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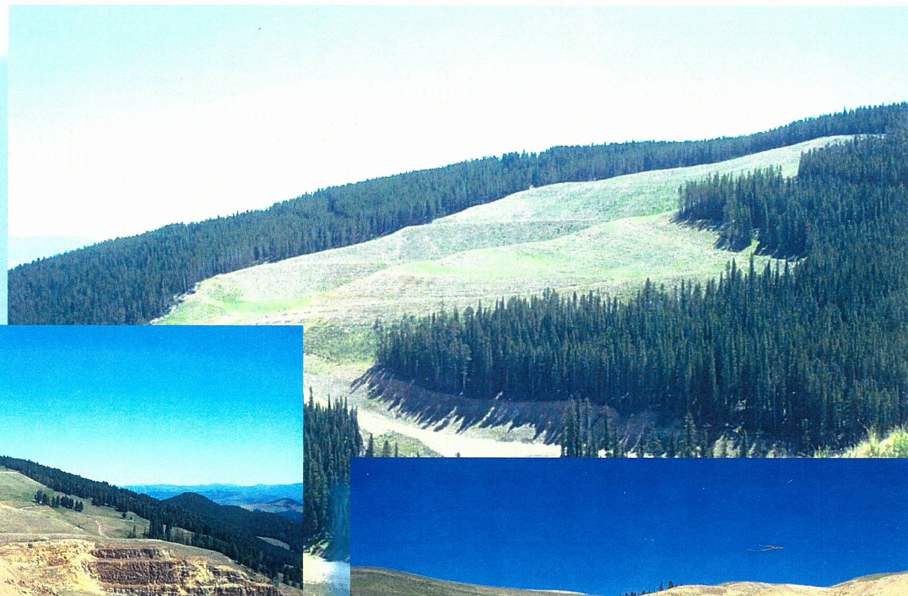
EXISTING CONDITIONS REPORT

Beal Mountain Mine

Beaverhead-Deerlodge National Forest
Silver Bow County, Montana



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BEAL MOUNTAIN MINE
EXISTING CONDITIONS REPORT
BEAVERHEAD-DEERLODGE NATIONAL FOREST

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EXISTING CONDITIONS REPORT
BEAVERHEAD DEERLODGE NATIONAL FOREST

Prepared For:

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EXECUTIVE SUMMARY

INTRODUCTION

The Beal Mountain Mine is located in the headwaters of German Gulch in the Pioneer Mountains, Silver Bow County Montana, about 16 miles west-southwest of Butte and 10 miles south-southwest of Fairmont (Gregson) Hot Springs. The mine is primarily situated on land managed or controlled by the United States Department of Agriculture, Forest Service (USDA-FS), Beaverhead-Deerlodge National Forest (B-DNF).

The Beal Mountain Mine completed mining operations in 1997 and gold recovery from the pad in 1999, with reclamation of the mine disturbances continuing through 2003. With a filing of bankruptcy in 1998, and exhaustion of bonding funds to complete reclamation, the USDA-FS, in cooperation with the Montana Department of Environmental Quality (MDEQ), became the lead agency responsible for final mine closure. As the land management agency, the USDA-FS placed the mine closure under its CERCLA (Comprehensive Environmental Responsibility, Compensation, and Liability Act) authority, and determined that the non-time-critical removal action process would be followed for mine closure. As part of that process, the USDA-FS contracted with Maxim Technologies, Inc.® (Maxim) to develop an Engineering Evaluation/Cost Analysis (EE/CA) that will evaluate final closure options for the Beal Mountain Mine.

The USDA-FS goal for the site is to close the mine and allow for the area to return to its multiple use state. Although the majority of the mine property has been reclaimed, there are several ongoing operational and maintenance requirements that need to be met before final closure. To complete the closure, there are several remaining data gaps that need to be investigated to address outstanding issues that potentially impact human health and the environment. These issues include the long-term geochemical reactivity of mine wastes (including both acidity and the release of selenium to the environment from several potential mine sources), geotechnical stability of the pit highwall and leach pad dike, infiltration into the leach pad, and treatment and disposal of remaining heap leach solution.

This Existing Conditions Report has been prepared in advance of the EE/CA and presents a summary of existing conditions that describes the natural environmental setting and the specific site conditions that have resulted from operation and closure activities completed to date at the Beal Mountain Mine.

MINING

Beal Mountain Mining, Inc. mined two small low-grade gold-silver deposits, Beal Mountain and South Beal, in open pits from 1988 through 1997. In all some 14,807,100 tons of ore and 20,300,000 tons of waste were mined. Early waste rock production from the Beal Mountain pit was used to construct an embankment or containment dike for the leach pad. Later, waste rock from the Beal Mountain pit was placed on a waste rock dump and was used for haul road construction foundations. Waste rock from the South Beal pit was used to partially backfill the Beal Mountain pit and as a cover for portions of the waste rock dumps and leach pad. A portion of South Beal pit waste rock was also disposed in the waste rock dump.

Major facilities at the site include: two open pit mines; a waste rock disposal area; a heap leach pad with a large containment dike or embankment along its southern flank and a smaller one on its north side; ore stockpile and crushing/agglomeration facility area; processing plant area; a water treatment plant; an onsite maintenance shop/warehouse and fuel storage area; and an offsite office/warehouse complex.

During reclamation and closure the processing plant was converted to a water treatment facility. Several ponds are also used at the mine site. Ancillary facilities included access and haul roads, soil storage piles, drainage systems and two pump stations in German Gulch.

EXISTING ENVIRONMENT

Hydrology

German Gulch is the principal drainage in the Beal Mountain Mine area. German Gulch collects water from most of the main mining facilities including the Beal Mountain and South Beal pits, and the waste rock dump. Minnesota Gulch lies to the north of German Gulch and drains the north side of Beal's Hill. As the topographic divide between German and Minnesota Gulches occurs beneath the leach pad facility with the largest portion of the facility draining to the south into German Gulch, water falling on the heap leach facility flows both to Minnesota and German Gulches. Maximum streamflow in German and Minnesota gulches typically occurs between mid-April and late June, and seasonally low flows typically occur in late fall and winter. Minnesota Gulch drains the area north of the leach pad and most of the land application areas.

Surface Water Quality

Existing conditions for surface water quality were reviewed for 2003. Surface water in the German Gulch drainage is generally a calcium bicarbonate type (hardness of 74 milligrams per liter (mg/L) to 339 mg/L) and is poorly buffered. During 2003, German Gulch exhibited pH values that ranged from 7.3 to 8.5 standard units (su).

Concentrations of nitrate in all 2003 surface water samples were below the maximum contaminant level (MCL) of 10 mg/L, with nitrate concentrations in samples collected from German Gulch increasing downstream to STA-3A then decreasing below this point. This trend was also true for sulfate concentrations in German Gulch (i.e. STA-3A containing the highest average concentrations). Concentrations of sulfate measured in 2003 are also below the secondary maximum contaminant levels for all except the May 2003 sampling event at stations STA-3 and STA-3A where the values were 368 and 280 mg/L respectively.

During 2003, total recoverable concentrations of most metals or metalloids, including arsenic, copper, and iron were below chronic aquatic life standards. Total recoverable iron concentrations in German Gulch stations did exceed the secondary MCL in some of the monthly samples collected near the mine site.

Total recoverable selenium concentrations measured during 2003 in German Gulch at STA-4 and all stations downstream of STA-3A are below the chronic aquatic life standard for selenium of 0.005 mg/L, primarily because most of the flow collected from the toe of the waste rock dump that contains the highest concentrations of selenium is captured before it can enter German Gulch. Concentrations of selenium measured in all of the surface water samples collected in 2003 from STA-3 and STA-3A exceeded the chronic aquatic life standard, but none exceed the acute aquatic life standard. Selenium concentrations measured in surface water samples from stations STA-4, STA-3, and STA-3A reached their highest levels between 1997 and 1999 and have generally declined since then.

In September 2003, the USDA-FS conducted a metal loading study in German Gulch (Gurrieri, 2003). The purpose of this study was to characterize selenium concentrations and identify possible sources contributing selenium to German Gulch during low flow conditions. Results of the study indicated that all main stem-sampling sites above the road crossing of German Gulch near the main Beal pit mouth had selenium concentrations below the chronic aquatic life criteria of 0.005 mg/L. Selenium, sulfate, and nitrate concentrations increase appreciably below this point, which is a large flow-volume right bank tributary that discharges just below the culvert crossing. This right-bank tributary contributes as much as 65 percent of the total load encountered in the reach of German Gulch that was included in the synoptic study. Subsurface inflow at this point is considerable and was calculated to contribute as much as 46 percent of the measured load. Therefore, most of this subsurface selenium loading occurred in the reach of German Gulch within and downstream of a very short reach (approximately 300 feet). Using water quality data below the study reach, the greatest increase in selenium and sulfate loading occurred between STA-3 (5000 feet downstream of STA-4) and STA-2 (about 13,000 feet downstream of station STA-4). Loads of selenium and sulfate decrease below STA2.

The study identified potential sources of selenium including the waste-rock dump, waste material used as road fill, and the leach pad where waste rock was used to construct the leach pad containment dike. The chemical signature of selenium, sulfate, and nitrate are indicators of contamination from waste rock. The study also concluded that ground water discharging to German Gulch from faults that cross the valley in the vicinity of the Beal Mountain pit are probably not a source of selenium because the pit water has low to negligible selenium concentrations.

Groundwater Occurrence and Flow

Groundwater in the study area occurs in fractured bedrock, colluvium, alluvium, and backfill material within the Beal Mountain pit. Groundwater flow is controlled by the presence and location of unconsolidated materials and by the orientation of fractures and faults in bedrock. Groundwater is recharged by snowmelt and precipitation events. This water percolates vertically through overlying colluvial material and into bedrock fractures. Groundwater in unconsolidated material generally occurs under unconfined conditions. The degree of hydraulic communication between groundwater in unconsolidated material and the underlying bedrock fracture system varies based on the nature of the unconsolidated material and its topographic position.

The potentiometric surface generally parallels the topographic surface and groundwater flow is generally from the ridge tops toward German Gulch. However, groundwater flow in bedrock appears to be anisotropic and controlled by faults, joints, and fractures and the presence of low permeability igneous intrusions and clay seems within bedrock. Major faults within the area include the Beal Shear, the Gully Fault, and German Gulch Fault. Unfractured bedrock generally has very low permeability. These faults have likely created preferential pathways for groundwater flow due to the increase fracturing of rock near or adjacent to the faults. In some cases, cross-fault permeability within faults zones is relatively low due the presence of fault gouge.

Hydrographs for paired well locations along German Gulch where one well is completed in colluvium/alluvium and is adjacent to a bedrock well show that groundwater elevations are higher in bedrock than in adjacent alluvium, indicating that vertical hydraulic gradients are upward from bedrock into the overlying alluvial material. This implies that groundwater is discharging from the bedrock system to the alluvial system. Water in alluvium likely flows parallel to the creek and discharges to the creek.

Groundwater Quality

Comparison of water quality data from monitoring wells to groundwater standards (MCLs) indicates that June, July, August, and November 2003 samples from one well in the land application disposal (LAD) area exceeded standards for cyanide. Cyanide was generally not detected in monitoring wells in the LAD area prior to 2001 when land application of treated water from the leach pad was initiated. Since that time, cyanide concentrations in the one monitoring well in the LAD area and in the wells placed near the process pond and leach pad have increased. In addition, springs located within and downhill of the land application area show appreciable increases in cyanide and selenium concentrations since land application began in 2001. Land application was discontinued in November of 2003.

Selenium and sulfate concentrations increased in colluvial wells located north of the northern portion of the leach pad dike, which was constructed with unoxidized waste rock from the Beal Mountain pit. This may have resulted from the flushing of soluble selenium from this rock that infiltrated into shallow groundwater in this area.

Springs sampled at the toe of the waste rock dump have shown impacts of water draining trough waste rock. Concentrations of selenium, sulfate, nitrate, and total dissolved solids are elevated in these springs. A comparison of selenium and nitrate concentrations in wells located in the waste rock toe area indicates that selenium and nitrate impacts are much more pronounced in shallow alluvial groundwater than in the underlying bedrock. Sulfate began increasing in groundwater in both bedrock and alluvium at that location in about 1992 and has been increasing since.

Groundwater samples from wells adjacent to German Gulch downstream of the Beal Mountain pit exceeded the MCL for iron and contained relatively high concentrations of total dissolved solids and sulfate. Selenium concentrations increased slightly in alluvial and bedrock groundwater in these wells from 1993 to 1995, with another increase in selenium concentrations noted in bedrock groundwater in 2001. Changes in selenium concentrations in surface water in German Gulch at STA-3 parallel changes in the bedrock well near this station, suggesting good communication between surface and groundwater at this location.

Rock Geochemistry

Geochemical data were collected and analyzed to evaluate the risk of acid rock drainage (ARD) formation using static and kinetic test methods, and to predict trace element release by weathered mined material or in pit highwalls. Related studies evaluated the mineralogy of weathered and unweathered rock, and characterized rocks that would be exposed in the ultimate Beal Mountain pit highwall as a basis for predicting post-mine water quality.

The mineralogy of ore and waste, and thus the geochemistry, varies across the mined deposit. Rock mined from a particular area may have been placed as waste rock on the dump, as fill for construction, or as post-mine backfill. Roughly one-third of waste rock and ore mined from the Beal Mountain pit is potentially acid generating based on static tests and another third is not. Remaining waste rock and ore have uncertain potential to generate acid.

Kinetic tests showed variable potential for ARD generation and trace element release; most columns, while maintaining a near-neutral pH, were maintaining or increasing sulfate release rates with declining alkalinity. Mineralogy showed variable alteration and some degree of encapsulation of sulfide minerals, which may explain the slow reaction rates. It isn't clear from the data that all samples would remain non-acidic if kinetic tests were conducted for longer periods. Some trace element release is likely to occur, including aluminum, arsenic, copper, iron, selenium, and zinc. As the waste rock dump is primarily composed of waste mined from the Beal Mountain pit (except for cover materials and some waste from the South Beal pit), the potential for ARD and metal mobility at this facility are expected to be similar to rock from the Beal Mountain pit. The heap leach embankment and the haul road prism were also constructed with waste rock from the Beal Mountain pit.

Data collected during static and kinetic testing of South Beal pit ore and waste rock suggest a low potential for ARD from the pit highwalls and waste rock, and a high potential from residual ore. During reclamation, the entire South Beal pit was regraded and covered with South Beal pit waste, topsoiled, and revegetated. While South Beal ore presents a high risk of ARD, it is unlikely that the relatively small amount of residual ore remaining in the buried pit walls will generate enough acidity to overwhelm the neutralization potential of the surrounding rock. While limited, the available data for evaluating metal mobility indicate that leachate from South Beal rock will be of good quality.

Analyses of spent ore were used to characterize material on the leach pad. Static testing of spent ore indicates that material contained in the leach pad has a high potential for acid generation. However, kinetic testing of spent ore and pad solution pH measurements indicate low ARD risk. It is possible that, while spent ore poses a risk of ARD, the high pH of the barren/pad solution is buffering acid generation in the heap leach pad. It is noteworthy that pH and alkalinity have decreased somewhat following cessation of leaching operations indicating that the neutralizing capability of the heap is slowly being depleted. Kinetic test data indicate that leachate from the spent ore will be of generally good quality with possible exceedances of human health based standards for arsenic. Barren/pad solution analyses indicate that most metal concentrations in the heap are near equilibrium with elevated levels of selenium, iron, and copper. Selenium and copper concentrations in pad solution appear to be declining.

Aquatics

Selenium was found to be elevated in fish whole-body tissues from middle German Gulch, while levels were not elevated in Minnesota Gulch or Beefstraight Creek. Physical habitat conditions in the German Gulch watershed have been influenced by historic placer mine dredging activities as well as current livestock use. Biotic conditions, including benthic macroinvertebrates communities and fish, are exposed to elevated levels of selenium in the water column as well as bed load sediment. This exposure is primarily occurring in the upper and middle reaches of German Gulch (STA-3A, STA-2). The result of this exposure is elevated selenium in both macroinvertebrates and fish, which may result in impacts to fish populations, including westslope cutthroat trout.

Studies conducted in the German Gulch subwatershed in 2003 also quantified effects of cyanide concentrations in surface water draining the mine and LAD areas. Results of a bioassay study showed 100% survival of hatchery westslope cutthroat trout placed in cages in Beefstraight Creek and Norton Gulch for 10 days. Plasma extracted from blood collected from brook trout in German Gulch and Beefstraight Creek showed the highest thiocyanate levels in fish from Beefstraight Creek. Fish from the control stream, Divide Creek, had higher concentrations of thiocyanate in plasma than German Gulch fish. These same results were mirrored by the hepatosomatic index values calculated for brook trout collected during the same period. Fish collected from German Gulch had the greatest number of eggs and the largest size of eggs, followed fish in Beefstraight Creek and then by Divide Creek. These differences were not significant but were consistent with findings in other studies that showed reduced fecundity following prolonged cyanide exposure.

LAD Areas

Land application of treated water at the Beal Mountain Mine site was conducted during three time periods: from 1994 to 2003, land application was used to dispose of captured water from the toe of the waste rock dump and pit area; in 1995, a limited, one-time application of treated solution was disposed; and, between 2001 and 2003, an extensive application of treated heap leach solutions were disposed. In 1995, land application occurred over a period of several days, and involved disposal of a total of 5.33 M gallons of water. Following this operation, impacts to meadow vegetation and downslope conifers were observed, including a browning and dying off of foliage. Studies performed in 1999 and 2000 suggest that thiocyanate concentrations in the solutions applied may have contributed to the observed impacts to vegetation, as well as elevated salt content and peroxide concentrations.

In 2001, as part of final mine closure operations, a biological treatment plant was constructed at the mine to treat leach pad solution prior to its disposal in land application areas. Treated solution was applied via drip lines and sprinklers on several small land application cells comprising a total of approximately 31 acres within the overall permitted LAD area. A total of 152,084,681 gallons of solution were treated and applied more or less continuously between July 2001 and November 2003. Overall, vegetation in the LAD area was not severely impacted based on field observations.

Of primary concern with respect to selenium is the accumulation in plant tissue and the potential effects on wildlife. The amount of selenium that can lead to chronic or acute toxicity varies by species, but a continuous dietary intake value of less than 2.0 milligrams per kilogram (mg/kg) is generally considered safe for all species. Plant tissue data from Beal shows that the majority of samples have selenium values of less than 2.0 mg/kg. The risk to grazing animals from selenium toxicity is likely limited because of the small acreage treated. Long-term effects of land application on surface and groundwater resources would be expected to be limited to those observed to date within the land application area.

ISSUES RELATED TO EXISTING CONDITIONS OF MINE FACILITIES

Pit Wall and Leach Pad Stability

There are currently two active slides in the Beal Mountain pit area, the west wall and the clay/sill slide. These slides are wedge-shaped blocks of metasediments that move along clay layers which dip at a low angle to the northeast and are likely occur along minor thrust faults parallel to the regional thrusts. Near vertical northwest trending joints and shears border the blocks along their northeast and southwest boundaries.

The west wall slide has moved across and into the Beal Mountain pit in an eastward direction. During active mining, movement of this slide was reported in the range of 10 to as much as 100 feet per year. A large portion of this movement resulted from undercutting the toe of the slide during Beal Mountain pit mining operations. Based on analysis of projected slide configurations, it is projected that the west wall slide may move as much as another 200 feet before movement ceases.

The clay/sill slide is a relatively small slide located immediately south of the southern corner of the heap leach pad and to the immediate north of the west wall slide. The slide moves along a clay layer that is similar to the west wall slide. The vertical Gully Fault bounds the slide to the northeast and apparently cuts off the clay layers to the northeast of the fault (therefore, they do not extend under the heap leach embankment). Some of the movement on the clay/sill slide is directly related to movement of the west wall slide, which through its eastward movement leaves the southern edge of the clay/sill slide unsupported and allowed it to move to the south and east toward the pit. During the period of active mining, movement of this slide propagated slump-like features and cracks or fractures upward into the unconsolidated fill of the southern corner of the heap leach pad. These features lead to geotechnical stability studies of the leach pad dike in the southern corner of the pad.

During mining, the southern corner of the leach pad's dike has experienced some geotechnical instability due to movement of the clay/sill slide. There were several responses implemented to mitigate the clay/sill slide's movement during mining and closure activities. These included constructing surface water diversion ditches, unloading material above the slide, excavating material lying to the southwest of the leach pad embankment, constructing a rock buttress, and installing and operating dewatering wells (1995 and later) to reduce pore pressure on the slide plane. With the completion of active dewatering in July 2003, groundwater levels in the slide area will rebound, and this may result in renewed movement of the clay/sill slide. There are no indications that the clay/sill slide is actively moving at the present time.

Slope stability analyses indicate that the crest of the leach pad dike has a relatively low factor of safety under worst-case conditions (1.02) and regression of the clay/sill slide uphill into the leach pad dike could occur. If the slide should regress further uphill, cracking on the dike face may be observed. However, large-scale movement of the slide (i.e. on the order of 10 or more feet per year) is not anticipated, and this amount of movement has not been characteristic of slide movement at any time in the past. Regression of the clay/sill slide into the leach pad dike is not likely based on existing data. The portion of the leach pad's interior presently containing solution (i.e. within the volume defined by the 7465 to 7467 foot contours and the pad's base liner) has a relatively high factor of safety under worst-case conditions (1.40) with respect to stability. Regression of the clay/sill slide into this area is not likely. A monitoring plan has been implemented to detect deleterious movements, and a contingency plan has been developed for the leach pad facility to assure the geotechnical integrity of the leach pad.

Waste Rock

Waste rock was generated from mining of both the Beal Mountain pit and the South Beal pit. The total amount of waste generated is about 20,300,000 tons. Waste has been used or placed in at least four areas including the waste rock dump, leach pad dike construction, road prism, or road base construction and as pit backfill in the Beal Mountain pit. The lower portion of the waste rock dump has been reclaimed by regrading of the slope to a 2:1 minimum, the placement of a 5-foot thick compacted South Beal waste cap and 14 to 20 inches of soil cover. The upper third of the waste rock dump (above 7,300 feet) has been regraded and a minimum five-foot thick layer of capping materials has been placed on the wastes in this area. The upper third of the waste rock dump has had no topsoil placed on it to date, and it has not been revegetated.

Most of the rock placed in the waste rock dump was mined from the Beal Mountain pit. These wastes were also used in the construction of the leach pad dike and haul roads. South Beal pit waste was placed on the dump in 1993 and 1994. A significant portion of waste rock (35% to 65%) mined from the Beal Mountain pit presents a risk of acid generation and subsequent acid rock drainage. Water emanating from SPR-10A (buried under the upper end of the waste), SPR-5 (at the toe of the waste rock dump), and water from the toe drain collection system were historically pumped to a storage pond near the processing plant and discharged directly through the LAD system. This captured flow is currently being retained in the pond. This water has elevated selenium, sulfate, and nitrates that cannot be discharged directly to surface or groundwater without treatment.

Leach Pad Solution Volumes and Geochemistry

In October 2003 in anticipation of closure of the water treatment facility, the drawdown and treatment of the leach pad solution was completed. When the solution reached its final elevation, the sump pump began to cavitate and additional water could not be pumped. Depth of solution above the base liner in the vicinity of the sumps was approximately 17 feet. At that time the pad was estimated to contain approximately 3,100,000 gallons of solution.

Two of the four sumps (No. 1 and No. 2) located in the southwest corner of the leach pad and one of the two sumps (No. 3A) on the north side of the leach pad are still functional. In the time since cessation of treatment the leach pad solution volume has increased to about 7,500,000 gallons. There has been almost no precipitation in the area since late October and the increase in volume is thought to be the result of continued draindown in the pad rather than a leak in the cover.

Water quality in the pad has changed dramatically over the closure and treatment period such that the remaining water currently contains approximately: 2600 milligrams per liter (mg/L) sulfate, 0.38 mg/L selenium, 0.16 mg/L As, 4.0 mg/L Fe, and 0.42 mg/L Cu. Alkalinity has decreased from about 360 mg/L to about 100 mg/L ($CaCO_3$ equivalent). In August 2003, total cyanide was about 9.5 mg/L and weak acid dissociable cyanide was about 0.061 mg/L.

German Gulch

German Gulch is the receiving stream for the majority of water quality issues associated with the mine facilities and a likely place to measure the success of reclamation efforts at the Beal Mountain Mine. German Gulch and its two main tributaries, Beefstraight and Minnesota, support populations of native westslope cutthroat trout (recognized as "sensitive" by USDA-FS) and non-native eastern brook trout.

The main impacts to water quality from mine facilities that appear to have potential long-term effects (based on concentrations that exceed chronic aquatic water quality standards) are elevated total recoverable concentrations of cyanide, selenium, and rarely copper. The most recent total concentration of cyanide at STA-3A in German Gulch (December 2003) was 0.008 mg/L, slightly higher than the chronic standard of 0.0052 mg/L. Total recoverable concentrations of copper were lower than chronic aquatic standard at all stations in German Gulch in December 2003.

Prior to mine development, selenium concentrations throughout the stream were considered low with respect to Montana water-quality standards, with readings from non-detect to 0.004 mg/L. With the covering of spring SPR-10A with waste rock, selenium concentrations in German Gulch increased, and remained elevated until recently. The highest concentrations of selenium in German Gulch are typically measured at Station 3A, with the most recent concentrations of 0.011 mg/L measured in December 2003. Instream selenium concentrations have been decreasing since 1997 when water from SPR-10A was captured and pumped to the LAD area for disposal.

During the summer of 2001, fish and aquatic macroinvertebrate tissues from the German Gulch sub-watershed were collected and analyzed for selenium and copper concentrations. Copper concentrations were not elevated in macroinvertebrates or fish. Mean dry weight selenium concentrations in middle German Gulch macroinvertebrates were above the range of suggested toxic effects thresholds to fish from dietary organisms (3 to 11 micrograms per gram). Selenium concentrations were found to be statistically higher in fish whole-body tissues from middle German

Gulch than in fish collected from Minnesota Gulch and Beefstraight Creek. These results suggest a potential pathway for bioaccumulation of selenium in the German Gulch sub-watershed.

In 2002 and 2003, samples were collected and analyzed for selenium at five sample sites in the sub-watershed in fish tissue, fish eggs (two sites), and macroinvertebrates. Bedload sediment samples were also collected in 2002 and 2003. Selenium was found to be elevated above literature values for range of toxic effects all media sampled in the three German Gulch locations; levels were not elevated above these thresholds in Minnesota Gulch and Beefstraight Creek. The hazard rating for selenium in German Gulch was high or moderate for fish eggs and high for macroinvertebrates at all three stations. For sediment, the hazard rating was high at the two upstream stations, but had diminished to none at the downstream station. Elevated selenium concentrations in these media may result in impacts to fish populations including westslope cutthroat trout.

Other measures of biological integrity of German Gulch show differing results. Results of periphyton sampling indicate the biotic integrity in the upper and middle reaches of German Gulch in 1999 was generally rated as good, with minor impairment of aquatic life. Other biotic data (algae metrics) indicate relatively unimpaired biota existing in these streams. Aquatic macroinvertebrate data from 1999 indicate generally good biotic conditions, with upper German Gulch classified as moderately impaired during the summer but improved to non-impaired during the fall. Middle German Gulch was classified as non-impaired during both sample events. Biointegrity scores relative to macroinvertebrates were slightly lower in 1999 than in 1997 for all sample sites, the likely reason being environmental stress related to drought and low streamflow.

Habitat data have also been collected on German Gulch and on Greenland Gulch, a tributary to German Gulch. Physical habitat condition for the upper German Gulch location was considered "sub-optimal" during all three-sample years for most habitat parameters. Habitat degradation was primarily attributed to historic placer mine dredging and livestock use.

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LIST OF ACRONYMS AND ABBREVIATIONS

ARARs	Applicable or Relevant and Appropriate Requirements
ARD	Acid Rock Drainage
B-DNF	Beaverhead-Deerlodge National Forest
BMMI	Beal Mountain Mining, Inc.
CERCLA	Compréhensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
DL	detection limit
DNRC	Montana Department of Natural Resources and Conservation
DSL	Department of State Lands
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Department of the Interior Environmental Protection Agency
FONSI	Finding of no significant impact
GCL	Geosynthetic Clay Liner
gpm	gallons per minute
HDPE	High Density Polyethylene
HELP Model	Hydrologic Evaluation of Landfill Performance Model
HHS	human health hazard
kg	kilograms
LAD	Land Application Disposal
LCS	Leachate Collection System
M	million
MCL	Maximum Contaminant Level
MDEQ	Montana Department of Environmental Quality
MPDES	Montana Pollutant Discharge Elimination System
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mm	millimeter
MOU	Memorandum of Understanding
μg/s	micrograms per second
μg/L	micrograms per liter
ppm	parts per million
su	standard units
TCLP	Toxicity Characteristic Leaching Procedure
USDA-FS	United States Department of Agriculture Forest Service

1.0 INTRODUCTION

The Beal Mountain Mine is located in the headwaters of German Gulch in the Pioneer Mountains, Silver Bow County Montana (**Figure 1**). The city of Butte is located about 16 miles east-northeast of the mine and Fairmont (Gregson) Hot Springs is located about 10 miles to the southwest. The mine is primarily situated on land managed or controlled by the United States Department of Agriculture, Forest Service (USDA-FS), Beaverhead-Deerlodge National Forest (B-DNF).

The Beal Mountain Mine completed mining operations in 1997 and metal recovery in 1999 with reclamation of the mine disturbances continuing through 2003. With a filing of bankruptcy in 1998, and exhaustion of bonding funds to complete reclamation, the USDA-FS, in cooperation with the Montana Department of Environmental Quality (MDEQ), became the lead agency responsible for final mine closure. As the land management agency, the USDA-FS placed the mine closure under its CERCLA (Comprehensive Environmental Responsibility, Compensation, and Liability Act) authority, and determined that the non-time-critical removal action process would be followed for mine closure. As part of that process, the USDA-FS contracted with Maxim Technologies, Inc.® (Maxim) to develop an Engineering Evaluation/Cost Analysis (EE/CA) that will evaluate final closure options for the Beal Mountain Mine.

The USDA-FS goal for the site is to close the mine and allow for the area to return to its multiple use state. Although the majority of the mine property has been reclaimed, there are several ongoing operational and maintenance requirements that need to be met before final closure. To complete the closure, there are several remaining data gaps that need to be investigated to address outstanding issues that potentially impact human health and the environment. These issues include the long-term geochemical reactivity of mine wastes (including both acidity and the release of selenium to the environment from several potential mine sources), geotechnical stability of the pit highwall and leach pad dike, infiltration into the leach pad, and treatment and disposal of remaining heap leach solution.

1.1 PURPOSE AND OBJECTIVES

This Existing Conditions Report has been prepared in advance of the EE/CA and presents a summary of existing conditions that describes the natural environmental setting and the specific site conditions that have resulted from operation and closure activities completed to date at the Beal Mountain Mine. The USDA-FS developed the Statement of Objectives used to define the work plan for this project. Some of these objectives have been recently modified by discussions between the USDA-FS, Maxim, and representatives of Beal Mountain Mining, Inc. (BMMI). These objectives include:

- Identify the physical project boundary and the various features associated with the site, and assess the quantity and quality of existing data pertinent to the project.
- Identify potential human health, safety, and environmental issues associated with various features at the site and develop potential alternatives to mitigate such problems. The mine features where issues have been identified include:
    a) The main waste rock dump
    b) The leach pad and associated features
    c) All features that have the potential for generating selenium, heavy metals or acid rock drainage (ARD) that may be related to mineralization of the area.

- Identify potential safety and geo-technical deficiencies associated with the Beal Pit and the leach pad dike; and develop alternatives that will mitigate such deficiencies.
- Identify any overall miscellaneous issues that are needed to allow for a total closure of the Beal Mountain mining site.

To meet these objectives existing data has been reviewed and compiled, site investigation activities were performed, and an EE/CA will be prepared so that alternatives to closure can be developed and compared. A closure plan that is based on the preferred alternative developed in the EE/CA will be prepared that will address the conceptual plan for final closure of the mine facility and reclamation of the former mine property.

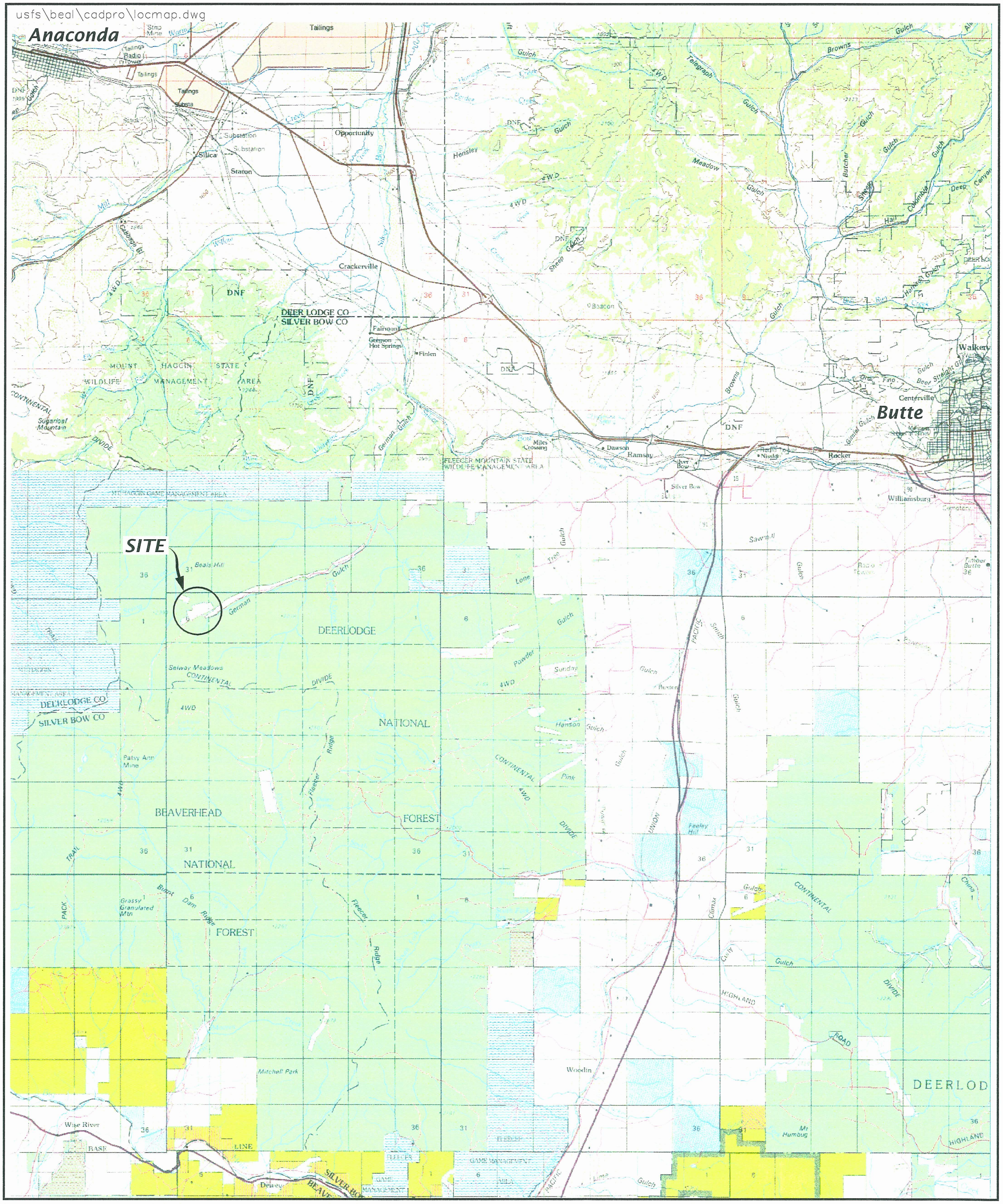
1.2 PERTINENT ISSUES

The primary human health and environmental issues associated with mine closure were discussed with the USDA-FS and other involved parties on July 29, 2003. A few additional items have been added since that meeting. These issues include the following:

- Determine the sources of selenium from mine facilities and determine the impact of selenium on human health and the environment.
- Determine the probability and potential risk for the development of acid rock drainage (ARD) and associated heavy metal mobilization in the leach pad, pits and waste rock storage facility.
- Determine the affect of infiltration into the leach pad in terms of increasing solution volume within the pad.
- Determine the affects of geochemistry and geochemical changes of the heap leach solution over time.
- Determine options for short-term and long-term leach pad solution management.
- Determine final closure for the detoxification pond.
- Determine final land use options for the mine property.
- Determine risk factors associated with the geo-technical stability of the pit wall and potential impacts to the leach pad dike.
- Develop alternatives for closure that address the issues identified above.

1.3 REPORT ORGANIZATION

This Existing Conditions Report is arranged in four sections. Following this introductory section, Section 2.0 provides descriptions of the site, mining history, and mining operations. Section 3.0 describes the existing environment, including the site's climatic, geologic, hydrologic, and hydrogeologic setting. Section 4.0 presents data pertinent to characterizing contaminant sources and pathways of contaminant movement, and potential geotechnical risks associated with various facilities located at the Beal Mountain Mine. In particular, contaminated surface water, groundwater, and mine waste sources located in German Gulch, and geotechnical stability of the Beal Mountain pit highwall and leach pad dike are reviewed. Figures and tables are incorporated into the text of the report. References cited in the document are listed at the end of the text. Appendices contain supporting information and are included at the back of the report.



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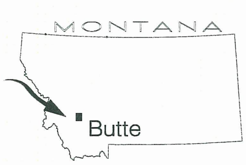

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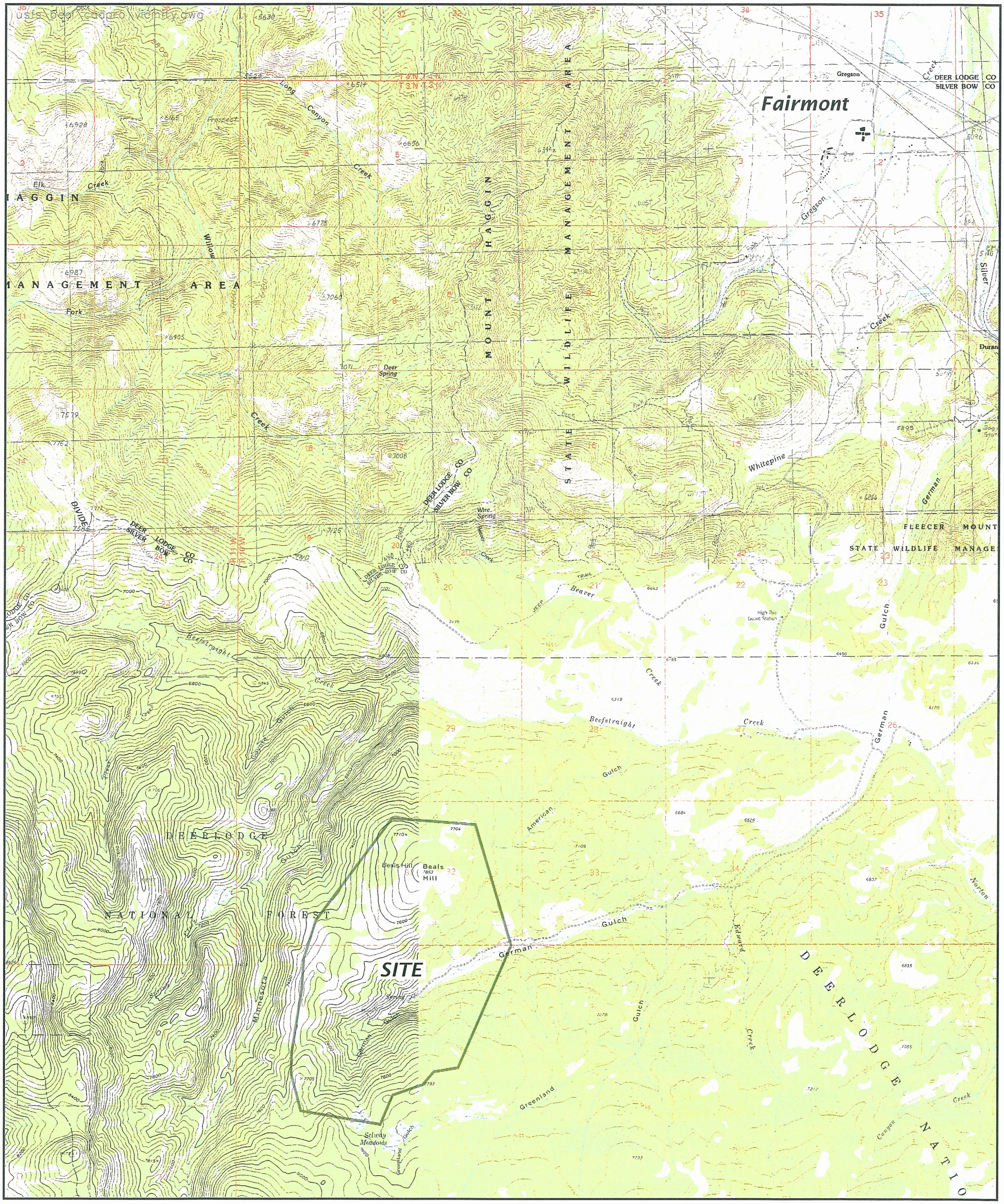
Location Map
Beal Mountain Mine
Silver Bow County, Montana
FIGURE 1



From USGS 7.5 minute Dickie Peak, Burnt Mountain, Opportunity and Anaconda South Quads

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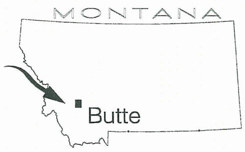

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Vicinity Map
Beal Mountain Mine
Silver Bow County, Montana
FIGURE 2

2.0 BACKGROUND

Beal Mountain Mining, Inc., a subsidiary of Pegasus Gold Corporation (Pegasus), mined two low-grade gold-silver deposits from 1988 through 1997. Mining was from two open pits and gold/silver recovery was by heap leaching of crushed and agglomerated ore. The parent company of BMMI filed for bankruptcy in January of 1998 and a Trustee was appointed for BMMI to over see closure activities using reclamation bonding in January of 1999.

This section of the Existing Conditions Report briefly describes the mining history of the Beal Mountain Mine area, and summarizes current status of the mine and past operations.

2.1 MINING HISTORY

The Beal Mountain deposits occur within the historic Siberia Mining District (Karvinen, 1954). Placer gold was discovered in German Gulch in 1864 and placer mining reached its peak in the early 1900's. Lode deposits were also discovered in the late 1860's and the lode deposits were explored by a number of shallow shafts and adits, most of which are caved and inaccessible today. The only significant historical production was from placer deposits.

Sharon Steel Corporation (later to become US Smelting and Refining Company and then US Steel) staked approximately 100 unpatented mining claims (the Tax Claims) around a core group of 12 patented claims in upper German Gulch. They conducted exploration for gold deposits from the late 1960s through the early 1970s. Placer-Amax, Inc., was also actively exploring the area in the early to mid-1970s. The Montoro Gold Company acquired the property in the late 1970s and in the early 1980s submitted a permit application to mine the main Beal Mountain deposit as an open pit; with floatation concentration and vat leach cyanide milling circuits, and a valley fill tailings impoundment in German Gulch. The State of Montana denied the permit.

2.2 BEAL MOUNTAIN MINE STATUS AND OPERATIONS

2.2.1 Current Status

The Beal Mountain Mine property has been in a closure phase since about 1999 and a large amount of closure and reclamation work has been completed since that time. The details of these closure activities are discussed in some detail in this report. The funds available for closure activities under bonds held by the MDEQ were anticipated to fall short of the closure needs and a Memorandum of Understanding (MOU) was signed between the MDEQ and the B-DNF to jointly cover necessary funding to continue closure operations at the Beal Mountain Mine site upon depletion of the money. In February of 2002 the first of these funds were paid by the USDA-FS.

Much of the reclamation work since 2000 has centered on the design and construction of a biological water treatment plant to treat excess heap leach pad solutions. In October of 2002 the MDEQ issued a revised MPDES permit for discharges from Land Application Disposal (LAD) systems that included a discharge from the previously permitted drain into infiltration galleries along German Gulch. Water treatment and land application of the resulting solution went on in earnest from July 2001 through November of 2003 when solution in the leach pad was lowered the maximum amount in the south side sumps. When treatment of solution ceased, about 3.1 M gallons remained in the sumps. The water treatment plant, which is now the property of MDEQ, was mothballed for the winter of 2003-2004.

2.2.2 Mine Permitting

Following acquisition of the Tax Claim block in 1983 by Pegasus, Pegasus acquired additional properties and executed a multi-year (1983-1986) exploration program within a 6400-acre area that led to delineation and development of the main Beal Mountain deposit and discovery of the South Beal deposit. Feasibility studies were completed in 1987. Beal Mountain Mine was permitted under terms of Montana Metal Mines Reclamation Act and BMMI obtained an Operating Permit (No. 00135) from MDEQ in 1988 (BMMI, 1988) and at the same time received approval for their Plan of Operations from the B-DNF.

The South Beal deposit was permitted by amendment to the Operating Permit 00135 and brought into production in 1993. Both deposits remained in production into 1997.

2.2.3 Beal Mountain Operations

The main Beal Mountain deposit was brought into production in 1988 with announced reserves of approximately 9.2 million metric tons grading 0.044 ounces/ton (opt) gold (Hastings and Harrold, 1988). The chronology of major elements associated with the permitting, mining, reclamation, and closure of the Beal Mountain Mine project are presented in **Table 1 (see also Appendices A-1 and A-2).**

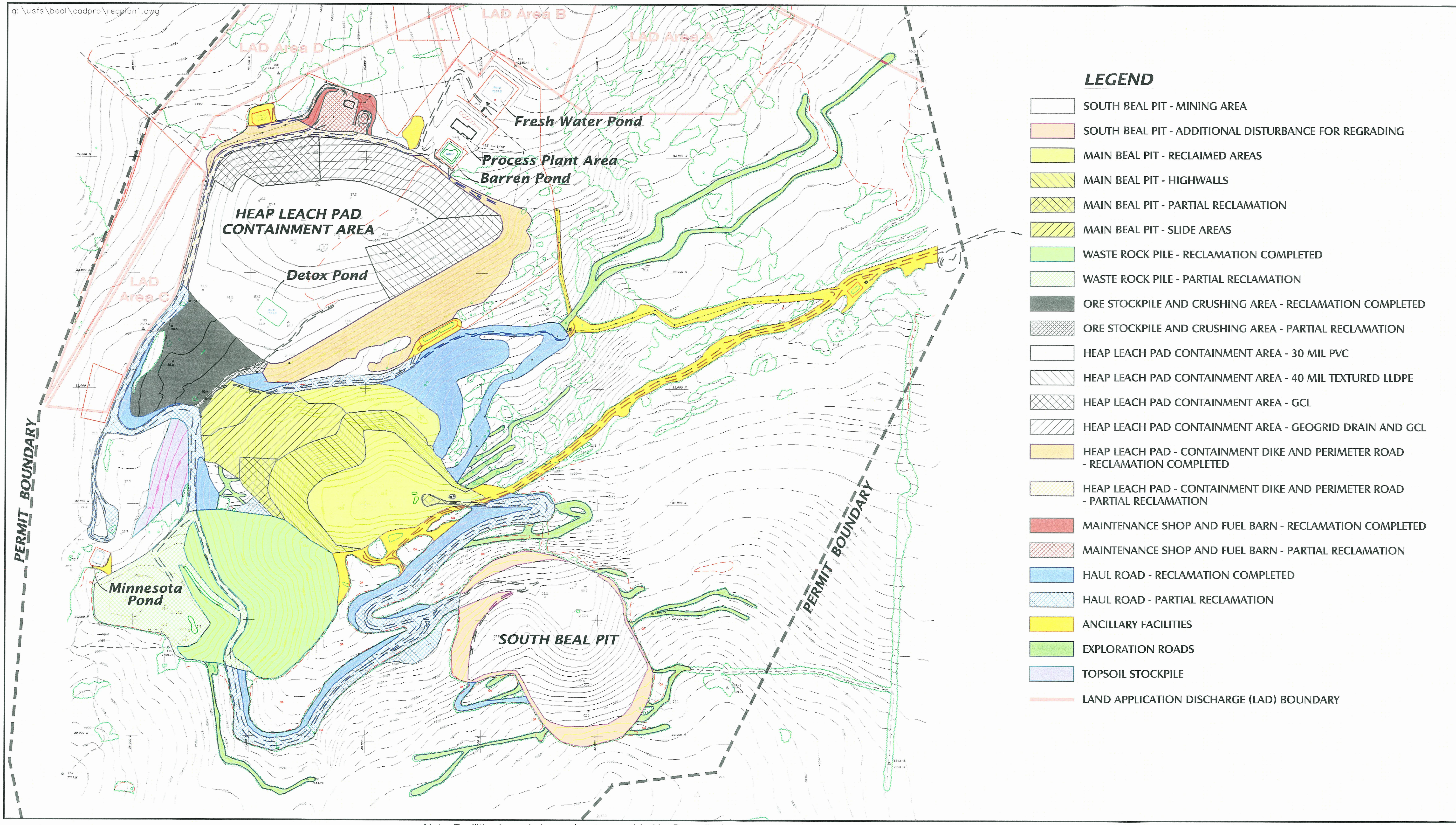
Mining at Beal Mountain used conventional open pit methods that included: topsoil stripping and stockpiling; waste rock stripping and mining of ore by drilling, blasting, loading, and hauling methods. The pits were mined on 20-foot high benches with 30-foot wide safety benches every 60 vertical feet producing a final pit slope of approximately 45 degrees. Mining operations were conducted two shifts/day, five days/week, 180 to 200 days per year (March through November) at a rate of three to four million tons per year, with approximately half being ore and half waste.

Mined ore was hauled to an ore stockpile located near the crushing facility (**Figure 3**). Ore was crushed in jaw and cone crushers, screened to minus 1/2-inch and fine material was agglomerated with approximately 5% cement, again to about a 1/2-inch size. Lime was added to crushed rock to raise the pH. Both agglomerated and crushed ore were hauled to the leach pad (**Figure 3**) for leaching of gold and silver with a dilute cyanide solution from a barren solution pond. Leach solutions were actively applied to the heap year-round.

Gold and silver bearing pregnant solutions were pumped from the leach pad sumps to a carbon adsorption circuit within the processing plant (**Figure 3**). The processing plant had a capability of processing 3,200 to 3,500 gallons of pregnant solution per minute. Gold and silver were refined to bullion at the project site. The processing plant operated 7 days a week 3 shifts per day, 365 days per year, and operated for about two years after the cessation of mining (1997-1999).

Portions of the first three years of waste rock production (about three million tons) from the Beal Mountain pit were used to construct an embankment or containment dike for the leach pad. Later, waste rock from the Beal Mountain pit was placed on a waste rock dump (**Figure 3**). Waste rock from the South Beal pit placed on the waste rock dump in portions of 1993 and 1994, later it was used to partially backfill the main Beal pit and as cover for the waste rock dump and leach pad.

Major facilities at the site included two open pit mines; a waste rock disposal area; a leach pad with a large containment dike or embankment along its southeast flank and a smaller containment dike along the north flank; ore stockpile and crushing/agglomeration facility area; processing plant area (for recovery, assaying and refining of gold and silver); a water treatment plant; an onsite maintenance



Note: Facilities boundaries and status provided by Bruce Parker, Beal Mountain Mine, December 2003
Topography from Horizons Aerial Photogrammetry, September 2003

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Site Map
Beal Mountain Mine
Silver Bow County, Montana
FIGURE 3

Figure 3 – back page

TABLE 1
BEAL MOUNTAIN MINE CHRONOLOGY

DATE	ACTION
5/1983	German Gulch/Beal property acquired by Pegasus Gold from Montoro.
2/1988	Pegasus Gold submits an application for a hard rock mining permit to DSL (joint approval of operating plan by FS).
7/8/88	DSL approves the permit for the Beal Mountain Mine under a bond of $2,770,172.
7/12/88	Beaverhead-Deerlodge Forest Supervisor signs a Decision Notice & FONSI approving Beal Mountain Mine Project.
1/21/91	BMMI submits initial proposal for South Beal Project, withdrew in 6/92 and resubmitted in 8/92
8/1992	BMMI applies for Amendment #1 to their Operating Permit. This amendment was to move the haul road from the north side of German Gulch to the south side.
8/14/92	DSL approves Amendment #1 after completion of an EA.
8/18/92	BMMI resubmits South Beal Project operating permit amendment to DSL & FS.
1/7/93	BMMI presents a proposal to mine deeper into main Beal pit. Proposal is called Main Beal Extension. Agencies in attendance include DSL, DHES Water Quality Bureau, & Beaverhead-Deerlodge NF. Proposal is to go 200 ft deeper than permitted free-draining level, taking the pit more into Beal Shear Zone on south wall of pit. Future plans might include further deepening.
3/3/93	DSL & FS determine that the South Beal Project proposal is complete.
3/1993	Draft EIS completed for South Beal Project by DSL & FS.
6/30/93	Final EIS completed for South Beal Project by DSL & FS.
7/20/93	Arthur Clinch signs ROD for South Beal EIS on behalf of DSL. Same wording regarding trigger levels and selenium concentrations as in the FS ROD.
10/26/94	Completion of checklist EA by DSL for deepening main Beal pit by 100 ft.
7/10/95	BMMI submits an application to FS & DEQ for minor revision to increase the height of the waste dump.
4/19/96	DN/FONSI signed by Butte DR for waste rock storage expansion.
4/29/96	DSL approves waste rock expansion subject to concurrence by FS.
7/16/96	DN/FONSI signed by Butte DR for South Beal pit expansion.
9/25/96	FS approves South Beal expansion.
10/16/96	DSL approves South Beal expansion subject to receipt of $14,732,000 bond (prev. at $6,274,000).
2/1997	Mining ceases in main Beal pit.
10/1997	Mining ceases in South Beal pit.
1/16/98	BMMI files voluntary petition under Chapter 11 of Title 11 of USC (Bankruptcy Code).
12/22/98	Kelvin J. Buchanan appointed as Chapter 11 Trustee for BMMI.
1/14/99	Trustee converts BMMI Chapter 11 to Chapter 7 under Bankruptcy Code.
4/22/99	Final version of Beal Reclamation Agreement sent out for agency signatures by Timothy A. Lukas with Hale Lane Peek Dennison Howard and Anderson out of Reno, NV.
12/13/99	Leach pad solution overtops containment dike.
6/7/2000	Pilot biotreatment plan brought into limited service.
1/5/2001	Notice of Intent to prepare EIS for land application modifications at Beal is published in the Federal Register.
3/20/2001	BMMI submits a draft MPDES Permit application report for land application at Beal.
4/6/2001	BMMI submits final application for MPDES Permit for LAD, etc.
6/27/2001	MOU signed between DEQ and B-D NF to jointly cover necessary funding to continue operations at Beal upon depletion of bond money.
7/5/2001	Startup of land application of bio-treated leach pad solution.
7/25/2001	Complete Beal Agreement sent out for agency signatures by Timothy A. Lukas with Hale Lane Peek Dennison Howard and Anderson out of Reno, NV.
2/20/2002	First payment made by FS for joint funding agreement w/DEQ to cover Beal expenses.
9/6/2002	60-day notice of intent to sue from CFC, directed to BMMI, DEQ & FS. BMMI operating unpermitted LAD discharging Se, Cu, CN, & other pollutants into groundwater hydrologically connected to German Gulch.
10/23/2002	DEQ issues MPDES Permit for LAD and drains at Beal.
12/13/2002	Letter from BMMI to DEQ stating that as of 12/5/02, BMMI is re-directing captured seepage from the toe of the waste dump, including Springs 5 & 10A, into the LAD circuit.

Note: Table is complete through 1/22/03

shop/warehouse and fuel storage area; and an offsite office/warehouse complex (**Figure 3**). During reclamation and closure, the processing plant was converted to a water treatment facility. Several ponds were constructed for various uses throughout the operations area. Ancillary facilities included access and haul roads, soil storage piles, and two pump stations in German Gulch.

Facilities are described in detail in section 4.0 of this report. **Table 2** presents total acreages of disturbed ground with each facility and the extent of reclamation to date.

TABLE 2
TOTAL DISTURBED ACRES BY FACILITY

	Total Facility Acreage	Reclaimed Acreage	Unreclaimed Acreage
Permit Area	1202	--	--
Main Beal Mountain Pit	47.7	34.7	13.0
South Beal Pit	45.5	45.5	0
Waste rock disposal area	48.2	31.4	16.8
Heap leach pad (77 acres) area includes containment dike	101.6	101.6	0
Soil storage	20.3	14.5	5.1
Ore processing facilities	19.0	19.0	0.0
Ore stockpile and Crushing Area	12.8	12.8	0
Maintenance, fuel and shop area	4.8	1.4	3.4
Haul roads and associated disturbance	50.8	26.5	24.3
Exploration roads	18.7	18.7	0
Ancillary Facilities	16.6	--	--
Access road (SE of point E)	4.2	--	--
Subtotal	**390.2**	**287.1**	**81.6**
Beefstraight-German Gulch Creek Pump Station and Intake Structures	0.1	--	--
Subtotal	**0.1**	--	--
Office/Shop Complex	5.0	--	--
Access road	15.1	--	--
Subtotal	**20.1**	--	--
Outside Permit Boundary Access Road	41.6	--	--
Grand Total	**452.0**	**287.1**	**81.6**

2.2.4 Beal Mountain Production

Table 3 presents overall production data from the Beal Mountain Mine without regard to which of the two deposits the material came from. In all, some 14,807,100 tons of ore and 20,046,144 tons of waste were mined. Capital costs for the mine were $23,700,000 and total operating costs were $98,649,736.

TABLE 3
BEAL MOUNTAIN PRODUCTION DATA BY YEAR

Year	Ore Production (tons per year)	Waste Production (tons per year)	Gold Production (ounces)	Silver Production (ounces)
1988	179,431	692,940	3,000 (estimated)	--
1989	1,501,914	1,996,860	40,615	--
1990	1,916,095	2,638,713	50,003	--
1991	1,773,098	1,965,017	47,300	7,800
1992	1,673,347	2,274,361	52,213	8,334
1993	1,709,928	1,569,071	59,260	8,000 (est.)
1994	1,783,574	1,440,913	61,217	8,700
1995	1,635,530	1,384,795	59,880	10,200
1996	1,893,385	2,279,011	45,067	7,834
1997	740,797	4,054,463	30,740	4,900
1998	--	--	7,116	--
1999	--	--	4,474	--
Totals	**14,807,100**	**20,296,144**	**457,884**	**55,768**

Gold and silver production was 457,884 and 55,768 ounces, respectively, bringing the gross value of the deposit to $137,640,200 (at per ounce prices of $300 gold and $5 silver). The average gold grade for ore mined at the Beal Mountain Mine was 0.0309 opt and the average silver grade was 0.004 opt. Of the total production, South Beal accounted for 959,840 tons of ore and 1,289,000 tons of waste and was principally mined in 1993-94 and 1997.

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3.0 EXISTING ENVIRONMENT

The Beal Mountain Mine is located on the northeastern flank of the Pioneer Mountains of southwestern Montana. Access to the site is by about 10 miles of National Forest roads and a private road that connects Fairmont Hot Springs with the mine site.

The Beal Mountain deposits (Beal Mountain and South Beal) occur in the headwaters area of German Gulch (**Figure 2**). The main Beal Mountain deposit occurs on the south flank of a prominent northeast–southwest trending ridge that is located between two creeks, German Gulch on the southeast and Minnesota Gulch to the northwest, and along whose crest is a topographic feature called Beal Mountain (Beal's Hill on older topographic maps). Both of these creeks are tributaries of Silver Bow Creek and the Clark Fork. An outlying deposit, South Beal, occurs about 1,500 feet south of the main Beal Mountain deposit on a steep north-facing valley side-slope and across German Gulch. Elevation in the vicinity of the mine ranges from about 6,500 feet in German Gulch to 7,863 feet at the top of Beal Mountain. The deposits themselves occur at elevations between 6,930 and 7,560 feet. The mining permit boundary contains about 1202 acres, with about 90% of the permit area in German Gulch and 10% in Minnesota Gulch.

Topography consists of broad, gently to moderately sloping ridge tops and steep V-shaped valleys. Ridge tops and south facing slopes are typically open and north-facing slopes are tree covered. Few outcrops are present within the project area and are limited to ridge crests and steep side-valley slopes. Elsewhere, glacial, talus, or colluvial deposits typically cover the outcrops (BMMI, 1988). Most of the site facilities, including the main Beal Mountain pit, leach pad, maintenance and process facility areas, are situated on slopes with a south-facing aspect. The waste rock dump is on an east-facing slope and the South Beal pit is on a north-facing slope.

3.1 LAND STATUS AND USE

The permit area contains 12-patented mining claims located in its core and along German Gulch (**Figure 4**). The remainder of the land is federally owned and administered by the B-DNF. Predominant historical land uses in the vicinity of the mine include grazing, timber and recreation. The area is primarily forested with open parks present on ridgelines and along south-facing slopes. Commercial grade timber exists both north and south of the permit area although there has not been commercial logging in German Gulch. The USDA-FS manages a grazing allotment within the Beal Mountain Mine permit boundary, although grazing has been excluded from one of the three areas historically used for pasture (i.e. the portion of the allotment within the permit area).

The Deerlodge National Forest Plan, which is currently undergoing revisions, has goals for areas north of German Gulch that include: continue to provide healthy and economic levels of timber while maintaining overall levels of wildlife habitat, livestock grazing and dispersed recreation (paraphrased from the Deerlodge National Forest Plan, USDA Forest Service, September, 1987). Mining operations and timber harvesting are uses that are compatible with these goals. The goals set by the Deerlodge National Forest for the area immediately south of German Gulch are to preserve existing conditions with minimal investment for resource activities (paraphrased from the Deerlodge National Forest Plan, September, 1987). National Forest System lands in this area are considered unsuitable for timber development.

3.2 CLIMATE

The northern Pioneer Mountain Range has a continental climate that is significantly modified by locally mountainous terrain. Large daily and annual temperature ranges and marked differences in precipitation, temperature, and wind directions are common on a local scale.

The average annual precipitation calculated in the vicinity of the site is 25 inches per year based on information published by the Natural Resources Conservation Service (NRCS, 1998). Site-specific precipitation and evaporation data have also been collected by BMMI. **Table 4** lists climate data collected during the period from 1988 through 1995. During this period precipitation at the site ranged from 13 to 23 inches per year. About half of the average annual precipitation occurs during the period from April to July. June has the highest average monthly precipitation (2.77 inches; 16% of total annual precipitation) and January has the lowest average monthly precipitation (0.49 inches; 3% of total annual precipitation).

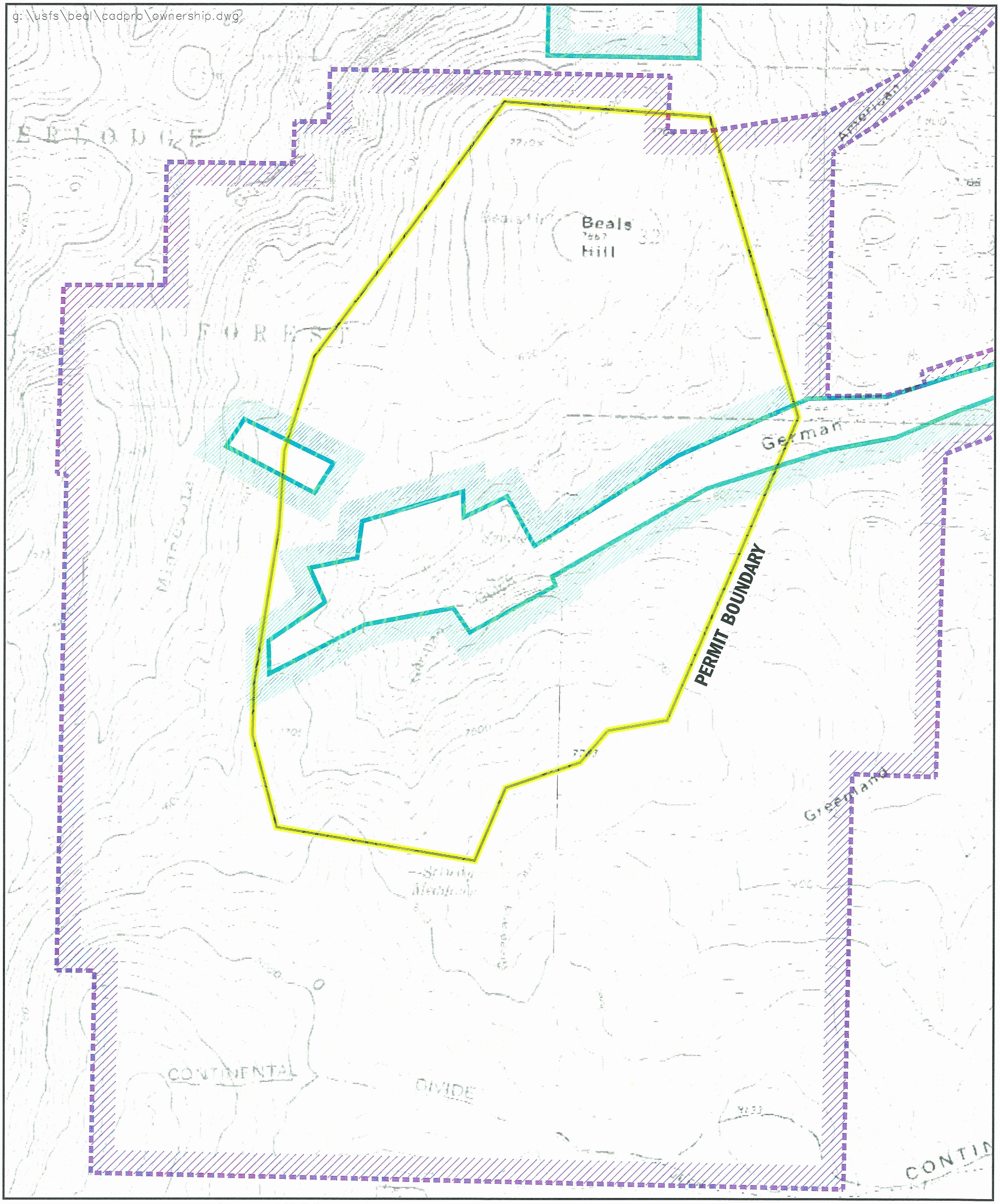
TABLE 4
MEAN MONTHLY CLIMATIC DATA MEASURED AT THE BEAL MOUNTAIN MINE SITE

Month	Mean Monthly Precipitation (in inches per month)	Mean Monthly Evaporation* (in inches per month)
January	0.49	Not routinely measured
February	0.65	Not routinely measured
March	1.33	Not routinely measured
April	2.15	2.42
May	2.34	4.00
June	2.77	4.85
July	2.03	6.64
August	1.35	7.38
September	0.93	4.35
October	1.30	1.48
November	0.58	Not routinely measured
December	0.51	Not routinely measured
Average annual total	**17.21 (range 13.05-23.13)**	**31.12**

Notes: Data represent period from 1988-1995 (Schafer and Associates, Inc., 1996).
* Values based on experience gained during operations, heap leach water balance values, and measured pan evaporation values. In some cases, only a limited number of monthly measurements are available.

3.3 GEOLOGY

The Beal Mountain Mine area occurs within a tectonic province called the Northern Cordilleran overthrust belt. This tectonic belt is over 200 miles wide in the Northern Rocky Mountain area of central Idaho-Montana. Within the belt, Cretaceous and older rocks have been intensely folded, faulted and thrust faulted into imbricated layers of locally very complex structure. This portion of the belt also includes intrusive rocks of the Idaho and Boulder batholiths. In the vicinity of these very large intrusive bodies, sedimentary rocks have been intensely deformed. These intrusive bodies have also produced contact metamorphism and locally mineralized zones, such as those found at the Beal Mountain Mine,



Source: USGS 7.5 minute Dickie Peak and Burnt Mountain Quadrangles

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Patented Land

Unpatented Land

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Land Status Map
Beal Mountain Mine
Silver Bow County, Montana
FIGURE 4

Figure 4 – Back page

within the adjacent sedimentary rocks (Hastings and Harrold, 1988). Other important sources of local geology can be found in Moore (1956) and Noel (1956).

3.3.1 Site Geology

The Beal Mountain Mine area is located along a regional northeast-southwest trending contact zone between intrusive and sedimentary rocks (**Figure 5**). Intrusive rock crops out to the east of the sediment/intrusive contact and about 2,500 to 3,000 feet east of the Beal Mountain deposits. This intrusive body is a Cretaceous (72 million year old) outlier of the Boulder Batholith and is predominantly a fine-grained equigranular stock that is granodioritic to dioritic in composition (Hastings and Harrold, 1988). A fine-grained dioritic stock is also located about 200 to 300 feet to the southwest of the South Beal deposit and a similar or the same stock occurs along the western margin of the Beal Mountain deposit (BMMI, 1988) (**Figure 5**). Other smaller sill-form and dike-like bodies occur within the metasediments and are difficult to distinguish from the hornfels metamorphic assemblages and textures.

Volcanic rocks of the Tertiary age (53 to 48 million years old) Lowland Creek Volcanic sequence overlie the intrusive rocks about two miles east of the intrusive/sediment contact and well outside of the permit area. These volcanic rocks are extrusive flows and tuffs that are latitic and dacitic in composition.

Sedimentary rocks in the Beal Mountain area, range in age from Precambrian to Cretaceous and occur to the west of the regional sediment/intrusive contact zone (**Figure 5**). Within the Beal Mountain area, Precambrian and Paleozoic sedimentary rocks are complexly thrust faulted over younger Cretaceous-age sediments (**Figure 5**). Precambrian age quartzite of the Missoula group (Belt Supergroup) has been thrust to the east and overlies an incomplete sequence of overturned Paleozoic rocks. The Cambrian Pilgrim Formation, Devonian Dry Creek and Jefferson Formations, and the Mississippian Madison Formation are the units that occur within this partial sequence of Paleozoic rock. This sequence of rock is in turn thrust along a post mineralization, low angle (10 degree) fault plane over clastic continental sediments of the Vaughn Member of the Cretaceous Blackleaf Formation further to the east (BMMI, 1988). It is the Cretaceous Blackleaf Formation that occurs in the Beal Mountain Mine area proper.

High angle fault structures associated with intense fracturing and local brecciation occur along the German Gulch, the Beal Shear, and various northeast and northwest trending faults, including the Gully Fault in the mine area (Hastings and Harrold, 1988). These faults are discussed in greater detail below.

3.3.2 Alteration

Petrogenetic studies suggest that contact metamorphic (high temperature) and metasomatic (migrating hydrothermal fluids) processes associated with the emplacement of Cretaceous Boulder Batholith intrusives were principally responsible for alteration of the host rocks and formation of the Beal Mountain Mine ore deposits. Alteration is characterized by bleaching, chloritization, silicification, and minor sericitization (Hastings and Harrold, 1988). Potassium feldspar, diopside, biotite, chlorite, and quartz-bearing hornfels assemblages dominate the alteration.

Intense silicification is associated with the contact metamorphic effects in sediments adjacent to the intrusive bodies. This silicification has limited oxidation of the main Beal Mountain deposit to the near surface or intensely fractured zones, whereas as much as 75% of the South Beal deposit is thoroughly oxidized (BMMI, 1992).

The intensity of contact metamorphism related to the intrusive body decreases rapidly outward from the intrusive centers and the Beal ore deposits such that at the project's western permit boundary only regional prophylitic alteration assemblages remain. Granitic rocks east of the contact zone are largely unaltered (BMMI, 1988).

Post mineralization weathering has produce clay alteration in both host and country rock predominantly along fracture surfaces.

3.3.3 Beal Mountain Deposit

Mineralization in the German Gulch area is spatially, temporally, and genetically related to the emplacement and alteration of the sediments of the Blackleaf Formation by the intrusives of the granodioritic outliers of the Boulder Batholith Intrusive Complex (**Figure 5**).

3.3.3.1 Main Beal Mountain Deposit Area Geology

The main Beal Mountain ore deposit is located about 3,000 feet southwest of the intrusive sedimentary contact (**Figure 5**). The deposit is a pipe-like body that is nearly vertical in orientation and is hosted in Cretaceous age clastic sedimentary rocks of the Vaughn Member of the Blackleaf Formation. These sediments were initially deposited as a thick (885 to 1240 ft) sequence in a fluvio-deltaic setting as thick-bedded conglomerate, fine-grained sandstone, and laminated multi-colored siltstone and shale. Folding and faulting have rotated the beds such that within the mine area they trend northwest (N 0-30 W) and dip gently to the northeast (5 to 20 degrees). Sediments have been metamorphosed and metasomatically altered by hydrothermal fluids from the Cretaceous granodiorite intrusives to biotite, amphibolite or pyroxene-potassium-feldspar hornfels, metaquartzite, and metaconglomerate. Alteration assemblages contain quartz, feldspar, diopside, hornblende, biotite, and chlorite. This alteration has produced rocks that are very hard, dense, and brittle, and subsequent faulting has resulted in narrow to wide zones of intensely fractured, sheared, and broken rock.

In the mine area the zones of most intense fracturing are associated with two prominent steeply dipping sets of faults: the east-west trending Beal Shear zone and the northwest-southeast trending Gully Fault (**Figure 5**). Portions of each of these structures are highly mineralized and are important centers of mineralization for portions of the Main Beal Mountain ore deposit. In addition, a steeply dipping fault is inferred to lie along the axis of German Gulch based on subtle stratigraphic evidence. However, the fault is not visible in very limited outcrops anywhere along the valley bottom.

The Gully Fault is a normal fault that cross-cuts the Beal deposit. It trends N. 45 W. and is approximately vertical to very steeply dipping to the southwest. Displacement has been measured at about 25 feet and is down-dropped to the southwest. A 20-foot wide fault gouge has developed along the fault plane that contains iron-stained clays and sedimentary breccia fragments.

The Beal Shear zone is a brecciated and sheared zone that varies from 70 to 120 feet in width and is located along the south side of the Beal deposit (**Figure 5**). It trends approximately east-west and dips 70-80 degrees to the south. A 100-foot wide fracture zone parallels the Beal Shear to the north and ore-grade mineralization appears to occur within and to the north of this fracture zone. Numerous parallel faults and fractures seem to have localized the emplacement of diorite dikes throughout the deposit area. In addition, fracturing and jointing is developed within the metasediments that is sub-parallel to both the Beal Shear and Gully Fault systems that results in a blocky character to the rock and ore in the vicinity of the main Beal deposit.

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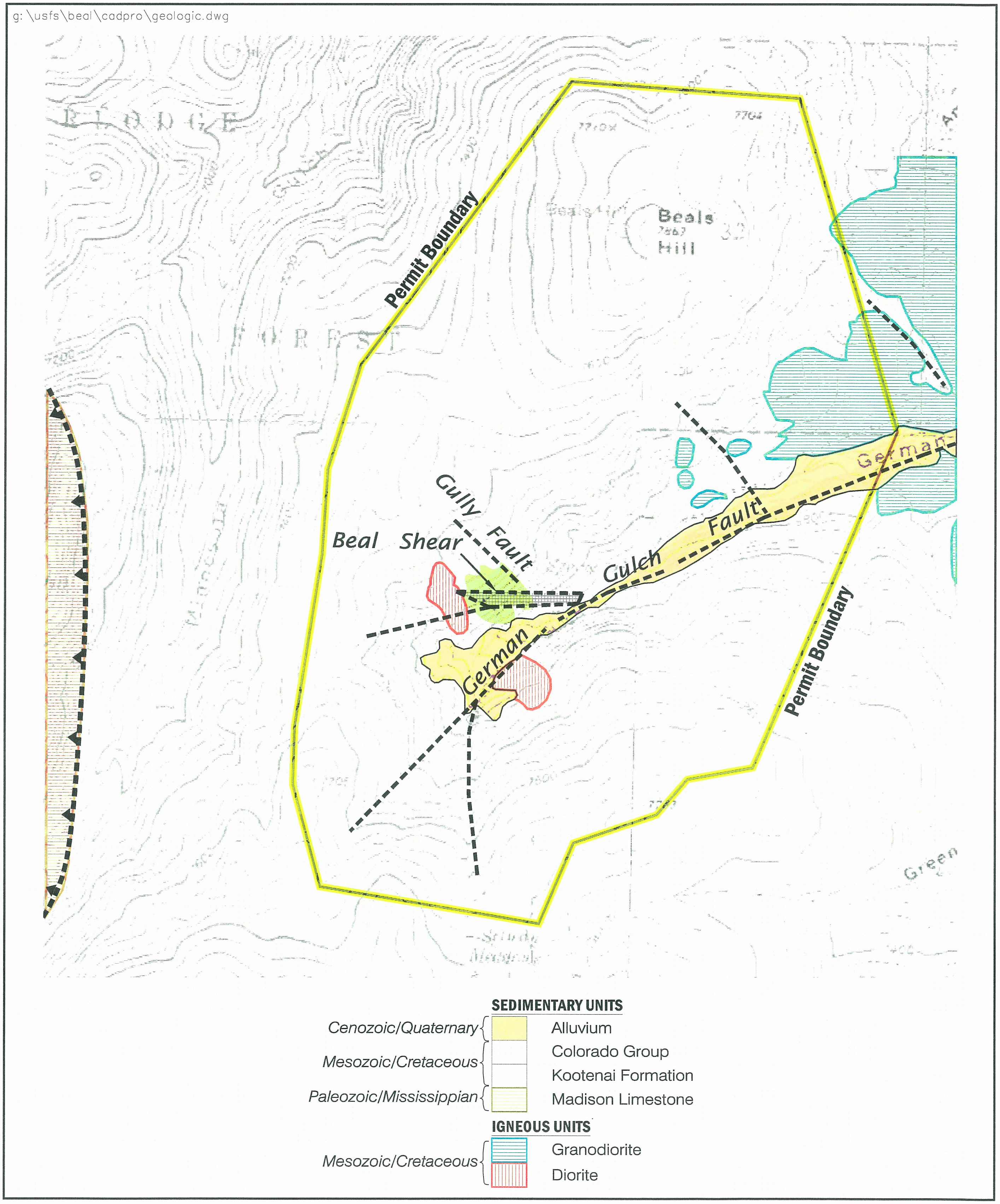

Basemap Source: USGS 7.5 minute Dickie Peak and Burnt Mountain Quadrangles
Geology: Hastings and Harrold, 1988 and Hydrometrics, Inc. 1988 Exhibit 1-3

N

Not to Scale

Beal Deposit
High Angle Fault
Thrust Fault

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Regional Geologic Map
Beal Mountain Mine
Silver Bow County, Montana
FIGURE 5

Figure 5 – back page

Numerous pre-mineralization faults, at very low angles to the bedding planes, are comprised of brecciated sedimentary fragments in a clay matrix and occur throughout the mine area. These faults are likely minor, low-angle thrusts that are developed parallel to large-scale regional thrust faults. Some of these faults have been reactivated during mining and movement of as much as three feet per day has been measured along some beds and zones (see west wall slide and clay/sill slide in the geotechnical stability analysis section). The rate of movement seems to be related to the amount of water lubricating the fault zone surfaces.

The main Beal Mountain ore deposit produced gold and silver at a ratio of about 8:1. The principal occurrence for gold is as extremely fine-grained (1-5 micron) disseminations in the coarser-grained facies (quartzite and conglomerate) of the Cretaceous sedimentary rocks. In addition, gold occurs in a telluride phase that is also rich in lead, bismuth, and silver. Gold also occurs associated with late-stage, narrow (less than three centimeters) quartz veins that cross-cut the disseminated sediment-hosted gold-bearing zone. Based on drill and surface samples, trace metals associated with the gold mineralization include silver, bismuth, copper, and arsenic, with lower concentrations of lead and zinc (BMMI, 1992). Sulfide mineralization occurs within the altered Cretaceous sediment host rocks in concentrations ranging from three to eight percent both within and outside of the gold-bearing mineralized zone, and may or may not be directly associated with gold mineralization. The effectiveness of heap leaching as the principal mechanism for gold recovery further suggests the presence of free gold as disseminations within the host rock as opposed to gold being contained as inclusions or present along fracture surfaces within sulfide minerals. Sulfide minerals include pyrrhotite, pyrite, chalcopyrite, and minor amounts of molybdenite and arsenopyrite.

Petrogenetic studies indicate that sulfide minerals precipitated early in the metamorphic alteration and mineralization sequence, followed by silicification of intergranular clastic pore space. This was followed by gold-bearing fluids that were trapped in the interstices precipitated gold at the clastic or silica-sulfide grain boundaries. Finally silica, with or without gold was deposited in late stage cross-cutting fractures as veins and veinlets. Adularia from late stage gold-bearing quartz-adualaria-chlorite veins has been dated by potassium/argon methods at 71.8 million years, and similar in age to the Boulder Batholith.

A detailed study of rock from the Main Beal pit highwall was completed by Dr. David Mogk of Montana State University, using transmitted and reflected light petrography with scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS) (Mogk, as presented in Gallagher, 1995). A total of 19 samples were collected from mineralized sulfide veins, massive zones, and/or fractures and groundwater seeps in the highwall. These samples contained oxidized and reduced sulfide minerals, including pyrrhotite, pyrite, chalcopyrite, and galena, as well as minor arsenopyrite. The sulfide minerals were shown to be relatively pure in composition, free of contaminants that might accelerate weathering. Arsenopyrite, in particular, was shown to be encapsulated by silica and therefore less available for dissolution. Analyses did not show trace element enrichment in oxidized zones, indicating that these elements were not liberated during the oxidation of sulfides. Analyses did not identify the primary selenium host mineral, although selenium was detected in trace concentrations through EDS analysis in galena and tellurobismuthanite. Calcite was present in many samples, providing some buffering capacity for acid or acid-soluble trace elements generated through sulfide oxidation. Mineralogy data suggest that sulfide oxidation may play an important role in the chemistry of mine seepage, with oxyanionic elements such as selenium and arsenic potentially constituents of concern in mine seepage.

3.3.3.2 SOUTH BEAL DEPOSIT AREA GEOLOGY

The South Beal deposit (**Figure 3**) is hosted in an individual bed of impure calcareous quartzite or siliceous limestone that is now largely metamorphosed and altered to a chalky calc-silicate hornfels, comprised of 50 to 90% diopside and wollastonite. The bed is about 32 feet thick, trends northwest, and dips from 5 to 20 degrees to the northeast, essentially parallel to the north facing hill slope. Gold mineralization is offset by a northwest trending fault on the east side of the deposit.

Like the main Beal Mountain deposit, sulfides occur as disseminated and fracture controlled mineralization with pyrite, pyrrhotite, and chalcopyrite being the most abundant phases. Gold occurs principally as fine, free gold (5-20 micron) and is confined to the favorable host metaquartzite and calc-silicate hornfels lithologies. The South Beal deposit differs from the main Beal Mountain deposit in that gold/silver ratios are about 3:1 and that gold seems to be more commonly associated with bismuth-rich tellurides (BMMI, 1992). In addition, the late stage gold-adularia-chlorite veins associated with gold do not seem to be present in the South Beal deposit.

Waste rock associated with both deposits are Cretaceous sediments that have been altered and consist of predominantly fine-grained, brown quartzite; cherty limestone that has been altered to calc-silicate (wollastonite-pyroxene) hornfels; mudstone that has been altered to biotite or amphibole/k-feldspar hornfels, and, locally in the South Beal deposit, a thin quartzite bed that is 10 to 15 feet thick and contains as much as 5% sulfides. In general, however, waste rock in the more highly fractured main Beal Mountain deposit contains more abundant sulfides than the waste rocks of the South Beal deposit. In addition, weathering and oxidation also appears to be more pervasive in the South Beal deposit, which in addition to oxidizing sulfide, is responsible for the intense clay alteration and high clay content associated with South Beal wastes. Alteration assemblages include biotite, diopside, potassium feldspar, chlorite, scapolite, quartz, actinolite-tremolite, and hornblende with retrograde wollastonite and sepiolite.

3.3.4 <u>Rock Geochemistry</u>

The geochemistry of ore and waste rock mined by BMMI from the Main Beal, Beal Extension and South Beal areas was evaluated in several studies (Gallagher, 1994; 1995; 1996; Pegasus Gold, 1998; Schafer and Associates, 1994; 1995) conducted over the life of the mine project. The goal of these investigations was to evaluate the risk of ARD formation using static and kinetic test methods, and to predict trace element release by weathered mined material or in-pit highwalls. Related studies evaluated the mineralogy of weathered and unweathered rock, and characterized rocks that would be exposed in the ultimate Beal Mountain pit highwall as a basis for predicting post-mine water quality. This geochemistry overview section summarizes and integrates available data, listed in **Table 5,** as a basis for evaluating existing conditions at the Beal Mountain Mine. As available whole rock data are limited (**Table 5**) and paste pH data were found to be inconsistent with static test data, these data are not discussed.

Roughly one-third of waste rock and ore mined from the Beal Mountain Pit is potentially acid generating based on static tests and another third is not. The remaining rock has uncertain potential to generate acid. Kinetic tests showed variable potential for ARD generation and trace element release; most columns, while maintaining a circumneutral pH, were maintaining or increasing sulfate release rates with declining alkalinity. Mineralogy showed variable alteration and some degree of encapsulation of sulfide minerals, which may explain slow reaction rates.

TABLE 5 SUMMARY OF BEAL MOUNTAIN MINE GEOCHEMICAL TESTING							
Material Type	Number of Samples						
	Whole Rock	ABA[1]	Paste pH	Humidity Cells	EPA 1312	EP Toxicity	In Situ Rinsing
Waste Rock	26[2]	572[2]	124	23	13	13[2]	0
Ore	1	75	39	1	1	0	0
Spent Ore	0	20	0	3	0	0	0
Pit Wall	0	23	0	0	4	0	4

1 Only samples for which location description and raw ABA data were available are included.
2 No distinction between waste rock and ore is provided for 8 samples studied for original baseline report.

It isn't clear from the kinetic test data that samples which had not produced acid at the end of the twenty week tests would remain non-acidic if the tests were run for a longer period. Twenty weeks is the standard humidity cell-testing period, but recent research (Lapakko, 2003) has shown that as many as 60 to 120 weeks may be necessary to properly evaluate some samples in a humidity cell test. Some trace element release is likely to occur, including aluminum, arsenic, copper, iron, selenium, and zinc.

Data collected during static and kinetic testing of South Beal pit ore and waste rock suggest a low potential for ARD from pit highwalls and waste rock and a high potential from ore. During reclamation the entire South Beal Pit was covered with South Beal wastes, top-soiled and revegetated. It is unlikely that the presumed small amount of residual ore from the buried pit walls will generate enough acidity to overwhelm the neutralization potential of the surrounding rock. While limited, available data for evaluating metal mobility indicate that leachate from South Beal rock will be of good quality.

As the waste rock dump is composed predominantly of waste mined from the Beal Mountain pit and a much smaller component from the South Beal deposit,, the potential for ARD and metal mobility at this facility are expected to be similar as discussed for non-ore samples from the Beal Mountain pit. Static testing of drill samples collected from the waste rock dump confirms the potential for ARD production on a run-of-mine basis.

Crushing, agglomeration and cyanidation during leaching significantly altered the geochemistry of the mined ore; analyses of spent ore are therefore used to characterize material on the leach pad. Static testing of spent ore indicates that material contained in the leach pad has a high potential for acid generation. However, kinetic testing of spent ore and pad solution pH measurements indicate low ARD risk. It is possible that, while spent ore poses a risk of ARD, the high pH of the remaining heap leach solution is buffering acid generation in the heap leach pad. It is noteworthy that pH and alkalinity have decreased somewhat following cessation of leaching operations, indicating that the neutralizing capability of the heap is slowly being depleted. Kinetic test data indicate that leachate from the spent ore will be of generally good quality with possible exceedances of human health-based standards for arsenic. Recent analysis of the remaining heap leach solution indicates that most metal concentrations in the heap are near equilibrium with elevated levels of selenium, iron, and copper. Selenium concentrations in pad solution appear to be declining. In addition to impacts originating from the spent ore and pad solution, there is an unknown but significant risk of potential ARD and metal release from the heap leach embankment, which was constructed with waste rock from the Beal Mountain pit.

3.4 HYDROLOGY

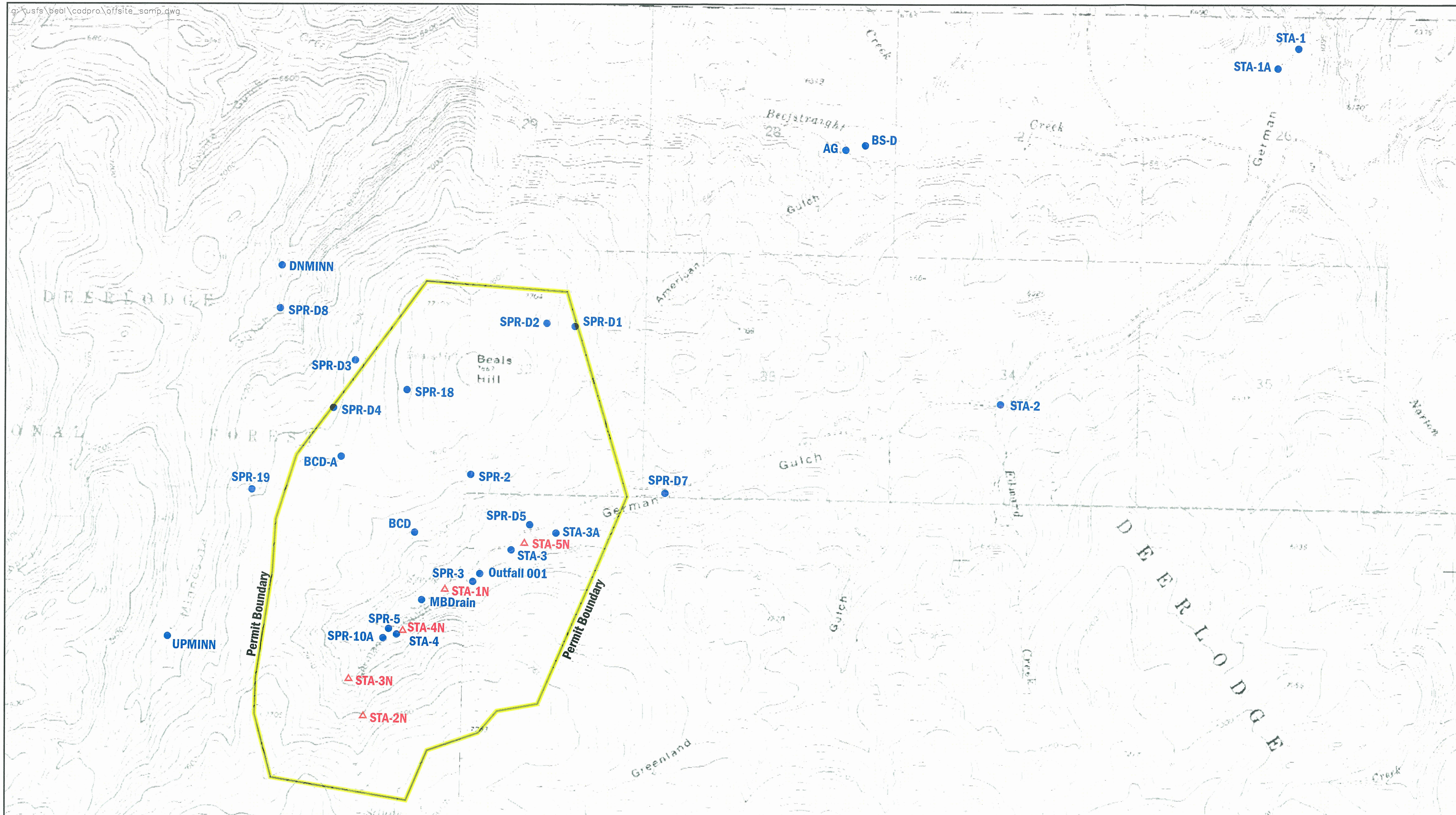
German Gulch is the principal drainage in the Beal Mountain Mine area. German Gulch collects water from most of the mining facilities including the main Beal Mountain and South Beal pits, and the waste rock dump (**Figure 3**). Minnesota Gulch lies to the north of German Gulch and drains the north side of Beal's Hill. The topographic divide between German and Minnesota Gulches occurs beneath the leach pad facility, with the largest portion of the facility draining to the south into German Gulch. Therefore, water from the heap leach facility flows both to Minnesota and German Gulches (**Figure 3**). The areas west, north and northeast of the leach pad, contains land application disposal areas, and most of the land application areas used drain into Minnesota Gulch. Minnesota Gulch flows northeast around Beal's Hill and into Beefstraight Creek, which in turn flows into German Gulch. American Gulch drains the north flank of Beal's Hill and flows into Beefstraight Creek. German Gulch flows into Silver Bow Creek approximately two miles downstream of the German Gulch-Beefstraight Creek confluence.

The upper portion of the German Gulch watershed consists of mixed forest and open grassland mountain slopes. Major tributaries of German Gulch include upper German Gulch, Edwards Creek, Norton Creek, and Beefstraight Creek. The drainage area of German Gulch is 40.6 square miles (25,984 acres) (BMMI, 1988) with elevations ranging from 5,300 feet at its mouth to 8,909 feet on the western divide of Minnesota Gulch

3.4.1 <u>Flow</u>

Streamflow has been routinely measured in German Gulch and its tributaries as part of permitting and compliance activities for the Beal Mountain Mine. In addition, the U.S. Geological Survey (USGS) maintained gauging station 12-3235 on German Gulch 0.5 miles upstream of its confluence with Silver Bow Creek from 1955 through 1969. Surface water-sampling sites are shown on **Figures 6a and 6b**. **Figure 7a** shows stream flows measured over time at Stations STA-4, STA-2, and USGS 12-3225. Maximum streamflow typically occurs between mid-April and late June, and seasonally low flows typically occur in late fall and winter. The furthest upstream monitoring point STA-4 (**Figure 6a**) has minimal flow during low flow conditions (**Figure 7a**). The highest flow recorded at STA-4 was 5.25 cubic feet per second (cfs) in June 1995. The highest flow measured within the study area was 84 cfs at STA-1 (**Figure 6a)** in June of 1995. The lowest flow recorded at STA-1 was 4.0 cfs in January 2002. Maximum and minimum daily mean flows recorded at the USGS station near the mouth of German Gulch between 1955 and 1969 were 300 cfs and 2.8 cfs, respectively. Flow in German Gulch increases with distances downstream (**Figure 7b**). Flow data collected since 1987 indicate that most of the flow in German Gulch is contributed by Beefstraight Creek, Edwards Creek, and Greenland Creek tributaries. BMMI (1988) estimated the 5-year and 100-year peak flow at STA-4 at 3.9 and 15.8 cfs, respectively. Peak 5-year and 100-year peak flows at STA-2 were estimated at 62 cfs and 625 cfs, respectively.

Minnesota Gulch drains the area north of the leach pad and most of the land application areas. Stream flows have been measured periodically since 1994 at sites DNMINN and UPMINN (**Figure 6a**). Low flow in Minnesota Gulch is typically from late fall through early spring, and flows are most heavy during spring runoff. Maximum flows measured at stations UPMINN and DNMINN between 1994 and 2003 are 18 and 30 cfs, respectively. BMMI (1988) estimated the 5-year and 100-year peak flow at the mouth of Minnesota Gulch at 42 and 133 cfs, respectively.



Source: USGS 7.5 minute Dickie Peak and Burnt Mountain Quadrangles

N

0 Feet 2000

STA-3A ● Surface Water Sample Location

STA-3N △ Additional 2003 Sediment Sample Location

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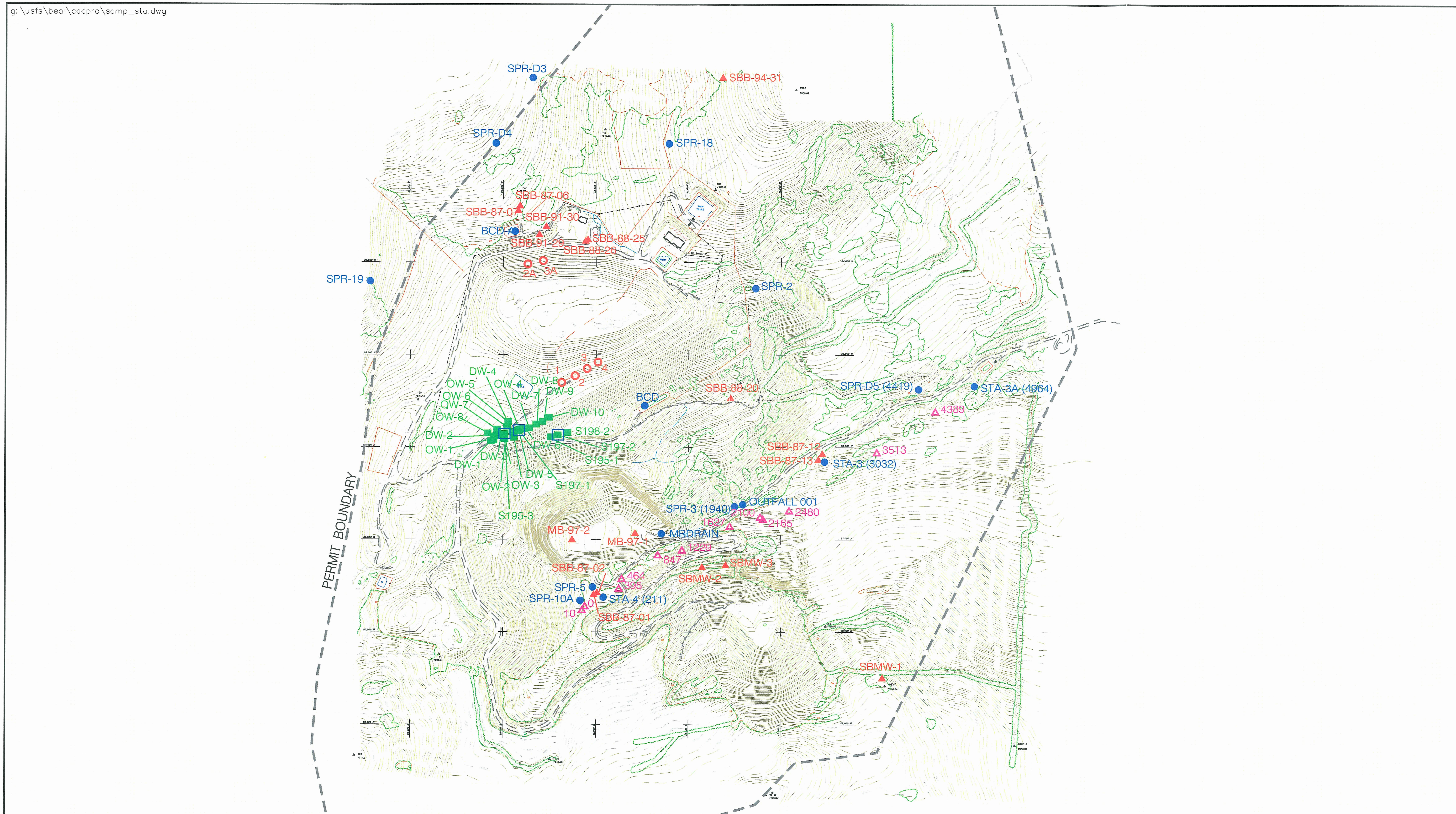
On-Site and Off-Site Surface Water Monitoring Locations
Beal Mountain Mine
Silver Bow County, Montana
FIGURE 6a



Topography from Horizons Aerial Photogrammetry, September 2003

N

0 Feet 1000

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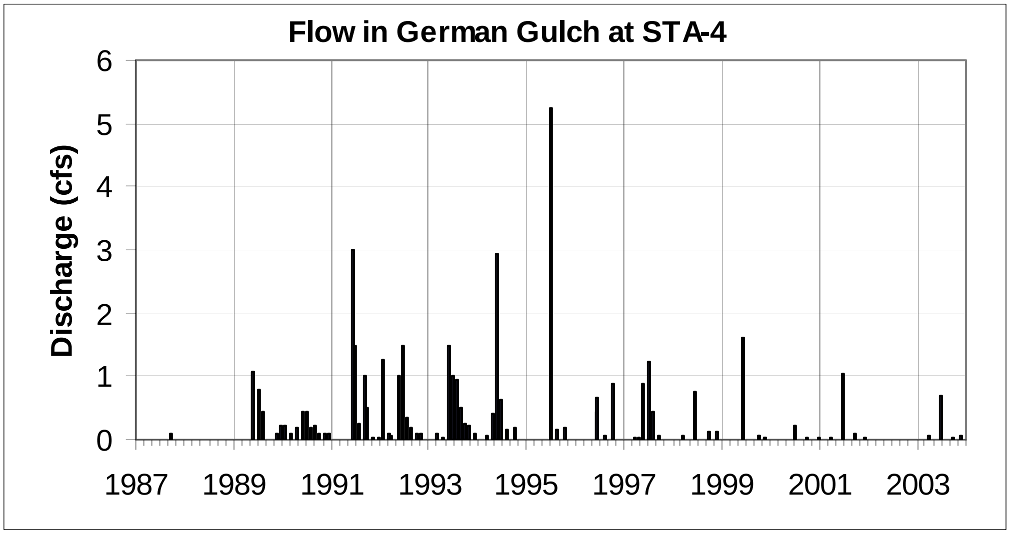
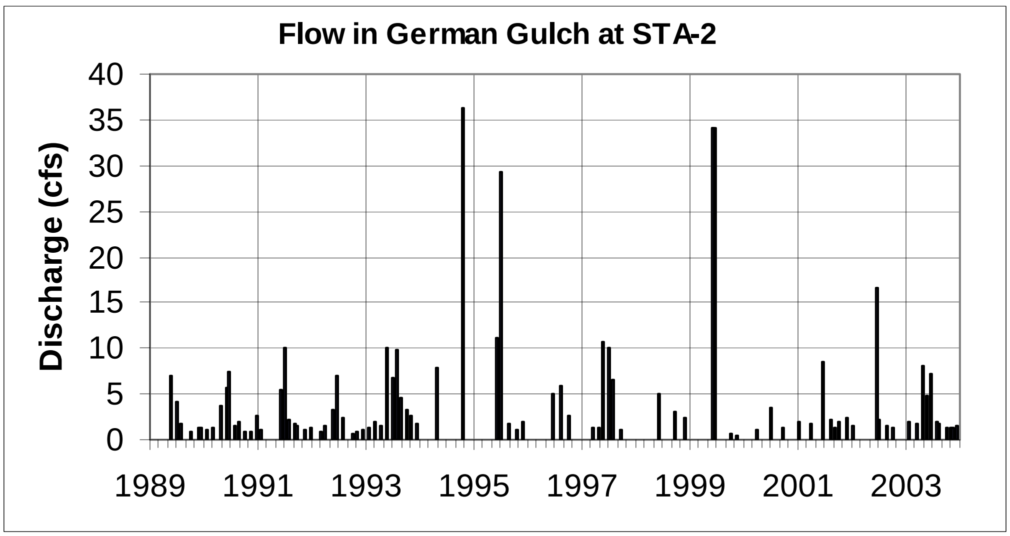
Slide Monitoring Well Location

S197-1	SI - Inclinometer (Active)
S198-2	SI - Inclinometer (Inactive)
OW-5	OW - Observation Well
DW-8	DW - Dewatering Well
SPR-5	Surface Water Sample Location
SBB-87-01	Groundwater Sample Location
1229 (211)	Synoptic Sampling Site (Gurreri, 2003)
2A	Sump Location

On-Site Surface Water and Groundwater Monitoring Locations
Beal Mountain Mine
Silver Bow County, Montana
FIGURE 6b





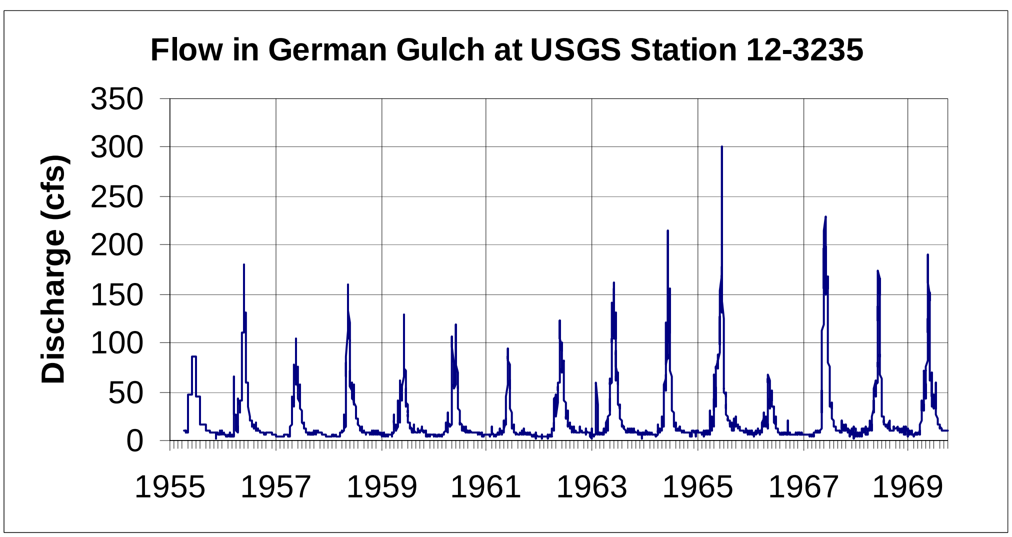


Figure 7a. Surface Water Hydrographs (flow in cubic feet per second)

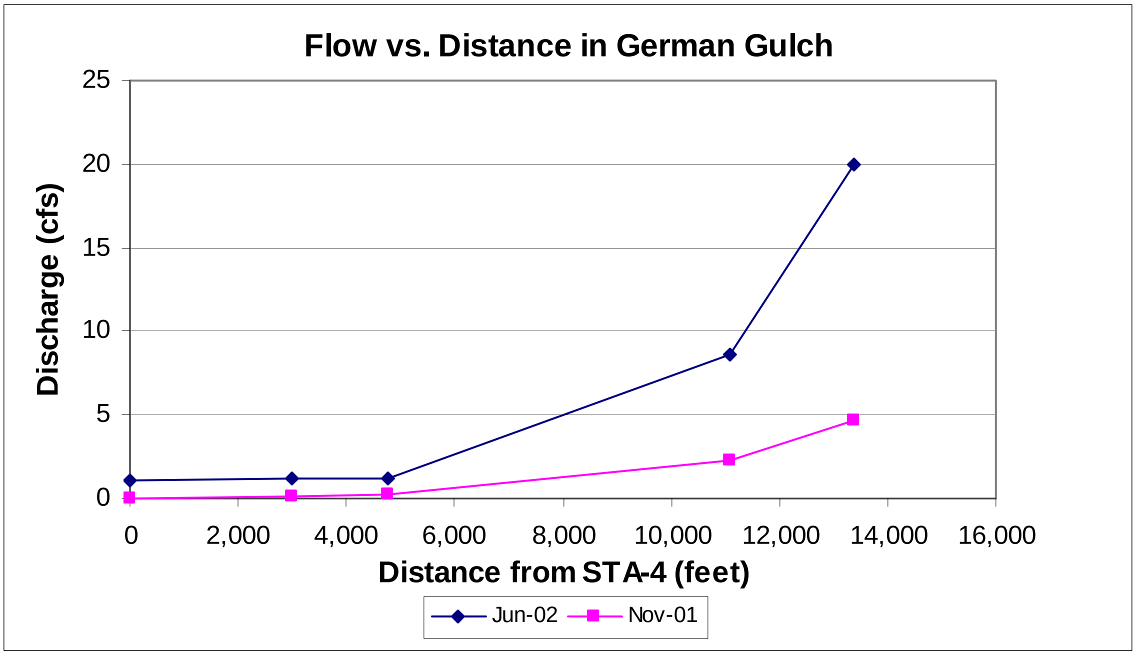


Figure 7b. Flow downstream in German Gulch (flow in cubic feet per second)

Flows in American Gulch in 2003 ranged from winter-time lows of three to five gpm to spring runoff flows of 40 to 50 gpm. Following spring runoff, flows in American Gulch range from four to six gpm. Flows have been measured periodically at stations BS and BS-D on Beefstraight Creek (**Figure 6a**) between 1993 and 2003. The highest flow measured in Beefstraight Creek was 68 cfs in June 1995.

3.4.2 Surface Water Quality

Surface water samples have been collected periodically at many stations in the study area since 1987 and analyzed for various constituents. **Table 6** summarizes surface water quality data collected in 2003.

Surface water in the German Gulch drainage is generally a calcium bicarbonate type and is poorly buffered (BMMI, 1988). Surface water samples collected in 2003 exhibited pH values that ranged from 7.3 to 8.2 standard units (su). The pH is a little higher in Minnesota Gulch and Beefstraight Creek averaging about 8.0 su compared to an average of 7.7 su for water samples collected from German Gulch stations. Total dissolved solids (TDS) measured in samples from German Gulch ranged from 109 milligrams per liter (mg/L) to as much as 679 mg/L. TDS concentrations in German Gulch were generally highest in samples from stations STA-3 and STA-3A and decreased downstream from those stations. Hardness in German Gulch ranged from 74 mg/L to 339 mg/L; calcium concentrations ranged from 23 mg/L to 117 mg/L; and, magnesium concentrations ranged from 5 mg/L to 11 mg/L, with the highest concentrations of all three of these constituents being measured in samples from STA-3A.

In 2003, nitrate concentrations in samples collected from German Gulch were generally low at STA-4, increasing downstream to STA-3A, then decreasing downstream of STA-3A (**Figure 8**). Nitrate concentrations were highest in water samples collected at STA-3A ranging from 0.600 mg/L to 1.6 mg/L. Nitrate concentrations were 0.100 mg/L or less at STA-1 and STA-1A. Nitrate concentrations in samples from Minnesota Gulch (UPMINN and DNMINN) and Beefstraight Creek were generally less than 0.100 mg/L. Nitrate concentrations from American Gulch Station A-G ranged from less than 0.050

TABLE 6
2003 SURFACE WATER QUALITY DATA SUMMARY
Beal Mountain Mine

STATION	DATE	pH (standard units)	Total Dissolved Solids	Total Suspended Solids	Hardness (as CaCO3)	Sulfate	Nitrate+ Nitrite as N		Dissolved Arsenic		Total Recoverable Copper		Total Recoverable Iron		Total Recoverable Nickel		Total Recoverable Selenium		Total Recoverable Zinc		Total Cyanide		Thiocyanate	
A-G	1/15/2003	7.8	168	10		25	0.1	U	0.003	U	0.004		0.43				0.001	U			0.005	U	0.2	U
A-G	2/12/2003	7.8	158	10		30	0.05	U	0.003	U	0.002		0.04				0.001	U			0.005	U	0.2	U
A-G	3/12/2003	7.8	161	10		26	0.1	U	0.003	U	0.001		0.03				0.001	U			0.005	U	0.2	U
A-G	4/23/2003	7.6	148	12		46	1.6		0.004		0.004		0.80				0.001	U			0.081		0.2	U
A-G	5/13/2003	7.6	167	10		58	0.1		0.003	U	0.002		0.05				0.001				0.053		0.2	U
A-G	6/18/2003	7.5	305	10		109	1.6		0.003	U	0.001		0.03				0.002				0.102		0.2	U
A-G	7/25/2003	7.7	182	10		32	2.0		0.003	U	0.001	U	0.03				0.001	U			0.009		0.2	U
A-G	8/7/2003	7.6	194	10		29	0.1	U	0.003	U	0.002		0.12				0.001	U			0.005	U	0.05	U
A-G	9/23/2003	7.6	177	10		26	0.1	U	0.003	U	0.001		0.02				0.001	U	0.01	U	0.005	U	0.05	U
A-G	10/23/2003	8.2	161	10		26	0.1	U	0.003	U	0.002		0.05				0.001	U	0.01	U	0.005	U	0.20	U
A-G	11/12/2003	7.9	172	10		30	0.1	U	0.003	U	0.001	U	0.01	U			0.001	U			0.005	U	0.20	U
A-G	12/10/2003	7.9	162	18		27	0.1	U	0.003	U	0.001	U	0.07				0.001	U			0.005	U	0.20	U
BS-D	1/15/2003	8.2	169	10	149	8	0.1	U	0.003	U	0.001	U	0.01	U	0.02	U	0.001	U	0.01	U	0.005	U	0.2	U
BS-D	2/12/2003	8.0	161	1	149	19	0.1	U	0.003	U	0.001	U	0.01	U	0.02	U	0.001	U	0.01	U	0.007		0.2	U
BS-D	3/12/2003	8.0	236	1	174	51	0.1	U	0.003	U	0.001	U	0.02		0.02	U	0.002		0.01	U	0.020		0.2	U
BS-D	4/23/2003	7.9	117	5	95	22	0.1	U	0.003	U	0.003		0.29		0.02	U	0.001	U	0.01	U	0.024		0.2	U
BS-D	5/13/2003	8.0	136	10	108	29	0.24		0.003	U	0.001		0.07		0.02	U	0.001		0.01	U	0.034		0.2	U
BS-D	6/18/2003	8.1	158	1	117	20	0.1	U	0.003	U	0.001	U	0.04		0.02	U	0.001	U	0.01	U	0.020		0.2	U
BS-D	7/25/2003	8.1	148	10	135	13	0.1	U	0.003	U	0.001	U	0.02		0.02	U	0.001	U	0.01	U	0.013		0.2	U
BS-D	8/7/2003	8.0	164	4	145	10	0.1	U	0.003	U	0.001	U	0.01	U	0.02	U	0.001	U	0.01	U	0.009		0.05	U
BS-D	9/23/2003	8.0	186	10	152	18	0.01	U	0.003	U	0.001	U	0.01	U	0.02	U	0.001	U	0.01	U	0.024		0.05	U
BS-D	10/23/2003	8.5	168	10	165	13	0.1	U	0.003	U	0.001		0.01	U	0.02	U	0.001	U	0.01	U	0.018		0.2	U
BS-D	11/12/2003	8.2	202	10	169	23	0.1		0.003	U	0.052		0.26		0.02	U	0.002		0.01	U	0.022		0.2	U
BS-D	12/10/2003	8.1	172	10	158	14	0.1	U	0.003	U	0.001	U	0.01	U	0.02	U	0.001	U	0.01	U	0.017		0.2	U
MINN-DN	1/14/2003	8.2	200	1	174	7	0.1	U	0.003	U	0.001	U	0.01	U	0.02	U	0.001	U	0.01	U	0.005	U	0.02	U
MINN-DN	2/12/2003	8.1	179	1	170	14	0.1	U	0.003	U	0.001	U	0.01	U	0.02	U	0.001	U	0.01	U	0.005	U	0.2	U
MINN-DN	3/11/2003	8.1	194	1	163	15	0.1	U	0.003	U	0.001	U	0.01	U	0.02	U	0.001		0.01	U	0.005	U	0.2	U
MINN-DN	4/24/2003	8.1	186	10	204	31	0.1		0.003	U	0.002		0.06		0.02	U	0.001		0.01	U	0.017		0.2	U
MINN-DN	5/21/2003	8.1	228	10	167	28	0.1	U	0.003	U	0.001		0.04		0.02	U	0.002		0.01	U	0.029		0.2	U
MINN-DN	6/30/2003	8.1	162	2	155	19	0.03		0.003	U	0.001	U	0.01	U	0.02	U	0.001	U	0.01	U	0.016		0.2	U
MINN-DN	7/25/2003	8.2	197	10	159	14	0.1	U	0.003	U	0.001	U	0.01		0.02	U	0.001	U	0.01	U	0.015		0.2	U
MINN-DN	8/7/2003	8.4	189	4	169	9	0.1	U	0.003	U	0.001	U	0.01	U	0.02	U	0.001	U	0.01	U	0.005	U	0.05	U
MINN-DN	9/18/2003	8.6	268	10	223	46	0.1	U	0.003	U	0.001	U	0.02		0.02	U	0.002		0.01	U	0.081		0.05	U
MINN-DN	10/22/2003	8.6	212	10	195	21	0.1	U	0.003	U	0.001	U	0.01	U	0.02	U	0.001		0.01	U	0.031		0.2	U
MINN-DN	11/12/2003	8.7	263	10		44	0.3		0.003	U	0.001	U	0.01	U	0.02	U	0.002		0.01	U	0.063		0.2	U
MINN-DN	12/9/2003	8.7	222	10		20	0.2		0.003	U	0.001	U	0.01		0.02	U	0.001	U	0.01	U	0.039		0.2	U
MINN-UP	1/14/2003	7.9	145	14	123	2	0.1	U	0.003	U	0.003		0.35		0.01	U	0.001	U	0.01		0.005	U	0.2	U
MINN-UP	6/30/2003	7.8	84	1	79	1	0.1	U	0.003	U	0.001		0.01	U	0.02	U	0.001	U	0.01	U	0.005	U	0.2	U
MINN-UP	7/25/2003	7.8	121	10	106	2	0.1	U	0.003	U	0.001		0.01	U	0.02	U	0.001		0.01	U	0.005	U	0.2	U
MINN-UP	8/7/2003	8.1	154	10	113	1	0.1	U	0.003	U	0.001	U	0.01	U	0.02	U	0.001	U	0.01	U	0.005	U	0.2	U
MINN-UP	9/18/2003	8.5	140	10	123	1	0.1	U	0.003	U	0.001		0.08		0.02	U	0.001	U	0.01	U	0.005	U	0.2	U
MINN-UP	11/12/2003	8.4	136	10		3	0.1	U	0.003	U	0.001	U	0.01	U	0.02	U	0.001	U			0.005	U	0.2	U
STA-1	1/15/2003	7.9	181	1	125	26	0.1		0.003	U	0.002		0.05		0.02	U	0.001		0.01	U	0.005	U	0.2	U
STA-1	2/13/2003	7.8	150	1	105	30	0.1		0.003	U	0.001	U	0.04		0.02	U	0.001	U	0.01	U	0.005	U	0.2	U
STA-1	3/12/2003	7.6	156	14	109	37	0.1		0.003		0.002		0.42		0.02	U	0.002		0.01	U	0.014		0.2	U
STA-1	4/23/2003	7.7	127	18	93	29	0.1	U	0.003		0.004		0.56		0.02	U	0.001		0.01	U	0.010		0.3	
STA-1	5/13/2003	7.6	119	10	74	30	0.0		0.003		0.002		0.24		0.02	U	0.001	U	0.01	U	0.007		0.2	U
STA-1	6/18/2003	7.9	153	2	104	32	0.1	U	0.003	U	0.002		0.17		0.02	U	0.001		0.01	U	0.011		0.2	U
STA-1	7/25/2003	7.7	165	10	133	25	0.1	U	0.003		0.001	U	0.06		0.02	U	0.001	U	0.01	U	0.009		0.2	U
STA-1	8/7/2003	7.8	175	4	141	26	0.1	U	0.004		0.001	U	0.04		0.02	U	0.001		0.01	U	0.021		0.2	U
STA-1	9/23/2003	8.3	184	10	126	29	0.0	U	0.003	U	0.001		0.06		0.02	U	0.001	U	0.01	U	0.012		0.2	U
STA-1	10/23/2003	8.0	161	10	143	29	0.1	U	0.003	U	0.001		0.04		0.02	U	0.001		0.01	U	0.007		0.2	U
STA-1	11/12/2003	8.4	183	10	142	23	0.1	U	0.003	U	0.001	U	0.03		0.02	U	0.001		0.01	U	0.016		0.2	U
STA-1	12/10/2003	8.5	171	10	135	28	0.1	U	0.003	U	0.001		0.03		0.02	U	0.001	U	0.01	U	0.009		0.2	U

TABLE 6
2003 SURFACE WATER QUALITY DATA SUMMARY
Beal Mountain Mine

STATION	DATE	pH (standard units)	Total Dissolved Solids	Total Suspended Solids	Hardness (as CaCO3)	Sulfate	Nitrate+ Nitrite as N	Dissolved Arsenic	Total Recoverable Copper	Total Recoverable Iron	Total Recoverable Nickel	Total Recoverable Selenium	Total Recoverable Zinc	Total Cyanide	Thiocyanate
STA-1A	1/15/2003	7.9	184	1	135	27	0.1 U	0.003 U	0.001 U	0.01	0.02 U	0.002	0.01 U	0.005 U	0.2 U
STA-1A	2/12/2003	7.8	165	1	133	36	0.1 U	0.003 U	0.001 U	0.02	0.02 U	0.001 U	0.01 U	0.005 U	0.2 U
STA-1A	3/12/2003	7.6	202	16	134	50	0.1 U	0.003 U	0.003	0.50	0.02 U	0.002	0.01 U	0.012	0.2 U
STA-1A	4/23/2003	7.7	123	11	97	35	0.1 U	0.003	0.004	0.38	0.03 U	0.001 U	0.01 U	0.015	0.2
STA-1A	5/13/2003	7.9	159	10	109	43	0.08	0.003 U	0.002	0.10	0.02 U	0.002	0.01 U	0.018	0.2 U
STA-1A	6/18/2003	8.0	163	4	109	34	0.1 U	0.003 U	0.002	0.12	0.02 U	0.001	0.01 U	0.012	0.2 U
STA-1A	7/25/2003	7.8	168	10	130	26	0.1 U	0.003 U	0.001 U	0.03	0.02 U	0.001	0.01 U	0.009	0.2 U
STA-1A	8/7/2003	8.3	179	4	141	27	0.1 U	0.003 U	0.001 U	0.02	0.02 U	0.001	0.01 U	0.009	0.2 U
STA-1A	9/23/2003	8.3	190	10	130	31	0.01 U	0.003 U	0.001 U	0.01	0.02 U	0.001	0.01 U	0.015	0.2 U
STA-1A	10/23/2003	8.1	174	10	154	32	0.1 U	0.003 U	0.001 U	0.01	0.02 U	0.001	0.01 U	0.008	0.2 U
STA-1A	11/12/2003	8.3	196	10	157	38	0.1 U	0.003 U	0.001 U	0.01 U	0.02 U	0.002	0.01 U	0.014	0.2 U
STA-1A	12/10/2003	8.5	182	10	147	32	0.1 U	0.003 U	0.001 U	0.01	0.02 U	0.001	0.01 U	0.01	0.2 U
STA-2	1/15/2003	7.7	246	2	154	102	0.2	0.003	0.002	0.03	0.02 U	0.002	0.01 U	0.005 U	0.2 U
STA-2	2/13/2003	7.6	214	1	136	95	0.2	0.003	0.001 U	0.01	0.02 U	0.002	0.01 U	0.005 U	0.2 U
STA-2	3/13/2003	7.7	236	10	141	97	0.2	0.003 U	0.001 U	0.01 U	0.02 U	0.003	0.01 U	0.005 U	0.3
STA-2	4/23/2003	7.6	182	10	124	80	0.2	0.005	0.006	0.24	0.02 U	0.003	0.01 U	0.034	0.2 U
STA-2	5/13/2003	8.0	255	10	156	121	0.3	0.004	0.002	0.04	0.02 U	0.005	0.09	0.005 U	0.2 U
STA-2	6/18/2003	7.5	173	1	88	70	0.1	0.003 U	0.002	0.04	0.02 U	0.002	0.01 U	0.005 U	0.2 U
STA-2	7/25/2003	7.9	274	10	162	116	0.1	0.004	0.002	0.01	0.02 U	0.004	0.01 U	0.005 U	0.2 U
STA-2	8/7/2003	8.3	293	4	178	138	0.1 U	0.004	0.001	0.01 U	0.02 U	0.004	0.01 U	0.005 U	0.2 U
STA-2	9/23/2003	8.4	316	10	190	144	0.04	0.004	0.001 U	0.01 U	0.02 U	0.003	0.01 U	0.005 U	0.2 U
STA-2	10/22/2003	8.4	291	10	208	140	0.1 U	0.004	0.001	0.01	0.02 U	0.003		0.006	0.2 U
STA-2	11/12/2003	8.25	284	10	188	126	0.1	0.004	0.005	0.05	0.02 U	0.003	0.01 U	0.005 U	0.2 U
STA-2	12/9/2003	8.31	209	10	141	82	0.1	0.004	0.001 U	0.01 U	0.02 U	0.003	0.01 U	0.005 U	0.2 U
STA-3	1/15/2003	7.7	305	10		137	0.7	0.012	0.003	0.15		0.013		0.005 U	0.2 U
STA-3	2/13/2003	7.6	283	10		126	1.17	0.009	0.001	0.01 U		0.010		0.005 U	0.2 U
STA-3	3/11/2003	7.9	323	10		151	0.8	0.010	0.002	0.05		0.010		0.005 U	0.2 U
STA-3	5/13/2003	8.0	679	10		368	0.9	0.009	0.003	0.03		0.011		0.005 U	0.2 U
STA-3	6/30/2003	7.8	360	10		182	0.5	0.010	0.002	0.03		0.010		0.005 U	0.2 U
STA-3A	1/15/2003	7.7	294	1	195	120	1.1	0.009	0.001	0.02	0.02 U	0.008	0.01 U	0.005 U	0.2 U
STA-3A	2/13/2003	7.6	278	1	188	127	1.2	0.009	0.001 U	0.01	0.02 U	0.005	0.01 U	0.005 U	0.2 U
STA-3A	3/12/2003	7.5	283	1	181	120	1.3	0.009	0.003	0.09	0.02 U	0.007	0.01 U	0.005 U	0.2 U
STA-3A	4/23/2003	7.6	433	2	339	215	1.0	0.008	0.003	0.06	0.02 U	0.008	0.01 U	0.005 U	0.2 U
STA-3A	5/13/2003	7.7	533	10	326	280	1.61	0.008	0.003	0.03	0.02 U	0.012	0.01 U	0.017	0.2 U
STA-3A	6/18/2003	7.7	325	2	188	159	0.6	0.004	0.003	0.09	0.02 U	0.006	0.01 U	0.005 U	0.2 U
STA-3A	7/25/2003	8.0	390	10	239	167	0.9	0.01	0.002	0.01	0.02 U	0.010	0.01 U	0.012	0.2 U
STA-3A	8/7/2003	8.1	396	4	239	187	0.9	0.01	0.002	0.01	0.02 U	0.011	0.01 U	0.011	0.2 U
STA-3A	9/23/2003	8.0	352	10	209	149	1.02	0.01	0.001	0.01 U	0.02 U	0.011	0.01 U	0.009	0.2 U
STA-3A	10/22/2003	8.0	328	10	239	148	1.1	0.011	0.003	0.03	0.02 U	0.010	0.01 U	0.014	0.2 U
STA-3A	11/12/2003	8.1	371	10	256	161	1.3	0.01	0.001	0.01 U	0.02 U	0.013	0.01 U	0.007	0.2 U
STA-3A	12/9/2003	8.15	356	10		165	1.3	0.01	0.001 U	0.01 U	0.02 U	0.011		0.008	0.2 U
STA-4	3/28/2003	7.6	159	10		70	0.1 U	0.003 U	0.001 U	0.01		0.002		0.005 U	0.2 U
STA-4	6/18/2003	7.3	109	10		41	0.1 U	0.004	0.002	0.04		0.002		0.005 U	0.2 U
STA-4	9/23/2003	7.8	197	10		81	0.1 U	0.003	0.001 U	0.01 U		0.002		0.005 U	0.2 U
STA-4	11/12/2003	7.0	195	10		81	0.1 U	0.003 U	0.001 U	0.01 U		0.003		0.005 U	0.2 U
Aquatic Life Standards	Acute	--	--	--	--	--	--	0.34	0.014 *	NA	0.469 *	0.020	0.12 *	0.022	NA
	Chronic	--	--	--	--	--	--	0.15	0.009 *	1.00	0.088 *	0.005	0.12 *	0.005	NA

Notes:

Aquatic Life Standards from MDEQ Circular WQB-7 (2002)

Concentrations in milligrams per liter (mg/L)

* - based on a hardness of 100 mg/L

U - Concentration is less than laboratory reporting limit indicated

Blank cells inidicate sample not analyzed for that parameter

Value exceeds acute aquatic life standard

Value exceeds chronic aquatic life standard

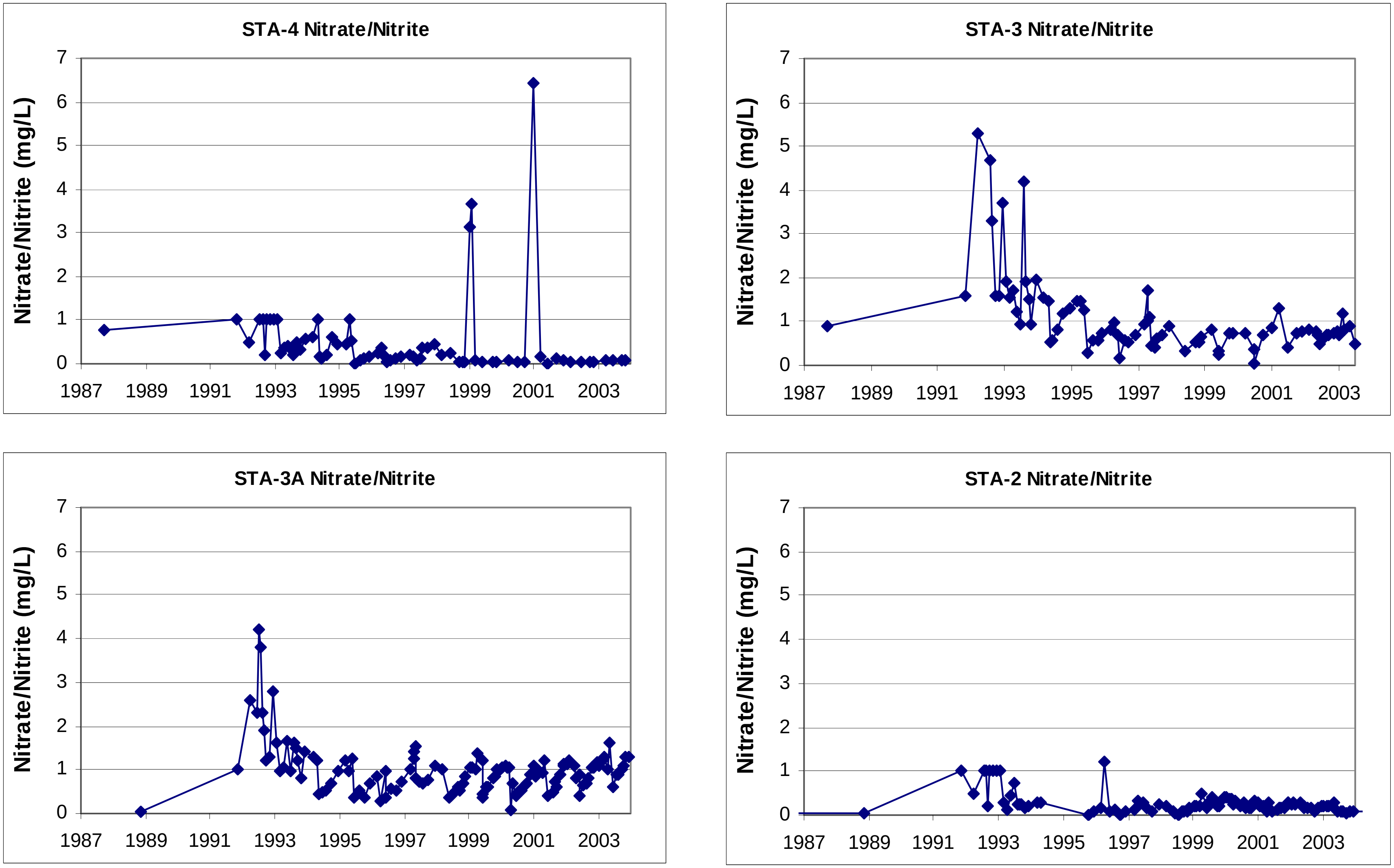


Figure 8. Nitrate Trends at select German Gulch Surface Water Stations (concentrations in milligrams per liter)

mg/L to 2.0 mg/L. Nitrate concentrations at STA-3 and STA-3A were highest in 1992 and then declined until 1995 (**Figure 8**). Since that time, nitrate concentrations at these two stations have exhibited a seasonal trend with the lowest nitrate concentrations being measured during spring runoff, with concentrations increasing as stream flows decrease. Nitrate concentrations have been generally low (less than 0.100 mg/L) at STA-4 with the exception of three samples collected since 1999 then have contained greater than 3.0 mg/L nitrate. Concentrations of nitrate from STA-2 downstream have remained low since 1987.

Sulfate concentrations in surface water samples from German Gulch stations ranged from 23 mg/L to 368 mg/L. Samples from station STA-3A generally contained the highest sulfate concentrations. Sulfate concentrations decrease with distance downstream from STA-3A, with samples from STA-1 containing the lowest sulfate concentrations. Samples from the upstream station in Minnesota Gulch (UPMINN) contain very low sulfate concentrations (less than 3.0 mg/L). Sulfate concentrations are somewhat higher at stations DNMINN and BS-D. Sulfate concentrations in surface water at most German Gulch stations have generally been increasing since the early 1990s (**Figure 9**). Sulfate concentrations have also increased at stations DNMINN and BS-D since 2001, undoubtedly resulting from LAD application of treated pad solution.

Dissolved arsenic concentrations in samples collected in 2003 from all surface water stations except STA-3 and STA-3A were less than 0.005 mg/L. Surface water samples from STA-3 and STA-3A ranged from 0.004 mg/L to 0.010 mg/L in 2003 (**Figure 10**). Concentrations of arsenic in all 2003 surface water samples were below the chronic aquatic life standard (0.15 mg/L). Concentrations of arsenic in surface water from STA-3 and STA-3A exhibited an overall declining trend between 1988 and 1999, but have remained fairly constant since then (**Figure 10**).

Total recoverable copper concentrations in all 2003 surface water samples were less than the chronic aquatic standard of 0.005 mg/L, which is calculated for a hardness of 50 mg/L (**Figure 11**). Elevated total recoverable copper concentrations were detected in surface water samples from STA-3 and STA-3A between 1995 and 2001, but copper concentrations in samples from these stations have been less than 0.005 mg/L since that time (**Figure 11**).

Total recoverable iron concentrations in surface water samples collected from German Gulch stations during 2003 ranged from less than 0.010 to 0.420 mg/L. The chronic aquatic standard for iron is 1.0 mg/L. Iron concentrations generally increase with distance downstream in German Gulch with highest concentrations detected at STA-1 and STA-1A. January and April 2003 samples from American Gulch station A-G had elevated iron concentrations (greater than 0.400 mg/L).

Total recoverable selenium concentrations measured in 2003 samples of surface water from German Gulch stations downstream from STA-3A are well below the chronic aquatic life selenium standard of 0.005 mg/L with the exception of a sample collected from STA-2 in May 2003 (0.005 mg/L). Concentrations of selenium measured in all but one of the surface water samples collected between January and July 2003 from STA-3 and STA-3A exceeded the chronic aquatic life standard (**Figure 12**). Five out of 10 samples collected from STA-4 between July 1997 and February 1999 contained selenium concentrations ranging from 0.025 to 0.055 mg/L, which exceed the acute aquatic life standard of 0.020 mg/L. Selenium concentrations measured in surface water samples from stations STA-4, STA-3, and STA-3A reached the highest levels between 1997 and 1999 and have generally declined since (**Figure 12**). This decline is related to the capturing and redirecting of water from spring 10A (SPR-10A). Concentrations of selenium in samples from station STA-2 continued to increase until 2002, but have generally declined since.

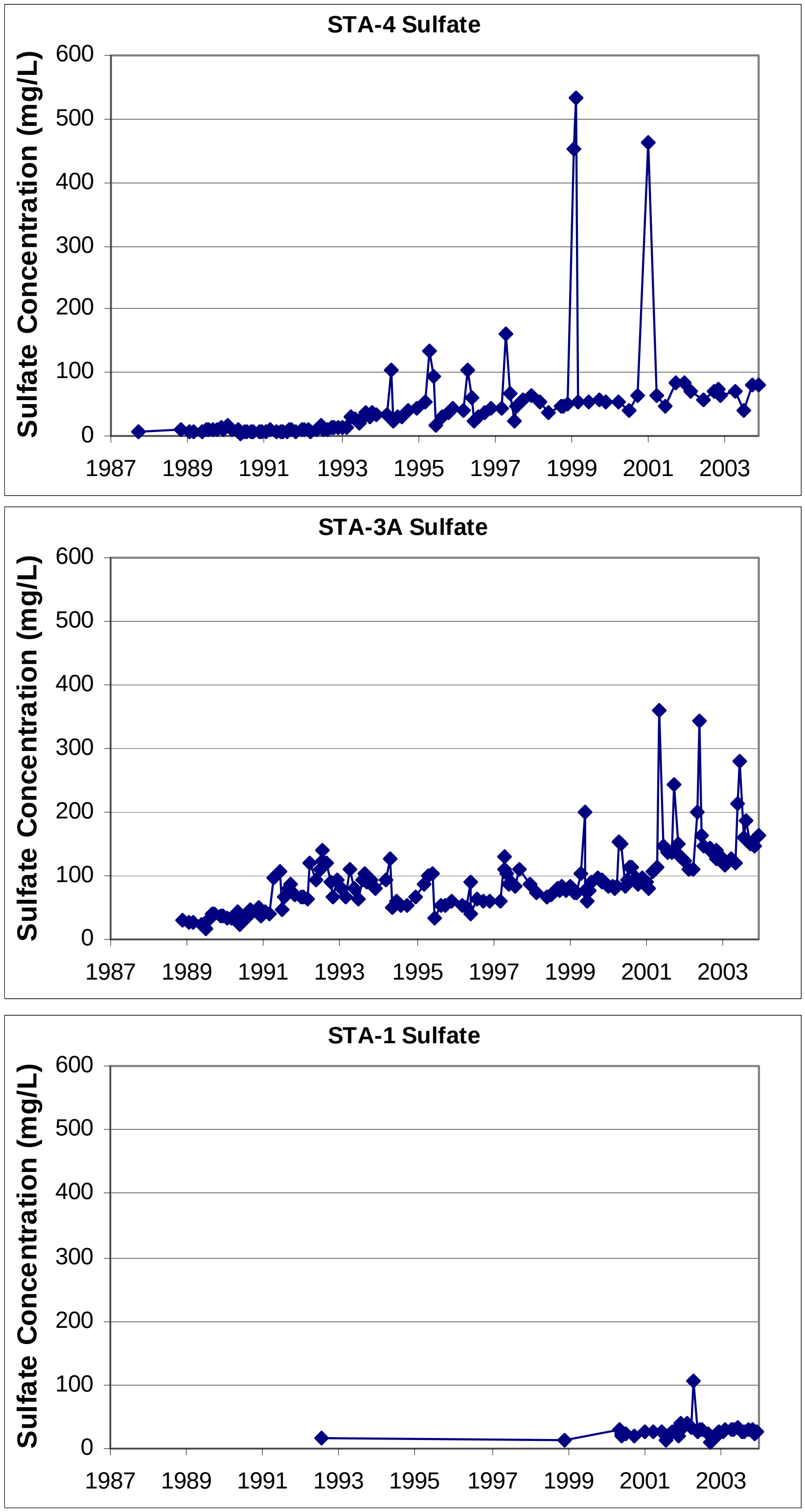
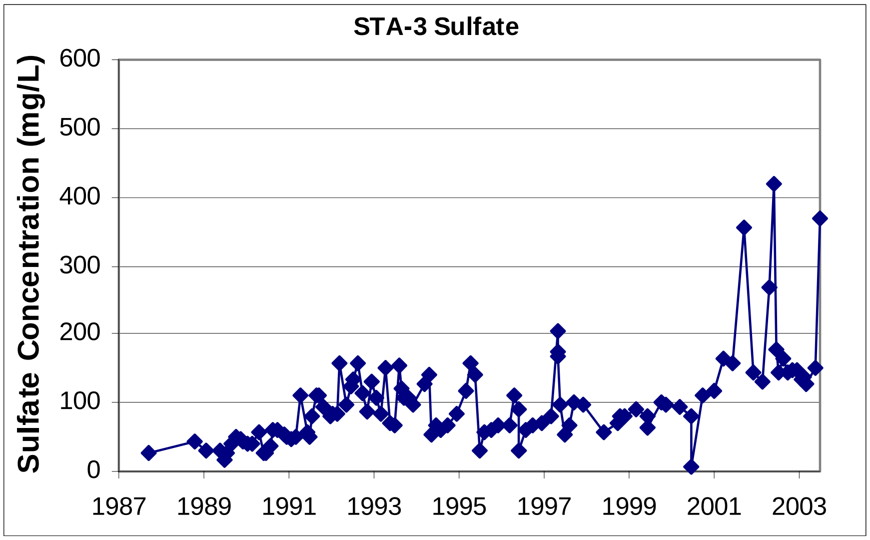
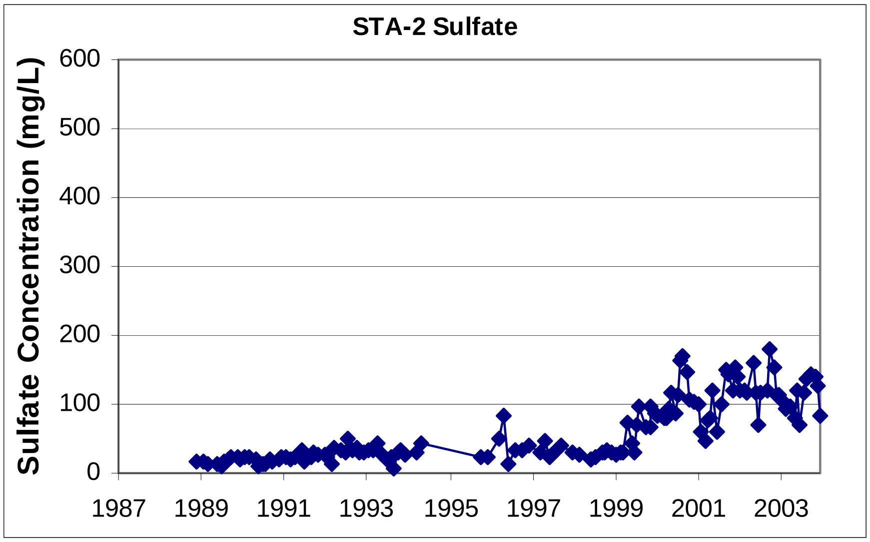


Figure 9. Sulfate Concentrations in German Gulch (milligrams per liter)





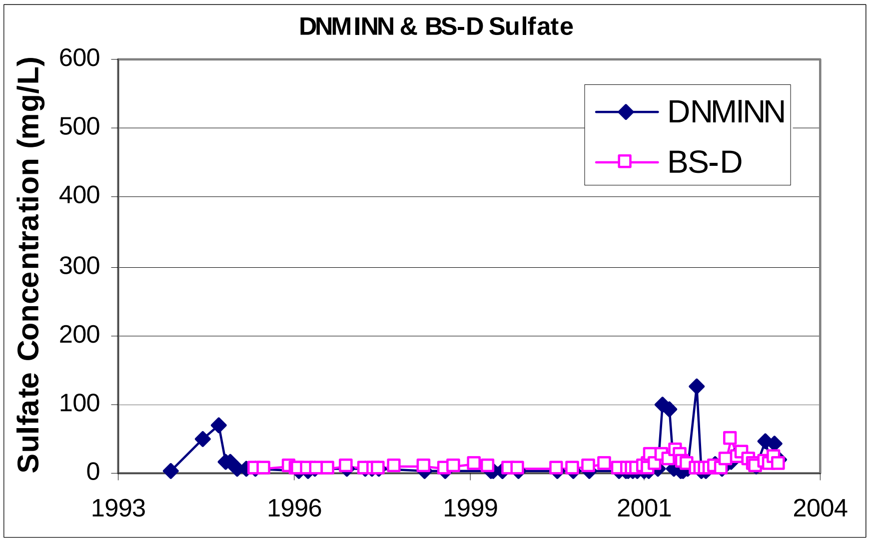


Figure 9 (cont'd). Sulfate Concentrations in German Gulch

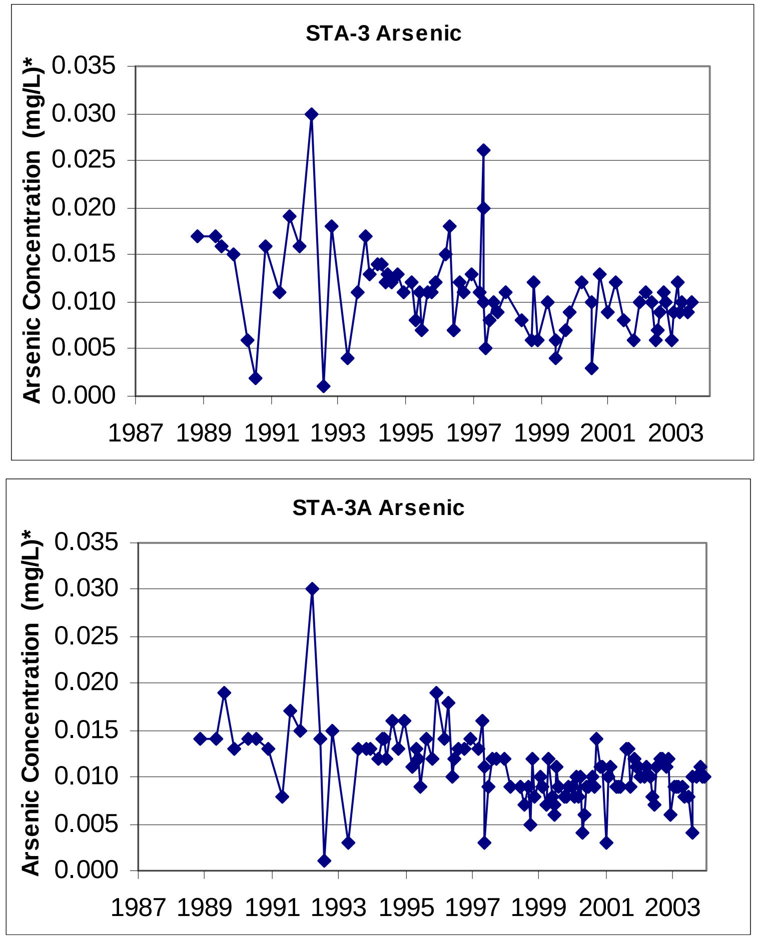


Figure 10. Arsenic Concentrations in German Gulch (dissolved arsenic is reported prior to October 1993 and after August 2003. All other concentrations are totals)

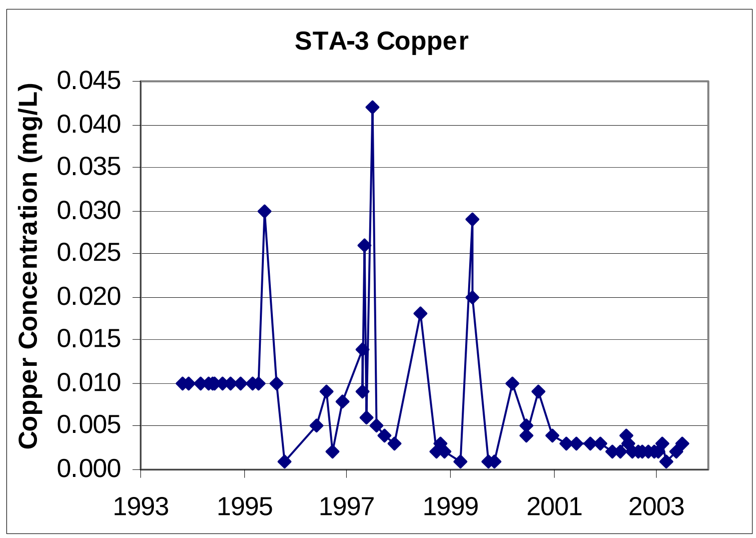


Figure 11. Total Recoverable Copper Concentrations in Surface Water at Stations STA-3 and STA-3A (milligrams per liter)

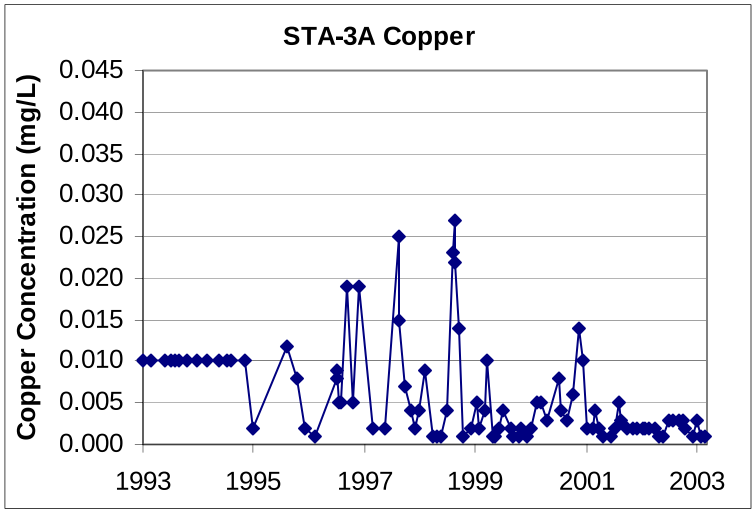


Figure 11 (cont'd). Total Recoverable Copper Concentrations in Surface Water at STA-3 and STA-3A

Concentrations of cyanide exceed the chronic standard (0.005 mg/L) and occasionally the acute standard (0.022 mg/L) for some sampling events in 2003 in both American Gulch and in Lower Minnesota Gulch. All samples in Beefstraight Gulch exceeded the cyanide chronic standard and occasionally the cyanide acute standard for in 2003 surface water samples (**Table 6**). These three tributaries are located to the north of the German Gulch divide and drain the areas that were used for LAD application north of the leach pad. Surface water from samples at STA-3A in upper German Gulch was also occasionally elevated in cyanide (above the chronic but below the acute level) also probably from contamination by LAD solutions (**Figure 13**). Surface water Station 2 (STA-2) showed only one exceedance of the cyanide standard, although STA-1 and STA-1A, located below the confluence of Beefstraight Gulch (the tributary creek that drains the LAD area) and German Gulch, frequently exceeded the chronic standard for cyanide. LAD applications were discontinued in November 2003 and it is thought that cyanide concentrations should decline in surface water and groundwater over time.

Figure 14 is a series of charts plotting concentration and load of various constituents with distance downstream for surface water stations on German Gulch. The loading rate in milligrams per second is the mass of constituent transported by the stream per unit of time and is calculated by multiplying concentration of constituent in the stream by its respective flow measured at each location. November 2001 concentration and streamflow data were used to calculate load rates shown in **Figure 14. Figure 14** illustrates the greatest increase in selenium and sulfate loading occurred between STA-3 (5,000 feet downstream of STA-4) and STA-2 (about 13,000 feet downstream of station STA-4). Loads of selenium and sulfate decrease below STA2. Arsenic and nitrate loads increased with distance downstream. The greatest copper loading occurred downstream of STA-3.

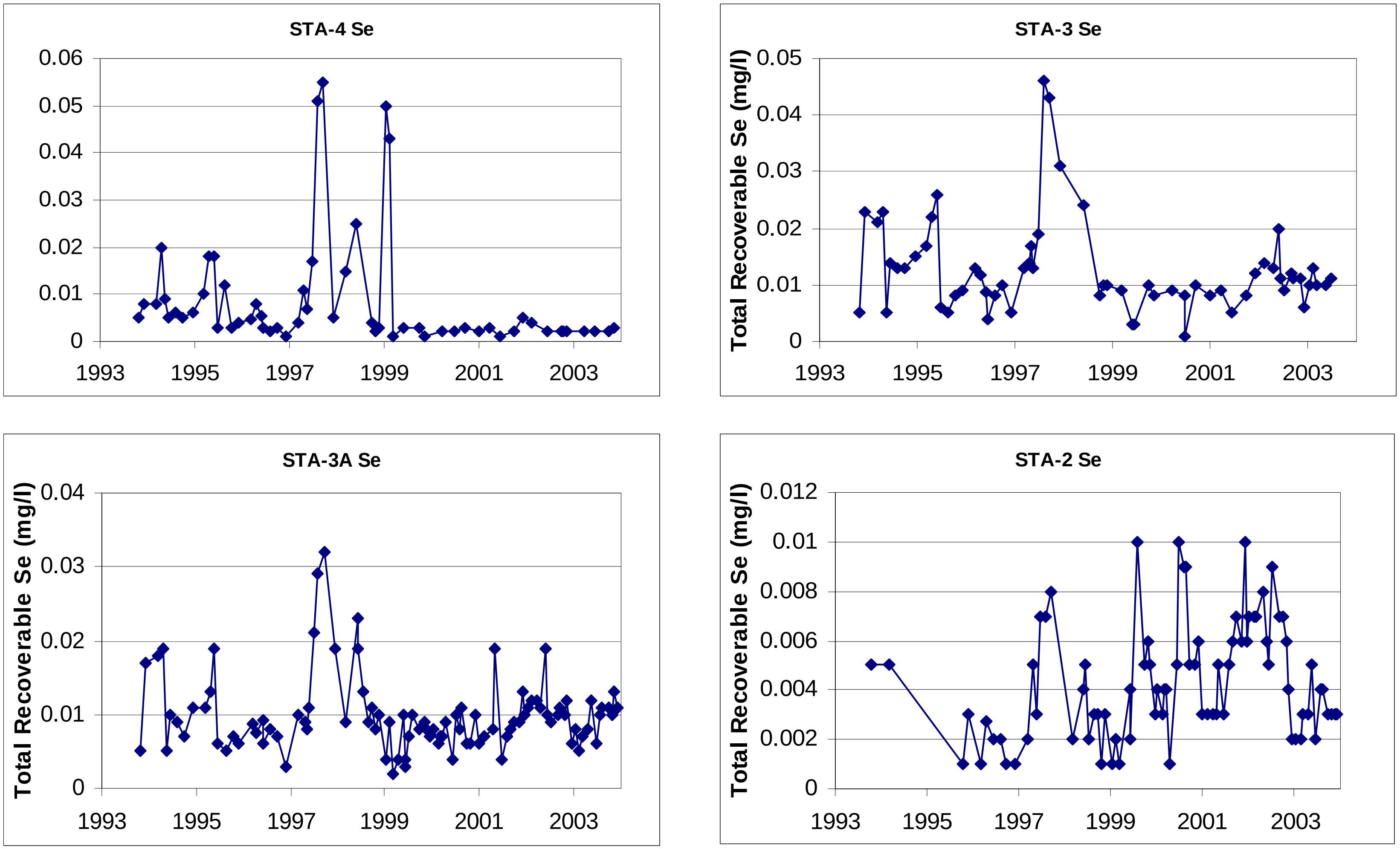


Figure 12. Total Recoverable Selenium Concentrations in German Gulch (milligrams per liter)

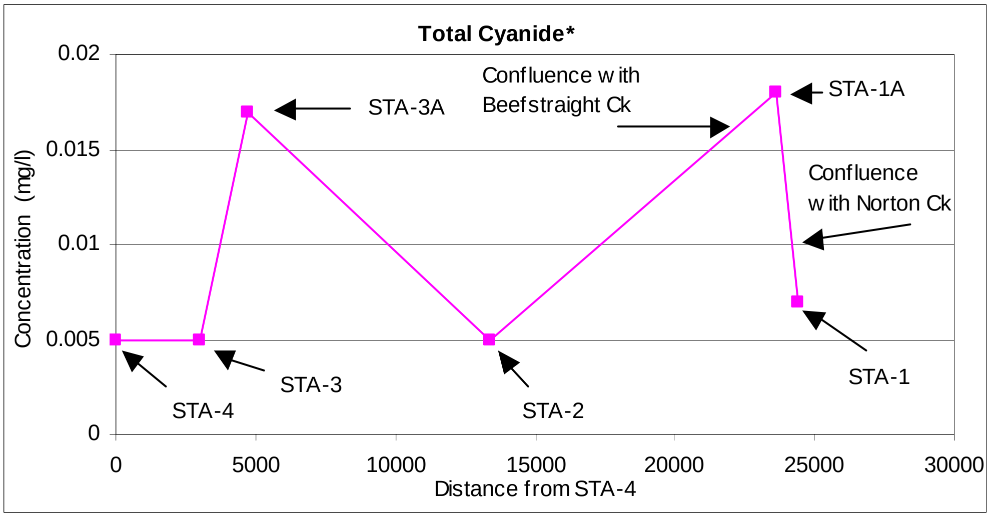
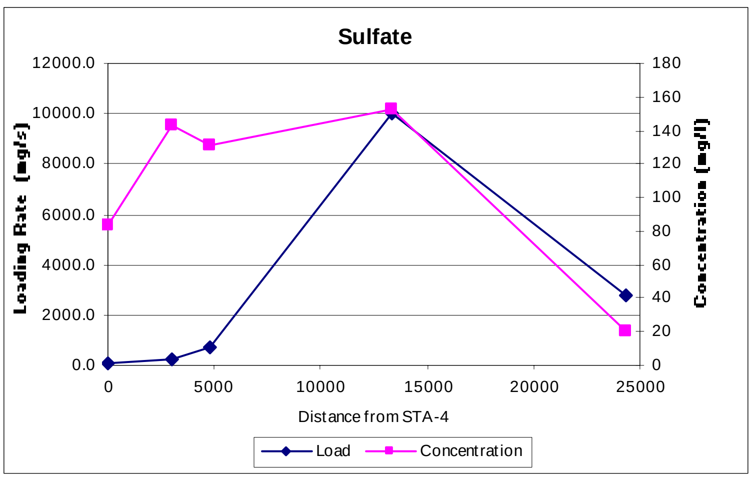


Figure 13. Total Cyanide Concentrations in German Gulch (June 18, 2003 data reported for STA-4, all other data collected on May 13, 2003)



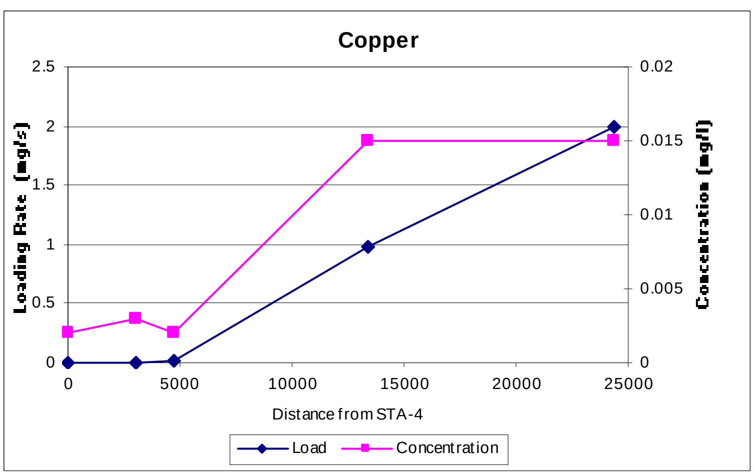
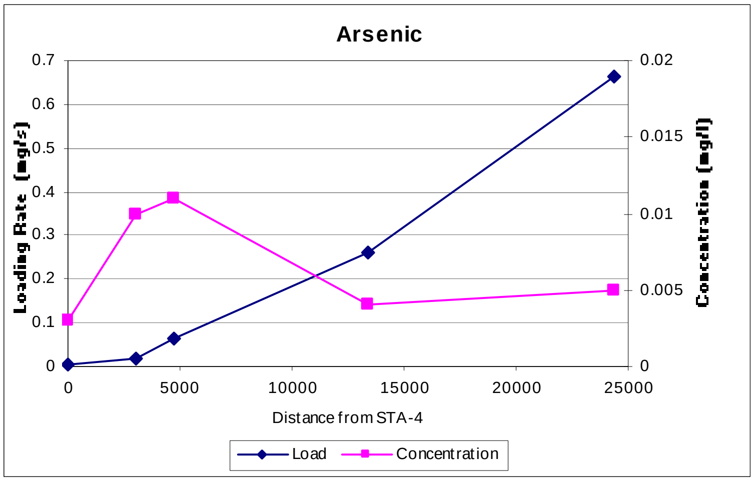
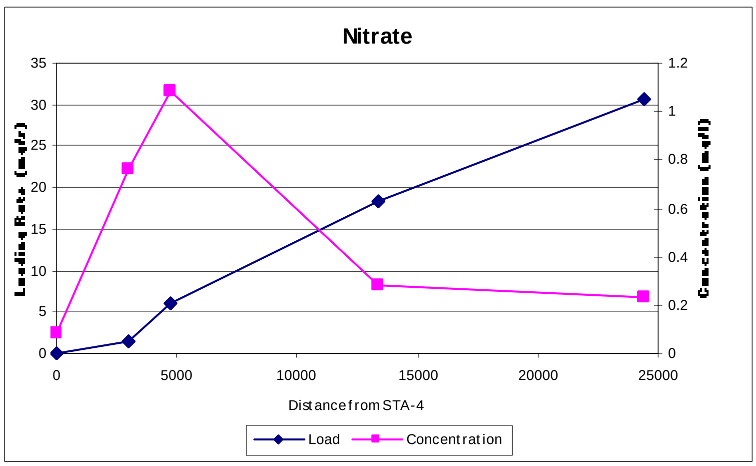


Figure 14. Constituent Concentration and Loading in German Gulch (loading in milligrams per second; concentration in milligrams per liter)





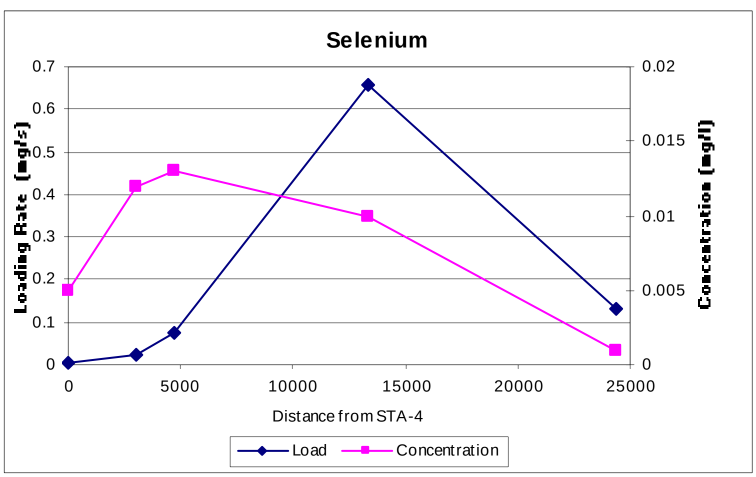


Figure 14 (cont'd). Constituent Loading in German Gulch (loading in milligrams per second; concentration in milligrams per liter)

3.4.3 Synoptic Water Quality Sampling in German Gulch

In October 2002, MDEQ conducted a synoptic sampling of the upper portion of German Gulch (Jepson, 2002). Samples were collected and analyzed from uppermost German Gulch to a sample site located downstream of STA-3A (Outfall 001). At the time sampling, water from springs SPR-5 and SPR-10A and seepage from the toe drain of the waste rock dump was being collected in a pipeline because these out flows were known to contain elevated levels of selenium. Further downstream, the outflow from the main Beal Mountain Pit was collected and combined with the pipeline flows and disposed in a series of five infiltration galleries adjacent to German Gulch beginning about 400 feet downstream of STA-3A. The chemistry and flow of the combined water was measured at Outfall 001.

The MDEQ study sampled the two springs and the toe drain seepage separately. Because flow at each of these inflows was also measured, a comparative loading analysis of the contribution of each of these sources to the total outflow from the waste rock dump, assuming the toe drain system collects all of the outflow from the toe area of the dump (which is likely not the case). **Table 7** summarizes these loading calculations. Data shown in **Table 7** indicates that of the total load measured from these three sources, the toe drain contributes almost 71.8% of the total waste rock seepage.

Addition of flow from main Beal Mountain Pit underdrain system, although only having a concentration of 8 micrograms per liter, contributes 21.3% of the total load at Outfall 001, principally because of the its relatively high flow component (58.8 gpm). The waste rock dump component loads are also shown in **Table 7** normalized to 100% at Outfall 001.

TABLE 7
SELENIUM LOADING FROM WASTE ROCK COMPONENTS AND PIT DRAIN[1]

Sample Site	In-Flow To Drain (gpm)[2]	Total Selenium (μg/L)[2]	Selenium Load (pounds/day)	Selenium Load from Waste Rock dump Components (%)	Selenium Load at Outfall 001 below STA-3A (%)
Spring 10A	1.0	346	0.00416	19.9%	15.7%
Spring 5	1.7	84	0.00172	8.2%	6.5%
Toe Drain	13.0	96	0.01500	71.8%	56.5%
Total Waste Rock Dump	15.7	--	0.02088	100%	78.7%
MB Drain	58.8	8	0.00566	--	21.3%
Total at Outfall 001	82	23	0.02654	--	100.0%

1 Data collected by Wayne Jepson, MDEQ, 10/17/02
2 gpm = gallons per minute; μg/L = micrograms per liter

The MDEQ study also measured main stem flows in German Gulch at several stations and a number of springs. Because selenium is not conserved in the downstream loading analysis, loading data cannot be used to show loading contributions in German Gulch. However, what can be said of these data is that almost all of the loading enters the system from downstream of STA-4 and not from the surface water inflows measured. In addition, almost 50% of the load is present at STA-3 (presumably mostly from underflow contributions) and the remainder of the load enters between STA-3 and STA-3A.

In September 2003, the USDA-FS and MDEQ in cooperation with the USGS conducted a metal loading study in German Gulch (Gurrieri, 2003). The purpose of this study was to characterize selenium concentrations and identify possible sources contributing selenium to German Gulch during low flow conditions. Surface-water samples were collected at 18 main stem and 17 inflow sites along German Gulch (**Figure 6b**) and were analyzed for dissolved chloride, sulfate, nitrate, and selenium. These sites included STA-4, STA-3, STA-3A, as well as additional sites identified specifically for the study. The study reach was about 5,000 feet in length. Two slug-injection tracer tests were conducted to determine the approximate travel time in the main stem of German Gulch. Study results were used to quantify stream flows and surface water inflows within the study reach. Selenium concentrations resulting from laboratory analysis were multiplied by the stream flow at each location to calculate instantaneous selenium loading rates at each sample location.

Results of the study indicated that all main stem-sampling sites above station 2100 had selenium concentrations below the chronic aquatic life criteria of 0.005 mg/L. Selenium, sulfate, and nitrate concentrations increase appreciably between station 1627 and 2165 (there are no sample sites between these two stations), suggesting there is major source of water containing these constituents somewhere in this reach (**Figure 15**). Sources included right-bank and left-bank (looking downstream) surface inflows and sub-surface inflow. The highest level of selenium (0.0370 mg/L) was measured at station 2100. A right-bank inflow at 2132 had selenium concentrations of 0.0112 mg/L with a main stem concentration in this area of 0.0150 mg/L. Below station 2165, selenium increased slightly at station 3032 to 0.0160 mg/L and then decreased downstream to 0.0094 at the end of the study reach (station 4964) (Gurrieri, 2003).

Station 2131 is a large flow-volume right bank tributary that discharges just below a culvert that brings the flow of German Gulch from beneath a road fill area. This right-bank tributary contributes as much as 44 micrograms per second (μg/s) or about 65 percent of the total load encountered in the entire study reach (**Figure 16**). The subsurface inflow at this point of the stream is considerable and was calculated to contribute as much as 27 percent (18 μg/s) of the measured load. (These observations are consistent with the relative amount of loading seen at STA-3, as indicted by the MDEQ study described above.) Therefore, most of this subsurface selenium loading occurred in the reach of German Gulch within and downstream of a very short (approximately 300 foot reach between stations 1825 to 2132) road-fill area (Gurrieri, 2003). Mine waste from the main Beal Mountain pit was apparently used for road fill from about station 2100 upstream. Main Beal pit rock was not used to construct or surface roads below site 2100 (personal communication, Bruce Parker, BMMI, 12/31/03).

The synoptic study identified potential sources of selenium to German Gulch, including the waste-rock dump, waste material used as road fill, and the leach pad dike where waste rock was used in dike construction (Gurrieri, 2003). The chemical signature of selenium, sulfate, and nitrogen are a clear indicator of contamination from waste rock. Altered and in-place bedrock is not a likely source based on historical water quality data. The study also concluded that ground water discharging to German Gulch from the faults that cross the valley in the vicinity of the main Beal pit are probably not a source of selenium because the pit water has low to negligible selenium concentrations (Gurrieri, 2003). The report speculates that shallow subsurface flow between the waste rock dump and the section of German Gulch containing road fill may be an important selenium transport pathway.

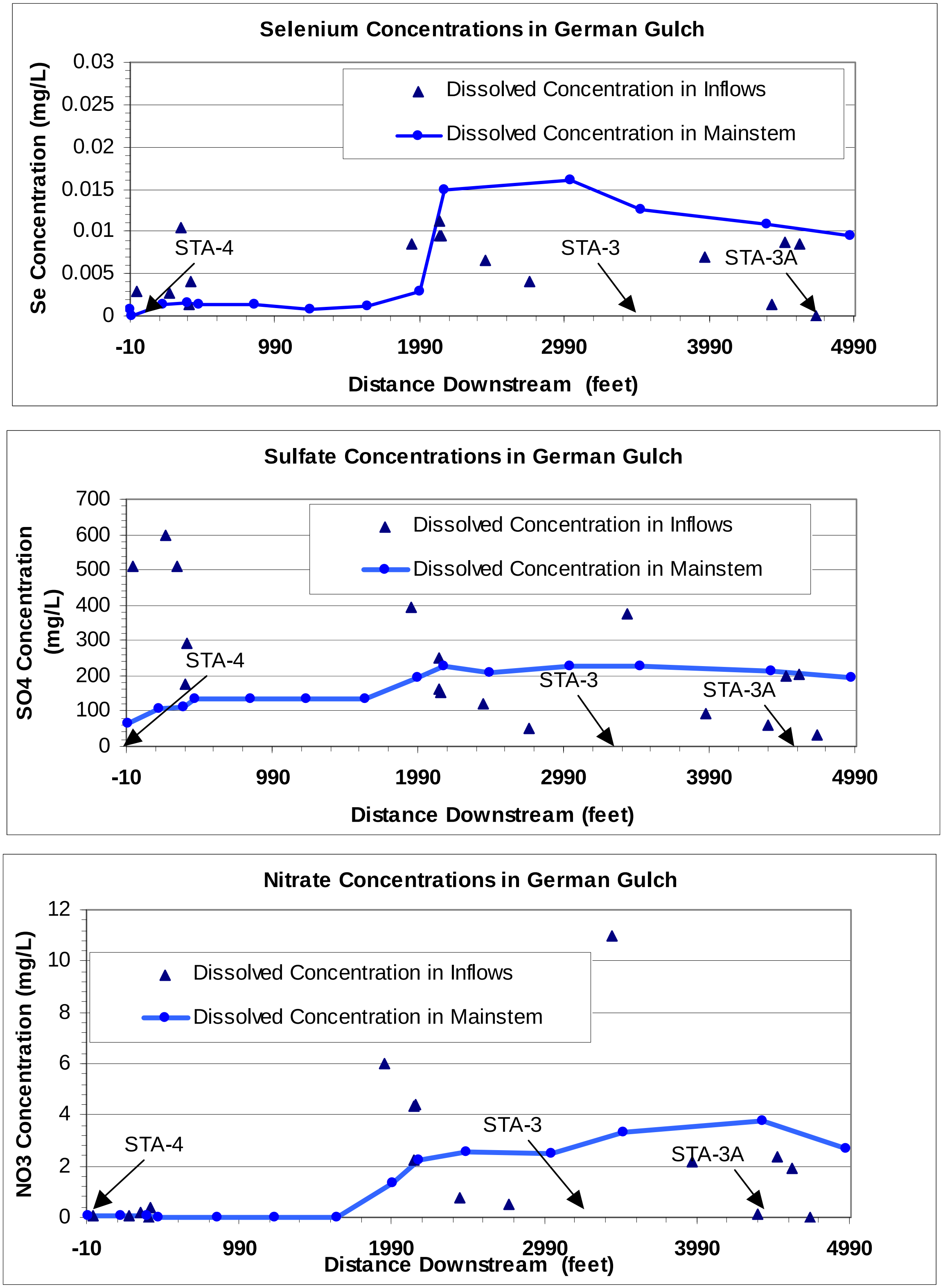


Figure 15. Selenium, Sulfate and Nitrate Concentrations in German Gulch (milligrams per liter; after Gurrieri, 2003)

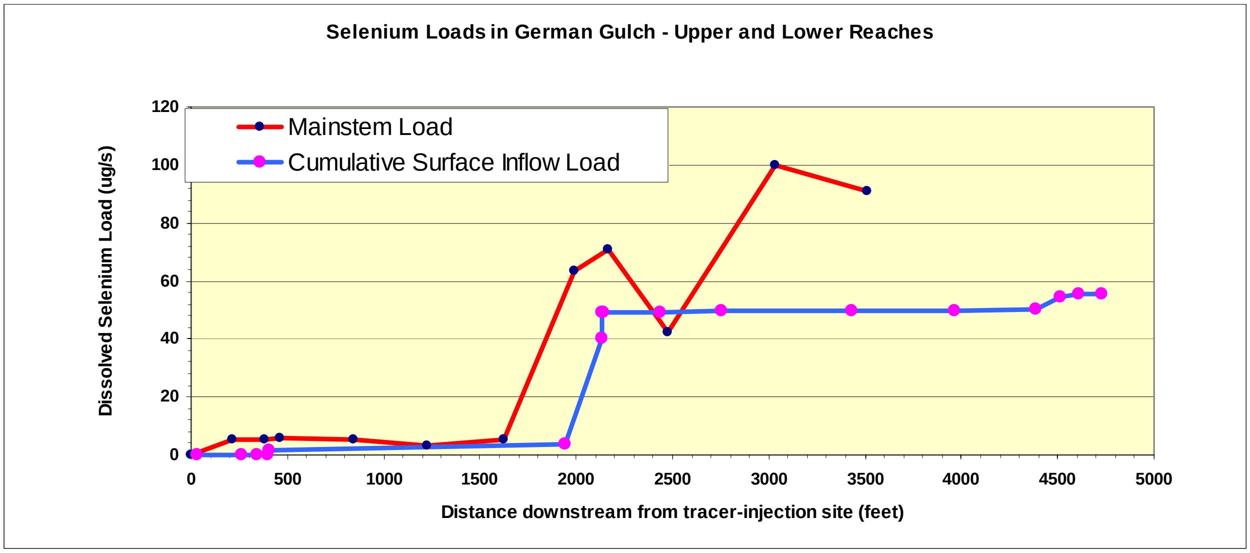


Figure 16. Selenium Loading in German Gulch (micrograms per second) (after Gurrieri, 2003)

3.5 HYDROGEOLOGY

Groundwater in the Beal Mountain Mine area occurs in fractured bedrock, colluvium, alluvium, and backfill material within the Beal Mountain pit. Numerous monitoring wells have been installed in different materials and monitored periodically since 1987 to track groundwater levels and quality. Numerous springs, which are the surface expression of groundwater, have also been identified and sampled. Spring data in this report are used to represent groundwater quality.

Groundwater flow is controlled by the presence and location of unconsolidated materials and by the orientation of fractures and faults in bedrock. Groundwater flow characteristics and spring and groundwater quality are discussed in this section. Hydraulic conductivity values and well yields are from BMMI (1988).

Unconsolidated deposits exist in three main areas in German Gulch. A thin veneer (less than two feet thick) of glacial material ranging from silty sand to clayey silt overlies bedrock on the ridge under and north of the leach pad. This is overlain by as much as 60 feet of more coarse-grained colluvial material on the ridge tops and valley slopes. Deposits of alluvial material fill the bottom of German Gulch. Artificial backfill, as much as 250 feet thick, in the Beal Mountain pit is the third area of unconsolidated material. A fourth area of unconsolidated material is the dike that was constructed along the southern flank of the leach pad. This structure is also artificial and is comprised of layered clay, weathered bedrock, and other waste rock fill material used in the construction of the dike.

3.5.1 Groundwater Flow

Groundwater is recharged by snowmelt and precipitation events. This water percolates vertically through overlying colluvial material and into bedrock fractures. Groundwater in unconsolidated material generally occurs under unconfined conditions. The degree of hydraulic communication between groundwater in unconsolidated material and the underlying bedrock fracture system varies based on the nature of the unconsolidated material and its topographic location. **Figure 17** is a potentiometric map based on June 2003 groundwater elevation data. The map represents a composite of the water table in unconsolidated material and the potentiometric surface for underlying bedrock units in the study area because it was prepared using groundwater elevation data from monitoring wells completed in a variety of materials. Spring elevations were also used in constructing this map (although some may be associated with perched water tables). The map indicates that the potentiometric surface generally parallels the topographic surface and that groundwater flow is generally from the ridge tops toward German Gulch. However, groundwater flow is likely to be more complex than this map indicates. Bedrock units in the study area have little primary porosity, and as a result, the majority of groundwater flow in bedrock undoubtedly takes place in joints and fractures. Boreholes drilled into the Beal Shear and Gully Fault usually encountered fine-grained gouge indicating that faults may be barriers to groundwater flow (BMMI, 1988). Groundwater flow directions and characteristics for different bedrock and unconsolidated units are discussed further below.

3.5.1.1 German Gulch Alluvium

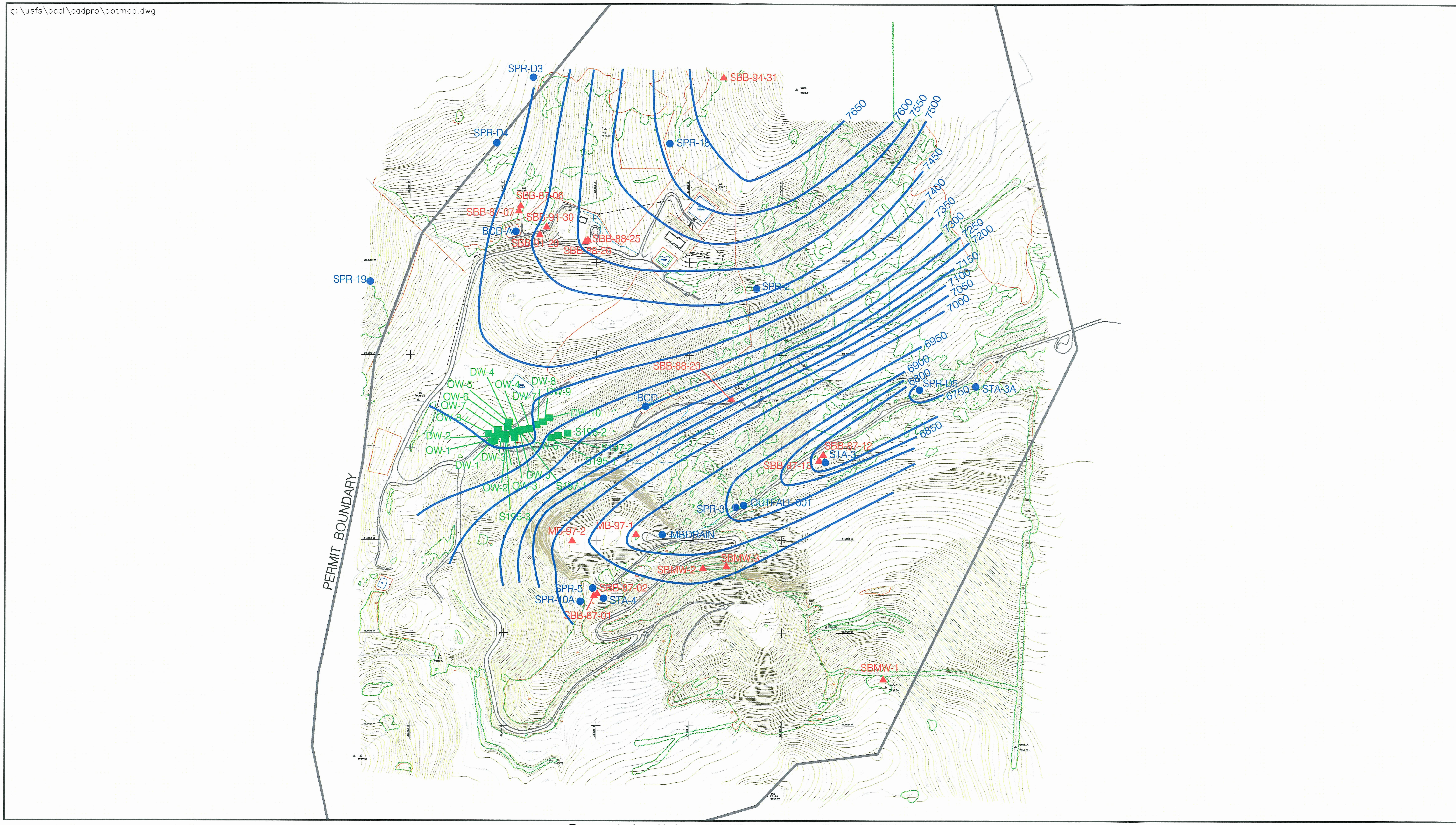
Groundwater flows in alluvium along German Gulch. Monitoring wells SBB-87-01 and SBB-87-13 (**Figure 17**) are completed in unconsolidated material adjacent to the creek. Well SBB-87-01 is completed near the head of German Gulch below the waste rock dump, and well SBB-87-13 is located near surface water monitoring station STA-3, and is completed through coarse gravel fill deposits from historic hydraulic placer mining. The water table is shallow at these locations (less than 10 feet). Well SBB-87-01 is competed in clay with boulders and some sand and silt. An aquifer test on this well revealed that saturated material in this area has a relatively low hydraulic conductivity (0.29 to 0.49 feet/day). During the aquifer test, draw down was observed in adjacent bedrock monitoring well SBB-87-2, indicating hydraulic communication between alluvial and bedrock groundwater in this area. Aquifer testing was not performed on well SBB-87-13 but the alluvium in this area appears to have much higher hydraulic conductivity due to its coarse grained nature.

3.5.1.2 Colluvium North of Leach Pad

Wells SBB-87-07, SBB-88-25, SBB-91-29, and SBB-91-30 (**Figure 17**) are completed in colluvium north of the leach pad. This colluvium is up to 65 feet thick and ranges from sandy clay to gravel with clay. **Figure 17** indicates that groundwater flow within this colluvium is to the northeast toward Minnesota Gulch. Aquifer testing was not performed on this material. Well yields reported for wells SBB-91-29 and SBB-91-30 are one gallon per minute or less indicating that this material has relatively low permeability.

3.5.1.3 Beal Mountain Pit Backfill

Wells MB-97-1 and MB-97-2 (**Figure 17)** were completed within backfill of the Beal Mountain pit. This backfill is reportedly as much as 250 feet deep. Groundwater flow in the pit is to the east toward the Beal Mountain pit drain (MBDRAIN, **Figure 17**). There is both a surface drain system and a constructed underdrain system that is below grade at the downgradient end of the pit backfill. The underdrain system is designed to prevent the water table from rising above the surface of the backfill. Until November of 2003, this water was captured, pumped to the top of Beal's Hill, and discharged through a LAD system. Drained water is currently allowed to discharge directly into German Gulch. Flows measured at MBDRAIN have ranged from about 15 gpm to 150 gpm. Flows are typically highest during spring runoff and lowest during mid-winter.



Topography from Horizons Aerial Photogrammetry, September 2003

N

0 Feet 1000

SPR-5 ●	Surface Water Sample Location
SBB-87-01 ▲	Groundwater Sample Location
S197-2 ■	Slide Monitoring Well Location

MAXIM TECHNOLOGIES INC® 3560621

Potentiometric Surface Map
Beal Mountain Mine
Silver Bow County, Montana
FIGURE 17

Figure 17 back page

3.5.1.4 BEDROCK

Groundwater flow in bedrock appears to be anisotropic and controlled by faults, joints, fractures, and the presence of low permeability igneous intrusions and clay seams within bedrock. Major faults within the area include the Beal Shear, the Gully Fault, and German Gulch Fault. Unfractured bedrock generally has very low permeability. These faults have likely created preferential pathways for groundwater flow due to the increased fracturing of rock near or adjacent to the faults. In some cases cross-fault permeability within fault zones is relatively low due the presence of fault gouge.

Wells SBB-87-02 and SBB-87-12 (**Figure 17)** are completed in quartzite, and fault gouge and fractured quartzite, respectively in the German Gulch Fault adjacent to the creek. Well SBB-87-02 is located next to alluvial well SBB-87-01 (discussed above) and well SBB-87-12 is located next to alluvial well SBB-87 – 13 (also discussed above). Well SBB-87-06 is completed in quartzite in a fault perpendicular to the German Gulch Fault (BMMI, 1988) adjacent to colluvial well SBB-87-07. The hydraulic conductivity of bedrock along the German Gulch fault is about 0.1 feet/day based on results of aquifer testing in wells SBB-87-02 and SBB-87-12. Other bedrock wells include SBB-88-26 completed in hornfels bedrock north of the leach pad and west of the ore processing plant. This well is paired with colluvial well SBB-88-25.

Several dewatering wells were installed south of the leach pad to help lower the water table in that area due to concerns regarding the geotechnical stability of the leach pad's south containment dike. Southwest of the gully fault, several low-angle clay seams are present in hornfels and metasediments. These clay seams are the result of weathering of the metasediments along what are likely old thrust fault slip surfaces. These clay seams serve as aquitards and separate layers of perched groundwater. Piezometers installed in this area in the mid 1990's indicated that several distinct perched systems are present. Groundwater flow within these perched systems is poorly understood. The area north of the Gully Fault does not contain these clay seams as the older thrust faults appear to have been cut off by the Gully Fault.

3.5.1.5 SEASONAL WATER LEVEL CHANGES AND VERTICAL GRADIENTS

Figure 18 is a series of groundwater hydrographs for paired well locations where one well is completed in colluvium/alluvium and is adjacent to a bedrock well. The hydrographs for wells SBB-87-01 and -02 and SBB-87-12 and -13 show that groundwater elevations are higher in bedrock than in adjacent alluvium, indicating that vertical hydraulic gradients are upward from bedrock into the overlying alluvial material along German Gulch. This implies that groundwater is discharging from the bedrock system to the alluvial system. Water in the alluvium likely flows parallel to, and discharges into, the creek.

The hydrograph for paired wells SBB-87-06 and -07 and SBB-88-25 and -26 indicate that at these locations vertical gradients are downward from colluvium into bedrock. These wells are located on a ridge that is a recharge area for groundwater. Rain and snowmelt infiltrate through the colluvial material recharging the underlying bedrock creating a downward head potential.

3.5.2 <u>Groundwater Quality</u>

Tables 8 and **9** summarize groundwater and spring water quality data, respectively, for the January through July 2003 monitoring period. These data are discussed in the following sections.

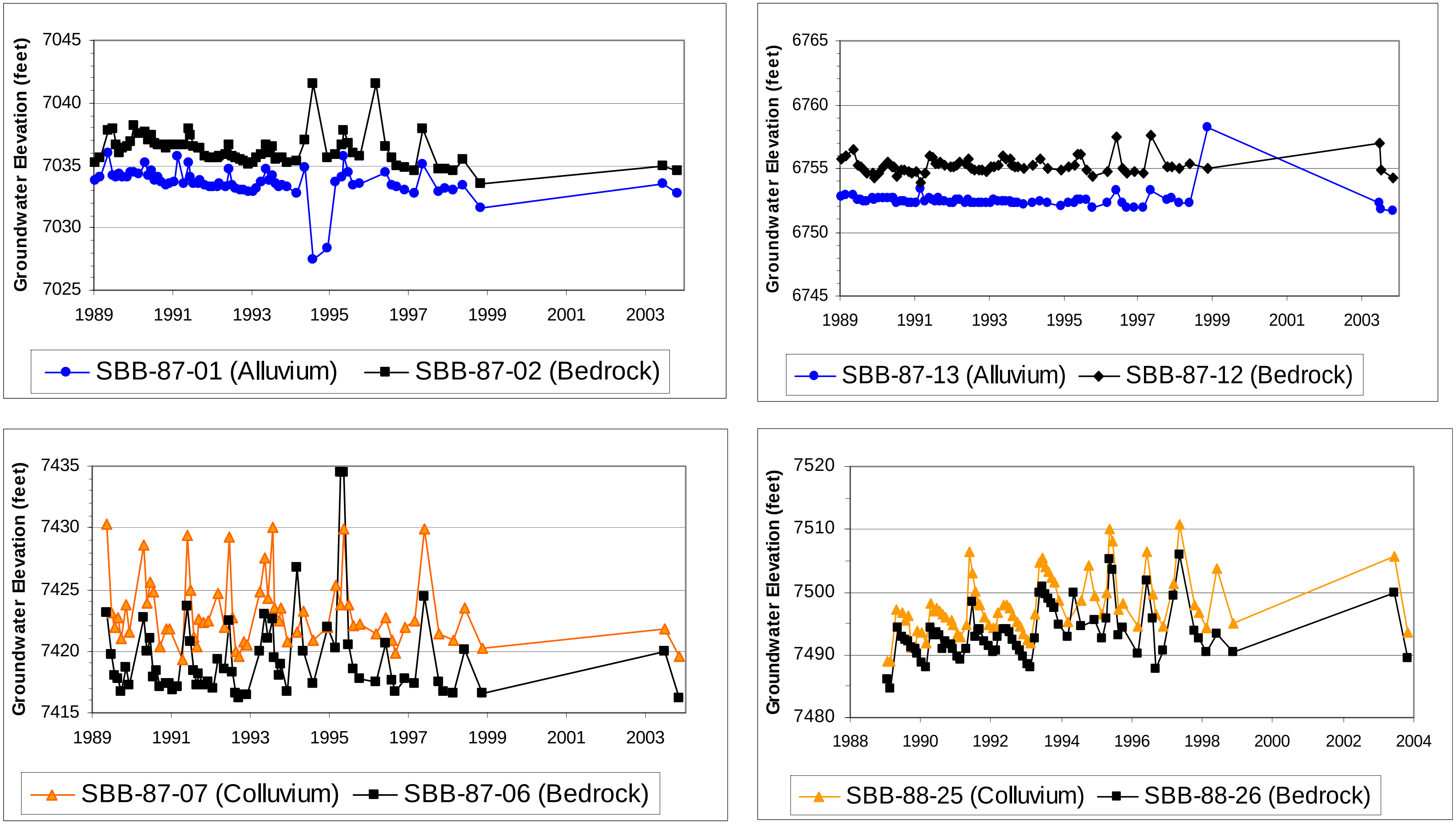


Figure 18. Groundwater hydrographs

TABLE 8
2003 GROUNDWATER DATA SUMMARY
Beal Mountain Mine

STATION	DATE	pH (standard units)	Dissolved Concentration (milligrams per liter)								
			Total Dissolved Solids	Sulfate	Nitrate/ Nitrite as N	Arsenic	Copper	Iron	Selenium	Total Cyanide	Thio-cyantate
MB-97-1	6/30/2003	6.8	1490	882	0.1 U	0.003 U	0.001 U	0.88	0.003	0.005 U	0.2 U
MB-97-2	11/13/2003	6.7	1070	679	0.1 U	0.003 U	0.001 U	5.26	0.001 U	0.046	0.2 U
SBB-87-01	6/30/2003	6.9	1010	598	0.2	0.003 U	0.004	0.08	0.012	0.005 U	0.2 U
SBB-87-01	11/13/2003	7.2	1060	658	0.3	0.003	0.002	0.04	0.012	0.005 U	0.2 U
SBB-87-02	6/30/2003	7.4	1170	691	0.1 U	0.008	0.001 U	0.12	0.002	0.005 U	0.2 U
SBB-87-02	11/13/2003	7.7	1220	783	0.1 U	0.007	0.001 U	0.14	0.001 U	0.005 U	0.2 U
SBB-87-06	6/30/2003	7.7	142	7	0.4	0.005	0.001	0.03	0.001 U	0.005 U	0.2 U
SBB-87-06	11/13/2003	7.9	160	6	0.5	0.006	0.003	0.02	0.001 U	0.005 U	0.2 U
SBB-87-07	11/13/2003	7	448	214	2.3	0.003 U	0.001 U	0.06	0.001	0.013	0.2 U
SBB-87-12	1/15/2003	7.8	188	59	0.1 U	0.010	0.002	0.03	0.001 U	0.005 U	0.2
SBB-87-12	2/13/2003	7.9	179	61	0.05 U	0.011	0.001 U	0.01 U	0.001 U	0.005 U	0.3
SBB-87-12	3/11/2003	7.8	191	63	0.1 U	0.008	0.001 U	0.04	0.001 U	0.005 U	0.3
SBB-87-12	4/30/2003	7.9	184	63	0.1 U	0.011	0.001 U	0.09	0.001 U	0.005 U	0.3
SBB-87-12	5/21/2003	7.7	197	60	0.1 U	0.009	0.001 U	0.08	0.001 U	0.005 U	0.2 U
SBB-87-12	6/30/2003	7.8	183	64	0.1 U	0.008	0.001 U	0.03	0.001 U	0.005 U	0.2 U
SBB-87-12	7/25/2003	7.6	189	56	0.1 U	0.009	0.001 U	0.52	0.001 U	0.005 U	0.2 U
SBB-87-12	8/22/2003	7.8	195	63	0.1 U	0.009	0.001 U	0.01	0.001 U	0.005 U	0.2 U
SBB-87-12	11/13/2003	7.9	204	67	0.1 U	0.01	0.001 U	0.02	0.001 U	0.005 U	0.2 U
SBB-87-13	1/15/2003	7.0	291	122	0.9	0.01	0.007	0.09	0.011	0.005 U	0.6
SBB-87-13	2/13/2003	7.0	286	132	0.91	0.01	0.006	0.01	0.011	0.005 U	0.7
SBB-87-13	3/11/2003	6.9	288	129	0.9	0.012	0.008	0.07	0.010	0.005 U	0.4
SBB-87-13	4/30/2003	7.0	407	197	1.5	0.014	0.016	0.60	0.009	0.005 U	0.7
SBB-87-13	5/21/2003	6.6	456	225	1.7	0.010	0.008	1.38	0.010	0.005 U	0.5
SBB-87-13	6/30/2003	6.8	311	138	1.5	0.010	0.005	0.02	0.009	0.005 U	0.2 U
SBB-87-13	7/25/2003	6.8	338	131	1.3	0.013	0.010	1.02	0.009	0.005 U	0.2 U
SBB-87-13	8/22/2003	7.0	335	147	1.2	0.012	0.006	0.03	0.010	0.010	0.4
SBB-87-13	11/13/2003	7.0	320	139	1.1	0.012	0.008	0.02	0.010	0.005 U	0.2 U
SBB-88-20	11/13/2003	6.9	659	336	9	0.003 U	0.004	0.03	0.026	0.014	0.2 U
SBB-88-25	6/30/2003	7.1	277	82	1.2	0.003	0.007	0.03	0.010	0.052	0.2 U
SBB-88-25	11/13/2003	7.2	411	168	2	0.003 U	0.011	0.03	0.013	0.059	0.2 U
SBB-88-26	6/30/2003	7.2	293	88	1	0.003	0.002	0.04	0.008	0.067	0.2 U
SBB-88-26	11/13/2003	7.2	432	181	2.2	0.003 U	0.003	0.05	0.009	0.090	0.2 U
SBB-91-29	6/30/2003	6.5	1390	734	16	0.003 U	0.002	0.56	0.047	1.68	0.2 U
SBB-91-30	6/30/2003	6.6	1200	616	10.7	0.003 U	0.002	0.06	0.020	0.109	0.2 U
SBB-94-31	1/15/2003	7.3	340	103	2.7	0.003 U	0.006	0.21	0.015	0.052	0.3
SBB-94-31	2/13/2003	7.3	339	117	2.46	0.003 U	0.005	0.14	0.016	0.116	0.3
SBB-94-31	3/11/2003	7.3	358	119	2.4	0.003 U	0.006	0.28	0.016	0.145	0.4
SBB-94-31	4/30/2003	7.4	366	123	2.3	0.003 U	0.005	0.15	0.018	0.005 U	0.3
SBB-94-31	5/21/2003	7.3	400	125	2.9	0.003 U	0.004	0.11	0.018	0.156	0.2 U
SBB-94-31	6/30/2003	7.2	393	125	4.2	0.003 U	0.004	0.07	0.015	0.138	0.2 U
SBB-94-31	7/25/2003	7.1	430	132	3.2	0.003 U	0.004	0.10	0.019	0.21	0.2 U
SBB-94-31	8/22/2003	7.3	457	168	2	0.003 U	0.002	0.05	0.021	0.250	0.2 U
SBB-94-31	11/13/2003	7.3	454	177	2.2	0.003 U	0.003	0.08	0.02	0.136	0.2 U
SBMW-3	6/30/2003	7.7	195	70	1.2	0.003 U	0.001 U	0.01 U	0.004	0.005 U	0.2 U
Groundwater Standard		NA	NA	NA	10	0.02	1.3	0.3	0.050	0.2	NA

Notes: Groundwater Standard from MDEQ Circular WQB-7 (2002)
Concentrations in milligrams per liter (mg/L) except for pH.
U - Concentration is less than laboratory reporting limit indicated

Shading indicates value exceeds groundwater standard

3.5.2.1 GROUNDWATER WELLS

Comparison of data to groundwater standards (MDEQ 2002) indicates that the June 2003 samples from paired wells SBB-91-29 and -30 exceeded the groundwater standard for nitrate. Groundwater samples from SBB-87-02, -12, -13, and SBB-91-29, and -31 exceeded the groundwater standard for iron. Groundwater samples from wells SBB-88-25, SBB-88-26, and SBB-91-29, -30, and -31 exceeded the groundwater standard for cyanide. Samples from paired wells SBB-87-01 and -02 and SBB-91-29 and -30 exhibit relatively high concentrations of total dissolved solids (TDS) and sulfate.

Figures 19, 20, and **21** are graphs showing trends in concentrations of selenium, sulfate, and nitrate and cyanide concentrations, respectively for selected monitoring wells. **Figures 19** and **21** indicate that selenium and nitrate concentrations increased markedly in alluvial monitoring well SBB-87-01 (waste rock toe area) in 1991 and then decreased in 1995. Prior to 1995, water draining from the waste rock dump was discharged to a marshy area at the head of German Gulch near well SBB-87-01 (personal communication, Bruce Parker, Beal Mountain Mining). In 1995 a toe drain collection system was put in place to capture water draining through the waste rock dump. This likely resulted in a decrease in groundwater selenium concentrations at that time and also resulted in the marshy area drying up.

Similar increases in selenium and nitrate concentrations did not occur in the adjacent bedrock well SBB-87-02 (**Figures 19** and **21**). A comparison of selenium and nitrate concentrations in these paired wells indicates that selenium and nitrate impacts are much more pronounced in shallow alluvial groundwater than in the underlying bedrock. **Figure 20** indicates that sulfate began increasing in groundwater in both bedrock and alluvium at that location in about 1992 and has been increasing since.

Selenium concentrations increased slightly in alluvial and bedrock groundwater at paired well location SBB-87-12 and -13 (near surface water station STA-3) in 1993 to 1995 and another increase in selenium in bedrock groundwater in 2001 **(Figure 19)**. **Figure 20** shows that an increase in sulfate concentrations in groundwater from alluvial well SBB-87-12 began in 1992, similar to that observed in wells SBB-87-01 and -02. This suggests that bedrock at this location may not receive recharge from the same area as the alluvium, which is in hydraulic communication with surface water. **Figure 19** also shows that changes in selenium concentration in surface water in German Gulch at STA-3 parallel changes in well SBB-87-13, suggesting good communication between surface and groundwater at this location.

Figure 19 indicates that selenium increased in colluvial wells SBB-87-07 and SBB-91-29. These wells are completed in colluvium and are located north of the north leach pad dike. The north leach pad dike was constructed in 1991 with unoxidized rock from the Beal Mountain pit. Soluble selenium may have been flushed from this rock in the dike and infiltrated into shallow groundwater. Sulfate concentrations have shown a general increasing trend in wells SBB-87-07, SBB-91-29 and -30 since the early 1990s. A similar trend has not been observed in well SBB-87-06 which is the deeper well paired with SBB-87-07.

Selenium and sulfate concentrations generally increased between 1992 and 2002 in colluvial and bedrock groundwater paired well location SBB-88-25 and –26 (north of the leach pad), but have decreased since then **(Figures 19** and **20)**. Selenium and sulfate concentrations in well SBB-94-31 increased between 1995 and 1997, but have decreased since that time **(Figures 19** and **20)**. During this period, water extracted from dewatering wells in the Beal Mountain pit was land applied on the north flank of Beal's Hill. This freshwater land application was the likely source of the observed increases.

TABLE 9

2003 SPRING WATER QUALITY DATA SUMMARY

Beal Mountain Mine

STATION	DATE	pH (standard units)	Total Concentration (milligrams per liter)									
			Total Dissolved Solids	Total Suspended Solids	Sulfate	Nitrate/ Nitrite as N	Arsenic	Copper	Iron	Selenium	Total Cyanide	Thio-cyantate
SPR-10A	3/28/2003	7	814	10 U	416	2.9	0.003 U	0.001 U	0.01 U	0.319	0.005 U	0.2 U
SPR-10A	6/18/2003	6.9	812	10 U	437	2	0.003 U	0.002	0.01 U	0.173	0.005 U	0.2 U
SPR-10A	9/18/2003	6.9	936	10 U	511	2.6	0.003 U	0.001	0.01	0.318	0.005 U	0.2 U
SPR-10A	11/12/2003	7	946	10 U	483	2.6	0.003 U	0.001	0.01	0.301	0.005 U	0.2 U
SPR-18	5/16/2003	7	165	10 U	22	0.7	0.004	0.001	0.07	0.002	0.030	0.2 U
SPR-18	6/30/2003	7.3	139	10 U	18	0.7	0.006	0.001 U	0.05	0.002	0.013	0.2 U
SPR-18	7/25/2003	7.2	140	10 U	18	0.7	0.005	0.001	0.26	0.002	0.030	0.2 U
SPR-18	8/7/2003	7.1	165	10 U	16	0.8	0.005	0.001 U	0.04	0.002	0.011	0.2 U
SPR-19	1/14/2003	7.5	592	10 U	173	1.9	0.003 U	0.003	0.03	0.01	0.438	0.2 U
SPR-19	2/12/2003	7.3	534	10 U	81	1.88	0.003 U	0.001	0.02	0.008	0.407	0.2 U
SPR-19	3/11/2003	7.4	541	10 U	155	1.9	0.003 U	0.001	0.02	0.009	0.410	0.2 U
SPR-19	4/24/2003	7.4	430	10 U	103	1.7	0.003 U	0.001	0.01	0.006	0.27	0.2 U
SPR-19	5/21/2003	6.9	1340	16	951	0.1 U	0.003 U	0.003	0.32	0.033	1.04	0.2 U
SPR-19	6/30/2003	7.2	1440	10 U	561	5.8	0.003 U	0.002	0.17	0.02	1.08	0.2 U
SPR-19	7/25/2003	7.2	1260	10 U	405	5.2	0.003 U	0.001	0.15	0.023	0.77	0.2 U
SPR-19	8/7/2003	7.1	1210	10 U	469	4.9	0.003 U	0.002	0.11	0.02	0.84	0.2 U
SPR-2	1/15/2003	7.3	295	10 U	77	2	0.007	0.001 U	0.01 U	0.016	0.012	0.2 U
SPR-2	2/12/2003	7.3	289	10 U	85	2.09	0.006	0.001 U	0.01 U	0.015	0.048	0.2 U
SPR-2	3/11/2003	7.4	308	10 U	88	2.1	0.005	0.007	0.06	0.016	0.057	0.2 U
SPR-2	3/28/2003	7.7	1750	12	1050	3	0.004	0.004	0.14	0.07	0.005 U	0.2 U
SPR-2	4/23/2003	7.3	255	10 U	68	1.9	0.006	0.001	0.01 U	0.016	0.048	0.2 U
SPR-2	5/16/2003	7.3	244	10 U	50	1.6	0.007	0.002	0.01 U	0.008	0.034	0.2 U
SPR-2	6/30/2003	7.2	203	10 U	38	1.2	0.007	0.001	0.01 U	0.006	0.022	0.2 U
SPR-2	7/25/2003	7.1	867	10 U	410	1.2	0.003 U	0.001 U	0.01 U	0.069	0.02	0.2 U
SPR-2	8/7/2003	7.0	838	10 U	469	1.1	0.003 U	0.001 U	0.01 U	0.059	0.026	0.2 U
SPR-3	3/12/2003	7.5	504	14	267	1.8	0.008	0.005	0.53	0.01	0.02	0.2 U
SPR-3	6/30/2003	7.8	628	10 U	326	2.2	0.006	0.002	0.09	0.011	0.030	0.2 U
SPR-5	3/28/2003	7.7	1750	12	1050	3	0.004	0.004	0.14	0.07	0.005 U	0.2 U
SPR-5	6/18/2003	7.5	1790	10 U	1110	3.8	0.005	0.003	0.02	0.069	0.005 U	0.2 U
SPR-5	9/18/2003	7.9	1890	10 U	1140	2.6	0.007	0.002	0.12	0.066	0.005 U	0.2 U
SPR-5	11/12/2003	7.7	1880	11	1140	2.8	0.007	0.003	0.18	0.069	0.005 U	0.2 U
SPR-D1	4/24/2003	6.7	1020	10 U	500	0.1 U	0.003 U	0.002	0.14	0.023	0.90	0.2 U
SPR-D1	5/16/2003	6.6	1080	13	495	0.1	0.003 U	0.001	0.17	0.024	0.86	0.2 U
SPR-D1	6/18/2003	6.5	1050	10 U	526	0.1 U	0.003 U	0.001 U	0.12	0.02	0.60	0.2 U
SPR-D1	7/25/2003	6.95	1010	10 U	417	0.1 U	0.003 U	0.001 U	0.13	0.02	0.65	0.2 U
SPR-D1	8/7/2003	6.6	1030	10 U	514	0.1 U	0.003 U	0.001 U	0.11	0.018	0.53	0.2 U
SPR-D2	2/12/2003	6.3	2220	10 U	62	0.18	0.003 U	0.005	0.31	0.075	1.88	0.2 U
SPR-D2	3/12/2003	7	1580	12	855	0.3	0.003 U	0.003	0.35	0.029	1.26	0.2 U
SPR-D2	4/24/2003	6.4	2280	10 U	1320	0.1	0.003 U	0.005	0.55	0.035	2.01	0.2 U
SPR-D2	5/16/2003	6.4	1320	13	697	0.1 U	0.003 U	0.002	0.41	0.023	0.90	0.2 U
SPR-D2	6/30/2003	6.8	1120	10 U	568	0.1 U	0.003 U	0.001	0.12	0.018	0.85	0.2 U
SPR-D2	7/25/2003	6.5	1090	10 U	493	0.4	0.003 U	0.002	0.21	0.015	0.57	0.2 U
SPR-D2	8/7/2003	6.9	1270	10 U	720	0.4	0.003 U	0.001	0.15	0.017	0.74	0.2 U
SPR-D3	1/14/2003	7.1	201	10 U	75	0.1 U	0.003 U	0.001 U	0.01	0.002	0.005 U	0.2 U
SPR-D3	2/12/2003	7.1	198	10 U	80	0.05	0.003 U	0.001 U	0.01 U	0.002	0.025	0.2 U

TABLE 9

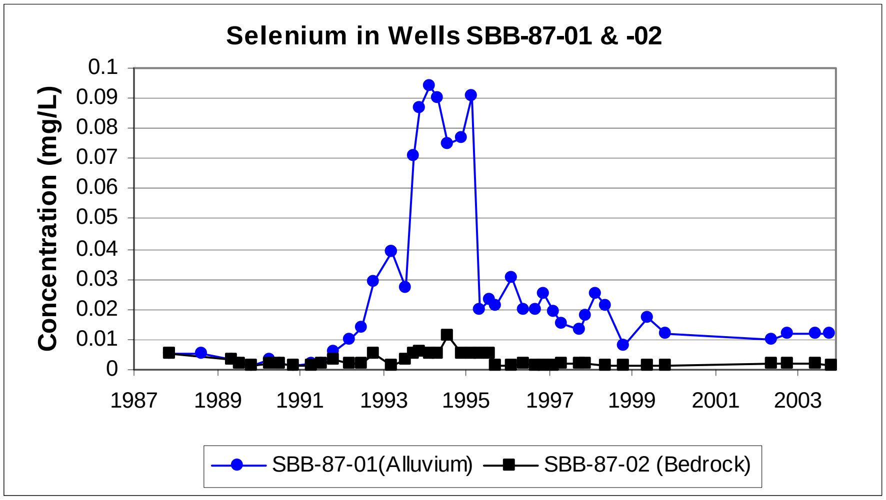
2003 SPRING WATER QUALITY DATA SUMMARY

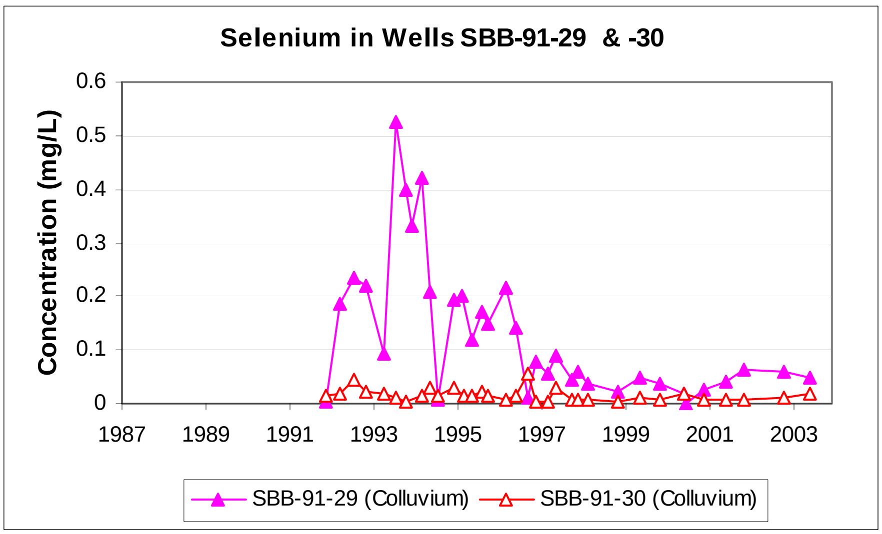
Beal Mountain Mine

STATION	DATE	pH (standard units)	Total Concentration (milligrams per liter)									
			Total Dissolved Solids	Total Suspended Solids	Sulfate	Nitrate/ Nitrite as N	Arsenic	Copper	Iron	Selenium	Total Cyanide	Thio-cyantate
SPR-D3	3/11/2003	7.3	214	10 U	80	0.1 U	0.003 U	0.002	0.06	0.002	0.025	0.2 U
SPR-D3	4/23/2003	7	193	10 U	75	0.1 U	0.01 U	0.002	0.03	0.002	0.021	0.2 U
SPR-D3	5/16/2003	6.7	214	10 U	79	0.1	0.003 U	0.001 U	0.01 U	0.002	0.030	0.2 U
SPR-D3	6/30/2003	6.8	214	10 U	88	0.1 U	0.003 U	0.001 U	0.01 U	0.003	0.063	0.2 U
SPR-D3	7/25/2003	7.5	201	10 U	70	0.1 U	0.003 U	0.001 U	0.01 U	0.002	0.021	0.2 U
SPR-D3	8/7/2003	7.4	217	10 U	75	0.1 U	0.003 U	0.001 U	0.01 U	0.002	0.028	0.2 U
SPR-D4	1/14/2003	7.4	176	10 U	38	0.1 U	0.003 U	0.01	0.01 U	0.001	0.007	0.2 U
SPR-D4	2/12/2003	7.6	157	10 U	39	0.09	0.003 U	0.002	0.01	0.001 U	0.008	0.2 U
SPR-D4	3/11/2003	7.6	182	10 U	39	0.1 U	0.003 U	0.001	0.01	0.001 U	0.009	0.2 U
SPR-D4	4/23/2003	7	163	10 U	34	0.1 U	0.003 U	0.002	0.03	0.001 U	0.007	0.2 U
SPR-D4	5/16/2003	6.8	169	10 U	36	0.1 U	0.003 U	0.002	0.05	0.001 U	0.005 U	0.2 U
SPR-D4	6/30/2003	6.8	176	10 U	69	0.1 U	0.003 U	0.001 U	0.01 U	0.002	0.027	0.2 U
SPR-D4	7/25/2003	7.25	236	10 U	76	0.1 U	0.003 U	0.001 U	0.01 U	0.001 U	0.024	0.2 U
SPR-D4	8/7/2003	7.2	263	10 U	95	0.1	0.003 U	0.001 U	0.01 U	0.001	0.019	0.2 U
SPR-D5	3/13/2003	7	182	55	36	0.3	0.007	0.006	1.26	0.003	0.005 U	0.2 U
SPR-D5	4/23/2003	7.2	176	10 U	36	0.5	0.005	0.001	0.03	0.003	0.005 U	0.2 U
SPR-D5	5/13/2003	7.2	172	10 U	38	0.4	0.005	0.001 U	0.14	0.003	0.005 U	0.2 U
SPR-D5	6/18/2003	7.2	181	10 U	38	0.1 U	0.007	0.001	0.07	0.004	0.005 U	0.2 U
SPR-D5	7/25/2003	7.3	198	10 U	36	0.1 U	0.007	0.001 U	0.06	0.003	0.013	0.2 U
SPR-D5	8/7/2003	7.6	219	12	38	0.1 U	0.006	0.003	0.44	0.002	0.015	0.2 U
SPR-D5	9/18/2003	8.2	211	23	39	0.2	0.004	0.002	0.41	0.004	0.018	0.2 U
SPR-D5	10/22/2003	7.5	196	10 U	38	0.1 U	0.004	0.001 U	0.01	0.003	0.011	0.2 U
SPR-D5	11/12/2003	7.7	206	10 U	41	0.1 U	0.004	0.001	0.13	0.004	0.018	0.2 U
SPR-D5	12/9/2003	7.88	208	10 U	38	0.2	0.004	0.001 U	0.02	0.004	0.011	0.2 U
SPR-D7	1/14/2003	7.6	141	24	20	0.1 U	0.006	0.003	0.51	0.001 U	0.005 U	0.2 U
SPR-D7	4/23/2003	7.8	110	10 U	20	0.1 U	0.005	0.003	0.28	0.001 U	0.072	0.2 U
SPR-D7	5/13/2003	7.8	122	10 U	20	0.1 U	0.006	0.003	0.31	0.001 U	0.005 U	0.2 U
SPR-D8	1/14/2003	7.6	221	10 U	79	0.3	0.003 U	0.001 U	0.01	0.003	0.005 U	0.2 U
SPR-D8	2/12/2003	7.7	230	10 U	100	0.22	0.003 U	0.002	0.04	0.001 U	0.050	0.2 U
SPR-D8	3/11/2003	7.7	319	10 U	141	0.2	0.003 U	0.001 U	0.01	0.005	0.132	0.2 U
SPR-D8	4/24/2003	7.8	402	10 U	187	0.6	0.003 U	0.003	0.15	0.005	0.098	0.2 U
SPR-D8	5/21/2003	7.3	317	10 U	139	0.5	0.003 U	0.002	0.09	0.004	0.054	0.2 U
SPR-D8	6/30/2003	7.7	318	10 U	150	0.2	0.003 U	0.001 U	0.01 U	0.004	0.054	0.2 U
SPR-D8	7/25/2003	8.2	310	26	122	0.1	0.003 U	0.006	0.21	0.003	0.040	0.2 U
SPR-D8	8/7/2003	8.0	330	10 U	137	0.1 U	0.003 U	0.001	0.03	0.003	0.045	0.2 U
SPR-D8	9/18/2003	8.3	305	10 U	138	0.2	0.003 U	0.001 U	0.02	0.003	0.066	0.2 U
SPR-D8	10/22/2003	7.7	272	10 U	118	0.1 U	0.003 U	0.002	0.1	0.003	0.041	0.2 U
SPR-D8	11/12/2003	7.8	294	36	121	0.2	0.003 U	0.016	0.61	0.004	0.055	0.2 U
SPR-D8	12/9/2003	8.3	287	14	125	0.2	0.003 U	0.003	0.04	0.004	0.055	0.2 U
Aquatic Life Standards	Acute		NA		NA	NA	0.087	0.073 *	NA	0.02	0.022	NA
	Chronic		NA		NA	NA	0.75	0.052 *	1	0.005	0.005	NA

Notes: Aquatic life standards from MDEQ Circular WQB-7 (2002)
U - Concentration is less than laboratory reporting limit indicated
* - indicates standard calculated using a hardness of 100 mg/L

Shading indicates value exceeds acute standard (yellow)
Shading indicates value exceeds chronic standard (light blue)





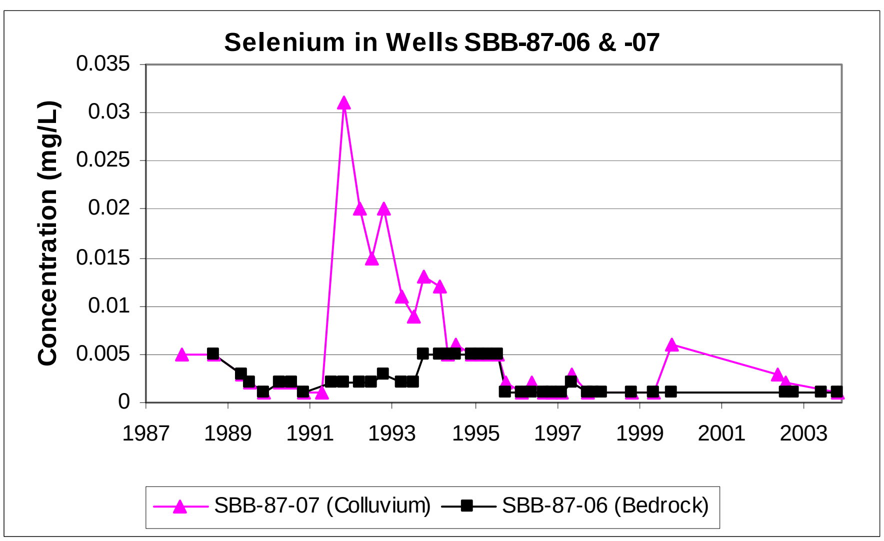
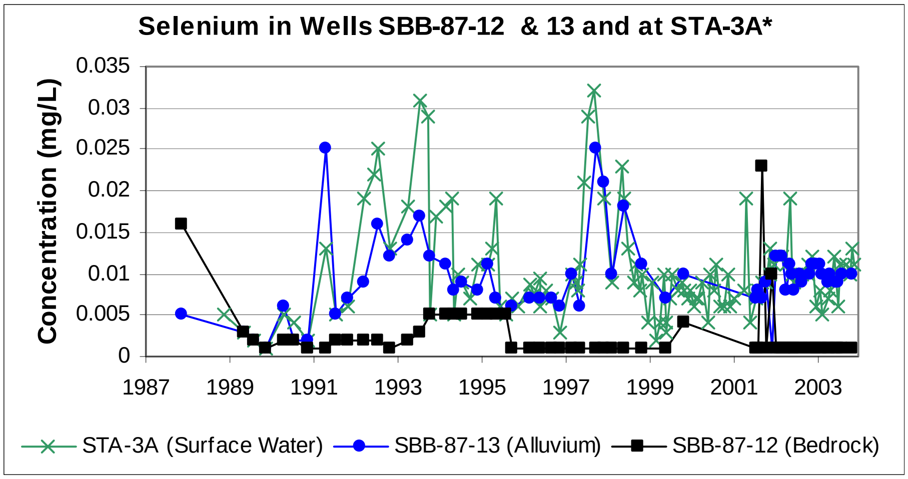
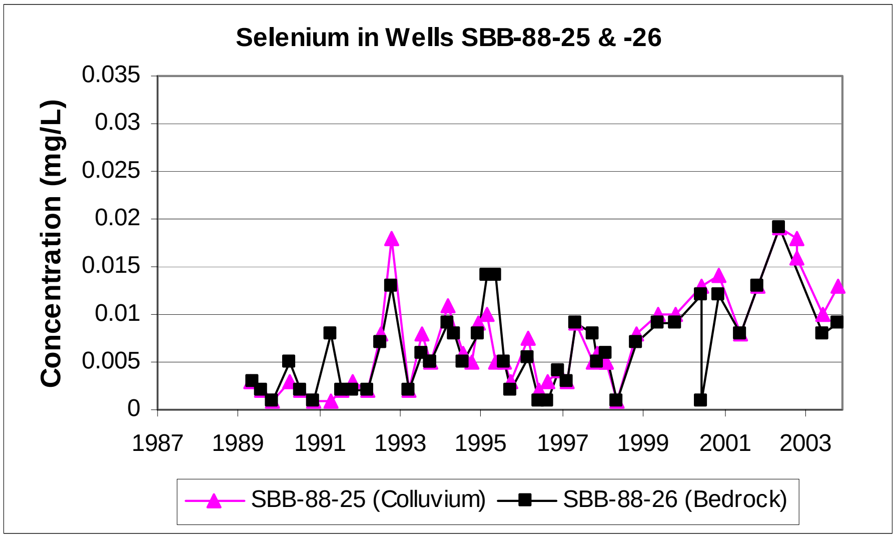


Figure 19. Selenium Trends in Select Monitoring Wells (milligrams per liter)





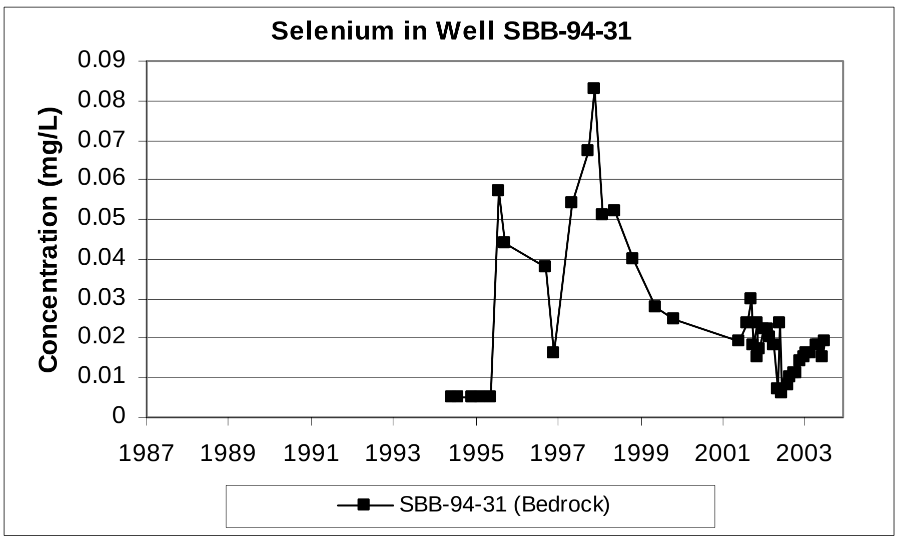


Figure 19 (cont'd). Selenium Trends in Select Monitoring Wells (* concentrations are dissolved for STA-3A prior to October 1993; other concentrations are totals)

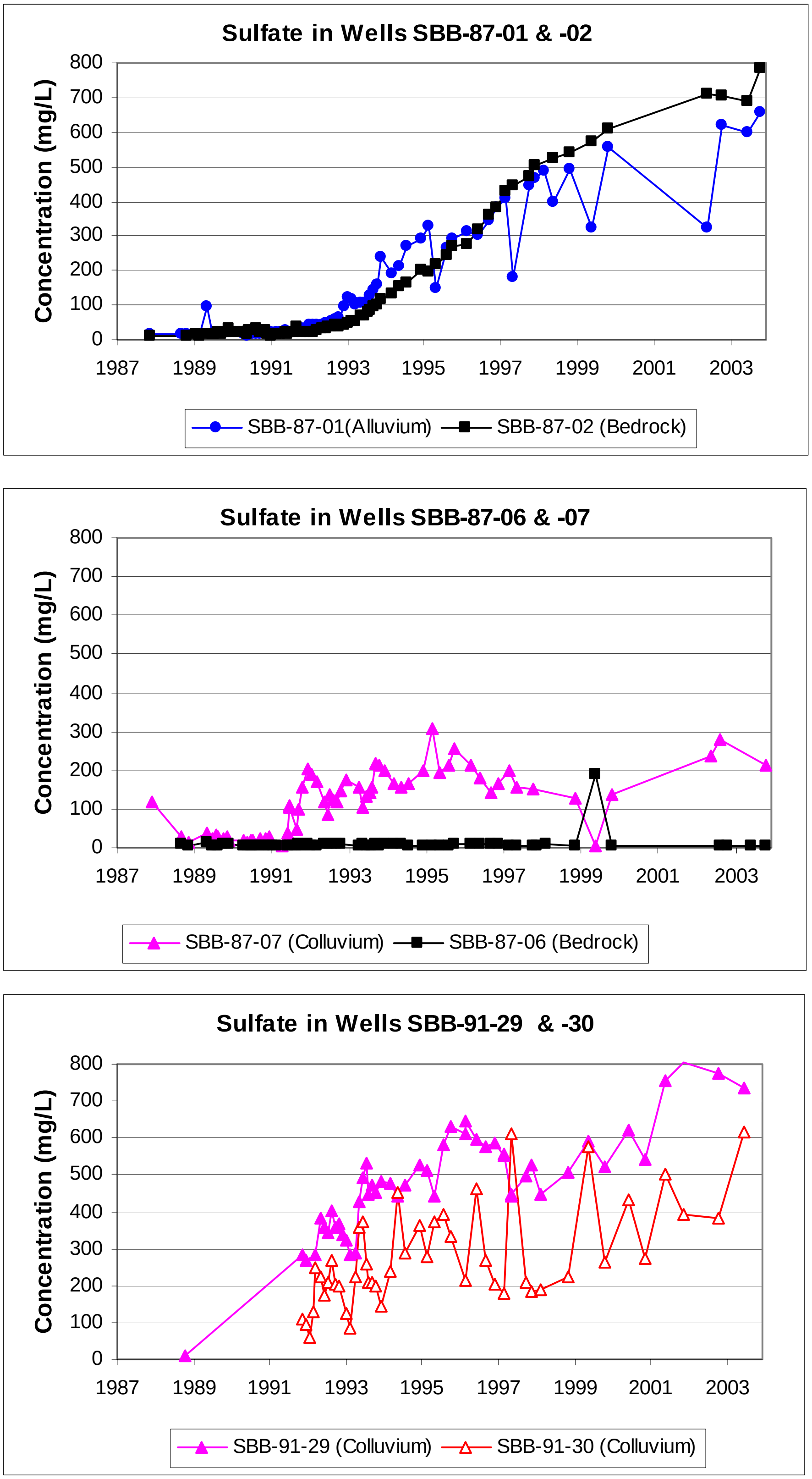


Figure 20. Sulfate Trends in Select Monitoring Wells (milligrams per liter)

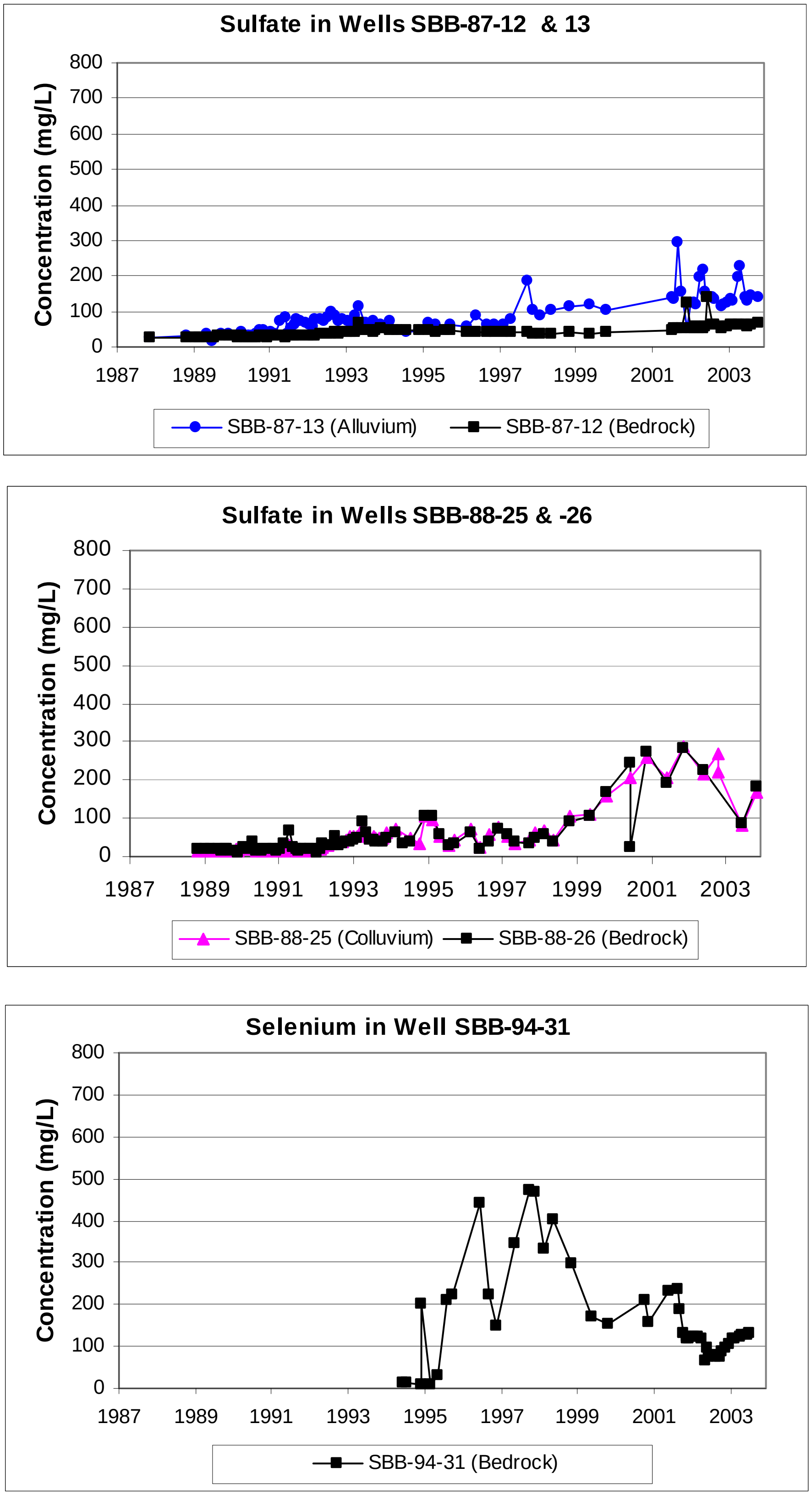


Figure 20 (cont'd). Sulfate Trends in Select Monitoring Wells.

Figure 21 shows that cyanide was generally not detected in monitoring wells north of the leach pad before land application discharge (LAD) operations began in 2001. Since that time, with the active land application of treated leach pad solution on-going until November 2003, cyanide concentrations in most monitoring wells north of the leach pad have increased.

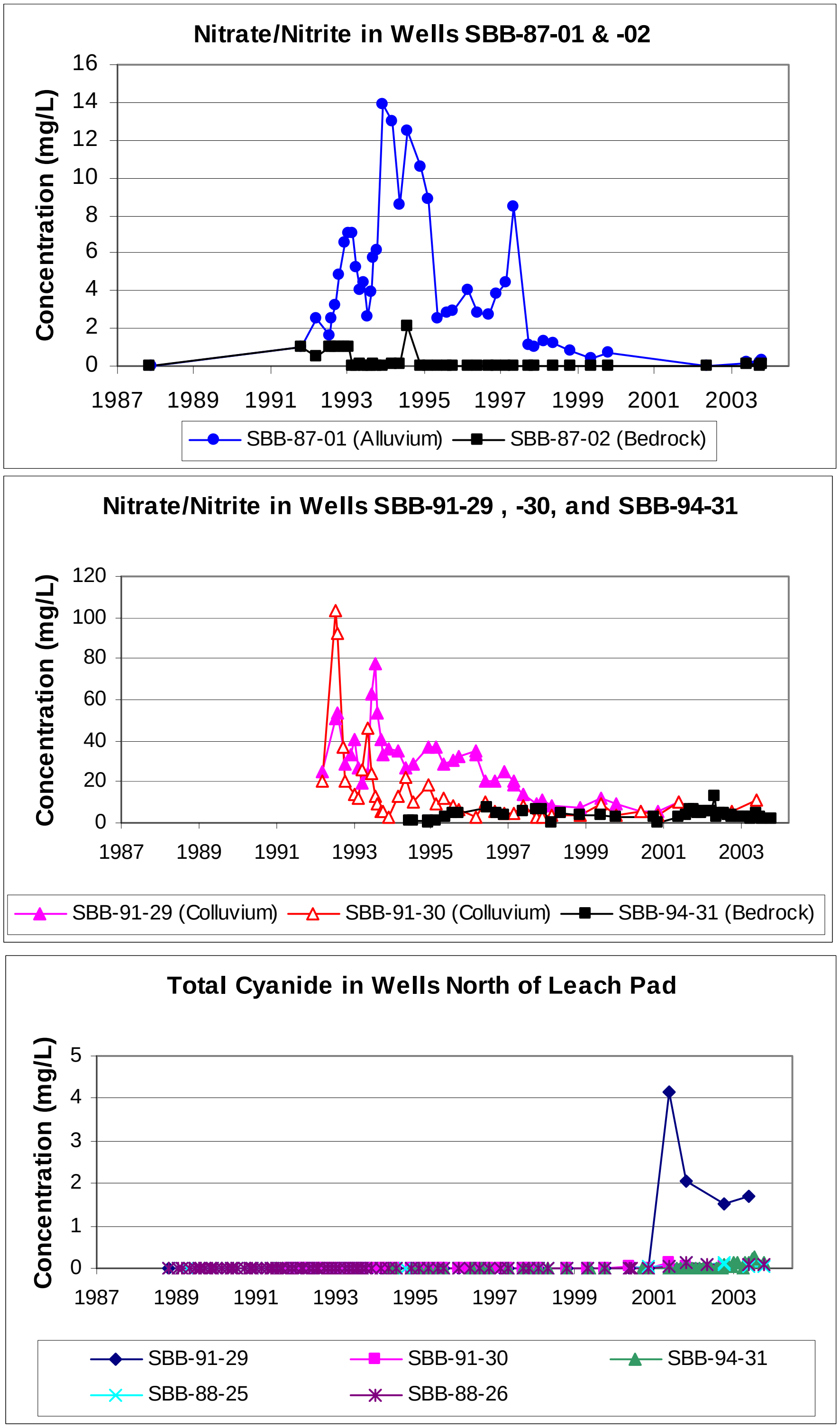
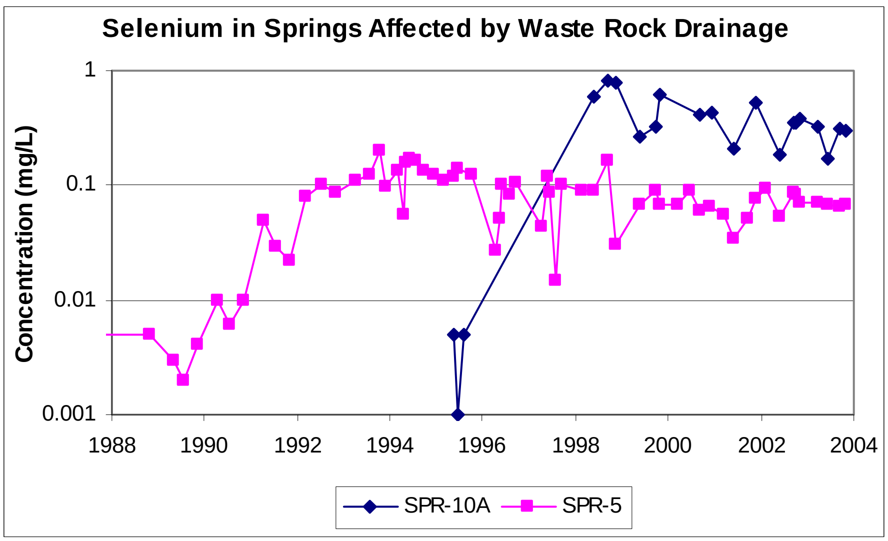


Figure 21. Nitrate and Cyanide Trends in Select Monitoring Wells (milligrams per liter)

3.5.2.2 SPRINGS

Numerous springs have been identified and monitored since 1987. Most of these springs are located in the headwaters of German Gulch, Beefstraight, and Minnesota gulches (**Figures 6a and 6b**). Many of these springs occur at the contact between alluvium/colluvium and underlying bedrock. Joints or fractures in bedrock control the location of other springs.

Impacts to water quality have been noted in several springs. For example, springs SPR-5 and SPR-10A have been impacted by water in contact with the waste rock dump (**Figure 22**). Concentrations of selenium, sulfate, nitrate, and total dissolved solids are elevated in these springs. Springs located within and downhill of the land application area have also shown impacts from mine operations, with appreciable increases being measured in cyanide and selenium concentrations since land application began in 2001(**Figure 22)**.



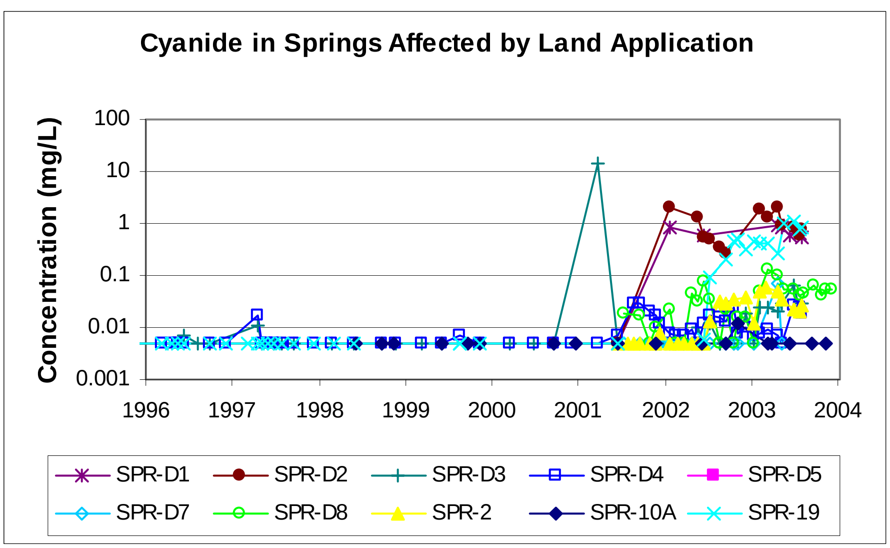


Figure 22. Springs Affected by Waste Rock Drainage and LAD Application (milligrams per liter)

Numerous springs were monitored in 2003. A summary of recent water quality data for monitored springs is presented in **Table 9**. Characteristics and water quality of recently monitored springs are summarized below. Spring locations are shown on **Figures 6a and 6b**. Bruce Parker (BMMI) provided some of the information presented in this discussion.

- **SPR-2**

This spring is located at the base of a landslide below and to the southeast of the ore processing plant. It was originally developed for watering cattle. Water is piped from where it seeps from colluvium, into a trough. Flows have ranged from 0.4 gpm to 12 gpm. Flow increased and water quality decreased in this spring in response to land application discharge on Beal's Hill. Most of the samples collected monthly from this spring between January and September 2003 exceeded acute aquatic life standards for cyanide (**Table 9**). Most of the samples also exceeded the chronic aquatic life standard for selenium and three of the monthly samples exceeded the acute standard. Sulfate concentrations were below 100 mg/L in many of the samples, but samples collected in March, July, and August 2003 exhibited sulfate concentrations of 267, 410, and 469 mg/L respectively. Nitrate concentrations were below 2.1 mg/L.

- **SPR-3**

This spring is located in German Gulch about 800 feet downstream from the Beal Mountain pit. Flows in SPR-3 have ranged from no flow to 200 gpm but typical flows ranges from one gpm to 40 gpm. Flow increases significantly during spring runoff and following precipitation events. Historic water quality data indicate that this water from this spring has contained elevated arsenic concentrations (up to 0.978 mg/L). This spring was sampled in March and June 2003 and contained concentrations that exceeded the chronic aquatic life standards for selenium and the acute and/or chronic standards for cyanide.

- **SPR-5**

Spring SPR-5 occurs at the waste rock dump toe where it joins with water piped from SPR-10A and water collected in the toe drain. This water is collected in a pipe and is pumped to the process water pond near the plant site. Flow measured at SPR-5 has ranged from no flow to 450 gpm (**Figure 23**).

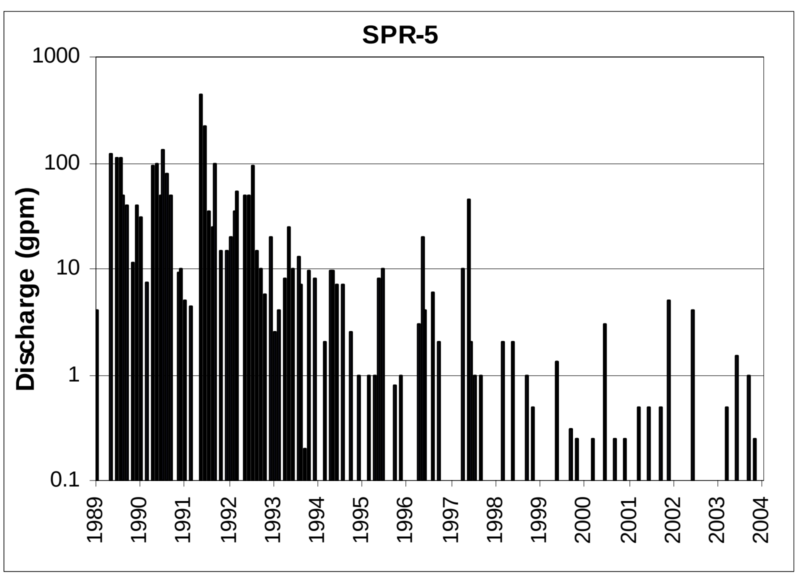


Figure 23. Discharge at Spring SPR-5 (gallons per minute)

Samples collected from this spring in 2003 exceeded the acute aquatic life standard for selenium (**Figure 22**) on each of the four sampling events conducted. Selenium concentrations increased substantially in SPR-5 between 1989 and 1993, but have declined to a consistent level of about 0.07 mg/L.

❖ **SPR-10A**

SPR-10A is a seep that was buried in 1997 under waste at the top of the waste rock pile. Water from this spring is brought from under the waste rock dump and around the dump's southern edge in a pipeline that is sampled in a drop box at the waste rock dump toe adjacent. Before the first lift of waste rock was placed over the spring, about five feet of material from the Beal Shear Zone was placed first as a low permeability undercoat. This Beal Shear Zone material is now known to contain relatively high concentrations of selenium.

Water from SPR-10A is collected in a pipe and pumped along with water collected in the toe drain and water from spring SPR-5 (located 200 feet downhill) and stored in the process water pond near the plant site. Flows measured in this seep typically ranged from one to 30 gpm. Samples were collected from this spring on four occasions during 2003 (March, June, September, and November), with laboratory results showing exceedances of acute aquatic life standards for selenium for each event (**Table 9**). Selenium concentrations in SPR-10A increased substantially after the spring was covered with Beal Shear material (**Figure 22**). Since that time, selenium concentrations in SPR-10A have been higher than those detected in water from SPR-5 or in water from the waste rock toe drain. This is an indication that the Beal Shear material used to cover the spring is a source of selenium. Sulfate concentrations in samples from this spring are typically greater than 400 mg/L. Nitrate concentrations in SPR-10A samples were all above 2.0 mg/L (**Table 9**).

❖ **SPR-18**

SPR-18 is located northwest of the ore processing plant and was originally developed for watering cattle. Water is piped from where it seeps from the ground into a trough. Flows in this seep are typically less than 1.0 gpm. Although this spring is located within the land application area, flow does not vary much in response to land application rates. Cyanide was detected above the acute or chronic level in all four samples collected from this spring in 2003.

❖ **SPR-19**

Spring 19 is located about 1,000 feet west of the leach pad in the Minnesota Gulch drainage and was originally developed for cattle watering. This spring was sampled monthly through August in 2003 to monitor changes in water quality resulting from discharge of water from the biotreatment facility to LAD Area C (**Figure 3**). Flow at SPR-19 has ranged from no flow to 20 gpm. In the eight 2003 samples collected from this spring, cyanide concentrations exceeded the acute aquatic life standard, and selenium concentrations exceeded either the chronic or acute aquatic life standards (**Table 9**). Two samples from SPR-19 contained sulfate concentrations greater than 500 mg/L, and two samples contained nitrate concentrations greater than 5.0 mg/L (**Table 9**).

❖ **SPR-D1**

SPR-D1 is located in the headwaters of American Gulch. The spring flows from the surface and runs downhill about 300 feet and then infiltrates into colluvium. Observed flow in this spring (SPR-D1) has ranged from no flow to six gpm in the spring, and it often does not flow during winter months. Flow in the spring increases during periods of land application. Water quality in the spring is also affected by land application; concentrations of sulfate, selenium, and cyanide have been markedly higher in samples collected from this spring after initiation of land application than those collected before land application. All five samples collected from the spring in 2003 exceeded acute or chronic aquatic life standards for selenium and cyanide (**Table 9**).

- **SPR-D2**

SPR-D2 is located in a swale about 600 feet uphill from SPR-D1 on the northeast slope of Beal's Hill within the land application area. Flow and water quality in this spring responds rapidly to land application discharge. Observed flow has ranged from no flow to five gpm. The seven samples collected from SPR-D2 in 2003 all contained selenium and cyanide concentrations exceeding the acute or chronic aquatic life standards (**Table 9**). During periods of land application, water from this spring contains relatively high concentrations of total dissolved solids (TDS), sulfate, and iron.

- **SPR-D3**

SPR-D3 is a very small seep north of the leach pad on the Minnesota Gulch side of the ridge. Observed flows have ranged from no flow to three gpm but have been less than 0.5 gpm since 2000. When flowing, water from this seep runs approximately 15 feet before infiltrating into the ground. Except for the sample collected in January 2003, the remaining seven monthly samples collected in 2003 exceeded the acute or chronic aquatic life standard for cyanide (**Table 9**).

- **SPR-D4**

SPR-D4 is an approximate 40,000 square-foot wetland located north of the leach pad on a bench in Minnesota Gulch. The wetland appears to be a discharge point for water from land application and is also recharged by snowmelt. The wetland is drained by a depression that appears to lead down the ridge toward spring SPR-D8. Snow drifts as much as 40 feet deep often accumulate in the area surrounding the wetland during winter months. Observed flows have ranged from 0.1 to 20 gpm but are typically less than two gpm. Of the eight samples collected from this site between January and August 2003, all but one contained cyanide concentrations exceeding acute or chronic aquatic life standards.

- **SPR-D5**

SPR-D5 is located in German Gulch, south of Beal's Hill about 250 feet in elevation above the creek. Observed flows have ranged from 0.5 gpm to three gpm. Flow and water quality in this spring vary slightly in response to land application. The spring was sampled monthly from March through December 2003. Concentrations of cyanide in these samples exceeded the chronic aquatic life standard of 0.005 mg/L from July through December (**Table 9**).

- **SPR-D7**

SPR-D7 is a small seep located in an aspen grove in a road cut about 200 feet above German Gulch. Observed flows have ranged from 0.5 gpm to 3.0 gpm. Flows do not appear to increase much during spring runoff. It was sampled in January, April, and May 2003. One of these three samples exceeded the acute chronic life standard for cyanide (**Table 9)**. Other parameters do not indicate impacts from land application or mining activities.

❖ SPR-D8

SPR-D8 is located in Minnesota Gulch below the land application area. Flow in SPR-D8 increases appreciably during spring runoff and during periods of land application discharge. Observed flows have ranged from no flow to 50 gpm. Four of twelve monthly samples collected from SPR-D8 in 2003 exceeded the acute aquatic life standard for cyanide (**Table 9**). The March and April 2003 samples were equal to the chronic aquatic life standard for selenium.

3.6 AQUATICS AND FISHERIES

Water quality and aquatic resource investigations have been used to evaluate conditions of aquatic resources in the vicinity of the Beal Mountain Mine. Investigations include those that evaluate selenium and cyanide in fish, habitat quality, macroinvertebrates and periphyton health, and the potential risk to these resources from elevated contaminant concentrations in streams.

Streams in the watershed where fish and aquatic resources data have been collected include German Gulch, Beefstraight Creek, Minnesota Gulch, and Greenland Gulch (**Figure 6a**). Greenland Gulch was used as a "control" for aquatic bio-monitoring. These streams support populations of native westslope cutthroat trout (*Onchorhyncus clarki lewisi*), a species recognized as "sensitive" by the USDA-FS, and non-native eastern brook trout (*Salvelinas fontinalis*) (La Marr, 2002).

3.6.1 Selenium and Copper

As discussed previously, water quality data have been collected from the late 1980s through 2003 at numerous sampling locations in German Gulch. Prior to mine development, selenium concentrations throughout the stream were considered low with respect to Montana water-quality standards, with readings from non-detect to 0.004 mg/L (La Marr, 2003). Montana's chronic aquatic life standard for selenium is 0.005 mg/L (MDEQ, 2002). Selenium concentrations in German Gulch increased during mining, primarily in springs SPR-10A and SPR-5 that are influenced by the waste rock dump, with concentrations consistently above the acute standard (0.02 mg/L) since 1990 in SPR-5 and since 1998 in SPR-10A. Instream selenium concentrations have been decreasing since 1997 in both springs (**Figure 22**) but not to a level that is below the acute standard.

During summer 2001, fish and aquatic macroinvertebrate tissues from the German Gulch sub-watershed were collected and analyzed for selenium and copper concentrations (La Marr, 2002). Whole-body fish tissue samples of westslope cutthroat trout and brook trout were collected from Minnesota Gulch (DNMINN), Beefstraight Creek (BS-D), and middle German Gulch (STA-2) (**Table 10).**

TABLE 10
SELENIUM AND COPPER CONCENTRATIONS IN WHOLE-BODY FISH TISSUE [1]

Stream	Mean Selenium Concentration[2] +/- 95% Confidence Interval	Mean Copper Concentration[2] +/- 95% Confidence Interval
Minnesota Gulch	2.51+/- 0.43	7.98 +/- 13.42
Beefstraight Creek	3.53 +/- 0.40	10.50 +/- 4.75
Middle German Gulch	10.76 +/- 0.68	2.79 +/- 0.71

1. Table after La Marr (2002).
2. Concentrations are in µg/g on a dry weight basis

As summarized by La Marr (2002), selenium concentrations were found to be statistically higher in fish whole-body tissues from middle German Gulch than in fish collected from Minnesota Gulch and Beefstraight Creek. Statistical differences could not be calculated for copper concentrations due to sample variances.

Caddisfly, mayfly and stonefly macroinvertebrates were sampled from Beefstraight Creek (BS-D), upper German Gulch (STA-3A), and middle German Gulch (STA-2) and analyzed for selenium and copper (**Tables 11 and 12**).

TABLE 11
SELENIUM CONCENTRATION IN MACROINVERTEBRATES [1]

Sampling Site	Caddisfly	Mayfly	Stonefly	Mean Total	Standard Deviation
Beefstraight Creek	3.79[2]	12.2	5.2	7.06	4.5
Upper German Gulch	7.2	7.7	5.1	6.67	1.38
Middle German Gulch	12.4	18	11.3	13.9	3.59

1. Table after La Marr (2002).
2. Concentrations are in µg/g on a dry weight basis

TABLE 12
COPPER CONCENTRATION IN MACROINVERTEBRATES [1]

Sampling Site	Caddisfly	Mayfly	Stonefly	Mean Total	Standard Deviation
Beefstraight Creek	17.3[2]	19.6	37.8	24.9	11.2
Upper German Gulch	25.6	79.2	81.2	62	31.5
Middle German Gulch	20.6	57.6	46.2	41.5	19

1. Table after La Marr (2002).
2. Concentrations are in µg/g on a dry weight basis

Mean dry weight selenium concentrations in middle German Gulch macroinvertebrates were above the range of suggested toxic effects thresholds to fish from dietary organisms of 3 to 11 micrograms per gram (µg/g) as summarized in various studies reported in La Marr (2002). These results suggest a potential pathway for bioaccumulation of selenium in the German Gulch sub-watershed. Selenium concentrations were elevated in fish whole-body tissues from middle German Gulch (STA-2), while levels were not elevated in Minnesota Gulch or Beefstraight Creek (La Marr, 2002). Copper concentrations were not elevated in macroinvertebrates or fish.

In 2002 and 2003, samples were collected and analyzed for selenium at five sample sites in the sub-watershed in fish tissue, fish eggs (two sites), and macroinvertebrates. Bedload sediment samples were collected in 2002 from four sample locations in the sub-watershed and analyzed for selenium concentrations. Selenium concentrations in the sampled media, including fish tissue and eggs, at each sample location were compared to established toxicity indices (Lemly, 2002) and rated as high, moderate, or low hazard to aquatic life (**Table 13**) (La Marr, 2003).

TABLE 13
SELENIUM IN WATER, SEDIMENT, MACROINVERTEBRATES, AND FISH EGGS [1]

Site	Water Column		Sediment		Aquatic Inverts		Fish Eggs	
	Measured Ranges of Selenium Concentrations and Hazard Ratings by Component							
	Measured in (µg/l)	**Hazard Rating**	**Measured in (µg/g)[2]**	**Hazard Rating**	**Measured in (µg/g)[2]**	**Hazard Rating**	**Measured in (µg/g)[2]**	**Hazard Rating**
(STA-1)	1-6	High	<1	None	6.4-11.6	High	16.8-28.1	High
(STA-2)	5-8	High	4.0-5.1	High	8.7-14.2	High	17.2-25.1	High
(STA-3A)	1-19	High	2.0-4.5	High	5.1-7.7	High	3.0-14.1[3]	Moderate
(BS-D)	0-2	Minimal	1.3-1.4	Minimal	3.5-7.5	High	5.2-7.8[3]	Low
(DNMINN)	0-5	High	No Data	None	1.4-2.1	Minimal	4.7-8.4	Low

1 Table after La Marr (2002).
2 Concentrations are in µg/g on a dry weight basis
3 Values are extrapolated from fish whole-body data

In 2003, bedload sediment samples were collected from nine locations including STA-2, STA-3A, and BS-D, which were sampled previously in 2002, and STA-1A located approximately 600 feet upstream from STA-1 on German Gulch and between the confluences with Beefstraight and Norton Creeks (**Figure 6a)**. Sediment samples were also collected from five new locations, designated with the letter "N", located upstream from STA-3A on the main channel (STA-1N and STA-5N) and on inflows (STA-2N, STA-3N, and STA-4N) in the headwaters of German Gulch (**Figure 6a)**. Locations of the new stations were logged with GPS and are on file with Maxim and the USDA-FS.

Bedload sediment selenium concentrations measured in 2003 at STA-2, 3A, and BS-D were similar to concentrations measured in 2002 (**Table 14**).

TABLE14
GERMAN GULCH BEDLOAD SEDIMENT SELENIUM CONCENTRATIONS

Station	Selenium Concentration (micrograms/gram)	
	October 2002[1]	**Sept. 2003[2]**
STA-1A	<1	< 1
STA-2	4.0-5.1	5
STA-3A	2.0-4.5	3
BS-D	1.3-1.4	< 1
STA-1N	--	3
STA-2N	--	2
STA-3N	--	2
STA-4N	--	2
STA-5N	--	5

1 Data collected by La Marr (2002).
2 Data collected by Maxim; concentrations in µg/g on a dry weight basis

Selenium was below detection at STA-1A. Selenium concentrations in sediment collected from the new stations were greatest at STA-1N (3 μg/g) and STA-5N (5 μg/g) located upstream from STA-3A on German Gulch. Sediment from stations STA-2N, 3N, and 4N, located on inflows at the head of German Gulch, all had selenium concentrations of 2 μg/g. Therefore it appears that selenium in stream sediments appears to be most concentrated (3-5 μg/g) from stations on the main stem of German Gulch between stations STA-5N and STA-2.

3.6.2 Cyanide

Several studies were conducted in the German Gulch subwatershed in 2003 to quantify the effects of cyanide concentrations in surface water draining the mine and LAD areas and are reported in a briefing paper by Don Skaar (2004). These studies included in-site bioassays, collecting blood samples from brook trout, collecting liver and fish tissue samples, and collecting eggs from brook trout.

Results of the bioassay study showed 100% survival of hatchery westslope cutthroat trout placed in cages in Beefstraight Creek and Norton Gulch for 10 days. Cyanide concentrations in surface water during this period ranged from less than the detection limit to 0.017 mg/L. The chronic and acute aquatic life standards for cyanide are 0.005 and 0.022 mg/L, respectively.

Plasma extracted from blood collected from brook trout in German Gulch and Beefstraight Creek showed the highest thiocyanate levels in fish from Beefstraight Creek. Fish from the control stream, Divide Creek, had the next highest levels of thiocyanate followed by fish collected from German Gulch. The difference in thiocyanate plasma concentrations between the three streams was not significant. These same results were mirrored by the hepatosomatic index values calculated for brook trout collected during the same period. Mean total cyanide concentrations in Beefstraight Creek during the collection period were almost twice as high as in German Gulch.

The egg collection study indicated that German Gulch fish had the greatest number and the largest size of eggs, followed by Beefstraight Creek and then by Divide Creek. These differences were not significant but were consistent with findings in other studies that showed reduced fecundity following prolonged cyanide exposure (Skaar, 2004).

3.6.3 Habitat Quality

Habitat data have been collected at two locations on German Gulch (upper, lower) and one location on Greenland Gulch, a tributary to German Gulch south and east of the permit area (**Figure 6a**). The 1999 aquatic monitoring report (McGuire and Weber, 2000) described both physical and biotic habitat conditions encountered during monitoring in 1999, and compared those data with data collected in 1996 and 1997.

3.6.3.1 PHYSICAL HABITAT

A wide variety of physical habitat parameters were evaluated at the sites studied by McGuire and Weber (2000). Physical habitat condition for the upper German Gulch location was considered "sub-optimal" during all three sample years for most habitat parameters. Habitat degradation in this area was primarily attributed to historic placer mine dredging. Habitat in middle German Gulch was rated optimal in 1996 and 1997, and sub-optimal in 1999. The decline in habitat condition was attributed to reduced vigor in riparian vegetation and an increase in bank erosion and sediment deposition due to use of the riparian area by cattle during summer 1999. Greenland Gulch habitat condition was generally optimal during all three years based on the parameters evaluated.

3.6.3.2 BIOTIC HABITAT

Periphyton are a useful measure of baseline water quality and as biomonitors of changing conditions because they typically occur in large numbers, are highly sensitive to physical and chemical factors, and have known environmental requirements and pollution tolerances (Bahls, 1979, cited in McGuire and Weber, 2000). Aquatic macroinvertebrates are good indicators of local environmental conditions because of their relative immobility, predictable associations with specific habitats, and differential tolerances to pollution (McGuire and Weber, 2000). Sampling of periphyton and aquatic macroinvertebrates occurred during 1999 at the three sample locations described above.

Results of the periphyton investigation indicated the biotic integrity in the upper and middle reaches of German Gulch during 1999 was generally rated as good, with minor impairment of aquatic life. The authors suggest that the 1999 results may indicate a "reversal of a downward trend since 1996" in these stream reaches. Biotic integrity in lower Greenland Gulch during 1999 was also rated as good, with only minor impairment to aquatic life due to an elevated siltation index value. The authors conclude that although siltation index values suggest minor to moderate impairment, other biotic data (algae metrics) indicate relatively unimpaired biota existing in these streams (McGuire and Weber, 2000).

Aquatic macroinvertebrate data from 1999 indicate generally good biotic conditions in all three sample reaches. The upper German Gulch sample site was classified as moderately impaired during the summer but improved to non-impaired during the fall. Both middle German Gulch and Greenland Gulch were classified as non-impaired during both sample events (McGuire and Weber, 2000). Biointegrity scores relative to macroinvertebrates were slightly lower in 1999 than in 1997 for all sample sites, the likely reason being environmental stress related to drought and low streamflow (McGuire and Weber, 2000).

3.6.4 Summary

Historic placer mine dredging activities as well as current livestock use have influenced physical habitat conditions in the German Gulch watershed. Biotic conditions, including benthic macroinvertebrate communities and fish, are exposed to elevated levels of selenium in the water column as well as bed load sediment. This exposure is primarily occurring in the upper and middle reaches of German Gulch (STA-3A, STA-2). The result of this exposure is elevated selenium in both macroinvertebrates and fish, which may result in impacts to fish populations.

4.0 EXISTING CONDITION OF MINE FACILITIES

This section presents a discussion of each of the six mine facility areas, which are:

1. Beal Mountain Pit
2. South Beal Pit
3. Waste Rock Dump
4. Heap Leach Facility
5. Land Application Disposal Areas
6. Other Facilities (including maintenance area, roads, ponds, water treatment plant, and stormwater system)

The discussion for each facility presents a description, summarizes the reclamation status of the facility, and presents the available data pertinent to the issues that were identified in the previous section on Existing Environment.

4.1 BEAL MOUNTAIN PIT

The Beal Mountain pit was originally permitted in July of 1988 and was developed in an amphitheater-like configuration with an open end to the east that allowed the pit to be free draining toward German Gulch. The original pit was mined to a depth of about 310 feet from the northwest highwall (elevation 7,240) to the lowest point near German Gulch (6,930 feet in elevation). Beal Mountain's mining permit was amended in 1993 to include the "Beal Extension" as part of the South Beal Amendment. The "Beal Extension" called for deepening the south central portion of the Beal Mountain pit an additional 190 feet below the level of German Gulch. Overall pit dimensions at the conclusion of mining were approximately 1,300 feet in a north-south direction and 1,600 feet in an east-west direction with a total depth of about 500 feet. Bench heights of 20 feet were used during mining with 30-foot wide safety benches constructed every 60 vertical feet. Overall slope angles are approximately 45 degrees. Mining in the Beal Mountain pit ended in February 1997.

4.1.1 <u>Pit Water Drainage and Pit Reclamation</u>

The Beal Mountain pit was reclaimed by partial backfilling and construction of an underdrain system (**Figure 24**). The deep central portion of the pit called the "Beal Extension" was backfilled to the elevation of German Gulch. Backfill material consisted of mined waste from the South Beal deposit. The final reclamation configuration of the partially backfilled pit surface was graded to slope from west (6,940 feet in elevation) to east toward German Gulch (6,920 feet in elevation) for drainage of both surface and groundwater. A buttress of mine waste was also placed along the north highwall of the pit (**Figure 24)**. In addition, to partially buttressing the slide this waste was used to cover sulfide exposed in the pit highwall.

An underdrain system was constructed about five to seven feet below the final reclaimed pit surface. This underdrain system consists of a dendritic arrangement of very coarse rock filled channels constructed about 12 to 15 feet wide, and about two to three feet in depth that were covered with a filter fabric material. An underdrain system was also constructed around the entire perimeter of the pit that tied into the limbs of the dendritic portion of the drain and the lower outfall from the pit. The channels were laid out to collect water throughout the pit floor and deliver it to the east end of the pit, toward German Gulch. A three-foot layer of compacted South Beal pit waste was placed across the pit floor and also covered the constructed rock drain channels. This compacted waste layer in turn was covered with 14 to 20 inches of cover soil and revegetated (**Figure 24**). A surface drainage channel system was established with coarse rock filled channels of wollastonite-pyroxene skarn material from South Beal arranged such that surface water was also diverted toward German Gulch. Both the underdrain system (MBDRAIN on **Figure 6b**) and the surface water system draining the pit area have discharged directly into German Gulch since January of 2004. Prior to that time, all of the surface water and underdrain groundwater from the pit drains was captured and pumped to the holding pond by the processing plant and land applied. Flow from the pit is estimated to average about 30 gpm at low flow conditions to as much as 100 to 150 gpm at high flow.

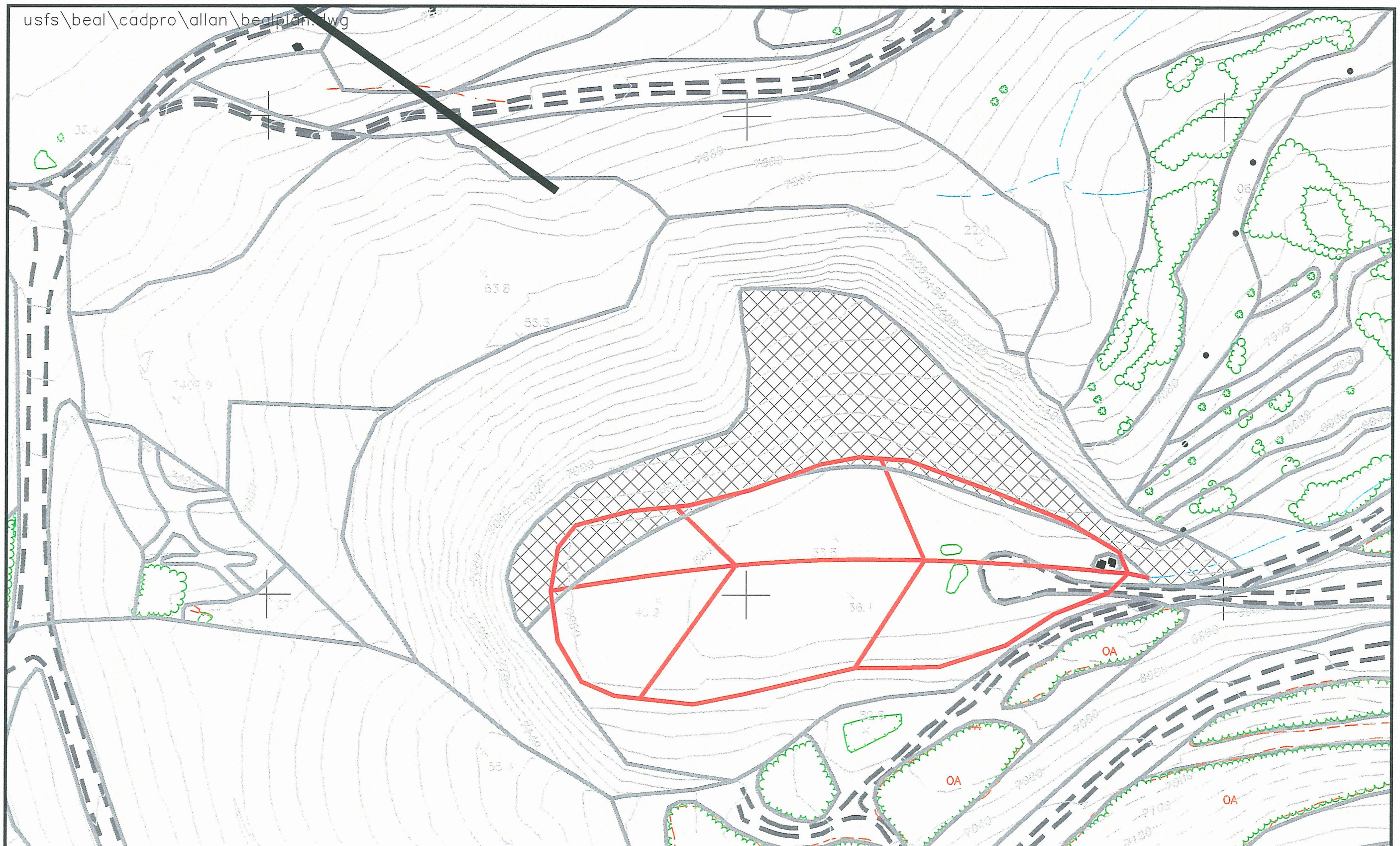
4.1.2 Pit Wall Stability

During the course of mining, several slope stability problems were identified in the Beal Mountain pit. There are currently two active slides, the west wall slide and the clay/sill slide (**Figure 25**). These slides are wedge-shaped blocks of metasediments that move along clay layers which dip at a low angle (approximately 20°) to the northeast (Sitka, 1996). The orientations of the clay layers are apparently not parallel to, but occur at a low angle to metasediments bedding planes and are likely thrust fault planes parallel to the regional thrusts. Near vertical northwest trending joints and shears border the blocks along their northeast and southwest boundaries.

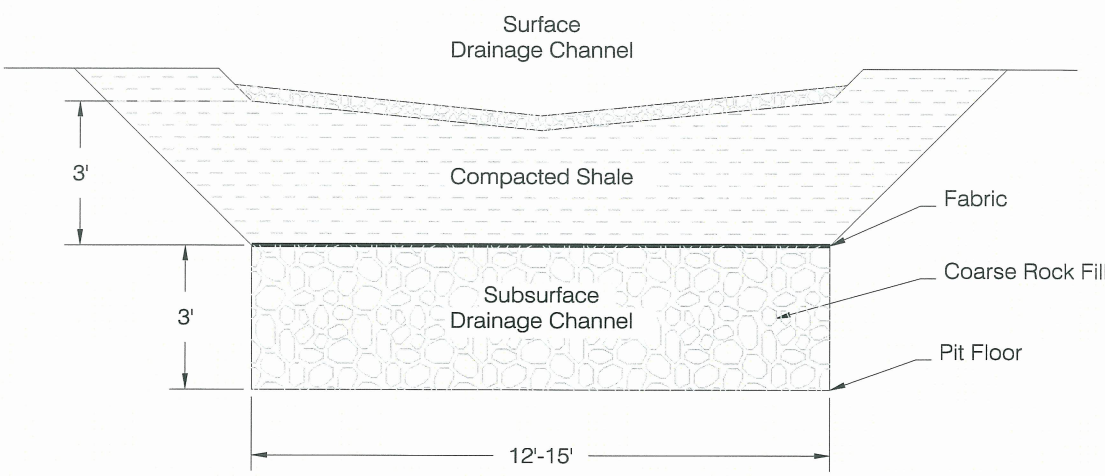
The west wall slide (**Figure 25**) has moved across and into the Beal Mountain pit in an eastward direction at high rates of speed and covered large distances. During the years when the main Beal Pit was actively being mined, movement of this slide was reported in the range of 10 to as much as 100 feet per year. A large portion of this movement resulted from undercutting the toe of the slide during Beal Mountain pit mining operations. The toe of the slide is exposed in the north pit wall. Numerous surface cracks occur on a flat bench in the central portion of the slide area, and a fault-scarp with two to four feet of displacement has developed in response to movement along the westernmost portion of the south flank of the slide. A spring at the toe of this slide was producing approximately 0.5 gpm in September 2003. Efforts to mitigate the slide's movement were implemented during mining operations by changes in the pit development plan that left ore reserves in the northwest corner of the pit to buttress the slide and over time curtail its movement. Current rates of movement are discussed in the following section on pit wall stability monitoring (Section 4.1.3).

The clay/sill slide is a relatively small slide located immediately south of the southern corner of the heap leach pad (**Figure 25**) and to the immediate north of the west wall slide. The slide moves along a clay layer that is oriented similar to the west wall slide (dips 20 degrees to the northeast) and the clay layers may represent weathering along small thrusts that are parallel to the main regional thrust faults. The vertical Gully Fault bounds the slide to the northeast and apparently cuts off the clay layers to the northeast of the fault towards the heap leach pad and dike. Some of the movement on the clay/sill slide is directly related to movement of the west wall slide, which through its eastward movement leaves the southern edge of the clay/sill slide unsupported and allowed it to move to the south and east toward the pit (**Figure 25**). During the period of active mining, movement of this slide propagated slump-like features and cracks or fractures upward into the unconsolidated fill of the southern corner of the heap leach pad. These features led to geotechnical stability studies of the leach pad dike in the southern corner of the pad (Section 4.1.3).

There were several responses implemented to mitigate the clay/sill slide's movement during mining and closure activities. These included, the construction of surface water diversion ditches; unloading of material above the slide; excavation of a an are to the southwest of the southern corner of the leach pad embankment and the installation of a rock buttress; and the installation of dewatering wells (1995 and later) to reduce pore pressure on the slide plane. A large volume of material was excavated and a



Note: Underdrain system shown is conceptual, not actual.



DRAIN CROSS-SECTION

Topography from Horizons Aerial Photogrammetry, September 2003

N

Not To Scale

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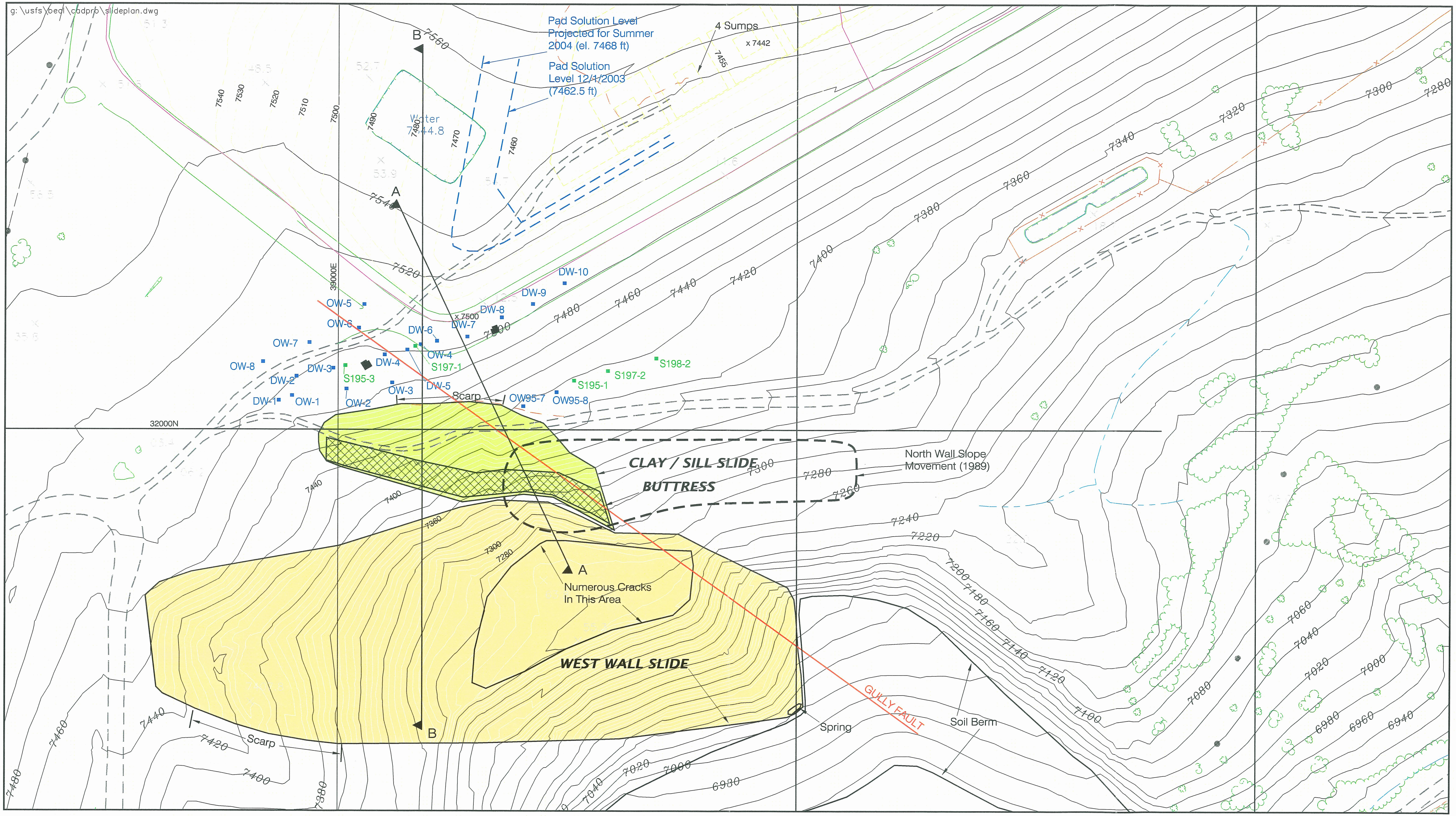
Area Containing South Beal Waste Backfill

Underdrain

Schematic of Beal Mountain Pit Underdrain System
Beal Mountain Mine
Silver Bow County, Montana
FIGURE 24



0 Feet 200

N

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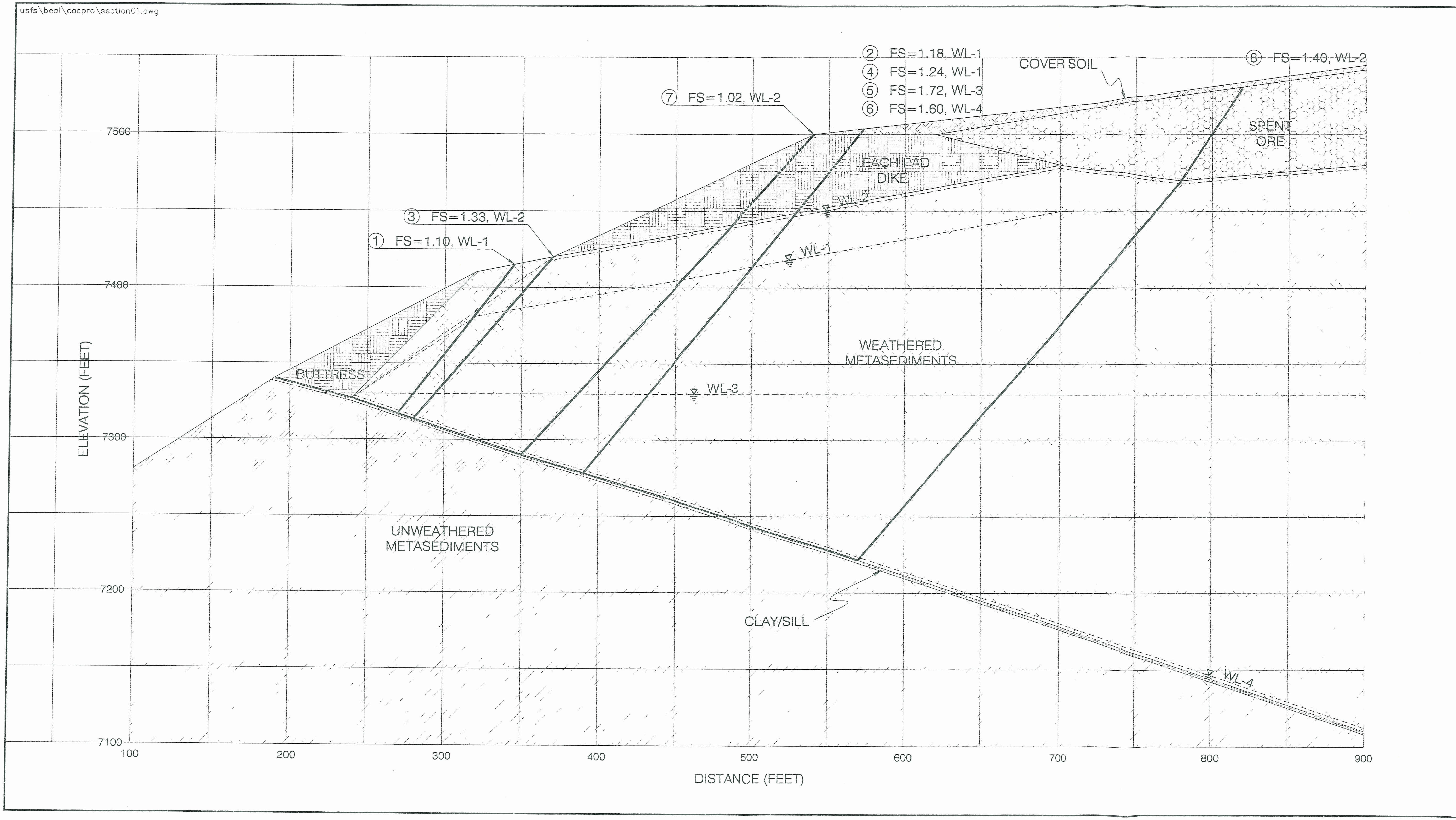
OW-7 ▪ Dewatering or Obserbvation Well
S195-3 ▪ Geotechnical Monitoring Well
- - - - Leach Pad Base Contour

Main Beal Pit Slides
Beal Mountain Mine
Silver Bow County, Montana
FIGURE 25



Failure surface generated by STABL computer program

② Analysis number

WL-1 Water level 30 feet below the top of weathered metasediments

WL-2 Water level at top of weathered metasediments

WL-3 Water level on 12/15/2003

WL-4 No water table in weathered metasediments

Note: Analyses 1 and 2 are pre buttress. Analyses 3 through 8 are post buttress.

0 Feet 60

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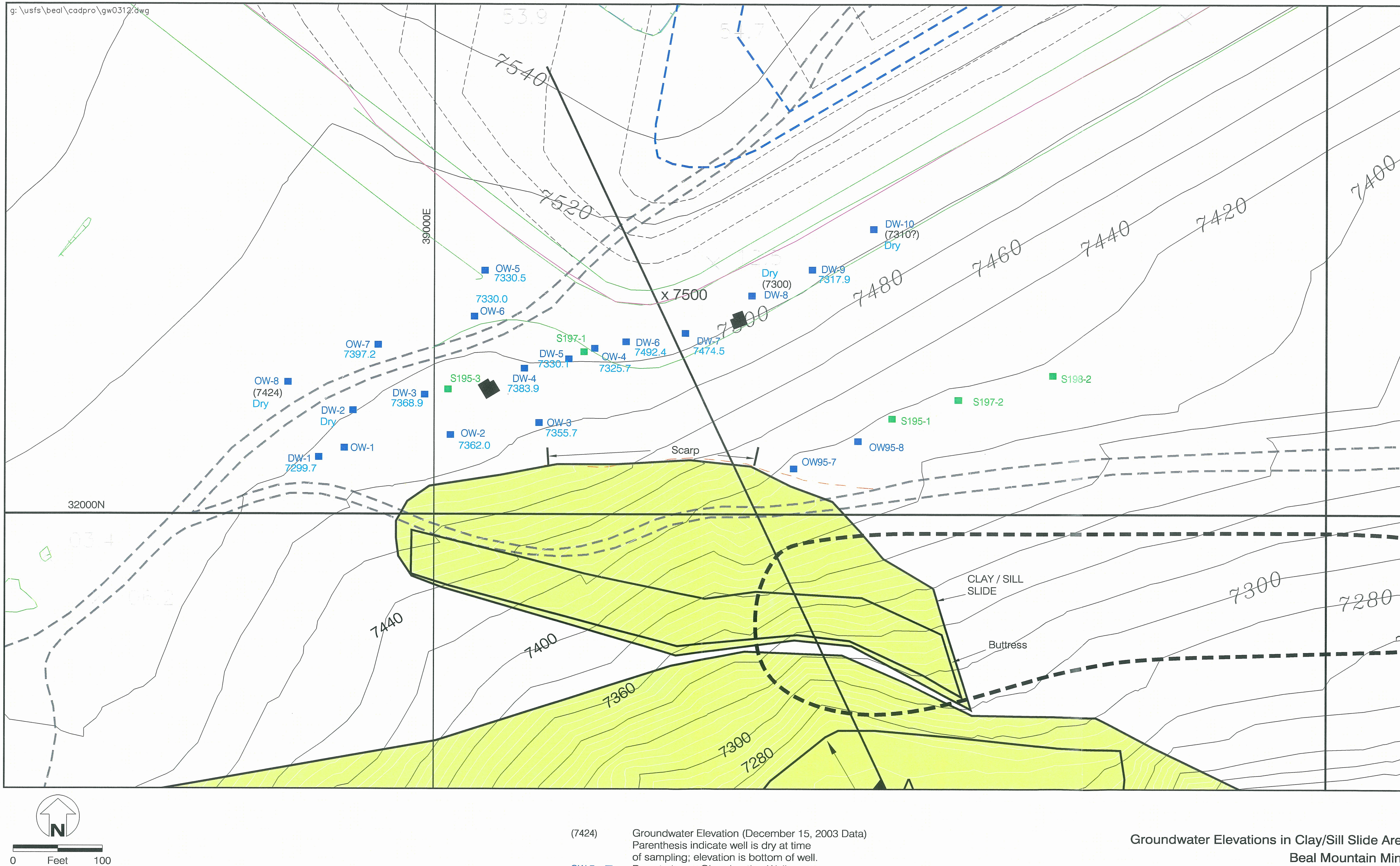
Section A
Beal Mountain Mine
Silver Bow County, Montana
FIGURE 26



(7424) Groundwater Elevation (December 15, 2003 Data)
Parenthesis indicate well is dry at time of sampling; elevation is bottom of well.

OW-7 ■ Dewatering or Obserbvation Well

S195-3 ■ Geotechnical Monitoring Well

- - - - - Leach Pad Base Contour

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Groundwater Elevations in Clay/Sill Slide Area
Beal Mountain Mine
Silver Bow County, Montana
FIGURE 27

buttress comprised of coarse rock with an underdrain system was constructed in 1997 to control movement of material along the clay/sill slip plane that was prone to moving downhill to the south and east and into the pit (**Figures 26 and 27**).

Dewatering wells (**Figure 27**) were in operation from 1995 through July 2003, when dewatering was discontinued. Currently, the clay/sill slide is being monitored for possible recurrent movement. The most obvious signs of slope movement on the clay/sill slide are presumed to be several years old and not an indication of recent movement. These include, three small slump blocks located near well OW-95-7 and a scarp that has developed from this point upslope in a northwest direction (**Figure 27**). In addition, there may be another crack on the slope of the constructed buttress that supports the leach pad embankment, but these features could not be observed directly as this area was too steep for safe access. Evidence of widespread cracking similar to the west wall slide is not apparent. A pit slope stability model was completed by Maxim in September/October 2003 with the specific intent of examining potential risks to the leach pad dike (**Appendix B**). Results of this modeling are presented in greater detail in the discussion of the heap leach facility and the leach pad dike (Section 4.4.3).

4.1.2.1 PIT WALL STABILITY MONITORING

Active monitoring of the west wall and clay/sill slides was discontinued in early 2000. Currently, there is no instrumentation in place to monitor the west-wall slide; ground movement is estimated to be in the range of 10 to as much as 20 feet per year. Based on analysis of projected slide configurations following displacement of 50, 100, and 200 feet, it is projected that the west wall slide may move about another 200 feet before movement ceases (Sitka, 1997a).

Late in 2003, BMMI installed three survey prisms in the clay/sill slide area to monitor ground movement. In addition to the prisms, there are several pre-existing inclinometers (SI 95-1, SI 95-3, SI 97-1, SI 97-2, SI 98-2; **Figure 6b**) located in the vicinity of slide. Inclinometers SI 93-3, SI 97-1 and SI 97-2 are periodically monitored. There are currently no indications that the clay/sill slide is actively moving, however.

4.1.2.2 DEWATERING SYSTEM

Figure 27 shows the location of existing dewatering wells installed for controlling movement of the clay/sill slide. The first dewatering wells were installed in 1995 and a couple of additional wells were installed in subsequent years to expand the volume of material dewatered. The dewatering system included submersible pumps, pump controllers, and portable power transformers. Discharge water from the dewatering well system was routed via pipelines and discharged. Dewatering of the slide was discontinued in July 2003; water levels have been monitored on a regular basis since then.

4.1.3 Beal Mountain Pit Geochemistry

As discussed previously, mineralogy, and thus geochemistry, varies somewhat across the mined deposit. Rock mined from a particular area may have been placed as waste rock on the dump, as fill for construction, or as post-mine backfill. To characterize existing conditions at the mine, geochemical data are presented in this report by mine facility. Materials are described for the facility in which they were located at the time of analysis; for example, rock mined from Beal Mountain pit and placed in the waste rock dump is characterized in this section of the report. Analyses of waste rock collected from the dump in more recent studies are described in the waste rock dump section. Ore and waste rock have been described independently for each mine facility, and a general summary of existing geochemical conditions is provided for each facility.

The primary ore bearing rocks in the Beal Mountain pit consist of meta-quartzite and meta-conglomerate, while waste is composed of meta-quartzite, and amphibole and biotite/k-feldspar hornfels. Ore was crushed and/or agglomerated and leached on the pad. Waste rock was first used to construct the containment dike for the leach pad and later to construct the haul roads. As is typical of oxidized sulfide-bearing deposits, oxidized rock was mined early in mine life, with less oxidized material (richer in reduced sulfide minerals) mined later from the deeper portions of the deposit. Much of the waste rock mined from the Beal Mountain pit was placed on the waste rock dump.

4.1.3.1 BEAL MOUNTAIN PIT ORE ACID ROCK DRAINAGE POTENTIAL

❖ **Static Testing**

The potential for ARD from mined rock can be conservatively assessed based on the ratio of neutralization potential to acidification potential (NP:AP ratio) determined during static testing. Samples having NP:AP ratio greater than 3 present little risk of acid generation while NP:AP ratio ratios less than 1 indicate that acid generation is probable. Acid generation potential is uncertain for samples with NP:AP ratio ratios between 1 and 3. This criterion is widely used and has been adopted as the BLM standard for assessment of ARD potential (BLM, 1996)

The potential for acid generation from non-mined ore remaining in the Beal Mountain pit was evaluated based on static test results for 66 samples of ore as reported by Gallagher (1994 and 1995) and Schafer and Associates (1994) (**Figure 28**). It is unclear whether these samples were representative of the range of ore lithology and sulfide content observed in the highwall, or were collected from the active mining level at the time of sampling. Thirty-five percent of the samples had NP:AP ratios less than 1 while 30 % were between 1 and 3. The remaining 35 % of main Beal Mountain ore samples had NP:AP ratios greater than 3. These results indicate that a significant percentage of ore exposed in the Beal Mountain pit floor and highwall areas presents a risk of acid generation with associated trace element release.

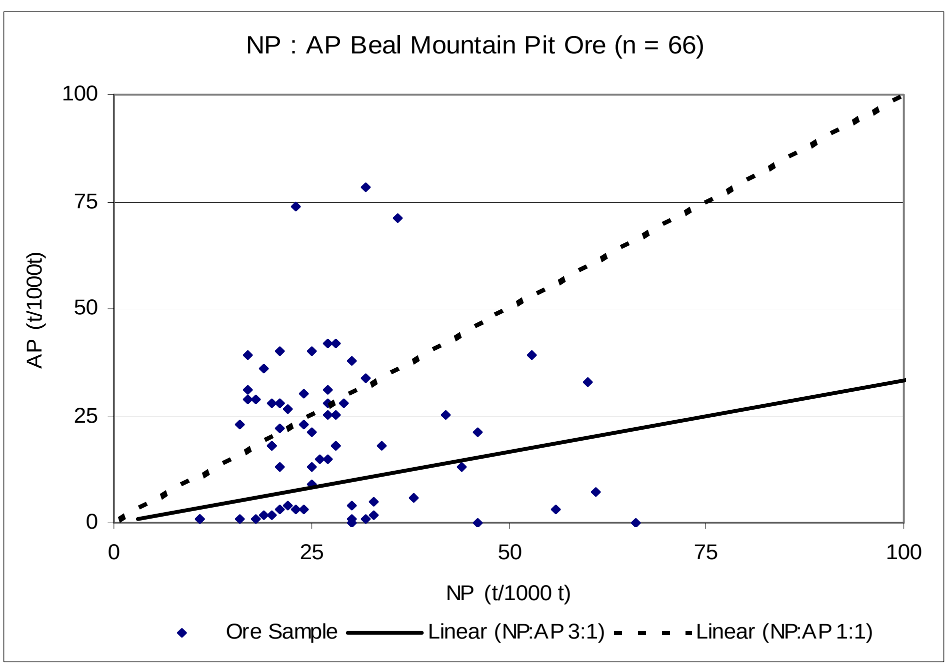


Figure 28. Beal Mountain Pit ore static test results (tons/1000 tons)

❖ **Kinetic Testing**

A 20-week modified humidity cell procedure was performed on an ore sample with an NP:AP ratio of 0.41 (Schafer and Associates, 1994). This sample-released sulfate at a rapid rate and produced leachate with pH values dropping from 6.0 to 4.0 su after 10 weeks of testing, thus indicating a high risk of acid generation. Unfortunately, this sample only serves to confirm the static test result, but does not resolve the uncertain potential of ore samples with NP:AP ratios between 1 and 3.

4.1.3.2 Beal Mountain Pit Ore Metal Mobility

❖ **Static Testing**

One sample of ore representative of that mined from the Beal Mountain pit and Beal Extension was analyzed using the Synthetic Precipitate Leaching Procedure (SPLP) (Schafer and Associates, 1994). The SPLP test is useful in identifying potentially mobile trace elements, but more recent convention suggests that it cannot be used to estimate concentrations released under field conditions.

Most constituents, including selenium, were present at levels below their respective detection limits. However, it should be noted that the detection limits (DL) used were above those required by MDEQ Circular WQB-7 standards and above or at the chronic aquatic life standard for aluminum (DL = 0.1 mg/L), lead (DL = 0.01 mg/L), mercury (DL = 0.001 mg/L), and selenium (DL = 0.005 mg/L). The detection limit for silver (0.005 mg/L) was greater than the acute aquatic life standard. Metals present in detectable concentrations were aluminum (0.3 mg/kg), barium (0.5 mg/kg), iron (0.43 mg/kg), and zinc (0.02 mg/kg).

❖ **Kinetic Testing**

The same ore sample subjected to SPLP testing was also tested in a humidity cell. Metal concentrations were measured to provide data for assessing metal mobility (Schafer and Associates, 1994). However, raw data from this test are not reported and the results of leachate analysis from this particular sample are not discussed in the original report.

4.1.3.3 Beal Mountain Pit Waste Rock Acid Generation Potential

❖ **Static Testing**

Static test results for waste rock from the Beal Mountain pit, including the subsequent extension of this pit, are reported by Gallagher (1994, 1995, and 1996), Schafer and Associates (1994 and 1995), and Pegasus Gold (1998). These data were used to evaluate the potential for acid generation from the Beal Mountain pit floor and highwalls based on NP:AP ratios as discussed above for ore. Raw data for approximately 40 samples used to compute the summary statistics reported in the Geochemical Assessment reports were not available and thus were not considered in the following evaluation. At the time of sampling, the samples collected were representative of the range of lithology and sulfide content observed in the highwall waste (B. Parker, personal communication, 2/9/04).

Of the 442 samples of Beal Mountain pit waste rock for which data are available (**Figure 29**), 30% had NP:AP ratio less than 1 while 33 % were between 1 and 3. The remaining 37 % of main Beal Mountain waste rock samples had NP:AP ratios greater than 3. These data show that a portion of waste rock exposed in the Beal Mountain pit floor and highwall areas, placed as fill, or located in the waste rock dump will present a risk of acid generation.

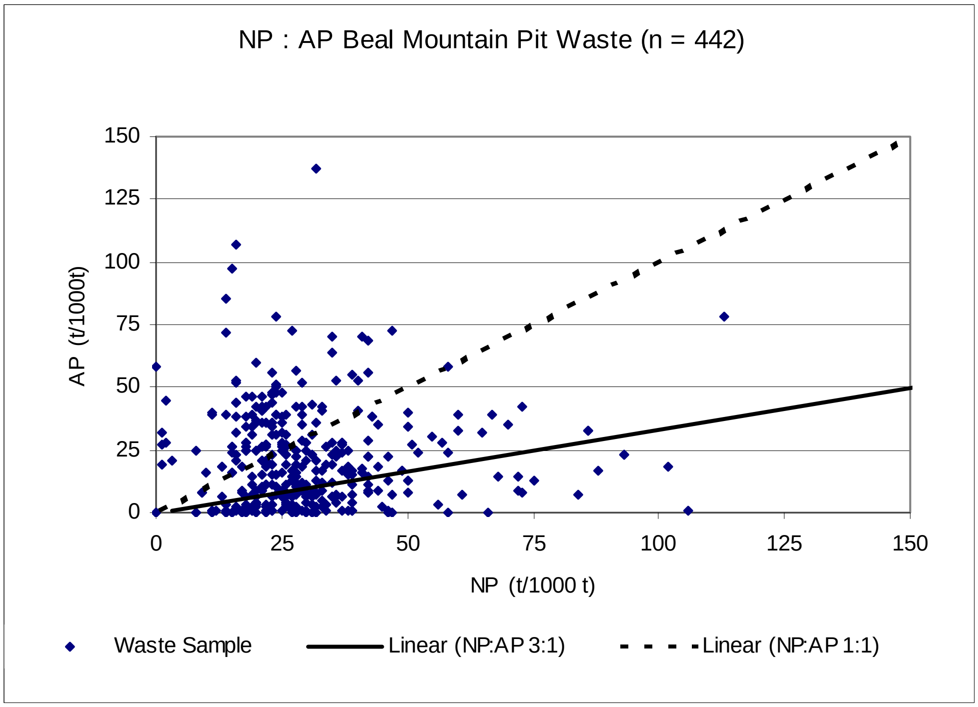


Figure 29. Beal Mountain Pit waste rock static test results (tons/1000 tons)

❖ Kinetic Testing

A 20-week humidity cell test was performed on 17 composite waste grade samples selected from the Beal Mountain pit, including the subsequent extension of this pit (Gallagher, 1995 and Schafer and Associates, 1994). These samples consisted of amphibole hornfels (n = 3), Beal Shear material (n = 4), biotite hornfels (n = 1), breccia (n = 2), quartzite (n = 6), and one quartzite / amphibole hornfels composite.

These samples represented the higher end of NP:AP ratios observed in static test results. The Beal Shear samples discussed by Gallagher (1995) were not expected to produce acidity during humidity cell testing as indicated by previous acid/base account (ABA) testing of this material type. Of the remaining humidity cell samples reported by Schafer and Associates (1994), two had NP:AP ratios greater than 3 while the remaining 11 had NP:AP ratios between 1 and 3.

Two amphibole hornfels samples produced leachate with pH values that were circumneutral for the first 4 weeks but fluctuated somewhat afterwards with occasional drops in pH to values between 5.5 and 6.0 su. While no sharp increase in sulfate release was observed in these two samples, alkalinity remained near 0 mg/L throughout the test. The third amphibole hornfels sample presented a clear risk of acid generation with rapid sulfate release and leachate pH values that steadily decreased to approximately 4.5 su.

The Beal Shear samples produced leachate with pH values that remained steady between 7.0 and 8.0 su throughout testing. Three samples produced leachate with alkalinity that decreased rapidly from values of approximately 100 milligrams calcium carbonate per liter (mg $CaCO_3$/L) during the first week to between 10 and 40 mg $CaCO_3$/L for the remainder of testing. A fourth sample displayed similar trend but the initial alkalinity was below 60 mg $CaCO_3$/L and dropped to below 10 mg $CaCO_3$/L. A gradual increase in sulfate release was observed for three samples while a more rapid release occurred from one sample. After 20 weeks of testing, results indicate that Beal Shear material presents little risk of acid generation, but the ongoing and increasing rate of sulfate release coupled with depleted alkalinity indicate that the test may not be conclusive. Such a material has the potential to turn acidic after further leaching.

The biotite hornfels sample produced leachate with pH values that fluctuated between 6 and 7, alkalinity that approached 0 mg $CaCO_3$/L, and moderate sulfate release. The response of this sample indicated that a continued decrease in pH exists due to on-going sulfide oxidation.

Both breccia samples produced leachate with alkalinity that approached 0 mg $CaCO_3$/L, and moderate sulfate release. Leachate from one breccia sample had pH values that fluctuated between 6 and 7 with an increasing sulfate release rate toward the completion of testing. The second sample produced pH values that declined from approximately 7 to below 5 after 3 weeks then returned to circumneutral values after 14 weeks. Sulfate release from this sample appeared to decline to near steady state conditions toward the completion of testing. This result may reflect depletion of the sulfide source by oxidation.

Data from three of the six-quartzite samples indicated little potential for acid generation, with leachate pH values ranging from 6.5 to 8 and low sulfate release rates. Two other samples displayed rapid sulfate release and pH values decreasing from 7 to approximately 5.5 in one sample and in the other sample a steady pH of approximately 3. Data for the sixth quartzite sample were not available, but this sample reportedly presented a moderate risk of acid generation.

Low sulfate release that did not increase appreciably after 15 days of testing was observed from the composite quartzite/amphibole hornfels sample. However, leachate from this sample produced very little alkalinity (near 0 mg $CaCO_3$/L) and pH values that fluctuated between 4 and 7 after 8 weeks of testing.

4.1.3.4 BEAL MOUNTAIN PIT WASTE ROCK METAL MOBILITY

❖ **Static Testing**

SPLP data for 13 Beal Mountain pit and extension waste samples are reported by Schafer and Associates (1994). These samples are splits of those subjected to kinetic testing and consisted of amphibole hornfels (n = 3), biotite hornfels (n = 1), breccia (n = 2), quartzite (n = 6), and one quartzite / amphibole hornfels composite. As discussed above for ore SPLP results, the detection limits used were above those required by MDEQ Circular WQB-7 standards and above or at the chronic aquatic life standard for aluminum (DL = 0.1 mg/L), lead (DL = 0.01 mg/L), mercury (DL = 0.001 mg/L), and selenium (DL = 0.005 mg/L). The detection limit for silver (0.005 mg/L) was greater than the acute aquatic life standard.

Cadmium, chromium, copper, lead, mercury, nickel, selenium, and silver, were at or below detection for all samples. Extracts from amphibole hornfels and the quartzite / amphibole hornfels samples had the greatest concentrations of aluminum (range = 0.4 to 2.1 mg/L) and high concentrations of iron (range = 0.38 to 3.6 mg/L). One quartzite sample displayed the greatest concentrations of iron (21 mg/L), manganese (0.82 mg/L), and zinc (0.24 mg/L). Other detections were similar between the remaining samples and included aluminum (0.1 to 0.5 mg/L), arsenic (0.005 to 0.029 mg/L), barium (0.4 to 0.7 mg/L), iron (0.03 to 0.67 mg/L), manganese (0.01 to 0.03 mg/L), and zinc (0.02 to 0.04 mg/L).

Four rock samples representing metasediments from the east wall, Beal Shear material from the south wall, amphibole hornfels / Beal Shear material from the south wall, and biotite hornfels from the north wall were subjected to SPLP and *in-situ* rinse testing with distilled water during the 1995 Pit Wall Study (Schafer and Associates, 1995). Cadmium, chromium, lead, manganese, nickel, silver, and mercury were not detected in SPLP extracts from any sample. Arsenic, barium, cadmium, chromium, and silver were not detected in rinsate collected from any rock type.

The greatest concentration of aluminum (1.3 mg/L), barium (0.7 mg/L), and iron (0.52 mg/L) were observed in SPLP extract from the metasediment sample. This sample produced rinsate with the greatest concentrations of aluminum (1.5 mg/L), copper (0.16 mg/L), iron (0.45 mg/L), manganese (0.74 mg/L), nickel (0.08 mg/L), and zinc (0.25 mg/L). The greatest concentration of arsenic (0.017 mg/L) and the only detection of selenium (0.011 mg/L) were observed in SPLP extract from the south wall Beal Shear sample.

While selenium was only detected in the SPLP extract for the Beal Shear sample (which absorbed applied water, thus precluding rinsate collection during the *in-situ* test) all rinsate samples had measurable concentrations of selenium during the rinse test. Selenium concentration was greatest in rinsate collected from biotite hornfels (0.47 mg/L), followed by amphibole hornfels/Beal Shear (0.09 mg/L), and metasediments (0.016 mg/L).

During baseline geochemical characterization work, four samples were analyzed for arsenic, cadmium, copper, lead, and zinc using the EP Toxicity method (Gallagher, 1994). These samples consisted of quartzite, diopside hornfels, biotite / potassium feldspar hornfels, and granodiorite. All analytes were present in concentrations that were below detection limits although these limits were above MDEQ Circular WQB-7 water quality standards.

❖ **<u>Kinetic Testing</u>**

Twenty-week humidity cell testing was performed on 17 composite waste grade samples selected from the Beal Mountain pit and its extension (Gallagher, 1995 and Schafer and Associates, 1994). These samples consisted of amphibole hornfels (n = 3), Beal Shear material (n = 4), biotite hornfels (n = 1), breccia (n = 2), quartzite (n = 6), and one quartzite / amphibole hornfels composite.

Leachate metal concentrations for the Beal Shear samples are reported for weeks 7, 14, and 20 (Gallagher, 1995). Concentrations of all analytes except arsenic, selenium, and zinc were near or below their respective detection limits throughout the test period. Arsenic concentrations for one Beal Shear sample ranged from 0.11 to 0.18 mg/L throughout the test while all other leachate samples had arsenic concentrations of 0.051 mg/L or less. Selenium concentrations ranged for the detection limit (0.001 mg/L) to 0.005 mg/L. Zinc concentrations ranged from 0.02 to 0.07 mg/L.

Weekly humidity cell data for the remaining samples are not available but a summary of results is provided by Schafer and Associates (1994). It was concluded that excessive concentrations of aluminum, copper, iron, and zinc could be expected should low pH conditions occur. Several samples, including quartz and breccia, released selenium at high concentrations throughout the test. These samples, and an amphibole hornfels sample, released arsenic at levels above 0.01 mg/L throughout the test duration.

4.1.3.5 BEAL MOUNTAIN PIT ROCK CHEMISTRY SUMMARY

Static test data for ore and waste rock from the Beal Mountain pit and the associated extension indicate significant potential for acid generation from a portion of the pit walls and waste rock removed from these areas. The NP:AP ratio for waste was less than 1, indicating a potential for acid generation, for 30% of all static test samples. Thirty-three percent of the samples had NP:AP ratio between 1 and 3, indicating an uncertain potential for acid generation.

In most cases, kinetic testing of multiple samples of similar rock types produced conflicting data for evaluating acid generation potential. While data indicate that the Beal Shear material is the least likely to present a risk of ARD, at least some samples of each of the other rock types tested (amphibole hornfels, biotite hornfels, breccia, and quartzite) displayed chemical behavior indicative of moderate to high ARD risk. In several cases, humidity cell tests were terminated for samples, which showed active, and/or increasing rates of sulfate release with very low and declining alkalinity; such samples could become acidic if leached for a longer period of time.

Static and kinetic test data indicate that metal mobility from main Beal Mountain rock is low under neutral pH conditions. However, excessive concentrations of aluminum, copper, iron, and zinc could be expected under low pH conditions. While the available data do not allow direct comparison of selenium mobility from the various rock types, elevated selenium concentrations were recorded during pit wall rinsing and kinetic testing of biotite hornfels, Beal Shear material, breccia, quartz, and a composite sample of amphibole hornfels and quartz. Selenium impacts have been documented in receiving water downgradient of facilities that include waste rock from the Beal Mountain pit.

4.2 SOUTH BEAL PIT

The South Beal pit was also mined as an open pit in an amphitheater-like configuration that is open to the north (**Figure 3**). The pit is developed on a relatively steep north-facing sedimentary bedding-plane-controlled dip-slope that dips about 20 degrees to the north. The overall pit dimensions were approximately 1600 feet in a both a north-south and east-west direction. Bench heights of 20 feet were used during mining with 30-foot wide safety benches constructed every 100 vertical feet. Overall slope angles are approximately 2.5H: 1V. The depth of the pit is approximately 450 feet (elevations 7,700 to 7,240) along the southern highwall.

During mining in 1993 and 1994, much of the South Beal waste rock (clay-rich weathered hornfels) was placed on the waste rock pile, once mining was completed on a given bench waste was stockpiled on the mined-out benches for use as in reclaiming the South Beal pit. When mining in South Beal resumed in late 1996, almost all of the waste was used to backfill the Main Beal Mountain pit. South Beal waste was used as part of the composite cap constructed for the leach pad and large portion of cap for the waste rock dump. In addition, approximately 40,000 cubic yards of wollastonite-pyroxene hornfels (or skarn) was segregated for construction of the clay/sill buttress.

4.2.1 <u>South Beal Reclamation Status</u>

The South Beal pit was reclaimed during 1998 and 1999 by stripping topsoil and some waste rock from an area about 100 feet to the south of the upper edge of the south highwall. Pit slopes were regraded using this waste material to form an upper slope covered area at 3H:1V, and an upper covered bench area at 2.5H:1V, and two lower-slope covered benches with slopes of 2H:1V (**Figure 3**). In late 1999 approximately 100,000 cubic yards of South Beal waste was stockpiled on the floor of the South Beal pit for use in construction of the leach pad cap. Regraded slope areas were covered with approximately 12 inches of subsoil and 12 inches of topsoil and revegetated.

4.2.2 Pit Geochemistry

The South Beal pit was mined late in mine life (1993-1997). South Beal pit waste rock was placed on the waste rock dump during mining in 1993-94 and was used as was used as a compacted cover material for the waste rock dump and the leach pad cover. The South Beal pit was partially backfilled with South Beal waste, along with rock and soil excavated in proximity to the South Beal pit. Ore in the South Beal pit is hosted in an individual bed of impure calcareous quartzite or siliceous limestone that is now largely metamorphosed and altered to a chalky calc-silicate hornfels, comprised of 50-90% diopside and wollastonite. South Beal waste rock is comprised of similar rock types as the Beal Mountain pit, although metaquartzite waste rock is much more common at South Beal and waste rock in the more highly fractured main Beal Mountain deposit contains more abundant sulfides than waste rock from the South Beal deposit. In addition, weathering and oxidation appears to be more pervasive in the South Beal deposit, which in addition to oxidizing sulfide is responsible for the intense clay alteration and high clay content associated with South Beal wastes.

4.2.2.1 SOUTH BEAL ORE ACID ROCK DRAINAGE POTENTIAL

Evaluation of potential acid generation from non-mined ore remaining in the South Beal pit floor and highwalls is based on static test data from nine South Beal ore samples (**Figure 30**) (Gallagher, 1994). Seventy-eight percent of these samples had NP:AP ratio less than 1:1 indicating a high potential for acid generation from residual ore remaining in the pit. No kinetic test data are available for predicting acid generation from South Beal ore. Likewise, no tests for metal mobility were conducted on South Beal ore.

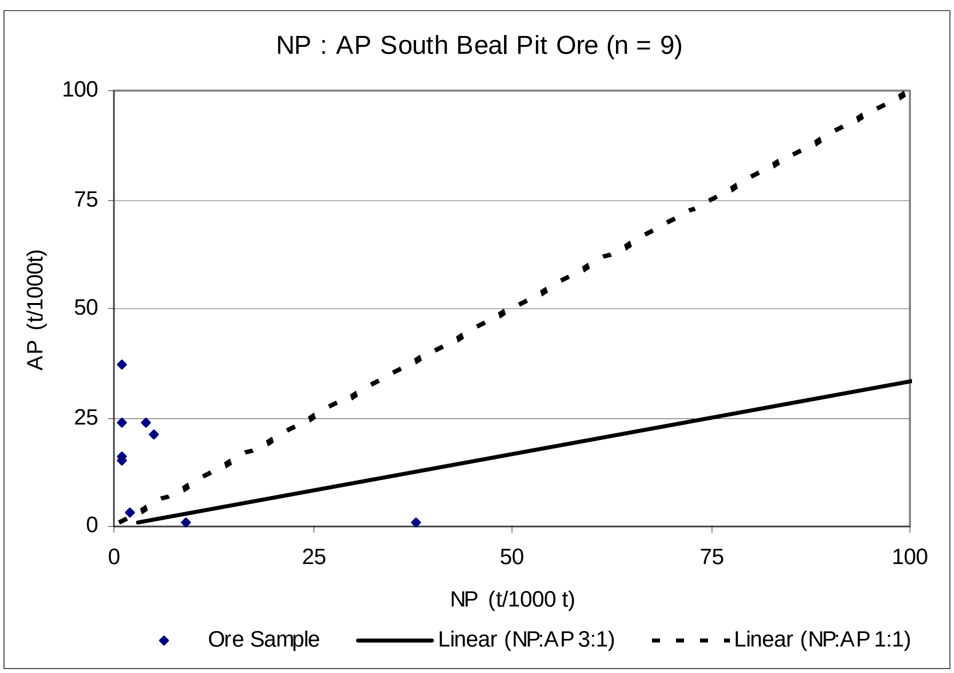


Figure 30. South Beal Pit ore static test results (tons/1000 tons)

4.2.2.2 SOUTH BEAL WASTE ROCK ACID ROCK DRAINAGE POTENTIAL

❖ **Static Testing**

Data for evaluating the acid generation potential from waste remaining in the South Beal pit floor and highwalls include NP:AP ratios for 144 samples of waste rock mined from South Beal (**Figure 31**) (Gallagher, 1994; Pegasus Gold, 1998; and Schafer and Associates, 1994). Eight percent of the samples had NP:AP ratio less than 1 or between 1 and 3. The remaining 92 % of the samples had NP:AP ratio greater than three indicating that the pit floor / highwalls (excluding residual ore) and waste removed from this pit have little potential to generate acidity.

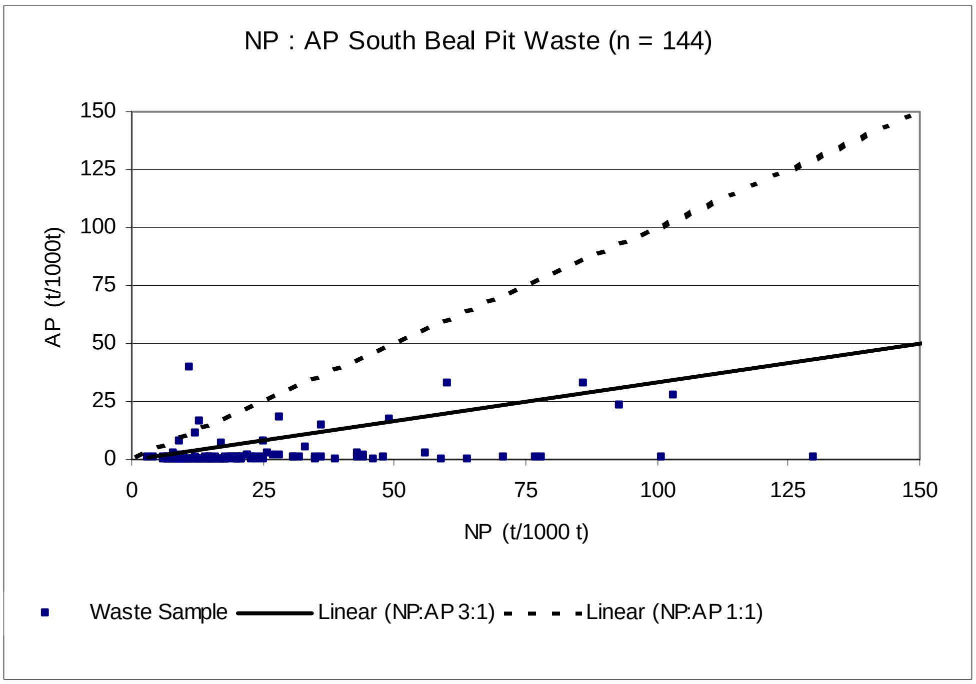


Figure 31. South Beal Pit waste rock static test results (tons/1000 tons)

In addition to the static test results discussed above, Gallagher (1995) presents summary ABA statistics for 22 additional South Beal waste rock samples for which no raw data are available. These statistics (mean ABA = 12.5, range 3 to 64) indicate low potential for acid generation.

❖ **Kinetic Testing**

Humidity cell data for quartzite (n = 3) and marble (n = 1) waste rock from the South Beal pit are reported in Appendix B of the South Beal Permit Amendment. All of these samples produced leachate with circumneutral pH fluctuating between 5.9 and 9.0 su and low sulfate release, indicating low but uncertain acid generating potential.

4.2.2.3 SOUTH BEAL WASTE ROCK METAL MOBILITY

❖ **Static Testing**

Data collected during EP Toxicity testing of nine South Beal waste rock samples are reported in Appendix B of the South Beal Permit Amendment. All constituents, including arsenic and selenium, were below their respective detection limits in extracts from all samples. However, these detection limits were all above applicable MDEQ Circular WQB-7 water quality standards.

❖ **Kinetic Testing**

Humidity cell testing was conducted on four samples of South Beal waste rock as reported in Appendix B of the South Beal Permit Amendment. Results of leachate metals analyses are reported for leachate collected on the ninth week of testing. Leachate metal concentrations were low with only copper (0.01 mg/L), iron (0.03 and 0.04 mg/L), and zinc (0.01 and 0.02 mg/L) measured above detection limit values.

Two additional South Beal waste rock samples were leached in humidity cells and data reported for weeks 7, 14, and 20 (Gallagher, 1995). These samples produced leachate of good quality with only arsenic (range 0.001 to 0.003 mg/L) and zinc (range 0.03 to 0.06 mg/L) measured repeatedly above detection limit values. One detection of lead (0.01 mg/L) was recorded; all other parameters including selenium were consistently below detection.

4.2.2.4 SOUTH BEAL PIT SUMMARY

Data collected during static and kinetic testing of South Beal pit ore and waste rock suggest a low potential for ARD from pit highwalls and waste rock and a high potential from ore. The relative percentage of the pit highwall area containing exposed, residual ore is not known. It is unlikely that the presumed small amount of residual ore remaining in the pit walls will generate enough acidity to overwhelm the neutralization potential of the surrounding rock. While limited, the available data for evaluating metal mobility indicate that leachate from South Beal rock will be of good quality.

4.3 WASTE ROCK DUMP

The Beal Mountain Mine has only one waste rock dump. It is situated on an east-facing slope at the head of German Gulch (**Figure 3**). The site covers approximately 48 acres and was constructed in several lifts over the years with 2H:1V slopes. Most of the waste rock in this dump was derived from the Beal Mountain pit. About 11.9 million tons of waste rock is contained in the dump (**Table 13**). In the later years of mining (post 1992) the main haul road from the Beal Mountain pit and the South Beal pit were relocated to cross the waste rock dump in route between the pits and the crusher pad (**Figure 3**).

Waste rock was generated from mining of both the Beal Mountain pit and the South Beal pit. The total amount of waste generated is about 20,300,000 tons. Waste has been used or placed in at least four areas including the waste rock dump, leach pad dike, road prism or road base, and as pit backfill in the Beal Mountain pit. Volume estimates presented in **Table 15** are rough and based on a few known volumes including the total amount of waste generated, volume of material used in waste rock dump cap, volume of material calculated for the leach pad dike, volume of material calculated for the road prisms, other roughly calculated volumes, and a reconstruction of mining and construction history with respect to the proportion and distribution or placement of waste rock.

TABLE 15 APPROXIMATE DISTRIBUTION OF MINE WASTES		
	Tons	**Bank Cubic Yards***
Waste rock Dump	11,900,000	24,990,000
Leach Pad Dike	3,000,000	6,300,000
Leach Pad Cap	150,000	315,000
Waste Rock Dump Cap	350,000	735,000
Road Prisms	750,000	1,575,000
Main Beal Mountain Pit Backfill	4,150,000	8,715,000
TOTAL	**20,300,000**	**42,630,000**

Notes: Quantities are estimates that are based on few know volumes.
* Assumes 2.1 bank cubic yards/ton

Figure 32 is a schematic cross-section of the waste rock dump that illustrates its basic construction and a number of other relevant characteristics. The waste rock dump was constructed in lifts by year. The upper portion of the waste rock dump (1996 and 1997 lifts) was excavated into an area known to contain a spring and this portion of the excavated area was undercoated or lined with a low permeability layer of rock mined from the Beal Mountain Shear zone in the Beal Mountain pit. This spring continued to discharge under and into the waste, and the Beal Shear zone material, although low in permeability, was relatively enriched in selenium, and is likely contributing to contamination of water flowing through and beneath the dump.

A diorite dike that outcrops under the middle portion of the dump forces shallow groundwater to the surface, resulting in a series of seeps and springs (**Figure 32**). In 1994, a fence of piezometer wells was drilled across the toe area of the waste rock dump. These wells showed elevated selenium and sulfate concentrations along with elevated temperatures in water that was either groundwater within the waste or, more likely, perched groundwater. In addition, spring SPR-5 was showing degraded water quality with respect to selenium and sulfate. As a result of these observations, BMMI constructed a waste rock dump toe drain collection system in the fall of 1994.

4.3.1 Waste Rock Dump Toe Drain Collection System

The toe drain collection system for the waste rock dump consists of several components that are illustrated schematically on **Figure 33**. A 150-foot long trench was excavated across the toe of the waste rock dump in order to accomplish a number of goals related to water control and water quality. The trench varied from 15 to 25 feet deep, and was as much as 20 feet wide. In October of 1994, a series of shallow dipping holes were drilled uphill into bedrock under the waste rock to penetrate the diorite dike (**Figure 32**), which was forcing water up to the surface and into the waste rock. Although a number of holes were drilled, only three penetrated the dike and produced water (other holes were deflected up into the waste rock). The trench was then lined on the sides and bottom with an 80-mil PVC liner. A six to eight inch perforated pipe was placed along the bottom, and other solid HDPE pipes were used to bring water from the drill holes to the drainpipe. The perforated pipe was backfilled with a thin layer of crushed limestone rock and covered with a filter fabric. The ditch was backfilled with very coarse limestone imported from the Continental Limestone mine near Townsend, Montana, and the limestone covered with fabric and topped with a compacted layer of 2-inch minus wollastonite-pyroxene hornfels (skarn) material. The water collected by the perforated drainpipe and trench was delivered by a solid pipe to a buried toe drain collection system at the southeast margin or toe area of the dump. From there it went to a tank that was used to water haul roads or allowed to flow through the tank, and merge with other parts of the collection system. Prior to February of 1996 this water was sent to the leach pad for make-up water or to a LAD. After February of 1996 this water was discharged through infiltration galleries along German Gulch. Later in 2001 this water was pumped to the makeup water pond and from there to discharge through the land application discharge (LAD) system.

A solid buried pipeline collects water from spring SPR-10A at the top of the waste rock dump and brings it in a buried trench along the south flank of the dump to a steel box at the toe of the dump (**Figure 33**). This box was the sampling site for spring SPR-10A. This water was then combined with water from the buried toe drain and these combined flows entered a large tank and was used for dust suppression along roads and work areas. Later the tank was removed and the piping system was buried. At that time water from spring #5 was collected and transported in a short buried pipeline to merge with the toe drain pipeline. The combined flow (Spring 10A, waste rock toe drain and Spring #5) could be directed to either the infiltration galleries along German Gulch, or alternatively pumped to a pond near the processing facility for discharge to a LAD system. Initially, this combined water flow was discharged via a pipeline into a series of infiltration galleries along German Gulch under a MPDES permit (February 1996 through 2002. After 2002, and throughout the reclamation period, water quality from these sources was such that the water was placed in a pump-back pipeline system to the make-up (process) water pond at the process plant where it was disposed of through a LAD system. This was done in an attempt to decrease the Se loading into German Gulch. This water is still being pumped back to the process water pond at this time. A cumulative flow from the waste dump including spring 10A, Spring 5 and the waste rock toe drain ranges between 8 gpm at low flow to about 250 gpm during high flow. Average annual flow is about 70 gpm, although not all of the flow can be captured during high flow conditions.

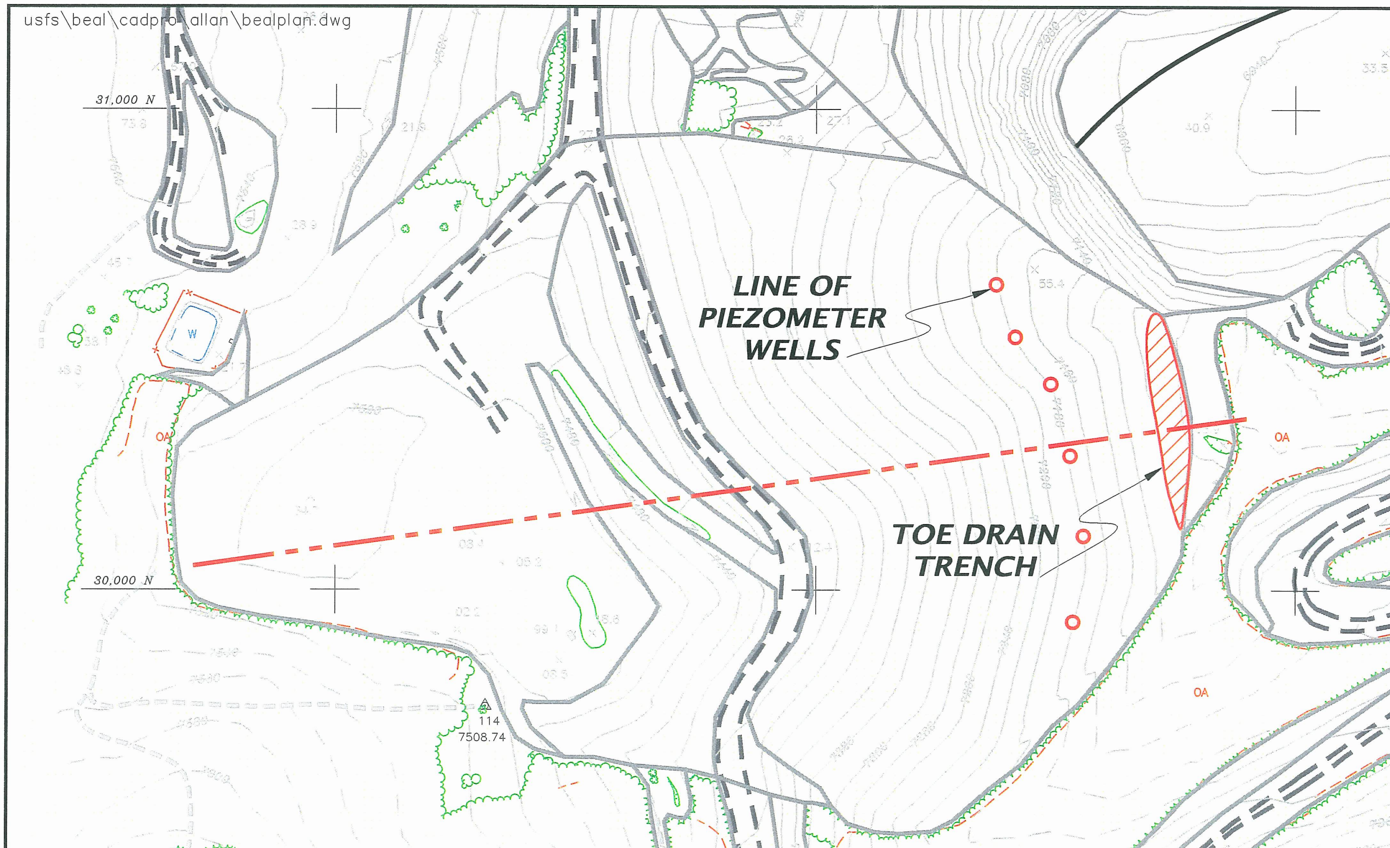
Another component of the toe drain system consists of a constructed stormwater channel along the lower margins of the dump that routes water into three settling ponds near the toe of the waste rock dump and allowed to discharge into the forest (**Figure 33**).

4.3.2 Reclamation Status

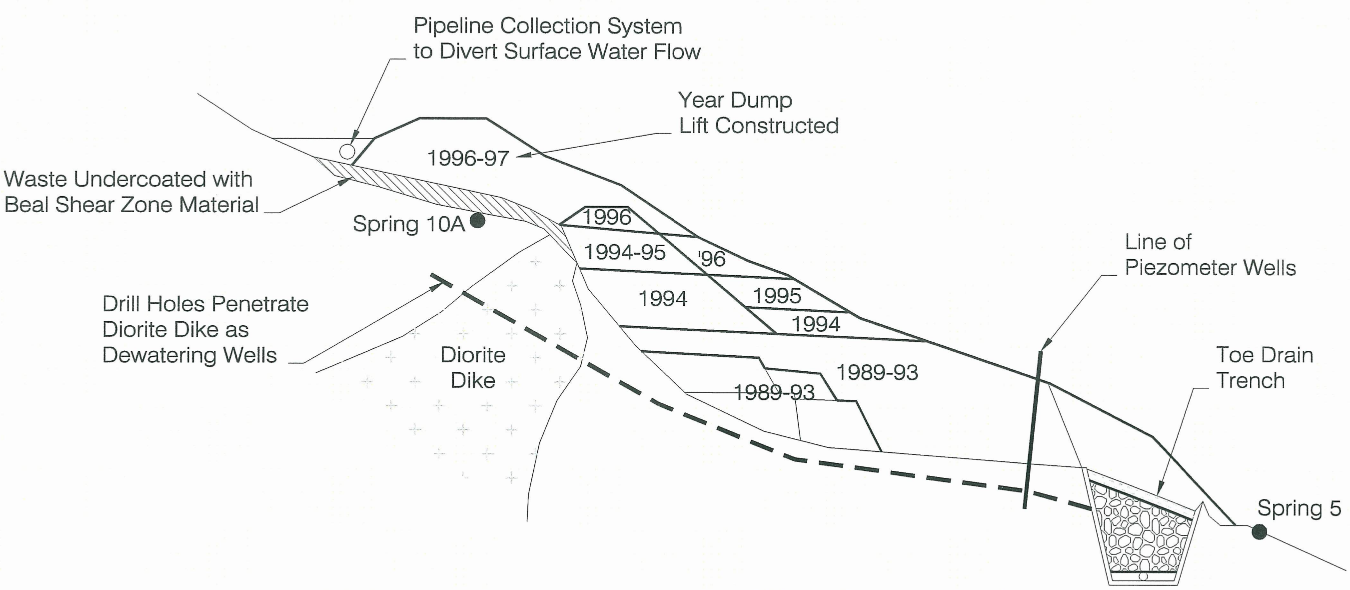
The lower portion of the waste rock dump has been reclaimed by regrading slopes to approximately 2:1 (**Figure 3**). A minimum five-foot lift (usually 10 to 20 feet) of compacted clayey, weathered hornfels waste rock from the South Beal pit and Beal Shear Zone material was placed over the surface of the waste rock dump as it was regraded. The placement of approximately 14 to 21 inches of cover soil and revegetation of the surface completed the composite cap. The upper portion of the waste rock dump had not been fully reclaimed as of the fall of 2003; it has been regraded. Armored surface water drainage channels were constructed in low areas along the sloping surface of the waste rock dump.

4.3.3 Water Balance

A Hydrologic Evaluation of Landfill Performance (HELP) water balance model was run for the Beal Mountain waste rock dump. Modeling results indicate an average annual percolation rate of approximately 0.85 inches per year. Given that the area of the facility is about 48 acres, the average seepage rate from waste rock is about 2.14 gallons per minute. HELP model assumptions, conditions, data, and output are presented in **Appendix C**. Because many of the model input parameters are estimated, the output from the model should be considered an estimate that could range over an order of magnitude above and below the estimate.



Note: Location of sections and toe drain trench details are conceptual, not actual.



WASTE ROCK DUMP CROSS-SECTION

Not To Scale

Topography from Horizons Aerial Photogrammetry, September 2003

N

Not To Scale

MAXIM TECHNOLOGIES INC® 3560621.500

Schematic Cross-Section of the Waste Rock Dump
Beal Mountain Mine
Silver Bow County, Montana
FIGURE 32

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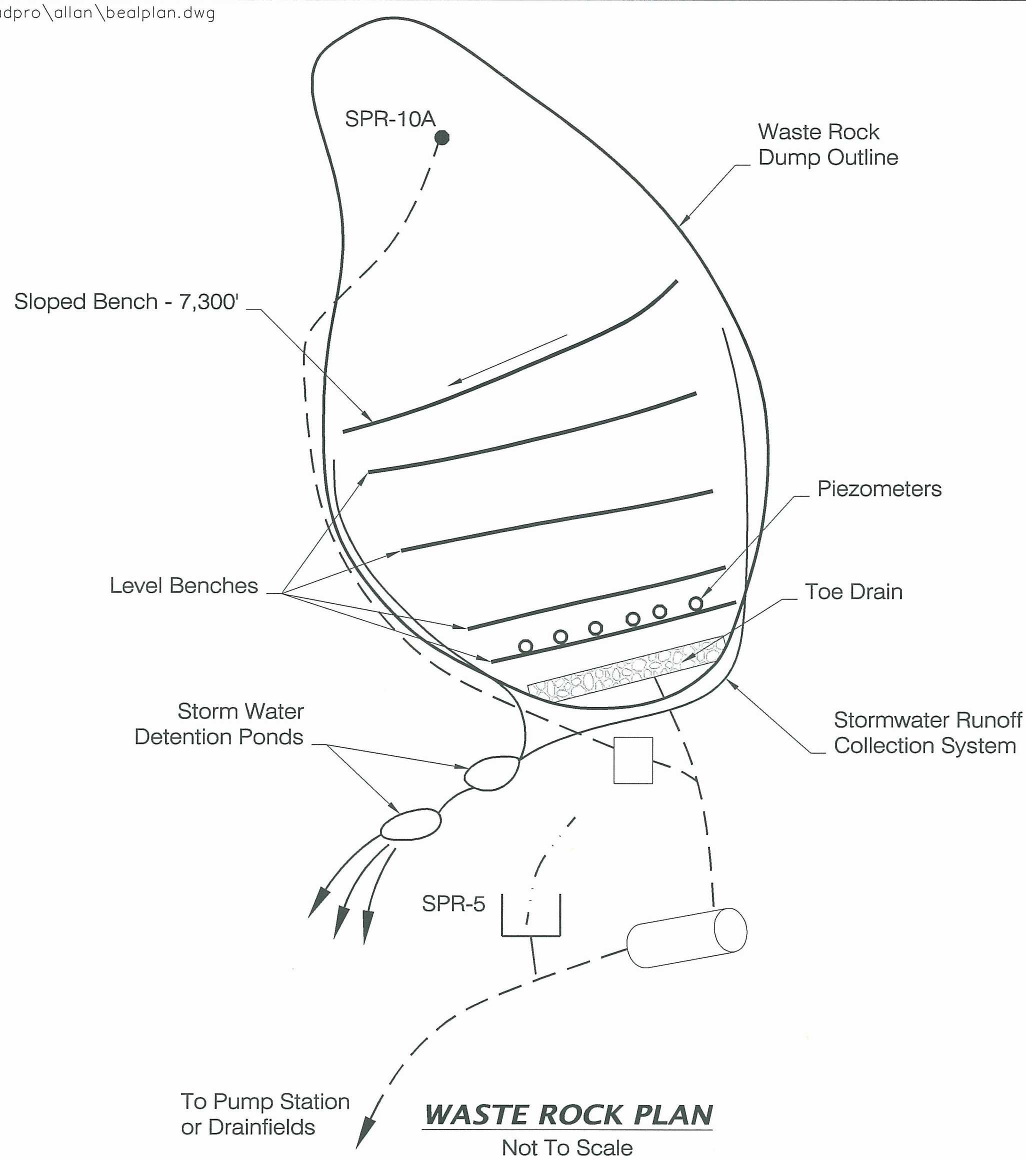
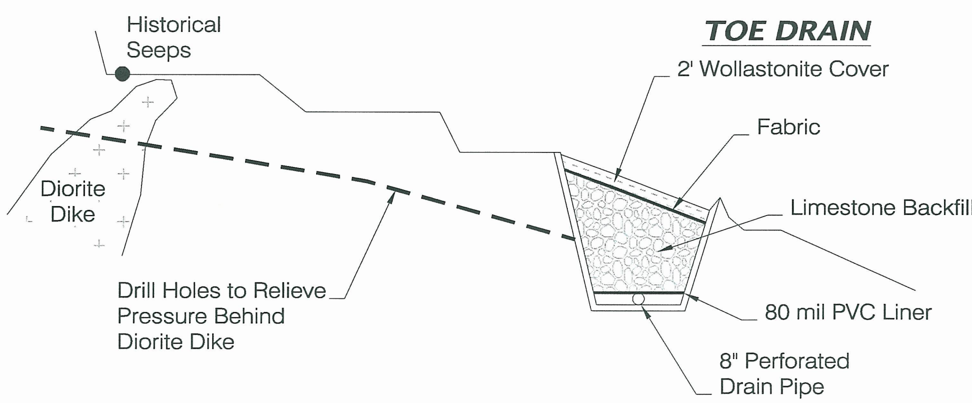


WASTE ROCK PLAN
Not To Scale



WASTE ROCK SECTION
Not To Scale

January 2004

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Schematic of the Waste Rock Dump Toe Drain Collection System
Beal Mountain Mine
Silver Bow County, Montana
FIGURE 33

4.3.4 Waste Rock Dump Geochemistry

4.3.4.1 WASTE ROCK DUMP ACID ROCK DRAINAGE POTENTIAL

Most of the rock placed in the waste rock dump was mined from the Beal Mountain pit. Data presented previously indicate that a significant portion of waste rock (between 35 % to 65 %) mined from the Beal Mountain pit presents a risk of acid generation and subsequent acid rock drainage. While these data do not necessarily reflect run-of-mine tonnages or sequencing of the various waste rock types placed in the dump, review of static test data sorted by rock type (amphibole hornfels, diorite, marble, etc.) indicate that all rock types except marble (actually a wollastonite-pyroxene hornfels) have at least some potential to generate acid.

During the 1993/1994 Geochemical Assessment Program (Gallagher, 1994) two reverse circulation boreholes were drilled into the waste rock dump and nine samples representative of run-of-mine waste rock were collected and subjected to static testing (**Figure 34**). Of these 9 samples, 44 % had NP:AP ratio greater than 3 and 44 % had NP:AP ratio less than 1. The remaining 11 % had uncertain acid generating potential. These data suggest that predictions based on waste rock origin only slightly over-predict risk of acid generation of the run-of-mine waste rock and that the waste rock dump does represent a source of potential acid generation. It is also likely that trace elements released by sulfide oxidation or locally acidic conditions may become mobile in seepage from this facility.

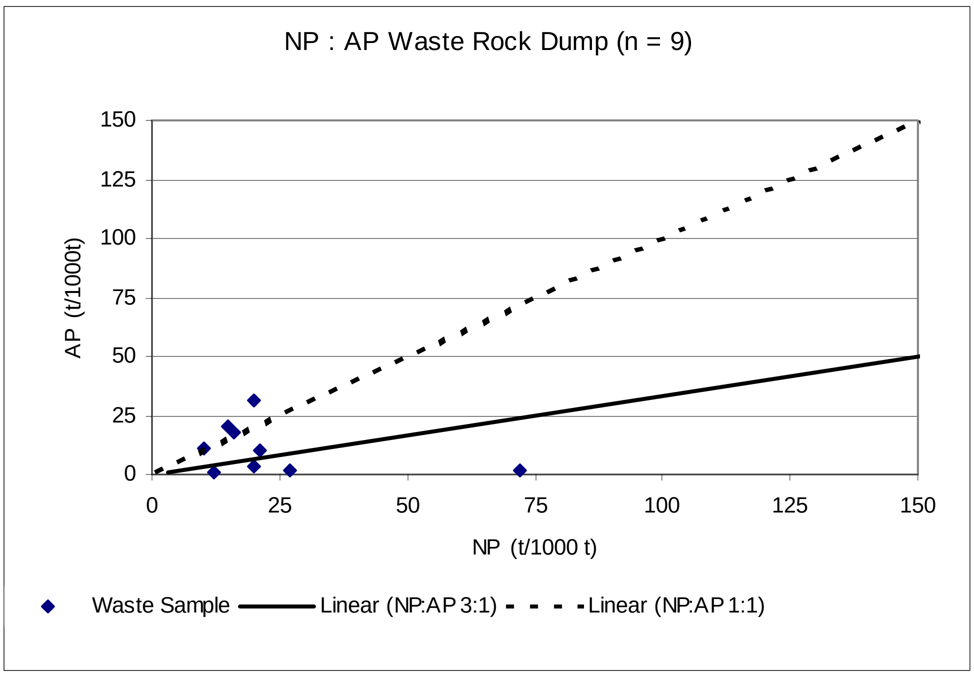


Figure 34. Waste rock dump static test results (tons/1000 tons)

4.3.4.2 WASTE ROCK DUMP METAL MOBILITY

Results of metal mobility tests discussed previously indicate that aluminum, copper, iron, and zinc could become mobile should low pH conditions occur in the waste rock dump. Selenium and minor arsenic release are also indicated, although it is difficult to assess the magnitude of these releases using the reported data. Recent surface water monitoring data downgradient of waste rock facilities (SPR-5 and SPR-10A) suggest that selenium and sulfate release rates are significant.

4.4 HEAP LEACH FACILITY

The heap leach facility (**Figures 3**) covers approximately 75 acres, stores an estimated 14,807,100 tons of spent ore, and has a capacity to hold 108,000,000 gallons of solution. The foundation materials on which the pad is constructed are unconsolidated and discontinuous glacial till overlying weathered bedrock. A containment dike or embankment surrounds the leach pad. A very large (tall, wide, and long) segment of the containment dike was constructed along its southern (downhill) side to stabilize and hold ore on the side hill construction site and to act as a surface on which to layout the bottom composite liner. Depth of spent ore is approximately 100 to 120 feet with the thickest section located in the southern part of the facility. Reclaimed perimeter ore slopes are 3H:1V or flatter. Six sumps were constructed for recovering leachate solution from the heap leach pad **(Figure 35**).

4.4.1 <u>Under Drain System and Leach Pad Base Liner</u>

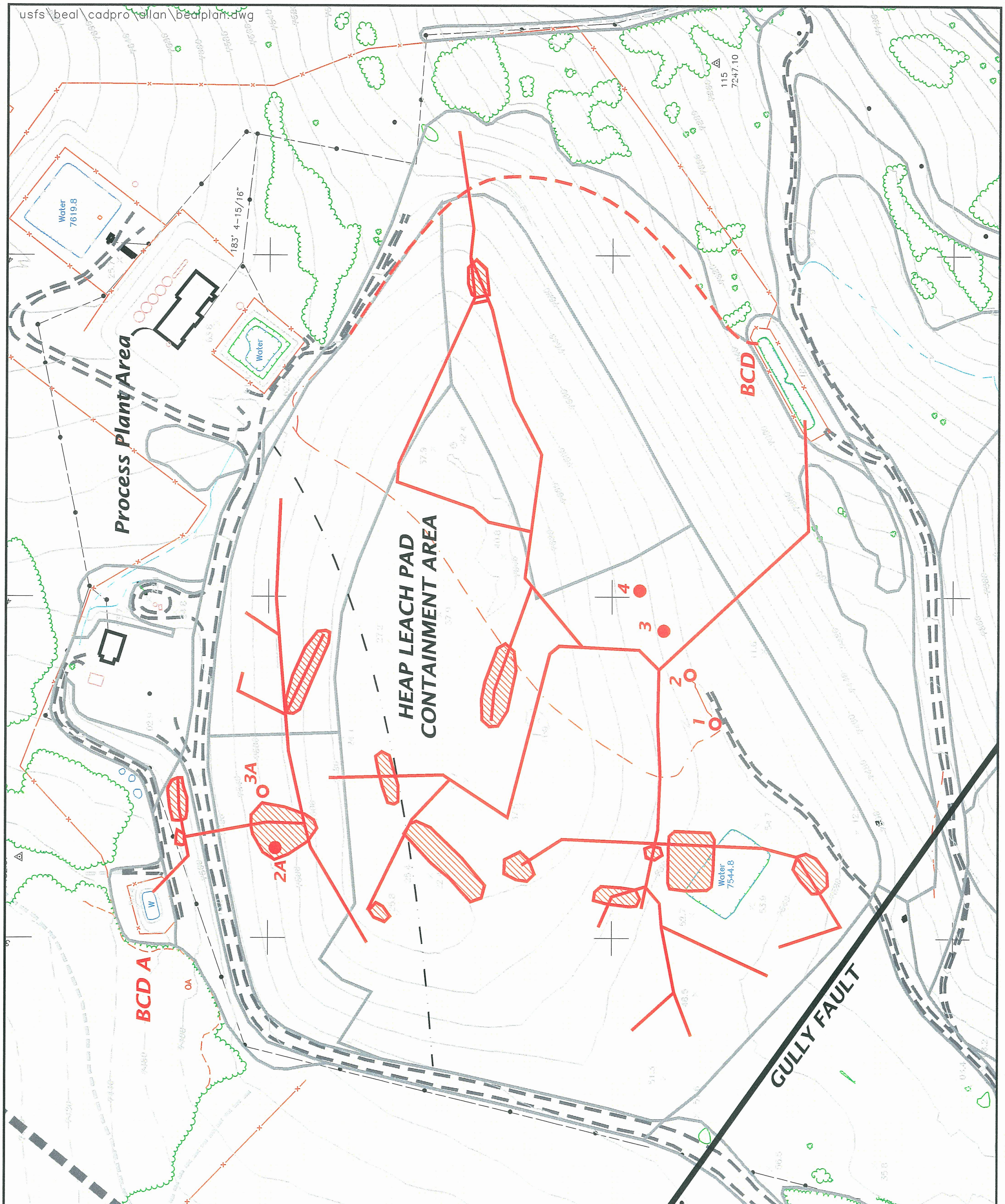
On top of the foundation materials and beneath the base liner, a series of under drains were installed to remove shallow groundwater (**Figure 35**). The underdrain system drains to both the north and south as the topographic divide between German and Minnesota gulches occurs beneath the pad. The under drains were built beginning at the southern edge of the pad and were extended northward as new lifts were added to the containment dike and the footprint of the leach pad expanded. The under drains are a dendritic system of pipes called a blanket collection drain (BCD), that began with perforated pipe at the southern end of the pad that drains in the subsurface to the BCD pond (**Figure 35**). The dendritic pattern was extended using solid HDPE pipes that were excavated into surficial materials toward low and or wet areas on the construction surface. Pipes were terminated in rock-filled collection basins. As the leach pad expanded the solid branch pipes were brought together in a manifold to a main pipe, which exits through the south central portion of the leach pad dike. A smaller but similar under drain system was constructed on the northern portion of the leach pad foundation that drains to the north into pond BCDA (**Figure 35**).

A construction plan for the composite base liner of the heap leach facility is shown on **Figure 36**. The base liner consists of two six to nine inch lifts of compacted clay as a bottom liner overlain by a 40-mil PVC geomembrane liner.

4.4.2 <u>Leach Pad Containment Dike (Embankment)</u>

The leach pad containment dike or embankment surrounds about 60 to 70% of the leach pad and was constructed in five lifts between June of 1989 and October of 1991. The Beal Mountain pit was the first to be mined and approximately 3,000,000 tons of waste rock from portions of these first three years of mining was used to construct the dike. Along the southern side of the leach pad the preexisting topography was a steep south facing hill slope. Because of this topography, the dike along the south side is about 70 feet wide across its crest and about 350 feet wide at the base. It is also about 175 feet high and over 2,400 feet in length.

Based on a comparison of aerial photos taken annually of the project site, the lower three-quarters (approximately) of the leach pad dike was constructed with oxidized waste from the Beal Mountain pit. The upper quarter (perhaps 20% of the total volume of material) was derived from reduced (sulfide-bearing) waste from the Beal Mountain pit (personal communication Bruce Parker, BMMI, 12/31/03).



Topography from Horizons Aerial Photogrammetry, September 2003
Note: Location of perforated pile conceptual.

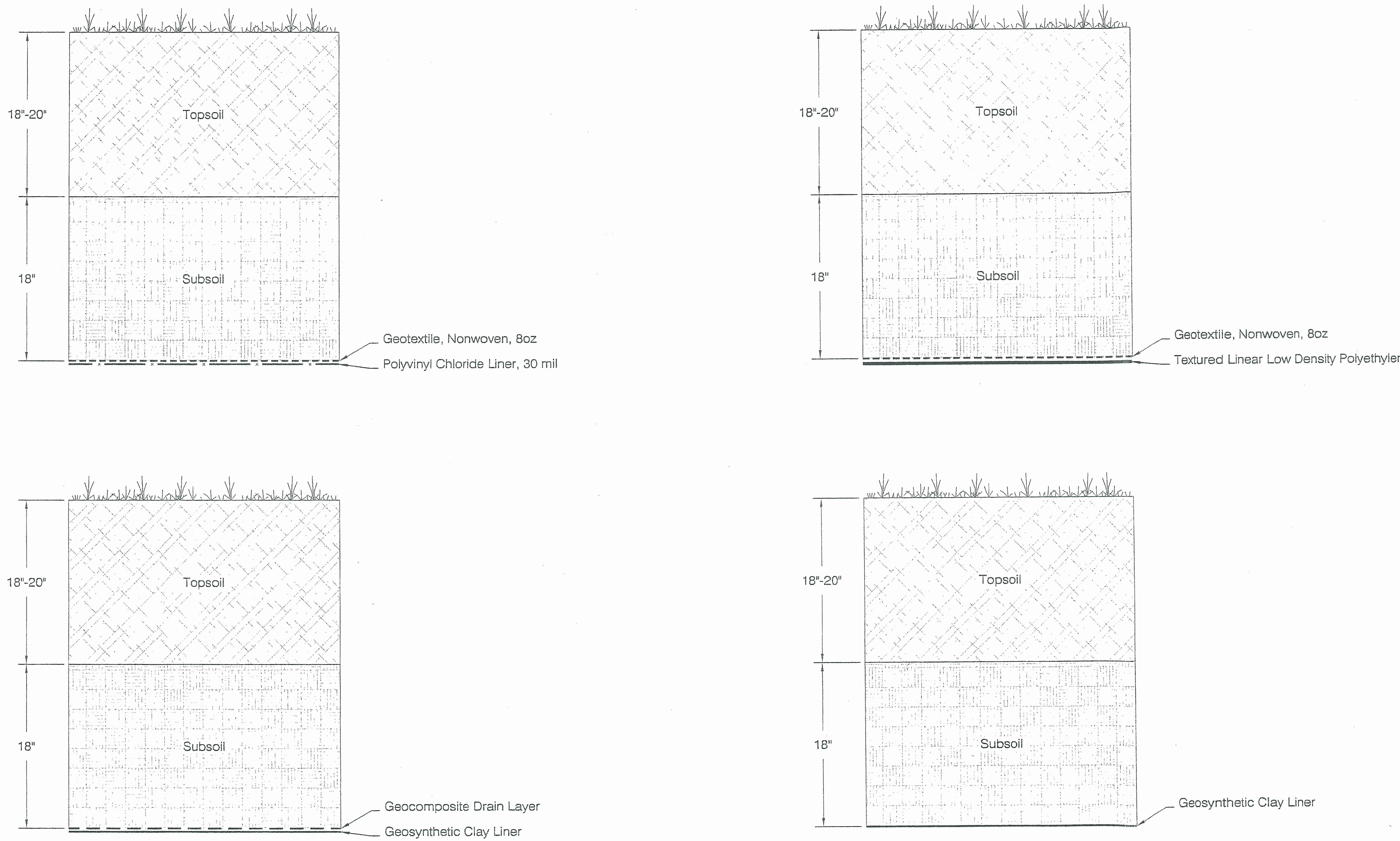
N
Not To Scale

MAXIM TECHNOLOGIES INC® 3560621.500

Symbol	Description
●	Sump (Buried)
○	Sump (Active)
BCD & BCD A	Blanket Collection Drain Ponds
——	Collector Drain
— — —	Barren Pond Seepage Drain
▨	Blanket Drain
— · —	Topographic Divide

Schematic of Heap Leach Underdrain System
Beal Mountain Mine
Silver Bow County, Montana
FIGURE 35

usfs\beal\cadpro\coversys.dwg



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MAXIM TECHNOLOGIES INC® 3560621.200

Leach Pad Cover Types
Beal Mountain Mine
Silver Bow County, Montana
FIGURE 36

In the fall of 1997, during the last year of active mining, an additional five foot lift was added to the containment dike (final elevation 7,504.5 feet) to accommodate the last of the ore mined and to accommodate an increasing volume of pad solution. The liner was extended during the construction of this lift.

In December of 1999, at the end of a very wet year, the leach pad solution overtopped the containment dike along its southern margin. The leach pad was not being operated at the time and had been shut down for the winter with what was thought to be sufficient volume for storage of pad solution. Spill volumes were estimated at 80,000 to as much as 190,000 gallons. Approximately 70,000 gallons of solution were captured in the lined pond (BCD pond) at the base of the dike.

4.4.3 Leach Pad Geotechnical Stability Issues

The southern corner of the leach pad's dike has experienced some geotechnical instability due to movement of the clay/sill slide (Section 4.1.2). The causes and potential effects of this instability were the subject of previous investigations by Sitka (1994, 1995, 1996, 1997a, 1997b, and 2000). During mining, slope movement was monitored and corrective measures were undertaken (including surface water diversions, dewatering of the embankment, and the construction of a toe buttress) to stabilize the slope such that the integrity of the leach pad embankment would not be compromised. **Appendix B** contains a summary of the clay/sill slide as it is related to leach pad stability. The following bulleted items present a summary of pertinent information regarding the slope stability in this area and are largely developed from work by Sitka.

- Lubrication of the slip surfaces of the west wall and clay/sill slides and hydrostatic pressures resulting from high groundwater levels within the slide material, substantially increase the likelihood and amount of movement of the slide. Historically, most movement of the slide has occurred in the spring when the groundwater table is the highest.
- Groundwater dewatering during active mining substantially improved the slope's stability.
- Although the toe buttress likely prevents smaller slides and slumps from developing at the toe of the slide, it appears to have less significance than dewatering in preventing overall slide movement.
- With discontinuation of active dewatering in July 2003, groundwater levels in the slide area will likely increase during spring snowmelt conditions, which may result in renewed movement of the clay/sill slide.
- Groundwater levels in the slide area may increase more rapidly and attain higher levels than in the past because of increased runoff from the newly capped leach pad.
- Slope stability analyses indicate that the crest of the leach pad dike has a relatively low factor of safety under worst-case conditions (**Appendix B**) and regression of the clay/sill slide uphill into this area could occur. If the slide should regress, further uphill cracking on the dike face may be observed. Large-scale movement of the slide (i.e. on the order of 10 or more feet per year) is not anticipated, this amount of movement has not been characteristic of slide movement at any time in the past.
- The portion of the leach pad's interior presently containing solution (i.e. within the volume defined by the 7,460 contour) has a relatively high factor of safety under worst-case conditions (1.40) with respect to slope stability. Regression of the clay/sill slide into this area is not likely.

A monitoring plan was implemented in November 2003 and a contingency plan has been developed for the leach pad facility to assure the geotechnical integrity of the leach pad. Groundwater level monitoring and monitoring geotechnical completions instrumented to collect data that measure movement of the slide are currently being monitored on a routine basis. If renewed movement of the clay/sill slide during spring 2004 should be detected and indicate that the area containing the leach pad solution could be breached by a geotechnical failure the contingency plan will be implemented. The measures envisioned by this contingency plan include reactivating the dewatering well system and/or removing additional fluid from the leach pad by pumping the sumps into the process pond for temporary storage and treatment prior to discharge in the LAD areas.

4.4.4 Leach Pad Water Balance

Appendix C contains a water balance analysis completed for the heap leach facility. The HELP model was used to estimate seepage rates through the various cover material configurations. Seepage rates through the cover are 0.7 inches/year using an evaporation depth of 28 inches. This equates to a seepage flow into the leach pad of about three gallons per minute, or about 1.6 million gallons per year. The highest seepage rates are correlated with areas covered by PVC cover materials. These high rates are related to the relatively flat slope of the uppermost surface of the reclaimed leach pad, the fact that water is predicted to pool to depths of about five inches on the PVC liner (there is no lateral drain layer) and predicted defects in the PVC liner material. Increasing the slope to 4% and increasing the evaporation depth to 36 inches results in a percolation rate of about 0.6 inches per year.

An estimate of leakage through the base liner of the leach pad was completed using information on current fluid depths in the leach pad and assumptions on defects in the base liner. The base liner consists of 40 mil PVC overlying 18 inches of compacted clay material that was imported to the site. For calculation purposes, clay is assumed to be similar to bentonite in composition. **Figure 36** shows the leach pad base liner contours and the elevation of fluid in the pad on December 1, 2003.

The estimate of leakage through the base liner was prepared assuming that there is one liner defect in the base of each of four sumps located on the south side of the leach pad and one defect per acre in the liner material within the area containing fluid. Using these assumptions, a leakage rate of 4x10E-4 gallons per minute (0.0008 inches/year) was computed. Approximately 90 percent of leakage through the base liner is from the sump areas.

4.4.5 Leach Pad Geochemistry

Two options are available to characterize the geochemistry of the leach pad. Analyses of leach solutions provide good empirical data. Geochemical analyses of spent ore provide insight into long term potential for impacts to water quality. Due to chemical changes that result from use of cyanide and addition of alkalinity to maintain leaching efficiency, as well as subsequent changes during heap drain down and/or rinsing, spent ore has a very different environmental geochemistry than unprocessed ore.

Data from analyses of barren heap leach solution from January 1999 until August 2002 are available. Data for solution remaining in the leach pad (pad solution) after leach operations were discontinued are available from September 2002 to August 2003. **Table 16** presents water quality data from the barren pond and the in-pad solution over time. Metal concentration data are primarily dissolved concentrations prior to mid-2002, and total concentrations after that date. The terms barren and pad solutions are used interchangeably after about 2001, although there is no difference between the two after this date. No cyanide has been added to the pad since late 1997 or early 1998 and metals have not been recovered since 1999.

TABLE 16
LEACH PAD SOLUTION WATER QUALITY DATA

Sample Type	Sampling Date	pH s.u.	SC umhos/ cm	Alkalinity (as CaCO3) mg/L	SO4 mg/L	Ammonia mg/L	Nitrate/ Nitrite (as N) mg/L	Dissolved concentrations (mg/L)						Cyanide (Total) mg/L	Cyanide (WAD) mg/L	SCN mg/L
								As	Cu	Fe	Mn	Ni	Se			
Barren	1/12/99	9.38	6590	360	1444	10	14.58	0.226	129	24.4			1.271	227.5	129.3	
Barren	1/28/99	9.45	6630	298.3	1695	10.1	15.5	0.403	117	22.6	< 0.005	5	1.674	124.4	118.2	
Barren	2/9/99	9.19	6350	277.5	1526.5	10.2	11.8	0.128	106	23.3			1.21	105.4	97.8	
Barren	3/11/99	9.41	6730	329	1565	10.5	14.5	0.072	106	23			1.458	207.3	122	
Barren	4/15/99	9.43	6740	200	1625	6.25		0.209	89.7	21.5			1.574	206.6	105.2	
Barren	8/30/99	9.31	6830	242	1791	7.95	14.1							98.05	31.87	
Barren	10/11/99	9.37	6990	163	1768.8	12.5	13.85	0.096	9.52	16.1	0.023	1.24		94.58	14.4	
Barren	12/3/99	9.27	7520	153	2046.7		23.4	0.274	13.7	18.7	< 0.005	0.63		87.5	28.25	
Barren	12/13/99		7400		1864				14.7	18.7		0.65		98.45		
Barren	12/20/99	9.16	7030	154	2026.7		19.55	0.769	1.59	22.8			0.879	75.35	4.08	1173.5
Barren	3/22/00	9.23	7030	176	2057	13	16.6	0.126	0.086	18.2	0.005	< 0.02	0.718	66.42	16.97	1196.5
Barren	1/19/01	9.2	6650	84.1	3149.3	15.2	19.4	0.195	1.06	10.5			0.621	37.65	4.622	354.2
Barren	2/13/01	9.14	6540	74.5	3114	18.5	16.52							32.45	3.104	282.1
Barren	3/25/01	9.25	6430	70	3132.2	16.5	292.6	0.146	1.12	7.86		0.07	0.67	30.14	4.862	182.4
Barren	8/22/01	9.05	6280	75	2842	19.5	75.5	0.15	1.61	5.58	0.019	0.08	0.7	17.14	2.668	104.75
Barren	11/30/01	9.18			2706	30	147.9	0.131	1.03	3.61		0.08	0.596	12.07	1.404	40.85
Barren	1/24/02	9	6220	86	2620	26.2	170							12	1.28	36
Barren	5/8/02	8	6700	227	2700			0.049	0.06	1.37		0.09	0.637			
Barren	6/3/02				2460	30.5	211							10.7	1.06	6.3
Barren	7/22/02			70	2480	27.6								9	0.85	16
Barren	8/1/02	9	7180	81	2570	29.5	252							8.5	0.6	19
Pad solution	9/23/02	8.7	6350	105	2660	2.4	170							14.6	3.26	6.6
Plant feed	2/18/03	8.7		82	2660	29.5	121	0.158						12.6	0.92	15
Pad solution	6/4/03													1.35		
Pad solution	8/7/03	8.6	--	72	2540	26.5	104	0.17	0.28	2.73	0.01	0.06	0.356	9.5	0.61	

4.4.5.1 LEACH SOLUTION ACID GENERATION POTENTIAL

Barren/pad solution data indicate that acidic conditions are not currently present in the heap leach facility (**Figure 37**). Between January 1999 and August 2002 barren solution pH decreased slightly from approximately 9.5 to 9.0 su, with one outlying pH measurement of 8.0 su. Pad solution pH decreased slightly from 8.7 to 8.6 following discontinuation of leach operations.

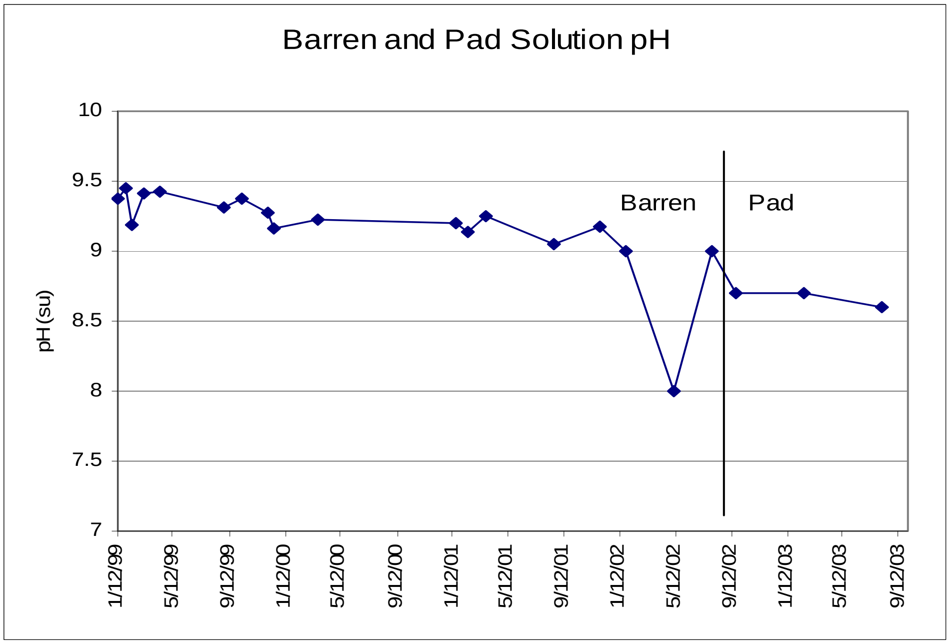

Figure 37. Beal Mountain Barren and Pad solution pH (standard units)

Sulfate concentration in the barren/pad solution has increased from 1,500 mg/L, peaking at 3,150 mg/L in January 2001, then dropping to 2,660 mg/L and remaining relatively steady following cessation of leach operations (**Figure 38**). Alkalinity has decreased from a maximum of 360 mg/L (as $CaCO_3$) to approximately 100 mg/L. These data may indicate that some degree of sulfide oxidation is occurring and that alkalinity is being consumed, but may also reflect draindown of the alkaline operating solutions.

4.4.5.2 LEACH SOLUTION METAL MOBILITY

After declining from a high of approximately 1.7 mg/L in January 1999, dissolved selenium concentrations in pad solution decreased to (and fluctuated around) 0.6 mg/L from January 2001 to May 2002 (**Figure 39**). Total concentration data reported from March 2000 until August 2003 show that the concentration of selenium decreased from 0.6 mg/L to 0.35 mg/L, indicating that selenium concentrations are decreasing within the heap leach facility.

Dissolved arsenic concentrations were relatively steady, fluctuating between 0.05 and 0.2 mg/L between 1999 and 2003 with a peak of 0.77 mg/L in December 1999 (**Figure 40**). Total arsenic concentrations increased from approximately 0.06 mg/L in August 1999 to a maximum of 0.18 mg/L in February 2001. Afterwards, dissolved arsenic concentrations declined to 0.16 mg/L where they remained steady following cessation of leach operations.

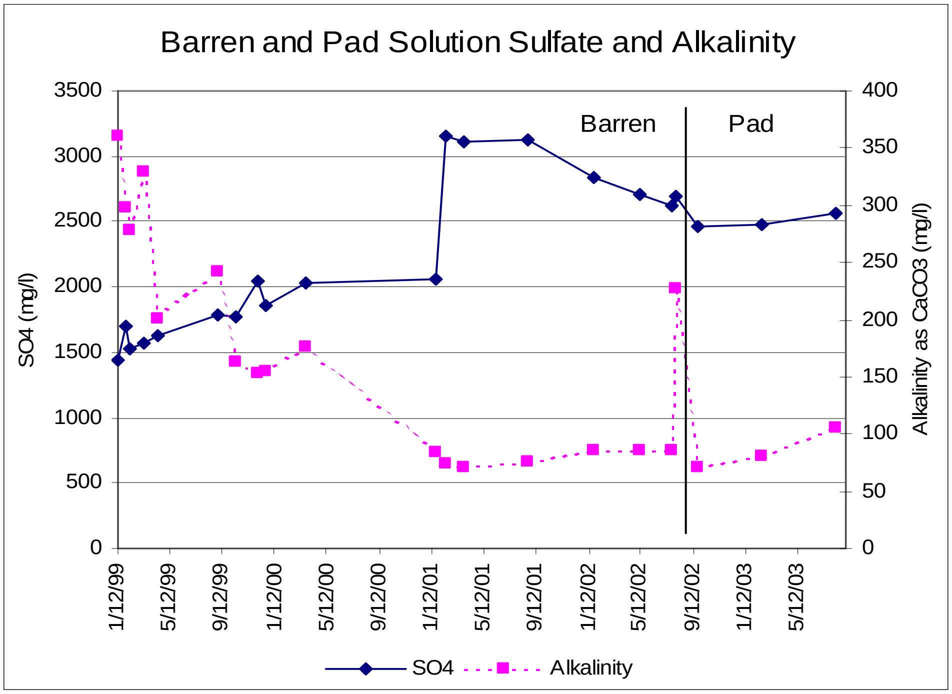

Figure 38. Beal Mountain Barren and Pad solution sulfate and alkalinity (milligrams/liter)

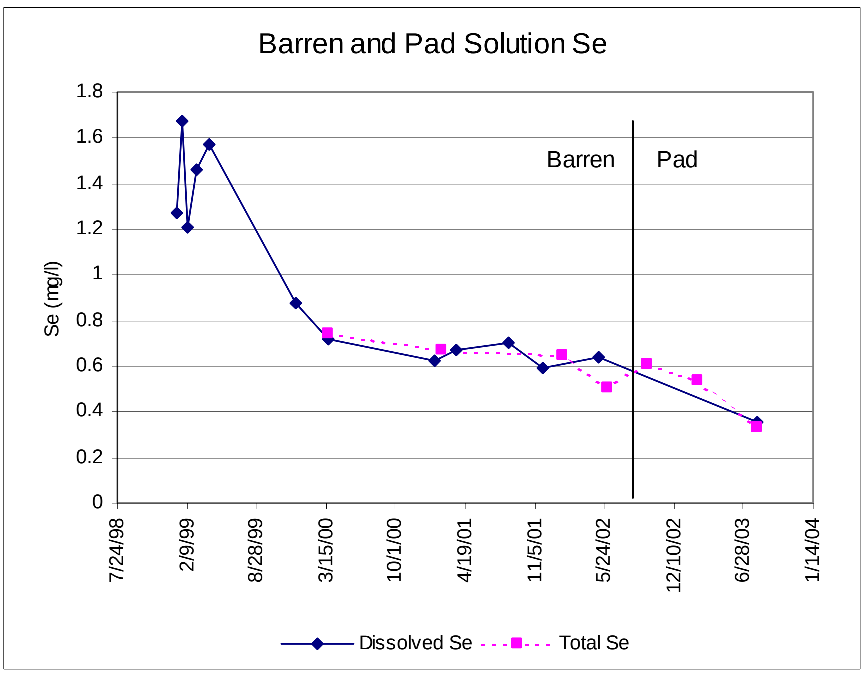

Figure 39. Beal Mountain Barren and Pad solution selenium (milligrams/liter)

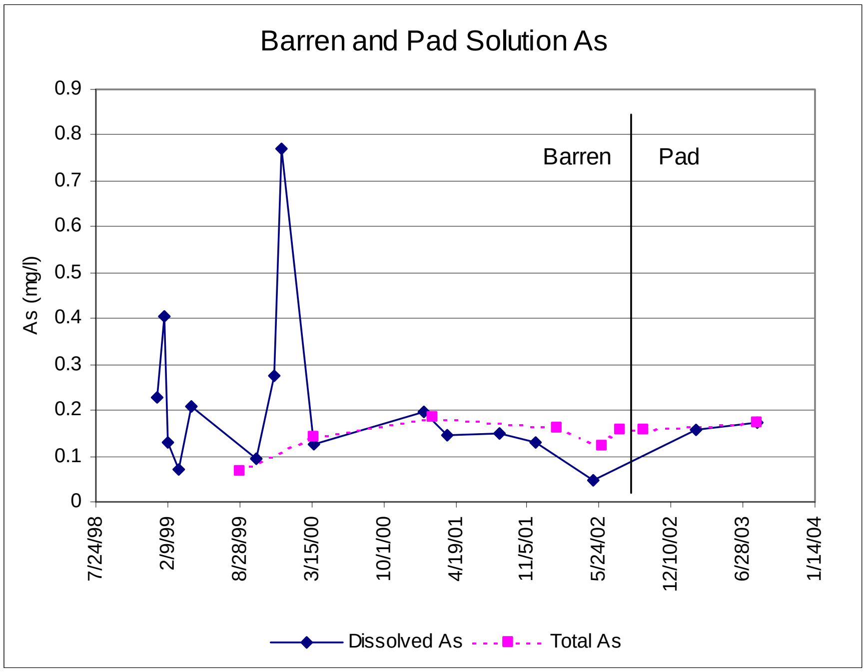

Figure 40. Beal Mountain Barren and Pad Solution Arsenic Concentration (milligrams/liter)

Dissolved and total iron concentrations were similar and decreased steadily over the monitored period (**Figure 41**). Maximum concentrations of approximately 25 mg/L were recorded in early 1999 and decreased to approximately 3 mg/L by 2002. Total iron remained between 3.5 and 4.5 mg/L following cessation of leach operations.

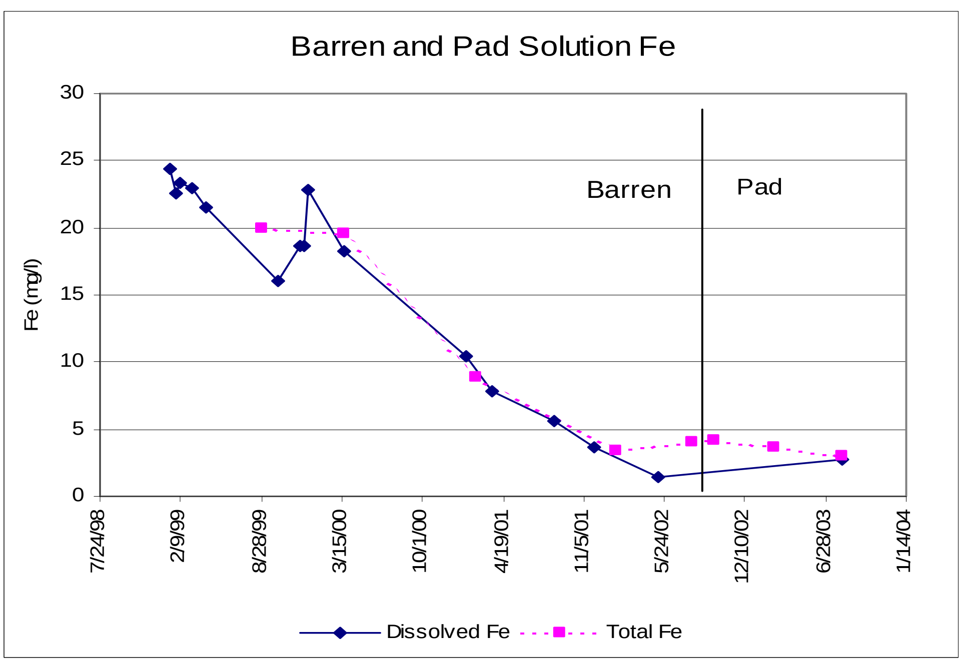

Figure 41. Beal Mountain Barren and Pad Solution Iron Concentration (milligrams/liter)

Dissolved copper concentrations followed the same trend as iron, decreasing from initial concentrations of greater than 300 mg/L (1997 and 1998, B. Parker, personal communication, 2/9/04) to less than 1 mg/L after January 2000 (**Figure 42**). Total copper concentrations available for four dates between August 2002 and August 2003 indicate that copper remained below 0.45 mg/L, although an increase from 0.13 mg/L to 0.42 mg/L occurred following discontinuation of leach operations.

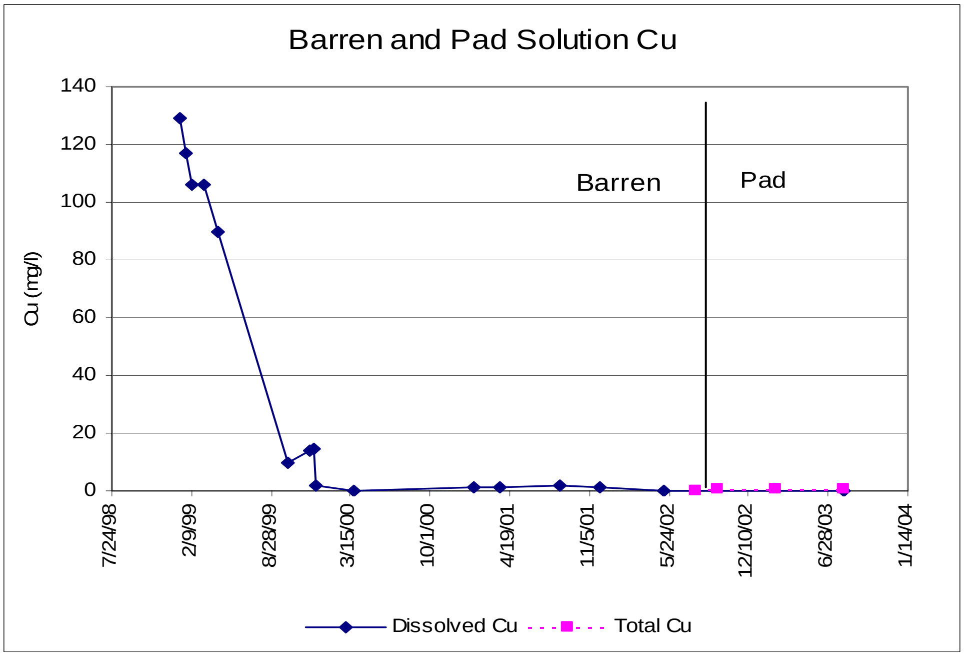

Figure 42. Beal Mountain Barren and Pad Solution Copper Concentration (milligrams/liter)

4.4.5.3 Leach Pad Cyanide Solution Concentration Changes

Total and weak acid dissociable (WAD) cyanide, as well as thiocyanate concentrations, have all decreased from operating levels of about 450 mg/L (B. Parker, personal communications, 2/9/04) to steady-state minimum values by January 2002 (**Figure 43**). Total cyanide and thiocyanate concentrations measured in the pad solution since September 2002 are typically 15 mg/L or less. WAD cyanide measured during this period ranged from 0.92 to 3.26 mg/L.

4.4.6 <u>Leach Pad Spent Ore Acid Rock Drainage Potential</u>

4.4.6.1 Static Testing

Data for use in evaluating the acid generating potential of spent ore located in the leach pad include static test data for 20 spent ore samples reported by Gallagher (1994) (**Figure 44**). These data conservatively indicate that spent ore may present a risk of acid generation with no sample having NP:AP ratio greater than 3. Forty-five percent of the samples had NP:AP ratio less than 1 and the remaining 55 % had NP:AP ratio between 1 and 3.

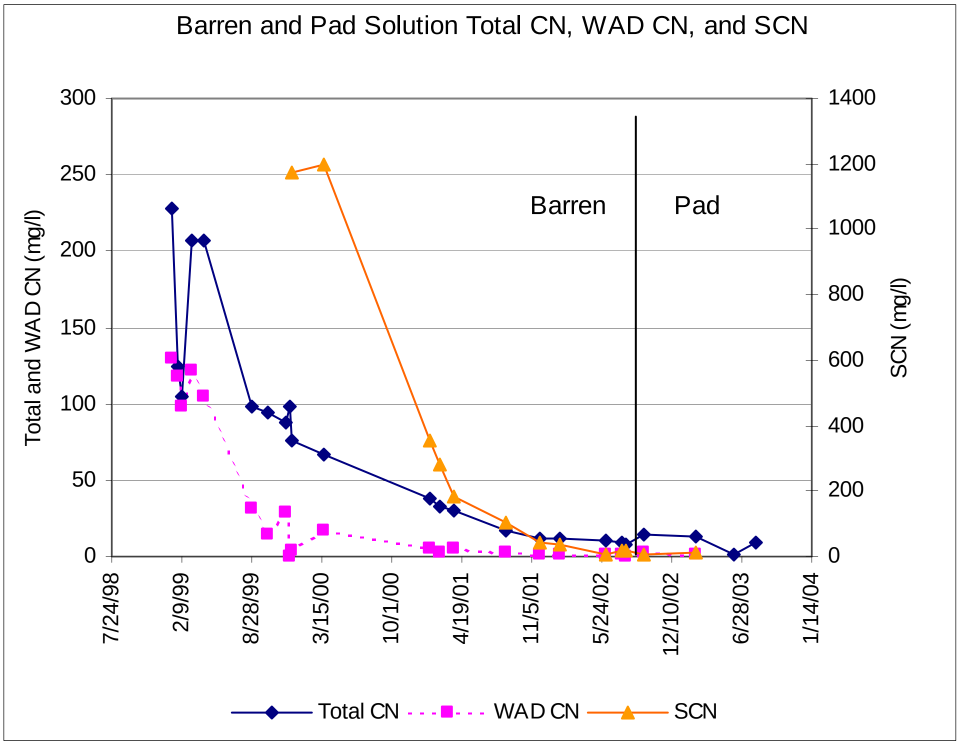

Figure 43. Beal Mountain Barren and Pad solution total and WAD cyanide and thiocyanate (milligrams per liter)

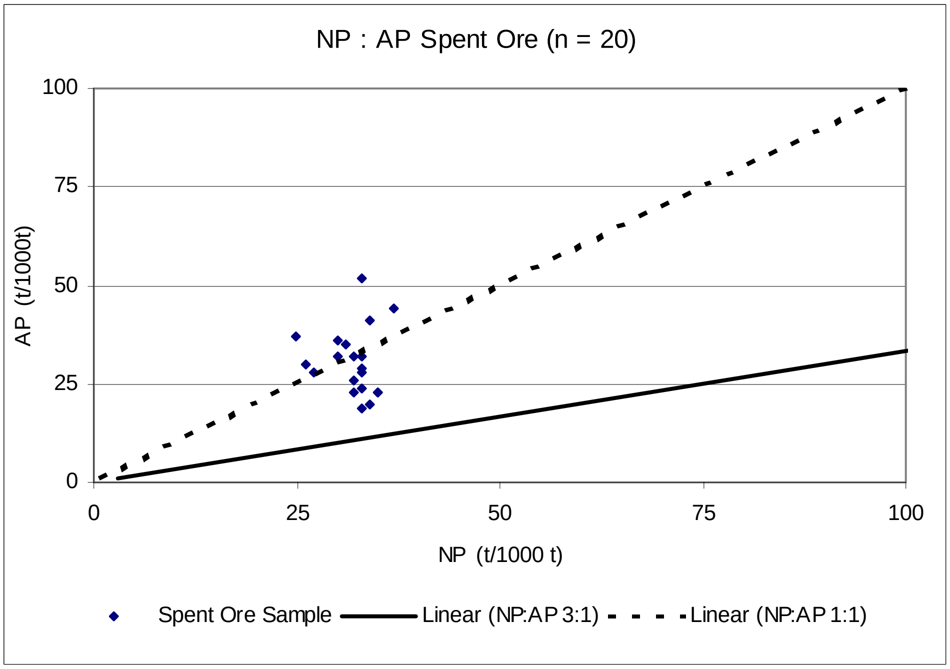

Figure 44. Spent ore static test results (tons/1000 tons)

4.4.6.2 KINETIC TESTING

Appendix B of the South Beal Permit Amendment reports humidity cell data for spent ore. Three different size fractions of spent ore were tested; > 2 mm, < 2 mm, and whole ore. Sulfate release from each of the samples was gradual and pH remained near or above 8 in the < 2 mm and whole ore samples. For the > 2 mm sample, leachate pH values fluctuated between 8.0 and 8.9 for the first 10 weeks than decreased steadily from 8.6 to 7.1 between weeks 11 and 15. Alkalinity measured from the > 2 mm sample decreased steadily from 22 mg/L to 6 mg/L during the 15 week testing period. Alkalinity remained relatively steady, fluctuating between 50 and 88 mg/L, for the < 2 mm sample and between 30 and 74 mg/L for the whole ore sample. These results suggest a low potential for acid production and agree with the empirical data collected during leach/pad solution analyses.

4.4.7 Leach Pad Spent Ore Metal Mobility

4.4.7.1 KINETIC TESTING

Appendix B of the South Beal Permit Amendment reports metal concentrations in leachate collected on week 9 of spent ore humidity cell testing discussed above. Arsenic (range 0.019 to 0.113 mg/L) and iron (range 0.13 to 0.26 mg/L) were detected in leachate from each of the 3 particle sizes tested. Copper was also detected (0.01 mg/L) in leachate from the > 2 mm sample. All other constituents analyzed; cadmium, lead, manganese, silver, and zinc were below detection. Selenium concentrations were not measured.

4.4.7.2 LEACH PAD CHEMISTRY SUMMARY

Static testing of spent ore indicates that this material has a high potential for acid generation. However, kinetic testing of spent ore and pad solution pH measurements indicate low ARD risk. It is possible that, while spent ore poses a risk of ARD, the high pH of the barren/pad solution is buffering acid generation in the heap leach pad. It is noteworthy that pH and alkalinity have decreased somewhat following cessation of leaching operations indicating that the neutralizing capability of the heap is slowly being depleted.

Kinetic test data indicate that leachate from the spent ore will be of generally good quality with possible exceedances of human health based standards for arsenic. Barren/pad solution analyses indicate that most metal concentrations in the heap are near equilibrium with elevated levels of selenium, iron and copper. Selenium concentrations in pad solution appear to be declining.

In addition to impacts originating from the spent ore and pad solution, there is an unknown but significant risk of potential ARD and metal release that may be expected from the heap leach embankment, which was constructed with waste rock from the Beal Mountain pit. The reader is referred to the Beal Mountain pit section for a discussion of the geochemistry of these rocks.

Water quality in the pad has changed dramatically over the rinsing, closure and treatment period such that the remaining water currently contains approximately (**Table 16**). Alkalinity has decreased from about 360 mg/L to about 100 mg/L in that period with total cyanide currently about 15 mg/L and WAD cyanide is about 0.02 to 3.2 mg/L (**Table 16**).

4.4.8 Leach Pad Cover Construction and Reclamation

The heap leach pad was largely reclaimed during 2002 and 2003 (**Figure 37**). Work completed for reclaiming the pad included reclamation of the containment dike, drawing down solution contained within the pad, regrading the spent ore to a more stable configuration and constructing a low permeable cap.

The containment dike, which is constructed of waste rock derived from the Beal Mountain pit, was reclaimed by regrading, placing a cover soil of 12 to 18 inches and revegetation.

During reclamation of the leach pad, a composite cap for the leach pad was constructed using various low permeability geosynthetic and soil covers. **Figure 37** shows the various configurations of materials used for the cover construction and the locations where each configuration was placed on the leach pad.

A 30 mil PVC geomembrane was installed over most of the leach pad, where slopes were 4H:1V or less (**Figure 37**). Along the steeper leach pad side slopes, both a geosynthetic clay liner (GCL) and a textured linear low-density polyethylene (LLDPE) liner were used. Textured LLDPE liners are used in steeper areas as they provide a greater degree of friction with adjacent materials. In the northeast corner of the leach pad, where deep snowdrifts were known to accumulate, a geocomposite drainage layer was placed over the GCL and then a geocomposite was added to provide additional infiltration and surface water drainage control. In the south corner of the pad, where the slopes are relatively steep and there is greater concern with the slope's stability a cover comprised of a textured LLDPE was installed.

After placement of the geocomposite covers, an 18-inch thick layer of clayey and weathered quartzite South Beal waste and Beal shear zone material was placed as a sub-soil cover, over which an 18-inch layer of soil cover was placed. The soil was seeded with an approved seed mixture. In the fall of 2003, most of the soil cap was supporting a stand of vegetation, however, as the vegetation is only one to two years old, vegetation density is only poor to fair.

4.4.9 Closure Leach Pad Dewatering

In October 2003 in anticipation of closure of the water treatment facility, the draw down and treatment of the in-pad solution was completed. When the solution reached its final elevation the sump pump began to cavitate and additional water could not be pumped. Depth of solution above the base liner in the vicinity of the sumps was approximately 17 feet (written communication Bruce Parker, BMMI, 1/15/04) (**Table 17**). At that time the pad was estimated to contain approximately 3,100,000 gallons of solution. Two of the four sumps located in the southwest corner of the leach pad have not yet been decommissioned. In the time since cessation of treatment the in-pad solution volume has increased to about 7,500,000 gallons (**Table 17**). There has been almost no precipitation in the area since late October and the increase in volume is thought to be the result of continued drain down in the pad rather than a leak in the cover.

TABLE 17
LEACH PAD SOLUTION ELEVATION AND VOLUME

Date	Solution Elevation (feet)	Solution Volume (million gallons)
10/22/03	7459.6	3.1
11/15/03	7460.3	3.6
12/01/03	7462.4	5.5
12/15/03	7463.2	6.5
01/10/04	7464.1	7.75

4.5 LAND APPLICATION DISPOSAL AREAS

Land Application Disposal (LAD) (**Figure 45**) at the Beal Mountain Mine site included three distinct events. These include: 1) LAD of captured water from the toe of the waste rock dump and pit area beginning in 1994 (discussed above under waste rock dump toe drain collection system, Section 4.3.1); 2) a limited, one-time application of treated solution in 1995 during mining operations, and 3) an extensive application of post-mining treated heap leach solutions between 2001 and 2003.

The later two events two events are discussed separately below, with the focus on the latter due to the much greater volume of solution applied and size of the area used. The history of land application of mining solutions (timing of application, and water quality and quantity) at the Beal Mountain Mine site, and the current conditions of the land application areas with respect to soil and vegetation are both discussed.

4.5.1 <u>1995 Land Application and Impacts</u>

Land application at Beal Mountain Mine was first undertaken in July 1995 in order to decrease leach pad solution volume. The 1995 area of land application area was located on approximately 3.5 acres in a grass/forb meadow on a 4H:1V west-facing slope slightly northeast of another land application cell C-7 on Beal's Hill (**Figure 45**). A detailed chronology of LAD operations is provided in **Appendix D-1**.

Approximately 2.58 M gallons of solution were first treated in a lined pond with hydrogen peroxide and allowed to circulate for 5 days. A pH of approximately 8.5 was maintained via the addition of phosphoric acid. Prior to land application of the solution, additional hydrogen peroxide was added, "in-line" to ensure cyanide destruction (Montana Tech, 1996).

The treated solution was mixed with roughly equal amounts of fresh makeup water and applied at a rate of 400 gpm using a sprinkler delivery system. Application occurred over a period of 8.5 days, and included a final fresh water rinse of the area using 0.49 M gallons of makeup water. Thus, a total of 5.33 M gallons of water were applied to this area. No complete chemical analyses of the applied solution were available, but Bruce Parker of BMMI (personal communication) indicated that total cyanide levels were < 1 mg/L, as requested by MDEQ.

Soon after land application, impacts to meadow vegetation and down-slope conifers were observed, including a browning and dying off of foliage. A greenhouse study performed by Montana Tech (1996) evaluated several potential causes of the observed effects including elevated salt and/or hydrogen peroxide concentrations. Although none of the observed field effects on vegetation could be reproduced in the greenhouse study, the report suggested that salts and/or elevated hydrogen peroxide concentrations were the likely cause of vegetation impacts. By inference, subsequent field and greenhouse studies performed in 1999 and 2000 (Spotts, 2000) suggest that thiocyanate may also have contributed to the observed impacts to vegetation.

4.5.2 Post Mining Land Application

In 2001, as part of final mine closure operations, a biological treatment plant was constructed at the mine to treat leach pad solution prior to its disposal in land application areas. Treated solution was applied via drip lines and sprinklers on several small land application cells ranging between approximately 0.5 and 2.5 acres and comprising a total of approximately 31 acres within the overall permitted land application area (**Figure 45**). Not all cells referenced in the table cited below are illustrated on this figure.

A total of 152,084,681 gallons of solution were treated and applied more or less continuously between July 2001 and November of 2003. Flow rates varied between approximately 125 and 200 gpm. The USDA-FS provided details of the location, volumes, and timing of solution application (**Appendix D-2).**

Water quality data for the applied solution varied somewhat by analyte over the course of land application. Bruce Parker of BMMI provided several analyses representative of treated solution throughout the application period. The range of key constituents is shown in **Table 18**. Complete data are available from files at the Beal Mountain Mine and through the MDEQ.

TABLE 18
REPRESENTATIVE TREATMENT PLANT DISCHARGE WATER QUALITY

Sample Date	pH	Concentration (milligrams per liter)				
		Total Dissolved Solids	Total Cyanide	Arsenic	Copper	Selenium
6-16-01	8.35	5365	6.96	0.013 [1]	0.042 [1]	0.584 [1]
8-22-01	7.72	5184	2.08	0.006 [2]	0.015 [2]	0.418 [2]
8-1-02	7.5	3450	2.9	0.050 [2]	0.03 [1]	0.274 [1]
12-23-02	7.6	5400	12.5*	0.077 [1]	0.043 [1]	0.260 [1]
4-30-03	7.6	3350	5.0	0.044 [1]	0.059 [1]	0.216 [1]
10-22-03	8.2	5110	3.7	0.097 [1]	0.186 [1]	0.357 [1]

1 – Total recoverable
2 – Dissolved
* - Value believed to be result of analytical methodology. Subsequent analyses of samples by this lab resulted in lower, more consistent values (Bruce Parker, BMMI, personal communication, 2003).

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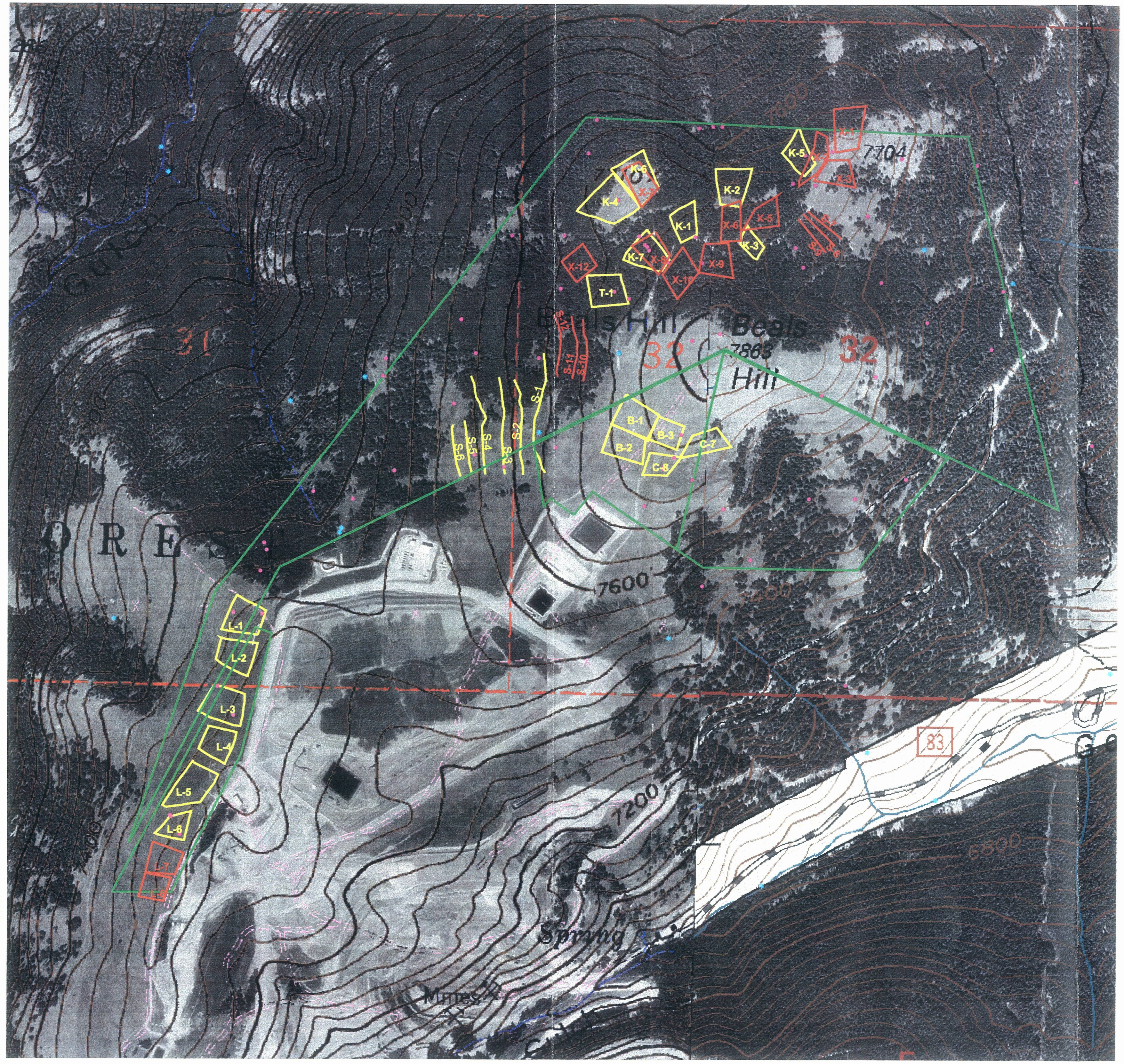

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X-1 B-1 (green box)	Drip Application Sites
S-1 X-1	Spray Application Sites

Land Application Disposal (LAD) Areas
Beal Mountain Mine
Silver Bow County, Montana
FIGURE 45

Figure 45 – Back page

4.5.3 Soil Chemistry and Vegetation Data, and Related Issues

4.5.3.1 SOILS

Laboratory and field soil studies (BMMI, 1988; Schafer and Associates, 1989; Schafer and Associates, 1990; Schafer and Associates, 1992) noted the ability of Beal Mountain land application area soils to attenuate metals and metalloids to varying degrees. This information, in conjunction with known "treated barren solution" chemistry, was the basis for approval and permitting of the Beal land application areas.

At the Beal mine site primary concerns are the accumulation of metal/metalloids, particularly selenium, in land application area soils, and their potential impact to vegetation, wildlife, and surface and groundwater resources. Additionally, there is a concern that elevated salt levels may also affect vegetation. While this may be true for some species, conductivity values of treated solution (around 4,100 micromhos per centimeter) suggest that salts in the soil do not pose a long-term threat to overall vegetation. This needs to be substantiated by forthcoming soil data. Extensive soil sampling was performed during land application by MDEQ staff and representatives. These data have not been available for review at the writing of this report.

The following exercise is used to put the loading of selenium to soils in perspective. Using the total volume of water applied (152,084,681 gallons) over 31 acres yields an average of 15 feet of water per acre over the land application area. It is recognized that actual rates over individual cells varied substantially and 15 feet is used only for discussion purposes. Using a selenium concentration in applied water of 0.3 mg/L (**Table 18**), the total load of selenium is equivalent to 14.2 kg/ha, or 12.5 lb/acre. Assuming a one foot depth of soil and a soil mass of 1,000 tons/six-inch acre slice, an average concentration of 3.1 mg/kg is calculated. This value is higher than those typically found in soils with non-seleniferous parent material but on the low end of soils derived from seleniferous sedimentary rocks (McNeal and Balistrieri, 1989). In reality, selenium would not be equally distributed throughout the soil profile and some selenium would move through the profile. Nonetheless, in the current absence of soil data, this example may be useful for establishing limits.

4.5.3.2 VEGETATION

Information on vegetation includes both qualitative and quantitative visual observations and plant tissue metal/metalloid analyses performed by MDEQ, USDA-FS and/or their representatives. Documents reviewed include USDA-FS memos (Clough, 2003; Wolley, 2003) and a report by Bighorn Environmental (2003) and data files summarizing plant tissue analyses obtained from the USDA-FS.

Visual observations have been made by USDA-FS scientists and contractors (Bighorn Environmental, 2003) in several areas representative of a range of vegetation communities present in the land application area. Solution application areas were compared to areas of no application. Bighorn Environmental (2003) noted a decrease in cover, species richness and a delay in phenology of some species on land application plots. However, factors other than land application, including grazing and land use history, were cited as being as important as land application in the observed results. Observed impacts were thus greater on grassland plots compared to forest plots, and on sprinkler plots (foliar damage) compared to drip areas. Additionally, it was acknowledged that the timing of the investigation (early spring) and the selection of plots affected observed results. Given the fact that many factors outside of land application can affect plant health and vegetation community composition, the observed affects were attributed primarily to areas in which high application rates occurred (possibly elevated salt

(TDS) concentrations) and unregulated grazing in areas of land application. Recommendations included protection from grazing and use of drip irrigation.

The USDA-FS findings indicated that overall, the vegetation community was not severely impacted based on field observations. Visual impacts to conifers were negligible. Land application had the greatest effect on the understory vegetation in forested areas, most notably grouse whortleberry (*Vaccinium scoparium*). In some areas, a large portion of the grouse whortleberry was apparently killed by application of solution. Additionally, other effects, but not mortality, were observed in some lupine plants, and reproduction appeared to be impaired. Some chlorosis was observed in other species. Conversely, western wheatgrass (*Agropyron smithii*) and several other grass species appeared to be thriving in the land application areas.

Additional vegetation monitoring was performed along transects by Westech under contract to the agencies. These data were not available for review at this writing.

Tissue metal and metalloid analyses were performed on approximately 255 samples collected from throughout the land application area representing about 40 species of grasses, forbs and sedges (**Appendix D-3**). It is not known what parts of the plant (leaf, stem, or root) were analyzed. Concentrations of metals and metalloids in vegetation, an agency concern, are affected by many factors including soil metal/metalloid concentrations, soil type and chemistry, species of metal/metalloid (i.e. elemental, organic complex, valence), plant species, plant phenology and the presence of competing anions (Mikkelsen, 1989). It is noteworthy that selenium uptake is decreased in the presence of sulfate, the concentrations of which are high (2,000 to 2,500 mg/L) in treated solution.

Analyses of Beal samples indicate that concentrations vary by analyte between and within a species and across levels of irrigation (none, moderate, high). However, although concentrations of many analytes are similar between treated and untreated areas, the higher concentrations are typically found in areas where land application occurred.

Of primary concern to the agencies are the accumulation of selenium in plant tissue and the potential effects on wildlife. The amount of selenium that can lead to chronic or acute toxicity varies by animal specie, but a continuous dietary intake of plants having an selenium concentration of < 2 mg/kg is generally considered safe (NAS-NRC, 1980) for all species. Selenium levels in vegetation that cause toxic effects range between 3 and 20 mg/kg for chronic exposure and 400 to 800 mg/kg for acute exposure (Girling, 1984). The plant tissue data from Beal shows that the majority of samples have selenium values < 2.0 mg/kg and that the majority of plants with values > 2.0 are represented by common yarrow (*Achillea millefolium*), heartleaf arnica (*Arnica cordifolia*) and pinegrass (*Calamagrostis rubescens*). This information, in conjunction with the relatively small (31 acres) amount acreage that land application area comprises relative to the surrounding watershed, suggests that the risk of selenium toxicity to terrestrial wildlife is limited.

4.5.4 Potential Long Term Impact to Water Quality

The determination of the potential impacts of the long-term release of selenium, total cyanide or other constituents of concern from land application area soils to surface or groundwater would require collection of subsurface soil pore water samples and characterization and modeling of fate and transport along the proposed flowpath. Even then, such an approach would provide only a predictive estimate of impacts. This level of effort is not warranted under the present circumstances.

A more direct, practical and empirical approach recognizes that the best indicator of impacts to groundwater and surface water is the monitoring data collected from these media. These data indicate that land application was likely responsible for recent increases in total cyanide, TDS, N and Se in both seeps and springs and surface water in German Gulch, Beefstraight Creek, and Minnesota Creek. Water quality data reported in many documents supports the claim that the elevated selenium concentrations in German Gulch are primarily related to springs and seeps in contact with selenium-rich waste rock and/or ore. Arsenic, copper and other metals are not currently present in elevated concentrations.

Future monitoring of these resources, now that land application is complete, will yield the most definitive information regarding long-term impacts of land application to surface and groundwater quality in these areas. However, examining the behavior of constituents of concern in soils can provide insight to the potential for long-term impacts.

Total cyanide in treated solution is comprised of strong (iron and cobalt) cyanide complexes, weak acid dissociable (WAD) (copper, cadmium zinc, etc.) cyanide complexes and free cyanide (Mudder, 1995; Logsdon et al, 1999). Free cyanide, as well as WAD cyanide, readily breaks down under the oxidized, neutral pH environment typical of soils and can be sorbed or utilized by microbes. Iron cyanide complexes are considered nontoxic under normal environmental conditions, and the release of free cyanide primarily via photolytically enhanced decomposition, would be subject to the forces discussed above. The amount of free cyanide associated with the breakdown of strong cyanide complexes is also quite small (Mudder, 1995). Therefore, over the long-term, release of cyanide from soils to surface and groundwater resources would not be expected to be substantial. Elevated levels of total cyanide observed in these resources at the Beal Mountain Mine may be the result of the application of relatively high volumes of water over a small area and subsequent localized saturated and/or runoff conditions.

The mobility of selenium in soil is dependent on soil pH and redox, the amount of organic matter present, microbial reduction potential, clay and iron and aluminum hydroxide content, and the concentration of competing ions (particularly sulfate) (Elrashidi et al, 1989). Under the circum-neutral to alkaline pH values and oxidizing conditions of the treated solution and soils in the LAD areas, selenium is most likely present as selenite (Se^{4+} as SeO_3^{-2}) or selenate (Se^{6+} as SeO_3^{-2}). These are the most mobile forms of selenium and their mobility in soils is controlled primarily by sorption, which increases with decreasing pH. Selenite sorbs more strongly than selenate and is thus less mobile. Laboratory and field testing has shown some sorption of selenium by land application area soils.

The degree to which selenium may be expected to move through soils and into surface and groundwater is difficult to determine without performing the studies and evaluations discussed at the beginning of this section. In lieu of this approach, an alternative approach is to examine the land application area in the context of the watershed in which it lies.

The land application area is approximately 31 acres, the majority of which lies in the Minnesota Gulch watershed. This area comprises a very small percentage (0.01%) of the overall 25,984 acres of the German Gulch watershed. Given that land application is complete and that the amount of infiltration and recharge in the land application area would be expected to return to more normal conditions (i.e. greatly reduced), the loading of constituents of concern to surface and groundwater should decrease. Pending the receipt of soil analytical data for conductivity (salts) and sodium adsorption ratio, rinsing of the land application area may not be warranted.

In conjunction with the information discussed above, the long-term effects of land application on surface and groundwater resources would be expected to be limited to those observed to date within the land application area and somewhat lesser to resources located downgradient of the area. This is particularly true for German Gulch, where the majority of water quality impacts (selenium and other constituents) are believed to be associated with buried seeps or surface water in contact with waste rock and/or ore.

4.6 OTHER FACILITIES

4.6.1 Maintenance area and Fuel Storage

The maintenance and fuel storage area consists of a 4.8 acres site that was historically used as a maintenance shop, warehouse and a fuel storage area. A small portion of this site has been regraded and topsoil applied and it has been revegetated (1.4 acres, **Table 2**) (**Figure 24**). Reclamation on the remainder of this site has consisted of only minor regrading. Soil testing will likely be required in this area to determine the presence or absence, and extent of any spills associated with fuels handling.

4.6.2 Crusher and Ore Storage Pad

The crusher and ore storage pad area consists of about 12.8 acres that was used as a pad for storing ore prior to crushing, agglomeration and placing ore on the leach pad. The pad also contained the primary and secondary crushers and an agglomeration facility. All of the crushing and agglomeration components have been removed from this site the area has been regraded. Twelve to 15 inches of cover soil were placed on the regraded pad and the area was revegetated.

4.6.3 Ancillary Facilities

Ancillary facilities consist of various corridors used for different purposes that include water management systems, access roads, and utility corridors. Reclamation varies depending on facility and has not been examined in detail.

4.7 ROADS

There are three main types of roads in the Beal Mountain Mine area access roads, haul roads and exploration roads.

Access roads such as those providing egress to the mine site were in existence prior to the mines development, and although these roads have been upgraded to provide all weather access to the site and better maintenance (culverts, drainage ditches, etc.), at the present time there is no plan to change these access roads by reclamation or closure activities.

Currently, there are about 10,600 lineal feet of main haul roads that have an average width of 70 feet (top of cut bank to bottom of fill slope). Originally the main haul roads in the Beal Mountain Mine area went through the Beal Mountain pit and out across a road constructed above the north highwall to the crusher pad. The expansion of the pit and heap leach facility, and movement of the west wall slide caused these roads to be relocated in the fall of 1992 and the spring of 1993 to their present position. These main haul roads can be seen on **Figure 3**. Haul roads run from the Beal Mountain pit, to the South Beal pit, along the south side and head of German Gulch, and across the waste rock dump to the crusher site. Most of the waste rock used to construct these roads came from reduced waste from the Beal Mountain pit. If one assumes an average thickness of waste rock in the foundation materials for the road prisms is about 20 feet, then there is about 824,444 cubic yards (634,187 tons) of waste contained in the road foundation materials. Some reclamation has been accomplished on these roads to date that includes pulling up of the fill slopes to narrow the road width, placing 10 to 16 inches of cover soil on the fill slopes, and revegetation. The surfaces of these roads have been regraded.

Another road exists along the crest on the west and north sides of the containment dike that surrounds the leach pad (**Figure 24**). This road is about 3,900 feet long and was used to access the maintenance and fuel storage area, the processing plant and LAD areas. As with the main haul roads, the fill slopes have been regraded, covered with 12 to 18 inches of cover soil and revegetated. The roadbed or surface has only been regraded.

Finally, there are a number of roads that were used for exploration purposes (**Figure 24).** These roads have a cumulative length of about 20,000 to 25,000 feet (3.8 to 4.7 miles) and all of them have been regraded and revegetated.

Reclaiming the surfaces of the main haul roads and the road on the berm of the containment dike may take as much as 75,000 cubic yards of material.

4.8 TOPSOIL STOCKPILE

There is a fairly large topsoil stockpile remaining on the Beal Mountain property located to the southwest of the crusher and ore storage pad (**Figure 3**). It contains between 230,000 and 300,000 cubic yards of material. It is estimated that an additional 75,000 cubic yards of material are needed to reclaim the remaining roads, and that probably an additional 50,000 are need to reclaim other miscellaneous facilities (maintenance area, processing plant area, top of waste rock pile), and rerouted drainage or pipeline areas (personal communication, Bruce Parker, BMMI, 12/31/03). If these estimates are accurate, this would leave an excess of topsoil of approximately 105,000 to 175,000 cubic yards of material to be used in final reclamation closure.

4.9 WATER TREATMENT PLANT

The original processing plant site consists of about 19 acres (**Figure 3**). The plant was constructed in an area cut into bedrock and has two of the larger ponds associated with the facility. The facility was originally used to process ore but was converted to a water treatment plant during closure activities at the Beal Mountain site. The water treatment plant treated process waters to destroy cyanide and reduce metal loads prior to application of the solutions to surface LAD areas. The water treatment facility is presently owned by MDEQ and has been mothballed for the winter of 2003-2004. The original closure plan for this site was to backfill the site, regrade and topsoil. Current plans call for drilling and blasting the rock cuts, regrading to an amphitheater-like shape, and topsoiling.

4.10 PONDS

4.10.1 <u>Description of Ponds</u>

There are six artificial ponds located on the Beal Mountain Mine site (**Figures 3**). Pond characteristics are summarized in **Table 19**.

TABLE 19
PONDS AT BEAL MOUNTAIN MINE SITE

Pond Name	Use	Location	Liner	Capacity (M gallons)	Area (acres)
Barren	Process	SW of Process Plant	PVC	2.0	0.59
Makeup Process Water	Makeup/LAD	NW of Process Plant	PVC	7.0	0.92
BCD under drain collection	Drain	South of leach pad	PVC	1.0	0.55
BCDA under drain collection	Drain	North of leach pad	PVC	0.3	0.19
Detox-Cyanide Destruct	Cyanide	On top of leach pad	PVC	4.0	1.12
Minnesota Pond	Makeup	SW of crusher	clay	0.45	0.25

All process water containment ponds at Beal Mountain were constructed with a base liner consisting of two 6-9 inch lifts of compacted clay as a liner overlain by a 40-mil PVC geomembrane liner. The Minnesota pond has a clay liner only and collects water from the headwaters of Minnesota Gulch, which was used for makeup water in drought years.

For the last few years, the BCD and BCDA ponds, when they discharge, do so directly over the hillsides below the ponds. In prior years, when the pad was in operation, this water was pumped into the leach pad as make-up water.

It is likely that the barren pond has a leak in its liner. Monitoring wells drilled to the southeast of the pond in the late 1990's indicated cyanide was present in groundwater next to the pond in the 0.01mg/L to 0.03 mg/L range. A collection system and a pipeline were constructed to drain seepage from the barren pond and to the BCD pond (**Figure 35**). Flow in the pipeline is estimated to range from 0.5 to five gpm, although flows as large as 15 gpm have been measured under very wet conditions (personal communication Bruce Parker, BMMI, 12/31/03).

4.10.2 Reclamation Status

None of the ponds have been reclaimed to date (**Figure 24);** a preexisting evaporation pond with a capacity of 16 million gallons was removed from the top of the heap leach pad in the recent past.

4.11 STORM WATER RUNOFF SYSTEM

The existing storm water drainage plan is shown on **Figure 46**. This map shows many of the site wide sampling sites, artificial drainage channels with flow directions, select portions of some drain systems and natural channels within the permit area.

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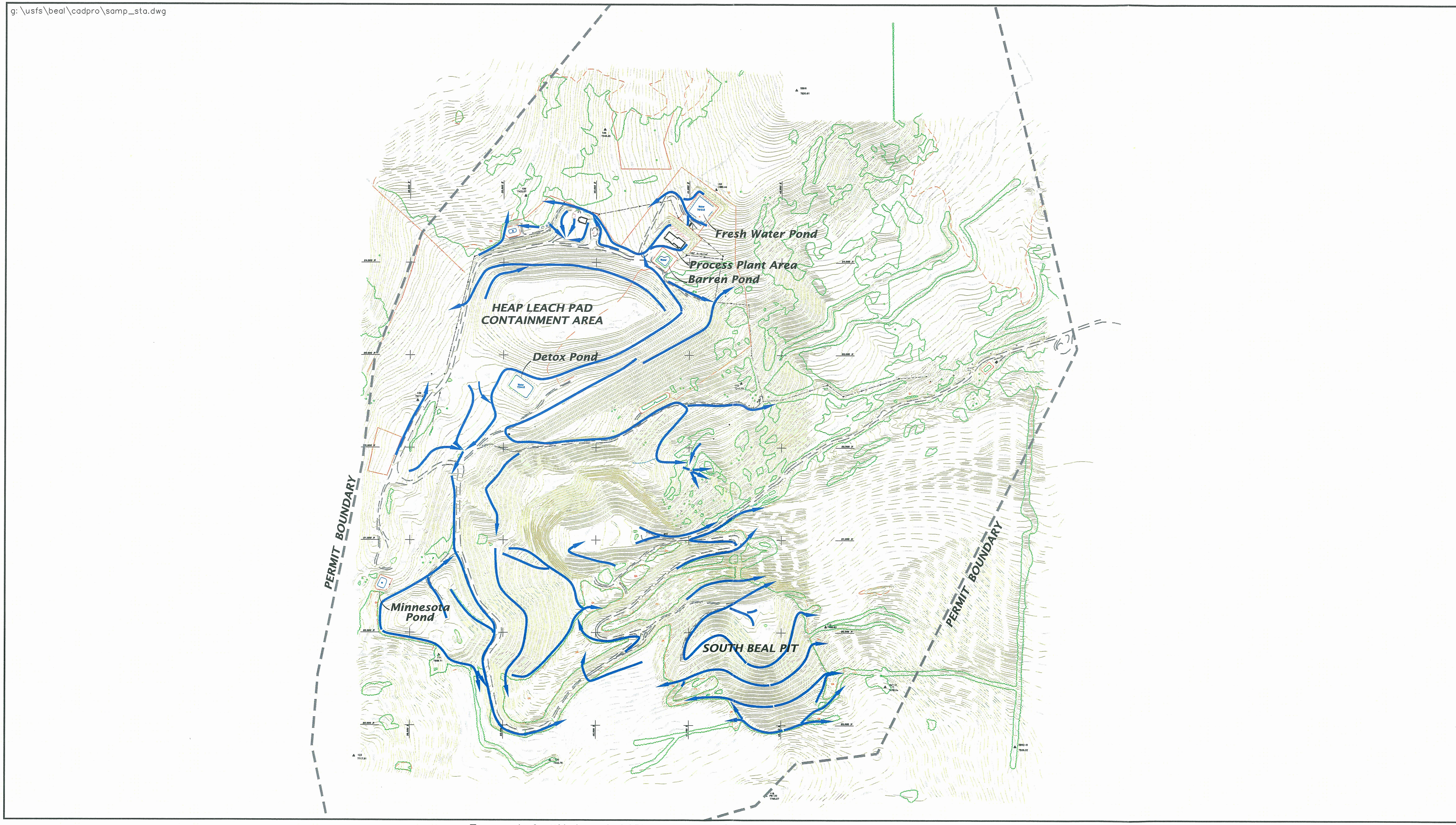

Topography from Horizons Aerial Photogrammetry, September 2003

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Stormwater Runoff Ditch

Stormwater Runoff Ditches
Beal Mountain Mine
Silver Bow County, Montana
FIGURE 46

Figure 46 – Back page

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APPENDIX A

Various Chronologies of the Beal Mountain Mine Project

Beal Mountain Mine Existing Conditions Report

Appendix A-1

BMMI mine Operations and Closure Chronology
Bruce Parker 01/04

PRE-MINING

Pegasus Gold acquired the Beal Mountain property from Montoro Gold Co. in May 1983. Earlier in the decade, Montoro had attempted to permit the property as a vat leach mill circuit, with a valley fill tailings impoundment (in German Gulch). The State of Montana denied the permit.

Pegasus Gold conducted additional drilling and exploration through 1986, performed mine design and feasibility in 1987, and submitted the Plan of Operations in February 1988. The application was deemed complete in June, 1988, with the Record of Decision issued on July 15, 1988. Construction began three days later.

JULY 1988 - NOVEMBER 1988

Mining commenced in the Main Beal pit on the 7400', 7380', and 7360' elevations. 100% of the waste rock went into construction of the leach pad dike; haul roads, and ancillary facilities. A total of 179,431 tons of ore and 692,940 tons of waste were mined in 1988.

Starting in October, ore was placed on the 7455', 7470' and 7485' lifts of cells 2 and 3 of the leach pad (stage 1). Construction began on the 7400', 7420' and 7440' lifts of the leach pad dike. Stage 2 leach pad construction was also initiated.

Other activities include construction of the fresh water makeup pond, barren pond, and Minnesota pond (additional makeup water storage), as well as construction of the carbon column process plant, and mine equipment maintenance shop (by Degerstrom). Work on the topsoil stockpile and crushing / agglomeration facilities also commenced. Clearing and grubbing was initiated on the waste rock storage area, and exploration drilling commenced on the South Beal deposit.

MARCH 1989 - JULY 1989

Mining continued in the Main Beal pit on the 7340', 7320', 7300', and 7280' elevations. Most of the waste rock continued to go to the construction of the leach pad dike. The first indication of geotechnical instability in the north highwall area was noted.

Ore was placed on the 7470' and 7485' lifts of stage 1 of the leach pad. Construction continued on the leach pad dike on the 7420', 7440', and 7460 lifts, and stage 2 of the leach pad construction continued with placement of the clay liner.

Construction of the waste rock storage area was initiated. A ramp grading downward from the 7300' elevation on the northeast side to the 7220' elevation on the south side was constructed. Clearing and grubbing continued on the lower portions of the waste rock storage area.

Other activities include construction of the fuel storage area near the mine maintenance shop, and South Beal exploration / drilling.

JULY 1989 - APRIL 1990

Mining continued in the Main Beal pit on the 7320', 7300', 7280', and 7260' elevations. The first indication of geotechnical instability along the west side of the pit (west wall slide bedding plane #1) was noted. A total of 1,501,914 tons of ore, and 1,996,860 tons of waste were mined in 1989.

Ore was placed on the 7500' lift of stage 1, and the 7500' and 7515' lifts of cells 2 and 3 (stage 2) of the leach pad. Construction continued on the leach pad dike on the 7440' and 7460 lifts.

Waste rock was placed in the 7175' and 7200' levels of the lower middle portions of the waste rock storage area. Clearing and grubbing continued on the lower portions (toe area), and the upper margins of the facility.

Other activities included concurrent reclamation and topsoil placement on the lower portions of the leach pad dike; clearing and grubbing was initiated on stage 3 leach pad expansion; and, construction of the middle haul road on the east side commenced.

APRIL 1990 - JULY 1990

Mining continued in the Main Beal pit on the 7280', 7260', 7240', and 7220 elevations, with almost all of the waste directed to the waste rock storage.

Ore was placed on the 7515' and 7530' lifts of cells 1, 2, 3, and 4 of stage 1, and cells 2 and 3 of stage 2 of the leach pad. By July, all of the stage 2-expansion area was covered with ore. Only minor activity occurred on the leach pad dike construction. Clearing and grubbing commenced on the stage 3 leach pad expansion.

On the waste rock storage area, another ramp was constructed down to the toe of the stockpile area, and waste rock was placed in the 7100', 7125', and 7150' levels. In addition, waste rock was placed in the 7275' and 7300' levels on the northeast side and the 7200' level in the middle portion of the waste rock storage area.

Other activities included drilling and excavation work activities in the north highwall area in preparation for constructing the north wall buttress, and completion of the middle haul road on the east side.

JULY 1990 - NOVEMBER 1990

Mining continued in the Main Beal pit on the 7240', 7220', 7200', and 7180' elevations, with a significant portion of the waste rock directed to constructing the stage 3 leach pad expansion (north dike, sumps, north catchment pond, and maintenance shop yard expansion). A total of 1,916,095 tons of ore, and 2,638,713 tons of waste were mined in 1990.

Ore was placed on the 7530' and 7545' lifts of the leach pad in stages 1 and 2 (cells 1, 2, 3, and 4). Waste rock was placed in the 7460' lift of the leach pad dike, and the south sump area was raised to the 7530' elevation.

Filling continued on the 7175' level of the lower portion, and the 7200' and 7225' levels of the middle portion of the waste rock storage.

Other activities included the stage 3 leach pad expansion, including construction of the north dike, sumps 2A and 3A, the north underdrain catchment pond, and the expansion of the maintenance shop yard. Construction of the north highwall buttress was completed, and major movement is noted on the west wall slide area.

NOVEMBER 1990 - JUNE 1991

Mining continued in the Main Beal pit on the 7180', 7160', 7140', and 7120' elevations, with the waste rock directed to the north and south leach pad dikes, construction of the haul road across waste rock storage, and the waste rock storage.

Ore was placed on the 7530', 7545', and 7560' lifts of stages 1 and 2 of the leach pad. The leach pad dike was finished to the 7480' elevation.

Filling continued on the 7225' and 7250' levels of the lower middle portion, and the 7350' level of the upper middle portion of the waste rock storage.

Other activities included ongoing stage 3 leach pad expansion, including installation of the clay liner in cells 2A and 3A. During this period, a new main haul road was constructed across the waste rock storage area and leading directly to the crusher area in an attempt to avoid the west wall slide geotechnical concerns. The east side hauls roads were abandoned following completion of the new haul road

The first South Beal permit application was submitted in January 1991.

JUNE 1991 - NOVEMBER 1991

Mining continued in the Main Beal pit on the 7160', 7140', 7120', and 7100' elevations. A total of 1,773,098 tons of ore, and 1,965,017 tons of waste were mined in 1991.

Ore was placed on the 7545', 7560', and 7575' lifts of stages 1 and 2 of the leach pad. The final lift of the leach pad dike (to 7500' elevation) commenced, and stage 3 leach pad expansion activities continued with installation of liner and sumps 2A and 3A, and final grading along the west side.

Filling continued on the 7250' and 7275' levels of the middle portion and the 7350' level of the upper waste rock storage area (just west of spring 1A).

Other activities included removal of material from the upper portions, and buttressing the lower portions of the west wall slide; and, reclamation of the north leach pad dike area (regarding, topsoil and revegetation).

NOVEMBER 1991 - JUNE 1992

Mining continued in the Main Beal pit on the 7140', 7120', 7100', and 7080' elevations.

Ore was placed on the 7545' and 7560' lifts of stages 1 and 2, and the 7515' and 7530' lifts of stage 3 (cells 2A and 3A) of the leach pad. The south leach pad dike is completed to the 7500' elevation.

Filling continued on the 7275', 7300', and 7325' levels of the middle portion of the waste rock storage pile. Clearing and grubbing to the 7440' elevation was initiated.

Other activities included relocation of a portion of the upper main haul road (“beaverslide section”) to avoid areas of geotechnical instability. The crushing and agglomeration system was replaced during the winter shutdown (December 1991 through February 1992). Systems to capture mine affected water from the toe of the waste rock storage area and various springs were constructed during this period, with the captured water directed to the process makeup circuit.

The first South Beal permit application was deemed complete by the regulatory agencies; however, Pegasus Gold immediately withdrew it in anticipation of re-submittal.

JUNE 1992 - NOVEMBER 1992

Mining continued in the Main Beal pit on the 7100’, 7080’, 7060’, and 7040’ elevations. A total of 1,673347 tons of ore, and 2,174,361 tons of waste were mined in 1992. A significant amount earthwork associated with the west wall slide was conducted during this period, including off-loading of the upper portions, and buttressing the lower portions of the slide area.

Ore was placed on the 7545’ and 7560’ lifts of the stage 3 portion of the leach pad (cells 2A and 3A). The south leach pad dike to the 7500’ elevation is completed, and the inside liner is extended to the top of the dike (7500’ elevation). The composite liner in cells 1A and 4A is completed during this period. Filling continued on the 7300’ and 7325’ levels of the middle portion of the waste rock storage area. Clearing and grubbing of the upper portion was nearly completed.

Other activities included construction of an upgradient, lined ditch above the west wall slide; additional regrading work on the haul road (beaverslide section); and, initiation of the capping program on the waste rock storage pile.

The South Beal permit application was resubmitted in August 1992.

NOVEMBER 1992 - MAY 1993

Mining continued in the Main Beal pit on the 7060’, 7040’, and 7020’ elevations. The first indication of geotechnical instability in the clay/sill area was detected during this period. Substantial groundwater was encountered in the floor of the pit near the toe of the west wall slide. A major campaign to off-load and regrade the upper west wall slide area was initiated during this period.

Ore was placed on the 7530’, 7545’, and 7560’ lifts of cells 1 and 1A, and the 7515’ and 7530’ lifts of cell 4A on the leach pad. The main access to the north leach pad and process plant area is routed across the south leach pad dike.

Filling continued on the 7350’ and 7375’ levels of the upper middle waste rock storage pile.

Other activities included construction of the main haul road along the south side of German Gulch, and the abandonment of the haul road across the lower waste rock storage pile.

The re-submitted South Beal permit application was deemed complete in March 1993, pending submittal of additional data.

MAY 1993 - NOVEMBER 1993

Mining continued in the Main Beal pit on the 7020', 7000', and 6980' elevations. A total of 1,709,928 tons of ore, and 1,519,071 tons of waste were mined in 1993. Clearing and grubbing commenced on the South Beal deposit.

Ore was placed on the 7545' lift of Cells 1, 1A, 2A and 4A, and the 7460' lift of cell 2A of the leach pad.

The 7100', 7150', 7200', 7250', and 7300' levels of the waste rock storage pile were filled and reclaimed (capped, regraded, and topsoiled). Filling continued on the 7350' level of the upper middle portion.

Other activities included surface buttressing and regrading in the clay/sill slide area.
The Record of Decision for the South Beal pit was issued in July 1993, and the permit granted. The permit instituted a number of compliance requirements, including "trigger levels" in German Gulch.

NOVEMBER 1993 - OCTOBER 1994

Mining continued in the Main Beal pit on the 7000', 6980', and 6960' elevations. A layback action on the west wall slide area was initiated, with material removed from the 7260' elevation down to the 7200' elevation. Mining commenced in the South Beal pit with the 7400', 7380', 7360' benches mined in the main portion of the pit, and the 7340', 7320' and 7300' benches in the satellite pit. A total of 1,783,574 tons of ore, and 1,440,913 tons of waste were mined in 1994 (combined Main Beal and South Beal pits).

Ore was placed on the 7560' lift of cells 1, 1A, 2A, and 4A, and the 7475' lift of cells 2, 3, 4, and 1A. The "detoxification pond", portable carbon columns, and a hydrogen peroxide application system were installed on cell 1 of the leach pad in anticipation of solution detoxification in 1995.

The 7350', 7375', and 7400' lifts of the waste rock storage area were filled during this period, and a ramp up to the 7425' elevation was initiated. Concurrent reclamation, including capping, regrading, topsoiling, and revegetation, were completed to the 7350' elevation.

Other activities included construction of the waste rock storage pile toe drain (October 1994), construction of the composite lined 7300 bench diversion September 1994, and installation of piezometers on the 7100 bench of the waste rock storage. In addition additional topsoil was placed on portions of the lower east side of the waste rock storage pile. Pit dewatering wells, pumping stations, and freshwater LAD systems were installed and operated due to increasing groundwater in the Main Beal pit. Additional fill was placed on the upper portions of the west wall slide.

Self-mining was initiated in 1994, with the purchase of equipment and construction of additional support facilities.

The Beal Extension (Phase 1) permit application was submitted in July 1994 as a Minor Amendment.

The first MPDES Permit application to discharge captured water from the waste rock toe drain, various mine-affected springs, and pit dewatering wells was submitted in July.

NOVEMBER 1994 - JUNE 1995

Mining continued in the Main Beal pit on the 6960' and 6940' elevations, and on the west wall slide layback. Mining in the South Beal pit was completed during this period.

Ore was placed on the 7575' and 7590' lifts of the leach pad. The detoxification pond is filled with hydrogen peroxide treated water in preparation for LAD.

The 7400' and 7450' levels of the upper portion of the waste rock storage area were filled with waste rock, primarily from the Main Beal pit.

Other activities included construction of overland conveyor system to allow agglomeration with pad solution; and, extensive pit dewatering and freshwater LAD in areas C and D. The storm water management system was designed, permitted, and ready for use by April 1995.

Approval was received for the Beal Extension (Phase 1) in December 1994. This permit allowed Beal Mountain to mine 100' below the original pit floor elevation of 6920' (to the 6820' elevation), and then backfill to the 6920' elevation with Beal Shear zone waste, or material from South Beal.

The first MPDES Permit application was withdrawn by Beal Mountain in May 1995.

JUNE 1995 - NOVEMBER 1995

Mining continued on the west wall slide layback (to the 6960' elevation), and in the bottom of the Main Beal pit (to the 6900' elevation). No mining activity occurred in the South Beal pit area during this period. A total of 1,635,530 tons of ore, and 1,284,795 tons of waste were mined in 1995

Ore was placed on the 7590' lift of the leach pad.

Waste rock was placed in the 7425' and 7450' levels of the waste rock storage area.

Other activities included reclamation of the lower east side haul road; regrading and reclamation of the upper north Main Beal pit highwalls; and, construction of the MPDES pipeline (approval was not granted to use the pipeline until January 1996.)

The MPDES Permit application was re-submitted in June 1995.

In July, approximately 2.5 million gallons of leach pad solution was treated and land applied on LAD Sites A/B on Beal's Hill, followed by a 2.5 million gallon freshwater rinse. Impacts to vegetation were noted.

A Minor Amendment to expand the waste rock stockpile was submitted and approved in July 1995.

Montana Tech was hired in September to investigate vegetation impacts in Sites A/B from the July land application disposal of detoxified leach pad solution.

NOVEMBER 1995 - JUNE 1996

Mining continued in the Main Beal pit on the 6920', 6900', 6880', 6860', and 6840' elevations. A layback of the south side (Beal shear zone) and the east side was initiated in anticipation of mining the deeper

Beal Extension. The Beal shear zone material was stockpiled near the crusher; just above the clay/sill slide area. An additional layback of the west wall slide was initiated using contractor.

Ore was placed on the 7590' and 7605' lifts of the leach pad.

Filling continued on the 7450' and 7500' levels of the upper portion of the waste rock storage pile.

Other activities included placement of a 200,000 ton stockpile of Beal shear zone capping material near the crusher area; clearing and grubbing to the 7500' elevation was initiated on the waste rock stockpile expansion; and, on-going reclamation of the east haul road system.

Exploration / drilling commenced on the upper South Beal expansion area.

The re-submitted MPDES Permit is approved in January 1996. Use of the MPDES pipeline began in February 1996.

A Minor Amendment application to expand the waste rock storage area to the 7500' elevation was submitted in February 1996, with approval received in May 1996.

JUNE 1996 - DECEMBER 1996

Mining continued in the Main Beal pit down to the 6780' elevation. Construction of access and haul roads in the upper South Beal pit were completed in preparation for mining. A total of 1,893,385 tons of ore, and 2,279,011 tons of waste were mined in 1996.

Ore was placed on the 7605' and 7620' lifts of the leach pad.

Filling with Main Beal waste rock continued on the 7450', 7475', and 7500' levels of the upper portion of the waste rock expansion area. The Beal shear zone stockpile is relocated from the crusher area to the 7550 lift of the expanded waste rock storage area.

Other activities include completion of clearing and grubbing on the waste rock storage expansion area, and undercoating the expansion area with Beal Shear zone material. LAD test plot studies were conducted on Beal's Hill.

JANUARY 1997 - DECEMBER 1997

Mining was completed in the Main Beal pit in February 1997, with an ultimate pit bottom of 6740'. Backfilling the Main Beal pit in 5' lifts with South Beal waste commenced in January 1997. Mining the South Beal expansion commenced in January 1997 at an upper elevation of 7560. Mining ceased in the South Beal pit in October 1997, with an ultimate pit floor elevation of 7200'. All of the waste from the South Beal expansion went to the Main Beal pit backfill, and for covering the east and north sections of the Main Beal pit highwalls. A total of 740,797 tons of ore, and 4,054,463 tons of waste were mined in 1997.

Ore was placed on the 7605, 7620' and 7635' lifts of the leach pad. The last ore was placed on the leach pad in October 1997. Phase 1 of the "evaporation pond" was constructed in June 1997, with a pond bottom elevation of 7600. The Phase 2 portion of the evaporation pond was constructed in October 1997, with an ultimate capacity of about 16 million gallons. The south leach pad dike was raised 5' (7505' elevation), including extension of the composite liner.

With the exception of a minor amount of waste rock generated from the Main Beal pit in early 1997, no waste rock was placed in the waste rock stockpile in 1997. Capping, regrading, topsoil placement and revegetation was completed to the 7500' elevation.

Other activities included construction of the clay/sill buttress in September 1997; regrading and reclamation work on the upper pit highwalls; capping and regrading work in the east pit "gazebo" area; and, initiation of regrading and reclamation work in the crusher area.

1998

Reclamation / closure activities which occurred in 1998 included: 1) the crusher area (removal of all crushing and agglomeration components, regrading, topsoil placement, drainage structures, and revegetation); 2) initiation of South Beal reclamation (tree removal, soil salvage, and initiation of regrading on the uppermost slopes); 3) east haul road, upper pit highwalls, and upper pit "gazebo" area reclamation (capping, regrading, topsoil placement, drainage diversion, and revegetation); 4) extension of the SPR-10A pipeline (from the upper south margins of the waste rock stockpile to the toe collection system); 5) Beal Shear zone reclamation (regrading and topsoil placement); 6) heap leach pad regrading (approximately 15% completed in 1998); and, 7) initiation of a project-scale bio-treatment study of the leach pad solution.

1999

Reclamation / closure activities which occurred in 1999 included 1) completion of the South Beal reclamation (regrading, topsoil placement, revegetation, and leach pad capping stockpile); 2) Main Beal pit (regrading, topsoil placement, and armored channels); 3) heap leach pad regrading (approximately 50% completed by the end of 1999); and, 4) raising the south leach pad dike to the 7510' elevation (compacted fill only).

2000

Reclamation / closure activities which occurred in 2000 included 1) a extensive investigation into leach pad solution treatment methods, including laboratory scale bio-treatment testing; 2) construction of a pilot scale biological treatment plant; 3) construction of a full-scale biological treatment plant (approx. 60% completed in 2000); and, 4) initial haul road reclamation.

2001

Reclamation / closure activities which occurred in 2001 included 1) completion and commissioning of the full-scale bio-treatment plant; 2) final regrading, capping, and revegetation of approx. 50% of the heap leach pad; 3) regrading of the upper waste rock stockpile area; and, 4) on-going haul road reclamation.

2002

Reclamation / closure activities which occurred in 2002 included 1) on-going bio-treatment and LAD of leach pad solution; 2) final regrading, capping, and revegetation of the remaining portions of the heap leach pad (approx. 50%); 3) final regrading and reclamation of the floor of the South Beal pit area; 4) additional revegetation work on portions of the South Beal pit area; 5) additional regrading of the upper waste rock stockpile area; and, 6) on-going haul road reclamation.

2003

Reclamation/closure activities that occurred in 2003 included: 1) on-going bio-treatment and LAD of leach pad solution (completed in November 2003); 2) on-going haul road reclamation; and, 3) completion of drainage structures on the northeast portion of the leach pad area.

Appendix A-2

USDA Forest Service Administrative Record Chronology

DATE	USDA DEERLODGE NATIONAL FOREST CHRONOLOGY OF MINE ACTIONS
6/28/83	Montoro Gold Inc. news release stating a preliminary feasibility study had been completed on the Beal property. Plans are for a 3,000 ton/day open pit followed by crushing, grinding, and either gravity, flotation, or cyanide leaching of the ore. A tailings impoundment would be placed in German Gulch.
9/1/83	Meeting between Deerlodge NF staff members and representatives from Montoro Gold to discuss Montoro's proposal to construct a mine and mill facility in German Gulch.
11/2/83	Letter to Deerlodge Forest Supervisor from Zone Fisheries Biologist states: "Although the fish habitat in German Gulch has only limited value, fingerling salmonids were observed within 100 yards of the proposed tailings dam. German Gulch, above Greenland Gulch, has very limited habitat due to low flows and past mining activity."
11/4/83	Montoro Gold submits a plan of operation to the FS for construction of a 3,000 ton/day open pit mine with a combination gravity and cyanide vat leach recovery system for gold.
3/22/84	Complete Operating Plan received for Montoro's German Gulch Mine project.
4/3/84	Public notice that the FS & MT Department of State Lands (DSL) will jointly prepare an EIS for Montoro's proposed German Gulch Mine.
Late 1984	German Gulch/Beal property acquired by Pegasus Gold from Montoro.
7/20/85	Pegasus Gold submits exploration plan for Beal property.
7/16/86	Pegasus Gold submits exploration plan for Beal property.
7/8/87	Pegasus Gold submits exploration plan for Beal property.
12/12/87	Montana Standard article saying Pegasus will propose an open pit gold mine in German Gulch which will produce 32-35K oz gold per year for 10 years.
2/1988	Pegasus Gold submits an application for a hard rock mining permit to DSL (joint approval of operating plan by FS).
7/1988	DSL and FS complete an Environmental Assessment and Preliminary Environmental Review of the Beal Mountain Project.
7/8/88	DSL approves the permit for the Beal Mountain Mine under a bond of $2,770,172.
7/12/88	The Deerlodge Forest Supervisor signs a Decision Notice & FONSI approving the Beal Mountain Mine Project.
11/28/88	Regional Forester John Mumma presents Pegasus with the Regional Forester's Excellence Award for outstanding efforts in development of the Beal Mountain Mine Project.
3/24/89	Butte Dist. Ranger Merrill Davis sends Beal Mountain Mining Inc. (BMMI) a letter after severe runoff created sediment problems in Beefstraight Creek. Measures to prevent future problems are outlined.
1/2/91	Pegasus submits nomination of BMMI for Environmental Leadership Award sponsored by DuPont Inc. Supporters of nomination include: George Grant Chapter of Trout Unlimited; Montana Chapter of Nature Conservancy; Montana Dept. of Fish, Wildlife & Parks; Deerlodge National Forest; U.S. EPA; Northern Region USDA Forest Service; and local government agencies and citizens.
5/1991	Movement noted in NW wall of pit. Area of movement is bounded on east by Gully Fault, a small, steeply-dipping fault plane running NW'ly through the pit and into the highwall; and on the bottom by a bedding plane shear clay-layer.
6/1991	Hydrometrics, Inc. submits 1990 annual hydrologic monitoring report to BMMI. Report notes that Se levels approached or exceeded the primary drinking water standard of 0.01 ppm at springs SPR-5 & SPR-12A during several months.

DATE	USDA DEERLODGE NATIONAL FOREST CHRONOLOGY OF MINE ACTIONS
6/1991	Movement of slide in NW wall of pit peaks at nearly 0.8 ft/day. Steps taken to reduce movement include unloading of cell 1 in the leach pad, unloading of top of slide area, blasting of bedding plane clay layer on which the slide was moving, and ceasing mining of a portion of the pit to be used as a buttress against further movement.
8/1991	Movement of slide has reduced to less than 0.1 ft/day.
9/12/91	DEQ inspection report from 8/22/91 trip. Talks about need to identify potential for acid production in the heap and waste rock. Initial plans to punch the pad liner at reclamation needs to be modified until potential for acid production is verified.
1/6/92	Klohn Leonoff, Inc. sends a letter to BMMI regarding their assessment of external stability of the ore heap.
1/21/92	BMMI submits initial proposal for South Beal Project. DSL & FS start MEPA/NEPA review of project, eventually determining that an EIS will be needed. BMMI subsequently withdraws proposal.
1/27/92	Klohn Leonoff, Inc. submits a "Design Review of Slope Stability and Water Balance Stage Three Leach Pad" to BMMI. Some concern raised over SW corner of pad, where they recommend reducing slope from 2H:1V to 2.5H:1V.
2/14/92	FS documentation of a 2/11/92 meeting at Schafer & Assoc. in Bozeman, including FS, DSL, & BMMI. Conclusion: 1. ARD doesn't appear to be a potential problem for waste or spent ore; 2. Waste sampling needs to continue to verify lack of ARD potential; 3. Humidity cell tests indicate As won't be a problem, but need additional analyses to verify; 4. Need to run through an analysis of spent ore heap detoxification & reclamation using USBM Heap Rec computer program; 5. Beal should conduct bench-scale tests on heap neutralization & detox to provide data for accurate cost determination and bond calc; 6. No special problems identified w/South Beal Amendment; 7. Beal will work w/Schafer & Assoc. to update a proposal for modification of the neutralization & reclamation plans.
4/22/92	Deerlodge Forest submits nomination of BMMI for National Wildlife Federation's 1992 Environmental Achievement Award.
5/22/92	DSL issued a Notice of Noncompliance to BMMI for failing to report a cyanide leak in the barren pond liner.
6/25/92	DSL sends a letter to BMMI requiring increased water monitoring to verify dissipation of cyanide levels after repair of the leak in the barren pond. The letter also notes that nitrate & sulfate levels have increased at some monitoring points. Beal was found to be taking steps to divert water from spring 5 without having 1^{st} contacted the regulatory agencies.
6/30/92	Some increased movement noted in slide area after 4 days of heavy rain. Lots of sediment problems throughout mine area.
7/9/92	Inspection by Water Quality Bureau, documented in undated report. Notes problems with turbidity, nitrate, sulfate at some sites. Fe, Mn & Zn elevated in Spring 5, but not over standards. No analysis for Se.
7/30/92	Highwall (slide) still moving, but down to 0.3 ft/day.
8/6/92	Highwall (slide) still moving, about same rate as 7/30.
8/1992	BMMI applies for Amendment #1 to their Operating Permit. This amendment was to move the haul road from the north side of German Gulch to the south side.
8/1992	BMMI submits a draft plan for a test heap evaluation in response to concerns by DSL & FS about long term environmental performance of reclaimed heap leach facilities. Parameters to be monitored included Se down to a detection limit of 0.005 mg/l.
8/11/92	Schafer & Associates submits a draft technical report to Pegasus: "Geochemical Behavior of Sulfate: Potential Source Identification at the Beal Mountain Mine." Conclusions are that increased sulfate levels are coming from the waste rock, and will decrease over time. Part of the proposed mitigation is to pump water from springs 3 & 5, which shows elevated levels of sulfate, to the plant to be utilized as process water.

DATE	USDA DEERLODGE NATIONAL FOREST CHRONOLOGY OF MINE ACTIONS
8/13/92	BMMI submits a draft "Operational Mine Waste Sampling and Geochemical Assessment Plan to DSL & FS.
8/14/92	DSL approves Amendment #1 after completion of an EA.
8/18/92	BMMI resubmits South Beal Project operating permit amendment to DSL & FS.
9/17/92	Highwall (slide) movement has been enough that the main access road has been closed. Access is through the main pit & up the haul road with the ore trucks to the crusher area.
9/30/92	Water Quality Bureau sends a letter to BMMI documenting observed sediment problems in German Gulch. An attached field investigation report based on a 7/9/92 inspection by the WQB shows elevated TSS, TDS, sulfate, & nitrates at all sites, with highest concentrations at spring 5. Spring 5 also showed elevated levels of Fe, Mn & Zn. There was no analysis for Se.
10/16/92	Highwall still moving. "Lots" of movement observed in lower 2 benches.
1993? (undated)	Draft Beal water quality restoration plan setting trigger levels for nitrate & nitrite as nitrogen (1.0 mg/l); sulfate (200 mg/l); TDS (400 mg/l); pH (6.5-8.5 s.u.); Cu (0.025 mg/l); As (0.025 mg/l); Se (0.025 mg/l).
1/7/93	BMMI presents a proposal to mine deeper into the main Beal pit. Proposal is called Main Beal Extension. Agencies in attendance include DSL, DHES Water Quality Bureau, & the Deerlodge NF. Proposal is to go 200 ft deeper than the permitted free-draining level, taking the pit more into the Beal Shear Zone on the south wall of the pit. Future plans might include further deepening.
1/12/93	DSL internal memo from agency specialists to DSL Hard Rock Bureau Chief outlining problems and possible violations at Beal, asking for guidance.
2/17/93	Letter from Butte Dist. Ranger to BMMI reiterating problems itemized in DSL memo of 1/12, and asking for info to be analyzed by FS specialists to determine if corrective action will be needed.
2/18/93	BMMI submits final "Operational Mine Waste Sampling and Geochemical Assessment Plan to DSL & FS.
3/1/93	Deerlodge Forest conducted a Beal "as-built" IDT meeting to go over any differences between the original approved operation and what was being done on the ground. Several differences were noted, but most were thought not to be significant.
3/3/93	DSL & FS determine that the South Beal Project proposal is complete
3/9/93	Work was continuing to unload top of slide area above pit. Plans were to stabilize it sufficiently to allow an excavator to construct a diversion ditch to keep runoff water away from the area.
3/23/93	DSL issues a Notice of Noncompliance and Order of Abatement to BMMI for one of the possible violations mentioned in their internal 1/12/93 memo. This is for the use of nitrogen-based fertilizer along with seed application for revegetation. The fertilizer is judged to be a contributing factor to nitrate level exceedances in German Gulch.
3/1993	Draft EIS completed for South Beal Project by DSL & FS.
4/22/93	Highwall slipping is stated to be down to 0.2 (ft/day?).
6/8/93	Pegasus submits a draft study plan for nitrate, sulfate, TDS and Selenium increases investigation at Beal. Arguments are made against using macroinvertebrate, fish, & periphyton sampling as means of measuring impacts. Proposal is for specific monitoring and source identification of contaminants.
6/16/93	Dozer removing additional material at top of highwall slump.
6/30/93	Final EIS completed for South Beal Project by DSL & FS.
7/8/93	Margie Ewing signs ROD for South Beal EIS on behalf of the FS. ROD includes trigger levels to be used, including 0.025 mg/l for Se. Figures in the ROD show that the average Se level at STA-3 in 1992 was 0.020 mg/l, and the highest level of Se at STA-3 was 0.027 mg/l. By 1998, maximum Se level at STA-3 and below was to be at 0.006 mg/l. Baseline (pre-mine) Se level was stated to be "in the 0.004 mg/l range." Exceedance of trigger levels was to result in a list of actions to correct the problem.

DATE	USDA DEERLODGE NATIONAL FOREST CHRONOLOGY OF MINE ACTIONS
7/20/93	Arthur Clinch signs ROD for South Beal EIS on behalf of DSL. Same wording regarding trigger levels and Se concentrations as in the FS ROD.
8/6/93	Trucks hauling waste from highwall lay-back (slump).
8/9/93	Letter from EPA to FS & DEQ outlining concerns regarding South Beal FEIS & ROD. Particularly concerned about water quality issues in German Gulch. Se not mentioned.
8/12/93	Trucks hauling waste from highwall lay-back (slump).
9/27/93	FS documentation of 9/17/93 meeting including BMMI, DSL & FS. Heavy 1993 rainfall has caused problems. Suggestion was made that any excess process water be land applied on the German Gulch side of the land app area. The slide is nearly dormant – movement down to hundredths of a ft/day. A portion of the highwall on the north side of the pit could have an ARD problem, so waste from this area will be isolated in the dump with a covering of high neutralization potential waste from the Beal Shear Zone. No mention of any Se problems documented in notes.
9/30/93	BMMI requests an extension on submittal of a NO_3/SO_3/Se report until 12/15/93.
10/29/93	DSL grants BMMI the requested extension for NO_3/SO_3/Se report.
10/29/93	BMMI submits a draft Revised Hydrologic and Water Chemistry Monitoring Plan to FS & DSL for review
11/3/93	FS grants BMMI the requested extension for NO_3/SO_3/Se report.
12/1/93	BMMI submits results of on-going sampling and analysis for selected water quality monitoring stations. Sample results show levels of nitrate and selenium below the trigger levels at STA-3 for 3 consecutive weeks.
12/22/93	BMMI submits a request to DSL & FS asking to use new LAD areas on a trial basis for fresh water disposal. (No designation of C & D in submittal)
1/6/94	FS responds to 10/29/93 draft plan submitted by BMMI, stating that it is satisfactory.
1/7/94	BMMI submits December 1993 hydrologic monitoring report for Beal. Se levels: STA-3 – 0.023 mg/L @0.25 cfs; STA-3A – 0.017 mg/L @0.3 cfs; STA-4 – 0.008 mg/L @0.15 cfs; SPR 5 – 0.098 mg/L @0.02 cfs.
1/21/94	Letter from DSL to BMMI approving trial use of LAD area C for disposal of degraded spring water.
2/8/94	FS responds to 12/22/93 request for use of new LAD areas for trial disposal of fresh water only. Additional info requested prior to use for anything beyond trial.
8/11/94	Letter from BMMI to DSL stating that due to good weather, it is unlikely that they will be conducting large scale LAD this year. They do plan to conduct some pilot scale LAD this summer/fall on Areas A & B to make sure system works as designed.
9/30/94	DEQ inspection report mentions horizontal dewatering wells being put in to intersect water behind a diorite dike underneath the waste rock dump in order to lower the phreatic surface behind the dike and de-water the waste dump.
10/24/94	Letter from DSL to BMMI stating "based on the data available to date, that metals migration from the Beal shear material is unlikely to be a problem." The letter does request continued monitoring and analysis of a suite of metals including Se.
10/26/94	Completion of checklist EA by DSL for deepening main Beal pit by 100 ft. The EA notes that some degradation of German Gulch waters has occurred as elevated nitrate, sulfate, and selenate. The primary source is seepage from the base of the waste dump, known as Spring 5. The sulfur and selenium occur naturally, and fracturing of the rock by mining has accelerated weathering and release of these elements. Capture of this water has helped to reduce flow of these contaminants to German Gulch.
10/31/94	Site inspection by Wayne Jepson (DSL) notes turbidity in German Gulch probably caused by runoff from haul roads. Water samples taken at STA-3 to check for trigger levels.

DATE	USDA DEERLODGE NATIONAL FOREST CHRONOLOGY OF MINE ACTIONS
1/5/95	Sample results for Spring 19, downgradient from LAD C (sampled 12/12/94) show Se level at <0.005 mg/l.
1/6/95	BMMI submits request for permit boundary expansion and use of LAD area D for fresh water disposal. Water sample results for pit area included for usual parameters, showing Se levels in pit dewatering wells to be <0.021 mg/l (2@ <0.005, 1@ 0.052); in SPR-1A to be 0.014 mg/l; in SPR-5 to be 0.123 mg/l; in SPR-10A to be 0.006 mg/l
1/31/95	Sample results for Spring 19 (sampled 1/19/95) show Se level at 0.011 mg/l.
2/15/95	Sample results for Spring 19 (sampled 2/2/95) show Se level at <0.005 mg/l.
6/16/95	Letter from BMMI to DSL & FS notifying agencies of intent to start LAD of treated barren solution in order to maintain favorable water balance in leach pad.
6/29/95	Letter from DSL to BMMI regarding 3rd review of Beal LAD Minor Amendment 007. Proposal found complete. Problems noted include: 1. Trigger levels for As & Se both exceed the surface water quality standards for German Gulch; 2. Trigger levels for As, Se, & CN exceed groundwater standards.
7/5/95	Letter from BMMI to DSL & FS notifying agencies of land application of treated barren solution. LAD undertaken due to unusually cool, wet spring and need to maintain favorable water balance in leach pad.
7/10/95	BMMI submits an application to FS & DEQ for minor revision to increase the height of the waste dump.
7/21/95	DEQ inspection of Beal. Note that horizontal drains into base of waste rock dump have lowered phreatic surface and improved water quality in Spring 5.
10/9/95	BMMI letter to EPA discussing water management at Beal. Talks about measures to capture flow from Spring 5, pit dewatering, and handling of stormwater.
10/17/95	Hydrologic monitoring report for July & August notes vegetation impacts from LAD on Area A. Possibly due to salt content? Arranged for a study by Montana Tech to look at treatment alternatives.
3/4/96	DSL approves an internal checklist analysis to expand permit boundary to provide additional acreage for land application. This covered inclusion of Areas C & D for fresh water land application.
3/5/96	FS agrees that the permit boundary extension for land application of fresh water at Areas C & D is a minor revision which will not require any further analysis by the Forest.
4/19/96	DN/FONSI signed by Butte DR for waste rock storage expansion.
4/29/96	DSL approves waste rock expansion subject to concurrence by FS.
6/11/96	Note in FS inspection report that area of pipeline installation along road has been hydroseeded.
7/5/96	BE for sensitive fish species prepared for South Beal Pit Expansion. No Impact to Arctic grayling and bull trout. May Impact Individuals or Habitat, but will not likely contribute to a trend towards federal listing or loss of viability to the population or species for westslope cutthroat.
7/16/96	DN/FONSI signed by Butte DR for South Beal pit expansion.
7/17/96	Internal EPA memo regarding Beal Mine water management, particular concerns about long-term management of flows from Spring 5.
8/18/96	1,200 – 2,500 gallon process solution spill w/in plant yard. 4.6 – 9.3 lbs of contained cyanide. All solution was contained & detoxified by hydrogen peroxide. Contaminated soil was hauled to the leach pad. No environmental impacts.
9/25/96	FS approves South Beal expansion.
9/27/96	DSL approves South Beal haul road revision.
10/16/96	DSL approves South Beal expansion subject to receipt of $14,732,000 bond (prev. at $6,274,000).

DATE	USDA DEERLODGE NATIONAL FOREST CHRONOLOGY OF MINE ACTIONS
1/30/97	Cover letter for 12/13/96 DEQ inspection and sampling of water. Sampling "indicated pit water to be alkaline, but to have elevated metals (particularly arsenic, selenium, iron, copper, and aluminum)…" The report stated that the metals were likely largely associated with the high TSS content of the sampled water. "These data are consistent with previous analyses which indicate that arsenic and selenium are the principal elements of concern at this site."
2/1997	Mining ceases in main Beal pit.
4/1997	Aquatic biological monitoring report for German Gulch in 1996 submitted to BMMI by Dan McGuire & Erich Weber. Macroinvertebrate & periphyton-based assessments indicated moderately impaired biointegrity in upper German Gulch, primarily due to sediment and channel alteration/degradation from historic placer mining. Only slight biological impacts from nutrient pollution. Metals pollution not indicated.
6/13/97	Montana Standard article: "Beal Prepares for Shutdown." 112 workers will be laid off in three waves starting Aug. 10
7/15/97	FS inspection reports that leach pad material above slide is being removed to take weight off.
7/24/97	Cover letter for 6/3/97 DEQ inspection and sampling of water. Water sample from Main Beal pit sump shows elevated Se. Note in report that "minimization of selenium release appears to be the key to achieving 'walk-away' reclamation of the Main Beal pit…"
7/29/97	BMMI submits letter to FS & DEQ proposing to proceed w/field test of LAD at 3 sites, each approx. 50' X 50': 2 in open grassland on the west-facing slope of Minnesota Ridge, just west of the leach pad; and 1 in a NW-facing lodgepole/spruce forested area ~500' north of the grassland plots. Solution will be detoxified w/H_2O_2 in combination w/sodium hydroxide & phosphoric acid.
10/1997	Mining ceases in South Beal pit.
1/16/98	BMMI files voluntary petition under Chapter 11 of Title 11 of USC (Bankruptcy Code).
2/23/98	Aquatic biological monitoring report for German Gulch in 1997 submitted to BMMI by Dan McGuire & Erich Weber. Biological assessments indicated good water quality in upper German Gulch. Macroinvertebrate-based assessment showed a significant improvement in upper German Gulch during 1997. Periphyton biointegrity was considered fair with moderate impairment due to sediment & slight impairment due to nutrient enrichment. Neither assessment indicated toxic (metals) pollution.
3/16/98	Cover letter from BMMI to FS DR for 1997 German Gulch aquatic biological monitoring report. Results indicate a "non-impaired biointegrity in 1997," 1st time since program initiated.
6/24/98	Cover letter for 5/6/98 DEQ inspection and sampling of water. Elevated nitrate & Se noted in North & South Main Beal pit backfill drains and at STA-3 in German Gulch. Subsequent info from Bruce Parker showed there had been a break in the pipeline from Spring 10A to Spring 5. This could have contributed to elevated Se levels in German Gulch prior to repair.
11/23/98	Cover letter for 8/19/98 DEQ inspection and sampling of water. Sample results showed a reduction in Se following measures taken to divert the upper waste rock underdrain water. Se remains somewhat elevated in the stream down gradient of the waste dump, but they were noted to be declining slowly.
12/22/98	Kelvin J. Buchanan appointed as Chapter 11 Trustee for BMMI.
1/14/99	Trustee converts BMMI Chapter 11 to Chapter 7 under Bankruptcy Code.
4/1/99	BMMI submits a minor revision for a final leach pad regrade and reclamation plan for Beal to FS & DEQ. Includes partial capping of the pad w/GCL liner.
4/1/99	DEQ issues MPDES Permit modification to discharge from drains around reclaimed Main Beal pit & springs in the immediate area, and from drains beneath the reclaimed waste rock dump.
4/22/99	Final version of Beal Reclamation Agreement sent out for agency signatures by Timothy A. Lukas with Hale Lane Peek Dennison Howard and Anderson out of Reno, NV.

DATE	USDA DEERLODGE NATIONAL FOREST CHRONOLOGY OF MINE ACTIONS
6/16/99	Unifield Engineering submits a heap leach pad water evaluation and wastewater review proposal to BMMI.
6/27/99	FS inspection report notes that leach pad grading is completed and crews are working on upper end of South Beal to move material down to a stockpile to be used as capping material on the leach pad at a later date.
6/29/99	Conference call on Beal including DEQ, BMMI, & FS. No commitment from Unifield yet on treatment of solution, but probably heading toward peroxide. Biggest problems from peroxide will be sodium salts and ammonia.
7/26/99	FS inspection report notes a meeting on the ground w/FS, DEQ & BMMI reps to go over 3 sites set up for testing of LAD.
8/27/99	FS inspection report notes LAD started on 3 test sites. Vegetation changes noted: needles falling off some spruce & alpine fir, whortleberry has dried out, veg in grassy areas has turned brown, lupine died after a few days application.
9/3/99	FS inspection report notes adverse effects to vegetation from land application of treated leach pad solution. Cause unknown. Will experiment w/lower application rate.
12/13/99	Leach pad solution overtops containment dike. Estimates of spilled volume range between 80,000 & 190,000 gallons. Approximately 70,000 gallons were captured in the lined pond at the base of the dike.
1/17/2000	BMMI provides a draft work plan for a land application treatment and greenhouse study.
1/25/2000	Unifield Engineering, Inc. provides BMMI with Preliminary Evaluation of Options for the Removal of Cyanide-Related Species from Beal Mountain Mining Process Solution. Treatment methods evaluated included alkaline chlorination, ozone oxidation, Caro's acid, hydrogen peroxide, copper thiocyanate precipitation, reverse osmosis, evaporation, and biological. Concludes that 3 processes are potentially suitable for use at Beal: ozone oxidation, hydrogen peroxide oxidation, and biological treatment. Recommends further testing of these processes to determine best.
1/31/2000	FS-DEQ-BMMI meeting to discuss contingency plan for handling solution volume at Beal. Need to obtain advice from legal counsel on options for dealing w/excess solution under CWA, etc.
3/6/2000	Cover letter from BMMI to FS DR for 1999 German Gulch aquatic biological monitoring report (2/23/2000). Biological assessments indicated good water quality throughout German Gulch in 1999. Summer sampling showed lower macroinvertebrate biointegrity and lower periphyton assessments for 2 German Gulch & 1 Greenland Gulch sites. Neither assessment indicated toxic (metals) pollution. October sampling indicated nonimpaired macroinvertebrate biointegrity at upper German Gulch and improved periphyton assessments. Lower German Gulch also showed a healthy biological community in October. Overall lower "scores" attributed to low stream flows and cattle impacts to riparian areas.
4/26/2000	BMMI submits 1st Quarter 2000 progress report to DEQ & FS. Results of solution detoxification study are included. Further study concluded that biological treatment was the only practical process, and a decision was made to proceed with construction of an on-site pilot treatment test. The progress report also included a consultant's conclusions that raising the containment dike by 5 ft would have a minimal impact on dike and heap stability. This would help to prevent any future overtopping.
5/8/2000	Internal BMMI memo on discharge issues. Note that higher concentrations of nitrate, sulfate, arsenic and selenium persist in the waste rock seepage.
6/7/2000	Pilot biotreatment plan brought into limited service.
6/19/2000	Letter from BMMI to FS & DEQ documents start of construction of full-scale biotreatment plant. Need for additional LAD areas is identified. Request for use of fresh water LAD areas C & D for treated solution.
7/5/2000	Public Scoping Notice signed by FS & DEQ to obtain comments on adding new LAD areas for treated process solution.

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7/10/2000	Internal BMMI memo on the pilot biotreatment plant. As of the memo date, treating 1.5 gpm of barren solution w/95% reduction of thiocyanate. Off-gassing ammonia until biomass is built up for conversion of ammonia to nitrate.
7/12/2000	2nd quarter 2000 progress report for Beal submitted to DEQ & FS. Mentions completion of an investigation into potential effects to groundwater and surface water due to LAD in the vicinity of Beal's Hill. "Results indicate that, with the exception of selenium, water quality in German Gulch (STA-2) and Beefstraight Creek (BS-D) will remain at or below aquatic standards."
7/13/2000	Letter from B-D Forest Mining Engineer Dan Avery to Director of RMLH&W in Regional Office concerning disposal of treated effluent from Beal Mtn Mine. Includes discussion of using CERCLA and decision not to at this time. Alternative methods of disposal that were considered, decision made jointly w/DEQ to go with land application.
8/10/2000	Letter from DEQ to FS discussing joint EIS for disposal of treated solution at Beal. Includes statement: "The treatment system will be operable by January of 2001, which is when the EIS and Montana Pollutant Discharge Elimination System (MPDES) permit must be completed to allow discharge of the treated effluent." Includes 5 options to be considered in EIS for disposal of solution: 1. Land application, 2. Groundwater drainfields at the confluence of German Gulch and Beef Straight Creek, 3. Discharge to Silver Bow Creek, 4. Land application on mine property at the lower end of German Gulch above Fairmont Hot Springs, and 5. Additional treatment (RO).
12/13/2000	BMMI submits an evaluation of long-term closure issues and costs to DEQ & FS. Concludes that any form of active water treatment for long term will be more costly than either a passive system or up front prevention of infiltration using an impervious cap. Recommendations depend upon whether deferring costs to a later date is selected (passive treatment recommended) or opt for a true "walk-away" plan (install an impervious cap).
1/5/2001	Notice of Intent to prepare EIS for land application modifications at Beal is published in the Federal Register.
3/20/2001	BMMI submits a draft MPDES Permit application report for land application at Beal.
4/6/2001	BMMI submits final application for MPDES Permit for LAD, etc.
5/10/2001	Notes from trip to Beal by FS & DEQ representatives. Bruce Parker reports that majority of the Se found in the water going to the drainfield comes from a spring buried near the upper end of the waste dump. The Se didn't show up until they placed Beal Shear rock over the spring, which turned out to be high in Se. High SO_4 levels are coming from the base of the waste dump, which is somewhat disturbing. Bruce noted need to finish capping the dump and route all run-on water around the edges of the dump.
6/19/2001	Letter from Butte DR to BMMI stating that the FS & DEQ are making minor revisions to the June 1995 LAD Management Plan for areas A & B.
6/27/2001	MOU signed between DEQ and B-D NF to jointly cover necessary funding to continue operations at Beal upon depletion of bond money.
7/5/2001	Startup of land application of bio-treated leach pad solution.
7/25/2001	Complete Beal Agreement sent out for agency signatures by Timothy A. Lukas with Hale Lane Peek Dennison Howard and Anderson out of Reno, NV.
8/6/2001	Notes from meeting including DEQ, FS & BMMI. John Joy expressed concern that LAD appeared to be killing vegetation. Alternate methods of application were discussed. Possibility of using CERCLA designation was brought up and discarded until all other alternatives are exhausted.
8/7/2001	Internal B-D FS letter on status of water treatment at Beal. Impacts noted to vegetation due to high salt levels of solution being land applied. Plan to contract additional studies and try other test plots.
9/7/2001	Soil Assessment (of) Land Application of Process Solution, Beal Mountain Mine Shutdown. Uneven distribution of solution noted. Need to monitor for effects to soils and vegetation.

DATE	USDA DEERLODGE NATIONAL FOREST CHRONOLOGY OF MINE ACTIONS
9/13/2001	IDT Meeting Notes regarding 18.1 review of the 1988 EA for Beal. Question: would new effects be displayed with additional NEPA or would additional analysis be based on more detailed monitoring and mitigation? Determination was made in discussion w/specialists that the original EA was sufficient in disclosing the effects of land application of treated process solution with the addition of monitoring and mitigation that was discussed in the meeting.
10/2/2001	FS Final Monitoring & Mitigation Plan for Terrestrial Wildlife at Beal. Calls for fencing of LAD site to prevent grazing by ungulates. Includes other monitoring & mitigations measures.
10/16/2001	Notes from meeting including FS, DEQ & BMMI. Current LAD test cell has been running 5 weeks, needs to be stopped & moved. New site to be further into forested area, will be monitored for new seeps. 12 LAD cells have been set up to be utilized over next 4 months. Forested sites preferred, as they appear to be the most effective. Cells on area C will be utilized in late spring to provide for additional dilution.
1/10/2002	DEQ inspection report states samples taken on 12/14/01 at BS-D (Beefstraight/ American confluence) and STA-1 (Beefstraight/German confluence) showed total cyanide levels of 0.022 ppm and 0.010 ppm, respectively. Follow-up samples taken on 1/8/02 showed no detectable cyanide.
1/16/02	Memo from Bruce Parker (BMMI) to Warren McCullough (DEQ) & Dan Avery (FS) regarding seasonal shutdown of biotreatment plant. Conclusions: 1. Critical to at least keep the pilot plant operational to maintain bacteria for future inoculation of main plant; 2. Critical to maintain key employees in order to restart and run main plant; 3. Seasonal shut down would lead to a number of mechanical problems and delayed startup of main plant; 4. Changes in pad chemistry during shut down could lead to pH changes, metals releases, and need for additional treatment at higher cost.
1/16/02	Meeting w/DEQ, FS & BMMI representatives. Still circulating/suspending some solution in leach pad – partly to utilize capacity of pumps, partly to keep a portion of the pad from freezing. DEQ recommended not running solution through pad as it could increase changes in pad chemistry. Dropping alkalinity noted. Plant was shut down on 12/15/01 due to problems in circuit. Decided to not use pretreatment & filter presses. Using H_2O_2 to drop CN_{TOT} after biotreatment discharge. Scott Fischer made observation that H_2O_2 makes Se go into selenate form, which is more mobile. Might be best to simply eliminate H_2O_2 treatment.
2/20/2002	First payment made by FS for joint funding agreement w/DEQ to cover Beal expenses.
3/4/2002	Notes from 2/19/02 meeting between FS & DEQ soil scientists. Includes plans for gathering soils data, laying out more effective application areas and methods, and monitoring.
3/20/2002	Aquatic biological monitoring report for German Gulch in 2001 submitted to BMMI by Dan McGuire & Erich Weber. Aquatic communities in German Gulch were generally healthy during 2001. Periphyton & macroinvertebrate assessments rated good biological integrity w/only minor impairment. Significant metals pollution was not indicated. Increased environmental stresses were noted, including declining water & habitat quality. Habitat quality declined due to reduced riparian plant cover, increased bank erosion, and increased sediment deposition. These conditions appeared to have worsened due to drought and increased riparian zone use by cattle during the summer.
5/3/2002	Hand-written note from conference call noting that DEQ thinks a "big gun" sprinkler setup is the only way to go for land app at Beal.
5/4/2002	DEQ paper on LAD changes. Discusses various application methods, need to move around and apply solution over a wider area to avoid saturation/runoff problems. Concludes use of "big gun" sprinkler application during summer months is best way to go.
5/10/2002	Hand-written note that Janette Kaiser has mandated there will be no change in the LAD to use a "big gun" w/o new NEPA. This type of application was not covered in the original EA.
6/17/2002	Meeting at Beal including DEQ, FS, TU & MPC representatives. Went over history of operation, on-going reclamation and water treatment, problems encountered, steps taken to solve problems. Included tour of mine area.

DATE	USDA DEERLODGE NATIONAL FOREST CHRONOLOGY OF MINE ACTIONS
8/2/2002	Draft proposal from Dan McGuire to BMMI to cover increased macroinvertebrate biomonitoring around Beal.
8/9/2002	Letter from CFC to DEQ & FS. RO probably provides best hope for preventing further exceedances of water quality standards. Fish tissue Se levels look like major concern. Looks like serious Se problem in German Gulch.
8/11/2002	Letter from BMMI to FS & DEQ outlining plans for dealing w/LAD issues at Beal: 1. Mike Botz & Bill Walker working on RO analyses; 2. Contract Dan McGuire to do 2002 aquatic monitoring program; 3. Immediately halt LAD w/sprinklers in open grassland behind maintenance shop (storage critical w/o on-going LAD); 4. Begin LAD trial w/pressure compensating tubing on N-side Beal's Hill; 5. Construct 7 new LAD cells N of Beal's Hill & 2 cells on S end of Minnesota Ridge using pressure compensating tubing; 6. Install in-line pressure regulators on 1 LAD cell w/in existing Minnesota Ridge LAD system; 6. Relocate certain other sprinkler LAD lines & await agency approval for use; 7. Relocate Minnesota Ridge LAD cells upslope to better utilize terrain; 8. Locate & mark all 4 corners of all past, current, and proposed LAD sites w/permanent steel markers. Also mark appropriate soil test pits.
8/22/2002	Letter from FS to BMMI approving certain LAD sites for 2002-3, including drip line LAD areas, pressure-regulated test plot LAD areas, and forested sprinkler test areas.
8/26/2002	Letter from FS to BMMI confirming that Westech has been retained to set up and monitor vegetation transects on Beal LAD sites.
8/27/2002	Walker & Associates submits a draft report to HB Management on explanation of costs for a reverse osmosis unit at Beal. Minimum cost estimated to be $3.2 million, w/many factors that could increase the figure.
8/29/2002	Memo prepared by Wayne Jepson, DEQ, giving a brief history of Beal.
9/6/2002	60-day notice of intent to sue from CFC, directed to BMMI, DEQ & FS. BMMI operating unpermitted LAD discharging Se, Cu, CN & other pollutants into groundwater hydrologically connected to German Gulch. RO system likely needed. LAD system has caused exceedances for CN. LAD discharge of Se provides ongoing hazard to fish, birds & insects.
9/26/2002	Letter & enclosed affidavit from CFC to DEQ requesting correction of what they believe is a violation of MMRA at Beal. Want shut down of LAD during winter – Kuipers says that restarting in spring would only take a few weeks and very little additional water would accumulate in the pad during shut down. Concerned about high Se levels in German Gulch resulting from improper handling of rock in waste dump.
10/15/2002	BMMI submits a memo to DEQ, FS & Trustee outlining 3 scenarios to move waste material from the dump around Spring 10A in hopes of significantly reducing Se loading in German Gulch.
10/15/2002	Draft report on selenium at the Beal Mountain Mine prepared by Wayne Jepson, DEQ. Discusses implementation of trigger levels for selenium (and other parameters), which required BMMI to reduce loading of Se in German Gulch over time. This required diversion of Springs 3 & 5. As a result, Se levels in German Gulch declined steadily from mid-1993 through mid-1997. At that time, area needed for waste dump expansion was lined with Beal Shear material, which was to provide a liner for the waste dump. This material was subsequently found to have elevated levels of readily soluble selenium. This expansion buried Spring 10A, and Se levels in German Gulch rapidly increased. Flow from 10A was then captured and routed to be combined with the Spring 5 capture system. Report includes a detailed listing of Se levels at various monitoring points over the years.
10/17/2002	German Gulch synoptic sampling/loading assessment conducted by Wayne Jepson & George Furniss, DEQ. Subsequent conclusions based on sampling state that little would be gained by removing material from waste dump around Spring 10A. That source only accounts for about 18% of the total Se load coming from the waste dump.
10/23/2002	DEQ issues MPDES Permit for LAD and drains at Beal.

DATE	USDA DEERLODGE NATIONAL FOREST CHRONOLOGY OF MINE ACTIONS
10/25/2002	Memorandum from Bruce Parker (BMMI) to DEQ, FS, & trustee regarding costs/implications of continued operation vs. shutdown for the winter of 2002-3. Recommendation is that full-scale treatment plant operations continue with LAD, through the winter. If that is not the decision, the pilot plant should be maintained to be able to restart full biotreatment. This option would increase overall costs by $680,000, and extend treatment for over a year. Also, this would create personnel problems, as well as potential for equipment damage and increased changes in pit chemistry.
11/25/2002	Elbow Creek Engineering submits an evaluation of reverse osmosis for treatment of leach pad solution to BMMI. Discussion of costs with limited conclusions. "Reverse osmosis is effective at reducing selenium concentrations in water, however this treatment process is relatively expensive and therefore is not widely used for selenium treatment." "Other treatment processes [acidic reaction w/reduced iron; anaerobic or anoxic biological processes; activated alumina adsorption; activated carbon adsorption; & ion exchange] could be investigated for potential application at Beal Mountain, but treating selenium to levels of 0.01 mg/L or lower is likely to be unfeasible and/or cost prohibitive."
12/3/2002	Response from Permits Section DEQ to Water Quality Bureau DEQ regarding MPDES Permit requirement to provide a plan and compliance schedule for dealing w/Se in German Gulch. Se loading analysis is attached. Moving upper waste dump will not make a significant improvement. Will temporarily reroute water from Springs 5 & 10A while looking for other long-term solutions.
12/10/2002	Summons in Civil Case: Clark Fork Coalition v. Thomas Reilly and US Forest Service regarding activities and problems at Beal.
12/13/2002	Letter from BMMI to DEQ stating that as of 12/5/02, BMMI is re-directing captured seepage from the toe of the waste dump, including Springs 5 & 10A, into the LAD circuit. This was done to reduce Se loading to German Gulch.

APPENDIX B

Beal Mountain Pit Slope Stability

Beal Mountain Mine Existing Conditions Report

INTRODUCTION

Slope stability problems have played a role during the course of the mine's development and under closure. Information on current conditions of slides at the mine was obtained during site visits completed on September 18 and 30, 2003. In addition to field observations, data on current water levels in a portion of one slide area were also obtained. Descriptions of slide characteristics are provided below. A more detailed analysis of one of the slides (clay/sill slide) is then presented.

MAIN BEAL PIT SLIDES

WEST WALL SLIDE

The west wall slide, located in the northwest corner of the pit (**Figure 1**), was first noticed in 1992 (Sitka, 1994). The slide developed along one of four clay layers (bedding planes No. 1 through No. 4) that approximately parallel each other with a dip of approximately 20° in a northeast direction (Sitka, 1996). In the eastern portion, the west wall slide is moving on bedding plane No. 2 in an eastward direction.

The surface of the west wall slide exhibits numerous cracks. The cracks are most pronounced on a flat bench in the central portion of the slide. A scarp with approximately two to four feet of displacement has also formed along the south flank of the slide's westernmost portion. At its west end, the trace of the slide can be followed up to near the main access road. The slide's surface was last graded approximately three years ago (personal communication, Maxim with Bruce Parker, 9-18-2003) and it is assumed that cracking observed in the field post-dates the grading. At the toe of the slide in the north central wall of the pit, there is a large bulge of rocky material above the slide plane. A spring at the slide toe produced approximately 0.5 gallons per minute. A berm of soil, placed against the north wall of the pit to cover exposed sulfide-enriched rock, may be providing some buttressing at the toe of the slide.

In 1997, the sliding movement was estimated to be in the range of 20 feet per year and that the slide could move an additional 200 feet before it reached a static position (Sitka, 1997a). Current information on slide movement is not available. The rate of movement may be in the range of 1 to 10 feet per year.

CLAY/SILL SLIDE

The clay/sill slide is a relatively small slide near the southwest corner of the leach pad (**Figure 1**). The slide is moving along a clay layer which dips approximately 20° to the northeast (Sitka, 1996), an orientation similar to the bedding plane of the west wall slide. The slide is bounded along its northeast flank by the Gully Fault which has a near vertical dip. This slide has caused concern with respect to the stability of the leach pad dike. A dewatering program was implemented in the area in 1995 to reduce pore pressure at the clay/sill interface. A buttress to further stabilize the slide was constructed in 1997. Figure 1 shows the location of the buttress and the clay/sill structure contours based on a construction map prepared by Sitka Corp., dated 9/4/97 contained in BMMI's files. There are several dewatering wells, observation wells, and geotechnical instrumentation borings in the vicinity of the clay/sill slide (**Figure1**). Dewatering in the clay/sill slide area ceased in July 2003 as part of the mine closure.

During inspection of the clay/sill slide area, evidence of widespread cracking at the surface (similar to that associated with the west wall slide) was not observed. Cracks that were observed appeared to not be recent. The most obvious sign of slope movement were three small slump blocks and an approximate 5 to 10 foot high scarp from this point that has developed in a westward direction upslope for a distance of about 200 feet (**Figure 1**). There may be at least one other fracture on the slope of the buttress constructed for the slide but this fracture could not be reached due to the steepness of the slope.

NORTH WALL SLUMP FAILURE

A slump type failure slide occurred in 1989 in the upper portion of the north highwall (**Figure 1**). The slope failure is described in a report by Klohn Leonoff (1990). The failure consisted of slumping of weak rock along most of the failure, except for the west end where the failure was a wedge type block. The western wedge failure appears to coincide with the clay/sill slide discussed above. Remediation of the slope was completed in 1989 and 1990 and consisted of installing a toe buttress and reducing the slope angle between the slide and the toe of the leach pad dike. Data reviewed for the site suggests that this area has remained stable since 1991 except for its west end (i.e. the clay/sill slide area).

OTHER MINE AREAS

The toe and crest of the waste rock dump were also inspected and evidence of cracking or other signs of slope distress were not observed. Along the top of the south wall of the pit, there was one faint crack that may indicate some slope movement in this area.

MONITORING DATA

Data provided by mine personnel suggests that collection of routine monitoring data pertinent to slide movements in the main pit area had not been collected since early 2000. Beginning in August 2003, following cessation of dewatering, groundwater levels have been measured periodically in wells located in the clay/sill slide area (**Attachment A**). During the period of August 2003 through March 2004, water levels in most of the wells dropped. Historic information to compare the water level data with is limited. Development of relationships for water table elevation data is difficult owing to the complex geology in the clay/sill slide area, likely differences in well construction, and that groundwater pumping from selected wells has only recently been discontinued.

Data on slope movement in the clay/sill slide area have been obtained from several inclinometers (**Figure 1**). Readings from the inclinometers were periodically obtained during active mining (through 2000). Several of the inclinometers have been lost due to previous slope movement. Beginning in February 2004, readings are being obtained for three of the inclinometers remaining in the clay/sill slide area (SI95-3, SI97-1, SI97-2; **Figure 1**). Displacement logs for the inclinometers are provided in **Attachment B**. For each inclinometer, data obtained in 2004 along with three readings obtained in 1999-2000 are presented. The inclinometer logs indicate that there has been no appreciable movement along faults (e.g. SI95-3, depth 170 feet). The logs for the inclinometers, in particular SI95-3, do show evidence of out of slope movement as indicated by an overall offset that increases uniformly from the base to the top of the inclinometer. This movement may be due to relaxation of the slopes following mining and/or due to recent repairs performed on the inclinometer instrument.

CLAY/SILL SLIDE EVALUATION

Maxim performed a preliminary evaluation of slope stability for the clay/sill slide because of concerns for continuing movement and the potential to impact the stability of the leach pad dike. The evaluation was performed with respect to conditions in December 2003 and conditions that may develop in the future. To complete the evaluation, a representative section through the area was developed following review of pertinent literature (Sitka, 1995, 1996 1997a, 1997b, 2000). The computer program STABL 6H was used in performing the evaluation. Two sections, A and B, were evaluated (**Figures 1, 2, and 3**). These sections correspond to sections F/803 and G/803 presented in Sitka, 1997b.

The evaluation first looked at conditions prior to construction of the buttress. Conditions following buttress construction were then examined, including current conditions. Several water table surfaces were included in the analysis. A description of the water table, and factors which may influence it, follows.

- A seasonal increase in the water table begins in late winter to early spring (Sitka, 1997c). The water table rebounds quickly during an approximate 6-week time frame and increases in water levels range from 30 to 50 feet. The last period of substantial movement of the clay/sill slide occurred in the spring of 1997 when precipitation was relatively high as compared to previous years.
- The discontinuation of the groundwater dewatering will result in increases in the water table elevation. Dewatering has been shown to lower the water table during drier portions of the year and to reduce the overall spike in the water table and its duration during spring.
- Data collected on groundwater levels in the slide area are difficult to understand given the complex hydrogeology of the area (Sitka, 1996). The complexity is related to the characteristics of the underlying metasediments (i.e. highly weathered, numerous discontinuities, and seams containing a high clay content).
- The limited groundwater elevation data available suggests that in the spring the water table may rise to within 30 to 50 feet of the ground surface without dewatering. However, some of the data also suggests that the water table could be very close to the surface.
- During operation of the leach pad (through 2001) the pad was uncovered and precipitation falling on the pad was used as process water. A low permeable cover system was installed over the leach pad in 2001 and 2002 and drainage at the toe of the cover liner may contribute substantial amounts of water to the subsurface in the clay/sill slide area.
- Grading completed for reclamation work may direct water into the clay/sill slide area.

Most of the groundwater elevations used in the analysis are intended to represent spring time conditions and included the following two water tables: 1) a water table established at 30 feet below the top of the weathered metasediments; and, 2) a water table at the surface of the weathered metasediments (worse case).

Results of the slope stability analyses are summarized in **Table 1** and computer printout files for selected analyses are provided in **Attachment C**. Adequate factors of safety (FS) for the leach pad dike and slopes below the leach pad dike are 1.5 and 1.25, respectively, based on Table 2-4 in the Environmental Protection Agency's (EPA) *Solid Waste Disposal Facility Criteria, Technical Manual* (1993).

TABLE 1
SUMMARY OF SLOPE STABILITY ANALYSES

CONDITION	ANALYSIS NO.	COMMENTS	FACTOR OF SAFETY	
			SEC A	SEC B
Pre-Buttress	1	Failure through toe of leach pad dike. Water table 30 feet below top of weathered metasediments	1.10	- -
	2	Failure through crest of leach pad. Same water conditions as above.	1.18	- -
Post-Buttress	3	Failure through toe of leach pad. Same water condition as above with drainage into buttress	1.33	- -
	4	Failure through crest of leach pad. Same water condition as above with drainage into buttress	1.24	- -
	5	Failure through crest of leach pad. Weathered metasediments above clay/sill layer fully dewatered (similar to conditions during late summer/fall with dewatering program)	1.72	- -
Current Condition	6	Water table elevation for 12/15/2003.	1.60	- -
Worse Case Condition	7	Water table at top of weathered metasediments. Failure surface intersects dike crest	1.02	1.50
	8	Water table at top of weathered metasediments. Failure surface intersects inboard toe of dike.	1.40	1.87

An FS of 1.0 or less would be indicative of an unstable slope, or a slope close to failure. The following points are offered with respect to Section A (**Figure 2**).

- The buttress primarily adds to the stability of the toe area of the leach pad dike, preventing smaller slope failures from regressing upwards into the leach pad dike.
- In analysis 4 (toe buttress installed, no dewatering) a FS=1.27 was computed for a failure surface through the leach pad dike crest. With dewatering (analysis 5), the FS is increased to 1.72.
- In analysis 6 a typical groundwater elevation of 7330 feet was used to represent current conditions based on December 2003 monitoring data. A FS = 1.61 was computed in analysis 6 and the failure surface with the lowest factor of safety was intersected the crest of the leach pad.

A worst-case condition was also analyzed as part of the evaluation for Section A in which the water table was placed at the surface of the weathered metasediment unit. For the worst-case condition (Analyses 7 and 8) an FS of1.02 was computed for a failure surface through the crest of the leach pad dike, and an FS of 1.40 was computed for a failure surface intersecting through the inboard toe of leach pad dike.

Two additional analyses were completed for Section B (**Figure 3**) using worst-case conditions similar to those analyzed for Section A. For both analyses a substantially higher FS was computed for section B as compared to Section A. This is largely attributed to that Section B is oriented more perpendicular to the strike of the clay/sill structure than for Section A.

DISCUSSION

The analysis for the clay/sill slide indicates that the factor of safety for the leach pad dike will fall below the minimum factor of safety requirement of 1.5 during the spring time when the water table elevation is high (Analyses 4 and 7). If conditions similar to the worse case modeled should develop, the clay/sill slide could regress further uphill and result in new cracks forming in the leach pad dike and possibly the capped area. While slope failures which result in damage to the cap liner of the leach pad would not be desirable, this type of damage can be repaired and no leach pad fluid would be released.

The greater concern is if a slope failure should occur that results in a release of fluid contained in the leach pad. On **Figure 1** the elevation of the fluid held in the leach pad is shown for December 1, 2003 at elevation 7462.5 feet. During the spring of 2003, monitoring of fluid levels in the pad suggested five million gallons of leachate entered the leach pad (personal communication, Maxim with Bruce Parker, 9-18-03). **Figure 1** shows the projected fluid level in the leach pad in early summer 2004 based on an increase of five million gallons (elevation 7468 feet).

Analysis 8 examined the stability of the leach pad with respect to the inboard toe of the dike, near to the leachate fluid level projected for the summer of 2004. Results for Sections A and B (FS of 1.4 and 1.9, respectively) indicate that it is unlikely that the leach pad area containing fluid will be damaged.

Two additional comments are offered in regards to the analysis. First, the factors of safety computed for slope stability were largely dependant on the elevation of the water table used. Groundwater elevation data was not available to support using a water table elevation 30 to 50 feet below the top of the weathered metasediments, although this had been used in previous geotechnical reports. There is also very limited data to support using a water table at the top of the weathered metasediments. Second, Dr. David Stone, who has extensive experience on the geotechnical aspects of the Beal Mine as a consultant with Sitka and Klohn Leonoff, indicated in a Beal Mountain Technical Working Group meeting on December 19, 2003 that the clay/sill slide does not extend north of the Gully Fault and that two boreholes (GT95-01 and GT95-06) that were drilled to intersect rock beneath the southwest corner of the leach pad encountered highly competent rock and that the leach pad foundation consists of competent bedrock. Previous Sitka reports, through 2000, present the clay-sill slide as a structure that extends north of the Gully Fault. Boreholes GT95-01 and GT95-06 both encountered competent bedrock, but at depth. The location of the competent bedrock in the subsurface would not substantially change the factors of safety shown in **Table 1** since the failure surfaces do not or only marginally intersect bedrock.

The current plan for 2004 is to monitor the clay/sill slide area and the southwest corner of the leach pad. A monitoring and contingency plan has been implemented. Monitoring wells and wells instrumented to collect geotechnical information are currently being monitored on a periodic basis. This monitoring will continue through June 2004. If renewed movement of the clay/sill slide during Spring 2004 should indicate unacceptable slope deformations in the area, contingency measures will be implemented. These measures include reactivating dewatering wells, and/or removing fluid from the leach pad and temporarily storing this fluid in existing ponds.

<u>References:</u>

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Sitka, 1997a. West Wall Slide Runout Analysis. May 19.
Sitka, 1997b. Geotechnical Review of Closure Options. May 19.
Sitka, 1997c. Site Visit Report for May 29-31, 1997. June 10.
Sitka, 2000. Geotechnical Analysis of Leach Pad Containment Dike Raise. April 21.

<u>Figures</u>

1	Main Beal Pit Slides
2	Section A
3	Section B

<u>Attachments</u>

A	Groundwater Elevation Data, Clay/Sill Slide Area
B	Inclinometer Well Monitoring Logs
C	STABL Computer Output Files

Attachment A

Groundwater Elevation Data, Clay/Sill Slide Area

Beal Mountain Pit Slope Stability

Attachment B

Inclinometer Well Monitoring Logs

Beal Mountain Pit Slope Stability

Attachment C

STABL Computer Output Files

Beal Mountain Pit Slope Stability

APPENDIX C

Water Balance Models Assumptions, Conditions, Data, and Output

Beal Mountain Mine Existing Conditions Report

WATER BALANCE MODELING
BEAL MOUNTAIN MINE
EXISTING CONDITIONS REPORT

INTRODUCTION

Estimates of water infiltration (percolation) into the subsurface were determined for several locations in the mine area. Data used for completing the evaluation are discussed below along with results of the analyses.

HELP MODELING

The computer model HELP v. 3.07 (Schroeder, et. al. 1994) was used for determining percolation rates into the subsurface. The model uses several input parameters which are discussed further below. The values selected for these parameters are intended to reflect general weather, soil and vegetation conditions at the site.

Modeling using HELP have been completed previously for the site (Schaefer, 1996; BMMI, 1999). These models were reviewed and the parameters used by these authors incorporated into the present analysis, as appropriate. The 1996 report was completed for the South Beal Expansion and presented an evaluation of a soil only cap for the leach pad and waste rock dump. In the 1999 report a modification to the leach pad was presented wherein a low permeable geosynthetic clay liner (GCL) was included. The 1999 report's HELP model used nearly identical input parameters as that used in the 1996 report.

Precipitation

There are two sources of precipitation information for the site. The first source, prepared by the Natural Resources Conservation Services, is the average annual precipitation information for Montana for the period 1961 to 1990 (NRCS, 1998). The NRCS data indicates an average annual precipitation for the site of 25 inches per year The second source is precipitation records maintained by the mine. The available mine information is for the period 1988 through 1995. For this period of record the average annual precipitation ranged between 13 and 23 inches with an average value of 17.2 inches. In a previous analysis for the mine (Schaefer, 1996) an average annual precipitation of 21 inches was used (**Attachment A**). This value appears appropriate and was used in the analysis.

The average annual precipitation is further subdivided into the monthly mean precipitation for use as input values in the HELP model. Monthly values could be obtained either using the mine information or information obtained from some other nearby weather station (e.g. Butte). The mean monthly values are then scaled accordingly such that their sum is equal to the average annual precipitation. For the analysis the mean monthly information for the mine was used which was also the case for the Schaefer, 1996 report. In comparison to weather data for Butte, this results in more precipitation occurring during the spring which should yield a more conservative result (i.e. a higher percolation rate)

Evaporation

Evaporation data obtained at the mine site (**Attachment A**) was used in the analysis. This data was also used in the Schaefer 1996 report.

Temperature and Solar Radiation Data

Temperature and solar radiation data for Helena was used for the analysis. This data was also used in the Schaefer 1996 report.

Other Evaporation Parameters

The following other evaporation parameters were used in the analysis

> Depth of Evaporation: In Schaefer (1996) an evaporation depth of 36 inches below ground surface was used based on data collected at the site; documentation for supporting this evaporation depth is not provided in their report. In the HELP model documentation a default evaporation depth of 28 inches is provided for Helena given a fair stand of vegetation. In the analysis both a 28 and 36 inch depth was used so that their influence on percolation rates could be examined.
>
> Leaf Area Index: A leaf area index (LAI) of 2.0 used in Schaefer (1996) was also used in the present analysis. An LAI = 2.0 is typical for a fair stand of grass.
>
> Growing Season: A growing season beginning on the 152nd calendar day and ending on the 255^{th} calendar day used in Schaefer (1996) was also used in the present analysis.

Soil Characteristics

Soil characteristics used in Schaefer (1996) (e.g. saturated hydraulic conductivity, porosity) were also used in the analysis. These soil characteristics were reported to have been obtained from studies completed at the mine site.

Liner Characteristics

Default values for characteristics for the GCL, PVC and LLDPE liner materials obtained from the HELP model guidance was used. All three liner materials are very low permeable material. In the case of the PVC and LLDPE geomembranes an installation defect rate of 4 defects per acre was used. The HELP model guidance states that defect rates range between 1 and 4 for excellent installations and 4 and 8 for good installations. During installation of the liner there was no quality assurance/quality control data produced to help in verifying the quality of installation. Therefore a defect rate of 4 per acre was used which falls within the high range for an excellent installation. The GCL lined areas also likely have defects but guidance on how this material should be modeled is not available.

HELP Modeling Results

Leach Pad Cover Analysis

Figure 1 shows the various cover configurations used in the analysis and **Table 1** summarizes the results for the HELP model analyses contained in **Attachment B**. Percolation rates presented in the table represent the rate of flow through the low permeable cover liner (e.g. GCL, PVC) and not the base of the waste pile. Results of the analyses discussed below.

- Case 1. This analysis was completed using nearly identical input parameters to those used in BMMI (1999). The percolation computed in the present analysis was 0.08 inches per year (in/yr) was similar to that computed in the 1999 analysis (0.05 in/yr). The difference in the percolation rates may be attributed to that different versions of the HELP program were used and that the simulation was completed for a 100 year time period versus 30 years in the 1999 analysis.

- Case 2. This analysis was completed similar to the Case 1 analysis but the depth of evaporation was reduced to 28 inches (HELP model default value for Helena, Montana and fair vegetation) and several small changes in slope parameters. The percolation for this model was 0.14 in/yr. The increase noted between the Case 1 and Case 2 analysis is likely due to the decreased depth of evaporation.

- Case 3. In the Case 3 analysis the geocomposite layer was added to the cover system used in the Case 2 analysis. A percolation rate of 0.036 in/yr was computed, approximately one order of magnitude less than that computed for the Case 2 analysis. This decrease in percolation rate is likely attributed to the geocomposite maintaining a relatively low fluid head on the GCL as compared to the installation modeled in Case 2.

- Case 4. A relatively high percolation rate of 1.3 inches per year was computed for the relatively flat areas lined with PVC (e.g. topdeck). Factors influencing the percolation rate included that infiltrating water collected on top of the PVC liner to an average depth of 5 inches, the PVC liner defects provided points where the water could pass through the liner and the ore underlying the liner has a relatively high permeability.

- Case 5. This case was similar to Case 4 but was modeled for the sideslope areas lined with PVC where water will be more readily shed off the cover. A percolation rate 0.79 in/yr was computed.

- Case 6. This case was similar to Case 5 but was modeled for sideslopes lined with LLDPE. A percolation rate of 0.66 in/yr was computed.

The results of the modeling using HELP indicate an average annual percolation rate of 0.7 in/yr through the cover using an evaporation depth of 28 inches. This equates to a seepage flow in to the leach pad of 3 gallons per minute, or 1.6 million gallons per year. Approximately 90% of this flow is attributed to the areas lined with PVC. The Case 4 analysis (PVC liner, 4% slope) was reanalyzed using a depth of evaporation of 36-inches to examine what influence this parameter would have; a percolation rate of 0.6 inches was computed, approximately one-half the amount determined for a 28 inch depth of evaporation (1.3 inches). Cases 5 and 6 would likely show a similar difference in percolation rate if the greater evaporation depth was used.

Leach Pad Base Liner

An estimate of leakage rate through the base liner was completed using information on current fluid depths in the leach pad and assumptions on defects in the base liner. The base liner consists of 40 mil PVC overlying 18-inches of compacted clay material imported to the site. The clay is assumed to be similar to bentonite in composition. Figure 2 shows the leach pad base liner contours and the elevation of fluid in the pad on December 1, 2003.

The estimate of leakage through the base liner was prepared assuming that there is one liner defect in the base of each of four sumps located on the south side of the leach pad and one defect per acre in the liner material within the area containing fluid. Using these assumptions a relatively low leakage rate of 4x10E-4 gal/min (0.0008 in/yr) was computed (**Attachment C**). Approximately 90 percent of the leakage is from the sump areas.

Waste Rock Dump

The cover for the waste rock dump consists of soil material with variable thickness. Portions of the topdeck area had not yet received final cover at the end of 2003. Cover soil thickness and soil properties assigned to the material were obtained from Schaefer (1996).

An initial analysis was first completed which was used similar parameters as those by Schaefer (1996) for soil, vegetation and weather conditions. Subsequently, additional analyses were completed that used different parameters, where deemed appropriate, and an alternate analysis method. The HELP model analyses are contained in **Attachment D** and are summarized below and in **Table 2**.

- Case W1. This analysis was completed using parameters nearly identical to those used by Schaefer (1996). A percolation rate of 0.0026 in/yr was computed which compares very closely with the Schaefer 1996 percolation rate of 0.0022 in/yr.

  Review of the HELP model output file for this case showed an anomalous value for the final water storage in soil layer 3 (mine waste). The field capacity for this layer and the underlying waste layer was set at 0.12 vol/vol and the initial soil water content was selected at approximately the same value. Following the model run for a 30 year time period, the final water content for layer 3 had increased to 0.15 vol/vol. Given the layer's thickness (50 feet) this increase amounts to several inches of water storage above the field capacity and suggests that a steady case condition has not yet been reached.

- Case W2. In order to simulate the waste rock dump more accurately, and in an effort to equilibrate the water content in layers 3 and 4 in a shorter period of time, the waste rock dump was modeled in an uncovered condition, similar to that which would be the case during active mining. For this case the LAI was reduced to 0 for bare soil and the depth of evaporation was reduced to 14-inches, the default value for bare soil in Helena. The model was run for 10 years which is approximately the time period much of the waste rock dump was open prior to cover construction (note: as of November 2003, the top deck area of the waste rock dump had not yet received final cover soil). Average annual percolation for this case was 0.0032 in/yr, nearly the same as for Case W1. The water content in the waste rock for layers was approximately 0.16 vol/vol.

- Case W3. This case was modeled similar to Case W1 but the initial moisture content for the waste rock layers (layers 3 and 4) was set equal to the ending moisture contents for these layers obtained from Case W2. The average annual percolation rate for the case was 0.85 in/yr. At the end of the run time (30 years) the water content in layers 3 and 4 (0.151 and 0.156 in/yr, respectively) was similar to those at time zero (0.164 and 0.155 in/yr, respectively) which indicates the average annual percolation rate computed for the time period was likely determined for near steady state conditions over the entire 30 year period.

- Case W4. The same modeling parameters as Case W3 were used but the run time was increased to 100 years. A percolation rate of 0.97 in/yr was computed. This compares relatively well with the Case W3 percolation rate of 0.85 in/yr and suggests that near steady state conditions were achieved.

- Case W5. The same modeling parameters as Case W4 were used but the depth of evaporation was decreased to 28-inches. A percolation rate of 0.88 in/yr was computed.

Results of modeling for the waste rock dump indicates that the facility has an average annual percolation rate of approximately 0.85 in/yr. Given that the facility area is approximately 48 acres in area, the average annual seepage flow from the facility is estimated at 2.1 gal/min.

REFERENCES

BMMI, 1999. Letter, RE: Heap Leach Pad Final Regrade and Reclamation Plan for the Beal Mountain Mine – Minor Revision to Operating Permit No. 00135. April 1.

Schaefer & Assoc., 1996. Water Balance Modeling for the Reclaimed Spent Ore and Waste Rock Piles. Technical memorandum prepared for Beal Mountain Mining. In Appendix H, South Beal Expansion Amendment. February 8.

Schroeder, P.R., Lloyd, C.M., Zappi, P.A.. 1994. “The Hydrologic Evaluation of Landfill Performance (HELP) Model: User’s Guide for Version 3,” EPA/600/R-94/168a, September 1994, U.S. Environmental Protection Agency Office of Research and Development, Washington, DC.

ATTACHMENTS

Figures and Tables

Attachment A Water Balance Supporting Data
Attachment B Leach Pad Cover HELP Model Results
Attachment C Leach Pad Base Liner Leakage Estimate
Attachment D Waste Rock Dump HELP Model Results

Attachment A

Water Balance Supporting Data

Beal Mountain Mine Water Balance Modeling

Attachment B

Leach Pad Cover HELP Model Results

Beal Mountain Mine Water Balance Modeling

Attachment C

Leach Pad Base Liner Leakage Estimate

Beal Mountain Mine Water Balance Modeling

Attachment D

Waste Rock Dump HELP Model Results

Beal Mountain Mine Water Balance Modeling

APPENDIX D

LAD Supporting Data

Beal Mountain Mine Existing Conditions Report

APPENDIX D-1

Chronology of LAD Operations

Appendix D-1 Beal Mountain Mine Administrative Record: Section E – Land Application Disposal				
Doc #	**# pgs**	**Document Date**	**Author**	**Description**
	1	1/21/1994	Robert C Winegar, MT Dept of State Lands (DSL)	Letter to Bruce Parker with Beal Mtn Mining Inc. (BMMI), approving use of LAD site C for disposal of degraded spring water, not process solution.
	1	2/8/1994	Margaret C Ewing, Forest Service (FS)	Letter to Bruce Parker (BMMI), approving use of LAD area identified in original operating permit, pp. 2-77,78, on a trial basis for disposal of spring water, not process water.
	2	8/11/1994	Bruce Parker (BMMI)	Letter to Wayne Jepson (DSL), outlining proposal to conduct trial LAD of treated solution on areas A & B, and of spring water on area C; to be followed by a described monitoring program.
	11	1/6/1995 (mis-dated as 1994)	Bruce Parker (BMMI)	Application for Amendment to Operating Permit No. 00135, submitted to Margie Ewing (FS) and Sandra Olsen (DSL), to provide boundary expansion and additional LAD area (D) for fresh water disposal. Includes sample data and map.
	5	8/30/1995	Wayne Jepson, MT Dept of Environmental Quality (DEQ)	Letter to Bruce Parker (BMMI) enclosing a supplement to a 7/21/95 inspection report, including water quality results and sketch map.
	3	10/9/1995	Bruce Parker (BMMI)	Letter to William Engle, US Environmental Protection Agency (EPA), summarizing water management at the mine, includes map.
	3	7/29/1997	Bruce Parker (BMMI)	Letter to Jocelyn Dodge (FS) & Joe Gurrieri (DEQ) proposing to proceed with a field test of land application of detoxified leach solution.
	2	1/6/1999	BMMI	Meeting agenda for closed Pegasus (MT) mine sites, includes reclamation/closure priorities for Beal Mtn Mine, some hand-written notes.
	10	4/1/1999	Bruce Parker (BMMI)	Letter to Margie Ewing (FS) and Wayne Jepson (DEQ) including a final plan to regrade, cap and reclaim the Beal leach pad. Includes climatic and estimated seepage data, plus responses to earlier comments/questions.
	3	6/14/1999	FS	Notes from a meeting that included FS, BMMI & DEQ representatives, regarding approval for invoices, planned 1999 reclamation, O&M, maintenance, etc.
	5	6/16/1999	Todd Fayram, Unifield Engineering, Inc. (Unifield)	Memo to Bruce Parker (BMMI) offering an engineering proposal to BMMI for evaluation of leach pad solution & design of water treatment & LAD.
	1	6/16/1999	Jocelyn Dodge (FS)	Minerals Operation Inspection/Modification form – leach pad grading complete, stockpiling leach pad capping material at S Beal. FS agrees w/proposal by Unifield to complete Phase I (site visit & data review).
	2	6/29/1999	Dan Avery (FS)	Letter to Butte District Ranger regarding a 6/28/99 conference call on Beal reclamation.

Appendix D-1 Beal Mountain Mine Administrative Record: Section E – Land Application Disposal				
Doc #	**# pgs**	**Document Date**	**Author**	**Description**
	2	7/1/1999	Dan Avery (FS)	Letter to Butte District Ranger regarding a 6/29/99 Beal reclamation meeting.
	5	7/2/1999	Todd Fayram (Unifield)	Memo to Bruce Parker (BMMI), Roy Norcross (Degussa Corp.), Terry Mudder (Times Ltd) & Kevin Harvey covering meeting notes from 6/29-30/99 site visit & Beal Mtn Mine wastewater review.
	1	7/2/1999	Jocelyn Dodge (FS)	Minerals Operation Inspection/Modification form – progress at S Beal, fence work, discussion of LAD & use of peroxide, discussion of revegetation of S Beal.
	4	7/6/1999	BMMI	Monthly Progress Report for 6/99 at Beal, submitted to Warren McCullough (DEQ) & Margie Ewing (FS). Includes info on leach pad regrade & detox.
	1	7/15/1999	Jocelyn Dodge (FS)	Minerals Operation Inspection/Modification form – Bruce Parker requested test plots for applying detoxed solution from leach pad on area C. Will be coordinated w/John Joy (FS) & Unifield.
	1	7/26/1999	Jocelyn Dodge (FS)	Minerals Operation Inspection/Modification form – Field review of LAD sites for detoxed solution, review of revegetation at S Beal.
	1	7/26/1999	John Joy (FS)	Memo to Jocelyn Dodge (FS) regarding agreements regarding monitoring of vegetation under LAD, and revegetation of reclaimed areas, made at a field review meeting that morning.
	4	8/4/1999	BMMI	Monthly Progress Report for 7/99 at Beal, submitted to Warren McCullough (DEQ) & Margie Ewing (FS). Includes info on solution detoxification & reclamation.
	3	8/12/1999	Reta Therriault, DEQ	Cover letter & inspection report by Joe Gurrieri to BMMI for field inspection on 7/26/99. Covered review of test plots to be utilized for LAD of leach solution.
	1	8/27/1999	Jocelyn Dodge (FS)	Minerals Operation Inspection/Modification form – LAD of detoxed leach solution has begun, vegetation is being heavily impacted.
	5	9/25/1999	BMMI	Monthly Progress Report for 8/99 at Beal, submitted to Warren McCullough (DEQ) & Margie Ewing (FS). Impacts to vegetation noted from LAD of detoxed leach solution.
	2	9/3/1999	BMMI	Summary of LAD testing at Beal, reference for meeting.
	1	9/3/1999	Jocelyn Dodge (FS)	Minerals Operation Inspection/Modification form – on-site meeting to go over LAD results & reclamation activity. Cause of impacts to vegetation from LAD is unknown, testing will continue.

Appendix D-1 Beal Mountain Mine Administrative Record: Section E – Land Application Disposal				
Doc #	**# pgs**	**Document Date**	**Author**	**Description**
	5	10/7/1999	Ed Spotts, Consulting Soil Scientist	Letter to Bruce Parker (BMMI) on LAD progress report. Adverse effects to vegetation noted, preliminary contact with Nickel Plate Mine regarding possibility that thiocyanate is causing the impacts to vegetation.
	5	10/10/1999	BMMI	Monthly Progress Report for 9/99 at Beal, submitted to Warren McCullough (DEQ) & Margie Ewing (FS). Problems with LAD noted, Ed Spotts' report cited.
	1	10/10/1999	Bruce Parker (BMMI)	Letter to Warren McCullough (DEQ) itemizing forecasted costs for the Beal Mine in 10/99.
	4	11/1/1999	Jade Nicolay (DEQ)	Cover letter & inspection report by Pat Plantenberg to BMMI for field inspection on 9/3/99. Review of LAD trials, more research into thiocyanate. Good reclamation progress noted.
	2	12/15/1999	BMMI	Information points put together to cover the 12/13/99 cyanide spill – overtopping of the leach pad dike.
	2	12/21/1999	Bruce Parker (BMMI)	Letter to Margie Ewing (FS) & Warren McCullough (DEQ) regarding the 12/13/99 cyanide solution incident at Beal. Documents what happened, how it was discovered, actions taken.
	3	12/21/1999	BMMI agenda w/Margie Ewing's (FS) handwritten notes	Meeting agenda covering short, medium, & long range plans for leach pad operations.
	5	1/17/2000	BMMI	Draft work plan for LAD treatment & greenhouse study. Objectives are to verify cause of toxicity of treated solution, analyze treatment methods, and utilize a greenhouse to test effects of solution treated by different methods.
	5	1/20/2000	Montana Tunnels Lab	Lab reports for total cyanide analysis from 3 sample points at Beal.
	23	1/25/2000	Unifield	Report prepared for BMMI on Preliminary Evaluation of Options for the Removal of Cyanide-Related Species from Beal Mountain Mining Process Solution. Nine processes analyzed, 3 recommended for further study: ozone oxidation, hydrogen peroxide oxidation & biological treatment.
	1	1/27/2000	BMMI	Leach Pad water balance program printout.
	2	1/31/2000	BMMI	Leach Pad water balance summary for 12/99.

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Doc #	**# pgs**	**Document Date**	**Author**	**Description**
	3	1/31/2000	Dan Avery (FS)	Notes for 1/31/00 Beal Mtn Mine contingency plan meeting, including FS, DEQ, BMMI & Kevin Harvey (hydrologist consultant). Phytotoxic agent in leach solution hasn't been verified – could be thiocyanate, cyanate, or salts. Solution volumes discussed along w/measures to handle excess solution and prevent future overtopping of dike.
	2	2/14/2000	Bruce Parker (BMMI)	Letter to Warren McCullough (DEQ) & Margie Ewing (FS) including a draft contingency plan for the Beal leach pad. Includes 7 possible measures for handling excess solution should the need arise.
	18	4/26/2000	BMMI	1st Quarter Progress Report for Beal Mtn Mine, submitted to Warren McCullough (DEQ) & Margie Ewing (FS). Covers solution management, results of greenhouse study, decision to go ahead w/bio-treatment plant. Includes 4/19/2000 Memo from Mike Botz (Unifield) to Bruce Parker (BMMI) covering options for water treatment.
	4	4/27/2000	Dan Avery (FS)	Letter to Ervin Brooks (FS) covering a 4/26/00 Beal Mine progress report meeting. Leach pad volumes/solution management discussed, going ahead w/pilot scale bio-treatment plant.
	3	5/8/2000	Bruce Parker (BMMI)	Technical memo to Kelvin Buchanan (Trustee) on discharge issues at Beal. Discusses both "fresh" and treated process solution discharge issues.
	2	5/25/2000	Dan Avery (FS)	Notes from meeting w/DEQ regarding proposed Beal Water Treatment EIS. Covered additional water treatment, alternate methods of disposal. EIS felt to be needed.
	1	7/7/2000	Jocelyn Dodge (FS)	Minerals Operation Inspection/Modification form – work on site is concentrated on completing pilot bio-treatment plant, preparing for full-scale plant.
	3	7/10/2000	Fred Stone (BMMI)	Memo to Bruce Parker (BMMI) on progress on pilot bio-treatment plant. The plant is in operation at 1.5 gpm, producing a 95% reduction in thiocyanate. Plant is off-gassing ammonia, as the anaerobic section isn't up to speed yet.
	22	7/12/2000	BMMI	2nd Quarter Progress Report for Beal Mtn Mine, submitted to Warren McCullough (DEQ) & Margie Ewing (FS). Heap solution is being pumped & evaporated, pilot bio-treatment plant is working, agencies have directed construction of full-scale plant.

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Doc #	**# pgs**	**Document Date**	**Author**	**Description**
	2	8/10/2000	Jan Sensibaugh (DEQ)	Letter to Margie Ewing (FS) Covers treatment and disposal of solution from leach pad, which must be done before pad reclamation can be completed. Discusses EIS & MPDES permit, need to complete by the time the full scale bio-treatment plant is in place (1/2001).
	11	10/4/2000	BMMI	Draft report on modeling of land application of treated solution.
	2	10/10/2000	FS	Notes from FS-DEQ meeting on Beal discharge permit. Discussed timelines/requirements for EIS & MPDES permit.
	2	11/13/2000	Dave Ruppert (FS)	Email to Jocelyn Dodge (FS) with attached info on soils.
	3	1/2001	BMMI	Short-term costs from 1/01 → 6/02, assuming balance of leach pad liner installed in 7-10/02.
	4	1/29/2001	BMMI	Short-term costs from 1/01 → 6/02, assuming balance of leach pad liner installed in 2003.
	1	2/7/2001	FS	DRAFT Key Messages on Beal Mine clean up.
	1	3/27/2001	Dan Avery (FS)	Email to Janette Kaiser (FS)
	33	2/21/2000 – 3/30/2001	FS compilation of BMMI data	Compilation of all (?) costs incurred in construction of full-scale bio-treatment plant at Beal.
	1	4/4/2001	Alan Campbell, Office of General Counsel (OGC) & Dan Avery (FS)	Email correspondence covering Trustee obligations, government supervision of activities, and potential risks at Beal Mine.
	10	5/10/2001	Dan Avery (FS)	Notes from trip to Beal on that date. Discussion of status of solution, treatment plant, waste dump, main pit, water monitoring. Photos included.
	1	5/11/2001	FS	Notes from meeting in Boulder on that date. Update on EIS, LAD, and general reclamation activities at Beal.
	1	5/21/2001	Dan Avery (FS)	Email to Carolyn Holmes & Janette Kaiser (FS) documenting phone call from Kel Buchanan (Beal Trustee). Among other things, Kel talked about what his role would be once the bond money was gone. Kel stated that he could stay on and act as an efficient manager for funds and activities at the mine site.
	2	5/28/2001	Unknown	Excerpt from report discussing soil & vegetation monitoring of LAD areas.
	1	5/29/2001	Unknown	Excerpt from report detailing soil sampling of LAD areas.
	2	6/1-5/2001	Stephen Potts (EPA) & Joe Gurrieri (FS)	Email from Potts to Gurrieri covering EPA concerns about solution treatment and LAD at Beal.

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Doc #	**# pgs**	**Document Date**	**Author**	**Description**
	5	6/19/2001	Terry Sexton (FS)	Letter to Bruce Parker (BMMI) making some minor revisions to the LAD management plan & post closure water monitoring plan.
	1	6/20/2001	Dan Avery (FS)	Email to Terry Sexton, Carolyn Holmes & Janette Kaiser covering update on Beal received verbally from Bruce Parker (BMMI). Water treatment looking good, soil & veg studies underway.
	1	7/23/2001	Stephen Potts (EPA)	Email to Pat Plantenberg & Wayne Jepson (DEQ); Joe Gurrieri & Jocelyn Dodge (FS) covering concerns from Orville Kiehn, EPA Mining Specialist about wastewater treatment at Beal.
	2	8/6/2001	FS	Notes from meeting on Beal including FS, DEQ & BMMI. John Joy was concerned about apparent effects to vegetation from LAD of treated solution. Discussed other possible methods of solution disposal.
	3	8/7/2001	Dan Avery (FS)	Letter to Carolyn Holmes (FS) on status of water treatment at Beal. Critical to get rid of excess solution. Impacts to vegetation noted, alternatives discussed. Studies on plant impacts continuing, may not be as bad as initially thought.
	2	8/14/2001	Scott Fisher (DEQ)	Beal Mt. Mine LAD Assessment Team & Activity Plan. Talks about reviewing existing & proposed irrigation system, soils, & vegetation data. Team members identified.
	10	8/15/2001	Dan Avery (FS)	Letter to Terry Sexton on Beal Mtn Update. Topics: FS funding for Beal; possibility of continuing work under CERCLA; monitoring of soils & vegetation; odor emanating from treated solution; installation of liner on leach pad.
	1	8/16/2001	Steve Smith & Dan Avery (FS)	Email on Steve's work at Beal including assistance with capping of leach pad and evaluation of LAD impacts on soils and vegetation.
	1	8/24/2001	Dan Avery (FS)	Email to numerous FS & DEQ people regarding urgent need to meet and reach a decision on how to proceed with finding a way for Beal to expand their LAD area.
	1	8/24/2001	Jocelyn Dodge (FS)	Email to John Joy, Dan Avery, & Dave Ruppert (FS) informing that Beal LAD has been moved from grassland to a forested area.
	1	8/27/2001	Jocelyn Dodge (FS)	Letter to Beal EIS ID Team. Documents 18.1 review proposal and needed response from specialists.
	2	9/4/2001	Dan Avery (FS)	Email to Dave Ruppert (FS) with attached table showing sample results for 8/01 samples taken of 1) Barren solution, 2) Final discharge, 3) Storage pond, & 4) LAD seep.

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Doc #	**# pgs**	**Document Date**	**Author**	**Description**
	2	9/4/2001	Dave Ruppert (FS)	Letter to Terry Sexton (FS) covering Beal EA review for LAD expansion.
	3	9/4/2001	Inter-Mountain Laboratories, Inc.	Results of analysis of Beal vegetation for levels of arsenic, copper, molybdenum, and selenium.
	1	9/7/2001	Tom Keck (NRCS)	Notes on LAD performance re soils.
	1	9/10/2001	Inter-Mountain Laboratories, Inc.	Results of analysis of Beal soils (?) for pH, saturation, EC, calcium, magnesium, sodium, SAR, CEC, etc.
	2	9/13/2001	Unknown	Soil assessment of LAD at Beal.
	1	9/24/2001	Inter-Mountain Laboratories, Inc.	Cover letter to Jocelyn Dodge (FS) to go with results of soil samples submitted for analysis.
	2	9/7/2001	FS	Soil assessment of LAD at Beal.
	1	9/27/2001	Unknown	Preliminary ideas on soil monitoring at Beal.
	2	10/5/2001	Unknown	Beal Mountain Mine soil monitoring.
	1	10/9/2001	Scott Fisher (DEQ)	Memo to Dave Ruppert (FS) & Pat Plantenberg (DEQ) on thoughts & conclusions on LAD at Beal.
	3	10/10/2001	Unknown	Beal Mountain Mine soil monitoring.
	1	10/14/2001	FS	Orthophoto map of LAD area and specific conductivity sampling results.
	3	10/16/2001	FS	Notes from meeting on Beal LAD, included FS, DEQ & BMMI. Reviewed specialists' reports for monitoring & mitigation.
	1	10/18/2001	John Joy (FS)	Documentation of a visit to the Beal Mine to look at forested LAD site after 5 weeks of application. Plants have gone dormant, but grouse whortleberry directly under emitters was impacted, along w/1 1 ft. subalpine fir.
	4	10/23/2001	Jocelyn Dodge (FS)	Letter to Cord Kountz requesting a quote to install an electric fence around LAD area at Beal. Includes specs on type of fence wanted.
	1	10/26/2001	FS	Orthophoto map of LAD area and specific conductivity sampling results.
	1	10/30/2001	C Kountz Fence & Dirt Work	Quote for installing electric fence around Beal LAD area.
	1	11/9/2001	FS	Orthophoto map of LAD area and specific conductivity sampling results.
	1	1/8/2002	Jocelyn Dodge (FS)	Email notification of meeting w/FS & DEQ to discuss Beal LAD.
	4	1/16/2002	FS	Notes from meeting w/FS, DEQ, & BMMI to discuss status of leach pad, treatment plant, LAD, MPDES permit, & funding.

Appendix D-1 Beal Mountain Mine Administrative Record: Section E – Land Application Disposal				
Doc #	**# pgs**	**Document Date**	**Author**	**Description**
	2	1/16/2002	Bruce Parker (BMMI)	Memo to Warren McCullough (DEQ) & Dan Avery (FS) regarding consequences of a seasonal shut-down of the bio-treatment plant. Concerns: loss of bacteria, loss of skilled manpower, mechanical problems, changes in pad chemistry.
	1	1/16/2002	FS (?)	Briefing information for agency staff. Discusses MPDES application, justification for continuing LAD, modifications made to optimize LAD process.
	31	1/16/2002	BMMI	Meeting agenda and reference info on water balance, solution chemistry, water monitoring, etc.
	5	3/4/2002	FS	Notes from a 2/19/02 meeting of FS & DEQ soil scientists to discuss the Beal LAD system. A draft 2/21/02 list of tasks to be performed is attached.
	7	3/18-27/2002	Amy Nerbun, Dan Avery, Dan Svoboda, Mike Burnside (FS); Stephen Potts (DEQ)	Series of emails concerning possible health hazards working around the LAD areas at Beal. Resolved w/o need for face-to-face meeting.
	2	4/2/2002	Pat Plantenberg (DEQ)	Letter to Bruce Parker (BMMI) re review of estimated costs to construct additional LAD areas at Beal.
	1	4/15/2002	Jocelyn Dodge (FS)	Email to Janette Kaiser, Von Helmuth & Carolyn Holmes suggesting a meeting date of 5/6/02 to provide an update on activities at Beal.
	2	4/30/2002	FS	Notes from meeting of that day w/FS & DEQ to discuss changes in LAD from drip to spray system.
	2	5/3/2002	Lorraine Clough (FS)	Handwritten notes from a teleconference call discussing LAD problems at Beal, need to modify system.
	5	5/4/2002	Scott Fisher? (DEQ)	Report on proposed LAD changes at Beal, emphasizing need to go to "big gun" sprinkler system.
	1	5/7/2002	FS	Briefing notes on LAD & monitoring at Beal.
	1	5/10/2002	Jocelyn Dodge (FS)	Handwritten notes covering a 5/3/02 conference call re LAD at Beal, plus notes on a discussion w/Janette Kaiser (FS) that there would be no change to the LAD w/o new NEPA.
	3	5/13/2002	FS	Notes w/handwritten additions on meeting of that date re LAD at Beal. Need to change; impacts to resources.
	3	5/30-6/3/2002	Jack deGolia, Von Helmuth, Lorraine Clough (FS)	Email regarding contact from Duncan Adams, *Anaconda Leader,* re cyanide problems at Beal. Includes points to be made w/Mr. Adams.

Appendix D-1 Beal Mountain Mine Administrative Record: Section E – Land Application Disposal				
Doc #	# pgs	Document Date	Author	Description
	3	6/17/2002	FS	Notes from meeting of that date w/BMMI, FS, DEQ, Trout Unlimited (TU), Mineral Policy Center (MPC) at the Beal Mine. Includes background notes passed out @ meeting.
	2	6/21/2002	FS	Briefing notes to provide Gary Morrison (FS) on LAD, monitoring, & budget situations at Beal.
	2	6/24/2002	FS	Memo to files on Beal LAD effectiveness monitoring.
	1	7/2002	BMMI	Tables showing drip & spray LAD numbers for 7/2001 – 7/2002.
	2	7/11/2002	Dan Avery, Von Helmuth (FS)	Email covering a 7/10/02 visit by Bruce Parker at which he gave info on problems at bio-treatment plant, results of monitoring, proposal for more monitoring.
	2	7/29/2002	Scott Fisher (DEQ)	Memo to Bruce Parker (BMMI) discussing revegetation, LAD studies, site security, etc. Includes page on Intermountain Laboratories methods of analysis for Beal LAD studies.
	2	8/2/2002	Mike Botz	Email to Fred Stone (BMMI) asking for info on solution chemistry on which to base his reverse osmosis (RO) evaluation.
	4	8/8/2002	FS	Agenda & notes from meeting of that date w/FS, DEQ & BMMI re progress on MPDES permit, LAD, monitoring, etc.
	2	8/11/2002	Bruce Parker (BMMI)	Letter to Von Helmuth (FS) & Pat Plantenberg (DEQ) – follow-up to 8/8/02 meeting, plans for further LAD studies, changes to LAD process.
	1	8/14/2002	Dan Avery & Dan Svoboda (FS)	Email correspondence re need to pick a location for BMMI to restart LAD.
	3	8/14/2002	Lorraine Clough, Von Helmuth, Dan Avery (FS)	Email correspondence re LAD, need for more fencing, impacts to vegetation.
	7	8/14/2002	Dan Adams (BMMI)	Letter to Scott Fisher (DEQ) re compost put on Beal leach pad & use of "pitter" on reclaimed slopes of S Beal.
	3	8/16/2002	Scott Fisher & Pat Plantenberg (DEQ); Jocelyn Dodge (FS)	Email correspondence starting w/Fisher's thoughts on LAD & reclamation, then Jocelyn's comments after review w/Dan Svoboda (FS).
	1	8/20/2002	Bruce Parker (BMMI)	Letter to Von Helmuth (FS) & Pat Plantenberg (DEQ) re LAD at Beal and conflicting direction coming from the 2 agencies.
	1	8/22/2002	Von Helmuth (FS)	Letter to Bruce Parker (BMMI) identifying approved and unapproved LAD areas.
	2	8/26/2002	Von Helmuth (FS)	Letter to Bruce Parker (BMMI) approving hiring Westech to set up vegetation transects on LAD sites at Beal. Includes procedures to be followed.

Appendix D-1 Beal Mountain Mine Administrative Record: Section E – Land Application Disposal				
Doc #	# pgs	Document Date	Author	Description
	1	8/27/2002	Tim LaMarr & Jocelyn Dodge (FS)	Email correspondence referencing a document by Tim responding to a letter from CFC re selenium impacts to German Gulch.
	10	8/27/2002	Walker & Associates, Inc.	Draft report on Explanation of Costs: Reverse Osmosis Unit, Beal Mountain Mine.
	1	9/17/2002	Von Helmuth (FS)	Letter to Bruce Parker (BMMI) documenting decision to implement aquatic monitoring.
	3	9/17/2002	FS	Agenda & notes from meeting of that date, including FS, BMMI, Mike Botz (Elbow Cr Engr) & Jim Kuipers. Discussed RO system analysis, meeting w/CFC.
	3	9/19/2002	Mike Botz (Elbow Cr Engr)	Memo to participants at 9/17/02 meeting covering Mike's understanding of decisions re RO analysis for Beal.
	2	9/18-26/2002	Joe Gurrieri (FS); Eric Regensburger & Pat Plantenberg (DEQ)	Email correspondence concerning effluent limits for the MPDES permit for Beal.
	1	9/27/2002	Pat Plantenberg (DEQ); Mike Botz (Elbow Cr Engr)	Email from Pat requesting that sodium levels be considered in RO analysis. Response from Mike that sodium, potassium, calcium, magnesium etc included.
	1	10/2002	Unknown (Tim LaMarr?)	Notes on selenium effects.
	1	10/1/2002	Tim LaMarr & Jocelyn Dodge (FS)	Email regarding lab testing of fish fillets for copper & selenium.
	1	10/4/2002	Mike Botz (Elbow Cr Engr)	Email to Jim Kuipers requesting RO info Jim had said he had on an operating plant at Cunningham Hill Mine.
	1	10/11/2002	Jocelyn Dodge (FS)	Email to Pat Plantenberg + others re comments on CFC & TU concerns, MPDES permit comments, etc.
	2	10/15/2002	Pat Plantenberg (DEQ)	Email response to Jocelyn Dodge (FS) email of 10/11/02
	2	10/18/2002	Jocelyn Dodge (FS)	Email to Mike Botz providing direction on RO analysis.
	5	10/23/2002	FS	Notes from meeting of that date w/FS, BMMI, DEQ & Jim Kuipers (1st part of meeting) covered RO & other treatment analysis, LAD options, etc.
	2	10/11-24/2002	Tim LaMarr, Dan Svoboda & Jocelyn Dodge (FS)	Email correspondence regarding Tim's questions on effluent parameters & standards.
	1	10/24/2002	Jocelyn Dodge (FS)	Email to Von Helmuth (FS) regarding topics & ground rules for upcoming meeting w/Mike Botz, Jim Kuipers, FS & DEQ.
	18	10/25/2002	Bruce Parker (BMMI)	Draft memo on various options to consider under continued operation of bio-treatment/LAD vs. winter shutdown.

Appendix D-1 Beal Mountain Mine Administrative Record: Section E – Land Application Disposal				
Doc #	**# pgs**	**Document Date**	**Author**	**Description**
	2	10/25-29/2002	Jocelyn Dodge, Dan Svoboda, Tim LaMarr & Dave Salo (FS)	Email correspondence starting w/cover for 10/16/02 conference call notes (not attached), going into selenium standards & issues.
	4	10/30/2002	Dave Salo (FS)	Memo to project file on Beal LAD effectiveness monitoring.
	2	11/13/2002	Jocelyn Dodge, Tim LaMarr & Lorraine Clough (FS)	Email correspondence regarding responses to concerns about water quality issues at Beal.
	2	11/13-14/2002	Lorraine Clough, Art Rohrbacher, Von Helmuth & Ray TeSoro (FS)	Email correspondence regarding selenium issues, involved FS parties, etc.
	1	11/15/2002	Jocelyn Dodge (FS)	Email cover for response to CFC, selenium sources at Beal, & 10/28/02 meeting notes (none included).
	2	11/18/2002	Unknown	List of plants at Beal, apparently sent to DEQ.
	1	11/19/2002	Lorraine Clough (FS)	Email to Jocelyn Dodge (FS) discounting importance of another operating season for LAD.
	4	11/19/2002	BMMI	Paper on possible changes in final reclamation plan at Beal.
	3	11/20/2002	FS	Notes on meeting of that date involving FS, DEQ, BMMI & Jim Kuipers. Review of draft RO report from Unified
	59	11/25/2002	Michael Botz (Elbow Cr Engr)	Evaluation of Reverse Osmosis for Treatment of Leach Pad Solution, prepared for BMMI.
	1	11/27/2002	Dave Salo (FS)	Note to Jocelyn Dodge (FS) on comparison of LAD rates vs. application limits per ft^2 → minimum area.
	2	12/2/2002	Pat Plantenberg (DEQ)	DRAFT letter to Eric Regensburger (DEQ) re response to compliance schedule attached to MPDES permit for Beal.
	2	12/2/2002	Jan Sensibaugh (DEQ)	DRAFT response to CFC letter of 9/26/02.
	1	12/3/2002	Mike Botz (Elbow Cr Engr)	Email to Jocelyn Dodge (FS) asking how MPDES permit discharge limits will be handled.
	3	12/5/2002	Jan Sensibaugh (DEQ)	DRAFT response to CFC letter of 8/9/02.
	2	12/5/2002	Jan Sensibaugh (DEQ)	DRAFT response to CFC letter of 9/26/02.
	1	12/6/2002	Ray TeSoro & Tim LaMarr (FS)	Email on draft letter to CFC.
	4	12/10/2002	Jan Sensibaugh	DRAFT response to CFC letters of 8/9 & 9/26/02.
	1	12/10/2002	Dan Avery (FS)	Email documenting diversion of flows from Springs 5 & 10A to LAD.
	1	1/8/2003	Dan Avery (FS)	Email documenting concerns of Bruce Parker that they have emergency, contingency sites for LAD.
	2	1/10/2003	Dave Ruppert (FS)	Beal Mountain Mine soil monitoring 2001.
	50	1/21/2003	Lorraine Clough (FS)	Monitoring & mitigation report for terrestrial wildlife at Beal, includes numerous attachments.

Appendix D-2

LAD Solution Applications Rates

Appendix D-3

LAD Vegetation Tissue Geochemistry