Rico-Argentine Site
Removal Action Work Plan

September 2021

Administrative Settlement Agreement and Order on Consent

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ACRONYMS AND ABBREVIATIONS

AECOM	AECOM Technical Services, Inc.
amsl	above mean sea level
Anaconda	Anaconda Company
AOC	administrative settlement agreement and order on consent
Atlantic Richfield	Atlantic Richfield Company
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CDPS	Colorado Discharge Permit System
CEPCO	Crystal Exploration and Production Company
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CHC	Charles H. Carpenter
CQAP	Construction Quality Assurance Plan
CWD	Constructed Wetlands Demonstration
EE/CA	Engineering Evaluation and Cost Analysis
EPA	United States Environmental Protection Agency
EWD	Enhanced Wetlands Demonstration
FCS	Flow Control Structure
FSP	Field Sampling Plan
gpm	gallons per minute

H_2S	hydrogen sulfide gas
HASP	Health and Safety Plan
HDS	high density sludge
HMWMD	Hazardous Materials and Waste Management Division
HWTT	Horizontal Wetland Treatment Train
IDF	Interim Drying Facility
MOB	manganese-oxidizing bacteria
NPDES	National Pollutant Discharge Elimination System
OM&M	operations, maintenance, and monitoring
POTD	potentially dissolved
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
QCP	Quality Control Plan
RAMCO	Rico Argentine Mining Company
RAWP	Removal Action Work Plan
SAP	Sampling and Analysis Plan
SCM	Site Conceptual Model
Site	Rico-Argentine Site
SLT	St. Louis Tunnel
SPCC	Spill Prevention, Control and Countermeasure
SRB	sulfate-reducing bacteria
STA	Small Tracts Act
SWMP	Stormwater Management Plan
UAO	Unilateral Administrative Order for Removal Action
USFS	United States Forest Service
USGS	United States Geological Survey
VCUP	Voluntary Cleanup and Redevelopment Program
VWTT	Vertical Wetland Treatment Train

EXECUTIVE SUMMARY

This Removal Action Work Plan (RAWP) is for the Rico-Argentine Site (Site), located in Rico, Colorado (see Figure 1). This RAWP has been prepared as an attachment to the Administrative Settlement Agreement and Order on Consent (AOC); Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Docket Number [ ]; United States Environmental Protection Agency (EPA) 2021 and is intended to describe the removal action tasks necessary to fulfill the requirements of the AOC.

The AOC supersedes and replaces in its entirety the Unilateral Administrative Order for Removal Action, Docket Number CERCLA-08-2011-0005 (UAO), which EPA issued to Atlantic Richfield Company (Atlantic Richfield) on March 17, 2011, and under which Atlantic Richfield has implemented certain removal action tasks consistent with the National Contingency Plan, including but not limited to: a) management of precipitation solids in the settling ponds including partial removal of solids from the upper ponds; b) construction of an on-site solids repository; c) investigation of actions to stabilize the adit opening and consolidate adit flows; d) development of a design for appropriate hydraulic controls at or near the adit opening to manage flows entering the treatment system; e) construction of hydraulic controls at or near the adit opening to manage flows; f) development of a design for an expanded treatment system for the St. Louis Tunnel adit discharge, including upgrades to pond embankments and hydraulic structures; and g) construction of a water treatment system to address the adit discharge. The AOC provides for completion of the removal action work tasks initiated under the UAO, including: 1) enhanced hydraulic controls; 2) expanding the water treatment system to full size; and 3) additional removal of pond solids and solids management.

Attachments to this RAWP include the *Performance Evaluation and Technology Selection Report* (Appendix A), which details the water treatment removal action alternatives analysis; the *Draft Water Treatment Performance Criteria* (Appendix B), which describes the draft performance criteria for water treatment; and *Previous Removal Action Task Status and Site Investigations* (Appendix C), which summarizes the status of completed and ongoing removal action tasks and deliverables.

The Site is located approximately 0.75 miles north of the northern boundary of the Town of Rico in Dolores County, Colorado. The Site consists of an adit, known as the St. Louis Tunnel (SLT), associated underground mine-workings, and a series of settling ponds located downgradient of the SLT adit. Mining activities at the Site began in the early 1900s and continued intermittently through approximately 1977; exploration work ceased in approximately 1983.

Lime treatment of SLT adit discharge was initiated in 1984 under a National Pollutant Discharge Elimination System (NPDES) permit. The property and NPDES permit were transferred to Rico Development Company (RDC) in 1986, and water treatment continued until approximately 1996. The NPDES permit expired in 1999 and has not been renewed. The SLT is inaccessible due to a tunnel collapse in 1996, resulting in the formation of several debris plug(s).

In 2011, EPA issued the UAO for Removal Action to Atlantic Richfield and an associated RAWP, attached as Appendix 3 to the UAO (EPA, 2011a, 2011b). The UAO presented a list of actions required in accordance with the 2011 RAWP. The required actions included the following:

- Hydraulic Controls
    - Investigation of actions that can be feasibly implemented at the collapsed SLT portal to stabilize the adit opening and consolidate adit flows;
    - Development of a preliminary 30% design for appropriate hydraulic controls at or near the adit opening to manage flows entering the treatment system; and
    - Construction, as appropriate, of hydraulic controls at or near the adit opening to manage flows.
- Water Treatment

    - Development of preliminary 30% design for an expanded treatment system for the SLT adit discharge; and
    - Construction of a water treatment system to address adit discharge.
- Solids Management
    - Management of precipitation solids in the settling ponds downstream of the SLT portal, including partial removal of solids from the upper ponds (Ponds 11, 12, 14, 15, and 18); and
    - Construction of an on-site solids repository in accordance with the siting requirements of Colorado Hazardous Materials and Waste Management Division (HMWMD) and Dolores County.

Further site characterization, source water controls, treatability testing, and alternative evaluations were performed pursuant to the 2011 UAO. Removal action activities under the UAO also included removal of pond solids from the St. Louis Ponds System; strengthening of pond dikes/berms; routing and management of stormwater; construction of a solids repository; installation of two relief wells and a flow control structure as adit hydraulic controls; and installation, operation, and monitoring of pilot-scale and demonstration-scale constructed-wetlands treatment systems.

Categories of work that remain include the analysis, design, and construction of: a) an expanded full-scale water treatment system to remove hazardous substances from the SLT discharge; b) additional hydraulic control measures for the collapsed area of the SLT adit; and c) ongoing solids management (collectively, the Water Treatment System as presented in the AOC); and d) the operation and monitoring of the SLT Water Treatment System and associated infrastructure.

Based upon data collected during operation of the Constructed Wetland Demonstration (CWD) and the Enhanced Wetland Demonstration (EWD) treatment systems, a number of removal action alternatives were considered and analyzed for a full-scale water treatment system, as described in Appendix A - Performance Evaluation and Technology Selection Report. The alternatives evaluated were: 1. No Further Action; 2. Expanded Constructed Wetlands; and 3. High-Density Sludge Lime Treatment. These alternatives were primarily evaluated for effectiveness, implementability, and cost. Based upon this comparative analysis, the design and application of a full-scale Expanded Constructed Wetlands Treatment System was selected as the recommended removal action alternative.

Management of precipitation solids from the Expanded Constructed Wetlands Treatment System components and from the partial removal of solids from the upper St. Louis Ponds System[1] during construction will be outlined in a Solids Management Plan. Solids will be managed on-site, as necessary, and placed in the constructed Solids Repository.

A significant amount of data regarding Adit Hydraulic Controls has been collected since the installation of two relief wells intersecting the SLT in 2016. The flow and water level data from the two relief wells and other monitoring locations confirm that the apparent hydraulic conductivity of the collapsed features within the SLT is decreasing over time. A design package will be developed and implemented for the installation of an additional relief well and construction of surface infrastructure and piping connected to the Expanded Constructed Wetlands Treatment System.

[1] All but 2 feet of Pond 18 solids were excavated conventionally by mechanical method and placed in an interim drying facility constructed over the inactive Ponds 16/17 area in 2011. The two feet were left in place to retard the downward seepage of pond water through any calcine tailings present and into the underlying predominantly coarse-grained alluvium deposits. Ponds 15, 12, 11, and 14 solids were dredged and conveyed to interim storage in Pond 13 during 2012, 2013, 2014 respectively, again leaving approximately 2 feet of solids in place (for the same reason).

1 INTRODUCTION

This Removal Action Work Plan (RAWP) is for the Rico-Argentine Site (Site), located in Rico, Colorado. This RAWP has been prepared as an attachment to the Administrative Settlement Agreement and Order on Consent (AOC); Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Docket Number [ ]; United States Environmental Protection Agency (EPA) 2021 and is intended to describe the removal action tasks necessary to fulfill the requirements of the AOC.

The AOC supersedes and replaces in its entirety the Unilateral Administrative Order for Removal Action, Docket Number CERCLA-08-2011-0005 (UAO), which EPA issued to Atlantic Richfield Company (Atlantic Richfield) on March 17, 2011, and under which Atlantic Richfield has implemented certain removal action tasks consistent with the National Contingency Plan, including but not limited to: a) management of precipitation solids in the settling ponds including partial removal of solids from the upper ponds; b) construction of an on-site solids repository; c) investigation of actions to stabilize the adit opening and consolidate adit flows; d) development of a design for appropriate hydraulic controls at or near the adit opening to manage flows entering the treatment system; e) construction of hydraulic controls at or near the adit opening to manage flows; f) development of a design for an expanded treatment system for the St. Louis Tunnel adit discharge, including upgrades to pond embankments and hydraulic structures; and g) construction of a water treatment system to address the adit discharge. The AOC provides for completion of the removal action work tasks initiated under the UAO, including: 1) enhanced hydraulic controls; 2) expanding the water treatment system to full size; and 3) additional removal of pond solids and solids management.

This RAWP includes the following elements:

- Introduction;
- Site characterization;
- Removal action objectives;
- Removal action tasks;
- Removal action work to be performed; and
- Removal action schedule.

Attachments to this RAWP include the *Performance Evaluation and Technology Selection Report* (Appendix A), which details the water treatment removal action alternatives analysis; the *Draft Water Treatment Performance Criteria* (Appendix B), which describes the draft performance criteria for water treatment; and *Previous Removal Action Task Status and Site Investigations* (Appendix C), which summarizes the status of completed and ongoing removal action tasks and deliverables. The ensuing sections discuss the following: site description and background; land use/ownership; and previous removal action tasks.

1.1 Site Description and Background

The Site was the location of historic mining and mineral processing operations. It consists of an adit known as the St. Louis Tunnel (SLT), associated historic underground mine workings, and a series of settling ponds downgradient of the SLT adit. Historically, the adit continuously drained water with elevated concentrations of metals, which eventually discharged to the Dolores River after traveling through the settling ponds.

The metals on-site are considered “hazardous substances” as defined by Section 101(14) of (CERCLA, 42 U.S.C. § 9601(14). Consequently, the EPA issued a UAO in 2011 that required Atlantic Richfield to conduct a removal action to abate endangerment to the public health, welfare, or the environment that may be presented by the actual or threatened release of hazardous substances at or from the Site (EPA, 2011a). Since the order was issued, Atlantic Richfield has been conducting work pursuant to the 2011 RAWP (EPA, 2011b) attached as Appendix 3 to the UAO for Removal Action.

1.1.1 Site Location

The Site is located approximately 0.75 miles north of the northern boundary of the Town of Rico in Dolores County, Colorado. The Site lies at an average elevation of 8,800 feet above mean sea level (amsl) at the base of Telescope Mountain (the lower portion of which immediately adjacent to the SLT is known as Charles H. Carpenter [CHC] Hill) in a relatively flat area adjacent to the Dolores River. This location is in the SW ¼ of Section 24 and the NW ¼ and SW ¼ of Section 25, T 40 N, R 11 W within the United States Geological Survey (USGS) Rico 7.5-minute Topographic Quadrangle.

1.1.2 Site Access

The Site is accessed via a gravel road from State Highway 145 from Telluride (28 miles) to the north and from Cortez (49 miles) to the south as shown on Figure 1. Due to avalanche paths to the east of the Site, the main access road is closed during the winter when avalanche hazards exist, and the Site is accessed via the dikes to the west throughout the St. Louis Ponds System (Ponds System). The typical active-work season for the Site runs from approximately May through October.

1.1.3 Climate

The climate is characterized as semi-arid with long, cold snowy winters and short, moderately wet, and warm summers. Monthly and annual climatic data has been compiled by the Colorado Climate Center at Colorado State University for Rico Station ID 057014 from 1893 through 1993. The mean annual temperature is 39°F. The warmest months are June, July, and August with monthly mean temperatures of about 55°F, and the coldest months are December, January, and February with monthly mean temperatures of about 7°F. The mean annual precipitation in the Rico area is about 27 inches with most precipitation occurring as snowfall in the fall, winter, and early spring.

1.1.4 Facilities/Features

The ensuing sections discuss the following key Site features and facilities: SLT, the Ponds System, demonstration-scale constructed wetlands systems, on-site repositories, and decommissioned treatment structures.

1.1.4.1 St. Louis Tunnel

The SLT extends approximately 5,000 feet east into the base of CHC Hill in the north-central portion of the Site. Based on historical geologic mapping and photographs, it is inferred that the intact portions of the tunnel are seven to eight feet high and nine to ten feet wide. Borrow material had been excavated from the area covering the SLT, causing a collapse of the roof and walls of the tunnel. Adit discharge continues to flow out of the obstructed adit and pools behind the debris plugs, which were identified by pressure transducers installed in tunnel monitoring wells and relief wells. To help alleviate the water pressure behind the debris plugs, two relief wells (RW-2A and RW-2B) were installed in 2016 to allow adit discharge from the SLT to be conveyed in a controlled method to the water treatment system and Ponds System.

The Flow Control Structure (FCS) was installed in 2017 to detain water that could be released during a potential debris plug breach. The FCS would detain much of the water in the tunnel behind the structure and divert overtopping flows to various on-site structures (i.e., Solids Repository and Pond 12) to contain an initial breach.

1.1.4.2 Ponds System

A series of constructed ponds occupy most of the central and southern portions of the Site along the valley floor on the eastern bank of the Dolores River and about 80 acres along the flood plain. Historically, the ponds were used for settling of solids in connection with lime treatment of the adit discharge, resulting in a lime-precipitation metals sludge in some of the ponds. There are 19 ponds on-site, but only eight are actively receiving water discharged from the demonstration-scale constructed wetlands treatment systems, as shown on Figure 2. Discharge from the SLT flows through the demonstration-scale constructed wetlands treatment systems (constructed under the UAO) or the active

ponds (Ponds 5–9, 11, 12, and occasionally 15) and discharges to the Dolores River from an outfall (DR-6) at Pond 5.

The demonstration-scale constructed wetlands treatment systems consist of the Constructed Wetland Demonstration (CWD), which includes the area formerly occupied by Pond 19, and the Enhanced Wetlands Demonstration (EWD), which includes the area formerly occupied by Pond 14 and Pond 18. Pond 15 is maintained dry and has been utilized, as needed, for additional settling when demonstration-scale constructed wetlands treatment systems are bypassed for maintenance or during times of high turbidity, while relief well maintenance was conducted. Pond 10 is fed by groundwater and is not in the current flow path. Ponds 16 and 17 currently serve as the solids Interim Drying Facility (IDF), and Pond 13 provides additional storage for precipitated solids. Ponds 11, 12, and 15 are referred to as the Upper Ponds, which have larger volumes and contain varying amounts of precipitated lime treatment metals-bearing solids. Ponds 5–9 are referred to as the Lower Ponds and contain little to no treatment solids, except for Pond 9. Over time, the Lower Ponds have become a series of naturalized wetlands with abundant vegetation and wildlife. Ponds 1–4 do not currently receive water discharged from the SLT but are fed by geothermally influenced groundwater. Solids management removal action tasks that have been conducted since the issuance of the UAO in 2011 are discussed in Section 1.4. Table 1 summarizes the current estimated volumes of precipitated solids located throughout the Site.

Table 1. *Estimated Volume of Precipitated Solids at Rico-Argentine Site*

Pond	Estimated Solids Volume (cy)
Online/Active Ponds	
11	1,900
12	1,300
15	2,900
Offline/Inactive Ponds	
13	25,500[1]

Notes:
1. Volume shown includes solids and incidental calcines temporarily placed in Pond 13 during removals from various ponds.

Placement of significant volumes of waste rock and other grading material in the central and northern portions of the Site resulted in ground elevations well above the original floodplain surface. Currently, the active channel and floodplain of the Dolores River are confined to the western portion of the historic 100-year floodplain (in some locations up to the 500-year floodplain) by contiguous dikes constructed along the east bank of the river adjacent to and upgradient of Pond 11 (AECOM Technical Services, 2012). However, Ponds 1 through 9 are within the 100-year floodplain, because the dikes are not sufficiently elevated downstream of Pond 11 and not present downgradient of Pond 5. Flood dike upgrades that have been performed to date are discussed in Section 1.4.

1.1.4.3 Demonstration-Scale Constructed Wetlands Treatment Systems

The two demonstration-scale constructed wetlands treatment systems constructed under the UAO are the CWD and the EWD. Water from the SLT is pre-treated with aeration and a coagulant to raise pH and aid precipitation of oxidized iron hydroxide, collected in a Parshall flume (DR-3), and then directed to either the CWD or the EWD, which can treat a maximum of 60 and 550 gallons per minute (gpm), respectively, for a total maximum treatment capacity of 610 gpm. Excess flow is diverted around the demonstration-scale constructed wetlands treatment systems and is sent directly to Pond 12. The CWD consists of two

separate treatment trains that can each treat up to a maximum of 30 gpm. These are referred to as the Vertical Wetland Treatment Train (VWTT) and the Horizontal Wetland Treatment Train (HWTT).

After coagulation addition, the SLT water that is directed towards the VWTT flows into a settling basin to allow for floc formation and coagulated solids settling. Next, water flows through a vertical-flow anaerobic biotreatment cell filled with organic media, which utilizes sulfate-reducing bacteria (SRB) to remove dissolved metals via sulfide precipitation. Finally, the water flows through an aeration cascade to strip excess sulfide and increase dissolved oxygen before flowing into Pond 12. If directed towards the HWTT after coagulation, the SLT water flows into a settling basin. Then, water flows through a surface-flow wetland and subsequently a horizontal-subsurface-flow anaerobic wetland filled with organic media and rock matrix support that utilizes SRB to remove dissolved metals via sulfide precipitation. The effluent then flows through an aeration channel and finally through a limestone rock drain, which utilizes manganese-oxidizing bacteria (MOB) for manganese removal before discharging to Pond 12.

In the EWD, water first enters a settling basin for solids settling. Water flows by gravity to a manganese removal cell, which utilizes MOB and then into a vertical flow anaerobic biotreatment cell filled with organic media, which utilizes SRB to remove dissolved metals via sulfide precipitation. Biotreatment cell effluent is fed into an aeration cascade and then discharged into Pond 12.

Treated water from the three wetlands treatment trains flows into Pond 12, where it is allowed to mix with any pre-treated SLT discharge from the wetland's diversion as well as any stormwater runoff from the Site. Pond 12 gravity-flows into the remaining ponds in the Ponds System and then eventually discharges to the Dolores River from Pond 5 at the DR-6 outfall.

1.1.4.4 On-site Repositories

There are two repositories on-site - the Soil Lead Repository and the Solids Repository.

The Soil Lead Repository occupies approximately 2.6 acres at the base of the CHC Hill in the north-central portion of the Site. The repository accepts soils with elevated lead concentrations removed from the Town of Rico under the Colorado Department of Public Health and Environment (CDPHE) Voluntary Cleanup and Redevelopment Program (VCUP). The permitted repository has a capacity at full build-out of 40,000 cubic yards. Roughly 10,000 cubic yards of soils from yard removals during 2005 to 2019 have been placed in the repository. The repository was built with a geosynthetic clay liner and an overlying leachate collection system that discharges to the Ponds System. Although located at the Site, the Soil Lead Repository was not constructed and is not being operated as part of a removal action activity pursuant to the UAO (or AOC).

A Solids Repository was constructed to provide an on-site management area for existing lime treatment metal-bearing pond solids generated from historic water treatment operations and removed during past/future water treatment system construction, as well as future water treatment generated solids. Solids previously removed from various ponds are currently stored in the IDF (former Ponds 16 and 17), and offline Pond 13, which are both isolated from the Ponds System. The Solids Repository provides capacity for disposal of all existing on-site precipitated treatment solids, estimated to be 31,000 cubic yards in-place in the repository, secured within an engineered, compacted starter dike. Additional capacity for other water treatment related solids from the Site is potentially available by stacking such materials above the starter dike crest elevation. Stacking these materials could add up to 32,000 cubic yards of storage for a maximum repository capacity of approximately 63,000 cubic yards. Since construction, the repository has been managed in an empty state and no solids have been placed in the repository. If future solids management requires repository expansion, the repository could be expanded to the west and could potentially have a maximum build-out capacity of approximately 365,000 CY.

1.1.4.5 Decommissioned Treatment Structures

Remnants of the former lime treatment operations remain on-site, including a metal treatment building and adjacent steel lime silo. The building now houses coagulant storage tanks, a laboratory used for calibration and storage of sampling equipment, and the Site telemetry system.

1.2 History

Mining in the Rico area began in 1869 and continued sporadically for over a century. Historical mining activities are described by Ransome (1901) and McKnight (1974). The St. Louis Smelting and Refining Company drove the SLT into the base of Telescope Mountain beginning in the 1930s and connected it via a northwest-running crosscut tunnel (Northwest Crosscut) to mine workings located to the northwest in CHC Hill and Telescope Mountain to drain those workings so they could be mined. A crosscut to the southeast connects the tunnel with and drains other workings.

In 1944, the Rico Argentine Mining Company (RAMCO) purchased the SLT from St. Louis Smelting and Refining Company, which later underwent various mergers and became a division of Crystal Exploration and Production Company (CEPCO).

In 1955, a sulfuric acid plant was constructed and began operations at the Site. Roasting of pyrite ore to produce sulfuric acid resulted in the generation of calcine residues. The calcine residues were primarily disposed of in Ponds 16 and 17 and the bottom of Pond 15.

RAMCO ceased most mining operations in 1971 and mine workings beneath Silver Creek were allowed to flood. All mining activities by RAMCO ended in 1976-1977 and exploration work ceased in 1978.

In 1980, the Anaconda Company (Anaconda) acquired RAMCO's assets in Rico, including the Site and pre-existing National Pollutant Discharge Elimination System (NPDES) permit (EPA, 2011b). Anaconda conducted exploration drilling at several locations in and around the Site in the 1980s; however, the depth and hot geothermal waters encountered made mining challenging and uneconomic, and no further exploration or development occurred. Anaconda never produced ore or operated milling facilities in Rico. Anaconda was merged into an Atlantic Richfield subsidiary in 1977, which later merged with Atlantic Richfield in 1981.

In 1983, water from the Blaine Mine on Silver Creek was redirected to the SLT, and the Blaine Tunnel became zero discharge. A slaked-lime addition plant was constructed and began operating in 1984 to treat the discharge from the SLT adit to achieve permitted water quality standards at the outfall (DR-6) into the Dolores River. The lime caused some of the metals to precipitate and form a lime metal-bearing precipitate sludge in the bottom of the settling ponds. It is believed in about 1996, the portal area of the SLT collapsed. In 1996, active treatment of the discharge was discontinued (EPA, 2011a).

Atlantic Richfield sold its Rico properties including the Site to Rico Development Corporation in May 1988 under a Purchase and Sale Agreement; the NPDES permit was also transferred at this time. Rico Development Corporation sold its property holdings in April of 1994. The NPDES permit expired in 1999 and has not been renewed.

1.3 Land Use/Ownership

Atlantic Richfield has acquired much of the real property immediately surrounding the SLT portal, Solids Repository, and demonstration-scale constructed wetlands treatment systems, which are located north of and outside the Town of Rico boundary. In October 2013, Atlantic Richfield submitted a Small Tracts Act (STA) application to the United States Forest Service (USFS) to acquire three mineral survey fraction tracts of USFS lands in the vicinity of the SLT. Conveyance of these three tracts to Atlantic Richfield occurred on December 3, 2015. On December 12, 2014, Atlantic Richfield acquired additional property at the Site occupied by the Solids Repository and portions of the Ponds System lying immediately to the east of the Dolores River. Remaining portions of the Ponds System located just to the east of the parcel acquired in 2014 are on property currently owned by the USFS, some of which Atlantic Richfield is currently seeking to obtain through a second pending STA application.

Land use at the Site is and will remain restricted to the CERCLA response actions, including water treatment and solids management. An unimproved access road enters the Site on its southern boundary, immediately east of the Dolores River and passes through the SLT project area. Owners of property north of the Site occasionally use this road to reach their property.

1.4 Previous Removal Action Tasks

In 2011, EPA issued a UAO for Removal Action to Atlantic Richfield and an associated RAWP, attached as Appendix 3 to the UAO (EPA, 2011a, 2011b). The UAO presented a list of actions required to be performed in accordance with the 2011 RAWP. The required actions generally included the following:

- Hydraulic Controls
    - Investigation of actions that can be feasibly implemented at the collapsed SLT portal to stabilize the adit opening and consolidate adit flows;
    - Development of a preliminary 30% design for appropriate hydraulic controls at or near the adit opening to manage flows entering the treatment system; and
    - Construction, as appropriate, of hydraulic controls at or near the adit opening to manage flows.
- Water Treatment
    - Development of preliminary 30% design for a treatment system for the SLT adit discharge; and
    - Construction of a water treatment system to address adit discharge.
- Solids Management
    - Management of precipitation solids in the settling ponds downstream of the SLT portal, including partial removal of solids from the upper ponds (Ponds 11, 12, 14, 15, and 18); and
    - Construction of an on-site solids repository in accordance with the siting requirements of Colorado Hazardous Materials and Waste Management Division (HMWMD) and Dolores County.

Other investigations and related activities related to the tasks described in the 2011 RAWP were completed prior to the issuance of the UAO, as described in Section 4.0 of the 2011 RAWP.

The 2011 RAWP presented specific tasks, subtasks, and deliverables related to the removal action tasks. Appendix C presents the status of each of these tasks and the relevant deliverables. The removal action work that has been conducted since the issuance of the UAO can be summarized as follows:

- Pre-Design and Ongoing Site Monitoring
    - A Sampling and Analysis Plan (SAP) for ongoing surface water, groundwater, and SLT discharge was established to further characterize the seasonal water quality, water levels and flow rates (Atlantic Richfield Company, 2014a).
- Hydraulic Controls
    - After a series of adit and source water control investigations and hydraulic control alternative evaluations, the following adit hydraulic control measures were implemented in accordance with the *St. Louis Tunnel Hydraulic Controls Interim Risk Reduction Measures Work Plan (*Atlantic Richfield Company, 2016): two relief wells (RW-2A and RW-2B) were drilled and installed in 2016, and the FCS was constructed downstream of the adit in 2017.
- Water Treatment
    - Technology screening and a series of treatability studies were performed. A pilot-scale test wetland was constructed and operated in 2013. Based on the successful results of the pilot-scale test wetland, a larger demonstration-scale constructed wetlands system consisting of the CWD and later EWD was designed and constructed to treat SLT

discharge. Operations began in 2014 (CWD) and 2015 (EWD) and continue to the present.

- Solids Management
    - A series of solids management removal action tasks were conducted 2011–2015.
        - In 2011, all but two feet of solids were removed from Pond 18 and placed in the IDF, which was constructed over the former Ponds 16/17 area. The two feet were left in place to retard the downward seepage of pond water into the underlying predominantly coarse-grained alluvium deposits.
        - In 2012, dike improvements were made to Pond 13 to increase solids storage capacity. Solids were then dredged from Ponds 15 (in 2012), and Ponds 11 and 12 (in 2013) and conveyed to interim storage in Pond 13, again leaving approximately two feet of solids in place for seepage control. Solids were removed from Pond 14, with an initial removal in 2014 and final removal in 2015 along with final solids removal of Pond 18 during the EWD construction.
        - The Solids Repository was constructed in 2014–2015.
- Flood Dike Upgrades
    - Flood dike upgrades performed in 2012 included reconstruction of the Pond 15/18 revetment to address two seeps, construction of the Pond 9 revetment, and placement of additional riprap as needed along the flood dike. An additional dike raise in the Pond 18 area and Pond 11 hydraulic structure improvements were performed during 2016 as an ancillary measure to the Interim Risk Reduction Measures.

Additionally, stormwater control measures were also implemented during construction and maintenance activities to mitigate acceleration of erosion and sedimentation, and to control, minimize, and prevent the release of impacted soils entrained in stormwater discharges. The remaining removal action work is further discussed in this RAWP.

2 SITE CHARACTERIZATION

The following sections discuss the source of contamination and the Site Conceptual Model (SCM).

2.1 Site Geology

The geology on-site consists of occasionally exposed bedrock and unconsolidated natural deposits (colluvium and alluvium) typical of mountain-valley terrain. Various surficial historic mining/mineral processing related by-products and fill materials are also present on-site.

The underlying bedrock is primarily comprised of the Middle Pennsylvanian Age Lower Member of the Hermosa Formation. Some volcanic intrusions of Late Cretaceous to early Tertiary age hornblende latite porphyry are present but are sparse and relatively insignificant to the context of the Site. The Hermosa Formation is locally exposed in the slopes above the Site on CHC Hill and is covered by an estimated 340 feet of talus/colluvium at the former SLT portal location. The volcanic intrusions are seen on the lower slopes of CHC Hill and were encountered during the drilling of the SLT (Atlantic Richfield Company, 2013). The average depth to bedrock on-site is 150–175 feet. The Lower member of the Hermosa Formation is comprised of alternating layers of sandstone, siltstone, shale, conglomeratic shale, and limestone or dolomite (Pratt, et al., 1969). Most of the ore was extracted from massive sulfide replacement deposits in the limestone beds (McKnight, 1974). Minerals of economic importance in the area included pyrite, sphalerite, galena, and chalcopyrite.

Colluvial deposits are extensive on the lower mountain slopes of CHC Hill. Penetrations of these deposits by mine workings on-site indicate an apparent thickness of several hundred feet. The colluvium typically consists of a wide range of crudely sorted grain sizes, from fines to large boulders, up to occasional rock blocks greater than 25 feet.

Underlying the relatively flat-bottomed Dolores River valley are alluvial deposits. Borings on-site have identified three alluvial zones:

1. Upper Coarse Alluvium – Typically gravel and gravelly sand ranging from 30 to 50 feet thick;
2. Fine Alluvium – Typically consists of sand with some scattered gravel and gravel lenses ranging from 70 to 90 feet thick; and
3. Lower Coarse Alluvium – Typically consist of gravel and gravelly sand and is approximately 40 feet thick.

Fill materials such as soil and riprap have been placed in a variety of locations around the Site, including at the base of CHC Hill, embankments impounding the Ponds System, and covering the prior floodplain of the Dolores River in the northern portion of the Site.

2.2 Surface Water

Site surface water system components include: 1) the SLT adit discharge; and 2) stormwater including spring run-on and runoff. This section provides a brief description of each Site surface water component as well as the downgradient Dolores River directly to the west of the Site.

The SLT discharge originates as infiltrating precipitation that migrates along joints, fractures, and faults and collects in the mine workings that drain into the SLT. As shown in Figure 3, the primary mine workings contributing to the drainage from the SLT include: the workings draining through the Northwest Crosscut, including the Mountain Springs and Wellington workings; the workings draining through the Southeast Crosscut, including the Blaine, Argentine, and 517 Shaft workings; and the 145 Raise. Groundwater is present in the underground mine workings as a result of infiltration of precipitation (rainfall and snowmelt) through natural discontinuities (i.e., joints, fractures and faults) that serve locally as high conductivity pathways (relative to the intact bedrock) from the surface to the workings. Air is also abundantly present within the workings primarily via mine features open at the surface (i.e., adits, tunnels, and shafts) at various locations, and secondarily from natural discontinuities, both of which connect the underground workings to the surface. Dissolution of mineralized rock present in the open, natural

discontinuities and mine workings occurs due to oxidation reactions resulting from contact of the groundwater (referred to herein as SLT adit discharge once it is intercepted by open mine workings) with susceptible ore minerals in the oxygenated environment.

Weathering and oxidation of the ore and associated minerals release metals and sulfate that originate from the ore minerals. The key contaminants are cadmium, copper, iron, manganese, lead, and zinc due to the mineralogy of the local ores and the geochemistry of these metals. Acidity is also produced by oxidation processes, particularly pyrite oxidation. This, in turn, enhances metals and sulfate release; however, acid is neutralized by limestone in bedrock and in resulting colluvium and alluvium. As a result, iron precipitates from solution and lead and copper are adsorbed by the iron oxides, or precipitate as other mineral phases. Cadmium, manganese, and zinc require higher pH conditions for adsorption, so tend to remain dissolved and be transported further downgradient by surface water and/or groundwater. Historical analytical data indicate that the Northwest Crosscut contributes most of the zinc, cadmium, and manganese loading in the SLT discharge (Atlantic Richfield Company, 2014b). The presence of limestone in bedrock neutralizes acidity to a circumneutral pH, resulting in partial reduction of some metals concentrations by precipitation or adsorption. Geochemically, the concentrations of metals in the adit discharge vary depending on seasonal changes in moisture conditions within the mine workings. Little moisture is needed initially during atmospheric oxidation, which results in formation of secondary, more soluble minerals. In the winter, less water infiltrates into and moves through the mine workings due to frozen surface and near-surface conditions. As a result, metal salts accumulate on the walls of the mine workings above the actively flowing adit discharge. When thawing occurs in the spring, a flush of infiltrating water moves through the mine workings and dissolves the accumulated and concentrated salts. As a result, metals concentrations are typically higher in the spring to early summer.

SLT discharge has been continuously monitored since 2011. Based on the monitoring results, SLT discharge varies seasonally with a base-flow of approximately 400-600 gpm during the late summer, fall, and winter. During the early spring, a sharp increase in SLT discharge occurs with observed peak flows ranging from 900-1250 gpm in the May-June timeframe. SLT discharge tapers off gradually to base-flow over the summer months. The peak flow and highest metals concentrations in the adit discharge do not precisely coincide with the seasonal onset of high runoff water flows in the Dolores River, but follow by up to about a month due to the time required for melt water to infiltrate soils, move through fractured bedrock, enter mine workings, and flow from the SLT.

A portion of SLT discharge flows from two relief wells (RW-2A and RW-2B), and the remainder of the flow passes through a series of three inferred debris plugs consisting of loose colluvial material, fractured bedrock, and wooden timber debris from collapsed tunnel supports, and then daylights at the collapsed SLT portal.

All SLT discharge is routed through the Ponds System. Up to approximately 610 gpm of base-flow water is treated through the demonstration-scale constructed wetlands system (discussed in Section 1.1.4.3). Any SLT discharge not treated by demonstration-scale constructed wetlands is diverted to the Ponds System for solids settling. Demonstration-scale constructed wetlands effluent and diverted flows are allowed to mix in the Ponds System before eventually discharging to the Dolores River.

Stormwater and spring runoff from the Site are collected in the Site stormwater control measures and directed to the Ponds System with eventual discharge to the Dolores River. The Site has a Stormwater Management Plan (SWMP), which is updated annually and continues to be used to meet the substantive requirements of the CDPHE General Construction Stormwater Permit and for stormwater control on-site during and after removal action construction. The SWMP is discussed in further detail in Section 5.3.1.1.

Directly west of the Site is a mile-long reach of the Dolores River, which flows from north to south. This reach of river is located near the headwaters and therefore experiences significant seasonal variation in flows due to spring snowmelt and stormwater runoff. Historically, water samples and flow measurements were collected at five locations on the Dolores River. In 2014, the flow measurement locations were

reduced to two locations upstream and downstream of the treated Ponds System discharge to the river. Water quality samples continue to be collected at all five locations.

2.3 Groundwater

The Site has an extensive system of 49 monitoring wells or piezometers. Groundwater elevations have been measured periodically since 2002 with more frequent data from November 2011 to present. Most of the groundwater wells were intentionally screened within the upper alluvium with the remainder screened in colluvium or one of the other overburden materials. The changes in groundwater elevation are generally consistent with the seasonal variations of flow in the Dolores River. The primary direction of groundwater flow beneath the Site is from north to south, parallel to the gradient of the valley floor with a local component of flow toward the river.

Some adit discharge seeps into underlying colluvium and into groundwater near and just downgradient of the SLT opening and from unlined portions of the Ponds System. Prior removal action tasks (i.e., removal of ponds from the Ponds System and installation of lined ponds for demonstration-scale constructed wetlands treatment system construction and installation of relief wells intersecting the SLT) have decreased the head levels in the adit and the amount of seepage to groundwater.

2.4 Precipitation Solids

Lime was used to treat the metals laden SLT discharge from 1984 to 1996. The treated water flowed into the Ponds System where the metals precipitated and sludge settled before discharging to the Dolores River. As a result, solids have accumulated in the upper ponds. The *Initial Solids Removal Plan* (Atlantic Richfield Company, 2011), submitted pursuant to the requirements of the 2011 RAWP, summarized a precipitation solids inventory performed in 2001. Since 2011, solids have been removed from Pond 18, Pond 14, and partially from Pond 15, Pond 12, and Pond 11, as a part of previous removal action work discussed in Section 1.4. After solids removals were performed, the precipitation solids inventory was updated. As discussed in Section 1.1.4.2, current volumes of solids are provided in Table 1.

3 REMOVAL ACTION OBJECTIVES

The primary removal action tasks necessary to fulfill the requirements of the AOC are: 1) hydraulic controls, 2) water treatment, and 3) solids management. The tasks and objectives are provided below.

3.1 Hydraulic Controls

Two relief wells were installed in 2016 to provide hydraulic control of water pooled within the SLT and to reduce the potential for an uncontrolled release of adit discharge from the SLT. However, a reduction in debris plug permeability over time has been observed through monitoring of outflows through the relief wells and debris plug combination. As a result, additional hydraulic controls are needed to:

1. Provide enhanced and redundant capacity in control of water levels within the SLT;
2. Minimize the potential for an uncontrolled release of adit discharge from the SLT;
3. Manage and convey flows to the full-scale Expanded Constructed Wetlands Treatment System; and
4. Provide metering of flow and maintain water quality for water treatment.

3.2 Water Treatment

Based on the successful results of the pilot-scale and demonstration-scale constructed wetlands and the *Performance Evaluation and Technology Selection Report* (see Appendix A), an Expanded Constructed Wetlands Treatment System to treat SLT water will be designed and constructed. Additional passive wetlands treatment capacity will enable year-round treatment of the 10-year to 25-year recurrence period for SLT flows. Water treatment objectives include:

1. Reduce key contaminants loading to the Dolores River to improve water quality;
2. Reduce metals concentrations to achieve agreed-upon performance criteria;
3. Treat base flows and freshet flows up to the 25-year recurrence period (design permitting);
4. Provide safe, reliable, year-round / all-weather operations; and,
5. Minimize waste production and energy usage.

The water treatment removal action alternatives evaluation is described in Appendix A - *Performance Evaluation and Technology Selection Report*.

3.3 Solids Management

Initial solids removals have been performed for Ponds 11, 12, and 15, and final solids removals have been performed for Ponds 14 and 18. Ponds 14 and 18 final solids removals were conducted as part of the construction of the EWD. Solids are currently stored in the IDF and Pond 13.

The objectives of Solids Management removal action task include the following:

1. Management of precipitation solids as necessary from the Expanded Constructed Wetlands footprint to achieve hydraulic residence times and accommodate water treatment flow rates;
2. Manage precipitation solids currently present in the IDF and Pond 13; and
3. Manage potential future solids from water treatment, including solids removal and drying.

4 PLANNED REMOVAL ACTION TASKS

The planned removal action tasks for hydraulic controls, water treatment, and solids management are provided in the following sub-sections.

4.1 Hydraulic Controls

Hydraulic control options will continue to be used to manage flows and minimize potential for uncontrolled release from the SLT. Construction of a third relief well, RW-3A, will provide hydraulic control and redundancy to the existing system configuration. This work will be described further in an Adit Hydraulic Controls Work Plan.

4.2 Water Treatment

Water treatment alternatives have been evaluated as described in the *Performance Summary and Technology Selection Report* (see Appendix A). Based on a number of factors, including influent chemistry, relatively stable year-round temperatures, and other site-specific considerations (i.e., limited winter access, high elevation, avalanche hazard, etc.), the Expanded Constructed Wetlands best meets the water treatment removal action objectives. The demonstration-scale constructed wetlands have provided excellent discharge water quality following commissioning, while allowing for a reduced on-site presence during the winter, especially during periods of high or extreme avalanche danger. Additionally, solids generation is considerably lower with a constructed wetland than with High Density Sludge (HDS) Lime Treatment, and consumable requirements are greatly reduced. Capital and operations, maintenance, and monitoring (OM&M) cost estimations also support the selection of this alternative.

The selected water treatment removal action is the Expanded Constructed Wetlands Treatment System. Additional wetland components and infrastructure will be designed and constructed as part of the Expanded Constructed Wetlands buildout. This work will be described further in a Water Treatment System Work Plan.

4.3 Solids Management

Continued management of the remaining solids in the St. Louis Ponds System, future water treatment-generated solids, IDF solids, Pond 13 solids, solids in the Solids Repository, and calcines encountered in the construction zone will be required. A Solids Management Plan detailing how existing and future water treatment generated solids are to be managed will be developed. Precipitation solids will be removed as necessary from the Expanded Constructed Wetlands footprint to complete construction of the Expanded Constructed Wetlands. Calcines will be removed where necessary to complete construction of the Expanded Constructed Wetlands and otherwise will not be excavated or managed. The Solids Management Plan will include specific details such as removal requirements, interim drying locations, placement locations, placement thicknesses, placement grades, and cover material specifications.

5 REMOVAL ACTION WORK TO BE PERFORMED

The removal action work to be performed is listed sequentially below. Removal action work to be performed primarily includes a) continued water quality, surface water flow, and groundwater level monitoring; b) the analysis, design, and construction of hydraulic control measures for the collapsed area of the SLT adit; c) the analysis, design, and construction of a full-scale water treatment system, to remove hazardous substances from the SLT discharge; d) solids management; and e) the operation and monitoring of the Water Treatment System, adit hydraulic controls, and associated infrastructure. The following removal action tasks will be performed.

5.1 Pre-Construction Water Quality, Surface Water Flow, and Groundwater Level Monitoring

Flow data and water quality samples will continue to be collected from the SLT discharge and outfall flumes, select locations within the Ponds System, and select locations in the Dolores River. Water level and water quality samples will continue to be collected from on-site groundwater monitoring wells. This monitoring will be conducted in accordance with the May 15, 2014 *Sampling and Analysis Plan for Surface Water and Groundwater* (Atlantic Richfield Company, 2014a) (as amended by Atlantic Richfield's January 22, 2018 letter reducing the sampling frequency from three times to twice annually) and the May 15, 2014 *Quality Assurance Project Plan for Surface Water and Groundwater* (Atlantic Richfield Company, 2014c). Monitoring will be performed during the peak flow (May/June) and moderate to low flow (October/November) timeframes. Water quality and flow monitoring will be conducted under the above plans until the Monitoring and Field Sampling Plan for Removal Action Construction (described further in Section 5.3.1.3) has been submitted and approved by EPA.

5.2 Adit Hydraulic Controls Work Plan

5.2.1 Relief Well - RW-3A

A draft design package for the installation of an additional relief well (RW-3A) will be prepared and submitted to EPA. This draft design will provide increased relief well capacity to allow for additional tunnel head control during freshet conditions to minimize the potential for an uncontrolled release of adit discharge from the SLT. The additional relief well is anticipated to include a horizontal relief well including surface completion, valves and piping, and a concrete protective well house. RW-3A is planned to be installed sufficiently in-by of the existing relief wells so that alternatives for additional adit hydraulic controls can be further evaluated and eventually constructed if deemed necessary. The draft relief well design package will include the following:

- Design criteria;
- Conceptual construction drawings;
- Sizing calculations; and
- Proposed construction schedule.

Following EPA review and approval of the draft design, a final relief well design package will be prepared. The final relief well design package will include the following:

- Construction drawings;
- Technical specifications;
- Sizing calculations;
- Project plans including a Technical Execution Plan detailing the proposed drilling implementation; and
- Construction schedule.

Following EPA review and approval of the final design, the work specified by the final design will be implemented in accordance with the schedule provided.

Following installation of RW-3A, additional monitoring and data collection is anticipated to monitor and adjust head levels within the SLT.

5.2.2 Construction Completion Report

Following completion of the relief well construction, a Construction Completion Report will be prepared to document the work performed. The Construction Completion Report will include the following:

- As-built drawings signed and stamped by a professional engineer;
- Technical variances;
- Quality control documents;
- Material submittals;
- Field reports; and
- Construction photograph logs.

5.3 Water Treatment System Work Plan

5.3.1 Expanded Constructed Wetlands

A draft water treatment design package will be prepared and submitted to EPA. This design will include means for improved solids management, redundancy to allow for maintenance, and improved capacity to allow treatment during freshet conditions. The expanded system is anticipated to include additional settling basins, an additional biotreatment cell, an additional aeration cascade, and a rock drain. Construction will require excavation of residual sediments, installation of liners, and reconstruction of site berms, as needed. Additional construction items such as treatment flow routing infrastructure, installation of media, and safety structures will be included. The draft water treatment design package will include the following:

- Design criteria;
- Revised draft performance criteria (as identified in Appendix B);
- Conceptual drawings;
- Sizing calculations; and
- Proposed construction schedule.

Following EPA review and approval of the draft design, a final water treatment design will be prepared. The final water treatment system design will include the following:

- Construction drawings;
- Technical specifications;
- Project plans as described in Sections 5.3.1.1through 5.3.1.3;
- Final performance criteria; and
- Construction schedule.

The project plans that will be included in the final water treatment design package submittal are further described in the Sections below.

Following EPA review and approval of the final design, the work specified by the final design (Removal Action Construction) will be implemented in accordance with the schedule provided.

5.3.1.1 Stormwater and Erosion Control Plan

The SWMP is updated annually and continues to be used to meet the substantive requirements of the CDPHE General Construction Stormwater Permit and for stormwater control on-site during and after removal action construction. The primary objective of the SWMP is to identify control measures that, when implemented, will meet the terms and conditions of the permit, by minimizing or reducing stormwater pollution of waters of the State of Colorado.

Non-affected waters coming from the north of the Site are intercepted and directed towards the Dolores River via site grading and stormwater controls. Non-affected stormwater that enters the Site from the east is routed to the Ponds System via stormwater controls. Affected stormwater from on-site, including from the IDF, is routed to Pond 12 for settling in the Ponds System via stormwater controls. The demonstration-scale constructed wetlands treatment systems have stormwater controls incorporated in their design/construction to prevent stormwater from entering the treatment components. All stormwater collected throughout the demonstration-scale constructed wetlands treatment systems is routed to Pond 12 for settling.

Atlantic Richfield's contractors will administer and manage the Site SWMP for continued monitoring of past and present construction activities in accordance with the requirements of Colorado Discharge Permitting System (CDPS). The SWMP addresses the limits of disturbance for the Site. The SWMP has been prepared in accordance with good engineering, hydrologic, and pollution control practices. It is intended to be a dynamic document that will continue to be updated as needed to address planned development, new disturbances, and other changes needed to manage stormwater and protect surface water quality.

Control measures will be implemented during construction and maintenance activities to mitigate acceleration of erosion and sedimentation, and to control, minimize, and prevent the release of impacted soils entrained in stormwater discharges. The selection of erosion and sediment control measures are contingent upon site specific conditions (e.g., construction, vegetation, precipitation, and evaporation). Control measures will be installed according to the Colorado Department of Transportation *Erosion Control and Stormwater Quality Field Guide* (CDOT, 2011).

Once the removal action construction activities have been completed for the Site, the SWMP will be used for long-term stormwater management. These activities will include maintaining the erosion-control measures installed as described in the SWMP. Also, a uniform vegetative cover will be established with an individual plant density of at least 70 percent of pre-disturbance levels, or equivalent permanent, physical erosion reduction methods will be employed once site activities have been completed and are ready for stabilization.

Spill prevention and response is also discussed in the SWMP. Through proper training and observant on-site personnel, spills can be prevented. Refueling equipment poses the risk of spilling fuel on-site and efforts will be made to perform this task away from any drainages or waterways. In the event a spill does occur, appropriate measures will be performed to minimize and eliminate the spill and/or damages and notification to the proper people will be executed as described in the SWMP. Contractors planning to refuel on-site will also be required to prepare a Spill Prevention, Control and Countermeasures Plan (SPCC) for their specific operations.

5.3.1.2 Construction Quality Assurance/Quality Control Plan

A Construction Quality Assurance Plan (CQAP) Plan or a Quality Control Plan (QCP) will be prepared as part of the final water treatment design. Specific tasks require quality assurance and quality control (QA/QC) to help ensure construction meets the specifications and the intent of the design. Anticipated tasks and means of QA/QC are listed below:

- Earthwork: surveying, grade checking, soil proctor and compaction, gradations, Atterberg Limits, and field density testing;
- Water Conveyance: surveying, grade checking, leak testing, materials verification, and grouting;
- Concrete Work: compressive strength and shear strength, slump, air content, and concrete placement;
- Liner Installation: materials, installation, welding seams and appurtenances, survey, grade checking, soil proctor, and compaction; and

- Soil Capping and Revegetation: cover materials and amendments, cover thickness, gradations, soil proctor and compaction, placement methods, seed mix, and seeding.

5.3.1.3 Monitoring and Field Sampling Plan

The Monitoring and Field Sampling Plan (FSP) will guide monitoring and sampling of surface water, groundwater, and water treatment systems during Removal Action Construction including the Water Treatment System shakedown period (see Section 5.3.2 for information on the shakedown period). The FSP will be prepared as part of the final water treatment design. The *Quality Assurance Project Plan (QAPP) for Surface Water and Groundwater, Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01, Rico, Colorado* dated May 15, 2014 (Atlantic Richfield Company, 2014c) will be updated and resubmitted as part of the FSP. A select number of surface water locations and groundwater wells will be monitored and sampled during Removal Action construction. It is anticipated that a number of groundwater wells will be abandoned and/or destroyed during Removal Action construction.

All sampling events will include collection of field parameters (e.g., pH, temperature, specific conductance, oxidation-reduction potential, dissolved oxygen) as well as analytical samples. The FSP will identify the monitoring parameters and frequencies.

The following parameters, at a minimum, will continue to be monitored during Removal Action Construction:

- Total SLT flow;
- Relief well flow(s), if applicable (and debris plug flow, if any);
- Water elevations/head pressures, if applicable;
- SLT water parameters (pH, turbidity, specific conductance, temperature, etc.);
- Effluent water parameters (pH, turbidity);
- Treatment flow rates at selected system points;
- Flocculant/chemical injection rates and concentrations;
- Aerator performance, if applicable;
- H_2S concentrations at selected locations;
- Site weather; and
- Web-based live cameras on specific site features.

The analyte lists for surface water, groundwater, and water treatment system water quality samples will be included in the FSP. The analyte lists may include alkalinity, anions, total cyanide, hardness, total metals, dissolved metals, potentially dissolved (POTD) metals, nutrients, total dissolved solids, total sulfide, total suspended solids, and total organic carbon. Field analyses may include sulfide and ferrous iron at select locations.

Sondes (measuring pH, specific conductance, temperature, oxidation reduction potential, dissolved oxygen, turbidity, and water level (select locations)) may be utilized to continuously monitor water quality throughout the Site and treatment system. Data will be uploaded to a remote server.

5.3.2 Water Treatment Shakedown

Following the completion of the Expanded Constructed Wetlands construction activities, a water treatment shakedown period will begin. The shakedown period will last for at least two years and include at least one freshet to review whether the Expanded Constructed Wetlands is functioning and performing as designed or if modifications to the system will need to be performed and noted in as-builts and appropriate project plans. Evaluation of system performance against performance criteria specified in the Expanded Constructed Wetlands Final Design will occur during system operation. Sampling is anticipated to continue to be performed at selective surface water sampling locations and groundwater sampling locations to monitor concentrations of contaminants of concern via water movement as necessary for performance criteria refinement and update. Sampling locations and monitoring

requirements will be developed as part of the FSP (Section 5.3.1.3). Removal Action Construction shall be considered complete after the shakedown period when it is determined that the Expanded Constructed Wetlands and adit hydraulic controls are achieving design criteria and EPA provides written certification in accordance with the AOC.

5.3.3 Construction Completion Report

Following the water treatment shakedown period, a Construction Completion Report will be prepared to document the work performed. The Construction Completion Report will include the following:

- As-built drawings signed and stamped by a professional engineer;
- Technical variances;
- Quality control documents;
- Material submittals;
- Field reports; and
- Construction photograph logs.

5.3.4 Operations Plan

The Operations Plan will guide operations, inspections, monitoring, and maintenance of the Water Treatment System for a period of no less than ten (10) years following completion of Removal Action Construction (including shakedown) . The Operations Plan will be developed to ensure personnel understand how and why systems are operated, and to maintain system integrity, function, safety, and compliance. Inspections of the designed facility will be completed as required to maintain safe, reliable operations. The Operations Plan will include safe operating limits, corrective actions, troubleshooting, and relevant equipment manuals for each section of the treatment train and adit hydraulic controls. In addition to describing normal operating procedures for the Water Treatment System, the Operations Plan will include a description of procedures to be used for managing SLT discharge during bypass, upset, and planned maintenance events.

Operational protocols aside, there are a number of unknowns associated with operating a constructed wetland of this configuration and magnitude that can affect performance of the biological system and would benefit from continued deliberate extended evaluation. Such unknowns run the spectrum from media life and regeneration capacity, to biological evolution and response to changing system conditions, to optimization of hydraulic controls and degassing/oxidation technologies. Many of the evaluations take years to complete; media life being one aspect of the technology that may require seven or move years of monitoring, given that most wetland systems depend on media lasting between seven and ten years. The Operations Plan will identify certain evaluations of the Water Treatment System components that are critical to optimization of performance, protectiveness, operational efficiency, and safe reliable operations. Example evaluations include:

- Methods and techniques to regenerate media;
- Prediction of media life;
- Hydraulic controls optimization;
- Improved solids settling; and
- Improved mass removal of metals.

The Operations Plan will provide monitoring and sampling requirements to be implemented following Expanded Constructed Wetlands construction and certification including quality assurance requirements. The Operations Plan will update, as necessary, the performance criteria set forth in the Expanded Constructed Wetlands Final Design. Compliance water quality samples are anticipated to be collected at the frequency set in the Operations Plan once the Expanded Constructed Wetlands Treatment System has been commissioned and operations initiated. This sampling will be completed to confirm that the reductions of metals concentrations from the mine discharge to the final discharge to the Dolores River

are meeting the Site performance criteria summarized in Appendix B and revised during the Expanded Constructed Wetlands design and Operations Plan development.

Additional wetlands unit operations focused sampling will be conducted throughout the Expanded Constructed Wetlands Treatment System at a frequency yet to be determined for diagnostic purposes. This sampling will be conducted to monitor water treatment system performance throughout the system. All sampling events will include collection of field parameters (e.g., pH, temperature, specific conductance, oxidation-reduction potential, dissolved oxygen) as well as analytical samples. The Operations Plan will identify the monitoring parameters and frequencies. The Operations Plan will be developed and submitted following completion and certification of Removal Action Construction.

5.4 Solids Management Plan

A Solids Management Plan will be developed and detail how existing and future water treatment generated solids will be managed. The Solids Management Plan will describe how remaining solids in the St. Louis Ponds System, future treatment generated solids, IDF solids, Pond 13 solids, solids in the Solids Repository, and calcines encountered in the construction zone will be managed. Solids and sludges resulting from operation of the existing treatment system and those generated through construction will be managed similarly. Pond solids will be removed as necessary from the Expanded Constructed Wetlands footprint to complete construction. Calcines will be removed as necessary or managed to complete construction of the Expanded Constructed Wetlands but otherwise left in place. The Solids Management Plan will include specific details such as removal requirements, interim drying locations, placement locations, placement thicknesses and grades, and cover material specifications. This plan will be implemented in conjunction with the CDPHE-approved *Rico-Argentine Solids Repository Engineering Design and Operations Plan*, dated October 3, 2014 (Atlantic Richfield Company, 2014d).

5.5 Health and Safety Plan

The Health and Safety Plan (HASP) prepared under the UAO has been resubmitted and will be used for future removal action activities. All removal action tasks will be performed in accordance with the HASP. A resubmission of the HASP is not required.

5.6 Historic Preservation Plan

Archeological assessments have been completed at the Site in connection with the Small Tract Act land acquisitions. A cultural resource inventory completed in 2018 identified a segment of the Enterprise branch of the Rio Grande Southern Railroad Grade. This segment is located to the east of the main site access road. Additional inventory of this segment was completed in 2019 at the request of the USFS. There are no other historical places on the Rico-Argentine Site that were designated for preservation. Given these evaluations, historic preservation and mitigation plans are not anticipated to be required unless the identified segment of the Enterprise branch of the Rio Grande Southern Railroad Grade is affected by the proposed design.

5.7 Post-Removal Site Control Plan

90 days prior to the expiration of the operations and monitoring period defined in the Operations Plan, a Post-Removal Site Control Plan will be submitted to EPA for approval. The Post-Removal Site Control Plan will detail continuing operations and monitoring for the Water Treatment System, adit hydraulic controls, and Solids Repository in accordance with the Operations Plan and Solids Management Plan and in a manner that maintains effectiveness and integrity of the systems.

6 REMOVAL ACTION SCHEDULE

The Draft Removal Action Schedule is presented in Figure 4. This schedule is based on existing information and may change depending on acquisition of new data, unanticipated design/construction issues, and/or regulatory requirements that have not been considered.

7 REFERENCES

AECOM, 2012, Interim flood dike upgrades technical memorandum—Rico Tunnels Operable Unit OU01, Rico, Colorado, EPA Unilateral Administrative Order, Docket No. CERCLA-08-2011-005, dated March 1, 2012.

Atlantic Richfield Company, 2011, Initial Solids Removal Plan, Rico-Argentine Mine Site—Rico Tunnels Operable Unit OU01, Rico, Colorado, submitted by Atlantic Richfield Company to US EPA, Dated July 7, 2011.

Atlantic Richfield Company, 2013, Adit and portal investigation report 2013 update, Rico-Argentine Mine Site—Rico Tunnels Operable Unit OU01, Rico, Colorado, submitted by Atlantic Richfield Company to US EPA, dated October 30, 2013.

Atlantic Richfield Company, 2014a, Sampling and analysis plan for surface water and groundwater, Rico-Argentine Mine Site—Rico Tunnels Operable Unit OU01, Rico, Colorado, submitted by Atlantic Richfield Company to US EPA, dated May 15, 2014.

Atlantic Richfield Company, 2014b, Evaluation of source water controls, Revision 1, Rico-Argentine Mine Site—Rico Tunnels Operable Unit OU01, Rico Colorado, submitted by Atlantic Richfield Company to US EPA, dated October 15, 2014.

Atlantic Richfield Company, 2014c, The Quality Assurance Project Plan for Surface Water and Groundwater, Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01, Rico, Colorado, submitted by Atlantic Richfield Company to US EPA, Document Control No. 2013-R1-001, dated May 15, 2014.

Atlantic Richfield Company, 2014d, Rico-Argentine Solids Repository Engineering Design and Operations Plan, Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01 Rico, Colorado, submitted by Atlantic Richfield Company to CDPHE, dated October 3, 2014.

Atlantic Richfield Company, 2016, Work Plan St. Louis Tunnel Hydraulic Controls Interim Risk Reduction Measures, Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01, submitted by Atlantic Richfield Company to US EPA, dated April 18, 2016.

Atlantic Richfield Company, 2018, St. Louis Tunnel discharge Constructed Wetland Demonstration treatability study work plan performance monitoring plan change request, Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01, submitted by Atlantic Richfield Company to US EPA, dated January 22, 2018.

Colorado Department of Transportation, 2011, Erosion Control and Stormwater Quality Field Guide. 2011.

EPA, 1993, Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA, EPA/540R-93/057, OSWER 9360.0-32, August 1993.

EPA, 2011a, Unilateral Administrative Order for Removal Action, U.S. EPA Region 8, CERCLA Docket No. CERCLA-08-2011-0005. March 23, 2011.

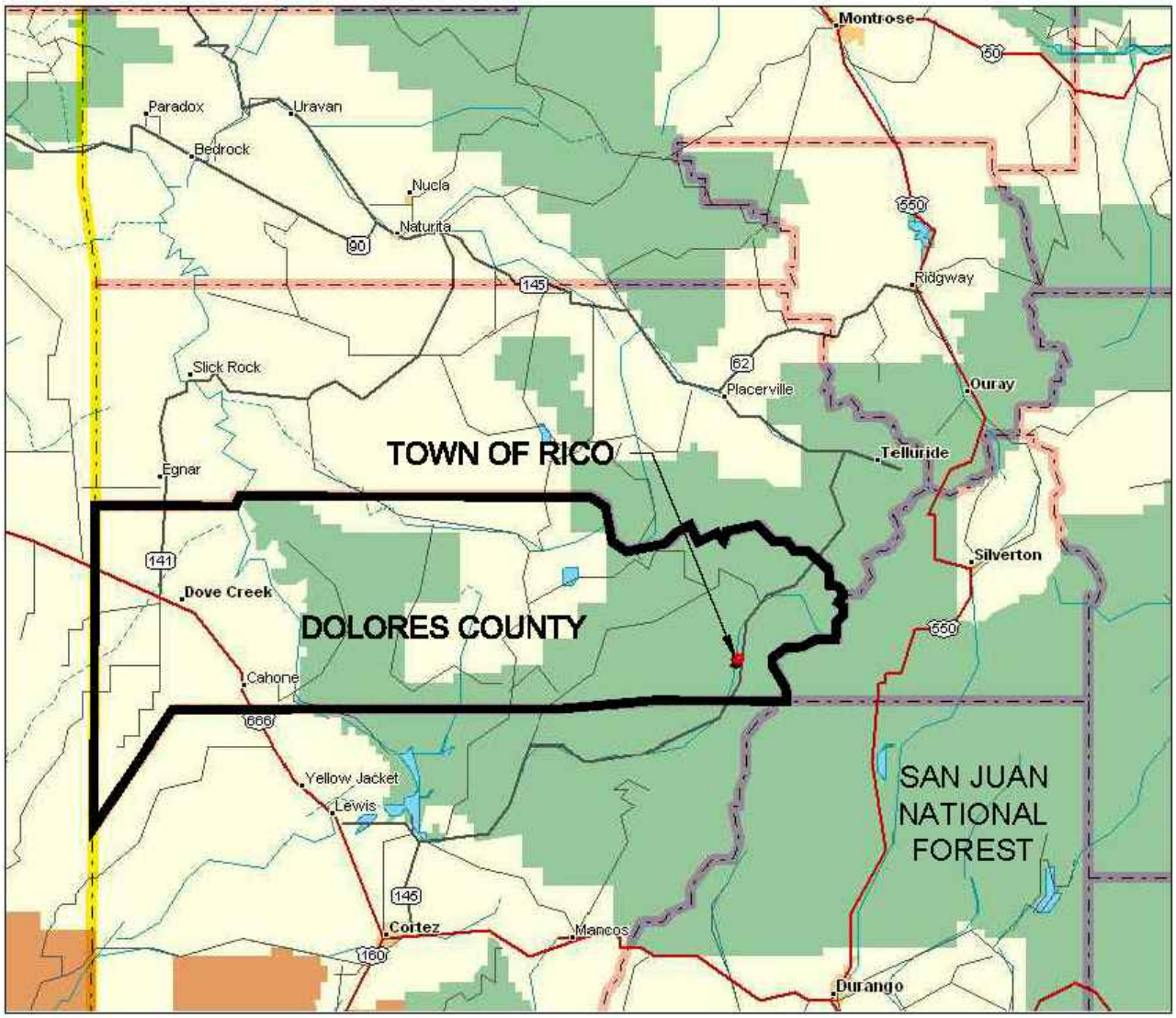
EPA, 2011b, Removal Action Work Plan Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01 Rico, Colorado, EPA Region 8, for Atlantic Richfield Company, March 9, 2011.

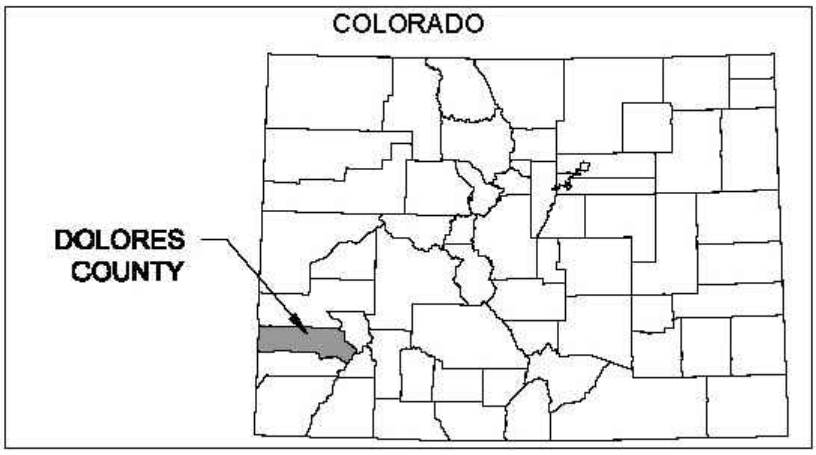
McKnight, E.T, 1974, Geology and ore deposits of the Rico District, Colorado, U.S. Geological Survey Professional Paper 723.

Pratt, Walden P., Edwin T. McKnight, and René A. DeHon. 1969, Geologic Map of the Rico Quadrangle, Dolores and Montezuma Counties, Colorado; GQ-797; U.S. Geological Survey.

Ransome, F.L., 1901, The ore deposits of the Rico Mountains, Colorado, U.S. Geological Survey 22nd Anniversary Report of the Survey, 1900-1901, part 2, p. 229–397.

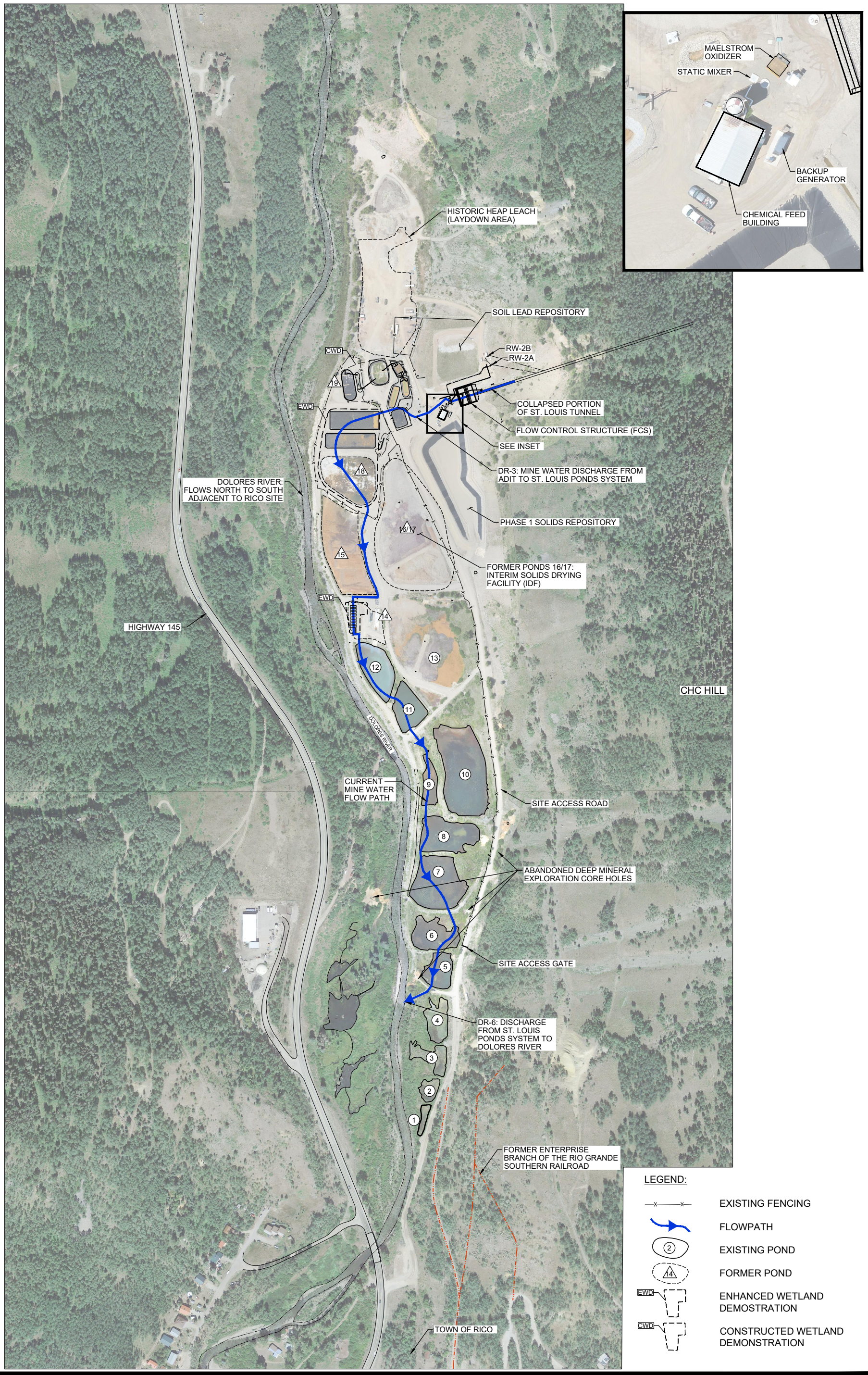
Figures





Copper Environmental Consulting A PRISM SPECTRUM COMPANY	4/17/2020	**Rico - Argentine Mine Site** **Dolores County, Colorado**	**Figure 1** **Site Location**
	Atlantic Richfield Company		
	Project: 70817.20		

Apr 21, 2020 - 12:08pm Patricia
F:\Work Files\Copper\70817 Rico\CADD\AOC Report\70817-F001.dwg



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4/17/2020

Atlantic Richfield Company

Project: 70817.20

N W E S

200 0 200 400 FEET

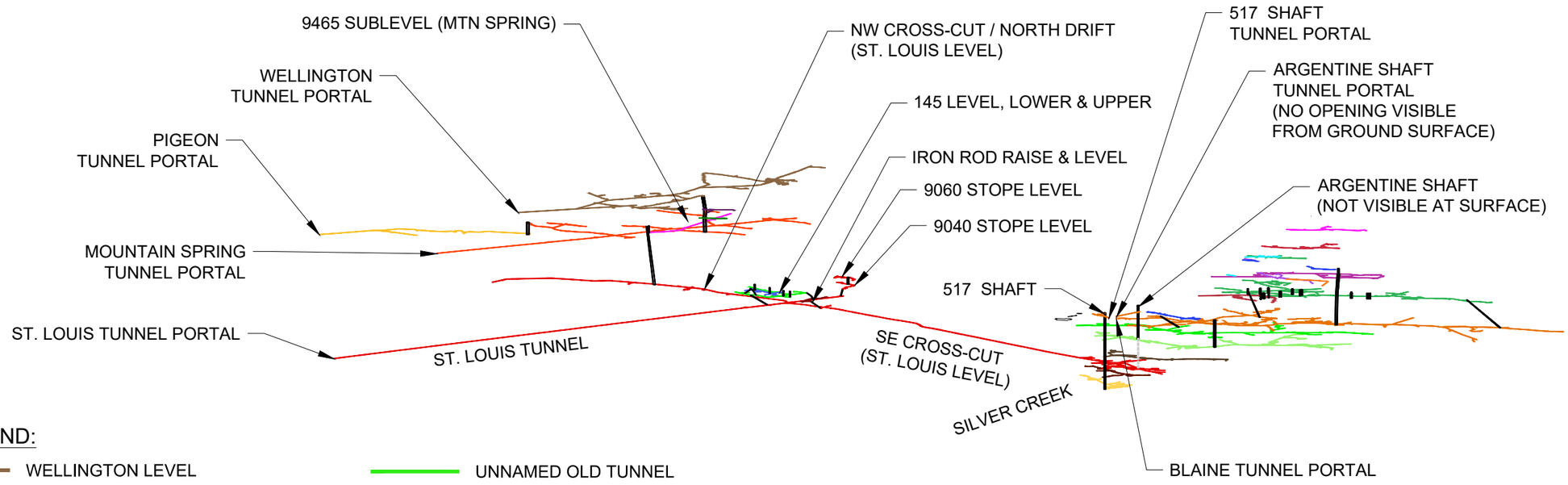
Rico - Argentine Mine Site
Dolores County, Colorado

Figure 2

Site Features

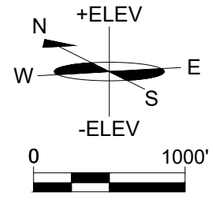
NOTES:

1. ALL MINE WORKINGS TRACED FROM "comp_Plan.tif", MAP #77 OF AECOM IMAGE INVENTORY, EXCEPT THE FOLLOWING:
   A. ARGENTINE SHAFT TUNNEL PER MAP #2, "scan02.tif", OF AECOM IMAGE INVENTORY. ("ARGENTINE MINE AND ST. LOUIS TUNNEL", DRAWN 5-21-55, P.L.J.)
   B. 517 SHAFT PER MAP #8, "scan08.tif", OF AECOM IMAGE INVENTORY. ("USGS/McKNIGHT PROFESSIONAL PAPER 723, PLATE 3")
   C. SILVER CREEK, BRIDGES & BUILDING FOOTPRINTS AT ARGENTINE TAILINGS PER ANDERSON ENGINEERING GROUND SURVEY, DATED AUGUST 2, 2011.
   D. ST. LOUIS SOUTHEAST CROSS CUT PER MAP #57, "00120110602202157.PDF", OF AECOM IMAGE INVENTORY. ("ST. LOUIS LEVEL, SHEET No. 2", DATED DEC. 1959 BY RT)
2. ALL LOCATIONS/DIMENSIONS APPROXIMATE ONLY.
3. ALL MINE LEVELS SHOWN AT SINGLE ELEVATION AND SEPARATED VERTICALLY PER USGS/McKNIGHT PROFESSIONAL PAPER 723 EXCEPT FOR LEVEL 700, WHICH IS SHOWN 100-FT BELOW 600 LEVEL.
4. NO EVIDENCE FOUND TO DATE ON HISTORIC MINE MAPS OF 517 SHAFT EXTENDING TO GROUND SURFACE.
5. ONLY SUGGESTIONS THAT ARGENTINE SHAFT EXTENDS BELOW 300 LEVEL ARE ON USGS/McKNIGHT PROFESSIONAL PAPER 723, PLATE 3, NOTATION ON MAP F (400 LEVEL) & MAP G (500 LEVEL): "ARGENTINE SHAFT (PROJECTED)". NOT SHOWN AT ALL ON MAP H (600 LEVEL); AND ON "ST. LOUIS LEVEL, SHEET No. 2", DATED DEC. 1959 BY RT.
6. FULL EXTENTS OF SOME LEVELS NOT SHOWN, AND INTERCONNECTIONS OF UPPER WORKINGS UNKNOWN AT THIS TIME.



LEGEND:

- WELLINGTON LEVEL
- 316 CROSS CUT / 425 DRIFT
- 417 DRIFT
- MOUNTAIN SPRINGS LEVEL
- MOUNTAIN SPRINGS 9465 SUBLEVEL
- PIGEON LEVEL
- IRON ROD LEVEL
- 145 LEVEL, LOWER & UPPER
- C TUNNEL LEVEL
- B TUNNEL LEVEL
- UNNAMED OLD TUNNEL
- UNNAMED OLD TUNNEL
- A TUNNEL LEVEL
- UNNAMED OLD TUNNEL
- ALLEGHANY LEVEL
- M TUNNEL LEVEL
- BLACKSMITH LEVEL
- BUNK HOUSE LEVEL
- DINING ROOM LEVEL
- CARBONATE LEVEL
- SMITH TUNNEL LEVEL
- BLACKHAWK / LOG CABIN LEVEL
- UNNAMED OLD TUNNEL
- RICO CONSOLIDATED UPPER LEVEL
- BERTHA S. UPPER LEVEL
- RICO CONSOLIDATED MIDDLE / ARGENTINE LEVEL
- BERTHA S. LOWER LEVEL
- RICO CONSOLIDATED LOWER LEVEL
- HUMBOLDT LEVEL
- BLAINE LEVEL
- 200 LEVEL
- 300 LEVEL
- 400 LEVEL
- ST. LOUIS / 500 LEVEL
- 600 LEVEL
- 700 LEVEL



Copper Environmental Consulting
A PRISM SPECTRUM COMPANY

Date: SEPTEMBER 2014

Atlantic Richfield Company

Rico - Argentine Mine Site
Dolores County, Colorado

Figure 3

Mine Workings Overview

Figure 4: *Removal Action Schedule*

Schedule	Submittal Due or Work to be Completed (or Started as Noted)
Water Treatment System	
Adit Hydraulic Controls	
Relief Well RW-3A Draft Design	2021
Relief Well RW-3A Final Design	2021
Relief Well RW-3A Construction	2021/2022
Construction Completion Report	90 Days after Adit Hydraulic Controls Construction Completion
Water Treatment	
Water Treatment Draft Design	180 Days after AOC Effective Date
Water Treatment Final Design (includes CQAP, SWMP, and Monitoring and Field Sampling Plan)	180 Days after Draft Design Approval
Water Treatment Construction – Start	Next Field Season following Final Design Approval
Water Treatment Construction (including Water Treatment System Shakedown Period) – Completion	Next 4 Field Seasons following Final Design Approval (Shakedown Period of at least two years and including at least one freshet)
Construction Completion Report	90 Days after Water Treatment Construction – Completion
Solids Management	
Develop Solids Management Plan	90 Days after AOC Effective Date
Final Solids Removals from Water Treatment Footprint	Next 2 Field Seasons following AOC Effective Date
Operations Plan	90 Days after Water Treatment Construction – Completion
Post-Removal Site Control Plan	90 Days prior to the Completion of the Operations and Monitoring Period