U.S. ENVIRONMENTAL PROTECTION AGENCY
POLLUTION/SITUATION REPORT
Rico Argentine Mine - Removal Polrep

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region VIII

Subject: **POLREP #4**
Progress
Rico Argentine Mine
08BU
Rico, CO
Latitude: 37.6927729 Longitude: -108.0303502

To:
From: Steven Way, OSC
Date: 2/18/2014
Reporting Period: June 2013 to January 2014

1. Introduction

1.1 Background

Site Number:	08BU	**Contract Number:**	
D.O. Number:		**Action Memo Date:**	1/11/2011
Response Authority:	CERCLA	**Response Type:**	Time-Critical
Response Lead:	PRP	**Incident Category:**	Removal Action
NPL Status:	Non NPL	**Operable Unit:**	OU 1
Mobilization Date:		**Start Date:**	5/31/2011
Demob Date:		**Completion Date:**	
CERCLIS ID:		**RCRIS ID:**	
ERNS No.:		**State Notification:**	
FPN#:		**Reimbursable Account #:**	

1.1.1 Incident Category

CERCLA Time-Critical Removal Action

1.1.2 Site Description

1.1.2.1 Location

The Rico Argentine Mine Site (Site) is located north of the town of Rico in Dolores County, Colorado, (Figure 1). The St. Louis Tunnel and the settling ponds area of the Site are located on the east bank of the Dolores River, but the mine workings extend into Telescope Mountain. Mine workings extend to the southeast surface near Silver Creek east of the town of Rico. The ponds area is bound to the west by the Dolores River and U.S. Forest Service land on the east. A portion of many of the ponds sits within U.S. Forest Service land boundaries. The remaining land covers several privately-held mining claims with different owners. In some cases, the ownership of specific parcels is uncertain.

Additional information is provided in POLREPs #1, #2 and #3.

1.1.2.2 Description of Threat

Mine water drains from multiple underground mine workings into the St. Louis Tunnel, which discharges to the Dolores River. Reported historic flow rates range from 500 gallons per minute (gpm) to 2200 gpm. Tunnel discharge samples collected between June 2010 and November 2012 contained cadmium concentrations ranging from 13 micrograms per liter (µg/L) to 67 µg/L and zinc concentrations ranging from 2900 µg/L to 11,700 µg/L. A series of ponds were used historically for lime treatment of the mine water before discharging to the Dolores River.

Currently untreated, the effluent from the pond system contains cadmium concentrations ranging from 9 µg/L to 52 µg/L and zinc concentrations ranging from 1900 µg/L to 8400 µg/L during this same time period. Lime precipitate sludge that contains heavy metals at percent levels (e.g., 4.4% zinc) is contained in the settling ponds. High water levels in the ponds relative to the top of the dikes increased the potential threat that sludge and metals-laden water would overtop the ponds and flow into the Dolores River. For example, the Pond 18 water level in June 2010 was within one foot of the top of embankment along the Dolores River.

Sensitive ecosystem impacts are potentially occurring due to the ongoing releases to the Dolores River, which is considered Cold Water Aquatic Life Class 1 by the state of Colorado. The metals concentrations

being released into the environment exceed the low flow assimilative capacity of the river segment as determined by the State 2008 Water Quality Assessment (WQA).

In addition, Silver Creek, a tributary to the Dolores River, flows through a portion of the Site and is impacted by acid mine drainage. The potential exists for mine water from the Blaine Adit to discharge to Silver Creek entering the Dolores River in the town of Rico.

1.1.3 Preliminary Removal Assessment/Removal Site Inspection Results

In 2000, an emergency removal was performed to prevent a breach where one of the ponds was overtopping. EPA's response consisted of raising and reinforcing the riverside embankment of the pond, adding an additional culvert between the pond and downgradient ponds, and installing overflow riprap as a backup drain path. Additional assessment was performed in 2010 by EPA's response program, and in 2011 the Atlantic Richfield Company (ARCO) began work under an administrative order.

The St. Louis Tunnel drains historical mine workings extending several thousand feet north into Telescope Mountain, which is east of the portal and Dolores Mountain to the southeast. The St. Louis Tunnel is or was directly hydraulically connected to the mine workings of the former Pigeon, Logan, Wellington, Mountain Spring, Argentine, Blaine, Blackhawk and other mines. The 2008 State WQA reports that flows generally range from 2 to 3.3 cubic feet per second (cfs). The tunnel has collapsed and there is an estimated 70 foot debris plug that impounds water in the St. Louis Tunnel. Based on work performed in 2011 through 2013, the mine pool has an estimated volume of 670,000 gallons during average flow conditions (e.g, 800 gpm); the extent and volume of the pool varies with the inflow from the mine workings. The investigations further conclude that the debris blockage and pressure head is not at risk of causing a blowout releasing the mine pool water. The St. Louis Tunnel is approximately 4600 ft long from the portal to where it intersects with the SE and NW cross-cuts; the first approximately 250 feet are collapsed and there is an open channel conveying the flow. The SE Cross-cut is estimated to be 4400 ft, and the NW Cross-cut is estimated to be more than 3000 ft.

The Blaine Mine Adit, located in Dolores Mountain approximately 500 feet above the St. Louis Tunnel level, discharged to Silver Creek as late as the year 2000. Reportedly, ARCO installed a coffer dam in the adit to direct water towards the Morris Cook Incline and ultimately under Silver Creek to the 517 Shaft that leads to the SE Cross-cut/St. Louis Tunnel. An ARCO 2000 sampling report cited metals concentrations in the Blaine mine water of 7,000 µg/L cadmium, 5,200 µg/L copper, 844,000 µg/L iron, 505 µg/L lead, 149,000 µg/L manganese, and 230,000 µg/L zinc. Based on these concentrations and the historic estimates from ARCO that 80 percent of the flow was in the SE Cross-cut, it was assumed the primary metals load originated from the SE Cross-cut connected workings. More recent analysis by ARCO of flow and loading data may indicate that contaminant sources from the NW Cross-cut are more significant than previously thought; this information is currently being reviewed. Regardless, the St Louis Tunnel conveys the mine water to the settling pond system adjacent to the Dolores River.

The St. Louis Tunnel discharge treatment historically consisted of lime addition and precipitation of heavy metals in a series of 19 settling ponds at the Site. As of 1996, the estimated volume of lime-precipitation/metals sludge was in excess of 68,000 cubic yards in 10 settling ponds. The settling ponds are unlined and surrounded by earthen dikes/berms. A portion of the settling ponds system is within the 100-year floodplain of the Dolores River. Recent hydrologic modeling indicates that the upper ponds would not be topped during a 100-year flood event, but the lower ponds would be inundated.

The upper, largest pond, Pond 18, was estimated to contain the largest volume of impounded treatment sludge. It is adjacent to the Dolores River and had little remaining freeboard at the dike along the river. In June 2010, for example, the sludge and water were measured to be less than 12 inches from the top of the dike embankment. During a second inspection, in September 2010, beaver damming caused pond water to overtop the lower pond (Pond 5) banks and bypass the outfall structure. In October 2010, Pond 18 was drained by ARCO following the EPA's removal assessment indicating that inadequate freeboard was remaining

2. Current Activities

2.1 Operations Section

2.1.1 Narrative

The actions implemented during the reporting period included ongoing water quality and flow monitoring; managing the settling ponds and associated historic lime precipitation solids; mine water source controls in the Blaine Adit; evaluation of hydraulic control alternatives for the St. Louis Tunnel discharge; and water treatment alternatives development and pilot scale testing.

2.1.2 Response Actions to Date

Ongoing Monitoring

- Continuous (hourly) flow measurements are made at the St Louis Tunnel discharge downstream of the historic portal (station DR-3) and at the pond system outfall (DR-6) to the Dolores River using automated instrumentation.

- Water samples are collected monthly from the St. Louis Tunnel discharge, two points within the pond system (discharge from Ponds 8 and 15), the outfall from the pond system to the Dolores River, and five locations in the Dolores River upstream, adjacent to, and downstream of the St. Louis settling pond system. The samples are analyzed for total and dissolved metals, potentially dissolved metals, alkalinity, hardness, total dissolved solids, total suspended solids, cyanide, salinity, and sulfate. The EPA START contractor collected split samples with ARCO contractors in November 2013. ARCO was informed in January 2014 that the frequency of the water sampling can be reduced

to quarterly.

- Groundwater samples are collected and water levels measured monthly when conditions permit in 48 monitoring wells (including some paired shallow/deep wells) located throughout the Site. In an effort to more completely evaluate removal alternatives and the contaminated groundwater near Ponds 16/17 and its migration, 17 of these wells were installed during 2013 and sampling and monitoring started in November 2013. Wells are located upgradient of the Site, along the hillside, along the adit collapse area, within the Pond 16/17 area, within Pond 13, along pond berms, and at the downgradient, southern boundary of the active settling ponds.

    - Prior to 2011 - 8 wells currently sampled (GW-1, GW-3, GW-4, GW-5, GW-6, GW-7, EB-1, EB-2)
    - 2011 Wells - 12 wells currently sampled, though MW-2S and MW-3S are typically dry (MW-1S, MW-1D, MW-2S, MW-2D, MW-3S, MW-3D, MW-4S, MW-4D, MW-5S, MW-5D, MW-6S, MW-6D)
    - 2012 Wells - 9 wells currently sampled, though MW-202 is frequently dry (MW-101, MW-102, MW-103, MW-104, MW-202, MW-204, CHV101-S, P13-102, P13-103)
    - 2 angled borings into the St Louis Tunnel (AT-2 and BAH-01)
    - 2013 Wells - 17 wells sampled beginning November 2013 (MW-105, MW-106, MW-107, MW-108D, MW-108S, MW-109S, MW-110, MW-201, MW-203, MG-205, MW-207, MW-208, CHV-101D, CHV-101M, CHV-101U, PZ-1, PZ-2)

Solids Management

- Solids from historic water treatment (lime addition) are being removed from the ponds to increase pond storage capacity and reduce the potential for releases to the Dolores River. A decision will be made regarding the remaining treatment waste solids in the ponds following the selection of the water treatment technology and system design.
    - Approximately 7500 cubic yards of lime precipitation solids were removed from Pond 18 during 2011 and placed in drying cells constructed in the Pond 16/17 area. The solids are being monitored for drying and handling characteristics.
    - Approximately 2200 cubic yards of solids were dredged from Pond 15 during 2012 and placed in Pond 13 for draining and temporary storage.
    - Approximately 1500 cubic yards of solids were dredged or excavated from Ponds 11 and 12 during 2013 and placed in Pond 13 for draining and temporary storage.
    - Two feet of solids were left in each pond to reduce infiltration from the ponds to the underlying aquifer and potentially to the Dolores River.
    - Pond 14 dredging/excavation has not started. The berm improvements needed for safe pond access were completed during 2013, and the solids removal work is scheduled to be completed in 2014.

- Geotechnical/geologic evaluations of potential solids drying and repository sites were performed in 2011, 2012 and 2013. The 2011 investigation identified landslide deposits in the steep slope of CHC Hill that ruled out the initially preferred repository site located north of the pond system. In 2012 and 2013, investigations focused on other potential onsite repository locations located to the south of the St. Louis Tunnel and in Pond 13, a relatively empty pond that does not receive St. Louis Tunnel flows. The evaluation included a range of potential storage volumes based on the solids currently on site and estimated solids generation for the two primary water treatment methods being considered for the St. Louis Tunnel. An alternatives evaluation report was completed in 2013 indicating the preferred location.

- Repository preliminary designs and operating plans were submitted by ARCO to EPA in December 2013. In addition, these plans were submitted to the State and County to allow ARCO to receive a Certificate of Designation to construct a waste repository pursuant to State solid waste regulations. (While a CD/permit is not required as part of the CERCLA action, long-term regulatory control is anticipated to fall under the State solid waste program.) The recommended alternative is a lined cell at the “South Stacked Repository A” location, located east of the Pond 16/17 interim drying facility. ARCO is working with the U.S. Department of Agriculture Forest Service (USFS) to secure part of the land needed for the permanent solids repository. EPA and USFS have coordinated on this topic.

- The Phase 1 Cell is designed for approximately 30,000 cubic yards (cy) of waste. The repository design allows for expansion into the Pond 16/17 area, if needed, for a full build-out storage capacity of 365,000 cy.

- Calcines, a solid waste from roasting pyrite ore to produce sulfuric acid, are present within the Pond 16/17 area and elsewhere on site, such as beneath Pond 13 and between Pond 19 and the VCUP soils repository. The calcines were sampled and underwent geochemical analysis to determine if drainage from the lime precipitation solids or groundwater flowing through the calcines causes leaching of hazardous substances and potential migration off-site. The results are being evaluated in combination with groundwater levels, contaminant concentrations in monitoring wells, and proposed Site uses. Approximately 6640 cubic yards of calcines excavated as part of the demonstration-scale wetland project (see below) were placed in drying cells 3 and 4 in the Pond 16/17 area during 2013 for temporary storage.

- The Flood Dike, forming the west bank of the settling ponds adjacent to the Dolores River, was upgraded and raised in June 2012 based on 100-year flood modeling (HEC-RAS). Upgrades included: dike embankment filter material was added near seeps, larger and more riprap was added near the upper ponds (18 and 15), and the elevation of the dike along Pond 9 was increased to provide more freeboard relative to flood stage water elevations.

- Pond berms were evaluated during 2011, 2012 and 2013, and the results will be used to design pond structures if needed for the selected water treatment system. In 2013, Pond 18 repairs were

performed where a buried pipe that posed stability concerns was identified, and Pond 18 was partially filled with mine discharge.

Hydraulic Controls at St. Louis Tunnel Collapsed Adit Area and Mine Water Source Control

- The collapsed portion of the exposed St. Louis Tunnel extends approximately 250 feet to the buried section of tunnel ("debris plug") overlain by loosely consolidated (sand to boulder size) colluvium. The "terrain trap," as this area is referred to, presents difficult and unsafe conditions in which to attempt opening the tunnel or to construct controls to capture the mine water flowing from the tunnel through the debris plug. Two borings were drilled into the bedrock and the open section of tunnel. The water levels and associated pressure on the blockage have been monitored through the bore holes.

- Hydraulic control alternatives and potential failure modes were analyzed by ARCO. A model was developed in 2013 to assist in determining the anticipated flows from the St. Louis Tunnel before and after hydraulic controls are installed. These analyses and recommendations for hydraulic controls were submitted to EPA in October 2013.

- A mine workings model/map was developed by ARCO contractors using historical mine maps and documents. This information was obtained from current and former owners of the mines in the area, and ARCO has digitized the records and maps.

- Underground mine workings investigations were performed during 2011 and 2012 to assess in-mine water chemistry, flow pathways, and the structural reliability of workings and to develop recommendations for rehabilitation needed to ensure access and continued transport of water to the St. Louis Tunnel. EPA, Colorado Division of Reclamation and Mining Safety (DRMS), and ARCO supported these efforts.

    - The Blaine and 517 adit portals were reconstructed in 2012 to provide structurally safe conditions to enter the adits. The portals and the initial sections of the adits were replaced with steel supports and steel lagging. The DRMS contractor performed this work.

    - A coffer dam at approximately 350 feet inside the Blaine Adit was replaced in 2013 to ensure that acid mine water continues to flow to the 517 Shaft and does not discharge from the adit to Silver Creek. The previous dam showed evidence of corrosion when the mine pool was drained for work in the adit in 2012.

    - Blockages from rock falls in the mine that were impeding flow to the Morris Cook Incline were removed to allow flow to continue towards the Morris Cook Incline and the 517 Shaft.

- A transducer was installed in the 517 Shaft in the fall of 2011 to measure water level changes at the water surface (approximately 455 feet below ground); however, winter icing conditions over the shaft caused the cable to break and the transducer was lost down the shaft. Water levels in the 517 Shaft were measured continuously during an injection test conducted in 2012 and 2013 (see below).

- A base flow measurement project was conducted by EPA and its contractors, DRMS, and ARCO to determine the amount of water that flows from the Blaine Tunnel to the 517 Shaft via the Humboldt Drift. The four day operation, conducted from July 9 through 12, 2012, involved pumping the pooled mine water from the Blaine Adit level to the 517 Shaft via 6 inch piping, then measuring flow into the tunnel behind the coffer dam. Estimated base flow in the Blaine Tunnel ranged from 10 to 20 gpm at the time of pumping, substantially lower than other historical accounts of flow (e.g., 200 gpm) within the Blaine system. It is unknown if the lower flow was due to possible diversion of Blaine Adit water to the Number 3 Shaft that also connects to workings moving water towards the 517 Shaft or other pathways or to the exceptionally low snow pack in the 2011/2012 winter.

- A flume was installed in the Blaine Adit to measure the flow of water from the workings entering into the 517 Shaft via the Humboldt Drift. A pressure transducer was installed to measure flow through the flume and readings began in October 2012. The most recent download of flow data occurred during November 2013.

- Mine water source controls beyond those described above appear to be an unlikely option at this time based on the conditions of the underground workings.

Water Treatment Studies

- At this time, potential water treatment methods being considered include an active lime treatment system, in-situ treatment, passive treatment (including rock drain, constructed wetlands, bioreactor), and ion exchange. Active lime treatment is the default system if the other components are not adequate to meet potential discharge criteria.

- A pilot-scale wetland/sulfate reducing water treatment test was initiated in November 2012. The passive treatment system included a rock drain for manganese removal and a constructed wetland for removal of other metals. The treatment substrate is contained in a lined cell within Pond 9; the system continues to be operated and monitored while treating a flow of approximately 5 to 10 gpm. Results indicate that the system was successful in removing the primary contaminants (95 percent removal of cadmium and 99 percent removal of zinc). The pilot-scale system leaked and had hydraulic problems due to consolidation of fine-grained substrate materials. The results of the pilot-scale passive system are summarized in a report submitted in November 2013. The pilot-scale passive water treatment system will remain active to support the bacteria/inoculum until it can be transferred to the demonstration-scale system.

- A demonstration-scale (10 to 50 gpm) passive water treatment test was designed and construction began in 2013. The overall demonstration-scale design includes both a horizontal flow treatment

system and a vertical flow treatment system. The horizontal flow system includes a settling basin to remove solids and iron, a surface flow wetland for additional iron removal, a horizontal flow subsurface flow wetland to remove metals, an aeration channel to oxygenate the wetland discharge, and a rock drain to remove manganese. The vertical flow system includes a settling basin, a vertical flow biotreatment cell, and an aeration cascade. The systems were designed to allow various flow configurations to assist in determining the components needed for optimum system design. The subgrade preparations and support structure construction was completed during 2013. The liner and substrate materials were not installed due to weather conditions and contractor performance. The construction schedule was extended to June 2014 to allow the system to be reconfigured to include a vertical flow bioreactor in parallel with the horizontal flow subsurface wetland that will allow comparison of the relative effectiveness of the horizontal versus vertical flow anaerobic treatment cells. Also, the system start-up will now be in June, which is a better time of year to begin treatment in the wetland/anaerobic based system than October/November as was originally scheduled.

- A pilot-scale in-situ (517 Shaft Injection) water treatment test was conducted from September to November 2012 and from June 21 to July 9, 2013. During 2012, potassium carbonate and sodium hydroxide were injected into the 517 Shaft to treat water. The Blaine/Argentine mine water drainage travels through the 517 Shaft, and treatment in the shaft resulted in improved discharge water quality at the St. Louis Tunnel. Cadmium and zinc concentrations at the St. Louis Tunnel discharge point were reduced by approximately 40 percent during the test. The 2013 test used sodium hydroxide for neutralization. The test was halted before consistent contaminant reductions were observed at the St. Louis Tunnel discharge point. While treatment in the shaft is feasible, the long-term operation poses technical challenges that have not been addressed. These studies did provide additional information as to the source of metals loads with the respective cross-cuts connecting to the St. Louis Tunnel.

- Bench-scale ion exchange water treatment tests were conducted on Blaine Tunnel and St. Louis Tunnel waters during 2012, and ion exchange resins effective for removing contaminants from each water source were identified.

- Estimated ranges of flows from the above described model and historic flow data are being used for water treatment system design.

2.1.3 Enforcement Activities, Identity of Potentially Responsible Parties (PRPs)

A Unilateral Administrative Order (UAO) was issued to the Atlantic Richfield Company in May 2011 to implement the Removal Action specified in the Work Plan.

2.1.4 Progress Metrics

Waste Stream	*Medium*	*Quantity*	*Manifest #*	*Treatment*	*Disposal*
Pond 18 precipitation solids	Lime precipitates	7500 cy	NA	NA	Pond 16/17 drying cells
Pond 15 precipitation solids	Lime precipitates	2200 cy	NA	NA	Pond 13
Pond 11 and 12 precipitation solids	Lime precipitates	1500 cy	NA	NA	Pond 13
Calcines (roaster waste)	Solid	6600 cy	NA	NA	Pond 16/17 cell

2.2 Planning Section

No information available at this time.

2.3 Logistics Section

No information available at this time.

2.4 Finance Section

No information available at this time.

2.5 Other Command Staff

No information available at this time.

3. Participating Entities

DRMS has been funded by EPA to provide support for underground investigation and adit rehabilitation oversight.

4. Personnel On Site

AECOM is the lead technical contractor for AR. AECOM personnel and contractors performed the geotechnical and hydrological investigations at the Site during 2011, 2012 and 2013.

AMEC Environment & Infrastructure, Inc. personnel, ARCO consultants, were on Site from mid- 2012 through December 2013 to conduct the 517 Shaft injection pilot test and the pilot-scale passive water treatment test, and to oversee initial installation of the demonstration-scale passive water treatment system.

Anderson Engineering Consultants, Inc. (AECI) is the lead construction contractor for AR. They maintain office facilities in Rico, perform monthly sampling and inspections, perform or contract for construction services, and provide for safe operations for all Site personnel. AECI contracted with Flare Construction for general construction services and with various other contractors for drilling, dredging, and other specialty efforts.

ARCO/British Petroleum (BP) maintains one or two personnel in Rico to provide oversight during fall and summer investigation and construction operations.

Colorado DRMS provided support for the 2011 and 2012 mine investigations and tracer studies, the Blaine Tunnel and 517 Shaft portal construction, and the 2011, 2012 and 2013 Blaine Tunnel coffer dam improvements, blockage removal, and flume installation. DRMS contractor Ken Bethers Construction performed the 517 Tunnel and Blaine Tunnel portal rehabilitation and blockage removal work.

The EPA OSC was on Site for oversight activities.

EPA's START contractor provided oversight and sampling teams throughout the project. The START contractor and subcontractor MSI supported the June and October 2011 tracer studies. START and subcontractor Environmental Restoration, Inc. (ER) provided underground support for the June 2012 base flow test. START also provided underground support for the 517 Shaft investigation and injection tests and the Blaine Tunnel flume installation. START conducted split water sampling with AECI in November 2013.

5. Definition of Terms

No information available at this time.

6. Additional sources of information

6.1 Internet location of additional information/report

www.epaosc.org

6.2 Reporting Schedule

7. Situational Reference Materials

No information available at this time.