21.8
PG-1B	Downstream of Hough Adit	476.0	551.6	2,104.5	86.3	4.9	1,413.9	4,504.9	15.6
PG-2	Palmetto below Sara Woods	3,485.0	1,888.7	20,230.4	BDL	15.8	1,066.8	12,486.0	BDL
PG-3	South Trib to Palmetto	686.1	336.1	510.3	7.7	1.5	27.9	1,881.7	BDL
PG-4	Palmetto Trib below Wyoming	887.7	653.0	BDL	BDL	3.6	BDL	280.9	BDL
PG-5	Below Confluence of PG-3 and PG-4	5,682.5	2,618.0	2,807.4	BDL	20.3	142.1	10,147.3	BDL
PG-6	Palmetto below Roy Pray	3,801.7	5,045.2	24,705.5	BDL	32.9	1,183.2	13,914.0	BDL
PG-6 DUP	Palmetto below Roy Pray	3,725.0	4,957.5	24,212.5	BDL	32.9	1,199.7	14,078.3	BDL
PG-7	Palmetto below Hough	3,519.9	2,755.7	11,156.5	200.8	22.3	5,254.7	11,491.2	BDL

Site #	Description	Diss. Na	Diss. Zn	Tot. Al	Tot. As	Tot. Cd	Tot. Cu	Tot. Fe	Tot. Pb
		g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day
PG-8	Palmetto below Palmetto Mine	8,767.2	1,403.2	5,763.7	116.0	11.6	2,215.0	5,879.6	BDL
PG-9	Palmetto below Tributary Confluence	22,059.7	10,888.8	40,057.2	BDL	84.6	4,033.9	33,569.1	BDL
PG-10	Palmetto above Henson	19,479.7	7,393.0	28,453.5	BDL	48.6	2,845.3	23,735.5	BDL
RC	Redcloud Gulch	12,686.1	2,252.9	2,438.8	BDL	10.9	BDL	BDL	BDL
SCG	Schafer Gulch	BDL	7,398.5	BDL	BDL	BDL	BDL	BDL	BDL
NFHC-1	North Fork Henson Headwaters	336,811.2	BDL	29,639.4	BDL	808.3	BDL	BDL	BDL
NFHC-1 DUP	North Fork Henson Headwaters	336,811.2	BDL	38,935.4	BDL	BDL	BDL	32,603.3	BDL
NFHC-2	North Fork Henson above Yellowstone	555,667.9	BDL	124,506.5	BDL	BDL	BDL	78,393.0	BDL
NFHC-3	North Fork Henson above Henson	674,670.0	BDL	164,009.7	BDL	BDL	BDL	99,930.2	BDL
NFHC-3	North Fork Henson above Henson	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NFHC-3	North Fork Henson above Henson	579,430.2	BDL	97,335.1	BDL	BDL	BDL	59,317.2	BDL
YG	Yellowstone Gulch	3,139.3	359.4	155.2	BDL	2.3	BDL	BDL	BDL
MHC	Matterhorn Creek	205,517.7	1,177.0	83,746.2	BDL	90.5	BDL	43,004.8	BDL
LSG	Lee Smelter Gulch	25,911.0	1,500.1	29,320.3	BDL	BDL	BDL	BDL	BDL
EPC	El Paso Creek	170,094.4	756.0	24,796.0	BDL	BDL	BDL	BDL	BDL
BCG-1	Big Casino Gulch above Pride of America	117.8	20.4	17.0	BDL	0.2	BDL	BDL	5.8
BCG-2	Big Casino Gulch below Pride of America	217.3	317.1	32.1	BDL	2.9	7.2	BDL	14.7
NC	Nellie Creek	171,843.8	BDL	18,199.0	BDL	BDL	BDL	BDL	BDL
OG	Owl Gulch	36,615.4	BDL	BDL	BDL	BDL	BDL	BDL	BDL
AG	Alpine Gulch	207,208.4	2,211.8	62,628.2	BDL	BDL	BDL	32,478.2	BDL
DM-2	Wyoming Mine	BDL	38.9	BDL	BDL	BDL	BDL	58.5	BDL
DM-5	Palmetto Mine	15.2	1.8	8.3	BDL	BDL	0.3	BDL	BDL
DM-7	Chicago Tunnel	1,566.2	101.1	BDL	BDL	BDL	BDL	632.7	BDL
DM-7 DUP	Chicago Tunnel	1,571.4	102.2	BDL	BDL	BDL	BDL	653.4	BDL
DM-8	Highland Chief Mine	459.3	6.0	BDL	BDL	BDL	BDL	BDL	BDL
DM-9	Moro Tunnel	18.7	BDL	BDL	BDL	BDL	BDL	BDL	BDL
DM-10	Vulcan Mine	519.7	5.0	BDL	BDL	BDL	BDL	98.8	BDL
DM-11	Lucky Strike Mine	857.0	BDL	BDL	BDL	BDL	1.3	BDL	BDL
DM-11 DUP	Lucky Strike Mine	857.0	BDL	BDL	BDL	BDL	1.4	BDL	BDL
DM-12	Adit between Copper & Big Casino	138.0	1.1	BDL	BDL	BDL	BDL	BDL	BDL
DM-14	Pride of America Mine	206.5	1,183.5	68.4	BDL	11.0	36.2	209.8	8.0
DM-16	Pelican Mine	68.2	18.0	7.5	BDL	0.1	BDL	4.0	0.1
DM-17	El Paso Gulch Draining Mine	369.9	72.2	32.0	BDL	0.8	13.0	BDL	1.8
DM-18	Brown Adit	27.8	0.1	BDL	BDL	BDL	BDL	BDL	BDL

Site #	Description	Tot. Mg	Tot. Mn	Tot. Ni	Tot. K	Tot.Zn	SO4	Total Alkalinity
		g/day	g/day	g/day	g/day	g/day	g/day	g/day
HC-1	Henson Headwaters	55,819,937.4	328.0	459.2	BDL	721.5	347,644.7	1,495,528.3
HC-2	Henson below Palmetto	No Data	No Data	No Data	No Data	No Data	No Data	No Data
HC-3	Henson below Redcloud	180,656,944.0	24,736.1	BDL	BDL	12,368.1	2,626,474.0	2,793,234.3
HC-4	Henson below Schafer	233,869,906.8	19,078.9	BDL	BDL	15,693.9	3,446,503.9	2,754,125.9
HC-4 DUP	Henson below Schafer	235,408,524.6	19,232.7	BDL	BDL	15,693.9	3,461,890.1	2,738,739.7
HC-5	Henson above Hanna Mill	448,742,649.7	6,253.0	BDL	BDL	15,816.3	6,032,278.2	8,533,466.8
HC-5	Henson above Hanna Mill	450,094,151.5	10,921.4	BDL	BDL	16,878.5	7,413,315.4	6,817,602.6
HC-5 DUP	Henson above Hanna Mill	467,133,741.9	9,195.5	BDL	BDL	16,552.0	6,032,278.2	8,533,466.8
HC-6	Henson above North Fork	456,841,385.0	5,482.1	BDL	BDL	17,177.2	6,249,590.1	8,478,976.1
HC-7	Henson above Lee Smelter	958,628,426.8	14,317.2	BDL	BDL	13,694.7	11,391,493.6	15,313,155.4
HC-8	Henson above Copper	No Data	No Data	No Data	No Data	No Data	No Data	No Data
HC-8	Henson above Copper	765,658,332.1	14,862.8	BDL	BDL	13,061.2	10,584,100.5	10,539,061.7
HC-9	Henson above Big Casino	1,134,258,635.3	20,894.2	BDL	BDL	21,640.5	14,476,722.1	18,058,591.4
HC-10	Henson below Big Casino Gulch	No Data	No Data	No Data	No Data	No Data	No Data	No Data
HC-10	Henson below Big Casino Gulch	883,852,844.2	18,229.5	BDL	BDL	15,467.4	12,871,107.0	12,594,903.0
HC-11	Henson above Nellie and Owl Gulch	1,154,479,784.3	18,595.6	BDL	BDL	18,595.6	14,334,145.0	19,215,502.5
HC-15	Henson above Alpine	1,283,192,768.0	25,836.1	BDL	BDL	29,280.9	14,812,695.0	21,530,080.0
HC-17	Henson Below Pelican	1,672,373,430.0	33,447.5	BDL	BDL	36,684.3	19,529,005.9	25,571,129.2
HC-17	Henson below Pelican	1,036,355,538.7	20,333.6	BDL	BDL	20,333.6	14,889,411.9	14,495,859.1
HC-18	Henson above Lake Fork	1,360,917,580.1	27,218.4	BDL	BDL	26,340.3	16,067,607.6	20,721,067.7
HC-18	Henson above Lake Fork	1,340,385,810.8	24,370.7	BDL	BDL	28,722.6	19,583,558.9	19,322,444.8
SW	Sara Woods Dump Drainage	13,546.8	2.2	BDL	BDL	0.4	366.8	BDL
PG-1	Palmetto Gulch Headwaters	369,597,500.9	6,346.6	BDL	BDL	BDL	3,135,978.8	5,431,963.3
PG-1	Palmetto Gulch Headwaters	3,028,254.7	7.2	BDL	BDL	BDL	54,488.0	39,449.7
PG-1A	Runoff from Hough Dump	1,467,617.5	365.8	3.5	442.0	810.0	35,492.8	BDL
PG-1B	Downstream of Hough Adit	1,085,116.0	296.8	2.5	1,307.1	540.1	36,006.1	BDL
PG-2	Palmetto below Sara Woods	17,978,228.5	5,215.7	43.5	BDL	1,928.2	446,492.3	BDL
PG-3	South Trib to Palmetto	1,479,006.4	828.6	3.1	BDL	326.0	50,177.8	5,126.2
PG-4	Palmetto Trib below Wyoming	1,374,054.4	109.4	BDL	BDL	631.1	53,624.6	11,746.3
PG-5	Below Confluence of PG-3 and PG-4	11,567,891.8	4,403.9	BDL	BDL	2,611.2	366,654.8	76,442.8
PG-6	Palmetto below Roy Pray	27,225,348.9	10,243.7	71.2	BDL	5,023.3	662,830.4	BDL
PG-6 DUP	Palmetto below Roy Pray	27,334,907.6	10,079.4	76.7	BDL	5,023.3	662,830.4	BDL
PG-7	Palmetto below Hough	10,263,976.3	1,846.4	27.9	6,582.3	2,649.7	229,823.8	58,013.8

Site #	Description	Tot. Mg	Tot. Mn	Tot. Ni	Tot. K	Tot.Zn	SO4	Total Alkalinity
		g/day	g/day	g/day	g/day	g/day	g/day	g/day
PG-8	Palmetto below Palmetto Mine	17,975,170.2	1,322.0	BDL	BDL	1,554.0	284,123.7	220,340.8
PG-9	Palmetto below Tributary Confluence	67,702,315.2	19,154.1	169.3	BDL	11,114.5	1,616,392.8	267,706.2
PG-10	Palmetto above Henson	55,447,785.1	14,324.0	97.3	BDL	8,365.8	1,218,392.1	291,830.4
RC	Redcloud Gulch	19,685,343.6	4,855.7	BDL	BDL	2,285.7	499,789.0	177,168.1
SCG	Schafer Gulch	88,860,512.0	2,779.3	BDL	BDL	7,124.5	1,495,361.9	322,951.2
NFHC-1	North Fork Henson Headwaters	127,314,629.4	808.3	BDL	BDL	1,616.7	350,283.6	3,637,560.8
NFHC-1 DUP	North Fork Henson Headwaters	127,718,802.9	1,077.8	BDL	BDL	BDL	350,283.6	3,664,505.7
NFHC-2	North Fork Henson above Yellowstone	458,829,492.2	10,375.5	BDL	BDL	2,997.4	3,758,251.6	5,948,643.7
NFHC-3	North Fork Henson above Henson	558,931,641.8	11,573.8	BDL	BDL	5,081.2	4,714,221.4	7,593,566.2
NFHC-3	North Fork Henson above Henson	453,467,083.2	7,786.8	BDL	BDL	3,206.3	3,847,599.5	6,664,592.0
YG	Yellowstone Gulch	2,415,748.4	4.7	BDL	BDL	343.1	14,237.7	71,072.0
MHC	Matterhorn Creek	318,688,244.2	10,321.2	BDL	BDL	1,901.3	3,521,867.2	1,720,192.2
LSG	Lee Smelter Gulch	42,048,490.9	4,704.9	68.2	BDL	1,591.0	1,195,540.9	BDL
EPC	El Paso Creek	77,109,443.3	1,511.9	BDL	BDL	982.8	733,295.7	1,753,861.8
BCG-1	Big Casino Gulch above Pride of America	117,803.8	0.8	BDL	BDL	20.5	2,014.8	2,928.6
BCG-2	Big Casino Gulch below Pride of America	203,557.1	5.7	BDL	BDL	285.8	4,032.0	4,971.5
NC	Nellie Creek	55,991,894.3	634.1	BDL	66,581.5	BDL	164,868.5	1,515,522.4
OG	Owl Gulch	42,063,659.8	BDL	BDL	BDL	BDL	813,230.8	905,370.2
AG	Alpine Gulch	214,192,979.5	4,190.7	BDL	BDL	1,979.0	3,247,817.5	1,548,242.7
DM-2	Wyoming Mine	390,976.5	8.9	BDL	BDL	38.1	8,791.9	4,152.9
DM-5	Palmetto Mine	44,109.8	2.4	BDL	15.8	1.9	788.9	299.0
DM-7	Chicago Tunnel	2,266,286.0	340.7	BDL	876.4	101.1	43,303.2	40,606.5
DM-7 DUP	Chicago Tunnel	2,240,355.9	351.1	BDL	892.0	105.8	43,406.9	40,606.5
DM-8	Highland Chief Mine	294,996.3	BDL	BDL	BDL	6.5	4,857.7	12,382.8
DM-9	Moro Tunnel	19,964.3	1.7	BDL	BDL	BDL	477.1	228.8
DM-10	Vulcan Mine	922,857.5	77.1	BDL	BDL	7.7	21,236.5	10,080.0
DM-11	Lucky Strike Mine	534,704.4	24.0	BDL	BDL	BDL	62,040.9	7,440.4
DM-11 DUP	Lucky Strike Mine	527,878.4	22.8	BDL	BDL	BDL	62,192.6	7,440.4
DM-12	Adit between Copper & Big Casino	103,931.6	0.2	BDL	BDL	1.0	2,442.7	3,217.8
DM-14	Pride of America Mine	193,428.2	50.5	BDL	BDL	1,198.3	5,868.4	3,934.1
DM-16	Pelican Mine	47,097.1	1.4	BDL	14.1	17.1	578.0	477.1
DM-17	El Paso Gulch Draining Mine	102,757.2	31.1	BDL	36.4	74.9	5,049.8	2,753.9
DM-18	Brown Adit	17,340.3	BDL	BDL	4.7	0.2	43.4	422.0

APPENDIX 3

Low-Flow Concentration Data

		Sample	Flow	Adjusted Flow	Diss. Al	Diss. As	Diss. Cd	Diss. Ca	Diss. Co
Site #	**Description**	**Date**	**cfs**	**cfs**	**ug/l**	**ug/l**	**ug/l**	**ug/l**	**ug/L**
HC-1	Henson Headwaters	9/20/2005	0.813	0.813	<100	<15	<1	19100	
HC-2	Henson below Palmetto	9/20/2005	1.084	1.084	<100	<15	1	31600	
HC-3	Henson below Redcloud	9/14/2005	2.326	1.55842	<100	<15	<1	32100	<2
HC-3	Henson below Redcloud	9/20/2005	1.534	1.534	<100	<15	<1	32300	
HC-4	Henson below Schafer	9/14/2005	3.22	2.1574	<100	<15	<1	35700	<2
HC-5	Henson above Hanna Mill	9/14/2005	10.393	6.96331	<100	<15	<1	38400	<2
HC-5	Henson above Hanna Mill	9/20/2005	6.996	6.996	<100	<15	<1	35200	
HC-6	Henson above North Fork	9/14/2005	9.062	6.07154	<100	<15	<1	33900	<2
HC-7	Henson above Lee Smelter	9/14/2005	22.604	15.14468	<100	<15	<1	33200	<2
HC-8	Henson above Copper	9/14/2005	17.331	11.61177	<100	<15	<1	34400	<2
HC-9	Henson above Big Casino	9/14/2005	24.718	16.56106	<100	<15	<1	34800	<2
HC-10	Henson below Big Casino Gulch	9/14/2005	27.674	18.54158	<100	<15	<1	34000	<2
HC-11	Henson above Nellie and Owl Gulch	9/14/2005	31.01	20.7767	<100	<15	<1	33300	<2
HC-12	Henson above Ute-Ule Tailings	9/14/2005	31.1	20.837	106	<15	<1	30700	<2
HC-13	Henson below Ute-Ule Tailings	9/14/2005	31.371	21.01857	<100	<15	<1	28600	<2
HC-13 DUP	Henson below Ute-Ule Tailings	9/14/2005	31.371	21.01857	<100	<15	<1	29700	<2
HC-14	Henson below Ute-Ule	9/14/2005	36.008	24.12536	<100	<15	<1	30500	<2
HC-15	Henson above Alpine	9/14/2005	35.402	23.71934	<100	<15	<1	28700	<2
HC-16	Henson below Alpine	9/14/2005	35.225	23.60075	<100	<15	<1	31000	<2
HC-17	Henson below Pelican	9/14/2005	35.843	24.01481	<100	<15	<1	30000	<2
HC-18	Henson above Lake Fork	9/14/2005	36.52	24.4684	<100	<15	<1	30900	<2
PG-1	Palmetto Gulch Headwaters	9/20/2005	0.00253575	0.00253575	<100	<15	<1	45900	
PG-2	Palmetto below Sara Woods	9/20/2005	0.013248	0.013248	<100	<15	6	69200	
PG-2B	Below Roy Pray (80ft from sed. pond)	9/20/2005	0.040572	0.040572	3450	<15	23	126000	
PG-3	South Trib to Palmetto	9/20/2005	0.02205	0.02205	<100	<15	2	73600	
PG-4	Palmetto Trib below Wyoming	9/20/2005	0.00245	0.00245	<100	<15	<1	47200	
PG-5	Below Confluence of PG-3 and PG-4	9/20/2005	0.052992	0.052992	<100	<15	<1	59500	
PG-6	Palmetto below Roy Pray	9/20/2005	0.091287	0.091287	5330	<15	22	122000	
PG-7	Palmetto below Hough	9/20/2005	0.040572	0.040572	<100	<15	1	42400	
PG-7A	Palmetto below Palmetto Waste Pile	9/20/2005	0.0828	0.0828	<100	<15	<1	33300	
PG-8	Palmetto below Palmetto Mine	9/20/2005	0.119232	0.119232	<100	<15	<1	31800	
PG-9	Palmetto below Tributary Confluence	9/20/2005	0.283383	0.283383	<100	<15	6	64000	
PG-10	Palmetto above Henson	9/20/2005	0.381	0.381	<100	<15	4	62000	

Site #	Description	Sample Date	Flow cfs	Adjusted Flow cfs	Diss. Al ug/l	Diss. As ug/l	Diss. Cd ug/l	Diss. Ca ug/l	Diss. Co ug/L
PG-10 DUP	Palmetto above Henson	9/20/2005	0.381	0.381	<100	<15	4	62700	
RC	Redcloud Gulch	9/20/2005	0.0406	0.0406	<100	<15	<1	54400	
SCG	Schafer Gulch	9/14/2005	1.77	1.1859	<100	<15	<1	35100	<2
BGO	Below Golconda	9/19/2005	0.1058	0.1058	<100	<15	2	21700	
NFHC-1	North Fork Henson Headwaters	9/14/2005	5.639	3.77813	<100	<15	<1	17400	<2
NFHC-2	North Fork Henson above Yellowstone	9/14/2005	9.885	6.62295	<100	<15	<1	29300	3
NFHC-3	North Fork Henson above Henson	9/14/2005	10.877	7.28759	<100	<15	<1	30900	2
MHC	Matterhorn Creek	9/14/2005	2.505	1.67835	1650	<15	<1	48400	14
YG	Yellowstone Gulch	9/14/2005	0.278501	0.18659567	<100	<15	4	36100	<2
LSG	Lee Smelter Gulch	9/14/2005	0.689	0.46163	2290	<15	<1	62500	3
EPC	El Paso Creek	9/14/2005		0	<100	<15	<1	13400	<2
BCG-1	Big Casino Gulch above Pride of America	9/14/2005	0.0128	0.008576	<100	<15	9	42500	<2
BCG-2	Big Casino Gulch below Pride of America	9/14/2005	0.016	0.016	<100	<15	29	42400	<2
NC	Nellie Creek	9/14/2005	4.543	3.04381	<100	<15	<1	7510	<2
OG	Owl Gulch	9/14/2005	0.744	0.49848	<100	<15	<1	34900	<2
AG	Alpine Gulch	9/14/2005	3.518	2.35706	147	<15	<1	27800	3
DM-1	Hough Mine	9/20/2005	0.003312	0.003312	6590	<15	29	44000	
DM-3	Roy Pray Mine	9/20/2005	0.008829	0.008829	927	<15	15	403000	
DM-4	Wyoming Mine	9/20/2005	0.0098	0.0098	320	<15	10	47000	
DM-5	Palmetto Mine	9/19/2005	0.000654	0.000654	<100	<15	<1	36300	
DM-5 DUP	Palmetto Mine	9/19/2005	0.000654	0.000654	<100	<15	<1	37200	
DM-6	BLM Adit below Confluence	9/20/2005	0.00129	0.00129	<100	<15	<1	30000	
DM-7	Chicago Tunnel	9/13/2005	0.285	0.285	<100	<15	5	58800	4
DM-7 DUP	Chicago Tunnel	9/13/2005	0.285	0.285	<100	<15	6	58700	4
DM-8	Highland Chief Mine	9/13/2005	0.029	0.029	<100	<15	<1	47800	<2
DM-9	Moro Tunnel	9/13/2005	0.001	0.001	<100	<15	<1	112000	<2
DM-10	Vulcan Mine	9/13/2005	0.083	0.083	<100	<15	<1	103000	2
DM-11	Lucky Strike Mine	9/13/2005	0.03	0.03	<100	<15	<1	347000	<2
DM-14	Pride of America Mine	9/14/2005	0.0032	0.0032	<100	<15	184	42100	6
DM-15	Pelican Mine	9/14/2005	0.003342	0.003342	<100	<15	<1	154000	<2
DM-18	Brown Adit	9/14/2005	0.0022	0.0022	<100	<15	<1	51000	<2
BL1	Blank	9/20/2005			<100	<15	<1	129	

Site #	Description	Diss. Cu ug/l	Diss. Fe ug/l	Diss. Pb ug/l	Diss. Mg ug/l	Diss. Mn ug/l	Diss. Ni ug/l	Diss. K ug/l	Diss. Na ug/l	Diss. Zn ug/l
HC-1	Henson Headwaters	<20	<100	<10	2030	<2	<4	<1000	2640	<10
HC-2	Henson below Palmetto	<20	<100	<10	3310	303	<4	<1000	2480	199
HC-3	Henson below Redcloud	<20	<100	<10	3110	295	<4	<1000	2510	134
HC-3	Henson below Redcloud	<20	<100	<10	3340	226	<4	<1000	2490	159
HC-4	Henson below Schafer	<20	<100	<10	4020	136	<4	<1000	2080	121
HC-5	Henson above Hanna Mill	<20	<100	<10	3170	5	<4	<1000	1760	40
HC-5	Henson above Hanna Mill	<20	<100	<10	2740	3	<4	<1000	1680	36
HC-6	Henson above North Fork	<20	<100	<10	2690	3	<4	<1000	1710	32
HC-7	Henson above Lee Smelter	<20	<100	<10	3370	56	<4	<1000	2880	21
HC-8	Henson above Copper	<20	<100	<10	3410	69	<4	<1000	2720	22
HC-9	Henson above Big Casino	<20	<100	<10	3400	68	<4	<1000	3050	21
HC-10	Henson below Big Casino Gulch	<20	<100	<10	3260	65	<4	<1000	2880	23
HC-11	Henson above Nellie and Owl Gulch	<20	<100	<10	3420	59	<4	<1000	3010	23
HC-12	Henson above Ute-Ule Tailings	<20	<100	<10	3050	40	<4	<1000	3100	18
HC-13	Henson below Ute-Ule Tailings	<20	<100	<10	2820	37	<4	<1000	3010	16
HC-13 DUP	Henson below Ute-Ule Tailings	<20	<100	<10	3030	39	<4	<1000	3140	16
HC-14	Henson below Ute-Ule	<20	<100	<10	2990	59	<4	<1000	3080	45
HC-15	Henson above Alpine	<20	<100	<10	2790	51	<4	<1000	3120	63
HC-16	Henson below Alpine	<20	<100	<10	3210	54	<4	<1000	3180	62
HC-17	Henson below Pelican	<20	<100	<10	3150	49	<4	<1000	3180	68
HC-18	Henson above Lake Fork	<20	<100	<10	3250	44	<4	<1000	3180	76
PG-1	Palmetto Gulch Headwaters	<20	<100	<10	3270	5	<4	<1000	2380	11
PG-2	Palmetto below Sara Woods	63	<100	<10	8050	1870	14	<1000	1310	733
PG-2B	Below Roy Pray (80ft from sed. pond)	330	6670	14	15500	6620	45	1370	1510	3550
PG-3	South Trib to Palmetto	<20	<100	<10	6180	387	4	<1000	2220	593
PG-4	Palmetto Trib below Wyoming	<20	<100	<10	3050	<2	<4	<1000	1680	250
PG-5	Below Confluence of PG-3 and PG-4	<20	<100	<10	4510	54	<4	<1000	2030	138
PG-6	Palmetto below Roy Pray	327	1060	<10	16800	6550	41	1280	1500	3560
PG-7	Palmetto below Hough	<20	<100	<10	4170	81	<4	1500	1610	102
PG-7A	Palmetto below Palmetto Waste Pile	<20	<100	<10	3620	30	<4	1180	1630	31
PG-8	Palmetto below Palmetto Mine	<20	<100	<10	3030	42	<4	<1000	1990	25
PG-9	Palmetto below Tributary Confluence	<20	135	<10	8780	2020	11	<1000	1930	1040
PG-10	Palmetto above Henson	<20	<100	<10	7040	1150	6	<1000	1980	701

Site #	Description	Diss. Cu ug/l	Diss. Fe ug/l	Diss. Pb ug/l	Diss. Mg ug/l	Diss. Mn ug/l	Diss. Ni ug/l	Diss. K ug/l	Diss. Na ug/l	Diss. Zn ug/l
PG-10 DUP	Palmetto above Henson	<20	<100	<10	6870	1120	7	<1000	1980	704
RC	Redcloud Gulch	<20	<100	<10	3710	46	<4	<1000	3020	131
SCG	Schafer Gulch	<20	<100	<10	4440	<2	<4	1080	1260	139
BGO	Below Golconda	<20	<100	<10	5340	7	<4	<1000	<500	730
NFHC-1	North Fork Henson Headwaters	<20	<100	<10	1800	3	<4	<1000	4070	<10
NFHC-2	North Fork Henson above Yellowstone	<20	316	<10	4580	173	<4	<1000	4220	12
NFHC-3	North Fork Henson above Henson	<20	<100	<10	4560	140	<4	<1000	4260	15
MHC	Matterhorn Creek	<20	2970	<10	9440	577	6	1100	4860	100
YG	Yellowstone Gulch	<20	<100	<10	3430	<2	<4	<1000	3800	563
LSG	Lee Smelter Gulch	<20	<100	<10	5930	594	11	1230	2390	188
EPC	El Paso Creek	<20	<100	<10	1480	61	<4	1300	3330	11
BCG-1	Big Casino Gulch above Pride of America	<20	<100	167	2650	<2	<4	<1000	2510	933
BCG-2	Big Casino Gulch below Pride of America	<20	<100	<10	2630	<2	<4	<1000	2600	2260
NC	Nellie Creek	<20	<100	<10	1060	4	<4	1070	3340	<10
OG	Owl Gulch	<20	<100	<10	2280	<2	<4	<1000	1770	<10
AG	Alpine Gulch	<20	569	<10	3890	54	<4	1510	3220	30
DM-1	Hough Mine	6070	3290	13	7590	3390	24	1160	4050	3600
DM-3	Roy Pray Mine	<20	76800	13	44800	27700	88	3740	3470	7110
DM-4	Wyoming Mine	43	1270	10	3450	551	<4	1130	2820	2060
DM-5	Palmetto Mine	<20	<100	<10	3360	100	<4	1040	2120	51
DM-5 DUP	Palmetto Mine	<20	<100	<10	3460	105	<4	<1000	2040	57
DM-6	BLM Adit below Confluence	<20	<100	<10	1470	<2	<4	<1000	4520	33
DM-7	Chicago Tunnel	<20	547	<10	4990	1800	<4	1750	3350	823
DM-7 DUP	Chicago Tunnel	<20	554	<10	5220	1870	<4	1700	3270	846
DM-8	Highland Chief Mine	<20	<100	<10	2500	4	<4	<1000	3880	58
DM-9	Moro Tunnel	<20	<100	<10	9580	1380	<4	1040	8440	<10
DM-10	Vulcan Mine	<20	1110	<10	9680	813	<4	<1000	5050	67
DM-11	Lucky Strike Mine	<20	<100	<10	8100	336	<4	<1000	12600	<10
DM-14	Pride of America Mine	38	<100	<10	2760	882	<4	<1000	2620	18700
DM-15	Pelican Mine	<20	<100	<10	7210	261	<4	3680	39200	204
DM-18	Brown Adit	<20	<100	<10	6520	2	<4	2080	22200	43
BL1	Blank	<20	<100	<10	<100	<2	<4	<1000	<500	<10

	.	Tot. Al	Tot. As	Tot. Cd	Tot. Cu	Tot. Fe	Tot. Pb	Tot. Mg	Tot. Mn	Tot. Ni
Site #	**Description**	**ug/l**	**ug/l**	**ug/l**	**ug/l**	**ug/l**	**ug/l**	**mg/l**	**ug/l**	**ug/l**
HC-1	Henson Headwaters	<100	<15	<1	<20	<100	<10	1.9	<2	<4
HC-2	Henson below Palmetto	138	<15	1	<20	<100	<10	3.11	288	<4
HC-3	Henson below Redcloud	403	<15	<1	20	216	<10	3.18	300	<4
HC-3	Henson below Redcloud	<100	<15	<1	<20	<100	<10	3.03	208	<4
HC-4	Henson below Schafer	<100	<15	<1	<20	<100	<10	3.85	131	<4
HC-5	Henson above Hanna Mill	<100	<15	<1	<20	<100	<10	2.88	6	<4
HC-5	Henson above Hanna Mill	<100	<15	<1	<20	<100	<10	2.65	5	<4
HC-6	Henson above North Fork	<100	<15	<1	<20	<100	<10	2.92	4	<4
HC-7	Henson above Lee Smelter	649	<15	<1	<20	359	<10	3.68	62	<4
HC-8	Henson above Copper	704	<15	<1	<20	337	<10	3.82	79	<4
HC-9	Henson above Big Casino	602	<15	<1	<20	268	<10	3.5	71	<4
HC-10	Henson below Big Casino Gulch	613	<15	<1	<20	260	<10	3.65	75	<4
HC-11	Henson above Nellie and Owl Gulch	507	<15	<1	<20	211	<10	3.5	62	<4
HC-12	Henson above Ute-Ule Tailings	375	<15	<1	<20	164	<10	3.06	43	<4
HC-13	Henson below Ute-Ule Tailings	355	<15	<1	<20	152	<10	3.02	41	<4
HC-13 DUP	Henson below Ute-Ule Tailings	379	<15	<1	<20	164	<10	3.08	43	<4
HC-14	Henson below Ute-Ule	327	<15	<1	<20	151	<10	3.08	63	<4
HC-15	Henson above Alpine	282	<15	<1	<20	163	<10	3.09	58	<4
HC-16	Henson below Alpine	457	<15	<1	<20	180	<10	3.15	56	<4
HC-17	Henson below Pelican	412	<15	<1	<20	167	<10	3.3	53	<4
HC-18	Henson above Lake Fork	392	<15	<1	<20	147	<10	3.16	46	<4
PG-1	Palmetto Gulch Headwaters	<100	<15	<1	<20	<100	<10	3.3	4	<4
PG-2	Palmetto below Sara Woods	5050	<15	6	161	123	<10	7.06	1650	15
PG-2B	Below Roy Pray (80ft from sed. pond)	5540	<15	26	334	7070	13	17.6	7400	48
PG-3	South Trib to Palmetto	260	<15	2	<20	<100	<10	6.17	387	4
PG-4	Palmetto Trib below Wyoming	<100	<15	1	<20	<100	<10	3.05	<2	<4
PG-5	Below Confluence of PG-3 and PG-4	<100	<15	<1	<20	<100	<10	4.39	53	<4
PG-6	Palmetto below Roy Pray	5780	<15	24	324	1370	<10	17.2	6780	44
PG-7	Palmetto below Hough	<100	<15	1	<20	<100	<10	4.34	85	<4
PG-7A	Palmetto below Palmetto Waste Pile	<100	<15	<1	<20	<100	<10	3.26	29	<4
PG-8	Palmetto below Palmetto Mine	<100	<15	<1	<20	<100	<10	3.11	44	<4
PG-9	Palmetto below Tributary Confluence	1400	<15	6	79	345	<10	7.02	1650	12
PG-10	Palmetto above Henson	506	<15	4	36	134	<10	6.01	1010	8

		Tot. Al	Tot. As	Tot. Cd	Tot. Cu	Tot. Fe	Tot. Pb	Tot. Mg	Tot. Mn	Tot. Ni
Site #	**Description**	**ug/l**	**ug/l**	**ug/l**	**ug/l**	**ug/l**	**ug/l**	**mg/l**	**ug/l**	**ug/l**
PG-10 DUP	Palmetto above Henson	496	<15	4	32	145	<10	6.65	1100	8
RC	Redcloud Gulch	<100	<15	<1	<20	<100	<10	3.74	50	<4
SCG	Schafer Gulch	<100	<15	<1	<20	<100	<10	4.81	<2	<4
BGO	Below Golconda	<100	<15	2	<20	<100	<10	5.46	6	<4
NFHC-1	North Fork Henson Headwaters	<100	<15	<1	<20	<100	<10	1.76	6	<4
NFHC-2	North Fork Henson above Yellowstone	2130	<15	<1	<20	1250	<10	4.87	183	<4
NFHC-3	North Fork Henson above Henson	1730	<15	<1	<20	946	<10	4.7	147	<4
MHC	Matterhorn Creek	6950	<15	<1	<20	4670	<10	10.2	607	5
YG	Yellowstone Gulch	<100	<15	4	<20	<100	<10	3.37	4	<4
LSG	Lee Smelter Gulch	2660	<15	<1	<20	<100	<10	6.09	615	9
EPC	El Paso Creek	569	<15	<1	<20	<100	<10	1.54	67	<4
BCG-1	Big Casino Gulch above Pride of America	<100	<15	10	<20	<100	184	2.98	<2	<4
BCG-2	Big Casino Gulch below Pride of America	<100	<15	27	<20	<100	<10	2.88	<2	<4
NC	Nellie Creek	<100	<15	<1	<20	<100	<10	1.17	7	<4
OG	Owl Gulch	<100	<15	<1	<20	<100	<10	2.27	<2	<4
AG	Alpine Gulch	2150	<15	<1	<20	902	<10	3.84	54	<4
DM-1	Hough Mine	6690	<15	31	6080	3760	14	8.41	3620	26
DM-3	Roy Pray Mine	1020	<15	14	<20	82900	13	46.7	28300	90
DM-4	Wyoming Mine	463	<15	10	52	3310	97	3.34	536	<4
DM-5	Palmetto Mine	<100	<15	<1	<20	<100	<10	3.33	106	<4
DM-5 DUP	Palmetto Mine	<100	<15	<1	<20	<100	<10	3.15	112	<4
DM-6	BLM Adit below Confluence	<100	<15	<1	<20	<100	<10	1.54	<2	<4
DM-7	Chicago Tunnel	245	<15	5	<20	2500	<10	4.87	1810	<4
DM-7 DUP	Chicago Tunnel	248	<15	5	<20	2510	<10	4.85	1810	<4
DM-8	Highland Chief Mine	<100	<15	<1	<20	<100	<10	2.65	5	<4
DM-9	Moro Tunnel	<100	<15	<1	<20	234	<10	9.51	2050	<4
DM-10	Vulcan Mine	<100	<15	<1	<20	1030	<10	9.55	811	<4
DM-11	Lucky Strike Mine	<100	<15	<1	<20	<100	<10	7.84	340	<4
DM-14	Pride of America Mine	734	<15	204	550	3540	172	3.1	1000	<4
DM-15	Pelican Mine	<100	<15	<1	<20	<100	<10	7.19	257	<4
DM-18	Brown Adit	<100	<15	<1	<20	<100	<10	6.81	2	<4
BL1	Blank	<100	<15	<1	<20	<100	<10	BDL	<2	<4

		Tot. K	Tot. Zn	SO4	Total Alkalinity	Cond.	pH
Site #	**Description**	**ug/l**	**ug/l**	**mg/l**	**mg/l**	**umhos/cm**	**s.u.**
HC-1	Henson Headwaters	<1000	<10	9.8	52.0	109	8.00
HC-2	Henson below Palmetto	<1000	190	53.6	44.0	185	7.93
HC-3	Henson below Redcloud	<1000	163	57.7	38.4	196	7.95
HC-3	Henson below Redcloud	<1000	145	56.6	43.4	191	7.78
HC-4	Henson below Schafer	<1000	117	71.7	29.4	205	7.57
HC-5	Henson above Hanna Mill	<1000	32	65.1	31.0	220	6.68
HC-5	Henson above Hanna Mill	<1000	34	69.3	34.0	206	7.64
HC-6	Henson above North Fork	<1000	32	65.6	32.2	208	7.68
HC-7	Henson above Lee Smelter	<1000	28	68.9	35.4	213	7.86
HC-8	Henson above Copper	<1000	33	72.5	33.9	223	7.80
HC-9	Henson above Big Casino	<1000	29	68.2	31.5	204	7.72
HC-10	Henson below Big Casino Gulch	<1000	31	67.6	31.7	208	7.77
HC-11	Henson above Nellie and Owl Gulch	<1000	27	67.1	32.7	211	7.82
HC-12	Henson above Ute-Ule Tailings	<1000	21	55.5	32.6	92.2	7.85
HC-13	Henson below Ute-Ule Tailings	<1000	20	56.5	33.0	193	7.78
HC-13 DUP	Henson below Ute-Ule Tailings	<1000	21	55.9	32.9		
HC-14	Henson below Ute-Ule	<1000	48	56.5	32.8	184	7.84
HC-15	Henson above Alpine	<1000	65	56.4	33.4	276	7.71
HC-16	Henson below Alpine	<1000	64	58.2	30.2	190	7.77
HC-17	Henson below Pelican	<1000	78	58.5	30.5	187	7.76
HC-18	Henson above Lake Fork	<1000	79	58.0	30.6	187	7.62
PG-1	Palmetto Gulch Headwaters	<1000	13	67.7	74.0	277	6.88
PG-2	Palmetto below Sara Woods	<1000	716	188	11.7	427	6.40
PG-2B	Below Roy Pray (80ft from sed. pond)	1310	3690	440	<5.00	800	4.96
PG-3	South Trib to Palmetto	<1000	596	187	19.8	425	7.55
PG-4	Palmetto Trib below Wyoming	<1000	247	104	35.3	282	6.76
PG-5	Below Confluence of PG-3 and PG-4	<1000	149	143	30.0	346	7.66
PG-6	Palmetto below Roy Pray	1180	3590	417	<5.00	755	4.79
PG-7	Palmetto below Hough	1470	89	96.2	27.0	261	6.70
PG-7A	Palmetto below Palmetto Waste Pile	1280	32	65.7	33.2	201	7.98
PG-8	Palmetto below Palmetto Mine	1020	18	55.7	<5.00	194	7.36
PG-9	Palmetto below Tributary Confluence	<1000	985	175	19.1	408	7.13
PG-10	Palmetto above Henson	<1000	642	154	24.6	387	7.30

		Tot. K	Tot. Zn	SO4	Total Alkalinity	Cond.	pH
Site #	**Description**	**ug/l**	**ug/l**	**mg/l**	**mg/l**	**umhos/cm**	**s.u.**
PG-10 DUP	Palmetto above Henson	<1000	691	154	24.6		
RC	Redcloud Gulch	<1000	124	123	39.3	320	7.61
SCG	Schafer Gulch	<1000	135	89.0	14.7	218	7.57
BGO	Below Golconda	<1000	746	76.4	<5.00	174	5.70
NFHC-1	North Fork Henson Headwaters	<1000	12	5.2	49.1	103	7.80
NFHC-2	North Fork Henson above Yellowstone	<1000	26	64.6	34.2	211	6.86
NFHC-3	North Fork Henson above Henson	<1000	38	64.1	37.6	220	7.77
MHC	Matterhorn Creek	<1000	101	170	<5.00	243	5.57
YG	Yellowstone Gulch	<1000	533	25.8	81.5	238	6.11
LSG	Lee Smelter Gulch	1130	169	177	<5.00	356	5.85
EPC	El Paso Creek	1160	12	30.0	15.7	104	7.76
BCG-1	Big Casino Gulch above Pride of America	<1000	917	71.3	49.1	267	7.75
BCG-2	Big Casino Gulch below Pride of America	<1000	2060	77.5	40.8	242	7.46
NC	Nellie Creek	<1000	<10	2.4	29.8	71.0	7.75
OG	Owl Gulch	<1000	<10	64.8	29.2	200	7.27
AG	Alpine Gulch	1400	26	84.4	<5.00	194	6.99
DM-1	Hough Mine	1270	3870	202	<5.00	465	3.89
DM-3	Roy Pray Mine	3870	7480	1400	81.8	2120	6.22
DM-4	Wyoming Mine	1210	2020	135	<5.00	299	5.82
DM-5	Palmetto Mine	1070	43	73.1	35.7	218	6.99
DM-5 DUP	Palmetto Mine	1130	44	73.2	35.6		
DM-6	BLM Adit below Confluence	<1000	<10	7.0	83.8	168	7.61
DM-7	Chicago Tunnel	1610	750	96.6	67.2	322	6.94
DM-7 DUP	Chicago Tunnel	1640	747	97.1	67.3		
DM-8	Highland Chief Mine	<1000	54	44.6	88.9	256	7.86
DM-9	Moro Tunnel	<1000	<10	196	93.3	551	7.35
DM-10	Vulcan Mine	<1000	73	178	104	527	7.34
DM-11	Lucky Strike Mine	<1000	<10	818	98.5	1500	7.40
DM-14	Pride of America Mine	<1000	21500	124	30.9	314	7.25
DM-15	Pelican Mine	3360	199	366	130	935	7.30
DM-18	Brown Adit	1910	36	34.7	145		
BL1	Blank	<1000	<10	<1.0	<5.00		

APPENDIX 4

Low-Flow Loading Data

Site #	Description	Sample Date	Flow cfs	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Ca g/day
HC-1	Henson Headwaters	9/20/2005	0.813	BDL	BDL	BDL	37,991.5
HC-2	Henson below Palmetto	9/20/2005	1.084	BDL	BDL	2.7	83,806.8
HC-3	Henson below Redcloud	9/14/2005	2.326	BDL	BDL	BDL	182,674.4
HC-3	Henson below Redcloud	9/20/2005	1.534	BDL	BDL	BDL	121,224.6
HC-4	Henson below Schafer	9/14/2005	3.22	BDL	BDL	BDL	281,246.5
HC-5	Henson above Hanna Mill	9/14/2005	10.393	BDL	BDL	BDL	976,416.5
HC-5	Henson above Hanna Mill	9/20/2005	6.996	BDL	BDL	BDL	602,497.8
HC-6	Henson above North Fork	9/14/2005	9.062	BDL	BDL	BDL	751,599.9
HC-7	Henson above Lee Smelter	9/14/2005	22.604	BDL	BDL	BDL	1,836,057.8
HC-8	Henson above Copper	9/14/2005	17.331	BDL	BDL	BDL	1,458,629.6
HC-9	Henson above Big Casino	9/14/2005	24.718	BDL	BDL	BDL	2,104,532.0
HC-10	Henson below Big Casino Gulch	9/14/2005	27.674	BDL	BDL	BDL	2,302,045.1
HC-11	Henson above Nellie and Owl Gulch	9/14/2005	31.01	BDL	BDL	BDL	2,526,439.9
HC-12	Henson above Ute-Ule Tailings	9/14/2005	31.1	8,065.5	BDL	BDL	2,335,940.3
HC-13	Henson below Ute-Ule Tailings	9/14/2005	31.371	BDL	BDL	BDL	2,195,115.5
HC-13 DUP	Henson below Ute-Ule Tailings	9/14/2005	31.371	BDL	BDL	BDL	2,279,543.0
HC-14	Henson below Ute-Ule	9/14/2005	36.008	BDL	BDL	BDL	2,686,963.8
HC-15	Henson above Alpine	9/14/2005	35.402	BDL	BDL	BDL	2,485,837.1
HC-16	Henson below Alpine	9/14/2005	35.225	BDL	BDL	BDL	2,671,626.0
HC-17	Henson below Pelican	9/14/2005	35.843	BDL	BDL	BDL	2,630,804.5
HC-18	Henson above Lake Fork	9/14/2005	36.52	BDL	BDL	BDL	2,760,909.8
PG-1	Palmetto Gulch Headwaters	9/20/2005	0.00253575	BDL	BDL	BDL	284.8
PG-2	Palmetto below Sara Woods	9/20/2005	0.013248	BDL	BDL	0.2	2,242.9
PG-2B	Below Roy Pray (80ft from sed. pond)	9/20/2005	0.040572	342.5	BDL	2.3	12,507.2
PG-3	South Trib to Palmetto	9/20/2005	0.02205	BDL	BDL	0.1	3,970.5
PG-4	Palmetto Trib below Wyoming	9/20/2005	0.00245	BDL	BDL	BDL	282.9
PG-5	Below Confluence of PG-3 and PG-4	9/20/2005	0.052992	BDL	BDL	BDL	7,714.2
PG-6	Palmetto below Roy Pray	9/20/2005	0.091287	1,190.4	BDL	4.9	27,247.8
PG-7	Palmetto below Hough	9/20/2005	0.040572	BDL	BDL	0.1	4,208.8
PG-7A	Palmetto below Palmetto Waste Pile	9/20/2005	0.0828	BDL	BDL	BDL	6,745.9
PG-8	Palmetto below Palmetto Mine	9/20/2005	0.119232	BDL	BDL	BDL	9,276.5
PG-9	Palmetto below Tributary Confluence	9/20/2005	0.283383	BDL	BDL	4.2	44,372.8
PG-10	Palmetto above Henson	9/20/2005	0.381	BDL	BDL	3.7	57,793.6

Site #	Description	Sample Date	Flow cfs	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Ca g/day
PG-10 DUP	Palmetto above Henson	9/20/2005	0.381	BDL	BDL	3.7	58,446.1
RC	Redcloud Gulch	9/20/2005	0.0406	BDL	BDL	BDL	5,403.7
SCG	Schafer Gulch	9/14/2005	1.77	BDL	BDL	BDL	151,999.9
BGO	Below Golconda	9/19/2005	0.1058	BDL	BDL	0.5	5,617.1
NFHC-1	North Fork Henson Headwaters	9/14/2005	5.639	BDL	BDL	BDL	240,057.0
NFHC-2	North Fork Henson above Yellowstone	9/14/2005	9.885	BDL	BDL	BDL	708,610.0
NFHC-3	North Fork Henson above Henson	9/14/2005	10.877	BDL	BDL	BDL	822,300.5
MHC	Matterhorn Creek	9/14/2005	2.505	10,112.4	BDL	BDL	296,630.7
YG	Yellowstone Gulch	9/14/2005	0.278501	BDL	BDL	2.7	24,597.8
LSG	Lee Smelter Gulch	9/14/2005	0.689	3,860.3	BDL	BDL	105,356.7
EPC	El Paso Creek	9/14/2005		BDL	BDL	BDL	0.0
BCG-1	Big Casino Gulch above Pride of America	9/14/2005	0.0128	BDL	BDL	0.3	1,331.0
BCG-2	Big Casino Gulch below Pride of America	9/14/2005	0.016	BDL	BDL	1.1	1,659.8
NC	Nellie Creek	9/14/2005	4.543	BDL	BDL	BDL	83,472.9
OG	Owl Gulch	9/14/2005	0.744	BDL	BDL	BDL	63,527.4
AG	Alpine Gulch	9/14/2005	3.518	1,265.2	BDL	BDL	239,278.5
DM-5	Palmetto Mine	9/19/2005	0.000654	BDL	BDL	BDL	58.1
DM-5 DUP	Palmetto Mine	9/19/2005	0.000654	BDL	BDL	BDL	59.5
DM-1	Hough Mine	9/20/2005	0.003312	53.4	BDL	0.2	356.5
DM-3	Roy Pray Mine	9/20/2005	0.008829	20.0	BDL	0.3	8,705.2
DM-4	Wyoming Mine	9/20/2005	0.0098	7.7	BDL	0.2	1,126.9
DM-6	BLM Adit below Confluence	9/20/2005	0.00129	BDL	BDL	BDL	94.7
DM-7	Chicago Tunnel	9/13/2005	0.285	BDL	BDL	3.5	41,000.1
DM-7 DUP	Chicago Tunnel	9/13/2005	0.285	BDL	BDL	4.2	40,930.4
DM-8	Highland Chief Mine	9/13/2005	0.029	BDL	BDL	BDL	3,391.5
DM-9	Moro Tunnel	9/13/2005	0.001	BDL	BDL	BDL	274.0
DM-10	Vulcan Mine	9/13/2005	0.083	BDL	BDL	BDL	20,916.0
DM-11	Lucky Strike Mine	9/13/2005	0.03	BDL	BDL	BDL	25,469.1
DM-14	Pride of America Mine	9/14/2005	0.0032	BDL	BDL	1.4	329.6
DM-15	Pelican Mine	9/14/2005	0.003342	BDL	BDL	BDL	1,259.2
DM-18	Brown Adit	9/14/2005	0.0022	BDL	BDL	BDL	274.5
BL1	Blank	9/20/2005		BDL	BDL	BDL	0.0

		Diss. Co	Diss. Cu	Diss. Fe	Diss. Pb	Diss. Mg	Diss. Mn	Diss. Ni	Diss. K	Diss. Na
Site #	Description	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day
HC-1	Henson Headwaters	0.0	BDL	BDL	BDL	4,037.8	BDL	BDL	BDL	5,251.2
HC-2	Henson below Palmetto	0.0	BDL	BDL	BDL	8,778.5	803.6	BDL	BDL	6,577.2
HC-3	Henson below Redcloud	BDL	BDL	BDL	BDL	17,698.4	1,678.8	BDL	BDL	14,283.9
HC-3	Henson below Redcloud	0.0	BDL	BDL	BDL	12,535.3	848.2	BDL	BDL	9,345.2
HC-4	Henson below Schafer	BDL	BDL	BDL	BDL	31,669.8	1,071.4	BDL	BDL	16,386.3
HC-5	Henson above Hanna Mill	BDL	BDL	BDL	BDL	80,605.2	127.1	BDL	BDL	44,752.4
HC-5	Henson above Hanna Mill	0.0	BDL	BDL	BDL	46,899.0	51.3	BDL	BDL	28,755.6
HC-6	Henson above North Fork	BDL	BDL	BDL	BDL	59,640.2	66.5	BDL	BDL	37,912.6
HC-7	Henson above Lee Smelter	BDL	BDL	BDL	BDL	186,370.9	3,097.0	BDL	BDL	159,272.5
HC-8	Henson above Copper	BDL	BDL	BDL	BDL	144,590.9	2,925.7	BDL	BDL	115,333.5
HC-9	Henson above Big Casino	BDL	BDL	BDL	BDL	205,615.2	4,112.3	BDL	BDL	184,448.9
HC-10	Henson below Big Casino Gulch	BDL	BDL	BDL	BDL	220,725.5	4,401.0	BDL	BDL	194,996.8
HC-11	Henson above Nellie and Owl Gulch	BDL	BDL	BDL	BDL	259,472.2	4,476.3	BDL	BDL	228,365.9
HC-12	Henson above Ute-Ule Tailings	BDL	BDL	BDL	BDL	232,072.2	3,043.6	BDL	BDL	235,876.7
HC-13	Henson below Ute-Ule Tailings	BDL	BDL	BDL	BDL	216,441.5	2,839.8	BDL	BDL	231,024.4
HC-13 DUP	Henson below Ute-Ule Tailings	BDL	BDL	BDL	BDL	232,559.4	2,993.3	BDL	BDL	241,002.2
HC-14	Henson below Ute-Ule	BDL	BDL	BDL	BDL	263,410.5	5,197.7	BDL	BDL	271,339.3
HC-15	Henson above Alpine	BDL	BDL	BDL	BDL	241,654.5	4,417.3	BDL	BDL	270,237.3
HC-16	Henson below Alpine	BDL	BDL	BDL	BDL	276,642.6	4,653.8	BDL	BDL	274,057.1
HC-17	Henson below Pelican	BDL	BDL	BDL	BDL	276,234.5	4,297.0	BDL	BDL	278,865.3
HC-18	Henson above Lake Fork	BDL	BDL	BDL	BDL	290,387.0	3,931.4	BDL	BDL	284,132.5
PG-1	Palmetto Gulch Headwaters	0.0	BDL	BDL	BDL	20.3	0.0	BDL	BDL	14.8
PG-2	Palmetto below Sara Woods	0.0	2.0	BDL	BDL	260.9	60.6	0.5	BDL	42.5
PG-2B	Below Roy Pray (80ft from sed. pond)	0.0	32.8	662.1	1.4	1,538.6	657.1	4.5	136.0	149.9
PG-3	South Trib to Palmetto	0.0	BDL	BDL	BDL	333.4	20.9	0.2	BDL	119.8
PG-4	Palmetto Trib below Wyoming	0.0	BDL	BDL	BDL	18.3	BDL	BDL	BDL	10.1
PG-5	Below Confluence of PG-3 and PG-4	0.0	BDL	BDL	BDL	584.7	7.0	BDL	BDL	263.2
PG-6	Palmetto below Roy Pray	0.0	73.0	236.7	BDL	3,752.2	1,462.9	9.2	285.9	335.0
PG-7	Palmetto below Hough	0.0	BDL	BDL	BDL	413.9	8.0	BDL	148.9	159.8
PG-7A	Palmetto below Palmetto Waste Pile	0.0	BDL	BDL	BDL	733.3	6.1	BDL	239.0	330.2
PG-8	Palmetto below Palmetto Mine	0.0	BDL	BDL	BDL	883.9	12.3	BDL	BDL	580.5
PG-9	Palmetto below Tributary Confluence	0.0	BDL	93.6	BDL	6,087.4	1,400.5	7.6	BDL	1,338.1
PG-10	Palmetto above Henson	0.0	BDL	BDL	BDL	6,562.4	1,072.0	5.6	BDL	1,845.7

Site #	Description	Diss. Co g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mg g/day	Diss. Mn g/day	Diss. Ni g/day	Diss. K g/day	Diss. Na g/day
PG-10 DUP	Palmetto above Henson	0.0	BDL	BDL	BDL	6,403.9	1,044.0	6.5	BDL	1,845.7
RC	Redcloud Gulch	0.0	BDL	BDL	BDL	368.5	4.6	BDL	BDL	300.0
SCG	Schafer Gulch	BDL	BDL	BDL	BDL	19,227.3	BDL	BDL	4,676.9	5,456.4
BGO	Below Golconda	0.0	BDL	BDL	BDL	1,382.3	1.8	BDL	BDL	BDL
NFHC-1	North Fork Henson Headwaters	BDL	BDL	BDL	BDL	24,833.5	41.4	BDL	BDL	56,151.3
NFHC-2	North Fork Henson above Yellowstone	72.6	BDL	7,642.3	BDL	110,765.7	4,183.9	BDL	BDL	102,059.2
NFHC-3	North Fork Henson above Henson	53.2	BDL	BDL	BDL	121,349.2	3,725.6	BDL	BDL	113,365.7
MHC	Matterhorn Creek	85.8	BDL	18,202.3	BDL	57,855.2	3,536.3	36.8	6,741.6	29,785.6
YG	Yellowstone Gulch	BDL	BDL	BDL	BDL	2,337.1	BDL	BDL	BDL	2,589.2
LSG	Lee Smelter Gulch	5.1	BDL	BDL	BDL	9,996.2	1,001.3	18.5	2,073.4	4,028.8
EPC	El Paso Creek	BDL	BDL	BDL	BDL	0.0	0.0	BDL	0.0	0.0
BCG-1	Big Casino Gulch above Pride of America	BDL	BDL	BDL	5.2	83.0	BDL	BDL	BDL	78.6
BCG-2	Big Casino Gulch below Pride of America	BDL	BDL	BDL	BDL	103.0	BDL	BDL	BDL	101.8
NC	Nellie Creek	BDL	BDL	BDL	BDL	11,781.8	44.5	BDL	11,892.9	37,123.8
OG	Owl Gulch	BDL	BDL	BDL	BDL	4,150.2	BDL	BDL	BDL	3,221.9
AG	Alpine Gulch	25.8	BDL	4,897.5	BDL	33,481.8	464.8	BDL	12,996.8	27,715.0
DM-5	Palmetto Mine	0.0	BDL	BDL	BDL	5.4	0.2	BDL	1.7	3.4
DM-5 DUP	Palmetto Mine	0.0	BDL	BDL	BDL	5.5	0.2	BDL	BDL	3.3
DM-1	Hough Mine	0.0	49.2	26.7	0.1	61.5	27.5	0.2	9.4	32.8
DM-3	Roy Pray Mine	0.0	BDL	1,659.0	0.3	967.7	598.3	1.9	80.8	75.0
DM-4	Wyoming Mine	0.0	1.0	30.5	0.2	82.7	13.2	BDL	27.1	67.6
DM-6	BLM Adit below Confluence	0.0	BDL	BDL	BDL	4.6	BDL	BDL	BDL	14.3
DM-7	Chicago Tunnel	2.8	BDL	381.4	BDL	3,479.4	1,255.1	BDL	1,220.2	2,335.9
DM-7 DUP	Chicago Tunnel	2.8	BDL	386.3	BDL	3,639.8	1,303.9	BDL	1,185.4	2,280.1
DM-8	Highland Chief Mine	BDL	BDL	BDL	BDL	177.4	0.3	BDL	BDL	275.3
DM-9	Moro Tunnel	BDL	BDL	BDL	BDL	23.4	3.4	BDL	2.5	20.6
DM-10	Vulcan Mine	0.4	BDL	225.4	BDL	1,965.7	165.1	BDL	BDL	1,025.5
DM-11	Lucky Strike Mine	BDL	BDL	BDL	BDL	594.5	24.7	BDL	BDL	924.8
DM-14	Pride of America Mine	0.0	0.3	BDL	BDL	21.6	6.9	BDL	BDL	20.5
DM-15	Pelican Mine	BDL	BDL	BDL	BDL	59.0	2.1	BDL	30.1	320.5
DM-18	Brown Adit	BDL	BDL	BDL	BDL	35.1	0.0	BDL	11.2	119.5
BL1	Blank	0.0	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Site #	Description	Diss. Zn g/day	Tot. Al g/day	Tot. As g/day	Tot. Cd g/day	Tot. Cu g/day	Tot. Fe g/day	Tot. Pb g/day	Tot. Mg g/day	Tot. Mn g/day
HC-1	Henson Headwaters	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3,779.3	BDL
HC-2	Henson below Palmetto	527.8	366.0	BDL	2.7	BDL	BDL	BDL	8,248.1	763.8
HC-3	Henson below Redcloud	762.6	2,293.4	BDL	BDL	113.8	1,229.2	BDL	18,096.7	1,707.2
HC-3	Henson below Redcloud	596.7	BDL	BDL	BDL	BDL	BDL	BDL	11,371.8	780.6
HC-4	Henson below Schafer	953.2	BDL	BDL	BDL	BDL	BDL	BDL	30,330.5	1,032.0
HC-5	Henson above Hanna Mill	1,017.1	BDL	BDL	BDL	BDL	BDL	BDL	73,231.2	152.6
HC-5	Henson above Hanna Mill	616.2	BDL	BDL	BDL	BDL	BDL	BDL	45,358.5	85.6
HC-6	Henson above North Fork	709.5	BDL	BDL	BDL	BDL	BDL	BDL	64,739.6	88.7
HC-7	Henson above Lee Smelter	1,161.4	35,891.6	BDL	BDL	BDL	19,853.8	BDL	203,514.8	3,428.8
HC-8	Henson above Copper	932.8	29,851.0	BDL	BDL	BDL	14,289.5	BDL	161,975.7	3,349.8
HC-9	Henson above Big Casino	1,270.0	36,406.0	BDL	BDL	BDL	16,207.3	BDL	211,662.7	4,293.7
HC-10	Henson below Big Casino Gulch	1,557.3	41,504.5	BDL	BDL	BDL	17,603.9	BDL	247,131.3	5,078.0
HC-11	Henson above Nellie and Owl Gulch	1,745.0	38,465.6	BDL	BDL	BDL	16,008.4	BDL	265,541.7	4,703.9
HC-12	Henson above Ute-Ule Tailings	1,369.6	28,533.5	BDL	BDL	BDL	12,478.6	BDL	232,833.1	3,271.8
HC-13	Henson below Ute-Ule Tailings	1,228.0	27,247.1	BDL	BDL	BDL	11,666.3	BDL	231,791.9	3,146.8
HC-13 DUP	Henson below Ute-Ule Tailings	1,228.0	29,089.1	BDL	BDL	BDL	12,587.4	BDL	236,397.0	3,300.3
HC-14	Henson below Ute-Ule	3,964.4	28,807.8	BDL	BDL	BDL	13,302.7	BDL	271,339.3	5,550.1
HC-15	Henson above Alpine	5,456.7	24,425.3	BDL	BDL	BDL	14,118.2	BDL	267,638.9	5,023.6
HC-16	Henson below Alpine	5,343.3	39,384.9	BDL	BDL	BDL	15,512.7	BDL	271,471.7	4,826.2
HC-17	Henson below Pelican	5,963.2	36,129.7	BDL	BDL	BDL	14,644.8	BDL	289,388.5	4,647.8
HC-18	Henson above Lake Fork	6,790.6	35,025.1	BDL	BDL	BDL	13,134.4	BDL	282,345.5	4,110.1
PG-1	Palmetto Gulch Headwaters	0.1	BDL	BDL	BDL	BDL	BDL	BDL	20.5	0.0
PG-2	Palmetto below Sara Woods	23.8	163.7	BDL	0.2	5.2	4.0	BDL	228.8	53.5
PG-2B	Below Roy Pray (80ft from sed. pond)	352.4	549.9	BDL	2.6	33.2	701.8	1.3	1,747.0	734.5
PG-3	South Trib to Palmetto	32.0	14.0	BDL	0.1	BDL	BDL	BDL	332.9	20.9
PG-4	Palmetto Trib below Wyoming	1.5	BDL	BDL	0.0	BDL	BDL	BDL	18.3	BDL
PG-5	Below Confluence of PG-3 and PG-4	17.9	BDL	BDL	BDL	BDL	BDL	BDL	569.2	6.9
PG-6	Palmetto below Roy Pray	795.1	1,290.9	BDL	5.4	72.4	306.0	BDL	3,841.5	1,514.3
PG-7	Palmetto below Hough	10.1	BDL	BDL	0.1	BDL	BDL	BDL	430.8	8.4
PG-7A	Palmetto below Palmetto Waste Pile	6.3	BDL	BDL	BDL	BDL	BDL	BDL	660.4	5.9
PG-8	Palmetto below Palmetto Mine	7.3	BDL	BDL	BDL	BDL	BDL	BDL	907.2	12.8
PG-9	Palmetto below Tributary Confluence	721.1	970.7	BDL	4.2	54.8	239.2	BDL	4,867.1	1,144.0
PG-10	Palmetto above Henson	653.4	471.7	BDL	3.7	33.6	124.9	BDL	5,602.2	941.5

Site #	Description	Diss. Zn g/day	Tot. Al g/day	Tot. As g/day	Tot. Cd g/day	Tot. Cu g/day	Tot. Fe g/day	Tot. Pb g/day	Tot. Mg g/day	Tot. Mn g/day
PG-10 DUP	Palmetto above Henson	656.2	462.3	BDL	3.7	29.8	135.2	BDL	6,198.8	1,025.4
RC	Redcloud Gulch	13.0	BDL	BDL	BDL	BDL	BDL	BDL	371.5	5.0
SCG	Schafer Gulch	601.9	BDL	BDL	BDL	BDL	BDL	BDL	20,829.6	BDL
BGO	Below Golconda	189.0	BDL	BDL	0.5	BDL	BDL	BDL	1,413.3	1.6
NFHC-1	North Fork Henson Headwaters	BDL	BDL	BDL	BDL	BDL	BDL	BDL	24,281.6	82.8
NFHC-2	North Fork Henson above Yellowstone	290.2	51,513.3	BDL	BDL	BDL	30,230.8	BDL	117,779.2	4,425.8
NFHC-3	North Fork Henson above Henson	399.2	46,038.2	BDL	BDL	BDL	25,174.6	BDL	125,074.8	3,911.9
MHC	Matterhorn Creek	612.9	42,594.7	BDL	BDL	BDL	28,621.2	BDL	62,513.1	3,720.1
YG	Yellowstone Gulch	383.6	BDL	BDL	2.7	BDL	BDL	BDL	2,296.3	2.7
LSG	Lee Smelter Gulch	316.9	4,484.0	BDL	BDL	BDL	BDL	BDL	10,266.0	1,036.7
EPC	El Paso Creek	0.0	0.0	BDL	BDL	BDL	BDL	BDL	0.0	0.0
BCG-1	Big Casino Gulch above Pride of America	29.2	BDL	BDL	0.3	BDL	BDL	5.8	93.3	BDL
BCG-2	Big Casino Gulch below Pride of America	88.5	BDL	BDL	1.1	BDL	BDL	BDL	112.7	BDL
NC	Nellie Creek	BDL	BDL	BDL	BDL	BDL	BDL	BDL	13,004.4	77.8
OG	Owl Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4,132.0	BDL
AG	Alpine Gulch	258.2	18,505.3	BDL	BDL	BDL	7,763.6	BDL	33,051.4	464.8
DM-5	Palmetto Mine	0.1	BDL	BDL	BDL	BDL	BDL	BDL	5.3	0.2
DM-5 DUP	Palmetto Mine	0.1	BDL	BDL	BDL	BDL	BDL	BDL	5.0	0.2
DM-1	Hough Mine	29.2	54.2	BDL	0.3	49.3	30.5	0.1	68.1	29.3
DM-3	Roy Pray Mine	153.6	22.0	BDL	0.3	BDL	1,790.7	0.3	1,008.8	611.3
DM-4	Wyoming Mine	49.4	11.1	BDL	0.2	1.2	79.4	2.3	80.1	12.9
DM-6	BLM Adit below Confluence	0.1	BDL	BDL	BDL	BDL	BDL	BDL	4.9	BDL
DM-7	Chicago Tunnel	573.9	170.8	BDL	3.5	BDL	1,743.2	BDL	3,395.8	1,262.1
DM-7 DUP	Chicago Tunnel	589.9	172.9	BDL	3.5	BDL	1,750.2	BDL	3,381.8	1,262.1
DM-8	Highland Chief Mine	4.1	BDL	BDL	BDL	BDL	BDL	BDL	188.0	0.4
DM-9	Moro Tunnel	BDL	BDL	BDL	BDL	BDL	0.6	BDL	23.3	5.0
DM-10	Vulcan Mine	13.6	BDL	BDL	BDL	BDL	209.2	BDL	1,939.3	164.7
DM-11	Lucky Strike Mine	BDL	BDL	BDL	BDL	BDL	BDL	BDL	575.4	25.0
DM-14	Pride of America Mine	146.4	5.7	BDL	1.6	4.3	27.7	1.3	24.3	7.8
DM-15	Pelican Mine	1.7	BDL	BDL	BDL	BDL	BDL	BDL	58.8	2.1
DM-18	Brown Adit	0.2	BDL	BDL	BDL	BDL	BDL	BDL	36.7	0.0
BL1	Blank	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Site #	Description	Tot. Ni g/day	Tot. K g/day	Tot. Zn g/day	SO4 g/day	Total Alkalinity g/day
HC-1	Henson Headwaters	BDL	BDL	BDL	19,493.0	103,432.5
HC-2	Henson below Palmetto	BDL	BDL	503.9	142,153.3	116,693.0
HC-3	Henson below Redcloud	BDL	BDL	927.6	328,358.7	218,526.4
HC-3	Henson below Redcloud	BDL	BDL	544.2	212,424.6	162,883.9
HC-4	Henson below Schafer	BDL	BDL	921.7	564,856.3	231,614.7
HC-5	Henson above Hanna Mill	BDL	BDL	813.7	1,655,331.1	788,252.9
HC-5	Henson above Hanna Mill	BDL	BDL	582.0	1,186,167.5	581,958.1
HC-6	Henson above North Fork	BDL	BDL	709.5	1,454,423.5	713,909.1
HC-7	Henson above Lee Smelter	BDL	BDL	1,548.5	3,810,373.0	1,957,724.3
HC-8	Henson above Copper	BDL	BDL	1,399.3	3,074,146.8	1,437,428.6
HC-9	Henson above Big Casino	BDL	BDL	1,753.8	4,124,399.0	1,904,964.4
HC-10	Henson below Big Casino Gulch	BDL	BDL	2,098.9	4,577,007.3	2,146,318.5
HC-11	Henson above Nellie and Owl Gulch	BDL	BDL	2,048.5	5,090,814.3	2,480,918.5
HC-12	Henson above Ute Ulay Tailings	BDL	BDL	1,597.9	4,222,953.9	2,480,509.9
HC-13	Henson below Ute-Ule Tailings	BDL	BDL	1,535.0	4,336,504.3	2,532,825.5
HC-13 DUP	Henson below Ute-Ule Tailings	BDL	BDL	1,611.8	4,290,452.9	2,525,150.3
HC-14	Henson below Ute-Ule	BDL	BDL	4,228.7	4,977,490.3	2,889,587.3
HC-15	Henson above Alpine	BDL	BDL	5,629.9	4,885,059.7	2,892,925.4
HC-16	Henson below Alpine	BDL	BDL	5,515.6	5,015,762.4	2,602,680.8
HC-17	Henson below Pelican	BDL	BDL	6,840.1	5,130,068.8	2,674,651.3
HC-18	Henson above Lake Fork	BDL	BDL	7,058.6	5,182,290.3	2,734,104.9
PG-1	Palmetto Gulch Headwaters	BDL	BDL	0.1	420.0	459.1
PG-2	Palmetto below Sara Woods	0.5	BDL	23.2	6,093.6	379.2
PG-2B	Below Roy Pray (80ft from sed. pond)	4.8	130.0	366.3	43,675.9	BDL
PG-3	South Trib to Palmetto	0.2	BDL	32.2	10,088.2	1,068.2
PG-4	Palmetto Trib below Wyoming	BDL	BDL	1.5	623.4	211.6
PG-5	Below Confluence of PG-3 and PG-4	BDL	BDL	19.3	18,540.0	3,889.5
PG-6	Palmetto below Roy Pray	9.8	263.5	801.8	93,133.9	BDL
PG-7	Palmetto below Hough	BDL	145.9	8.8	9,549.1	2,680.1
PG-7A	Palmetto below Palmetto Waste Pile	BDL	259.3	6.5	13,309.4	6,725.6
PG-8	Palmetto below Palmetto Mine	BDL	297.5	5.3	16,248.4	BDL
PG-9	Palmetto below Tributary Confluence	8.3	BDL	682.9	121,331.8	13,242.5
PG-10	Palmetto above Henson	7.5	BDL	598.4	143,551.8	22,931.0

Site #	Description	Tot. Ni g/day	Tot. K g/day	Tot. Zn g/day	SO4 g/day	Total Alkalinity g/day
PG-10 DUP	Palmetto above Henson	7.5	BDL	644.1	143,551.8	22,931.0
RC	Redcloud Gulch	BDL	BDL	12.3	12,217.8	3,903.7
SCG	Schafer Gulch	BDL	BDL	584.6	385,412.9	63,658.1
BGO	Below Golconda	BDL	BDL	193.1	19,776.2	BDL
NFHC-1	North Fork Henson Headwaters	BDL	BDL	165.6	71,741.2	677,402.1
NFHC-2	North Fork Henson above Yellowstone	BDL	BDL	628.8	1,562,327.8	827,114.7
NFHC-3	North Fork Henson above Henson	BDL	BDL	1,011.2	1,705,807.9	1,000,598.7
MHC	Matterhorn Creek	30.6	BDL	619.0	1,041,884.6	BDL
YG	Yellowstone Gulch	BDL	BDL	363.2	17,579.6	55,532.5
LSG	Lee Smelter Gulch	15.2	1,904.8	284.9	298,370.2	BDL
EPC	El Paso Creek	BDL	0.0	0.0	0.0	0.0
BCG-1	Big Casino Gulch above Pride of America	BDL	BDL	28.7	2,232.9	1,537.6
BCG-2	Big Casino Gulch below Pride of America	BDL	BDL	80.6	3,033.8	1,597.1
NC	Nellie Creek	BDL	BDL	BDL	26,675.8	331,224.1
OG	Owl Gulch	BDL	BDL	BDL	117,953.5	53,151.9
AG	Alpine Gulch	BDL	12,050.0	223.8	726,442.5	BDL
DM-5	Palmetto Mine	BDL	1.7	0.1	117.0	57.1
DM-5 DUP	Palmetto Mine	BDL	1.8	0.1	117.1	57.0
DM-1	Hough Mine	0.2	10.3	31.4	1,636.8	BDL
DM-3	Roy Pray Mine	1.9	83.6	161.6	30,241.4	1,767.0
DM-4	Wyoming Mine	BDL	29.0	48.4	3,236.9	BDL
DM-6	BLM Adit below Confluence	BDL	BDL	BDL	22.1	264.5
DM-7	Chicago Tunnel	BDL	1,122.6	523.0	67,357.3	46,857.3
DM-7 DUP	Chicago Tunnel	BDL	1,143.5	520.9	67,706.0	46,927.0
DM-8	Highland Chief Mine	BDL	BDL	3.8	3,164.4	6,307.6
DM-9	Moro Tunnel	BDL	BDL	BDL	479.5	228.3
DM-10	Vulcan Mine	BDL	BDL	14.8	36,146.1	21,119.1
DM-11	Lucky Strike Mine	BDL	BDL	BDL	60,039.6	7,229.7
DM-14	Pride of America Mine	BDL	BDL	168.3	970.8	241.9
DM-15	Pelican Mine	BDL	27.5	1.6	2,992.6	1,062.9
DM-18	Brown Adit	BDL	10.3	0.2	186.8	780.5
BL1	Blank	BDL	BDL	BDL	BDL	BDL

APPENDIX 5

MINING WASTE RESULTS

Site #	Description	Latitude			Longitude			pH	EC	Acidity	Ag	Al	As
		Deg.	Min.	Sec.	Deg.	Min.	Sec.	s.u.	uS	mg/l	ug/l	ug/l	ug/l
1	Upper Hough Mine	37	58	23.09	107	34	57.45	2.64	2,510	1590	BDL	63019.4	6994.4
2	Lower Hough Mine	37	58	23.09	107	34	57.45	2.4	4,490	3750	BDL	148703.3	26697.5
3	Backfilled shaft north of Sara Woods	37	58	16.80	107	34	48.90	3.45	125	42	BDL	214.2	BDL
4	Upper Sara Woods Mine	37	58	7.99	107	34	46.02	4.26	50	20	BDL	45.8	BDL
5	Lower Sara Woods Mine	37	58	11.91	107	34	45.37	2.49	2,700	1204	BDL	34537.2	4472.8
6	Dump East of lower Sara Woods Mine	37	58	12.65	107	34	42.72	3.2	154	34	BDL	124.3	BDL
7	Dump above Horsethief Trail	37	58	48.70	107	34	44.10	4.63	23	18	BDL	76.9	BDL
8	Miners Bank Mine	37	58	20.90	107	34	36.30	3.05	699	148	BDL	3217.2	96.7
9	Wyoming Mine	37	58	9.62	107	34	32.88	3.23	337	78	BDL	583.1	BDL
10	Engineer Mine	37	58	1.46	107	34	28.71	6.58	24	100	BDL	16.8	44.4
11	Hofman Mine	37	58	7.00	107	34	23.00	3.3	164	38	BDL	152.4	BDL
12	Upper Emporer. Wilhelm Mine	37	58	18.04	107	34	23.49	3	598	106	BDL	593.1	BDL
13	Lower Emperor Wilhelm	37	58	19.78	107	34	20.83	3.85	88	22	BDL	45.0	BDL
14	Collapsed Adit between Palmetto and Roy Pray	37	58	31.60	107	34	30.50	3.77	170	54	BDL	75.8	BDL
15	Second Dump above Palmetto Mine	37	58	37.50	107	34	28.00	3.32	179	38	BDL	123.8	BDL
16	Dump across stream from Palmetto Mine	37	58	40.30	107	34	26.40	5.76	2,300	52	7.3	14.1	BDL
17	Palmetto Mine	37	58	41.39	107	34	23.49	4.8	207	38	BDL	393.9	BDL
18	Mill across from Thoreau's Cabin	37	58	54.76	107	33	34.72	3.95	82	34	6.0	100.0	BDL
19	Mine near Stream in Redcloud	37	58	22.42	107	33	48.76	6.45	54	24	BDL	32.4	BDL
20	Mine on Southwest side of Redcloud	37	58	12.70	107	33	50.30	6.16	24	50	BDL	25.5	BDL
21	Mine Near Ridge on North Side of Schafer	37	58	8.05	107	33	32.37	4.39	35	16	BDL	157.2	70.4
22	Mine at Headwaters of Northwest Schafer Trib	37	57	55.14	107	33	49.86	4.35	32	26	BDL	40.8	BDL
23	Mine on Southwest side of Northwest Schafer Trib	37	57	46.24	107	33	44.52	3.55	69	12	BDL	75.5	BDL
24	Mine Below Siegel Mountain in Schafer Gulch	37	57	38.54	107	33	36.35	3.79	51	18	BDL	84.7	BDL

Site #	Description	Latitude			Longitude			pH	EC	Acidity	Ag	Al	As
		Deg.	Min.	Sec.	Deg.	Min.	Sec.	s.u.	uS	mg/l	ug/l	ug/l	ug/l
25	Mine on West Side of Henson Between Redcloud and Schafer	37	58	28.27	107	33	9.46	4.14	121	20	BDL	174.7	BDL
26	Lower Golconda Mine	37	57	20.20	107	32	52.83	4.16	54	28	BDL	12.3	BDL
27	Upper Golconda Mine	37	57	15.29	107	32	49.11	4.87	18	20	BDL	808.1	BDL
28	Lower Mine on Northwest Side of Gravel Mountain	37	57	26.62	107	32	29.07	5.33	26	8	BDL	12.6	BDL
29	Upper Mine on Northwest Side of Gravel Mountain	37	57	28.56	107	32	28.25	6.42	17	34	BDL	BDL	BDL
30	Chicago Tunnel	37	58	20.05	107	32	36.16	5.58	84	18	BDL	27.6	BDL
31	Upper Dolly Varden Fine Waste	37	59	21.74	107	32	14.64	5.69	18	80	BDL	BDL	BDL
32	Upper Dolly Varden Brown Waste	37	59	21.74	107	32	14.64	5.14	20	12	BDL	27.3	BDL
33	Lower Dolly Varden	37	59	13.80	107	32	7.72	4.88	138	29	BDL	170.8	BDL
34	Horseshoe Basin Mine West	37	57	30.66	107	31	41.91	3.91	42	36	BDL	14.4	BDL
35	Highland Chief Mine	37	58	27.55	107	31	17.11	5.13	899	24	BDL	19.1	BDL
36	Schafer Basin Mine West Side	37	57	39.91	107	30	28.28	3.64	228	57	BDL	276.0	BDL
37	Schafer Basin Mine East Side Upper	37	57	31.61	107	30	18.57	5.25	48	30	BDL	25.1	BDL
38	Schafer Basin Mine East Side Lower	37	57	50.30	107	30	6.51	5.13	62	21	BDL	17.2	BDL
39	Moro Tunnel	37	59	44.16	107	28	45.92	4.61	46	16	BDL	46.4	BDL
40	Hanna Mill Tailings	37	59	48.85	107	28	22.93	5.58	92	44	BDL	59.7	BDL
41	Vulcan Mine	38	0	57.62	107	28	51.57	6.7	73	24	BDL	173.2	BDL
42	Yellowstone Mill Tailings East	38	0	53.96	107	28	17.57	5.19	219	94	BDL	168.8	BDL
43	Yellowstone Mill Tailings West	38	0	53.05	107	28	19.30	3.69	291	90	BDL	581.7	BDL
44	Capital City Mine	38	1	6.60	107	28	14.19	4.86	955	314	BDL	104.0	BDL
45	Yellow Medicine Mine	38	1	10.79	107	28	7.79	4.32	80	20	BDL	117.2	BDL
46	Mountain Belle Lode	38	1	7.60	107	28	6.70	5.2	230	54	BDL	158.3	BDL
47	Dump at gate below Czarina (Broker Lode)	38	0	45.90	107	27	57.70	3.8	321	46	BDL	767.2	BDL
48	Excelsior Lode	38	0	43.20	107	27	58.30	2.84	727	81	5.2	3336.5	BDL
49	Lucky Strike Mine	38	0	31.70	107	27	54.10	5.11	65	20	BDL	69.6	BDL
50	Vermont Mine	38	0	57.52	107	26	21.65	4.35	41	30	BDL	155.6	BDL
51	Four Aces Lode	38	0	37.20	107	25	56.79	3.99	48	18	BDL	16.5	BDL
52	Little Casino	38	0	37.95	107	25	51.93	4.37	56	38	BDL	BDL	BDL

Site #	Description	Latitude			Longitude			pH	EC	Acidity	Ag	Al	As
		Deg.	Min.	Sec.	Deg.	Min.	Sec.	s.u.	uS	mg/l	ug/l	ug/l	ug/l
53	Four Aces Lode	38	0	38.70	107	25	56.20	3.84	123	38	BDL	85.1	BDL
54	Wave of the Ocean	38	1	7.00	107	25	49.60	3.63	229	66	BDL	358.6	BDL
55	Red Rover Tunnel/Little Hattie Lode	38	0	59.61	107	25	45.53	4.81	678	44	BDL	117.1	BDL
56	Pride of America Mine	38	0	53.40	107	25	37.70	2.07	653	74	BDL	12.5	BDL
57	Owl Gulch Mine	38	0	19.99	107	24	25.19	5.91	40	22	BDL	35.9	BDL
58	Yellow Jacket 2nd Level	38	1	13.57	107	24	21.81	3.51	104	42	BDL	17.9	BDL
59	Yellow Jacket 1st Level	38	1	15.41	107	24	19.02	6.46	49	40	BDL	25.2	BDL
60	Hidden Treasure Tailings	38	1	7.00	107	21	28.00	4.67	339	80	BDL	116.0	BDL
61	Risorgiomento Mine	38	1	10.20	107	20	37.50	2.73	1,458	370	BDL	10612.3	BDL
62	Mountain Chief Lower	38	1	6.90	107	21	2.00	4.54	70	34	BDL	44.0	BDL
63	Mountain Chief Upper	38	1	15.50	107	20	34.00	4.59	135	32	BDL	BDL	BDL
64	Lower Pelican Mine	38	1	27.07	107	20	23.14	4.44	280	26	BDL	42.2	BDL
65	Middle Pellican Mine	38	1	29.70	107	20	21.31	4.59	48	14	BDL	33.5	BDL
66	Upper Pellic Mine	38	1	31.20	107	20	20.36	4.68	32	16	BDL	214.4	BDL
67	Iron Bed 1 in Matterhorn Gulch	38	3	2.42	107	29	19.88	4.58	57	14	BDL	BDL	BDL
68	Iron Bed 2 in Matterhorn Gulch	38	2	49.64	107	29	16.11	5.04	21	140	BDL	19.5	BDL

Site #	Description	B	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	K	Li	Mg	Mn	Mo
		ug/l	ug/l	ug/l	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l	ug/l	mg/l	ug/l	ug/l
1	Upper Hough Mine	BDL	BDL	3.7	95.1	284.3	196.7	17.8	49826.4	256510.6	BDL	66.7	27.2	4090.6	15.6
2	Lower Hough Mine	BDL	7.3	11.7	174.9	527.6	473.4	47.0	102096.6	688856.0	B.D.L.	146.2	59.9	11961.4	39.8
3	Backfilled shaft north of Sara Woods	198.9	BDL	BDL	2.9	BDL	BDL	BDL	47.8	110.6	1.4	13.5	0.7	173.3	BDL
4	Upper Sara Woods Mine	221.9	65.8	BDL	3.1	BDL	BDL	BDL	11.0	19.5	1.7	3.0	0.4	149.7	BDL
5	Lower Sara Woods Mine	BDL	12.2	1.1	5.3	21.5	125.4	19.9	5693.1	493956.7	BDL	38.6	10.6	1331.4	72.3
6	Dump East of lower Sara Woods Mine	50.9	BDL	BDL	0.7	BDL	BDL	BDL	81.2	829.1	0.7	15.1	0.4	137.8	BDL
7	Dump above Horsethief Trail	69.7	9.8	BDL	0.8	BDL	BDL	BDL	BDL	130.5	1.3	BDL	0.1	37.9	BDL
8	Miners Bank Mine	136.1	BDL	BDL	3.6	31.4	10.3	BDL	1151.6	5942.2	0.3	9.6	1.9	235.0	BDL
9	Wyoming Mine	247.2	BDL	BDL	7.2	40.4	4.0	BDL	179.5	302.3	0.4	6.6	0.6	138.9	BDL
10	Engineer Mine	137.5	4.7	BDL	1.0	BDL	BDL	BDL	11.9	BDL	1.6	2.1	0.2	14.7	BDL
11	Hofman Mine	188.2	6.0	BDL	2.2	1.6	BDL	BDL	16.7	213.8	0.1	6.8	0.5	1023.5	BDL
12	Upper Emporer. Wilhelm Mine	44.6	20.4	BDL	7.6	26.6	5.5	BDL	246.8	1343.1	1.2	5.3	0.8	1400.4	BDL
13	Lower Emperor Wilhelm	219.5	BDL	BDL	3.5	3.6	BDL	BDL	56.5	12.0	2.9	4.1	0.3	320.6	BDL
14	Collapsed Adit between Palmetto and Roy Pray	201.7	BDL	BDL	1.5	BDL	BDL	BDL	28.2	329.3	1.8	8.5	0.4	103.3	BDL
15	Second Dump above Palmetto Mine	BDL	BDL	BDL	2.5	1.3	BDL	BDL	45.2	561.8	0.8	7.2	0.5	74.9	BDL
16	Dump across stream from Palmetto Mine	BDL	BDL	BDL	356.0	BDL	11.2	BDL	45.2	278.7	1.4	5.5		210.8	13.0
17	Palmetto Mine	269.4	5.3	BDL	19.8	5.7	8.7	BDL	96.6	47.6	1.6	11.8	1.8	1597.0	BDL
18	Mill across from Thoreau's Cabin	66.9	BDL	BDL	1.5	4.5	BDL	BDL	22.8	88.9	0.9	1.4	0.3	45.2	BDL
19	Mine near Stream in Redcloud	64.2	BDL	BDL	0.4	BDL	BDL	BDL	8.3	133.1	1.4	2.2	0.1	65.3	BDL
20	Mine on Southwest side of Redcloud	203.5	BDL	BDL	2.6	BDL	BDL	BDL	BDL	15.3	1.3	3.4	0.3	10.7	BDL
21	Mine Near Ridge on North Side of Schafer	150.1	11.8	BDL	0.3	BDL	BDL	BDL	18.9	877.9	1.7	3.5	0.1	86.5	BDL
22	Mine at Headwaters of Northwest Schafer Trib	47.2	BDL	BDL	0.4	BDL	BDL	BDL	13.8	85.0	1.4	4.2	0.1	68.4	BDL

Site #	Description	B	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	K	Li	Mg	Mn	Mo
		ug/l	ug/l	ug/l	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l	ug/l	mg/l	ug/l	ug/l
23	Mine on Southwest side of Northwest Schafer Trib	68.7	BDL	BDL	1.8	1.4	BDL	BDL	29.1	38.5	0.9	4.2	0.5	78.7	BDL
24	Mine Below Siegel Mountain in Schafer Gulch	194.5	6.6	BDL	1.9	BDL	BDL	BDL	5.5	487.2	1.5	6.3	0.5	43.6	BDL
25	Mine on West Side of Henson Between Redcloud and Schafer	153.3	12.6	BDL	11.0	5.7	BDL	BDL	46.3	10.5	2.3	9.9	1.2	1533.9	BDL
26	Lower Golconda Mine	214.8	6.6	BDL	2.7	1.4	BDL	BDL	14.7	13.7	3.0	3.9	0.3	221.0	BDL
27	Upper Golconda Mine	116.7	13.4	BDL	123.5	826.9	49.4	BDL	10925.2	69.2	6.1	14.5	3.6	3297.3	BDL
28	Lower Mine on Northwest Side of Gravel Mountain	185.2	BDL	BDL	0.9	BDL	BDL	BDL	BDL	BDL	1.3	8.3	0.2	40.1	7.0
29	Upper Mine on Northwest Side of Gravel Mountain	64.5	BDL	BDL	0.3	BDL	BDL	BDL	12.1	65.5	0.9	BDL	0.0	16.6	BDL
30	Chicago Tunnel	220.1	BDL	BDL	11.3	BDL	BDL	BDL	BDL	54.5	2.5	4.4	0.6	8.7	BDL
31	Upper Dolly Varden Fine Waste	131.5	BDL	BDL	0.8	BDL	BDL	BDL	9.9	18.3	1.5	2.4	0.1	12.9	BDL
32	Upper Dolly Varden Brown Waste	123.5	BDL	BDL	0.7	BDL	BDL	BDL	10.0	37.5	1.5	1.4	0.1	41.6	BDL
33	Lower Dolly Varden	266.2	5.4	BDL	2.0	BDL	BDL	BDL	210.7	224.4	4.3	5.2	0.5	223.0	BDL
34	Horseshoe Basin Mine West	286.5	BDL	BDL	0.6	BDL	BDL	BDL	43.2	62.1	2.1	1.7	0.1	107.2	BDL
35	Highland Chief Mine	212.6	9.7	BDL	157.3	24.2	BDL	BDL	52.2	BDL	4.3	10.8	4.9	4007.9	BDL
36	Schafer Basin Mine West Side	220.5	49.5	0.4	11.6	62.5	4.1	BDL	3496.1	21.2	3.3	26.1	2.1	1948.0	BDL
37	Schafer Basin Mine East Side Upper	266.2	BDL	BDL	6.9	BDL	BDL	BDL	4.0	15.8	1.9	1.6	0.1	4.1	6.8
38	Schafer Basin Mine East Side Lower	225.2	BDL	BDL	2.0	6.1	BDL	BDL	206.4	11.7	4.2	4.0	0.1	115.2	BDL
39	Moro Tunnel	238.1	11.1	BDL	2.3	2.0	BDL	BDL	12.2	61.2	1.6	16.5	0.3	265.5	26.1
40	Hanna Mill Tailings	260.1	79.4	BDL	2.5	56.5	BDL	BDL	1594.9	38.3	1.5	6.2	0.5	153.5	BDL
41	Vulcan Mine	150.8	16.1	BDL	0.7	13.1	BDL	BDL	128.0	47.7	1.6	14.1	0.1	24.0	24.6
42	Yellowstone Mill Tailings East	153.5	15.0	BDL	7.4	309.5	16.1	BDL	3361.9	394.1	2.9	4.4	1.9	1150.9	BDL
43	Yellowstone Mill Tailings West	128.4	17.8	BDL	5.3	180.6	4.1	BDL	4104.7	312.0	1.4	8.0	2.3	346.4	BDL

Site #	Description	B	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	K	Li	Mg	Mn	Mo
		ug/l	ug/l	ug/l	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l	ug/l	mg/l	ug/l	ug/l
44	Capital City Mine	117.9	BDL	BDL	3.0	6.2	BDL	BDL	20.7	63.0	1.4	9.1	0.6	528.8	4.8
45	Yellow Medicine Mine	BDL	17.9	BDL	1.7	7.8	BDL	BDL	155.9	74.5	1.5	6.6	0.2	137.7	5.5
46	Mountain Belle Lode	268.4	55.9	BDL	22.3	48.6	BDL	BDL	155.6	74.2	4.7	5.7	1.1	573.1	BDL
47	Dump at gate below Czarina (Broker Lode)	221.1	175.7	2.5	24.4	87.6	39.2	BDL	3854.0	84.7	6.4	6.4	4.7	10310.9	BDL
48	Excelsior Lode	182.0	30.9	BDL	4.8	152.9	25.7	BDL	10694.5	1951.6	1.1	8.9	2.1	426.2	BDL
49	Lucky Strike Mine	257.1	BDL	BDL	4.2	BDL	BDL	BDL	4.8	10.0	2.8	8.0	0.5	379.7	BDL
50	Vermont Mine	65.9	17.3	BDL	0.6	10.4	BDL	BDL	118.6	26.9	1.5	1.5	0.1	21.5	BDL
51	Four Aces Lode	47.1	9.4	BDL	0.7	BDL	BDL	BDL	8.4	80.6	1.2	3.8	0.2	33.7	BDL
52	Little Casino	254.8	37.2	BDL	0.4	14.0	BDL	BDL	23.5	BDL	1.4	1.9	0.1	230.2	BDL
53	Four Aces Lode	50.2	52.0	BDL	2.8	80.7	BDL	BDL	48.7	159.6	2.7	3.3	0.4	679.4	BDL
54	Wave of the Ocean	258.0	27.3	1.1	7.4	54.2	19.6	BDL	3234.7	119.2	2.9	6.2	1.2	2822.9	BDL
55	Red Rover Tunnel/Little Hattie Lode	283.4	118.4	BDL	102.6	73.3	12.8	BDL	187.7	BDL	4.9	15.0	4.7	2177.8	BDL
56	Pride of America Mine	110.3	28.0	BDL	97.9	391.8	4.2	BDL	123.7	7.3	1.7	8.9	4.0	4191.8	BDL
57	Owl Gulch Mine	157.8	15.4	BDL	2.6	BDL	BDL	BDL	37.9	16.3	2.9	BDL	0.4	79.3	BDL
58	Yellow Jacket 2nd Level	307.8	25.3	BDL	0.5	BDL	BDL	BDL	15.1	80.9	1.0	17.0	0.1	289.9	27.4
59	Yellow Jacket 1st Level	217.6	19.2	BDL	1.9	BDL	BDL	BDL	9.7	31.5	2.1	2.4	0.2	223.9	BDL
60	Hidden Treasure Tailings	262.0	21.6	BDL	12.8	365.5	4.7	BDL	132.4	BDL	1.5	4.2	2.9	38469.1	BDL
61	Risorgiomento Mine	226.0	BDL	19.3	85.7	50.2	42.9	BDL	1610.4	27776.2	0.3	30.1	5.4	13916.4	44.2
62	Mountain Chief Lower	264.4	56.8	BDL	2.7	5.7	BDL	BDL	13.9	10.8	3.5	2.9	0.4	2665.5	BDL
63	Mountain Chief Upper	267.3	37.5	BDL	9.0	12.5	BDL	BDL	BDL	5.1	2.9	2.8	1.6	6470.6	BDL
64	Lower Pelican Mine	258.4	84.1	BDL	34.4	13.3	BDL	BDL	15.2	18.4	5.4	11.4	3.5	2730.7	6.2
65	Middle Pellican Mine	126.9	96.5	BDL	1.5	7.2	BDL	BDL	89.1	12.2	2.8	2.2	0.2	351.9	BDL
66	Upper Pellic Mine	151.6	29.7	BDL	0.8	BDL	BDL	BDL	8.3	435.3	3.8	BDL	0.2	200.1	BDL
67	Iron Bed 1 in Matterhorn Gulch	117.0	BDL	BDL	0.7	BDL	BDL	BDL	3.4	37.5	0.9	2.7	0.1	29.9	BDL
68	Iron Bed 2 in Matterhorn Gulch	117.9	31.7	BDL	0.5	BDL	BDL	BDL	4.1	74.7	1.1	2.4	0.1	10.5	BDL

Site #	Description	Na	Ni	P	Pb	S	Sb	Se	Si	Sn	Sr	Ti	V	Zn
		mg/l	ug/l	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
1	Upper Hough Mine	BDL	129.6	7.7	337.8	510612.4	BDL	BDL	1097.4	61.8	183.9	BDL	58.1	34863.2
2	Lower Hough Mine	0.5	306.1	46.2	619.2	1320090.7	BDL	62.4	2137.4	159.1	398.0	BDL	345.3	63968.0
3	Backfilled shaft north of Sara Woods	0.0	BDL	BDL	BDL	9936.7	BDL	BDL	832.6	BDL	7.9	BDL	BDL	280.5
4	Upper Sara Woods Mine	0.2	BDL	0.2	BDL	1761.0	BDL	BDL	688.4	BDL	8.0	BDL	BDL	22.9
5	Lower Sara Woods Mine	0.1	75.2	4.9	181.2	518155.9	11.9	61.9	668.8	62.6	119.8	BDL	240.9	1296.4
6	Dump East of lower Sara Woods Mine	0.2	BDL	BDL	BDL	8291.2	13.1	BDL	404.5	BDL	2.0	BDL	BDL	136.6
7	Dump above Horsethief Trail	0.2	BDL	0.2	BDL	516.7	BDL	BDL	566.1	BDL	2.7	1.0	BDL	4.9
8	Miners Bank Mine	0.0	9.9	BDL	BDL	49979.8	14.4	BDL	105.2	BDL	3.4	BDL	13.8	5494.7
9	Wyoming Mine	0.1	BDL	BDL	BDL	24763.8	BDL	BDL	1370.5	BDL	41.7	BDL	BDL	6613.9
10	Engineer Mine	BDL	BDL	BDL	BDL	BDL	20.3	0.3	BDL	3.9	3.7	BDL	BDL	46.9
11	Hofman Mine	0.4	BDL	BDL	BDL	9809.2	BDL	BDL	506.2	BDL	0.5	BDL	BDL	372.0
12	Upper Emporer. Wilhelm Mine	0.0	6.1	BDL	88.2	26166.5	BDL	BDL	225.7	BDL	5.4	BDL	BDL	4158.6
13	Lower Emperor Wilhelm	0.1	BDL	BDL	BDL	7512.8	BDL	BDL	625.4	BDL	14.8	BDL	BDL	555.1
14	Collapsed Adit between Palmetto and Roy Pray	0.3	BDL	BDL	BDL	11485.3	BDL	BDL	496.4	BDL	3.4	BDL	BDL	211.0
15	Second Dump above Palmetto Mine	0.1	BDL	BDL	BDL	9325.5	BDL	BDL	242.9	BDL	1.9	BDL	BDL	465.7
16	Dump across stream from Palmetto Mine	1.3	11.9	BDL	BDL	470861.7	BDL	BDL	799.3	69.7	259.9	BDL	BDL	20.9
17	Palmetto Mine	0.1	8.8	BDL	BDL	26985.1	BDL	BDL	1390.6	BDL	14.9	BDL	BDL	879.1
18	Mill across from Thoreau's Cabin	0.3	BDL	BDL	BDL	6884.9	BDL	BDL	621.5	BDL	7.0	BDL	BDL	819.3
19	Mine near Stream in Redcloud	0.1	BDL	BDL	BDL	3599.8	BDL	BDL	458.2	BDL	1.1	BDL	BDL	48.7
20	Mine on Southwest side of Redcloud	0.5	BDL	0.1	BDL	1015.5	BDL	BDL	765.4	BDL	5.8	BDL	BDL	BDL
21	Mine Near Ridge on North Side of Schafer	BDL	BDL	BDL	130.0	2152.5	BDL	BDL	702.1	BDL	2.4	BDL	BDL	166.7
22	Mine at Headwaters of Northwest Schafer Trib	0.1	BDL	BDL	BDL	2057.2	10.7	BDL	530.0	BDL	0.4	BDL	BDL	28.2
23	Mine on Southwest side of Northwest Schafer Trib	0.4	BDL	BDL	BDL	4987.1	BDL	BDL	441.9	BDL	7.4	BDL	BDL	478.5

Site #	Description	Na	Ni	P	Pb	S	Sb	Se	Si	Sn	Sr	Ti	V	Zn
		mg/l	ug/l	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
24	Mine Below Siegel Mountain in Schafer Gulch	0.5	BDL	BDL	BDL	3781.9	BDL	BDL	1032.4	BDL	2.5	BDL	BDL	20.6
25	Mine on West Side of Henson Between Redcloud and Schafer	0.6	BDL	BDL	BDL	15255.8	BDL	BDL	1059.5	BDL	22.1	BDL	BDL	674.8
26	Lower Golconda Mine	0.1	BDL	BDL	29.3	4310.0	BDL	BDL	714.5	BDL	4.5	BDL	BDL	290.5
27	Upper Golconda Mine	0.3	75.5	0.1	2935.9	183007.0	BDL	BDL	760.6	BDL	111.8	BDL	BDL	120377.2
28	Lower Mine on Northwest Side of Gravel Mountain	0.3	BDL	BDL	BDL	1711.7	BDL	BDL	596.9	BDL	0.4	BDL	BDL	53.9
29	Upper Mine on Northwest Side of Gravel Mountain	BDL	7.1	BDL	BDL	840.2	BDL	BDL	372.6	BDL	BDL	BDL	BDL	14.3
30	Chicago Tunnel	0.2	BDL	BDL	BDL	3406.7	BDL	BDL	1007.4	BDL	32.3	BDL	BDL	35.1
31	Upper Dolly Varden Fine Waste	0.1	BDL	BDL	BDL	257.1	BDL	BDL	479.1	BDL	3.6	BDL	BDL	50.6
32	Upper Dolly Varden Brown Waste	0.1	BDL	0.2	BDL	634.3	BDL	BDL	628.8	BDL	2.3	BDL	BDL	37.1
33	Lower Dolly Varden	0.3	BDL	0.3	BDL	1876.6	20.5	BDL	1406.7	BDL	9.0	BDL	BDL	180.9
34	Horseshoe Basin Mine West	0.0	BDL	BDL	54.4	2424.5	BDL	BDL	715.8	BDL	0.7	BDL	BDL	108.9
35	Highland Chief Mine	0.2	BDL	BDL	BDL	159584.9	BDL	BDL	922.4	29.4	244.2	BDL	BDL	4043.1
36	Schafer Basin Mine West Side	0.2	BDL	0.1	2778.0	27764.0	BDL	BDL	1145.6	BDL	23.4	BDL	BDL	8430.1
37	Schafer Basin Mine East Side Upper	0.1	BDL	BDL	BDL	1150.6	BDL	BDL	528.5	BDL	11.6	BDL	BDL	6.0
38	Schafer Basin Mine East Side Lower	0.2	BDL	BDL	136.1	4329.9	BDL	BDL	1225.0	BDL	2.6	BDL	BDL	548.3
39	Moro Tunnel	0.3	BDL	0.2	24.1	3913.9	BDL	BDL	456.9	BDL	6.2	BDL	BDL	376.8
40	Hanna Mill Tailings	0.4	BDL	BDL	1071.0	7297.7	BDL	BDL	987.5	BDL	29.4	BDL	BDL	8919.4
41	Vulcan Mine	0.1	BDL	BDL	539.6	2336.6	BDL	BDL	842.2	BDL	4.5	BDL	BDL	888.4
42	Yellowstone Mill Tailings East	1.6	9.2	BDL	5029.3	39453.3	BDL	BDL	895.3	BDL	32.8	BDL	BDL	49854.1
43	Yellowstone Mill Tailings West	0.4	10.5	BDL	4676.3	33752.7	BDL	BDL	308.6	BDL	18.8	BDL	BDL	30490.5
44	Capital City Mine	0.6	BDL	BDL	BDL	6173.6	BDL	BDL	792.8	BDL	6.5	BDL	BDL	1016.0
45	Yellow Medicine Mine	0.1	BDL	BDL	719.9	4182.3	BDL	BDL	691.4	BDL	6.1	BDL	BDL	1656.9
46	Mountain Belle Lode	0.1	BDL	BDL	137.8	28538.9	BDL	BDL	1663.0	BDL	52.8	BDL	BDL	6029.4
47	Dump at gate below Czarina (Broker Lode)	0.9	7.5	BDL	2330.8	52382.8	BDL	BDL	720.6	BDL	111.9	BDL	BDL	13620.0
48	Excelsior Lode	1.0	6.9	0.5	1386.7	60751.6	18.9	BDL	424.5	BDL	22.8	BDL	BDL	29081.3

Site #	Description	Na	Ni	P	Pb	S	Sb	Se	Si	Sn	Sr	Ti	V	Zn
		mg/l	ug/l	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
49	Lucky Strike Mine	0.2	BDL	BDL	BDL	6385.0	BDL	BDL	702.7	BDL	14.0	BDL	BDL	38.0
50	Vermont Mine	BDL	BDL	BDL	517.1	2134.6	BDL	BDL	785.0	BDL	2.6	BDL	BDL	842.4
51	Four Aces Lode	0.5	BDL	BDL	BDL	3556.4	BDL	BDL	399.0	BDL	2.7	BDL	BDL	40.8
52	Little Casino	0.1	BDL	BDL	6407.9	3988.6	BDL	BDL	426.0	BDL	6.1	BDL	BDL	1787.3
53	Four Aces Lode	0.4	BDL	BDL	6317.3	10750.1	10.5	BDL	363.9	BDL	19.8	BDL	BDL	9810.4
54	Wave of the Ocean	0.0	BDL	BDL	6343.3	24884.4	BDL	BDL	556.8	BDL	31.4	BDL	BDL	6872.3
55	Red Rover Tunnel/Little Hattie Lode	0.3	BDL	BDL	1481.3	109822.7	BDL	BDL	766.3	BDL	425.5	BDL	BDL	6815.6
56	Pride of America Mine	0.2	BDL	BDL	1828.2	104091.8	BDL	BDL	198.0	26.9	281.4	BDL	BDL	22942.2
57	Owl Gulch Mine	0.5	BDL	0.3	BDL	1639.2	BDL	BDL	1084.1	BDL	16.9	BDL	BDL	25.2
58	Yellow Jacket 2nd Level	0.1	BDL	0.2	71.1	4958.8	BDL	BDL	481.1	BDL	3.1	BDL	BDL	56.7
59	Yellow Jacket 1st Level	0.1	BDL	0.2	BDL	2150.6	BDL	BDL	712.9	BDL	7.1	BDL	BDL	128.2
60	Hidden Treasure Tailings	0.2	BDL	BDL	4354.7	54371.4	BDL	BDL	282.7	BDL	41.0	BDL	BDL	26528.6
61	Risorgiomento Mine	0.1	18.7	0.4	BDL	186404.0	BDL	BDL	153.1	BDL	70.7	BDL	BDL	13103.6
62	Mountain Chief Lower	0.1	BDL	BDL	19.0	6628.4	BDL	BDL	437.8	BDL	26.8	BDL	BDL	1314.8
63	Mountain Chief Upper	0.1	BDL	BDL	BDL	15467.4	BDL	BDL	722.7	BDL	39.3	BDL	BDL	3970.7
64	Lower Pelican Mine	0.6	BDL	0.2	BDL	41617.2	BDL	BDL	728.0	BDL	177.8	BDL	BDL	1917.1
65	Middle Pellican Mine	0.1	BDL	BDL	201.0	4752.4	BDL	BDL	572.8	BDL	15.1	BDL	BDL	1038.6
66	Upper Pellic Mine	0.2	BDL	BDL	90.4	2959.3	BDL	BDL	1262.4	BDL	4.2	1.2	BDL	187.4
67	Iron Bed 1 in Matterhorn Gulch	0.1	BDL	BDL	BDL	567.8	BDL	BDL	634.5	BDL	1.3	BDL	BDL	19.4
68	Iron Bed 2 in Matterhorn Gulch	0.1	BDL	BDL	BDL	715.3	BDL	BDL	577.5	BDL	2.1	BDL	BDL	4.1

APPENDIX 6

MINE WASTE RANKING

		Individual Chemical Rank												
Site #	Description	pH	EC	Acidity	Al	As	Cd	Cu	Fe	Mn	Pb	Zn	Sum	Chemical Rank
1	Upper Hough Mine	4	3	2	2	2	6	2	3	7	18	4	53	2
2	Lower Hough Mine	2	1	1	1	1	2	1	1	3	15	2	30	1
3	Backfilled shaft north of Sara Woods	13	30	26	16	7	42	32	25	39	31	42	303	26
4	Upper Sara Woods Mine	30	50	54	41	7	42	53	50	41	31	61	460	54
5	Lower Sara Woods Mine	3	2	3	3	3	21	5	2	19	20	26	107	5
6	Dump East of lower Sara Woods Mine	9	26	35	25	7	42	27	9	43	31	47	301	24
7	Dump above Horsethief Trail	42	65	59	35	7	42	66	23	58	31	68	496	60
8	Miners Bank Mine	8	9	6	6	4	18	13	5	32	31	18	150	9
9	Wyoming Mine	10	14	15	10	7	17	18	16	42	31	16	196	13
10	Engineer Mine	69	63	9	59	6	42	52	65	65	31	54	515	63
11	Hofman Mine	11	25	29	24	7	37	44	20	21	31	40	289	22
12	Upper Emporer. Wilhelm Mine	7	12	8	9	7	19	14	7	18	25	19	145	8
13	Lower Emperor Wilhelm	23	35	51	42	7	35	29	58	29	31	34	374	40
14	Collapsed Adit between Palmetto and Roy Pray	19	24	19	36	7	42	39	14	47	31	43	321	28
15	Second Dump above Palmetto Mine	12	23	29	26	7	41	34	10	51	31	37	301	24
16	Dump across stream from Palmetto Mine	63	4	21	62	7	42	34	17	37	31	62	380	41
17	Palmetto Mine	45	22	29	12	7	31	25	41	15	31	30	288	21
18	Mill across from Thoreau's Cabin	26	37	35	31	7	34	41	26	54	31	32	354	33
19	Mine near Stream in Redcloud	67	47	46	48	7	42	58	22	53	31	53	474	57
20	Mine on Southwest side of Redcloud	65	63	22	51	7	42	66	55	67	31	70	539	69
21	Mine Near Ridge on North Side of Schafer	35	59	63	22	5	42	43	8	48	23	46	394	43
22	Mine at Headwaters of Northwest Schafer Trib	32	60	44	45	7	42	49	27	52	31	59	448	52

Site #	Description	Individual Chemical Rank											Sum	Chemical Rank
		pH	EC	Acidity	Al	As	Cd	Cu	Fe	Mn	Pb	Zn		
23	Mine on Southwest side of Northwest Schafer Trib	14	41	68	37	7	39	38	42	50	31	36	403	45
24	Mine Below Siegel Mountain in Schafer Gulch	20	49	59	34	7	42	61	11	55	31	63	432	50
25	Mine on West Side of Henson Between Redcloud and Schafer	28	32	54	17	7	31	33	61	17	31	33	344	32
26	Lower Golconda Mine	29	47	43	65	7	39	47	56	36	28	41	438	51
27	Upper Golconda Mine	49	68	54	7	7	1	3	34	9	7	1	240	17
28	Lower Mine on Northwest Side of Gravel Mountain	59	62	70	63	7	42	66	65	57	31	51	573	70
29	Upper Mine on Northwest Side of Gravel Mountain	66	70	35	66	7	42	51	35	64	31	65	532	67
30	Chicago Tunnel	61	36	59	49	7	42	66	39	69	31	58	517	64
31	Upper Dolly Varden Fine Waste	62	68	13	66	7	42	55	52	66	31	52	514	62
32	Upper Dolly Varden Brown Waste	55	67	68	50	7	42	54	44	56	31	57	531	66
33	Lower Dolly Varden	50	27	42	19	7	42	15	19	35	31	45	332	30
34	Horseshoe Basin Mine West	24	56	34	61	7	42	36	37	46	27	49	419	47
35	Highland Mine	53	7	46	56	7	20	30	65	8	31	20	343	31
36	Schafer Basin Mine West Side	17	20	18	14	7	12	8	49	14	8	13	180	12
37	Schafer Basin Mine East Side Upper	58	52	40	53	7	42	64	54	70	31	67	538	68
38	Schafer Basin Mine East Side Lower	53	44	53	58	7	30	16	59	45	22	35	422	48
39	Moro Tunnel	41	55	63	40	7	36	50	38	31	29	39	429	49
40	Hanna Mill Tailings	60	34	24	39	7	13	12	43	40	13	12	297	23
41	Vulcan Mine	70	39	46	18	7	24	22	40	61	16	29	372	39
42	Yellowstone Mill Tailings East	56	21	10	20	7	5	9	13	20	4	3	168	11
43	Yellowstone Mill Tailings West	18	16	11	11	7	7	6	15	28	5	5	129	6
44	Capital City Mine	48	6	5	30	7	29	42	36	24	31	28	286	20
45	Yellow Medicine Mine	31	38	54	27	7	27	19	32	44	14	24	317	27
46	Mountain Belle Lode	57	18	19	21	7	16	20	33	23	21	17	252	19

Site #	Description	Individual Chemical Rank pH	EC	Acidity	Al	As	Cd	Cu	Fe	Mn	Pb	Zn	Sum	Chemical Rank
47	Dump at gate below Czarina (Broker Lode)	21	15	23	8	7	9	7	28	4	9	9	140	7
48	Excelsior Lode	6	8	12	5	7	8	4	6	25	12	6	99	4
49	Lucky Strike Mine	52	42	54	38	7	42	62	62	26	31	56	472	56
50	Vermont Mine	32	57	40	23	7	26	24	47	62	17	31	366	36
51	Four Aces Lode	27	52	59	60	7	42	57	30	59	31	55	479	58
52	Little Casino	34	46	29	66	7	22	40	65	33	1	23	366	36
53	Four Aces Lode	22	31	29	33	7	10	31	21	22	3	11	220	16
54	Wave of the Ocean	16	19	17	13	7	14	10	34	10	2	14	156	10
55	Red Rover Tunnel/Little Hattie Lode	47	10	24	28	7	11	17	65	13	11	15	248	18
56	Pride of America Mine	1	11	16	54	7	3	23	63	6	10	8	202	14
57	Owl Gulch Mine	64	58	51	46	7	42	37	53	49	31	60	498	61
58	Yellow Jacket 2nd Level	14	33	26	57	7	42	46	29	30	26	50	360	35
59	Yellow Jacket 1st Level	68	51	28	52	7	42	56	46	34	31	48	463	55
60	Hidden Treasure Tailings	43	13	13	29	7	4	21	65	1	6	7	209	15
61	Risorgiomento Mine	5	5	4	4	7	15	11	4	2	31	10	98	3
62	Mountain Chief Lower	37	40	35	43	7	31	48	60	12	30	25	368	38
63	Mountain Chief Upper	39	28	39	66	7	25	66	64	5	31	21	391	42
64	Lower Pelican Mine	36	17	44	44	7	23	45	51	11	31	22	331	29
65	Middle Pellican Mine	39	52	66	47	7	28	26	57	27	19	27	395	44
66	Upper Pellic Mine	44	60	63	15	7	42	58	12	38	24	44	407	46

		Individual Physical Rank							
Site #	Description	Erosion	Distance to Drainage	Vegetation Kill Zone	Vegetation	Sum	Physical Rank	Overall Sum	Overall Rank
1	Upper Hough Mine	5	5	5	5	20	1	3	2
2	Lower Hough Mine	5	5	5	5	20	1	2	1
3	Backfilled shaft north of Sara Woods	1	4	4	5	14	17	43	20
4	Upper Sara Woods Mine	5	5	3	5	18	4	58	31
5	Lower Sara Woods Mine	5	5	5	5	20	1	6	3
6	Dump East of lower Sara Woods Mine	2	3	3	5	13	21	45	21
7	Dump above Horsethief Trail	1	1	2	3	7	57	117	60
8	Miners Bank Mine	2	3	5	5	15	14	23	7
9	Wyoming Mine	2	5	5	3	15	14	27	11
10	Engineer Mine	4	4	3	5	16	12	75	39
11	Hofman Mine	4	5	3	5	17	9	31	14
12	Upper Emporer. Wilhelm Mine	1	4	4	5	14	17	25	10
13	Lower Emperor Wilhelm	3	3	3	3	12	28	68	34
14	Collapsed Adit between Palmetto and Roy Pray	2	5	5	5	17	9	37	18
15	Second Dump above Palmetto Mine	5	5	3	5	18	4	28	12
16	Dump across stream from Palmetto Mine	5	5	1	3	14	17	58	31
17	Palmetto Mine	2	5	5	1	13	21	42	19
18	Mill across from Thoreau's Cabin	2	3	3	5	13	21	54	28
19	Mine near Stream in Redcloud	1	4	1	5	11	37	94	49
20	Mine on Southwest side of Redcloud	1	4	1	3	9	47	116	58
21	Mine Near Ridge on North Side of Schafer	1	2	1	2	6	62	105	55
22	Mine at Headwaters of Northwest Schafer Trib	1	2	1	3	7	57	109	56
23	Mine on Southwest side of Northwest Schafer Trib	3	2	4	3	12	28	73	37
24	Mine Below Siegel Mountain in Schafer Gulch	1	1	1	5	8	49	99	52
25	Mine on West Side of Henson Between Redcloud and Schafer	4	1	3	5	13	21	53	26
26	Lower Golconda Mine	2	2	2	5	11	37	88	46
27	Upper Golconda Mine	1	5	1	5	12	28	45	21

Site #	Description	Individual Physical Rank				Sum	Physical Rank	Overall Sum	Overall Rank
		Erosion	Distance to Drainage	Vegetation Kill Zone	Vegetation				
28	Lower Mine on Northwest Side of Gravel Mountain	1	1	1	5	8	49	119	64
29	Upper Mine on Northwest Side of Gravel Mountain	1	1	1	5	8	49	116	59
30	Chicago Tunnel	3	5	1	2	11	37	101	53
31	Upper Dolly Varden Fine Waste	2	2	1	2	7	57	119	64
32	Upper Dolly Varden Brown Waste	2	2	1	2	7	57	123	66
33	Lower Dolly Varden	2	2	1	2	7	57	87	45
34	Horseshoe Basin Mine West	1	2	1	2	6	62	109	56
35	Highland Mine	2	2	3	1	8	49	80	41
36	Schafer Basin Mine West Side	1	1	1	3	6	62	74	37
37	Schafer Basin Mine East Side Upper	1	1	1	5	8	49	117	60
38	Schafer Basin Mine East Side Lower	1	1	3	5	10	42	90	47
39	Moro Tunnel	1	2	3	2	8	49	98	51
40	Hanna Mill Tailings	2	4	1	5	12	28	51	25
41	Vulcan Mine	2	2	1	5	10	42	81	42
42	Yellowstone Mill Tailings East	2	4	5	5	16	12	23	7
43	Yellowstone Mill Tailings West	4	4	5	5	18	4	10	5
44	Capital City Mine	3	2	1	5	11	37	57	29
45	Yellow Medicine Mine	2	5	1	5	13	21	48	24
46	Mountain Belle Lode	3	5	1	3	12	28	47	23
47	Dump at gate below Czarina (Broker Lode)	2	4	1	5	12	28	35	17
48	Excelsior Lode	3	5	5	5	18	4	8	4
49	Lucky Strike Mine	2	1	1	2	6	62	118	63
50	Vermont Mine	3	5	1	5	14	17	53	26
51	Four Aces Lode	4	1	4	3	12	28	86	44
52	Little Casino	5	1	4	3	13	21	57	29
53	Four Aces Lode	3	1	3	3	10	42	58	31
54	Wave of the Ocean	3	4	1	5	13	21	31	14
55	Red Rover Tunnel/Little Hattie Lode	5	5	3	5	18	4	22	6
56	Pride of America Mine	5	5	4	3	17	9	23	7
57	Owl Gulch Mine	2	4	1	3	10	42	103	54

Site #	Description	Individual Physical Rank				Sum	Physical Rank	Overall Sum	Overall Rank
		Erosion	Distance to Drainage	Vegetation Kill Zone	Vegetation				
58	Yellow Jacket 2nd Level	3	2	1	2	8	49	84	43
59	Yellow Jacket 1st Level	1	2	1	2	6	62	117	62
60	Hidden Treasure Tailings	4	5	1	5	15	14	29	13
61	Risorgiomento Mine	2	4	1	5	12	28	31	14
62	Mountain Chief Lower	2	5	3	2	12	28	66	34
63	Mountain Chief Upper	2	3	3	3	11	37	79	40
64	Lower Pelican Mine	2	5	1	2	10	42	71	36
65	Middle Pellican Mine	2	3	1	3	9	47	91	48
66	Upper Pellic Mine	3	2	1	2	8	49	95	50