Buena Vista/Klau Mercury Mines
Paso Robles, San Luis Obispo, CA

Final Report

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1 INTRODUCTION

The U.S. Environmental Protection Agency (EPA) Emergency Response Office (ERO) directed the Ecology and Environment, Inc., Superfund Technical Assessment and Response Team (START) to conduct contractor oversight, air monitoring and cost tracking of removal activities at the Buena Vista and Klau mercury mines located outside the city of Paso Robles, San Luis Obispo County, California. This report summarizes the removal activities which began in August of 1999 and continued until mid-November of 2000.

In May of 1999, the Central Coast Regional Water Quality Control Board (RWQCB) requested EPA ERO assistance in preventing the continued release of mercury-laden sediments into the North and South Forks of Las Tablas Creek. On May 18, 1999, an EPA ERO representative, On-scene coordinator (OSC) Dan Suter, accompanied by representatives from the CET Environmental Emergency Rapid Response Services Contractor (ERRS) and the START, met with RWQCB at the Buena Vista/Klau mercury mine site and conducted a removal site evaluation. As part of the evaluation, representatives of the RWQCB shared analytical data and photos which documented surface erosion and transport of mercury-laden sediments to Las Tablas Creek which drains to the Lake Nacimiento Reservoir. This documentation as well as observations made at the site convinced the evaluation participants that an uncontrolled release of a hazardous substance to the environment had occurred and would continue to occur unless immediate stabilization actions were taken.

In July of 1999, the EPA issued a Comprehensive Environmental Resource Compensation Liability Act Section 106 Unilateral Administrative Order (Order) to the owner of the Buena Vista and Klau mercury mines (Buena Vista Mines, Inc. [BVMI]). The Order required that all proposed actions outlined in the *Action Memorandum,* a copy of which was attached to the Order, be addressed by BVMI. Representatives from BVMI claimed that there was not sufficient time before the rainy season to address the proposed actions; however, they submitted a limited work plan focusing on erosion control and acid mine drainage (AMD) treatment which they felt could be accomplished in the given time frame. The work plan was approved by the EPA with the stipulation that all the activities outlined in the *Action Memorandum* would be addressed the following year. In August 1999, the EPA ERO tasked the START to conduct oversight of the BVMI's contractor during on-site activities. Activities outlined in the limited work plan were completed at the end of October 1999.

In spring of 2000, the BVMI failed to finish the remaining work as stipulated in the Order. As a result, the EPA ERO assumed control over the site and tasked the START to conduct oversight of the ERRS contractor, track costs and monitor air during removal activities as well as collect and analyze samples on an as needed basis. The EPA on-site removal activities began July 10, 2000, and were completed in mid-November 2000.

2 BACKGROUND

2.1 Site Location

The Buena Vista/Klau Mercury Mine site is located at 35° 37' North latitude, 120° 53' West longitude, approximately 12 miles west of Paso Robles, San Luis Obispo County (Figure 1). The site consists of two properties; the Buena Vista Mine and the Klau Mine. The site is comprised of approximately 175 acres, and includes five miles of underground workings, a two acre mine pit, and approximately 300,000 tons of mine tailings, overburden and waste rock. This material is distributed throughout the site in large piles which erode and migrate to nearby creeks.

2.2 Site History

Mineral extraction at the site began in the late 1860s and continued until 1970 when operations ceased following pollution abatement orders from the RWQCB. Approximately 108,300 flasks, or 4,115 tons of mercury were extracted from the site[1]. Mining waste, including waste rock, tailings and mercury extraction wastes were stored in or along drainage channels down gradient of the mine. Mine waste piles along the banks of the Klau Branch of the South Fork of Las Tablas Creek have been eroded by runoff from the Klau mine. Weathering from heavy rains have caused the development of deep erosional channels in the waste piles, increasing the sediment load to Las Tablas creek. Additional background information is discussed in the report entitled *Environmental Assessment of the Buena Vista and Klau Mines, San Luis Obispo County, California*, Tetra Tech, June 16, 1998.

In 1994, the RWQCB commissioned a study to identify the sources of mercury contamination in the sediments of Lake Nacimiento Reservoir. The study concluded that the Buena Vista Mine and Klau Mine are the primary contributing sources of mercury contamination to Las Tablas Creek and the Lake Nacimiento Reservoir System.

In 1998, the RWQCB recently documented the erosion of sediments containing elevated concentrations of mercury into the North and South Forks of Las Tablas creek. The RWQCB has issued several written requests to BVMI to address the sources of contamination as well as the off-site migration. To date, BVMI has not complied with these requests.

2.3 Previous Actions

Prior to 1999 removal actions, the BVMI had taken the following remediation steps at the Buena Vista/Klau Mercury Mine site:

- Construction of a rudimentary collection, storage and treatment system to prevent the uncontrolled release of AMD.

[1] Clean Lakes Assistance Program for Lake Nacimiento, Coastal Resources Institute, April 1994

- Installation of silt fencing and concrete diversion channels at strategic locations throughout the site. This was an effort to prevent erosion and off-site migration of contaminants which has had limited success.

- Plugging of the main adit at the Klau Mine to prevent the flow of water into mine workings.

The BVMI has sponsored site assessments and various studies at the site, but no additional remedial actions have been taken.

FIGURE 2-1

3 FIELD ACTIVITIES

The removal activities which took place at the Buena Vista/Klau Mercury Mine site during the period of EPA ERO involvement with the site from August 1999 through November 2000, have been divided into two events for this report: BVMI Stabilization Efforts and EPA Removal Activities.

3.1 BVMI Stabilization Efforts

On July 12, 1999, Unilateral Administrative Order 99-13 was issued by the EPA to the BVMI. In response to the Order, representatives of the BVMI submitted a limited work plan to address slope stabilization and erosion control issues at the Buena Vista/Klau Mercury mine site. On August 12, 1999 the work plan was approved with the stipulation that all the actions outlined in the *Action Memorandum* provided with the Order would be addressed and completed during the next construction season. The BVMI hired a local contractor, Roadrunner Construction, who began work at the site on September 2, 1999. Primary activities focused on erosion control measures at the Buena Vista Mine (BVM) parcel.

3.1.1 Activities Completed at the Buena Vista Mine

The following activities were performed at the BVM:

- Constructing three sedimentation basins,
- Regrading of the Upper Holding Pond,
- Repairing Retort cap,
- Installation of additional AMD collection sumps,
- Implementing erosion control measures, and
- Providing additional AMD storage and secondary containment around the treatment system.

Sedimentation Basins B-1, B-2 and B-3

Three sedimentation basins were constructed at the BVM in an effort to capture runoff and provide time for sediments to settle out prior to migrating off-site. The basins were designed in general accordance with guidelines contained in the California Division of Mines and Geology Erosion and Sediment Control handbook (EPA440/3-78-003)[2]. The basins were constructed by cut and fill, with slopes of 2 horizontal to 1 vertical (2:1). The exception is sedimentation basin B-2 which had a 3:1 slope. The berm slopes were compacted to 90% of the maximum density as determined by ASTM Test method D 1557-91. The outlet of each basin consists of a horizontal discharge pipe fitted to a slotted corrugated riser pipe. The slotted portion of the riser was constructed with a gravel filter pack. The slotted riser pipes allow the sedimentation basins to drain while the filter pack minimizes the discharge of sediments. A rip-rap lined emergency overflow spillway was constructed at each basin to prevent water from overflowing the berms and eroding the slope during heavy rain events. Sedimentation basin B-1 was constructed immediately upstream of the site discharge culvert to capture

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2 *Report of Reclamation and Removal Actions Buena Vista/Klau Mine Superfund Removal Site*, SECOR, January 11, 2000

runoff from the western concrete-lined swale and the unlined eastern retort waste pile channel. The basin has a maximum capacity of 0.9 acre-feet but begins discharging water through the spillway at 0.5 acre-feet capacity as an added safety measure. Sedimentation basin B-2 was constructed south of the mill building and flask shed to capture sediments generated from the western overburden pile. The capacity of this basin is 0.6 acre-feet but begins discharging water through the spillway at 0.3 acre-feet capacity. Sedimentation basin B-3 was constructed south of the caretaker's house to capture sediments from the east-west trending concrete swale. The drainage receives runoff and sediment from the main overburden pile. The capacity of the basin is 0.4 acre-feet but begins discharging water through the spillway at 0.2 acre-feet capacity.

Regrading of the Upper Holding Pond

The upper holding pond was used by BVMI to store AMD which reacted with the native formation creating mineralized sediments with high sulphur content. When rainwater collected in this pond, the water became acidified and required treatment. In order to prevent rainwater from activating sulphur in the pond, the floor of the pond was regraded and capped with native material taken from the pond berm. A valve controlled, two-inch drainage pipe was also installed so that rain water could not collect in the pond and saturate the cap. Water which collects in the pond can now be drained into sedimentation basin B-3.

Repairing Retort Cap

There were several areas of the retort waste pile where the integrity of the clay cap had been compromised due to either erosion, surface disturbance (i.e. tire tracks) or burrowing animals. Repairs to the clay cap were made by placing unmineralized clay over the bare or thin spots and then compacting the material. On the steepest slopes where compaction was too dangerous, erosion control matting was placed over clay cover and secured with wire staples.

Installation of Additional AMD Collection Sumps

Two additional subsurface sumps were installed to enhance the existing AMD collection system. The locations of the sumps were based on the presence of seeps beneath the ore cart trestle and at the base of the mill building. The sump located below the ore cart trestle consisted of an 18 inch plastic standpipe placed 7 feet below ground surface. The bottom 3 feet of the standpipe was perforated and contained a gravel filter pack. A float activated pump was installed for dewatering and was plumbed to discharge into the Mahoney adit sump where it could eventually be pumped into the AMD storage tanks.

The sump located at the base of the mill building was designed to serve as a conveyance between a newly installed, 75-foot long, subsurface drain trench and an existing monitoring well (MW-5). The intention was to allow the material collected in the drain to be captured by MW-5 and then pumped into the AMD storage tanks.

Implementing Erosion Control Measures

The following erosion control measures were implemented at the BVM:

- Regrading to channelize water away from potentially erodible slopes,
- Lining drainage corridors with filter fabric and rock,
- Placing erosion control blankets (straw or coconut fiber mixture sewn into a synthetic netting) on areas disturbed by construction activities,
- Installation of silt fencing along steep sloped areas disturbed by construction or in steep sloped areas with potentially erodible mineralized soils,
- Placing straw mulch on relatively flat slopes, and
- Re-vegetating via mechanical hydroseeding and broadcasting by hand.

Providing Additional Capacity and Secondary Containment

In order to provide increased storage/collection capacity of AMD during the winter months, a 20,000 gallon bladder tank was installed adjacent to the existing treatment area. In an effort to prevent an uncontrolled release due to a treatment system failure, an emergency overflow outlet pipe was fitted to the existing AMD storage tanks and secondary containment was installed around three of the four sides around the treatment system and tanks, forcing any uncontrolled release into the adjacent treatment pond.

3.1.2 Activities Completed at the Klau Mine

The following activities were performed at the Klau Mine:

- Constructing a sedimentation basin,
- Regrading of Klau Mine Pit
- Regrading of collapsed Klau Mine workings, and
- Implementing erosion control measures.

Sedimentation Basin B-4

Sedimentation basin B-4 was constructed southwest of the Klau open pit to capture sediments from the open pit and the steep slopes above the access road before they entered into the Klau Branch of the South Fork of Las Tablas creek. The former mine road was regraded so that the northern side of the road would convey drainage down to the sedimentation basin. The capacity of the basin is 0.8 acre-feet but begins discharging through the spillway at 0.6 acre-feet capacity.

Regrading of Klau Mine Pit

In order to ensure that rainwater was not accumulating on the floor of the Klau Mine pit which provided a conduit to underground workings, the floor of the pit was regraded and compacted with fill material. The regrading of the floor mitigated potential sinkholes, while the fill was used to slope the floor toward the outlet of the pit leading to the former mine road, and then to sedimentation basin B-4.

Regrading Collapsed Klau Mine Workings

A sinkhole north of the Klau pit was regraded to prevent runoff from entering the underground workings. This area was likely a portion of Klau mine workings which subsided over time creating a sinkhole. Several caves were discovered in the immediate area and at least one showed evidence of historical rainwater drainage. The caves were filled in and subsequently the area was graded to allow runoff to flow into the Klau pit where it would drain to sedimentation basin B-4.

Implementing Erosion Control Measures

The following erosion control measures were implemented at the Klau Mine to mitigate erosional effects to Las Tablas Creek:

- Regrading the former mine road to channelize water against the inside bank as it traveled to the sedimentation basin,
- Installation of rip rap at strategic points throughout the drainage conveyance to slow down runoff, and
- Installation of approximately 200 feet of silt fencing along the base of the mining waste pile slope.

All these efforts should minimize erosion of the mine waste pile into the Klau Branch of the South Fork of Las Tablas creek.

Roadrunner Construction completed all the construction tasks by the end of October 1999. BVMI completed storage and containment modifications in December 1999. Additional information on the activities discussed above can be found in the *Report of Reclamation and Removal Actions Buena Vista/Klau Mine Superfund Removal Site*, SECOR, January 2000.

3.1.3 START Oversight Activities

The EPA ERO tasked the START to conduct oversight of the 1999 BVMI funded removal activities. The START focused on earthmoving activities performed by Roadrunner Construction, with specific attention toward dust suppression efforts to prevent the off-site migration of airborne particulates. The START also collected photo documentation and kept a written log of all on-site activities. Progress reports and were submitted to the OSC verbally and in writing throughout the oversight period. The START demobilized from the site when Roadrunner Construction completed all of their activities.

3.2 EPA REMOVAL ACTIVITIES

In spring of 2000, the BVMI failed to finish the work stipulated in the Order. On July 10, 2000 the ERO, START and ERRS mobilized to the site to conduct removal activities.

3.2.1 Activities Completed at the Buena Vista Mine

The following activities were completed at the BVM:

- Capping and slope stabilization of the western overburden pile
- Excavating and transporting retort pile,
- Constructing a repository,
- Draining primary treatment containment pond,
- Upgrading treatment system, and
- Implementing erosion control measures.

Capping and Slope Stabilization of the Western Overburden Pile

The Western Overburden Pile contains overburden excavated from the open pit and represents the greatest volume of mining waste on the site. The pile contains mercury concentrations ranging from 130 to 210 parts per million (ppm), however the overburden material is not acid generating. In order to minimize exposure of the overburden material as well as prevent further erosion of the pile, clean fill excavated during the construction of the repository was used to cap the pile. The ERRS crew excavated approximately 92,780 cubic yards of clean material and placed it on top of the western overburden pile. The slope was graded at 2:1.

Excavating and Transporting Retort Pile

Processed ore was deposited in the retort pile located in a drainage channel north of the flask shed and mill building. This processed ore is suspected to be a main source of AMD-generating material on site; samples collected from the retort pile have yielded mercury values ranging from 400 to 900 ppm. Approximately 112,000 cubic yards of material was removed from the retort pile and placed in the Buena Vista and Klau repositories. The drainage channel was restored to what was believed to be its original condition.

Constructing Repository

A repository was constructed just west of the open pit to hold the processed ore from the retort pile. The repository was designed to contain approximately 110,000 cubic yards. A leachate collection system was installed beneath the repository for transport of leachate to the AMD collection system. The repository was filled with approximately 6,354 truckloads of retort material (108,018 cubic yards) and then capped with two feet of clay. A surface water collection system was installed along the perimeter of the repository to minimize erosion.

Draining of the Lower Pond

Historically the lower pond was used as a settling basin for treated AMD. Sediments in the pond were allowed to build up causing a decrease in the pond's capacity. It was necessary to remove sediments to establish adequate capacity for the pond to be used for emergency storage of AMD during heavy rains. The ERRS subcontracted a high velocity vacuum truck and operator to remove and transport the saturated sediments from the lower pond to the Klau Mine repository. Samples of the sediments were collected in July and analyzed for metals and various inorganic and physical water quality parameters.

Upgrading Treatment System

The ERRS redesigned the existing AMD treatment system to mitigate safety concerns, decrease sludge generation, and minimize discharge requirements. Safety issues identified with the existing treatment system included problems associated with the electrical wiring of system and the dermal and inhalation hazards associated with hydrated lime. Electrical concerns were addressed by a licensed electrical subcontractor who rewired pumps and treatment system components in accordance with the National Electric Code. The hazards of handling hydrated lime was addressed by replacing it with sodium bicarbonate, which is a much safer neutralizing agent to physically handle. Also, sludge generation was decreased because neutralization of the AMD requires less sodium bicarbonate than lime. The ERRS instituted the use of aluminum sulfate as a flocculent, allowing for rapid settling of solids. The ERRS redesigned the treatment process so that treated effluent is no longer discharged off-site. The effluent is first tested on-site for neutral pH, clarity, and toxic metals above discharge action levels. If any of the levels are exceeded the effluent is recirculated for additional treatment and testing. When discharge action levels are met, the effluent is discharged to the Klau Mine parcel via water sprinklers. This method requires no permits.

Implementing Erosion Control Measures

Erosion control measures were implemented in areas disturbed by recent earthmoving activities. Slope stabilization materials were installed by the California Conservation Corps (CCC) and the site was seeded by a commercial hydroseeder. The following erosion control measures were implemented at the BVM.

- The Western Overburden Pile: Slopes were covered with jute netting and two rows of biologs (coconut fiber bound by coir fiber netting). Hay bails were placed in the drainage channel along the western side of the pile. The entire slope was hydroseeded with native vegetation.

- Retort Waste Pile: The pile was removed leaving a steep canyon in its place. Jute netting was placed along slopes with two rows of biologs and the entire area was hydroseeded. Rip rap was placed on the canyon bottom and several bushes and trees were planted.

- Buena Vista Repository: Systems were installed to collect and divert runoff and the entire repository was hydroseeded.

3.2.2 Activities Completed at the Klau Mine

The following activities were completed at the Klau Mine:

- Constructing a repository,
- Regrading the Klau workings and Open Pit, and
- Implementing erosion control measures

Constructing Repository

The amount of material uncovered in the retort pile at the BVM exceeded expectations, therefore a second repository was constructed on the Klau mine property. The Klau repository is located east of the old Klau workings. Approximately 355 truckloads of material (6035 cubic yards) were moved to the repository from the retort pile. In addition to retort material, approximately 155 vacuum truck loads (292,950 gallons) of material was collected from the BVM lower pond and placed in the repository[3] which was then capped with clean fill from the BVM. The repository currently has remaining storage capacity for treatment sediments and future removal activities.

Regrading of Klau Workings and Open Pit

Clean fill excavated during the construction of the BVM repository which was not used for the cap on the Western Overburden Pile was transported to the Klau Mine. The Klau Mine workings, including the sinkhole and the open pit areas were completely regraded and capped with 653 loads (11,101 cubic yards) of clean fill.

Implementing Erosion Control Measures

Hydroseeding was the only erosion control method implemented at the Klau Mine. The workings, including the sinkhole, open pit and the repository were all hydroseeded. Most of the slopes were stabilized during the regrading process and did not require the placement of additional stabilizing materials. The slopes of the waste pile bordering the Klau Branch of Las Tablas creek are so unstable that the installation of erosion control fabrics such as biologs and jute netting could not be done safely at this time.

3.2.3 START Sampling

Several separate sampling events occurred during the four months of EPA removal activities at the BVM. For ease of discussion, these sampling events have been segregated into three categories: AMD treatment system samples; field analytical and confirmation samples; and additional samples.

During the EPA removal activities a total of 15 water and 5 soil samples were submitted to three subcontracted laboratories: Columbia Analytical Services; EMAX Laboratories Inc.; and Sound

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[3] According to the vacuum truck owner, a single load is approximately 60 barrels or 1,890 gallons.

Analytical Services. Each laboratory analyzed for metals and various inorganic and physical water quality parameters. Rapid turn around times and required low level detection limits caused the START to switch laboratories between sampling events.

All laboratory data were validated by a START chemist in accordance with *EPA Quality Assurance/Quality Control Guidance for Removal Activities, OSWER Directive 9360.4-01* for definitive data use objectives and were found to be usable for the intended purpose. All data for target analytes meet the definitive data quality objective. The analytical data review summaries can be found in Appendix B.

AMD Treatment System Sampling

Prior to the ERRS designing a new treatment system, two samples of untreated AMD influent (BV-01-INF and BV-03-INF) and two samples of treated AMD effluent, (BV-02-EFF and BV-04-EFF) were collected from the BVMI treatment system and submitted for laboratory analysis. The AMD samples were collected from a 10,000 gallon storage tank used to store AMD prior to treatment. The effluent samples were collected from the lower pond, adjacent to the treatment system, used as a settling basin for treated water. Sample number BV-02-EFF was colleted from de-watered pond sediments taken from the bucket of an excavator. Sample number BV-04-EFF was collected from treated water in the lower pond. The analytical results for these samples are presented in Table 3-1 and Table 3-2.

The analytical results indicate that the influent samples are essentially a sulphuric acid solution containing high concentrations of metals, particularly iron and manganese. The effluent sample results indicate that the BVMI treatment process is effectively raising the pH of the solution and allowing for the majority of metals to settle out. The de-watered sample results indicate that water generated from drying out sediments would require additional treatment or settling prior to discharge.

Table 3-1
Metal Concentrations In AMD Influent and Treated Effluent

Analytes	Sample Dates, Numbers and Results (Concentrations in µg/L)			
	July 25, 2000	July 25, 2000	July 25, 2000	July 26, 2000
	BV-01-INF	BV-03-INF	BV-02-EFF	BV-04-EFF
	AMD Influent	AMD Influent	Effluent from Treatment Sediments	Treated Effluent from BVMI System
Aluminum	52,000	52,600	4,240	50 U
Antimony	100 U	100 U	50 U	50 U
Arsenic	10 U	10 U	10 U	2 U
Barium	5 U	5 U	49.2	45
Beryllium	5 U	5 U	5 U	5 U
Boron	128 J	113	1,640 J	792
Cadmium	20 U	20 U	5 U	5 U
Calcium	491,000	504,000	760,000	1,090,000
Chromium	77.4	80.5	10 U	10 U
Cobalt	159 J	165 J	10 U	10 U
Copper	52.7	54.5	11.2	10 U
Iron	6,230,000	6,460,000	249,000	182
Lead	4 U	4 U	4 U	2 U
Lithium	578	583	413	509
Magnesium	1,390,000	1,460,000	146,000	250,000
Manganese	17,000	12,600	942	13.5
Mercury	0.8 U	0.8 U	0.5	0.20 U
Nickel	1,230	1,240	108	20 U
Potassium	53,100	53,400	52,900	61,500
Selenium	13.7 J	12.3	10 U	10 UJ
Silicon	12,000	12,100	3,720	324
Silver	10 U	10 U	10 U	10 U
Sodium	59,700	61,200	61,600	65,000
Thallium	895	865	88	49.4

Table 3-1
Metal Concentrations In AMD Influent and Treated Effluent
Continued

Analytes	Sample Dates, Numbers and Results (Concentrations in µg/L)			
	July 25, 2000	July 25, 2000	July 25, 2000	July 26, 2000
	BV-01-INF	BV-03-INF	BV-02-EFF	BV-04-EFF
	AMD Influent	AMD Influent	Effluent from Treatment Sediments	Treated Effluent from BVMI System
Vanadium	10 U	10 U	10 U	10 U
Zinc	2,720	2,850	123	10 U

U = The material was analyzed for, but not detected. The associated numerical value is the sample practical quantitation limit or adjusted sample practical quantitation limit.

J = The associated numerical value is an estimated quantity because the reported concentrations were less than the required practical quantitation limits or because quality control criteria were not met.

UJ = The material was analyzed for but not detected. The reported practical quantitation limit is estimated because quality control criteria were not met.

µg/L = Micrograms per Liter

Table 3-2
Inorganic Concentrations In AMD Influent and Treated Effluent

Analytes	Sample Dates, Numbers and Results (Concentrations in mg/L)			
	July 25, 2000	July 25, 2000	July 25, 2000	July 26, 2000
	BV-01-INF	BV-03-INF	BV-02-EFF	BV-04-EFF
	AMD Influent	AMD Influent	Effluent from Treatment Sediments	Treated Effluent from BVMI System
pH (pH Units)	3.60	3.70	9.17	8.82
Conductivity (units in µMHOS)	15,200	13,400	2,440	3,570
Alkalinity as CaCO3, Total	2 U	2 U	1430	37
Bicarbonate as CaCO3	2 U	2 U	1370	37
Carbonate as CaCO3	2 U	2 U	62	2 U
Ammonia as Nitrogen	3.86	3.88	1.84	0.41
Biochemical Oxygen Demand (BOD)	1.26 J	10 J	5	4 U
Chloride	70.1	72.4	42.9	44.4
Color (Color Units)	35	25	70	5 U
Cyanide, Total	0.01 U	0.01 U	0.01 U	0.01 U
Flouride	10 U	10 U	2 U	4 U
Nitrate as Nitrogen	5 U	5 U	1.5	0.4 U
Nitrite as Nitrogen	5 U	5 U	1 U	0.4 U
Orthophosphate as Phosphorus	0.04	0.08	0.19	0.01 U
Solids, Total Dissolved (TDS)	27,000	28,300	3,320	5,490
Solids, Total Suspended (TSS)	218	169	4450	6
Total Settleable Solids	0.1 U	0.1 U	37.8	0.01 U
Sulfate	17,000	17,500	1,740	3,750
Sufide	2 U	2 U	2 U	2 U
Tannin & Lignin	4,180 J	3,970 J	14.4 J	0.2 U
Carbon, Total Organic	2.2	2.2	3.9	3.5
Turbidity (NTU Units)	392	63.8	1970	5

Table 3-2
Inorganic Concentrations In AMD Influent and Treated Effluent
Continued

Analytes	Sample Dates, Numbers and Results (Concentrations in mg/L)			
	July 25, 2000	July 25, 2000	July 25, 2000	July 26, 2000
	BV-01-INF	BV-03-INF	BV-02-EFF	BV-04-EFF
	AMD Influent	AMD Influent	Effluent from Treatment Sediments	Treated Effluent from BVMI System
Chromium, Hexavalent	0.05 UR	0.05 UR	0.05 UR	0.05 U
Oxygen, Dissolved	5.34 J	4.42 J	<1 UJ	9.33 J

U = The material was analyzed for, but not detected. The associated numerical value is the sample practical quantitation limit or adjusted sample practical quantitation limit.

J = The associated numerical value is an estimated quantity because the reported concentrations were less than the required practical quantitation limits or because quality control criteria were not met.

UJ = The material was analyzed for but not detected. The reported practical quantitation limit is estimated because quality control criteria were not met.

R = The sample results are rejected due to gross deficiencies in quality control criteria. Any reported value is unusable.

µMhos = Unit of conductivity

mg/L = Milligrams per liter

NTU = Nephelolometric Turbidity Units

Field Analytical and Confirmation Samples

The purpose of the redesigned treatment system at the BVM is to provide temporary treatment of AMD until a more permanent treatment system is installed. Treating AMD in batches allows for increased control over treatment parameters and waste sediments, however it presents challenges with regards to managing storage capacity which is particularly critical during heavy rain events and hinges on rapid analytical feedback. Reliable field testing protocols were developed by START in an effort to reduce the amount of time required to collect, treat and discharge a batch. The goal of the treatment system is to neutralize the pH of the AMD solution and reduce the metal concentrations to below their respective primary and secondary Maximum Contaminant Levels (MCL). The following treatment parameters were tested on-site

- pH
- Clarity
- Total Suspended Solids (TSS)
- Metals (iron, manganese, and arsenic)

Field testing results of treated AMD during EPA removal activities are presented in Table 3-3.

Table 3-3
Field Test Results

Analytes	Sample Dates, Numbers and Results (Concentrations are in µg/L)								
	Date (Year 2000)	9/18	9/26	10/3	10/13	10/25	11/13	11/8	11/29
	Batch No.	WT-1	WT-2	WT-3	WT-4	WT-5	WT-6	WT-7	WT-9
	Action Levels	WT-1	WT-2	WT-3	WT-5	WT-6	WT-7	WT-8	WT-10
pH	6.5 -8.5	8.00	8.40	7.88	8.05	7.54	7.55	7.00	7.30
Clarity	N/A	10	9	8	10	10	10	10	10
TSS	5	2	3	6	0	5	3	2	5
Iron	<150	210	210	150	110	150	90	70	100
Manganese	<1200	500	200	400	400	400	1200	500	90
Arsenic	10	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U

U = The material was not detected. The associated numerical value is the sample practical quantitation limit
N/A = Not Applicable
µg/L = Micrograms per liter
Shaded concentrations exceed Action Levels

Effluent samples were collected and submitted to an analytical laboratory to verify the accuracy of field testing and definitively confirm that all metals were being removed. The off-site analytical results are presented in Table 3-4. The strong correlation between field and laboratory data allowed the START to calculate site screening action levels for treatment parameters. The action levels, presented in Table 3-3, are the values used to determine if treatment is complete and a batch, approximately 20,000 gallons treatment effluent, can be safely discharged.

Table 3-4
Treated Effluent Results

Analytes	Sample Numbers, Dates and Analytical Results (Concentrations in µg/L)								
	Date	9-18-00	9-26-00	10-3-00	10-13-00	10-25-00	11-3-00	11-8-00	11-29-00
	Batch	WT-1	WT-2	WT-3	WT-4	WT-5	WT-6	WT-7	WT-9
	MCL	WT-1	WT-2	WT-3	WT-5	WT-6	WT-7	WT-8	WT-10
Antimony	6	100 U	100 U	36.8	0.73 U	1.2 U	1.1 U	1.7 U	50 U
Arsenic	50	10 U	3 6 U	10 U	15 U	9 6	5 U	15 U	50 U
Barium	2,000	3 42	ND	3.34	5 U	5 U	22	2.3	5 U
Beryllium	4	1U	1U	1U	2 U	2 U	2 U	2 U	1 U
Cadmium	5	10 U	10 U	2 05	3 U	2.1	0.5 U	0 5 U	5 U
Chromium	100	10 U	10 U	10 U	5 U	3.7	1.8	10	10 U
Cobalt	N/A	7.24	20 U	20 U	5 U	5 U	5 U	5 U	na
Copper	1300	1.93	10 U	10 U	10 U	10 U	10 U	10 U	20 U
Iron	N/A	na	na	na	74 J	93	91	100 U	78
Lead	15	10 U	10 U	10 U	0.5	10 U	0.24	0 065 U	5 U
Manganese	N/A	na	na	na	110	100	1,300	370	100
Mercury	2	0 5 U	0 5 U	0 5 U	0.2 U	0.2 U	0.2 U	0.2 U	0 5 U
Molybdenum	N/A	41.2	50 5	34.3	50 U	50 U	50 U	50 U	na
Nickel	N/A	9.46	20 U	17 6 U	5.9	7 6	68	140	na
Selenium	50	10 U	7.94	6.12	50 U	50 U	3 U	5 U	50 U
Silver	N/A	3 88	10 U	10 U	10 U	10 U	10 U	10 U	5 U
Thallium	2	144	49.1	168	77	31	22	11	4

Table 3-4
Treated Effluent Results
Continued

Analytes	Sample Numbers and Analytical Results (Concentrations in µg/L)								
	Sample Date	9-18-00	9-26-00	10-3-00	10-13-00	10-25-00	11-3-00	11-8-00	11-29-00
	MCL	WT-1	WT-2	WT-3	WT-5	WT-6	WT-7	WT-8	WT-10
Vanadium	N/A	6.5	10.9	4.03	5 U	5 U	5 U	5 U	na
Zinc	N/A	20 U	20 U	20 U	5U	15	5.4	17	20 U
pH	N/A	8.13	8.48	7.94	8.02	7.64	7.68	6.59	6.60

Shaded concentrations exceed Maximum Contaminant Level (MCL)

U = The material was analyzed for, but not detected. The associated numerical value is the sample practical quantitation limit or adjusted sample practical quantitation limit.

J = The associated numerical value is an estimated quantity because the reported concentrations were less than the required practical quantitation limits or because quality control criteria were not met.

µg/L = Micrograms per Liter

N/A= Not Applicable

na = Not analyzed for

The analytical results indicate, with the exception of Thallium, that all metals consistently dropped out of solution when treated. It is worth noting that although treatment does not appear to effect thallium levels, thallium began dropping consistently when the all the retort material was moved (October 9, 2000) and could no longer impact the AMD influent to the treatment system.

Additional Samples

Sample numbers, descriptions, locations, objectives, and determinations are briefly presented in Table 3-5 for additional sampling conducted by START during EPA removal activities. Analytical results can be found in Table 3-6 and 3-7.

TABLE 3-5
Additional Sample Objectives

Sample Number	Description	Location	Objective	Determination
BV-05-SLG	Saturated Sediment	Lower Pond	To determine if sediments needed to be placed into repository.	Sediments will be placed in repository due to elevated metal concentrations.
BV-06-SLG	Saturated Sediment	Lower Pond	Same as BV-05-SLG.	Same as BV-05-SLG.
BVM Retort #1	Dry, black, processed ore	Retort excavation	To determine metal concentrations in retort pile.	See Table 3-6.
BVM Retort #2	Wet, red, crushed cinnabar	Retort Excavation	To determine difference between this material and black ore material.	Results showed little variation between samples.
KL-02-S	Soil, cobbles	Klau Mine, overburden Pile near pond	To determine if material could be used as "roadbed".	Elevated mercury concentrations in sample prohibit use as road bed.
DWS-1	Liquid from de-watered lower pond sediments	Upper containment pond	To determine if material needed to be treated prior to discharge.	Material did not contain elevated metal concentrations and does not need to be treated.
BV-08-RT	Water	Excavation test pit in Retort	To determine if liquid found during retort excavation would require treatment.	Elevated metal concentrations were documented. Retort liquid required treatment.
KL-01-W	Water	Klau Pond	To document water quality of Klau Pond prior to discharging pond liquids to Las Tablas creek.	See Table 3-7.

Table 3-6
Additional Soil Sample Results

Analytes	Sample Numbers and Results (Concentrations are in mg/kg)				
	July 25, 2000	July 25, 2000	August 23, 2000	August 23, 2000	July 27, 2000
	BV-05-SLG	BV-06-SLG	BVM Retort #1	BVM Retort #2	KL-02-S
	BVMI Treatment Sediments	BVMI Treatment Sediments	Black, Dry Material	Red, Wet Material	Klau Pond Overburden
Aluminum	3,720 J	3,110 J	8,250 J	1,390 J	1,880 J
Antimony	10 UJ	10 U	12.4 J	18.9 J	10.1 UJ
Arsenic	1.4	1.3	11.3	12.4	12.2
Barium	2.3	3.6	173	204	31
Beryllium	1 U	1 U	1.13 U	1.17 U	1.01 U
Boron	99.8 J	93	na	na	16.5
Cadmium	1 U	1 U	1.13 U	1.17 U	1.01 U
Calcium	110,000	110,000	24,400	22,400	70 6
Chromium	2 U	2 U	38.1	10.3	37.7
Cobalt	5.3	5.6	7.9	2.34 U	2.01 U
Copper	4.1	4.8	31.4	4.6	21
Iron	207,000 J	180,000 J	118,000 J	132,000 J	27,700 J
Lead	20 U	20 U	22.5 U	23.4 U	20.1 U
Lithium	5.6	5.1	na	na	2.01 UJ
Magnesium	38,900	37,400	2,650	648	539 J
Manganese	842	841	65.6	21.9	41.7 J
Mercury	0.27	0.34	331 J	86.5 J	1,960 J
Nickel	104	91.9	89.5	12.5	31.3
Potassium	431 J	449 J	2,310	3,240	1,970
Selenium	1 U	1 U	6.6 J	2.93 UJ	1.01 U
Silicon	2,330	2,190	na	na	548
Silver	2 U	2 U	2.25 U	2.34 U	2.01 U
Sodium	460	409	127.	294	53.3
Thallium	7.9	14.4	217 J	537 J	9.3
Vanadium	5.1	4.2	24.7	18.8	31.2

Table 3-6

Additional Soil Sample Results
Continued

Analytes	Sample Numbers and Results (Concentrations are in mg/kg)				
	July 25, 2000	July 25, 2000	August 23, 2000	August 23, 2000	July 27, 2000
	BV-05-SLG	BV-06-SLG	BVM Retort #1	BVM Retort #2	KL-02-S
	BVMI Treatment Sediments	BVMI Treatment Sediments	Black, Dry Material	Red, Wet Material	Klau Pond Overburden
Zinc	90.9	80.9	47.7	13.9	11.3
pH	9.46	9.14	na	na	na
Sulfate	103,000	119,000	na	na	na

U = The material was analyzed for, but not detected. The associated numerical value is the sample practical quantitation limit or adjusted sample practical quantitation limit.

J = The associated numerical value is an estimated quantity because the reported concentrations were less than the required practical quantitation limits or because quality control criteria were not met.

UJ = The material was analyzed for but not detected. The reported practical quantitation limit is estimated because quality control criteria were not met.

na = Not analyzed for

mg/kg = Milligram per kilogram

Table 3-7
Additional Water Sample Results

Analytes	Sample Numbers and Results (Concentrations are in µg/L)		
	October 16, 2000	August 28, 2000	July 27, 2000
	DWS-1	BV-08-RT	KL-01-W
	De-watered treatment Sediments	Excavation test pit in Retort	Klau Pond Water
Aluminum	na	643,000 J	323
Antimony	2.6	323 J	50 U
Arsenic	15 U	835	2 U
Barium	46 J	3,690	30.2
Beryllium	2 U	25 U	5 U
Boron	na	na	70.8
Cadmium	3 U	98	5 U
Calcium	na	582,000	24,400
Chromium	10 U	2,760 J	10 U
Cobalt	5 U	1,700	10 U
Copper	10 U	2,250 J	10 U
Iron	63 J	2,860,000 J	510
Lead	0.5 U	228	2 U
Lithium	na	na	10 U
Magnesium	na	129,000	21,700
Manganese	23	29,000 J	21.7
Mercury	0.19	3,830 J	0 2 U
Nickel	6	19,100 J	20 U
Potassium	na	69,900	2000 U
Selenium	50 U	182	10 0 UJ
Silicon	na	na	798
Silver	10 U	50 U	10 U
Sodium	na	89,300	5610
Thallium	82	1,560 J	5 U
Vanadium	5 U	1,130 J	10 U

Table 3-7
Additional Water Sample Results
Continued

Analytes	Sample Numbers and Results (Concentrations are in µg/L)		
	October 16, 2000	August 28, 2000	July 27, 2000
	DWS-1	BV-08-RT	KL-01-W
	De-watered treatment Sediments	Excavation test pit in Retort	Klau Pond Water
Zinc	10 U	8,890 J	10 U
pH	na	na	8.27
Sulfide	na	na	2 U

U = The material was analyzed for, but not detected. The associated numerical value is the sample practical quantitation limit or adjusted sample practical quantitation limit.

J = The associated numerical value is an estimated quantity because the reported concentrations were less than the required practical quantitation limits or because quality control criteria were not met.

UJ = The material was analyzed for but not detected. The reported practical quantitation limit is estimated because quality control criteria were not met.

µg/L = Micrograms per Liter

na = Not analyzed for

4 ONGOING ACTIVITIES

AMD generated at the Buena Vista Mine Site continues to be treated by the ERRS contractor. Since the START and USEPA demobilized from the site (November 2000), approximately 120,000 gallons of AMD have been treated and discharged. The volume is expected to increase as the winter rains begin. Upon complete removal of retort pile, the pH of the AMD increased from approximately 4.0 to approximately 6.5 pH units. This increase in pH has caused a reduction in the amount of sodium bicarbonate needed to neutralize the AMD. This and other treatment parameters will likely require adjustment as winter rains effect the generation and flow of AMD.

Responsibility for continued operation and maintenance of the current treatment system is currently being negotiated between the EPA and RWQCB. The EPA is committed to funding treatment at least through the spring of 2001.

APPENDIX B

ANALYTICAL REVIEW SUMMARIES

Analytical Review Summaries - Metals

Analytical Review Summaries - Inorganic Analysis

Analytical Review Summaries - pH

Analytical Review Summaries - Sulfate

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