RESTORING OUR ENVIRONMENT • DESIGNING OUR FUTURE

Final Feasibility Study Report

Upper Blackfoot Mining Complex
Lincoln, Montana

Prepared for:

Montana Department of Environmental Quality
Remediation Division
P.O. Box 200901
Helena, Montana 59620

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March 2016

Table of Contents

List of Figures

List of Tables

List of Appendices

List of Acronyms

µg/dL	microgram per deciliter
µg/L	microgram per liter
AMD	Acid Mine Drainage
amsl	above mean sea level
AOC	Administrative Order on Consent
ARAR	Applicable or Relevant and Appropriate Requirements
ARCO	Atlantic Richfield Company
ARM	Administrative Rules of Montana
ASARCO	American Smelting and Refining Company
BER	Board of Environmental Review
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
CEA	Central Edith Area (EU 5)
CECRA	Comprehensive Environmental Cleanup and Responsibility Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
cfs	cubic feet per second
CMZ	Channel Migration Zone
COC	Contaminant of Concern
COPC	Contaminant of Potential Concern
CSEM	Conceptual Site Exposure Model
CSM	Conceptual Site Model
cy	cubic yard
DEQ	Department of Environmental Quality (Montana)
DEQ-7	Montana Department of Environmental Quality Circular 7: Montana Numeric Water Quality Standards
DOJ	Montana Department of Justice
DSR	Data Summary Report
EA	Evaluation Area
EEA	East Edith Area (EU 5)
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency
ERCLs	Environmental Requirements, Criteria, or Limitations
EU	Exposure Unit
FRTR	Federal Remediation Technology Roundtable
FS	Feasibility Study
ft	feet
ft/d	feet per day
FWP	Fish, Wildlife and Parks (Montana)
gpm	gallons per minute
GPS	Global Positioning System
GWIC	Groundwater Information Center
H:V	Horizontal:Vertical

HHRA	Human Health Risk Assessment
IASD	Initial Alternatives Screening Document
IASM	Initial Alternatives Screening Matrix
IC	Institutional Control
ILS	In Line (Oxidation) System
L	Liter
MBMG	Montana Bureau of Mines and Geology
MCA	Montana Code Annotated
METG	Montana Environmental Trust Group
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MNA	Monitored Natural Attenuation
MNR	Monitored Natural Recovery
MPDES	Montana Pollutant Discharge Elimination System
MWQA	Montana Water Quality Act
NCP	National Contingency Plan
NRIS	Natural Resource Inventory System
O&M	Operations and Maintenance
PLPs	Potentially Liable Persons
PQL	Practical Quantitation Limit
PRB	Permeable Reactive Barrier
PRAO	Preliminary Remedial Action Objective
RAO	Remedial Action Objective
RBC	Risk-Based Concentrations
RCRA	Resource Conservation and Recovery Act
RDI	Risk Driver Index
RI	Remedial Investigation
ROD	Record of Decision
RSS	Repository Siting Study
SEL	Screening Effects Level
SSCL	Site-Specific Cleanup Level
TCLP	Toxicity Characteristic Leaching Procedure
TSS	Total Suspended Solids
UBMC	Upper Blackfoot Mining Complex
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VCRA	Voluntary Cleanup and Redevelopment Act
WEA	West Edith Area (EU 5)
WRA	Watershed Restoration Agreement
WTP	Water Treatment Plant
WWTS	Wetlands-Based Water Treatment System
yd	Yard

1 INTRODUCTION

Pioneer Technical Services, Inc. (Pioneer) prepared this Feasibility Study (FS) to develop, screen, and evaluate remedial action alternatives for the Upper Blackfoot Mining Complex (UBMC). The UBMC, located approximately 15 miles east of Lincoln, Montana, in the headwaters area of the upper Blackfoot River, has been impacted by decades of historic hardrock mining activities. Human health and environmental issues at the UBMC are related to elevated levels of heavy metals in mine waste, mine tailings, soil, sediment, surface water, and groundwater.

In 2007, the Montana Legislature directed the Montana Department of Environmental Quality (DEQ) to complete a remedial investigation/feasibility study (RI/FS) to address the mine wastes, acidic discharges, and other associated contamination at the UBMC. Tetra Tech, Inc. (Tetra Tech) completed the RI report in early 2013. Pioneer prepared this FS using guidance and methodology provided by DEQ's Remediation Division.

1.1 *Report Organization*

The information presented in this FS document is organized as follows:

- Section 1 - report purpose and objectives.
- Section 2 - site description, individual mine history, regulatory history, and background information including climate, vegetation, wildlife, geology, hydrology, and land use.
- Section 3 - site characterization, risk assessment summaries, and contaminants of concern (COC).
- Section 4 - summary of the preliminarily identified applicable or relevant state and federal environmental requirements, criteria, or limitations (ERCLs); description of preliminary remedial action objectives (PRAOs); and site-specific cleanup levels (SSCLs).
- Section 5 - discussion of interim and concurrent actions.
- Section 6 - description of evaluation areas (EAs), including remediation volume estimates.
- Section 7 - development, screening, and retention of technologies and remedial options, and a summary of the initial alternatives screening document (IASD) and a secondary screening matrix. This includes a detailed description of retained technology options.
- Section 8 - discussion of remedial alternatives.
- Section 9 - analysis of remedial alternatives under the State of Montana's Comprehensive Environmental Cleanup and Responsibility Act (CECRA) criteria.
- Section 10 - references for sources cited in developing the FS.
- Figures referenced throughout the document.
- Appendices.

1.2 *Report Objectives*

The overall objective of the RI/FS process is to characterize the nature and extent of contamination associated with historic mining practices at the UBMC and to develop and evaluate potential remedial action alternatives. The RI report presented the characterization of the contamination at the UBMC, an inventory of identified abandoned mine features, and the results of additional data collection activities conducted in 2007, 2008, and 2011 (Tetra Tech, 2013a).

Using the RI characterization, Pioneer developed and screened a list of remedial action technologies and process options. Remedial technologies and process options most applicable to the UBMC were retained for further screening and evaluation in the FS and used to develop the remedial alternatives to satisfy the PRAOs for the UBMC. Under CECRA, each remedial alternative is evaluated individually against the seven criteria found in § 75-10-721 of Montana Codes Annotated (MCA) and, considering current and reasonably anticipated future uses, must:

- Attain a degree of cleanup of the hazardous or deleterious substance and control of a threatened release or further release of that substance that assures protection of public health, safety, and welfare and of the environment.
- Be consistent with applicable state or federal ERCLs and may consider substantive state ERCLs that are relevant to the site conditions.
- Demonstrate acceptable mitigation of exposure to risks to the public health, safety, and welfare and the environment.
- Be effective and reliable in the short term and the long term.
- Be technically practicable and implementable.
- Use treatment technologies or resource recovery technologies if practicable, giving due consideration to engineering controls.
- Be cost-effective.

Remedial alternatives are compared against each other using the same criteria in a comparative analysis. The alternatives identified in this FS are used by DEQ to prepare the proposed plan, which will identify and explain DEQ's preferred remedies at the UBMC. After public comment on the proposed plan, DEQ will select the final remedy for that portion of the UBMC not addressed by the U.S. Forest Service (USFS) in its Action Memorandum, as amended, in a record of decision (ROD). For remedial actions on federal land only within the UBMC, the USFS will either concur with DEQ's decision or will issue a separate federal decision.

To prepare this FS, Pioneer used data from the following supporting documents:

- *UBMC Flood Plain Data Sampling Report*, Spectrum Engineering, Inc. and Pioneer Technical Services, Inc., June 2013 (Spectrum and Pioneer, 2013).
- *Final Remedial Investigation Report, Upper Blackfoot Mining Complex*, Tetra Tech, Inc., January 2013 (Tetra Tech, 2013a).

- *Final Baseline Ecological Risk Assessment, Upper Blackfoot Mining Complex*, Tetra Tech, Inc., May 2013 (Tetra Tech, 2013b).
- *Final Baseline Human Health Risk Assessment, Upper Blackfoot Mining Complex*, Montana Department of Environmental Quality, May 2014 (DEQ, 2014a).
- *Final Data Summary Report* (DSR)*, Upper Blackfoot Mining Complex*, TerraGraphics Environmental Engineering, Inc., November 2010 (TerraGraphics, 2010).
- *Final Engineering Evaluation/Cost Analysis for the Mike Horse Dam and Impounded Tailings, Lower Mike Horse Creek, Beartrap Creek and the Upper Blackfoot River Floodplain Removal Areas, Upper Blackfoot Mining Complex*, Hydrometrics, Inc., July 2007 (Hydrometrics, 2007).

2 Site Description

The UBMC, encompassing an area of approximately 6 square miles, is located primarily south of U.S. Highway 200, 15 miles east of Lincoln, Montana, in Lewis and Clark County (Figure 1). For this FS, the UBMC includes the area of historic mining in the Heddleston District and surrounding lands, and roughly extends from the drainage area upgradient of the Mike Horse Mine and tailings impoundment, downstream to the first marsh (referred to as the "Upper Marsh") where Swamp Gulch enters the Blackfoot River, and includes the channel and portions of the floodplain of the Blackfoot River down to the confluence with Hogum Creek (Figure 1). The UBMC contains land privately owned by the Montana Environmental Trust Group, LLC (Trust) and individual landowners and federally owned by the USFS (Figure 2). This FS does not include the USFS property already being addressed pursuant to the Action Memorandum, as amended, based on the Engineering Evaluation/Cost Analysis (EE/CA) discussed in Section 5.1.

The largest mine in the Heddleston District was the Mike Horse Mine and its associated tailings impoundment in the upper reaches of the drainage. Other historic mines included the Anaconda, Capitol, Carbonate, Consolation, Edith, and Paymaster mines. The Heddleston District is characterized by heavily forested, steep mountainous terrain with elevations ranging from 5,200 feet above sea level (amsl) at the Blackfoot River near the Upper Marsh to 7,200 feet amsl on the ridge of Anaconda Hill. Tributary streams within the UBMC include Mike Horse Creek, Beartrap Creek, Anaconda Creek, Stevens Gulch, Shave Creek, Paymaster Creek, Pass Creek, Swamp Gulch, Meadow Creek, and Porcupine Creek (Figure 2). The Blackfoot River proper originates at the confluence of Beartrap and Anaconda Creeks within the UBMC.

Sections 2.1 through 2.3 contain descriptions of the regulatory, mining, and remedial history of the UBMC and Section 2.4 describes site background information. Various information comes directly from the existing UBMC RI prepared by Tetra Tech and that information is *italicized* and designated by surrounding quotations ("") (Tetra Tech, 2013a).

2.1 *Site History Overview*

"The Heddleston District was named for William Heddleston who, with his partner George Padbury, discovered the Calliope lode in 1889). A small mining operation was

begun and an arrastra was built on Pass Creek to process the ore. Prior to 1915, prospectors discovered a number of lodes containing lead, zinc, and copper, including the Mike Horse, Carbonate, Paymaster, Midnight, and Anaconda mines. The district's early development was hampered by difficult access created by the lack of suitable roads. As a result, only minor shipments of ore were made to off-site smelters during this early period of mining.

The district saw a revival of mining activity in 1915 when the Mike Horse Mine was taken over by the Sterling Mining and Milling Company of Ellensburg, Washington. A major lead deposit was developed at the Mike Horse Mine and in 1919 a (jig) concentrating mill was built to process the mine's ores, as well as the ore from the nearby Anaconda and Paymaster Mines. The Mike Horse Mine produced a modest amount of ore as concentrate by the end of the 1920s. The Mike Horse Mine was idle until 1938 when it was leased to the Mike Horse Mining and Milling Company. The following year, a 150 tons-per-day flotation mill was built, and, in 1940, a 15-mile electric power line was strung from Marysville to the mine. In 1941, the Mike Horse Dam was constructed across Beartrap Creek just upstream of the confluence with Mike Horse Creek to serve as an impoundment for the tailings from the newly constructed Mike Horse Mine flotation mill. The Mike Horse deposit continuously produced lead/zinc ore, containing some silver, for the next decade.

In 1945, the assets of the Mike Horse Mining and Milling Company were purchased by ASARCO, and it kept the Mike Horse Mine operating until 1955, at which point the mine closed due to declining metals prices and near exhaustion of the ore body. The Rogers Mining Company of Helena leased and operated the mine sporadically from 1958 until early 1964 when the Anaconda Company of Butte acquired a lease to mine the Mike Horse deposit from ASARCO. The Anaconda Company conducted exploration activities from 1962 through 1973 in the Heddleston District (although not on the Mike Horse Mine claims), including detailed geologic mapping; geochemical sampling; drilling of 340 rotary, diamond, and reverse circulation drill holes; and the driving of 2 adits to collect bulk samples. This exploration work defined a substantial underground copper/molybdenum porphyry deposit. In 1979, following cessation of the Anaconda Company's exploration activities in the Heddleston District, the Anaconda Company was merged into ARCO (the Atlantic Richfield Company). ASARCO purchased all of ARCO's holdings in the Heddleston District in 1981. From 1981 until resolution of its bankruptcy filing, ASARCO performed limited exploration work on the property, as well as mine reclamation activities (with ARCO's participation).

Although the Mike Horse Mine was the mainstay of the district, other small mining operations were also active during the twentieth century. The Paymaster was in operation early in the 1900s but had closed by the mid-1920s. In the early 1960s, it was reopened with minor development work conducted by Paramount Estates of New York. The Anaconda Mine was developed early in the 1900s and produced minor amounts of ore containing gold, silver, copper, and lead intermittently through 1940. Both properties were purchased by the Anaconda Company in the mid-1960s and subsequently acquired by ASARCO.

The preponderance of the district's mineral wealth came from the production of base metals such as lead and zinc. Total tonnage of ore produced from the Heddleston District is less than 450,000 tons, with 385,000 tons of that production coming from the Mike Horse Mine from 1945 to 1952. Although exact production figures for the district are not available, it appears that greater than 95 percent of the production from the district came from the Mike Horse Mine with only minor amounts of production coming from the Anaconda, Carbonate, and Paymaster mines."

2.2 *Upper Blackfoot Mining Complex Regulatory History*

"Regulatory clean-up activities at the UBMC commenced in 1987 when the Montana Legislature allocated funds to the Montana Department of State Lands (MDSL; now part of DEQ) for reclamation of the Mike Horse Mine under the State's abandoned mine reclamation program, with additional funding allocated in 1989. The MDSL performed site characterization activities and reclamation planning from 1987 through 1990, including plans for mine waste removal and water treatment designs (MDSL 1990). In 1990 however, the Montana Department of Health and Environmental Sciences (MDHES, now DEQ), determined that potentially liable persons (PLPs) may exist for the Mike Horse site, and the state's reclamation plans were put on hold.

In June 1991, ASARCO and ARCO were identified by the MDHES as PLPs for hazardous or deleterious substance contamination at the UBMC, under CECRA. Required actions included development of a RI and feasibility study (FS), and implementation of a remedy to be determined by MDHES.

Between February 1992 and May 1993, ASARCO and ARCO met with MDHES regarding implementation of a voluntary remediation program at the UBMC in lieu of the formal RI and FS process. Terms and conditions of a voluntary program are outlined in a May 26, 1993 letter from MDHES, including preparation and submittal of annual work plans and other documents. MDHES reviewed plans and work, but did not approve any of the work. Site reclamation activities proceeded under this agreement until 1998, when certain remedial actions, namely reclamation of the Paymaster Mine and No. 3 Tunnel area, proceeded under the newly established Montana Voluntary Cleanup and Redevelopment Act (VCRA) program.

In 1994, ASARCO applied for and, in 1995, received a Montana Pollutant Discharge Elimination System (MPDES) permit for discharge of treated water from the Mike Horse and Anaconda mine adit discharges. The MPDES permit (MTR-0030031) regulated the discharge of treated water to the Blackfoot River. However the form of treatment has changed from the old (constructed in 1995-96) wetlands-based water treatment system (WWTS) to the new (constructed in 2008) microfiltration water treatment plant (WTP).

ASARCO also applied for and received a Montana Groundwater Pollution Control System (MGWPCS) permit (permit MGWPCS-001001) in 1996 for treatment and subsurface discharge of a small (2 gallons per minute (gpm) or less) seasonal flow from the Paymaster adit. The Paymaster MGWPCS permit expired in September 2003 and was not renewed, since no discharge was ever recorded from the Paymaster Mine water *treatment wetlands cell. ASARCO also held an authorization to discharge storm water from the UBMC Facility under Montana's general permit for storm water discharges (Authorization MTR300157). The storm water permit remained in effect until May 2011, when DEQ's Site Response Section assumed administrative duties to ensure water quality compliance under its CECRA authority.*

*In 1999, ASARCO petitioned the Montana Board of Environmental Review (BER) for adoption of temporary water quality standards in portions of three streams at the UBMC. Temporary standards were requested in portions of Mike Horse Creek, Beartrap Creek, and the upper Blackfoot River. The temporary standards were approved by the BER and were established in the Montana Surface Water Quality regulations (*Administrative Rules of Montana [*ARM*] *17.30.630) in June 2000. The temporary standards temporarily modif[ied] the water quality standards for a number of metals, including cadmium, copper, iron, lead, manganese, and zinc, as well as pH, until 2008. As part of the temporary standards petitioning process, ASARCO was to develop a conceptual plan for mitigation of all "water quality limiting factors" identified in the temporary standards support document, referred to as the Temporary Standards Implementation Plan.*

In November 2002, ASARCO entered into an Administrative Order on Consent (AOC) with the USFS for performance of an EE/CA for certain public lands within the UBMC. The AOC covers National Forest System lands along portions of Mike Horse Creek, Beartrap Creek (including the Mike Horse tailings impoundment) (Sections 20, 21, 27, and 28), and the Blackfoot River upstream of the confluence with Pass Creek, which may have been affected by operation of the Mike Horse Mine and tailings impoundment. The objective of the AOC was for ASARCO to develop removal action alternatives through development of an EE/CA.

In 2003, DEQ brought legal action in State District Court against ASARCO and ARCO for recovery of DEQ's past and future remedial action costs associated with contamination and threats of contamination at the UBMC, and to require the companies to implement required remedial actions. As part of this action, DEQ also sought a declaratory judgment to establish liability for all future remedial action costs, including clean-up, which DEQ would incur in connection with the UBMC.

In 2005, ASARCO released a document entitled Comprehensive Data Summary Report for the Upper Blackfoot Mining Complex, Lewis and Clark County, MT. The initial draft of the report was prepared as part of an interim settlement of the pending litigation. DEQ reviewed the draft report and provided comments to ASARCO and ARCO. DEQ's review of the resubmitted document indicated that the companies had not incorporated DEQ's comments adequately. Therefore, DEQ revoked the interim settlement agreement and completed the Comprehensive Data Summary Report itself with the assistance of its contractor, Tetra Tech.

In August of 2005, ASARCO filed for Chapter 11 bankruptcy. DEQ, the Montana Department of Justice, and the USFS filed claims in the bankruptcy that have since been settled. This settlement also included settlement with ARCO. As part of the settlement, DEQ dismissed the state court action.

In December of 2006, the BER revoked the temporary water quality standards due to failures and delays on the part of ASARCO in implementing the Temporary Water Quality Standards Implementation Plan. ASARCO continued to treat water from the Mike Horse and Anaconda mine adit discharges using the WWTS. In 2008, ASARCO constructed the WTP at the same location, effectively replacing the old WWTS in January 2009. These discharges were regulated under MPDES permit MT-0030031 until May 2011 when DEQ's Site Response Section assumed administrative duties to ensure water quality compliance under its CECRA authority."

In July of 2007, the USFS - Region 1 issued an Action Memorandum approved by Regional Forester Tom Tidwell for the preferred removal action for the federal lands of the UBMC above Pass Creek. The USFS has indicated that the analysis and decision were developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, and was not inconsistent with the National Contingency Plan (NCP) (USFS, 2014). *"In brief, the Action Memorandum proposes: (1) total removal of the Mike Horse Dam and impounded tailings and placing the waste into the Paymaster Repository; (2) complete removal of mine waste from Lower Mike Horse Creek and placing the waste into the Paymaster Repository; (3) removal of all concentrated and intermixed tailings from the active floodplain of Beartrap Creek and placing the waste into the Paymaster Repository; and (4) complete mine waste removal (estimated at 45,000 cubic yards (yds3)) from the Upper Blackfoot River Sub-area and placement of the waste into the Paymaster Repository. In 2007, DEQ contracted with Tetra Tech to complete a RI of the UBMC."*

The RI field work was performed during fall 2007, summer 2008, and November 2011. The November 2011 work was completed by Pioneer to address data gaps and the results are included in the RI.

2.3 *Individual Mine History*

The RI included 11 principal mining operations, a number of smaller mines and prospects, and various mining-related features. The following sections summarize the mining and remediation history of the principal operations. Section 6.5 contains descriptions of the mining-related features inventoried in the RI.

2.3.1 Anaconda Mine

The Anaconda Mine is located near the confluence of Anaconda Creek and Beartrap Creek at the headwaters of the Blackfoot River (map location H4, Figure 1). The area is divided into a lower waste area located next to the Blackfoot River at the site of the WTP and an upper waste pile area on the hillside beginning approximately 200 feet in elevation above the WTP and the Blackfoot River. The following is a brief history of the mine's development and previous interim actions.

"The Anaconda Mine was discovered and developed during the early 1900s by Gottfried Krueger. The mine workings are located on the Little Joe, Copper Bell, Blue Cristle, and Anaconda patented mining claims. By 1933 about 1,000 tons of ore had

been produced from the Anaconda workings. There are no records of production between 1933 and 1939. In 1940, Giant Group Company of Helena processed 50 tons of mine tailings through the 50 ton mill they installed on the property. McClernan believed that total production from the Anaconda Mine was only about 1,660 tons of ore through the year 1948. This was apparently the last production year from the mine although GCM indicated some development work was conducted in 1961 by mine owner Paramount Estates of New York.

The Anaconda workings included two shafts and two adits, and were developed to mine a discontinuous, northeast-trending, brecciated, fracture-filled vein. The lower adit extended about 90 feet into the hillside while the upper adit was around 500 feet long. A shaft near the lower adit was approximately 325 feet deep. The vein occurred over a vertical distance of approximately 300 feet and was 3 to 5 feet thick along a strike length of 75 feet. The deposit contained several minerals including: sphalerite, pyrite, galena, arsenopyrite, bournite, and rhodochrosite.

Approximately 33,500 yd^3 of mine waste was removed from the Anaconda Mine in 1994 and 1995 and placed in the Mike Horse Repository. Most of the removed mine waste was originally located on the floodplain of the Blackfoot River resulting in potential leaching of metals, and erosion and subsequent transport of mine waste to the river. Two additional mine waste dumps located on a hillside adjacent to the Anaconda Mine were also reclaimed in 1995. The largest of the dumps was removed and placed in the Mike Horse Repository. Because of its distance from any surface water drainage, the other dump was reclaimed in-place, by amending with cement kiln dust, re-grading, covering with growth medium, and applying a seed/mulch mixture. In addition, the following remediation features were constructed: a concrete/bentonite plug was placed in the collar of the Anaconda shaft, and a permanent vehicle stream-crossing was constructed at the site, as were surface water run-on control ditches with rip-rap, and fencing.

In 1995 and 1996, the WWTS was built at the former location of the Anaconda mine waste adjacent to the Blackfoot River and just downstream from the confluence of Anaconda Creek and Beartrap Creek. A portal-plug with piping and controls was installed in the Anaconda adit, with the water discharge directed to the WWTS. This system was replaced in 2009 by the WTP."

2.3.2 Capital Mine

The Capital Mine is located in upper Stevens Gulch (map location G5, Figure 1). The following is a brief history of the area's development and previous interim actions.

"The Capital Mine is a small mine located in upper Stevens Gulch and reclaimed by ASARCO in 1997. Reclamation included removal of 725 yd^3 of mine waste from the Stevens Gulch drainage bottom to the Paymaster Repository. The removal area was amended with cement kiln dust. The excavation area was regraded and revegetated and 200 feet of stream channel reconstructed. A grout seal was placed in the Capital Mine adit to eliminate seasonal discharge of water from the adit."

2.3.3 Carbonate Mine

The Carbonate Mine is located at the south end of Swamp Gulch and immediately north of Highway 200 (map location F2, Figure 1). The following is a brief history of the mine's development and previous interim actions.

> *"The claims on the Carbonate Mine property were staked in 1889 and were mined during the early 1900s. The property consists of four patented claims. Pardee and Schrader reported that the mine consisted of an adit which intersected the lode 106 feet from the portal, from which workings followed the vein about 750 feet to the northwest. Near the middle of the adit was a shaft. The shaft crossed the adit level about 100 feet below the surface and extended 200 feet below the adit level. Working levels were developed at about 100 feet and 200 feet, respectively, below the main adit level. The deposit consisted of veins and pods of quartz–rich material in a shear zone that contained pyrite, galena, and sphalerite.*
>
> *Glacier Mining Trust of Wilborn, Montana controlled the mine in the 1930s; until 1939 when the mine was shut down. The mine was reported to have had 875 feet of tunnels and 425 feet of shafts. The mine was operated during the late 1940s until the mill burned down on August 8, 1949 and the mine was shut down. New Silver Bell Mining Company operated the claims beginning in 1947. At that time, the property had 3,000 feet of drifts and 200 feet of shafts. The mill processed gold, silver, copper, and lead at a rate of 120-ton per day. No production figures exist for the Carbonate Mine, but McClernan surmised that the amount of drifting in the mine and the nearby tailings pond indicate that although some production probably did occur that it does not seem that the mine was a major commercial operation.*
>
> *The following construction work was completed during 1993 and 1994:*
>
> - *Forty-three and three-quarters yd^3 of concrete were poured into and on top of an open mine shaft at the Carbonate Mine.*
> - *A surface water diversion ditch lined with rip rap was installed above the repository location.*
> - *Approximately 15,400 yd^3 of waste rock and tailings were removed from Swamp Gulch drainage (lower Carbonate mine area) and placed in a repository constructed at the upper Carbonate (material was compacted with a sheep's foot roller).*
> - *Quicklime (1,500 tons) was added to the mine waste deposited at the upper Carbonate repository.*
> - *The repository slope was covered with a 6-inch layer of drainage gravel (except for the north slope) overlain by 12 to 18 inches of cover soil. The north slope received a 12-inch cover soil only.*
> - *The flat portion of the repository was covered with gravel, a geosynthetic clay liner, and cover soil. The thicknesses of these materials are unknown.*
> - *Contaminated water from the pond created when the lower Carbonate Mine waste was removed was pumped to the repository and fill material was placed in the*

excavated hole. The Work Plan specified that a 2-inch layer of crushed limestone would be placed over the fill material to minimize acid generation potential.

- *The former tailings impoundment area was backfilled with borrow gravel and cover soil (13 to 17 inches deep), and the area graded to establish a wetland and meadow within Swamp Gulch drainage.*
- *The repository, wetlands, and other disturbed areas were revegetated.*
- *Groundwater monitoring wells were installed at the repository and in and around the Swamp Gulch removal area.*
- *Final grading was completed and storm water control ditches and structures were constructed.*
- *In 1995, the Carbonate Mine repository cap cover was compromised due to erosion. Consequently, the growth medium soil was replaced, an erosion mat placed over the eroded surface, and the area seeded and mulched during the 1995 construction season."*

2.3.4 Edith Mine

The Edith Mine (also known as the Edith Mine #2) is located just north of the Blackfoot River and west of the river's confluence with Shave Creek (map location G3, Figure 1). The following is a brief history of the mine's development and previous interim actions.

"The Edith Mine #2 is a recent mining development within the Paymaster and Black Diamond ore veins. The ore body was rich in molybdenum which had been exploited earlier by the Paymaster Mine and also the Midnight Mine, located on the hill above the Edith. The plat map for the original 1904 survey (Mineral Survey No. 7353 and 7356) of the mining claims showed two discovery shafts and two tunnels within the general vicinity of the Edith Mine. There is no record of production and no mine features remain from the early operation at the Edith Mine #2. The Anaconda Company re-opened the Edith Mine in 1967. The mining company drove a tunnel north into the ore body from the base of the south-facing hillside. While the ore body proved high in molybdenum, no known production was initiated by the Anaconda Company. The operation was shut down a few years later.

Approximately 5,000 yd^3 of mine waste were removed from the Edith Mine area in 1995 from several waste piles/waste areas and placed in the Mike Horse Repository. Mine waste removal areas were amended with lime-bearing material to neutralize soil acidity, and the area was seeded to promote vegetation establishment."

2.3.5 Consolation Mine

The Consolation Mine is located in lower Shave Gulch (map location H2, Figure 1). The following is a brief history of the mine's development and previous interim actions.

"Development on the Consolation Mine property prior to 1933 consisted of several pits, three caved adits, and a shaft about 20 feet deep. Mineralization occurs as a thin vein of

quartz-galena-pyrite and sphalerite adjacent to a porphyry dike in contact with the Spokane Shale.

The Consolation Mine consisted of two collapsed adits (upper and lower) and associated mine waste piles. The mine waste occurred as a relatively thin pile covering about 2.5 acres of hillside below each adit. Reclamation involved consolidation of the mine waste into the lower adit area by pushing the upper mine waste downhill into the adit, and hauling the lower mine waste pile uphill to the adit. Approximately 2,200 yd^3 of mine waste was placed into the prepped adit area, re-graded to match the surrounding topography, the upper 12 inches amended with cement kiln dust, covered with soil (12-inch minimum), and the entire removal area revegetated."

2.3.6 Mary P Mine

The Mary P Mine is located south of the Blackfoot River and prior to the river's confluence with Stevens Gulch (map location H4, Figure 1). The following is a brief history of the mine's development.

"The Mary P Mine started operation in 1911, a few hundred yards to the southeast of the Anaconda Mine and on the opposite side (southwestern side) of the Blackfoot River. The operation included a discovery cut with a tunnel and a second tunnel with a short drift. There is no evidence of production from the Mary P, and the mine was apparently closed down within a year or two."

No interim actions at the Mary P Mine were documented in the RI.

2.3.7 Mike Horse Mine

The Mike Horse Mine is located on Mike Horse Creek southwest of the confluence of Mike Horse Creek and Beartrap Creek (map location H5, Figure 1). The following is a brief history of the mine's development and previous interim actions.

"Joseph Heitmiller first located the Mike Horse claim in 1898. Development work was undertaken for the following 15 years. However, little ore was shipped to smelters because of inadequate haul roads for large quantities of ore shipments. A mill was constructed at the mine to process the lead-silver concentrate along with ore from the Anaconda and Paymaster mines. The mine continued to operate during the 1920s. The most productive years were 1923 and 1924 when 1,120 tons of ore were processed. Lead accounted for three-quarters of the ore's value while silver accounted for the remaining one-quarter.

The mine had multiple adits spaced along 300 vertical feet. The mine workings intersect the Mike Horse, Little Nell, and Intermediate veins. The workings were connected via raises and stopes. The mine depth is approximately 450 feet. The Mike Horse Mining and Milling Company leased the property in 1938. The company subsequently constructed a 150 tons-per-day flotation mill in 1939, connected the site to electricity in

1940, and constructed the tailings impoundment in 1941 across Beartrap Creek to handle flotation mill tailings from the Mike Horse Mill.

ASARCO purchased the mine in 1945 and operated it until closure in 1955 due to declining metal prices. In 1958, the Rogers Mining Company of Helena leased the mine and subsequently operated it until 1964 when the Anaconda Company of Butte acquired an assignment of the lease. The bulk of production in the Heddleston Districts was through the Mike Horse mine. Peak production for the mine occurred between 1941 and 1952, averaging approximately 200 tons of ore per day. The ore was processed for a lead-zinc concentrate through the flotation mill. During that period the mine had 660 feet of winzes and 22,620 feet of drifts and crosscuts.

Reclamation activities completed at the Mike Horse Mine include excavation of mine waste and construction of a repository at the lower Mike Horse Mine in 1995 and 1996, and in-place reclamation of approximately five acres of disturbed land at the upper Mike Horse Mine in 1998. The Mike Horse Repository is adjacent to the mine and was built to accommodate mine waste mainly from the Anaconda and Edith Mines, as well as a relatively small volume of mine waste from the lower Mike Horse Mine.

Construction of the Mike Horse Repository included a subsurface shallow groundwater collection and drainage system to maintain groundwater levels below the repository base, a limestone gravel drainage layer beneath the repository, amendment of the upper 18 inches of mine waste in the repository to limit long-term acid generation, a 12-inch growth medium layer on the repository slopes with vegetative cover, and a geosynthetic clay liner on the upper, flat repository crest. Approximately 38,000 cubic yards (DEQ, 2014b) *of mine waste from the Mike Horse, Anaconda, and Edith mines were placed in the Mike Horse Repository. In addition, a sludge drying bed for the pretreatment pond sediment was constructed on the top of the repository.*

Land disturbance at the upper Mike Horse Mine consisted of waste rock piles spread over steep hillsides. Reclamation included consolidation and re-grading of mine waste to minimize surface area and limit infiltration, incorporating amendments into the mine waste to raise pH and limit the solubility of metals, placement of local borrow soil over the mine waste, construction of ditches and berms to divert storm water runoff around mine waste areas, and seeding of all disturbed areas. Re-grading of the mine waste piles and establishment of a vegetative cover was intended to reduce infiltration of rainfall and snowmelt water, and erosion of mine waste, thus improving water quality in adjacent Mike Horse Creek.

Additional reclamation activities at the Mike Horse Mine included removal and off-site disposal of hydrocarbon contaminated soil, removal of a 1,000 gallon tank, removal of waste rock and debris from Mike Horse Creek, reconstruction of the Mike Horse Creek channel through the reclaimed area, construction of a surface water diversion system to divert Mike Horse Creek water around the disturbed area, and construction of a pond and filtration system (part of the original WWTS) *for treatment of the Mike Horse Adit discharge water.*

From 1993 to 1995, the Clay-Based Grouting Demonstration Mine Waste Technology Pilot Program, funded by the Environmental Protection Agency (EPA), was implemented in the upper mine area just below the present day coffer dam. A series of angled holes were drilled to intersect the Mike Horse vein and injected with a special grout with the intent to stop or slow Mike Horse Creek leakage into the mine. The program, designed to test and evaluate the grouting technology, experienced limited success and ran out of funding before the program could be completed (MSE, 1997).

ASARCO constructed a water treatment system to treat drainage from the Mike Horse Adit, as well as the combined discharges from an adit and shaft at the Anaconda Mine near the confluence of the Blackfoot River and Anaconda Creek. This system was completed and went on-line in October 1996. Components of the old WWTS *included: (1) a 600,000 gallon oxidation/settling pond and a sand filter bed at the Mike Horse Mine for removal of iron from the Mike Horse Adit discharge; (2) an open limestone channel at the Anaconda Mine for iron removal and alkalinity generation in the Anaconda Adit/Shaft discharge; and (3) a multi-cell constructed wetland water treatment system located at the Anaconda Mine, designed to remove metals from the combined Mike Horse Adit and Anaconda Adit discharges through sulfide generation.*

ASARCO installed the WTP to treat source water flows from adit discharges and seeps, primarily from the Mike Horse and Anaconda mines and adjacent areas including seeps at the base of the Mike Horse Repository. The WTP, began operations in January 2009, and replaced the WWTS located adjacent to the Anaconda Mine. The new WTP also bypasses the Mike Horse adit pretreatment system that includes the in-line (oxidation) system (ILS) pond and sludge drying beds. The WTP incorporates ceramic microfiltration technology to primarily remove cadmium, copper, manganese, and zinc."

2.3.8 Paymaster Mine

The Paymaster Mine is located in the lower Paymaster Creek drainage (map location G3, Figure 1). The following is a brief history of the mine's development and previous interim actions.

"The first work on the Paymaster Mine property occurred in February of 1902 when a tunnel was reported to be under construction. Also in 1902, the Paymaster Gold Mining Company was incorporated and staked four claims (Black Diamond, Jumbo, Bonanza, and Cicero Lodes), which were patented in 1912. In 1912, improvements on the property included four discovery shafts, four tunnels, three drifts, and a winze. Surface development apparently never went much beyond these initial improvements. When Pardee and Schrader examined the site in August of 1927, they reported the workings were partly closed by caving and it appeared they had not been worked for several years. The underground workings of the mines included a 900-foot long crosscut at the lowest adit, several hundred feet of drifts and a 50-foot winze. About 100 tons of ore were reportedly shipped from the mine. The ore body for the Paymaster area was rich in molybdenum. The Midnight and Edith mines also accessed the same ore body. The Paymaster was re-opened in the 1960s via the mine's lower adit. However, no production was reported.

Waste rock removal was implemented at the Paymaster Mine and No. 3 Tunnel areas in 1996. The Paymaster Mine was a relatively small operation which mined ore from three adits in lower Paymaster Creek drainage. No. 3 Tunnel was a bulk sample adit driven *by the Anaconda Company for exploration of the south copper-molybdenum ore zone. Three distinct waste rock piles, totaling approximately 8,065 yd^3, were removed from the Paymaster Creek drainage bottom, and an additional 4,955 yd^3 of mine waste was removed from the Tunnel #3 area. All material was fully amended with cement kiln dust to neutralize acidity and decrease metal solubility, and placed in an engineered repository located near the Paymaster Mine.*

In addition to the Paymaster Mine and No. 3 Tunnel mine wastes, approximately 8,412 yd^3 of mine tailings from an off-site DEQ abandoned mine reclamation project was placed in the Paymaster Repository. The Big Blackfoot tailings were transported from their location approximately 25 miles west of the UBMC and placed in the Paymaster Repository by DEQ with permission from ASARCO. All material placed in the Paymaster Repository was fully amended with lime products to neutralize the mine waste. The repository was designed for possible expansion in the future to accommodate additional mine waste, if necessary.

Remediation at the Paymaster Mine also included collection of a small volume of seasonal discharge from the historic Paymaster adit and treatment through a passive wetland treatment cell. The treatment system is located adjacent to the Paymaster Mine. Discharge from the Paymaster adit water treatment system was regulated under a MGWPCS permit. The passive wetland treatment system never discharged any water, and its operation was discontinued and the associated permit abandoned by ASARCO."

2.3.9 No. 3 Tunnel

The No. 3 Tunnel area is located along Paymaster Road and adjoins Stevens Gulch (map location G3, Figure 1). The No. 3 Tunnel was a bulk sample adit driven by the Anaconda Company for exploration of the south copper-molybdenum ore zone. Waste rock removal was implemented at the No. 3 Tunnel area in 1996 and approximately 4,955 cy of mine waste was removed. All waste material was fully amended and placed in the Paymaster Repository.

2.3.10 Midnight and Daylight Mines

The Midnight and Daylight mines are located in lower Shave Gulch near the confluence of the Blackfoot River and Shave Creek (map location G3, Figure 1). The following is a brief history of the mines' development.

"The Midnight Mine was listed as shipping ore in May of 1904, while the Daylight Mine showed production even earlier, in May of 1901. The two mines were part of the same operation of the Midnight Copper Mining Company, which had driven a connecting tunnel and drifts through the Midnight, Copper Gate, and Daylight claims (patented in 1911). The 1915 plat map of the claims shows four discovery cuts, two shafts, two tunnels, three extensive drifts, and a "branch of tunnel."

By 1929, the Midnight Mine was listed as having 3,000 feet of workings from several adits; however, during an idle period from 1926 to 1927, most of the old works had caved in. In 1929, work was underway on a new adit and 25 tons of copper and silver ore were shipped."

No interim actions at the Midnight and Daylight Mines were documented in the RI.

2.3.11 Red Wing Mine

The Red Wing Mine is located along Beartrap Creek (map location H4/5, Figure 1). The following is a brief history of the mine's development.

> *"The claims include small waste rock dumps located adjacent to Beartrap Creek. McClernan (1983) reported a mine named the Red Wing located on the same 40-acre parcel of ground, and it is probable that the Red Wing Mine operated on the Flossie and Louise mining claims. McClernan also reported that the Red Wing Mine has a 75 foot long adit that follows a near-vertical vein that trends southward. The vein is 2 inches to 4 feet thick and consists of crushed and sericitized diorite rock with sphalerite, galena, and pyrite. No productions statistics were available or reported."*

No interim actions at the Red Wing Mine were documented in the RI.

2.4 *Background Information*

This section contains general background information about the UBMC. Various information comes directly from the existing UBMC RI prepared by Tetra Tech and that information is *italicized* and designated by surrounding quotations ("") (Tetra Tech, 2013a).

2.4.1 Climate

> *"Climatic conditions at the UBMC are typical of intermediate to high elevation regions of the Northern Rocky Mountains with long, cold winters and short, moderately hot summers. Based on climatic records from the National Oceanographic and Atmospheric Administration weather station at Rogers Pass (approximately two miles north-northeast of the UBMC), average monthly minimum and maximum temperatures recorded at the Rogers Pass Station average 13.4 ˚F in January, and 81.5 ˚F in July, respectively. A record cold temperature of -70 ˚F was recorded on January 20, 1954.*
>
> *Average monthly precipitation for the period of record ranges from 0.65 inches in February to 3.10 inches in June. Annual precipitation for the period is 17.99 inches, with the highest annual precipitation (31.4 inches) occurring in 1975 and the lowest annual precipitation (13.9 inches) occurring in 1988. The greatest one-day storm event recorded since 1964 occurred on June 19, 1975, resulting in 2.98 inches of precipitation and a cross-valley embankment failure at the Mike Horse Tailing Impoundment.*
>
> *Average climatic data from the Lincoln Ranger Station weather station located about 14 miles west of the UBMC are similar to that from the Rogers Pass Station. This indicates that weather patterns are relatively uniform throughout the UBMC and are reasonably well represented by the Rogers Pass data."*

2.4.2 Vegetation

Vegetation within the UBMC is a mosaic of coniferous forest, modified by timber harvesting and mining, and consisting of lodgepole pine (*Pinus contorta*), Engelmann spruce (*Picea engelmanni*), and Douglas fir (*Pseudotsuga menziesii*). Many of the stands have been impacted by insects and disease. The open, drier areas of the UBMC contain mountain big sagebrush (*Artemisia tridentata*) and perennial grasses. Riparian and wetland communities are present along the streams and floodplains. The wetter communities also contain hardwood species such as aspen (*Populus tremuloides*) and cottonwood. Disturbed and reclaimed areas contain a suite of annual and perennial grasses and forbs, both native and introduced. Sheep fescue (*Festuca ovina*) and common yarrow (*Achillea millefolium*) appear ubiquitously throughout much of the UBMC. The *Upper Blackfoot Project Area Threatened and Endangered Species Reconnaissance* (WTE, 1993), provides a more detailed description of the UBMC vegetation.

2.4.3 Wildlife

> *"The ecology of the UBMC is diverse in terms of biological species. Portions of the UBMC are located in federally-designated grizzly bear and* Canada lynx *recovery areas and bald eagles, peregrine falcons, and whooping cranes may sometimes enter the UBMC. The Blackfoot River is considered to be a substantial fisheries resource below USFS's Aspen Grove Campground (approximately 12 miles downstream of the Blackfoot headwaters), and the Montana Department of Fish, Wildlife and Parks (FWP) considers the UBMC to include viable trout and big game habitats. Genetically pure westslope cutthroat trout were found in Anaconda Creek above the Anaconda mine site. Westslope cutthroat trout, a species of special concern in Montana, has declined over much of its historic range within the last century. Field personnel during the 2007 fall investigation for the RI also noted observing one fish in each Anaconda Creek and the upper Blackfoot River.*
>
> *Bull trout is a Montana species of special concern and threatened under the Endangered Species Act. The recovery of bull trout is a fisheries priority under both State Fish Wildlife and Parks (FWP) and Federal United States Fish Wildlife Service (USFWS) programs in the Blackfoot Watershed. Bull trout inhabit approximately 125 miles of the Blackfoot River main stem. Densities of bull trout are very low in the upper Blackfoot River, but increase downstream of the North Fork at river mile 54."*

2.4.4 Geology

This section contains a summary of the geology at the UBMC (Figure 3).

> *"In the area between Rogers Pass on the continental divide and the town of Lincoln, the Blackfoot River flows westward in a narrow valley parallel to US Highway 200. Along this stretch, the river has down-cut through a series of resistant bedrock ridges consisting of folded and thrust-faulted red, green and gray sedimentary mudstone units of the Precambrian Belt Formation. These units crop out in a geologic province called the southern Montana Overthrust Belt. The bedrock geologic units of the overthrust belt consist of a series of thick slabs of crustal rocks that have been sheared along low angle*

fault planes (thrust-faults) that moved the stacked (imbricated) slabs eastward over underlying rocks during the formation of the Rocky Mountains approximately 65 million years ago.

In the Rogers Pass area, these Precambrian sedimentary units are cross-cut by granite-like (quartz-monzonitic) intrusives that are several miles in diameter and approximately 35 million years old. A number of these intrusive bodies are associated with metallic ore deposits. The Heddleston District, where the UBMC is located, is associated with one of these intrusive stocks. Mineralization in the Heddleston District occurs as two distinct types of deposits including:

- *a number of structurally controlled high-grade, lead-zinc–silver-bearing vein-type mineralized fault and fracture structures that were mined from the turn of the century until the early 1950's; and*
- *a large tonnage, lower-grade disseminated intrusive hosted (porphyry) deposit of copper-molybdenum mineralization that was never developed or brought into production.*

The largest and most prominent mine in the Heddleston District was the Mike Horse Mine which occurred as vein-type mineralization associated with the Mike Horse Fault zone."

2.4.4.1 Unconsolidated Surficial Units

"The Blackfoot River valley from the headwaters area near Rogers Pass eastward was occupied by a valley glacier during the last ice age. During still stands of the glacial front, a number of end moraines of glacial debris with associated outwash plains were deposited. The glacial end moraines form where the glacial front stands in one place, with glacial advances balanced by melting of the glacial front, such that the movement of the glacier acts like a conveyor belt moving debris to the front of the glacier. End moraine deposits take the form of sinuous cross-cutting ridges that cross the valley floor and are comprised of a very poorly-sorted mixture of boulders, gravel, sand, silt, and clay. These glacially deposited features result in a poorly-drained, hummocky, terrain of merged ridges alternating with intervening hollows or swales. In the Blackfoot River valley, glacial moraines locally act as dams with wetlands, marshes, and small lakes developed on the eastern, upstream side of the moraines. Outwash plains result from large flows of glacial melt water along the front of the glacier that tend to rework and redistribute previously deposited glacial valley floor sediments (ground moraines) out in front of the end moraines as large low angle fan or apron-like alluvial deposits that cover much of the valley floor.

Unconsolidated deposits within the Blackfoot drainage of the UBMC consist of glacial end moraines and stream-reworked outwash materials in the valley bottoms, and colluvial slope-wash sediments on slopes transitional between ridge crests and valley bottoms. Alluvial sediments have been contaminated with mine wastes ranging from rather thick deposits of mine tailings with lateral and vertical continuity in the upper end of the drainage below the Mike Horse tailings dam, to inter-bedded alluvial and tailings deposits, to thinner over-bank deposits in downstream and marsh locations.

Ridge crests and upper flanks of ridges tend to be covered with residual, weathered-in place soils.

Alluvial material thicknesses in groundwater monitoring wells in the UBMC range from 8 to 30 feet thick, and average about 18 feet. The shallower alluvial deposits occur at the upstream end of the valley near the Mike Horse Mine, and the thicker deposits occur near tributary stream junctions along the Blackfoot River. Unconsolidated material thickness in groundwater monitoring wells in the vicinity of the marshes and confluences of Porcupine and Meadow Creeks range from 22 to 42.5 feet thick, and average about 29 feet."

2.4.4.2 Bedrock Units

"Three general bedrock units are found at the UBMC, including the Belt Series Spokane Formation, a diorite sill, and a series of Tertiary-age igneous intrusive bodies. The Precambrian Spokane Formation includes massive, light to dark gray quartzite and argillite at the bottom, grading upward to maroon to green argillite at the top. The bedding planes dip from 5° to 30° north. The Spokane Formation is generally devoid of mineralization, except along margins of mineralized veins intruded into fractures within the argillite.

The Spokane metasedimentary rocks are intruded by a flat-lying, diorite (gabbro) sill of Proterozoic age. The sill is tabular in form and cuts across bedding planes of the Spokane Formation at a slight angle. The sill is well exposed in the northern two thirds of the area (upper Anaconda Creek and Shave Gulch drainages) where it reaches a thickness of 500 feet, but occurs primarily in the subsurface to the south (upper Mike Horse, Stevens, and Paymaster Creek drainages) where the thickness decreases to 200 feet due to vertical displacement by faulting. The top of the sill dips gently northward and strikes southwest-northeast. The diorite sill contains abundant chalcopyrite (copper-iron sulfide) and pyrite (iron sulfide), with the highest copper concentrations in soils within the Heddleston District occurring above sub-crops of the diorite as opposed to above mineralized veins or ore zones.

A number of igneous intrusive stocks were emplaced within the older Spokane argillite and diorite sill in the central portion of the District. The igneous complex is quartz monzonite porphyry of Tertiary age. The quartz monzonite also forms linear dikes extending radially outward from the central stock, where molten rock intruded along faults and fracture zones within the country rock. Heat associated with the quartz porphyry at the time of emplacement caused hydrothermal solution to circulate through the country rock, producing the Heddleston District mineralization. The radial dikes extending outward from the central stock produced the mineralized veins first targeted for development in the district, including those at the Mike Horse, Anaconda, Paymaster, Carbonate, and other individual mines, while low grade, disseminated mineralization formed within the intrusive stock itself. Both the mineralized veins and zone of disseminated mineralization extend from south to north across the Blackfoot River drainage bottom."

2.4.4.3 Structure

"Two principal fault systems have been identified at the UBMC including the Mike Horse fault system and the Blackfoot fault system. Both systems trend northwest-southeast, and predate emplacement of the porphyry intrusive. The Mike Horse fault system is the southern-most of the two, and extends from east of Mike Horse Creek drainage, westward through Paymaster Creek drainage. The mineralized veins exploited at the Mike Horse occur within subsidiary faults associated with the Mike Horse fault system. The second fault system (the Blackfoot Fault) is located approximately 4,000 feet to the north and trends subparallel to the Blackfoot River drainage bottom. Both of these fault systems exhibit vertical displacements on the order of 400 feet. Numerous smaller northwest-trending structures occur within the UBMC, as well as older northeast trending structures. These structures control the localization of vein-type mineral emplacement, at several of the historic mines at the UBMC, including the Mike Horse, Anaconda, Paymaster and Carbonate."

2.4.4.4 Mineralization

"Multiple episodes of bedrock mineralization/alteration have occurred at the UBMC, with all mineralization related to the Tertiary-age intrusive complex. Early mineralization includes a network of base and precious metal veins (characterized as quartz/pyrite/chalcopyrite veins), occurring within the porphyry intrusive body and extending radially outward. These radial veins, which are typically fault controlled with considerable bedrock fracturing along vein margins, were the targets of early mine development in the district. Examples include the northwest-southeast trending Mike Horse, Intermediate, and Little Nell veins, which were the targets of underground development at the Mike Horse Mine. All three vein structures dip steeply (approximately 75°) south…. mineralized veins at the Mike Horse Mine average five feet in thickness.

Imprinted upon this fault-controlled vein mineralization and surrounding bedrock are localized, disseminated deposits of supergene enriched copper-molybdenum mineralization (the copper-molybdenum ore zones). Two distinct copper-molybdenum ore bodies have been identified within the UBMC, including the "Number 3 Tunnel Ore Zone" located south of the Blackfoot River, and the "North Ore Zone" located north of the river. These two ore zones were the focus of an extensive mineral exploration program conducted by the Anaconda Company in the 1960s. A third ore zone has been identified a couple of miles south of the UBMC in Sandbar Creek drainage."

2.4.4.5 Seismicity

"The Intermountain Seismic Belt extends through western Montana, from the Flathead Lake region in the northwest corner of Montana to the Yellowstone National Park region where the borders of Montana, Idaho, and Wyoming meet. In western Montana, the Intermountain Seismic Belt is up to 100 km wide. A branch of the Intermountain Seismic Belt extends west from the northwest corner of Yellowstone Park, through southwestern Montana, into central Idaho. This branch includes at least eight major, active faults and has been the site of the two largest known earthquakes in the northern

Rocky Mountains, the August 18, 1959 Hebgen Lake, Montana, earthquake (magnitude 7.5), and the October 28, 1983 Borah Peak, Idaho, earthquake (magnitude 7.3). According to data available through Montana Bureau of Mines and Geology (MBMG), small earthquakes are common in the region, occurring at an average rate of 7 to 10 earthquakes per day."

Based on information from the U.S. Geological Survey (USGS) earthquake database website (USGS, 2014), 141 earthquakes with a magnitude greater than 2.0 have occurred within a radius of 62 miles (100 km) of the UBMC between 1872 and 2014 (as of 08/28/14), with a maximum magnitude of 6.6 in 1925. Since 2007, there have been 20 earthquakes, ranging from 2.0 to 3.5 within 20 miles (30 km) of the UBMC, the largest (3.5) 13 miles to the southwest near the town of Lincoln.

2.4.5 Surface Water

The water courses within the UBMC and surrounding area (in a general upstream to downstream direction) are Mike Horse Creek, Beartrap Creek, Anaconda Creek, Blackfoot River, Stevens Gulch, Shave Creek (also known as Shaue Creek), Pass Creek, Paymaster Creek, Swamp Gulch, Meadow Creek, and Porcupine Creek (Figure 2). The Blackfoot River is formed by the confluence of Beartrap Creek and Anaconda Creek. A series of marshes begin near the confluence of the Blackfoot River and Pass Creek and extend several miles downstream. In some portions of the FS report, the terms gulch and creek refer to the same feature.

"All surface waters within the UBMC are classified as B-1 waters (ARM 17.30.607) with the following identified beneficial uses:

- *Growth and propagation of salmonid fishes and associated aquatic life, waterfowl, and furbearers;*
- *Contact recreation;*
- *Agriculture water supply;*
- *Industry water supply; and,*
- *Drinking, culinary, and food purposes after conventional treatment.*

The Blackfoot River (above Landers Fork), Beartrap Creek, and Mike Horse Creek are listed on Montana DEQ's 303(d) list as having impaired beneficial uses for aquatic life, cold water fish, and drinking water supply. Beneficial uses are identified as impaired due to the following pollutants of concern for the Blackfoot River and Beartrap Creek: cadmium, copper, iron, lead, manganese, and zinc; with the addition of aluminum for Mike Horse Creek. These pollutants are released from areas of historic mine activities and may also in part be related to natural background conditions.

DEQ's NRIS database was searched for water rights information. Within the UBMC, 13 surface water right diversions are on file with priority dates ranging from 1892 to 1963. The purpose listed for all 13 rights is "mining." Eleven of the water rights were owned by ASARCO and are now owned by the [Montana Environmental Trust Group, LLC (Trust)] *METG, one by a private individual, and one by the USFS (for Mike Horse Dam)."*

2.4.6 Groundwater

"Groundwater in the UBMC has been studied in areas of known mining impacts, and predominantly along the stream valley bottoms. The general pattern of groundwater flow is from higher elevation areas, where bedrock groundwater is recharged by snowmelt and spring storm events, towards the local drainage bottoms then along the axis of the drainage. Hydrogeology and groundwater quality are variable and appear to be site specific or locally controlled in many areas of the UBMC. Groundwater occurs within fractured metasediments, igneous bedrock units, and within unconsolidated alluvium in drainage bottoms. Bedrock groundwater discharges to local stream drainages, recharging the alluvial groundwater system and ultimately sustaining base flow in local streams during periods of low precipitation. The recharge area of the UBMC watershed is relatively small, due to topography and proximity to the Continental Divide and; therefore, annual precipitation amounts and timing significantly influence base flows in area streams.

Based on invariably low yields (a few gpm or less) from bedrock monitoring wells at the UBMC, bedrock permeability is considered to be low with groundwater flow occurring predominantly through secondary fractures, joints, and fault zones. This conclusion is supported by relatively low base flow discharge (typically 22 to 50 gpm) from the Mike Horse Mine adit despite workings that include more than 30,000 lineal feet of tunnels, drifts, raises, and winzes. Alluvium has a much higher permeability than bedrock due to the predominance of gravel and cobbles in the larger UBMC drainages (Beartrap Creek, Anaconda Creek, and the upper Blackfoot River).

Fifteen groundwater rights are on record within the UBMC study area. All are located downstream of the Upper Marsh. Given their physical location along tributaries to the Blackfoot River, it is unlikely that four of the fifteen groundwater rights receive water from the Blackfoot River valley fill deposits. It is unclear if the remaining eleven groundwater rights have the potential to receive water from Blackfoot River valley fill deposits. The nearest groundwater right listing to the UBMC is within Porcupine Gulch on the southern side of the Blackfoot River and downstream of Swamp Gulch. The location is hydraulically upgradient of the Porcupine Gulch and Blackfoot River confluence. The Porcupine Gulch groundwater right is owned by the USFS and designated for institutional use. The two nearest groundwater rights potentially hydraulically connected to the Blackfoot River and downgradient of the Upper Marsh are located near the mouth of Surveyors Gulch. Both are and designated for domestic use.

A total of 89 wells are on record with the State of Montana in the UBMC study area. Sixty-six of them are monitoring wells on record within the Facility and the remaining 23 wells are all within a half mile radius of the Facility downstream of the Upper Marsh area. These wells are listed with a variety of purpose including domestic, institutional, commercial, mining, irrigation, and stock use."

A search of the Montana Bureau of Mines and Geology (MBMG) Groundwater Information Center (GWIC) revealed six private drinking water wells within a one-mile radius of the approximate UBMC boundary (one-mile radius of the Mike Horse Tailings Impoundment, *and one mile radius of the confluence of Blackfoot River and Pass Creek). All six wells are located west of the UBMC in Sections 18 and 19 of Township 5 North, Range 6 West, with the closest well approximately 0.75-miles from the Blackfoot River/Pass Creek confluence and north of US Highway 200."*

2.4.6.1 Groundwater – Surface Water Interaction

Groundwater and stream flows originate as snowmelt and rainfall within steep upland slopes. Infiltration provides base flow to streams throughout the remainder of the year. "*Groundwater in the alluvial aquifer and surface water in the Blackfoot River valley and larger tributaries are intimately related, with the streams losing surface water to the alluvial aquifer system in some reaches and gaining water from it in other reaches."*

During October 2007 and June 2008, measured stream flows generally increased between the headwaters of the Blackfoot River and Upper Marsh, but decreased downstream of the wetland. October base flow conditions in the Blackfoot River showed flow lost to the shallow groundwater system from below the Mary P Mine downstream to Stevens Gulch as well as downstream of the marsh. Losing reaches during high-flow monitoring included locations just downstream of the Upper Marsh and within or adjacent to the Middle and Lower marshes. Broadly dispersed flow conditions could influence flow measurements in the marsh and the decreased flow in these marsh areas could be due to measurement limitations rather than losses into the groundwater system.

2.4.7 Human Population and Land Use

2.4.7.1 Demographics

The area surrounding the UBMC is rural and sparsely populated with a density of one person per square mile (U.S. Census Bureau, 2014). The town of Lincoln, Montana, 15 miles west of the UBMC, is the closest population center and has a population of 1,200 according to the 2010 U.S. Census. There are no residents within the UBMC; the closest residence is located along Beartrap Creek immediately upstream of the Mike Horse tailings impoundment. Aerial photographs show four residences located within two miles downstream (west) of the confluence of the Blackfoot River and Pass Creek.

2.4.7.2 Land Use

"*Land use in the project area is National Forest, private industrial forest, mining claims, conservation land, ranching, and to a small extent, residential. Management of National Forest System lands is guided by the Helena National Forest Plan."* There are also recreational uses such as woodcutting and fishing; active unpatented mining claims on National Forest System lands with small scale lode mining activities; and ongoing removal actions (USFS, 2014).

"*There are no developed recreational sites within the UBMC project area but dispersed recreation occurs throughout the area. Typical recreational uses may include hiking, camping, fishing, biking, motor biking, hunting, prospecting, and other similar uses. There is no known survey of actual use of the UBMC area, although long-time* *observations by USFS personnel indicate that facility use is largely recreational, with the highest facility use occurring in the fall during big game hunting season.*

US Highway 200 and the new Meadow Creek Road (constructed in 2010) provide general access to the area. The new Meadow Creek Road replaced the Mike Horse Creek Road to address safety concerns regarding poor visibility when entering on to Highway 200 from the old Mike Horse Road. Additional access is provided by local roads, USFS roads, and driveways. The southwestern most portion of the UBMC project area contains both irrigated and non-irrigated prime farmland."

3 SITE CHARACTERIZATION

Findings from the RI, including analytical results, background concentrations, and screening levels, as well as findings from post-RI investigations were used to establish the nature and extent of the environmental impacts at the UBMC. The RI relied on regulatory screening levels to determine the areas of contamination. Since the completion of the RI, and based on a subsequent baseline ecological risk assessment (BERA) and baseline human health risk assessment (HHRA), DEQ has identified SSCLs for the UBMC. The SSCLs are discussed in Sections 4.3 through 4.5.

3.1 *Extent of Contamination*

Elevated levels of metals are present in soil, sediment, groundwater, and surface water at the UBMC due to the leaching of contaminants from metal-laden mine waste rock and tailings, discharge of metal-laden groundwater from adits, exposure to atmospheric conditions in other areas disturbed by mining practices, and from areas of naturally occurring high mineralization. The interaction of these primary sources with precipitation, surface water, and groundwater, mobilized the metals from the source materials into surrounding media. A Conceptual Site Exposure Model (CSEM), discussed in detail in the RI report, identified Contaminants of Potential Concern (COPCs) for the UBMC and examined primary and secondary sources, release and transport mechanisms, migration pathways for exposure of human and ecological receptors, and attenuation mechanisms. Nine metals that exceeded the representative background concentrations, literature-based screening levels for various human and ecological receptors, or exceeded SSCLs in past interim actions were identified as COPCs for all media: aluminum (Al), arsenic (As), cadmium (Cd), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg), and zinc (Zn). A graphical representation of the CSEM (Tetra Tech, 2013a) is presented as Figure 4.

3.2 *Risk Assessments*

The COPCs identified in the RI were further evaluated in the UBMC BERA (Tetra Tech, 2013b) and the UBMC HHRA (DEQ, 2014a). In the BERA, the UBMC was divided into 13 exposure units (EUs) identified by physical location, habitat type, and waste sources. For purposes of the FS, EU 1 (Upper Anaconda Mine) and EU 9 (Paymaster Mine) are divided into sub-EUs. The EUs are listed below and Figure 5 shows the EU and sub-EU locations.

EU 1A – Upper Anaconda Mine Waste Area

EU 1B – Upper Anaconda Mine Waste Piles

EU 2 – Blackfoot River Dispersed Tailings Associated with EE/CA Removal Action Area and Overbank Deposits

EU 3 – Capital Mine Waste Area

EU 4 – Carbonate Mine Waste Area

EU 5 – Edith Mine Waste Area

EU 6 – Consolation Mine Waste Area

EU 7 – Mary P Mine Waste Pile

EU 8 – Mike Horse Mine Waste Area

EU 9A – Paymaster Mine Waste Areas (Surface)

EU 9B – Paymaster Mine Waste Area (Subsurface)

EU 10 – No. 3 Tunnel Waste Area

EU 11 – Beartrap Creek Dispersed Tailings Deposits Associated with EE/CA Removal Action Area, Overbank Tailings Deposits, and Red Wing Mine Waste Piles

EU 12 – Marsh

EU 13 – Stream Sediments

The BERA evaluated the risk posed by the COPCs to a variety of ecological receptors including plants, aquatic and terrestrial invertebrates, birds, and mammals. Six of the COPCs (aluminum, cadmium, copper, lead, manganese, and zinc) pose an unacceptable risk to plants, invertebrates, birds, and small mammals in EUs 1 through 12 and to invertebrates, fish, and birds in EU 13. Aluminum poses a risk to all receptors wherever pH is less than 5.5. Iron was not evaluated as a COPC in the BERA because no toxicity benchmarks are available for iron (Tetra Tech, 2013b). Based on a calculated Overall Risk Index for each receptor, the greatest risk at the UBMC is to aquatic receptors. The BERA concluded that actual risk at the UBMC may be lower than the calculated risk due to the limited ability of the habitat to support a healthy ecological community. Risk may occur when the receptor comes into contact with the contaminant; however, since the current habitat at the exposure units is unlikely to be attractive to many of the ecological receptors, much of the risk discussed in the BERA is hypothetical (Tetra Tech, 2013b). The UBMC BERA contains a detailed discussion of the risk characterization for each EU.

The HHRA evaluated risk at the UBMC for human health using four recreational scenarios, two worker scenarios, and a residential scenario to establish SSCLs that are protective of human health. Health risks were estimated at all EUs for exposure to COPCs in surface soil and sediment (0 to 2 feet below ground surface [bgs]) and in subsurface soil and sediment (2 to 10 feet bgs) at EUs 2, 9, 11, and 12. Based on the HHRA results, arsenic is a COC at all EUs except EUs 4, 12, and 13; and lead is a COC at all EUs except EUs 5, 9, 10, and 13. Lead as a COC at the UBMC is based on the current EPA blood lead modeling-based screening level of 10 micrograms per deciliter (µg/dL). However, EPA is considering lowering the blood lead modeling-based screening level to 5 µg/dL (DEQ, 2014a). If this change occurs, the 5 µg/dL as a target blood level, DEQ would use that level as the remediation goal for lead and all the EUs would have lead as a COC. The HHRA concluded that COCs in soil or sediment at each EU may pose a threat via leaching to groundwater. All of the COCs may pose a leaching to groundwater threat at one or more of the EUs. The UBMC HHRA contains a detailed discussion of the risk characterization for each EU.

3.3 *Contaminants of Concern*

Based on the BERA and the HHRA, this UBMC FS addresses eight COCs: aluminum, arsenic, cadmium, copper, iron, lead, manganese, and zinc. Although mercury was detected at concentrations above the EPA residential soil screening level in a single sediment sample from a stream in Shave Gulch, subsequent stream sediment sampling did not detect any mercury. Mercury was not included as a COPC in the HHRA or evaluated in the BERA and is not included in the FS.

4 REMEDIAL ACTION OBJECTIVES

Preliminary remedial action objectives (PRAOs) are established for the UBMC to aid in the identification and screening of remedial alternatives undertaken pursuant to CECRA, §§ 75-10-701, et seq., MCA. The selected remedy must "*attain a degree of cleanup of the hazardous or deleterious substance and control of a threatened release or further release of that substance that assures protection of public health, safety, and welfare and of the environment*." (§75-10-721, MCA). DEQ must require a cleanup consistent with applicable state or federal ERCLs and the statute provides for DEQ consideration of substantive ERCLs that are relevant to the site conditions. To ensure that the required cleanup is consistent with ERCLs, DEQ identified those laws or regulations promulgated as applicable or relevant to the facility (see Appendix A). This section discusses the preliminary ERCLs and PRAOs for all media at the UBMC and development of the SSCLs.

4.1 *Environmental Requirements, Criteria, or Limitations*

Applicable or relevant state and federal environmental requirements for the remedial actions at the UBMC have been preliminarily identified by DEQ. Applicable requirements would legally apply at the UBMC regardless of the CECRA action, while relevant requirements are not applicable but address situations or problems sufficiently similar to those at the UBMC. The ERCLs are grouped into three categories:

1) Action-specific requirements are relevant to implementation of a particular remedy. Action-specific requirements do not in themselves determine the remedy but rather indicate the manner in which the remedy must be implemented.
2) Contaminant-specific requirements establish an allowable level or concentration of a hazardous or deleterious substance or prescribe a level or method of treatment.

3) Location-specific requirements serve as restrictions on the concentration of a hazardous or deleterious substance or the conduct of activities because they are in specific locations.

Appendix A contains a description of the preliminary ERCLs for the UBMC. Preliminarily identified ERCLs for the remedial actions at the UBMC may change as DEQ develops the final remedy for the facility. DEQ will identify the final ERCLs in the ROD.

4.2 *Preliminary Remedial Action Objectives*

PRAOs are media- and source-specific goals achieved through completion of a remedial action that is protective of public health, safety, welfare, and the environment (here in after referred to as human health and the environment) and expressed in terms of the identified COCs, exposure routes, and receptors (ecological and human). The results of the HHRA and the BERA, as well as the preliminary ERCLs, were used to develop PRAOs for the UBMC. PRAOs may change as DEQ develops the final remedy for the facility. DEQ will identify the remedial action objectives (RAOs) in the ROD.

4.2.1 PRAOs for Solid Media

The following lists the PRAOs for solid media (mine waste, tailings, soil, and sediment) at the UBMC:

- Eliminate or minimize the pathways of ingestion, inhalation, dermal contact, and uptake (food chain) of solid media with concentrations of COCs that exceed SSCLs.
- Eliminate or minimize the migration of COCs from solid media to groundwater and surface water.
- Comply with ERCLS.

4.2.2 PRAOs for Water Media

The following lists the PRAOs for water media (surface and groundwater) at the UBMC:

- Implement remedial measures that limit COC concentrations in groundwater and surface water per Montana DEQ Circular DEQ-7 (DEQ-7), Montana Numeric Water Quality Standards (DEQ, 2012a).
- Comply with ERCLS.

4.3 *Site-Specific Cleanup Levels for Soil and Sediment*

The SSCLs are concentrations in environmental media that correspond to a specific, allowable target risk or hazard level when a receptor contacts the contaminated medium according to a defined exposure scenario, and are protective of leaching to groundwater (DEQ, 2014a). The SSCLs for soil and sediment at the UBMC were developed in the HHRA for all COCs, except lead. Exposure to lead is evaluated using blood lead levels as a biomarker, not threshold-based toxicity criteria, and blood lead modeling was used to predict the blood lead levels and develop the SSCL for lead. The HHRA used the following four-step process:

1) Determine risk-based concentrations (RBCs) using risk equations that incorporate chemical-specific exposure point concentrations, exposure scenario- and pathway-specific assumptions, and chemical-specific toxicity criteria to calculate cancer risks and non-cancer hazards.
2) Identify site-specific background concentrations using background data collected in the RI.
3) Calculate EU-specific soil screening levels for leaching to groundwater.
4) Compare RBCs developed in step 1 and select the lowest value as the final receptor-specific RBC. The EU-specific soil screening levels for leaching to groundwater were compared to the lowest resulting RBC, and the lower of the two selected as the SSCL. For lead and arsenic, site-specific background screening concentrations were used. If the background screening concentration exceeded the RBC, then the background screening concentration was selected as the SSCL.

The HHRA contains discussions on developing the SSCLs including calculations, modeling results, and analytical data (DEQ, 2014a). The EU-specific SSCLs for removal and protection of groundwater for soil and sediment at the UBMC are listed in Table 4-1.

Table 4-1 Summary of Soil and Sediment SSCLs

Exposure Unit/Media	Contaminant of Concern (mg/kg)							
	Al	**As**	**Cd**	**Cu**	**Fe**	**Pb**	**Mn**	**Zn**
Upper Anaconda Mine Waste Area (EU 1A) - Soil	**31,092**	**40.4**	**4.8**	**275**	*1.00E+06*	**1,109**	**4,893**	**551**
Upper Anaconda Mine Waste Piles (EU 1B) - Soil	**31,092**	**40.4**	**4.8**	**275**	*1.00E+06*	**1,109**	**4,893**	**551**
Blackfoot River EE/CA (EU 2)- Soil	**31,092**	**40.4**	**4.8**	**275**	*2.59E+05*	**1,109**	**4,893**	**551**
Capital Mine Waste Area (EU 3) - Soil	**31,092**	**40.4**	**4.8**	**275**	*1.00E+06*	**1,109**	**4,893**	**551**
Carbonate Mine Waste Area (EU 4) - Soil	**31,092**	**40.4**	**4.8**	**275**	**58,300**	**1,109**	**4,893**	**551**
Edith Mine Waste Area (EU 5) - Soil	**31,092**	**40.4**	**4.8**	**275**	**58,300**	**1,109**	**4,893**	**551**
Consolation Mine Waste Area (EU 6) - Soil	**31,092**	**40.4**	**4.8**	**275**	*1.00E+06*	**1,109**	**4,893**	**551**
Mary P Mine Waste Pile (EU 7) - Soil	**31,092**	**40.4**	**4.8**	**275**	*7.62E+05*	**1,109**	**4,893**	**551**
Mike Horse Mine Waste Area (EU 8) - Soil	**31,092**	**40.4**	**4.8**	**275**	*1.00E+06*	**1,109**	**4,893**	**551**
Paymaster Mine Waste Areas Surface	**31,092**	**40.4**	**4.8**	**275**	**58,300**	**1,109**	**4,893**	**551**

Exposure Unit/Media	Contaminant of Concern (mg/kg)							
	Al	As	Cd	Cu	Fe	Pb	Mn	Zn
(EU 9A) - Soil								
Paymaster Mine Waste Area Subsurface* (EU 9B) - Soil	**31,092**	*167*	**4.8**	**275**	**58,300**	**1,109**	**4,893**	**551**
No. 3 Tunnel Waste Area (EU 10) - Soil	**31,092**	**40.4**	**4.8**	**275**	**58,300**	**1,109**	**4,893**	**551**
Beartrap Creek EE/CA (EU 11) - Soil	**31,092**	**40.4**	**4.8**	**275**	*1.99E+05*	**1,109**	**4,893**	**551**
Marsh (EU 12) - Sediment	**8,083**	**32.3**	**3.53**	**197**	**14,500**	**174**	**696**	**315**
Streams (EU 13) - Sediment	8,980	17.0	3.53	197	**	91.0	578	315

Bold = SSCL based on site-specific background
Italicized = SSCL based on protection to groundwater
* See Section 6.1.10 for an explanation why only subsurface soil is screened in EU 9B
** Not a COC for the exposure unit

Aluminum concentrations in soil were not evaluated for ecological receptors. The aluminum SSCLs for EUs 1 through 9 and EU 11 are based on protection of human receptors and groundwater. Soluble aluminum, not total aluminum in soil, correlates with the uptake of aluminum from soils into plants. Aluminum in soil will bind with other elements at pH levels above 5.5. As the pH level drops below 5.5, the solubility of the aluminum increases and the aluminum is more bioavailable to living organisms/ecological receptors. The aluminum SSCLs for sediments in EUs 12 and 13 are for protection of human and ecological receptors, as well as groundwater.

Aluminum was detected at concentrations above screening levels in two shallow alluvial groundwater wells that monitor groundwater quality related to mine tailings seepage in EU 8 (Mike Horse Mine), but not detected in any groundwater wells downstream of these two wells. Impacted groundwater in the vicinity of these two wells is currently addressed, via an interim action, by a seepage collection system that pumps the collected water into the Mike Horse 200-foot level mine adit . This allows the seep water to be stored and partially mixed with other (higher pH) water in the mine workings before treatment. It is anticipated that most of the aluminum present in the seep water will precipitate inside of the workings since the pH in the workings is near the optimum pH for aluminum precipitation (CDM, 2008). Although one deep bedrock groundwater well in EU 4 (Carbonate Mine) had a concentration of aluminum above the screening level, aluminum was not present in the waste rock or soils sampled during the RI at concentrations above the SSCL for protection of groundwater at EU 4.

4.4 *Site-Specific Cleanup Levels for Groundwater*

Under the Montana Water Quality Act (MWQA), § 75-5-605, MCA, "it is unlawful to cause pollution of any state waters or to place or cause to be placed any wastes where they will cause pollution of any state waters." Montana classifies groundwater into four classes based on specific conductance and establishes groundwater quality standards applicable to each class. Class I is the highest quality class and ARM 17.30.1006 provides that concentrations of substances within Class I groundwater may not exceed the human health standards for groundwater listed in DEQ-7 (DEQ, 2012a). The quality of Class I groundwater must be maintained so that these waters are suitable for the following beneficial uses with little or no treatment: public and private water supplies; culinary and food processing purposes; irrigation; drinking water for livestock and wildlife; and commercial and industrial purposes. Class II is the next highest quality class and ARM 17.30.1006 provides that concentrations of substances within Class II groundwater also may not exceed the human health standards for groundwater listed in DEQ-7 (DEQ, 2012a). The quality of Class II groundwater must be maintained so that these waters are at least marginally suitable for the following beneficial uses: public and private water supplies; culinary and food processing purposes; irrigation of some agricultural crops; drinking water for livestock and wildlife; and most commercial and industrial purposes.

The lowest specific conductivity for the groundwater at the facility corresponding to the highest quality is appropriate for classification of the groundwater and therefore the UBMC groundwater is classified as Class I. Two specific areas, the upper Mike Horse waste pile area and the Carbonate mine area, exhibited Class II groundwater characteristics based on specific conductance. However, the groundwater in both of these areas is contaminated by mining-related activities that increase the specific conductance to a level indicative of Class II groundwater (Tetra Tech, 2013a). As the lowest measured specific conductance from unimpacted groundwater determines the classification, the groundwater is Class I..

The human health standards for the primary COCs in the groundwater at the UBMC listed in Table 4-2 are based on DEQ-7 standards. Compliance with all DEQ-7 standards is required and remedial actions must meet DEQ-7 standards for all contaminants at the UBMC, including any breakdown products generated during remedial actions. Numeric water quality standards are not included for aluminum, iron, and manganese in DEQ-7. For these COCs, the table lists the SSCL from the UBMC HHRA (DEQ, 2014a).

Edith groundwater and Paymaster groundwater are identified as having highly mineralized background conditions. In the Edith Mine Area all groundwater metals concentrations, except iron and manganese, are lower than the groundwater SSCLs. The groundwater iron and manganese concentrations appear to be a result of highly mineralized background conditions. Portions of the Edith Mine Area also contain fen and forested emergent wetland environments. The area-specific background concentrations found in the Edith Mine Area groundwater are the SSCLs for the groundwater in that area (Table 4-2).

Based on the metal concentrations found in the Paymaster Mine area wells, the shallow and bedrock aquifer groundwater quality in the Paymaster Mine area is similar to the groundwater quality found in the shallow and bedrock Paymaster background wells. This similarity in water quality suggests that the Paymaster Mine area groundwater is reflective of the highly mineralized background conditions. The area-specific background concentrations found in the Paymaster Mine Area groundwater are the SSCLs for the groundwater in that area (Table 4-2).

Table 4-2 Summary of Groundwater SSCLs

Contaminant of Concern (mg/L)[1]							
Al	**As**	**Cd**	**Cu**	**Fe**	**Pb**	**Mn**	**Zn**
20	**0.01**	**0.005**	**1.3**	*14*	**0.015**	*0.94*	**2.0**
Edith Mine (EU 5)							
20	**0.01**	**0.005**	**1.3**	*27.8*[3]	**0.015**	*3.03*[3]	**2.0**
Paymaster Mine (EU 9)							
20	**0.01**	**0.0056**[2]	**2.866**[2]	*15.12*[2]	**0.015**	*2.29*[2]	**2.0**

Note: For those compounds that have them, DEQ-7 standards are the groundwater SSCLs unless site-specific background exceeds the DEQ-7 standards in a particular location, in which case background becomes the SSCL for that location. For those compounds in groundwater for which no DEQ-7 human health standard exists (aluminum, iron, and manganese), DEQ calculated SSCLs or used site-specific background levels (Tetra Tech, 2014). For the Paymaster and Edith EUs – the geology in the Paymaster and Edith mine groundwater areas is from the gabbro geologic formation and is highly mineralized, which results in elevated metal concentrations in the groundwater. In addition, the Edith Mine area groundwater is also influenced by unique sensitive areas (fen and forested emergent wetland environments) known to accumulate peat layers that act to collect and retain metals.
[1] Values are based on dissolved concentrations.
[2] Paymaster Background
[3] Edith Background
Bold = DEQ-7 standard
Italicized = Site-specific cleanup values (DEQ, 2014a)

4.5 *Site-Specific Cleanup Levels for Surface Water*

Under the MWQA, §§ 75-5-101, et seq., MCA, Montana has promulgated regulations, ARM 17.30.601 et seq., to protect, maintain, and improve the quality of surface waters in the state. Surface water at the UBMC is part of the Clark Fork of the Columbia River drainage and is classified as B-1. ARM 17.30.607 provides that waters classified B-1 are to be maintained suitable for drinking, culinary, and food processing purposes, after conventional treatment; bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

The human health and aquatic life standards for the primary COCs in surface water at the UBMC listed in Table 4-3 are based on DEQ-7 standards (DEQ, 2012a) and compliance with all DEQ-7 standards is required. If both aquatic life and surface water human health standards exist for the same analyte, the more restrictive of these values is used as the applicable numeric standard. Hardness dependent metals will be adjusted on a sample by sample basis so that a cleanup level can be calculated that is specific to that location. Numeric water quality standards are not available for aluminum, iron, and manganese in DEQ-7. For these COCs, the table lists the SSCL from the UBMC HHRA (DEQ, 2014a).

Swamp Gulch (Carbonate Mine) surface water is identified as having highly mineralized background conditions. In Swamp Gulch the background station (BRSW-14) indicates that the creek in Swamp Gulch may be a source of highly mineralized water. Background was calculated, based on 15 sampling events and is reflective of the highly mineralized background conditions. The area-specific background concentrations found in Swamp Gulch are the SSCLs for the surface water in that creek (Table 4-3).

Table 4-3 Summary of Surface Water SSCLs

Contaminant of Concern (mg/L)[1]							
Al	**As**	**Cd**	**Cu**	**Fe**	**Pb**	**Mn**	**Zn**
0.087[2]	**0.01**	**0.0001**[3]	**0.0029**[3]	**1.0**	**0.0006**[3]	0.43	**0.037**[3]
Swamp Gulch (Carbonate Mine EU 4)							
0.27[4]	**0.01**	0.005[4]	0.15[4]	3.155[4]	0.028[4]	0.509[4]	0.584[4]

Note: For those compounds that have them, DEQ-7 standards are the surface water SSCLs. When taken from DEQ-7, the surface water SSCL is the most protective (lowest) concentration found between the human health, chronic aquatic, and acute aquatic standards for each COC. However, if a site-specific background COC concentration exceeds the DEQ-7 standards in a particular location, the background becomes the SSCL for that location.
[1] Values are based on total recoverable concentrations.
[2] Values are based on dissolved analysis and only applicable to waters with pH of 6.5 to 9.0.
[3] Hardness dependent standard – The standards for these metals are expressed as a function of total hardness (mg/L, CaCO3; see DEQ-7 footnote 12). The cleanup levels expressed in this table are based on 25 mg/L hardness. During the RI the surface water hardness at the UBMC ranged from 26 mg/L to 221 mg/L and is seasonally variable as well. Any new surface water sample, including post-construction monitoring samples, will be analyzed for the hardness specific to that sample and a cleanup level calculated that is specific to the sampled location.
[4] Swamp Gulch Creek background
Bold = DEQ-7 standard

5 Interim and Concurrent Actions

Between 1993 and 1998, ASARCO and ARCO conducted interim actions to address environmental impacts at the UBMC. Although DEQ provided review and comment on the project work plans and reports, the interim actions were conducted without DEQ approval. The individual mine histories presented in Section 2.3 contain information on the reclamation activities. Several areas of the UBMC that were addressed by interim actions were sampled in the RI and are in exceedance of one or more SSCLs. The following interim actions are included in the FS remedial action alternative analysis and discussed in greater detail in Section 6:

- Anaconda Mine - reclaimed waste areas and engineering controls.
- Capital Mine - reclaimed waste area, Stevens Creek reconstruction, and engineering controls.
- Carbonate Mine - reclaimed waste area and groundwater monitoring wells.
- Edith Mine - reclaimed waste areas.
- Consolation Mine - reclaimed waste area.
- Mike Horse Mine - reclaimed waste areas, groundwater collection and monitoring wells, and engineering controls.

- Paymaster Mine - reclaimed waste areas, constructed wetlands and water treatment system, surface water, and groundwater monitoring wells.
- No. 3 Tunnel Area - reclaimed waste area.

Although sampled in the RI, EU 2 (the Blackfoot River floodplain) and EU 11 (Beartrap Creek floodplain and Red Wing Mine waste pile) are included in concurrent actions addressed by the EE/CA removal action and discussed in Section 5.1. Discussion of interim actions at Mike Horse Creek (sampled in the RI) and Mike Horse Repository (not sampled in the RI) is presented in Section 5.2. Interim action areas not directly sampled in the RI include the Carbonate and Paymaster Repositories and the WTP; a summary of these interim actions is included in Sections 5.3 through 5.5.

5.1 *Engineering Evaluation/Cost Analysis Removal Action*

In November 2002, ASARCO entered into an Administrative Order on Consent (AOC) with the USFS to prepare an EE/CA to address mining-related impacts to the areas and drainages in the UBMC located primarily on USFS lands (Hydrometrics, 2007). The EE/CA objective was to develop and present interim action options that could be implemented to reduce or eliminate potential human health and environmental risks from mining-related impacts and to present a comparative analysis of the options.

Before ASARCO prepared the EE/CA, the USFS requested that ASARCO prepare conceptual alternatives for public review for the four primary mine waste elements on USFS lands. Two alternative technical memorandums were prepared: *Alternatives Technical Memorandum for Mine Waste Removal at the Upper Blackfoot Mining Complex Site*, (Hydrometrics, 2005), and *Draft Concept Alternatives Technical Memorandum for the Mike Horse Dam and Tailings Impoundment at the Upper Blackfoot Mining Complex Site*, (USFS, 2006a). Based on public and agency review of these documents, alternative options were refined and ultimately presented and evaluated in the EE/CA (Hydrometrics, 2007).

5.1.1 EE/CA Areas

The EE/CA addressed some portions of the UBMC located primarily on USFS lands (Figure 6) and divided the mining-related impacts into four subareas: Mike Horse tailings impoundment, Lower Mike Horse Creek, Beartrap Creek, and Upper Blackfoot River. The list below includes a description and a summary of each subarea as provided in Sections 2 and 3 of the EE/CA Summary (USFS, 2006b). The summary does not list specific wells or samples, but presented the following overall conclusions of the site characterization used in the EE/CA.

1) The Mike Horse tailings impoundment (dam and impounded tailings):
    - Tailings metals concentrations are higher in the tailings material impounded behind the tailings dam than in the material comprising the dam.
    - Surface water in Beartrap Creek upstream of the impoundment and in the impoundment is generally good.

- Surface water in Beartrap Creek below the impoundment is periodically slightly impaired for several metals. Seeps and water quality vary seasonally.
- Tailings materials within the impoundment have high concentrations of several metals including arsenic, cadmium, and copper and very high concentrations of lead, manganese, and zinc. [Note: Since the dewatering of the tailings impoundment, cadmium, manganese, and zinc concentrations in monitoring well TDMW-2S have increased significantly and consistently exceed water quality standards and SSCLs. Lesser exceedances of cadmium and zinc are found in two of the deeper monitoring wells, TDMW-1 and TDMW-6, but not TDMW-2D (TerraGraphics, 2010 and 2011; Portage, 2012, 2013, and 2014)].

2) Lower Mike Horse Creek drainage wastes from the USFS boundary downstream to the confluence with Beartrap Creek:
   - Approximately 10,000 to 15,000 cy of mine waste are adjacent to the Lower Mike Horse Creek stream channel and contain moderate to high levels of metals and the wastes are potentially acid generating.
   - The mine wastes are sources of metals loading to the creek, particularly during spring runoff.
   - Shallow bedrock groundwater near one well (MHMW-8) is impaired by cadmium, manganese, and zinc and may be a primary source of metals to lower Mike Horse Creek seasonally. [Note: At the time the EE/CA was finalized, there was a DEQ-7 standard for manganese which no longer exists; however, the manganese levels also exceed the SSCL for manganese.]

3) Beartrap Creek drainage bottom wastes from the Mike Horse Dam downstream to the confluence with Anaconda Creek:
   - Tailings, dam debris, and mine waste are found in and along the floodplain, intermixed with stream and floodplain sediments, and in a waste pile located at the Red Wing Mine. Metals concentrations in these wastes are moderate to high.
   - The concentrated tailings have higher potential to leach metals than the other types of tailings and wastes in this reach.
   - Small increases in metals loadings in surface water occur within Beartrap Creek.
   - Shallow groundwater in Beartrap Creek has cadmium, lead, manganese, and zinc metals concentrations that are elevated above the water quality standards and SSCLs. [Note: At the time the EE/CA was finalized, there was a DEQ-7 standard for manganese which no longer exists; however, the manganese levels also exceed the SSCL for manganese.]

4) The Upper Blackfoot River floodplain wastes from the confluence of Anaconda Creek and Beartrap Creek downstream to a large marsh system (Upper Marsh) near the confluence with Pass Creek:

- Mine wastes occur as relatively concentrated piles of tailings near the confluence of Shave Gulch and the Blackfoot River, and in smaller discrete deposits of fine-grained tailings and dispersed occurrences of coarser grained tailings throughout the floodplain.
- The wastes have moderate metals contents and are capable of generating elevated metals concentrations in runoff water coming into contact with them.
- Groundwater quality in the area of the WTP cells near Anaconda Creek is generally good with metal concentrations near or below detection limits, but the groundwater quality within the Shave Gulch concentrated tailings area is poor. The water quality varies seasonally in the Shave Gulch concentrated tailings area.

5.1.2 EE/CA Streamlined Risk Evaluation

The EE/CA included streamlined human health and ecological risk evaluations. The USFS used these risk evaluations to develop PRAOs and to define potential exposure pathways, identify appropriate cleanup goals, and select a removal action. Because the UBMC is not currently used as a residential area, the USFS applied the public recreational scenario to evaluate the potential hazard to human health. The evaluation results indicated that unacceptable risk exists because of potential human recreational exposure to arsenic, manganese, and/or lead in one or more of the exposure areas.

Ingestion is one of the potential routes of exposure for terrestrial receptors and includes direct or incidental contaminant contact by birds and mammals while eating. A similar ingestion scenario evaluation occurred for fish, aquatic plants, and benthic invertebrates. The results indicated a potential adverse health impact to species that live within or may otherwise frequent the locally impacted areas.

5.1.3 EE/CA Selected Site Wide Alternative

Several alternatives were developed in the EE/CA based on removal and various repository options. The 2007 USFS Action Memorandum (USFS, 2007) followed the EE/CA and identified Site Wide Alternative 4 as the selected action for the site. Alternative 4 included the following:

- Removal of Mike Horse Dam and the impounded tailings (Option 5).
- Complete removal of wastes in Mike Horse Creek (Option 3).
- Partial removal of wastes in Beartrap Creek (Option 4).
- Complete removal of wastes in the Blackfoot River floodplain (Option 4).

The waste volume from the USFS portions of the UBMC in Site Wide Alternative 4 was estimated at 467,500 cy, and the preferred repository site was an in-drainage repository. The decision and analysis completed in the EE/CA (Hydrometrics, 2007) assumed the material would be placed in the area of the existing Paymaster Repository site subject to further verification as described in the Action Memorandum.

5.1.4 Key Changes Post EE/CA and USFS Action Memorandum

Several important changes have occurred at the UBMC since ASARCO prepared the EE/CA and the USFS issued the Action Memorandum. In April 2008, USFS, DEQ, and the Montana Department of Justice (DOJ) (collectively "the Agencies") signed the *Settlement Agreement Regarding the Upper Blackfoot Mining Complex Site* ("Agreement") (DEQ/EPA/USFS, 2008a) with ASARCO and ARCO ("the Companies") as part of the ASARCO bankruptcy proceedings. Under the Agreement, the Agencies were awarded funds to address the UBMC and the settlement required the Agencies to enter into an agreement to stipulate how the Agencies would fund and manage the cleanup completed on the federal lands portion of the UBMC. This agreement, *Watershed Restoration Agreement Between the State of Montana and the United States Department of Agriculture, Forest Service Northern Region for the Clean Up of the NFS Portion of the Upper Blackfoot Mining Complex Site* (WRA) (DEQ/EPA/USFS, 2008b), was signed by the Agencies in April 2008. As part of a separate but related settlement in the bankruptcy, ASARCO properties in the mining area were transferred to the Trust. In December 2008, the Agencies received the settlement funds from the Agreement.

The WRA specifies how the Agencies use the settlement funds to fund cleanup actions on USFS lands, facilitate a cooperative relationship between the USFS and the State of Montana, and provide for USFS oversight of and involvement in the State's implementation of the cleanup on USFS lands. The Agencies agreed to take a site-wide approach to cleanup at the UBMC to maximize cleanup efficiencies and reduce costs as much as feasible and, under USFS oversight, DEQ agreed to implement the cleanup actions selected by the USFS in its Action Memorandum for the USFS lands.

Key technical changes determined after the EE/CA was completed included the following:

- The estimated volume of wastes on USFS land has increased from 467,500 cy to approximately 600,000 cy based on more detailed site characterization data.
- The estimated total potential waste volume from private lands is 400,000 cy for a total potential volume of approximately 1,000,000 cy.
- Subsequent data identified significant technical issues with enlarging the Paymaster Repository site, such as steep slopes, limited space, requirement of a structural berm to be constructed at the toe, and significant geochemistry issues. These issues raised concerns regarding the feasibility and effectiveness of enlarging the Paymaster Repository site as a stand-alone option.

The increased volume estimates and repository technical issues fundamentally changed the design parameters and feasibility of the alternatives considered in the EE/CA. For these reasons, the Agencies re-evaluated the sites considered in the EE/CA and initiated an effort to locate a new repository site capable of meeting all site-wide goals and applicable or relevant and appropriate requirements (ARARs).

In 2011, DEQ and USFS completed a detailed repository siting study to identify and evaluate other potential repository sites (Pioneer, 2011). After completion of that study, the USFS issued

Amendment 1 to the July 2007 Action Memorandum and selected Section 35 as the on-site repository location for the impacted media from the USFS property (USFS, 2012); DEQ concurred in this decision (DEQ, 2012).

Subsequent investigations have been completed to better define the extent of contamination throughout the EE/CA area and a conceptual design was prepared for the EE/CA portion of the UBMC (Spectrum, 2013). Based on current design information in the conceptual design, the total removal volume for Beartrap Creek increased from the 32,500 cy estimated in the EE/CA to approximately 43,000 cy. Remediation activities for the four EE/CA subareas began in 2014 with completion of major construction activities expected in 2018.

5.2 *Mike Horse Creek and Mike Horse Repository*

The repository interim action at the Mike Horse Mine was completed in 1995 and 1996 as part of the voluntary remedial actions conducted by ASARCO and ARCO, as summarized in Section 2.3.7. The Mike Horse Repository, located in the lower Mike Horse Creek area below the mine workings, was built to accommodate mine waste mainly from the Anaconda and Edith Mines, and a relatively small volume of mine waste from the lower Mike Horse Mine. Construction of the Mike Horse Repository included:

- A subsurface, shallow groundwater collection and drainage system to maintain groundwater levels below the base.
- A limestone gravel drainage layer beneath the repository.
- Amendment of the upper 18 inches of mine waste, a 12-inch growth medium layer on the side slopes with vegetative cover.
- A geosynthetic clay liner on the upper, flat crest.

The repository, located immediately adjacent to Mike Horse Creek, is at risk for erosion from the stream during high flow events. A groundwater collection and drainage system at the toe of the repository collects water that is routed to the WTP, along with water from the upper Mike Horse Mine seepage collection system. A seep surfacing at the base of the repository suggests that ASARCO did not construct the repository in an appropriate location. Currently, the seep is captured and the water treated by the WTP.

The collected water is generally at a different pH than the water from the seepage collection system causing problems in the conveyance system and at the WTP. Based on the available data, it is unclear if the repository is a source of contaminant loading to groundwater. Because of the issues caused by its location and the insufficient amount of cover material used to cap it, the Mike Horse Repository does not comply with ERCLs.

During the 1998 interim action, a waste rock dump, located in the upper Mike Horse Creek mine workings area, adjacent to Mike Horse Creek and within the floodplain was capped in place. This capped waste rock dump is actively eroding from the cap surface and side, exposing mine waste during high runoff events and contributing contaminated sediments to Mike Horse Creek.

In June 2014, DEQ prepared the *Upper Blackfoot Mining Complex, Phase 2 Construction, Construction Specifications, Drawings, and Bidding Documents* (DEQ, 2014b) to begin waste removal on USFS land covered by the WRA in the summer of 2014. Some areas scheduled for removal also contain waste that is not solely located on USFS land and not included within the 2007 Action Memorandum, as amended. To minimize the potential for recontamination and to maximize efficiencies and resources, DEQ included removal of this waste on non-USFS land which is in the same drainage and near the area that is addressed by the Action Memorandum as an interim action. The work on non-USFS land is being conducted in the same manner as the work on USFS land covered by the Action Memorandum, as amended (DEQ, 2014c).

As part of the implementation of the USFS EE/CA removal action, DEQ will remove contaminated sediments and other miscellaneous waste sources in the upper Mike Horse Creek floodplain area (DEQ, 2014b). The restoration work in Mike Horse Creek will also include remedial work to seal the bedrock to prevent surface water infiltration into the faults and mine workings in this area. The upper Mike Horse Mine seepage collection system will be relocated and extended to improve the effectiveness of the capture system, provide better protection of the surface water in Mike Horse Creek from the contaminated shallow groundwater, and minimize infiltration of surface water into the underlying mine workings.

The Mike Horse Repository will be removed as part of the interim action scheduled for 2014-2015 during the concurrent EE/CA work and is not further evaluated in the FS. Work on upper Mike Horse Creek, also addressed under the interim action during the concurrent EE/CA, is scheduled for 2015.

5.3 *Carbonate Repository*

Interim actions at the Carbonate Mine were completed in 1993 and 1994 as part of the voluntary remedial actions conducted by ASARCO and ARCO, as summarized in Section 2.3.3. The Carbonate Repository was constructed in the upper Carbonate Mine area for lime-amended waste rock and tailings removed from the lower Carbonate Mine area. The repository slope was covered with a 6-inch layer of drainage gravel (except for the north slope) overlain by 12 to 18 inches of cover soil; the north slope received 12 inches of cover soil. The flat portion of the repository was covered with unknown thicknesses of gravel, a geosynthetic clay liner, and cover soil. In 1995, the repository cap cover was compromised due to erosion. Repairs included replacing the growth medium soil, placing an erosion mat over the eroded surface, and revegetating the area.

Groundwater and surface water quality at the Carbonate Repository site, monitored since 1991, improved dramatically following completion of waste removal in 1994. Prior to waste removal, surface water sampling directly downstream of the site at BRSW-15 (Figure 21) showed elevated levels of total cadmium, copper, iron, manganese, lead, and zinc. Between 1995 and 1998 (the last year samples were collected), the levels for these six metals were all below DEQ-7 numeric water quality human health standards (DEQ, 2012a), but continued to have aquatic standards exceedances for cadmium, copper, iron, and lead. When compared to the reference surface water concentrations at BRSW-14 (upstream of all mining activities in Swamp Gulch), all post-cleanup metals concentrations at BRSW-15 were below those found at BRSW-14 (Figure 21).

Although elevated levels of some of these metals continue to be present in groundwater samples, most notably at monitoring well UCMW-11 (Figure 21) immediately downgradient of the repository, these elevated levels could be attributable to the completion of the monitoring well into former mine workings within a highly mineralized geologic zone. There is no evidence to indicate that the repository is a source for these metals. A vegetation survey, conducted by DEQ in 2013 as part of the operation and maintenance plan for the UBMC repositories, noted "a high percentage of vegetation and very little bare ground" (DEQ, 2014d). The bare ground was attributed to burrowing animals. Four transects were walked by field personnel and the average cover was 96 percent vegetation or vegetative litter, 3 percent bare ground, and 1 percent rock.

The Carbonate Repository will be evaluated by DEQ in the proposed plan.

5.4 *Paymaster Repository*

Interim actions at the Paymaster Mine were completed in 1996 and 1997 under DEQ's Voluntary Cleanup and Redevelopment Act (VCRA) and as part of the voluntary remedial actions conducted by ASARCO and ARCO, as summarized in Section 2.3.8. The repository was constructed on a bench above Paymaster Creek for lime-amended waste rock and tailings from the Paymaster Mine, the No. 3 Tunnel site, and the DEQ Blackfoot Tailings project and capping it with soil. In 2004 and 2005, approximately 15,000 cy of mine waste from Mike Horse Mine and sludge from the Mike Horse sludge-drying beds was placed in the repository.

One of three monitoring wells installed along the perimeter of the repository, PMMW-2 (Figure 23) exceeded DEQ-7 standards for cadmium and lead in 2006, 2012, and 2013 (DEQ, 2014d). An examination of the PMMW-2 well log shows a zone of iron stained fractures (34 to 37 ft bgs) in diorite followed by a quartz sulfide vein with high pyrite content (2-4 percent at 44 to 48 ft bgs) and galena. This mineralization in the water bearing zone is indicative of the poor water quality in PMMW-2. The sulfate content is five times higher and the lead 90 times higher than the other two monitoring wells for the Paymaster Repository, which lack the same mineralization as PMMW-2 (Figure 23).

A vegetation survey, conducted by DEQ in 2013 as part of the operation and maintenance plan for the UBMC repositories, noted "the most significant area of bare ground was located near the top (south) of the repository where the ground is relatively flat" (DEQ, 2014d). The bare ground was attributed to lack of vegetative growth due to poor soils. Three transects were walked by field personnel during the 2013 vegetation survey, and the average cover was 78 percent vegetation or vegetative litter, 11 percent bare ground, and 11 percent rock. The repository has exhibited no instability and is located well outside of any floodplains and away from any active faults.

The Paymaster Repository will be evaluated by DEQ in the proposed plan.

5.5 *Water Treatment Plant*

In 2009 ASARCO completed the WTP, located at the former Anaconda Mine site and adjacent to the Blackfoot River, in response to the revocation of the temporary water quality standards for the UBMC area. Originally, as part of the voluntary remedial actions conducted by ASARCO and ARCO as summarized in Section 2.3.7, ASARCO constructed a WWTS to treat drainage from the Mike Horse Adit, as well as the combined discharges from an adit and shaft at the Anaconda Mine near the confluence of the Blackfoot River and Anaconda Creek. This WWTS was completed and went on-line in October 1996. Components of the WWTS were designed to remove metals from the combined Mike Horse Adit and Anaconda Adit discharges through sulfide generation.

The current WTP, designed to treat those same discharges and seeps in addition to the seeps at the upper Mike Horse waste area and at the base of the Mike Horse Repository, began operations in January 2009 and replaced the WWTS located adjacent to the Anaconda Mine. The WTP also bypassed the Mike Horse adit pretreatment system that included the oxidation/settling pond and sand filter bed, but continued the use of the flow-through bulkhead plug with piping and controls at the Mike Horse adit to convey adit discharge to the WTP. The flow-through bulkhead plug at the Anaconda adit was also retained to convey adit discharge to the WTP. The WTP incorporates chemical treatment and ceramic microfiltration technology to primarily remove cadmium, copper, manganese, and zinc. After optimization in 2012, the WTP has continued to meet its discharge requirements. The technology used at the WTP is described in Section 7.5.7 and Section 7.5.8, and evaluated as a potential long-term remedy for groundwater in Section 9.5.5 and Section 9.5.6.

6 EVALUATION AREAS

Mining-related features, certain interim action areas that do not comply with CECRA and are not addressed by the EE/CA or the interim actions discussed in Sections 5.1 and 5.2, and EUs with areas exceeding SSCLs were combined into five Evaluation Areas (EAs) to streamline the development of remedial action alternatives in the FS. The EAs and the affected media are defined as follows:

- Evaluation Area 1 (EA 1) – Upland Waste Areas (soil)
- Evaluation Area 2 (EA 2) – Groundwater
- Evaluation Area 3 (EA 3) – Streams (sediment and surface water)
- Evaluation Area 4 (EA 4) – Upper Marsh (sediment and water)
- Evaluation Area 5 (EA 5) – Mining-related Features (soil)

Sections 6.1 through 6.5 provide a site characterization summary for each EA including a summary of the results from the soil and water sampling, interim action cover material sampling, ecological risk sampling, and aquatic investigations presented in the RI report. Remediation volumes are estimated for each EA and summarized for the UBMC in Section 6.6.

6.1 *Evaluation Area 1 - Upland Waste Areas*

Evaluation Area 1 includes the following:

- Upper Anaconda Mine Waste Area (EU 1A)
- Upper Anaconda Mine Waste Piles (EU 1B)
- Capital Mine Waste Area (EU 3)
- Carbonate Mine Waste Area (EU 4)
- Edith Mine Waste Area (EU 5)
- Consolation Mine Waste Area (EU 6)
- Mary P Mine Waste Area (EU 7)
- Mike Horse Mine Waste Area (EU 8)
- Paymaster Mine Waste Area Surface (EU 9A)
- Paymaster Mine Waste Area Subsurface (EU 9B)
- No. 3 Tunnel Waste Area (EU 10)

Soil sample results from the RI were compared against the SSCLs in Table 4-1 to determine areas of exceedance within each EU. Isopleth figures were created for EUs within EA 1 to indicate areas of exceedances for the protection of groundwater standard, human health risk for soil (arsenic and lead), and ecological risk for soil (all other COCs).

6.1.1 Upper Anaconda Mine Waste Area (EU 1A)

ASARCO and ARCO removed two waste dumps at the Upper Anaconda Mine, UAW2 and UAW5, in 1995 as interim actions. The larger of the waste dumps (UAW2) was placed in the Mike Horse Repository, along with a portion of the second dump. The remainder of the second dump was placed in an excavation area at the mine site. Both areas were regraded, amended with cement kiln dust, covered with soil, and revegetated with an upland species mix of fescue, wheatgrass, and one introduced legume, cicer milkvetch (Hydrometrics, 1996). During the RI sampling events in 2007 and 2008, samples were collected at the two removal areas along with perimeter and composite samples to define the extent of possible exceedances at the reclaimed waste area (Figure 7).

Comparison of the analytical results for the soil samples collected during the RI at the Upper Anaconda Mine reclaimed waste areas against the EU 1A SSCLs in Table 4-1 indicates that arsenic, cadmium, copper, lead, and zinc are present at concentrations above the SSCLs (Figure 16). The estimated remediation volume is 10,782 cy for the areas of exceedance, assuming a removal depth of 2 feet bgs. The extent of impacted media is widespread at the reclaimed waste area but is limited to the west by an intermittent stream and a talus slope and to the south by the WTP.

The two revegetated Upper Anaconda Mine reclaimed waste areas were investigated as separate areas in 2008, but due to the similarity of the sites and the composition of vegetation, monitoring results were grouped for the area as a whole. Vegetative coverage was observed at 57 percent, (similar to the reference area) with 40 percent wood, litter, and rock cover and 3 percent bare ground. Knapweed and cheatgrass was observed. The reclaimed areas were surrounded by a mature lodgepole pine forest and regenerated lodgepole pine noted within a portion of the removal area.

6.1.2 Upper Anaconda Mine Waste Piles (EU 1B)

During the RI sampling events in 2007 and 2008, composite samples were collected at three unreclaimed waste piles (UAW1, UAW3, and UAW4) in the Upper Anaconda Mine area along with perimeter samples at UAW1 to define the extent of the waste (Figure 7). Three mine features identified in the RI are included within the footprint of EU 1B. Features BR-36 and BR-38 were described in the RI as adits with waste rock pile. A review of field notes from the RI indicated that the adit at BR-36 was caved or reclaimed and part of the waste pile was graded into an old access road adjacent to the feature, and the adit at BR-38 was caved or collapsed. Feature BR-37 was identified as a waste rock pile with a prospect pit. These three features comprise EU 1B.

Comparison of the analytical results for the soil samples collected at the three Upper Anaconda Mine waste piles during the RI against the EU 1B SSCLs in Table 4-1 indicates that arsenic, cadmium, copper, lead, and zinc are present at concentrations above the SSCLs (Figure 16). The estimated total remediation volume is 3,513 cy for the areas of exceedance, assuming a removal depth of 3 feet bgs. The total estimate includes an approximate volume of the above ground surface waste piles (1,050 cy) from the RI. No vegetative cover surveys were completed for these unreclaimed waste piles.

6.1.3 Capital Mine Waste Area (EU 3)

ASARCO and ARCO removed wastes from the Capital Mine Waste Area as an interim action in 1997 that were placed in the Paymaster Repository and the removal area was treated with cement kiln dust, regraded, and revegetated with an upland species mix of fescue, wheatgrass, and bentgrass (Hydrometrics, 1998a). In addition to the waste removal, a 200-foot section of Stevens Creek, which bisects the waste area, was reconstructed and the Capital Mine adit sealed with grout to prevent seasonal discharge. Perimeter samples and a composite sample were collected to define the extent of the waste area (Figure 8). The Capital Mine Waste Area, originally identified as two discrete mine waste removal areas in historical references, was sampled during the RI in 2007 and 2008 as a single area.

A comparison of the analytical results for the soil samples collected at the Capital Mine Waste Area during the RI against the EU 3 SSCLs provided in Table 4-1 indicates that arsenic, copper, lead, and zinc are present in the removal area at concentrations above the SSCLs (Figure 16). The estimated remediation volume is 1,213 cy for the area of exceedance, assuming a removal depth of 2 feet bgs. The extent of impacted media is widespread at the Capital Mine Waste Area and extends slightly into adjacent forested or vegetated areas.

In 2008, the revegetated Capital Mine Waste Area contained 45 percent vegetative cover, 45 percent litter and rock, and 10 percent bare ground. Vegetation was well established and diverse and not significantly different than the lodgepole pine forest reference areas, with no weedy species encountered and no visible signs of erosion present.

6.1.4 Carbonate Mine Waste Area (EU 4)

ASARCO and ARCO removed wastes from the Carbonate Mine Waste Area as an interim action in 1993 and 1994 and placed the waste in the Carbonate Repository. The removal area was backfilled with borrow gravel and cover soil and graded and revegetated with a grass mix predominately comprised of fescue, sloughgrass, and red canarygrass (Hydrometrics, 1995a) to establish a wetland and meadow within the Swamp Gulch drainage. The reclaimed area at the Carbonate Mine was sampled during the RI in 2007 and 2008 (Figure 9).

Comparison of the analytical results for the soil samples collected at the Carbonate Mine Waste Area during the RI against the EU 4 SSCLs in Table 4-1 indicates that arsenic, cadmium, copper, lead, manganese, and zinc are present in the removal area at concentrations above the SSCLs (Figure 17). The extent of impacts is site wide and estimated to be 8,018 cy, assuming a depth of 2 feet bgs.

Results from the 2008 RI investigation indicated the Carbonate Mine waste removal area had 67 percent vegetative cover with 32 percent of the area covered with litter and less than 1 percent bare ground. Sampling transects included the upland transition area as well as the wetland. Standing water was present along some of the sampling transects indicating yearlong inundation. Vegetation was considered to be less established than at the Pass Creek Marsh reference area, and weedy species were encountered. No visible signs of erosion were noted.

6.1.5 Edith Mine Waste Area (EU 5)

In 1995 ASARCO and ARCO removed mine wastes from several waste piles and waste areas at two sites at the Edith Mine and placed the waste in the Mike Horse Repository. Removal locations at both sites, the East Edith and the West Edith, were amended with cement kiln dust, covered with soil, and revegetated with an upland species mix of fescue with one introduced legume, cicer milkvetch (Hydrometrics, 1996). The West Edith removal area was split into two areas, the West Edith Area (WEA) and Central Edith Area (CEA) and sampled along with the East Edith Area (EEA) in 2007 during the RI. Perimeter and composite samples were collected at all three areas to define the extent of the waste (Figure 10).

A comparison of the analytical results for the soil samples collected during the RI at the three Edith Mine waste areas against the EU 5 SSCLs in Table 4-1 indicates that arsenic, copper, lead, and zinc are present in the WEA and CEA removal areas at concentrations above the SSCLs (Figure 17). The estimated remediation volume is 3,115 cy for the areas of exceedance, assuming a removal depth of 2 feet bgs. There were no COC exceedances in any samples collected in the EEA. During the RI, samples were collected from a waste pile in the southernmost area of the CEA. Concentrations of metals in this area (CEA 4) exceeded the RI screening levels for several metals. However, in the FS evaluation, it was determined that CEA 4 is an area of dispersed fine tailings associated with the Blackfoot River floodplain (Figure 6) and is therefore addressed by the EE/CA and not included in the FS analysis for the Edith Mine Waste Area.

The revegetated Edith Mine Waste Area was investigated as three separate areas in 2008, but due to the similarity of the sites and the consistency of vegetation, monitoring results were grouped for the area as a whole. Although surrounded by a mature lodgepole pine forest, the Edith Mine Waste Area is a series of small grassland meadows, not capable of supporting a coniferous forest. The reported 35 percent vegetative cover was significantly less than the grassland meadow reference area in Shave Gulch and the area contained weeds. Wood, litter, and rock covered 59 percent of the area, 6 percent was bare ground, and there were no signs of erosion.

6.1.6 Consolation Mine Waste Area (EU 6)

In 1997 and 1998, ASARCO and ARCO consolidated two waste piles at the Consolation Mine into a prepped adit area as an interim action. The removal areas were regraded, amended with cement kiln dust, covered with soil, and revegetated with an upland species mix of fescue, wheatgrass, and bentgrass (Hydrometrics, 1998a). The two areas of removed waste were combined as one area in the RI and perimeter samples collected to define the extent of the waste area (Figure 11). Two composite samples were collected and a small waste pile in the forest east of the removal area was also sampled. It is unknown whether this small waste pile was part of the original waste removed from the adit during mining activities or part of an exploration pit.

Comparison of the analytical results for the soil samples collected during the RI at the Consolation Mine Waste Area against the EU 6 SSCLs in Table 4-1 indicates that arsenic cadmium, copper, lead, and zinc are present in the removal area at concentrations above the SSCLs (Figure 18). The estimated remediation volume is 4,687 cy for the area of exceedance, assuming a removal depth of 2 feet bgs. The extent of impacted media is widespread at the Consolation Mine Waste Area and traversed by an old access road on the western side.

In 2008, the revegetated Consolation Mine Waste Area contained 14 percent vegetative cover, 68 percent wood, litter, and rock cover and 18 percent bare ground. Vegetation cover at the site was significantly less than the sampled reference area and the area contained weedy species. There were no signs of erosion, but the area contained low levels of organic matter and much of the area within and adjacent to the waste removal showed signs of impact through staining/oxidation and stressed or lack of vegetation. Lodgepole pine existed throughout the removal area.

6.1.7 Mary P Mine Waste Pile (EU 7)

The Mary P Mine Waste Pile, located in a narrow strip of land between Mike Horse Road and a steep hillside, was sampled in 1995 (Figure 12). In 2008, the extent of mine waste was evaluated and perimeter samples collected during the RI. The mine waste appeared to impact adjoining soil at the time of the RI field work.

Comparison of the analytical results for the soil samples collected during the RI at the Mary P Mine Waste Pile against the EU 7 SSCLs in Table 4-1 indicates that arsenic, copper, and lead are present in the removal area at concentrations above the SSCLs (Figure 18). The estimated total remediation volume is 708 cy for the areas of exceedance, assuming a removal depth of 3 feet bgs for the unreclaimed waste. The total estimate includes the estimated volume of the above ground surface waste pile (103 cy) from the RI. The waste pile is limited to the north by Mike Horse Road and to the south, east, and west by the hillside. No vegetative cover surveys were completed for the waste pile.

6.1.8 Mike Horse Mine Waste Area (EU 8)

In 1998, mine wastes at five waste rock dumps (UMH-1, UMH-2, UMH-3, UMH-4, and UMH-5) in the upper Mike Horse Mine area were consolidated, regraded, and amended with lime kiln dust by ASARCO (Hydrometrics, 1998b). The reclaimed areas were covered with local borrow soil and revegetated with an upland species mix of predominately fescue, wheatgrass, and bentgrass (Hydrometrics, 1998a; MFG 1997). Some of the reclamation efforts were determined to be unsuccessful. In 2004 to 2006, ASARCO removed approximately 14,000 cy of mine waste from two of the previously reclaimed waste rock areas (UMH-4 and UMH-5), and in 2007 the areas were reseeded. Removal from the UMH-4 and UMH-5 waste rock areas continued until refusal at the bedrock/ore interface with the waste rock (Hydrometrics, 2004).

Perimeter and composite samples were collected to define the extent of the waste at UMH-1, UMH-2, and UMH-3 in 2007 and 2008 during the RI (Figure 13). The UMH-4 and UMH-5 area were not sampled during the RI, but samples were collected in 2006 following the aforementioned removal. The locations of the 2006 samples are shown on Figure 13 without sample identification. A comparison of the analytical results for the soil samples collected in 2006 and during the RI at the Mike Horse Mine Waste Area against the EU 8 SSCLs provided in Table 4-1 indicates that arsenic, cadmium, copper, lead, manganese, and zinc are present in the removal/reclaimed areas at concentrations above the SSCLs (Figure 19). The estimated total remediation volume is 18,898 cy for the area of exceedance, assuming a removal depth of 2 feet bgs.

In 2008 the revegetated UMH-1, UMH-2, and UMH-3 areas contained significantly less vegetation cover than the reference area. The UMH-1 area had 40 percent vegetative cover and 49 percent wood, litter, and rock. Approximately 11 percent of UMH-1 was bare ground with a lack of fine soil particles and organic matter. Vegetation at UMH-2 was sparse at 15 percent cover, with litter and rock comprising 59 percent, and bare ground the remaining 26 percent. The UMH-3 area had 28 percent vegetative cover, 45 percent wood, litter, and rock cover and 27 percent bare ground. The upper Mike Horse Mine Waste Area showed signs of impacts through the presence of staining/oxidation, stressed vegetation, and/or the lack of vegetation.

The extent of impacted media is widespread at the upper Mike Horse Mine Waste Area. All five waste areas are located in the fairly steep and narrow drainage of the Mike Horse Creek; the creek flows through the western portion of UMH-2 and along the eastern edge of UMH-5. Pioneer personnel noted during site visits in 2013 that each of the previously reclaimed waste rock dump areas is prone to surface erosion from run-on/runoff events attributed to the steepness of the slope and lack of vegetation. Pioneer observed areas of subsidence in UMH-1 and UMH-2 likely due to the close proximity of underground workings to the surface.

6.1.9 Paymaster Mine Waste Areas Surface (EU 9A)

In 1996 ASARCO and ARCO removed three waste pile areas at the Paymaster Mine and placed the waste into the Paymaster Repository as an interim action. Two of the removal areas were regraded, amended with lime kiln dust, covered with soil, and revegetated with an upland species mix of predominately fescue, wheatgrass, and bentgrass (Hydrometrics, 1998a; MFG, 1997). Perimeter and composite samples were collected in 2007 and 2008 at the two reclaimed areas (PMWA1 and PMWA2) to define the extent of the waste (Figure 14). These two areas comprise EU 9A. The third removal area was reconstructed as a wetland treatment system and is included in EU 9B.

In 2008, the revegetated Paymaster sites were investigated and contained 27 percent (PMWA1) and 36 percent vegetative cover (PMWA2). Both had significantly lower percent vegetation cover than the reference area, with litter as the dominant non-vegetated cover at 65 and 58 percent, respectively. Bare ground covered 8 percent at PMWA1 and 6 percent at PMWA2. Lodgepole pine regeneration existed on the south side of the area and there were no signs of erosion.

Comparison of the analytical results for the surface soil samples collected during the RI at the Paymaster Mine Waste Area against the EU 9A SSCLs in Table 4-1 indicates that copper is present in the removal area at concentrations above the SSCL (Figure 19). The estimated remediation volume is 862 cy for the areas of exceedance, assuming a removal depth of 2 feet bgs.

6.1.10 Paymaster Mine Waste Area Subsurface (EU 9B)

ASARCO and ARCO constructed a passive wetland treatment system in an area of removal at the Paymaster Mine to capture seasonal flow from the Paymaster adit through a collection system. The system was comprised of a pair of passive wetland treatment cells and an adit drainage collection system (piping and vault) that was combined with collapsing the adit opening. Interim actions also included the rerouting and reconstruction of Paymaster Creek around the new passive wetland treatment system. No water was discharged from the passive wetland and its use was discontinued. Subsurface soil samples were collected from test pits in Cell B (Figure 14).

Comparison of the analytical results for the subsurface soil samples collected during the RI against the EU 9B SSCLs in Table 4-1 indicates that arsenic and iron are present in the removal area at concentrations above the SSCLs (Figure 19). The estimated remediation volume for Cell B is 1,178 cy for the areas of exceedance, assuming a removal depth of 4 feet bgs. Although not sampled because it has a geosynthetic liner, for the purposes of this FS it is assumed that Cell A exhibits SSCL exceedances similar to Cell B and is included for a total exceedance volume estimate of 3,801 cy.

Sample results for Cell B indicate that concentrations remained relatively constant over sampling depths. During the RI test pit sampling, the encountered native material was compact and cementitious in nature, possibly the result of iron-oxide precipitation. Findings presented in the RI with regards to the Paymaster Wetland cells are summarized as follows (Tetra Tech, 2013a):

> "Results for groundwater samples collected in 2007 and 2008 from the Paymaster constructed wetlands downgradient monitoring wells indicated no detection of arsenic concentrations at or above the laboratory Practical Quantitation Limit (PQL). These data suggest that although the native soil horizon is enriched in arsenic (and potentially other trace metals), arsenic and other metals have likely adsorbed to or co-precipitated with iron-complexes and may also be bound with organics within the soil. Reducing conditions present in the groundwater system likely minimize mobility of many metals thereby reducing impacts to groundwater. Maintaining the current subsurface geochemical/oxidation state conditions in the vicinity of the Paymaster Constructed Wetland system is likely essential to limiting widespread deposition of ferrous iron (as ferric-hydroxide precipitates and the formation of ferricrete deposits) and increased metal mobility of at least arsenic and possibly other metals."

6.1.11 No. 3 Tunnel Mine Waste Area (EU 10)

ASARCO and ARCO removed mine wastes at the No. 3 Tunnel Mine in 1996 and placed the waste in the Paymaster Repository. The removal areas were amended with lime kiln dust, covered with soil and revegetated with an upland species mix of predominately fescue, wheatgrass, and bentgrass (Hydrometrics, 1998a; MFG, 1997). Perimeter samples and three composite samples were collected in 2007 to define the extent of the waste area during the RI (Figure 15).

Comparison of the analytical results for the soil samples collected at the No. 3 Tunnel Mine Waste Area against the EU 10 SSCLs in Table 4-1 indicates that arsenic, copper, iron, and zinc are all present in the removal area at concentrations above the SSCLs (Figure 20). Manganese was detected above SSCLs in a single sample (N3TA - Pile #1); however GPS coordinates were not recorded in the RI for the sample location and this exceedance is not represented on Figure 20. The estimated remediation volume is 2,184 cy for the area of exceedance, assuming a removal depth of 2 feet bgs.

In 2008, the revegetated No. 3 Tunnel Mine Waste Area was well established and diverse with 42 percent vegetative cover. Litter dominated the non-vegetative cover at 48 percent, with bare ground covering 7 percent and rock covering 3 percent. Vegetation cover at the site was not significantly different than the sampled reference area and the area contained weedy species. Small lodgepole pines existed throughout the removal area, but there were no signs of erosion.

6.1.12 Summary of EA 1 Remediation Volume Estimates

Remediation volume estimates for locations within EA 1 at the UBMC requiring remedial actions based on the SSCLs are summarized in Table 6-1.

Table 6-1 Remediation Volume Estimates for EA 1 - Upland Wastes

UBMC Location	Volume Exceeding SSCLs			
	Mine Waste/ Impacted Soil[1]	Sediment	Surface Water	Groundwater
Upper Anaconda Mine Waste Area (EU 1A)	10,782 cy	N/A[2]	N/A	See §6.2.1
Upper Anaconda Mine Waste Piles (EU 1B)	3,513 cy	N/A	N/A	N/A
Capital Mine Waste Area (EU 3)	1,213 cy	N/A	N/A	See §6.2.2
Carbonate Mine Waste Area (EU 4)	8,018 cy	N/A	N/A	See §6.2.3
Edith Mine Waste Area (EU 5)	3,115 cy	N/A	N/A	N/A
Consolation Mine Waste Area (EU 6)	4,687 cy	N/A	N/A	N/A
Mary P Mine Waste Pile (EU 7)	708 cy	N/A	N/A	N/A
Mike Horse Mine Waste Area (EU 8)	18,898 cy	N/A	N/A	See §6.2.4
Paymaster Mine Waste Areas Surface (EU 9A)	862 cy	N/A	N/A	See §**Error! Reference source not found.**
Paymaster Mine Waste Area Subsurface (EU 9B)	3,801 cy	N/A	N/A	See §**Error! Reference source not found.**
No. 3 Tunnel Waste Area (EU 10)	2,184 cy	N/A	N/A	N/A
Total	**57,781 cy**	---	---	---

[1]All volumes are to a depth of 2 feet bgs, except for EU 1B and EU 7 at 3 feet bgs and EU 9B at 4 feet bgs.
[2] N/A - Not a media of concern based on the RI.

6.2 *Evaluation Area 2 - Groundwater*

Groundwater is evaluated in EA 2 and includes the following features:

- Anaconda Mine (EU 1) Adit Discharge
- Capital Mine (EU 3) Adit Plug
- Carbonate Mine (EU 4) Groundwater
- Mike Horse Mine (EU 8) Adit Discharge and Seeps
- Upper Mike Horse Mine (EU 8) Bedrock Aquifer

6.2.1 Anaconda Mine (EU 1) Adit Discharge

The Anaconda Mine adit closure and discharge collection system was originally constructed by ASARCO and ARCO in 1996 to 1997 to convey flows from the adit to the WWTS. This system was modified by ASARCO with construction of the WTP in 2009, and water discharges from the Anaconda Mine (Figure 7) are currently piped directly to the WTP feed tank. The flow is continuously monitored using a magnetic flowmeter installed in the pipeline. The flow rate varies, but the average flow is approximately 4.1 gpm, with the peak flow at 10 gpm. Average water quality parameters, including COCs reported in milligrams per liter (mg/L), for the adit flow were measured in 2008 and included in the *Final Design Report for the Upper Blackfoot Mining Complex Water Treatment Plant* (CDM, 2008) and are summarized in Table 6-2.

Table 6-2 Anaconda Mine Adit Discharge COC Concentrations

	Contaminant of Concern (mg/L)							
	Al	As	Cd	Cu	Fe	Pb	Mn	Zn
Average	6.1	**0.014**	**0.027**	**2.804**	**35.2**	**0.136**	**13.8**	**5.1**

Bold values exceed groundwater SSCLs (Table 4-2 Summary of Groundwater SSCLs).

Measured pH for the adit water was 3.87. Adit groundwater COC concentrations exceeded DEQ-7 human health standards for arsenic, cadmium, copper, lead, and zinc and SSCLs for iron and manganese. A flow estimate of 4.1 gpm of impacted groundwater to the WTP was assumed for the adit to develop remedial alternatives. The WTP processes are described in Sections 7.5.7 and 7.5.8.

6.2.2 Capital Mine (EU 3) Adit Plug

As discussed in Section 2.3.2, an adit at the Capital Mine site (Figure 8) was plugged with a grout seal to reduce seasonal discharge of water from the adit as an interim action in 1997. The adit was collapsed and backfilled. A surface water sample collected from the adit flow prior to plugging exceeded DEQ-7 standards for aluminum, cadmium, copper, iron, lead, manganese, and zinc (Tetra Tech, 2007). Post-removal samples were not collected because the adit seal prevented adit discharge. There was no flow rate mentioned in the 1997 Activities Report summarizing the interim action (Hydrometrics, 1998a) nor was there any mention of the former adit condition in the RI field notes. The Capital Mine adit is included in the analysis of remedial alternatives, however no estimate of impacted groundwater flow was assumed.

6.2.3 Carbonate Mine (EU 4) Groundwater

Groundwater at the Carbonate Mine was not addressed as an interim action, and the source of elevated metals concentrations, whether natural or mining related, was identified as a data gap in the RI (Tetra Tech, 2013a). Groundwater samples collected in 2007 and 2008 at the Carbonate Mine during the RI exceeded groundwater SSCLs for several COCs (Table 6-3).

Table 6-3 Carbonate Mine Groundwater COC Concentrations

Sampling Location	Contaminant of Concern (mg/L)							
	Al	As	Cd	Cu	Fe	Pb	Mn	Zn
LCMW-1 (alluvial)								
Oct 2007	<0.03	<0.002	**0.00965**	0.019	0.04	<0.0005	0.119	0.2
June 2008	<0.03	<0.002	0.00325	0.02	0.17	<0.0005	0.122	0.2
LCMW-5 (alluvial)								
Oct 2007	1.83	<0.002	**0.1562**	0.761	**15.79**	**0.0342**	**20.01**	**6.78**
July 2008	3.22	<0.002	**0.1775**	**1.375**	6.52	**0.0602**	**13.14**	**7.53**
LCMW-12S (alluvial)								
Oct 2007	<0.03	0.004	0.00009	<0.001	**45.23**	<0.0005	**28.88**	0.57
July 2008	<0.03	0.004	<0.00008	<0.001	**46.99**	<0.0005	**34.14**	0.56
LCMW-12D (bedrock)								
Oct 2007	<0.03	<0.002	**0.01923**	0.029	**43.8**	<0.0005	**39.16**	1.26
July 2008	<0.03	<0.002	**0.00576**	0.004	10.16	0.006	**13.52**	0.48
UCMW-11 (bedrock)								
Oct 2007	0.14	<0.002	<0.00008	0.002	**20.72**	<0.0005	**62.9**	<0.01
July 2008	**21.06**	<0.002	**0.04187**	0.004	9.5	0.0006	**39.94**	**16.54**

Bold values exceed groundwater SSCLs (Table 4-2 Summary of Groundwater SSCLs).

A Conceptual Site Model (CSM) was prepared with the available information to date to better understand the groundwater at the Carbonate Mine. The CSM is discussed in Section 6.2.3.3; figures and tables referenced in this section are included in Appendix B.

6.2.3.1 Current Surface Water Conditions

The surface water system at the Carbonate Mine site appears to lose surface water to groundwater. Low flow data collected at BRSW-14 and BRSW-15 (Figure 21) suggest that during pre-interim action low flow conditions in 1991, lower Swamp Gulch lost approximately 6.5 gpm between surface water stations BRSW-14 and BRSW-15, while post-interim action low flow measurements in 1999 suggest that lower Swamp Gulch lost approximately 13.6 gpm (Figure B-1; Table B-1).

The corresponding surface water quality data collected from 1991 (pre-interim action) to 1999 (post-interim action) suggest that the interim action effort at the Carbonate Mine resulted in significant improvements in surface water quality, including decreased concentrations of aluminum, cadmium, iron, lead, manganese, and zinc, and increased field pH (Figures B-2 to B-8). It is likely that because lower Swamp Gulch loses water to the aquifer, minimal groundwater is discharged as surface water. While these surface water results are promising, the more recent increases in groundwater concentrations observed in 2010 and 2011 (discussed in Section 6.2.3.2) suggest that surface water data should be collected in conjunction with groundwater data to determine if surface water quality at the Carbonate Mine site has changed. Since 2010 and 2011 were unusually high runoff years, it is unclear if these changes may be attributable to the associated increases in flow.

6.2.3.2 Current Groundwater Conditions

The Carbonate Mine area exhibits Class II groundwater characteristics (ARM 17.30.1006). Locations of groundwater monitoring wells at the Carbonate Mine site and a shallow groundwater potentiometric surface are shown on Figure 21. This potentiometric surface extends to the approximate alluvium/bedrock interface depicted in *Geologic Map of the Rogers Pass Area* (USGS, 1987). The potentiometric surface does not include water level data from bedrock monitoring well UCMW-11 or deep monitoring wells LCMW-12D, PDGW102, or PMGW-119. Bedrock wells and deep alluvial wells were segregated from the surface because of variation in vertical gradient between the paired alluvial wells and the large seasonal fluctuation at the Carbonate Mine site, as observed in the bedrock aquifer at monitoring well UCMW-11. As shown on Figure B-15 in Appendix B, the typical gradient of groundwater within the alluvial aquifer at monitoring well pair LCMW-12S and LCMW-12D is upward. Additionally, the groundwater elevation within the bedrock aquifer tends to be significantly lower than alluvial groundwater elevations during base flow portions of the calendar year (i.e., August through April) and equal to or higher in elevation during runoff portions of the calendar year (i.e., May through July).

Current metals concentration data from 2010 through 2013 indicate that dissolved concentrations of cadmium, lead, and zinc have increased to levels similar to the mid-1990s, while dissolved concentrations of iron and manganese have steadily decreased (Figures B-9 to B-13). In conjunction with the increasing metals concentrations, the pH at several groundwater monitoring locations has decreased (Figure B-14). When compared with groundwater data collected from 2000 to 2009 where concentrations of cadmium, lead, iron, and zinc were near or below the DEQ-7 standards, the more recent data suggest that the groundwater at the Carbonate Mine has increased concentrations of metals.

Collected samples exhibit several metal concentrations above DEQ-7 standards, and recent pH values from monitoring wells (LCMW-5, LCMW-12D, and UCMW-11, with pH ranges between 3.9 and 5.8) as well as temperature values (LCMW-5 at 18 °C), suggest that acid generation may be occurring in some locations within the Carbonate Mine site.

6.2.3.3 Carbonate Conceptual Site Model

The Carbonate CSM uses available data from the Carbonate Mine site including surface water (Swamp Gulch) flow data, current groundwater potentiometric surface data, and metals data from surface water (total metals analysis per DEQ-7) and groundwater (dissolved metals analysis per DEQ-7) samples. The CSM was used to estimate the net dissolved metals concentration increases in the downgradient Blackfoot River and/or downgradient monitoring well(s) that could be attributed to the Carbonate Mine site. Dissolved metals analysis is used, instead of total metals analysis, because most of the Swamp Gulch water enters the Blackfoot River as groundwater. The Swamp Gulch surface water is adsorbed by the Upper Marsh complex before it can form a physical confluence with the Blackfoot River. By comparing the upstream dissolved cadmium concentrations in the Blackfoot River with the dissolved cadmium concentrations in the Blackfoot River near the Carbonate Mine, a determination can be made whether or not dissolved cadmium is entering the Blackfoot River from this area.

The CSM suggests that contributions of groundwater from the Carbonate Mine site are impacting downgradient groundwater and the Blackfoot River. Specifically, it appears that concentrations of cadmium from the Carbonate Mine site may be increasing dissolved cadmium concentrations in the Blackfoot River.

6.2.3.3.1 Estimation of Net Concentration Increase in the Blackfoot River

To estimate the net dissolved metals concentration increases in the downgradient Blackfoot River and/or downgradient monitoring well(s) that could be attributed to the Carbonate Mine site, two steps were completed. The first step estimates what concentrations of dissolved metals might be anticipated in the downgradient surface water and groundwater, while the second step uses sampling data to identify any measurable downgradient increases of dissolved cadmium from the Carbonate Mine site.

<u>Step 1: Blackfoot Constituent of Concern Estimate Using Carbonate CSM</u>

The first step estimates what concentrations of dissolved metals might be anticipated in the downgradient reach of the Blackfoot River using groundwater and surface water data from the Carbonate area, the Carbonate CSM, and dissolved metals attenuation estimates from Dolhopf (Dolhopf, 1988). This step uses the CSM estimate for the total mass of dissolved metals leaving the Carbonate Mine Waste Area on a per-day basis during base flow conditions, site-specific estimates of dissolved metals attenuation (Dolhopf, 1988) to estimate the total mass of dissolved metals attenuated by the wetlands located downgradient of the Carbonate Mine site, and assumes that the remaining mass of dissolved metals not removed by the wetlands enters the Blackfoot River (Table B-1). In all cases, the most complete, site-specific synoptic base flow sampling data sets were used, represented by the data sets collected in November 1994 and October 1995.

To estimate the net dissolved metals concentration increase at the Blackfoot River, the estimated flow and metals load from the Carbonate CSM (Table B-1) was mixed with an average base flow and hardness in the Blackfoot River. This estimate includes the following assumptions:

1) All the groundwater leaving the Carbonate Mine site discharges to the Blackfoot River.
2) The synoptic base-flow data sets selected (November 1994 and October 1995) are representative of current groundwater flow and groundwater quality within the Carbonate Mine site.
3) The metals load leaving the Carbonate Mine site is attenuated by the downgradient wetlands prior to discharging into the Blackfoot River. The assumption that these wetlands have a net attenuation efficiency of dissolved metals was determined by Dolhopf (Dolhopf, 1988) during a site-specific investigation of these wetlands, as

follows: cadmium (0.3 percent), copper (14 percent), iron (70 percent), lead (100 percent), manganese (0.7 percent), and zinc (5.8 percent).

Because this estimate does not account for dispersion and/or mixing with downgradient groundwater, the estimated contribution of dissolved metals to the Blackfoot River from the Carbonate Mine site is likely overestimated, and is therefore conservative.

Dolhopf estimated the attenuation of dissolved metals leaving the Carbonate Mine site (assumption number 3, above) by comparing the estimated 1988 load of lead entering the Lower Marsh wetland (1.2 pounds) to the estimated mass of lead sorbed to wetland matter within the Lower Marsh wetland (2,900 pounds). Dolhopf further assumed that lead is 100 percent attenuated by Lower Marsh wetland, and used this assumption to estimate that dissolved lead had been attenuating in the Lower Marsh wetland for 2,350 years. With this timeline, Dolhopf used the ratio of pounds of other dissolved metals (i.e., cadmium, copper, iron, lead, manganese, and zinc) entering the wetland to the pounds of the respective metals sorbed to wetland matter to estimate the percent attenuation of each dissolved metal through sorption onto wetland matter. Data collected under this investigation suggest that the portion of the wetland that was most effective at removing dissolved metals was the shallower portion of peat with living plants (i.e., the acrotelm). Even in this portion of the wetland, the study indicated limited removal of cadmium, zinc, and manganese (Dolhopf, 1988).

To estimate the net effect of the downgradient wetland attenuation on the dissolved metals load from the Carbonate Mine site, the percent attenuation of dissolved metals load (Dolhopf, 1988) was multiplied by the estimated dissolved metals load leaving the site (Table B-1), as follows:

$$\{DM_{out}\} = \{DM_{in}\} \text{ x } A_{LM} \qquad \text{(Equation 1)}$$

Where:

$\{DM_{out}\}$	=	Concentration of dissolved metals in groundwater flowing out of Lower Marsh (pounds per day [lbs/day])
$\{DM_{in}\}$	=	Influent load of dissolved metals flowing into Lower Marsh (lbs/day)
A_{LM}	=	Attenuation percentage of dissolved metals by the Lower Marsh wetland, as estimated by Dolhopf (%)

Based on the calculation provided in Equation 1, estimates of the dissolved metals load leaving the downgradient Lower Marsh wetlands in groundwater are listed in Table 6-4.

Table 6-4 Carbonate Mine COC Mass Balance

	Contaminant of Concern (lbs/day)					
	Cd	**Cu**	**Fe**	**Pb**	**Mn**	**Zn**
Entering the Carbonate Mine alluvial aquifer	0.00156	0.00089	0.90	0.00047	0.68	0.14
Leaving the downgradient Lower Marsh wetlands in groundwater	0.0074	0.0138	2.9	0.0	6.9	0.35

To complete the first step, the attenuated dissolved metals loads from the Carbonate Mine site from Table 6-4were mixed with the average base flow in the Blackfoot River to estimate the potential net increase of dissolved metal concentrations in the Blackfoot River. The following equation was applied to estimate the net gain in dissolved metals concentration in the Blackfoot River under an assumed base flow (2.6 cubic feet per second [cfs]) conditions with an assumed hardness of 87.5 mg/L (Table B-1):

$$\{COC\}_{BR} = \left(load_{Out} \times \frac{453{,}592mg}{1\,lb} \times \frac{0.0353cf}{1L}\right) \div \left((Baseflow_{BR} + Carbonate_{GW}) \times 1440\frac{min}{day} \times \frac{1\,cf}{7.48gal}\right) \quad \text{(Equation 2)}$$

Where:

$\{COC\}_{BR}$	=	Estimated net increase in Blackfoot River ($_{BR}$) dissolved metals concentration from discharge of carbonate groundwater (mg/L)
$\{Load_{Out}\}$	=	Total Carbonate Mine site groundwater dissolved metals load attenuated by the Lower Marsh wetlands and discharging to the Blackfoot River (lbs/day)
$Baseflow_{BR}$	=	Estimated average Blackfoot River base flow (gpm)
$Carbonate_{GW}$	=	Base flow groundwater ($_{GW}$) from carbonate (gpm)

As mentioned previously, this estimate does not take into account dilution with downgradient sources of groundwater, dispersion, or additional attenuation processes. Based on the calculation provided in Equation 2, Table 6-5 shows the estimates of net dissolved metal concentration increases in the Blackfoot River. In comparison to hardness-adjusted DEQ-7 standards (adjusted to an average Blackfoot River base flow hardness of 87.5 mg/L), the estimated contributions of dissolved metals from the Carbonate Mine site to the Blackfoot River represent the net percentage increase in dissolved metals listed in Table 6-5.

Table 6-5 Potential COC Increases from Carbonate Mine to Blackfoot River

	Contaminant of Concern (mg/L)					
	Cd	Cu	Fe	Pb	Mn[1]	Zn
Carbonate Mine to Blackfoot River	0.00051	0.00095	0.204	0	0.47	0.024
Comparison to DEQ-7[2]	209%	11%	20%	--	110%	23%

[1] Surface water SSCL (Table 4-3).
[2] Chronic aquatic standard adjusted to a hardness of 87.5 mg/L.

Based on these calculations and assumptions, the primary metal of concern at the Carbonate Mine site is cadmium, followed by zinc, iron, and copper. Furthermore, the fen wetlands located downgradient of the Carbonate Mine significantly reduce the concentrations of lead and iron in groundwater. Based on the estimates above, if DEQ-7 surface water standards are to be met in the Blackfoot River, the net contribution of cadmium from the Carbonate Mine site must be reduced. This estimate was cross-checked in the following Step 2 comparison, which determined if these estimated net increases in dissolved cadmium concentrations were observable in the downgradient Blackfoot River and/or monitoring wells.

Step 2: Compare Step 1 Estimate with Dissolved Cadmium Concentrations in the Downgradient Blackfoot River and Monitoring Wells

The second step involves comparing the estimates of net dissolved cadmium concentration increases from Step 1 with existing water quality monitoring data from the adjacent reach of the Blackfoot River and monitoring wells located downgradient of the Carbonate Mine site. Step 2 is intended to cross-check the estimate provided in Step 1 and to determine if any detectable increases in cadmium concentrations or load are indicated during base flow conditions.

The underlying assumption for the analysis in Step 2 supposes that if 14.2 gpm (0.03 cfs) of groundwater with 0.007 lbs/day of cadmium were to upwell into approximately 2.6 cfs of Blackfoot River water, the gain in flow would likely not be observable (i.e., 0.03 cfs would be within the measurement error of the flow measurement technique), but a gain in cadmium concentration of approximately 0.5 µg/L would likely be detectable. Similarly, an increase in the cadmium concentration in a downgradient monitoring well adjacent to the Blackfoot River (LCMW-1) would likely be detectable.

To accomplish this evaluation, the Step 2 process compared the following:

1) Flow, cadmium concentration, and cadmium load between upstream station BRSW-12 and downgradient station BRSW-31 for seven available base flow sampling events (Figure B-16).
2) Upgradient station BRSW-107 to downgradient station BRSW-106 for one available base flow sampling event (Figure B-16).

The first comparison used BRSW-12 and BRSW-31 with seven base flow sampling events between October 1998 and October 2004. Station BRSW-12 is located approximately 0.9 miles upstream of station BRSW-31, and along this reach are four tributaries to the Blackfoot River: Pass Creek, Paymaster Gulch, Meadow Creek, and Porcupine Gulch (Figure B-16).

For the seven sets of base flow data (flow and water quality) along the Blackfoot River at stations BRSW-12 and BRSW-31 (measured flow less than 5 cfs was assumed to reflect base flow conditions for this analysis), the average gain along this reach was approximately 0.5 cfs and the average reduction in cadmium concentrations was 2.7 µg/L. The net load at each station was determined using Equation 3:

$$Load_{BRSW-12} = \left[\left(\{COC\}_{BRSW-12} \times \frac{1\,lb}{453{,}592mg} \times \frac{28.3169L}{1\,cf}\right) \times \left(Q_{BRSW-12} \times \frac{86{,}400\,sec}{day}\right)\right] \qquad \text{(Equation 3)}$$

Where:

$\{COC\}_{BRSW-12}$ = Average dissolved cadmium concentration (mg/L) for the available data during base flow at Blackfoot River station BRSW-12

$Q_{BRSW-12}$	=	Average recorded base flow (i.e., flows below 5 cfs) at Blackfoot River station BRSW-12 (cfs)
$Load_{BRSW-12}$	=	Estimated average Blackfoot River load (lbs/day)

Using Equation 3, the average dissolved cadmium concentration and load for base flow data (i.e., Blackfoot River flows less than 5 cfs) at BRSW-12 was 0.0039 mg/L and 0.41 lbs/day, respectively; the average dissolved cadmium concentration and load at BRSW-31 was 0.0012 mg/L and 0.14 lbs/day. These results indicate a net average reduction in dissolved cadmium loading during base flow between these stations of 0.27 lbs/day. These data suggest that the Blackfoot River is not gaining appreciable cadmium concentrations between these two stations; however, significant issues may be influencing these results. Given the extended distance between the stations and the presence of four tributaries contributing to the Blackfoot River between the two stations, local gains and losses of flow could be occurring between these two stations (Figure B-16), and these stations likely do not represent conditions directly upstream and downstream of groundwater discharges from the Carbonate Mine site. However, the data indicate a decrease in cadmium concentrations and load from upstream monitoring location BRSW-12 to downstream monitoring location BRSW-31.

In addition to stations BRSW-12 and BRSW-31, upstream station BRSW-107 and downstream station BRSW-106 were sampled once during base flow conditions on October 4, 2007 (Figure B-16). These two stations bracket the Carbonate Mine site more effectively, with 0.4 miles separating the two stations and one tributary (Porcupine Gulch) entering the reach. Using Equation 3, the flow, concentration, and load was calculated at 3.5 cfs, 0.0023 mg/L, and 0.043 lbs/day, respectively, for the upstream station BRSW-107 and 3.04 cfs, 0.00193 mg/L, and 0.032 lbs/day, respectively, at downstream station BRSW-106. Between these two stations, the Blackfoot River lost approximately 0.5 cfs (13 percent of the total flow), the cadmium concentrations decreased approximately 0.00035 µg/L (15 percent of the cadmium concentration), and the cadmium load decreased by 0.011 lbs/day (26 percent of the total load). These surface water data also suggest no apparent increase in load in the Blackfoot River from the Carbonate Mine site.

Because no apparent increase in dissolved cadmium concentration or load was apparent in the Blackfoot River from the Carbonate Mine site, this analysis also evaluated downgradient monitoring well data. Based on a groundwater potentiometric surface map generated using 2008 monitoring data, monitoring well LCMW-1 appears to be located downgradient of the Carbonate Mine site (Figure B-17). Assuming this interpretation is correct, groundwater from the Carbonate Mine site reaches the Blackfoot River near surface water stations BRSW-107 and BRSW-101, as well as monitoring well LCMW-1.

At monitoring well LCMW-1, the dissolved cadmium concentrations from 1992 to 1997 are similar to the cadmium concentrations within the Blackfoot River water (Figure B-18); in 2007, the dissolved cadmium concentration in LCMW-1 groundwater increased to approximately 10 µg/L. This concentration is significantly higher than dissolved cadmium concentrations in the Blackfoot River and upstream groundwater concentrations (i.e., monitoring wells UMPZ-1, UMPZ-2, and UMPZ-3), but lower than the estimated dissolved cadmium concentration of 44 µg/L at the downgradient edge of the Carbonate Mine site (Table B-1) and suggests the following:

1) The Carbonate Mine site appears to be contributing a dissolved cadmium load that is sufficient to increase the dissolved cadmium concentrations at monitoring well LCMW-1.
2) The effective reduction in dissolved cadmium concentrations between the downgradient edge of the Carbonate Mine site and monitoring well LCMW-1 suggests an attenuation rate that is significantly higher than the rate determined by Dolhopf (Dolhopf, 1988) of 0.30 percent (Table B-1); and the combined effects of attenuation, dissolution, and mixing with downgradient groundwater likely decreases downgradient dissolved concentrations of cadmium by up to 80 percent.

6.2.3.4 Conclusions

Based on this two-step process comparing estimated Carbonate Mine site dissolved metals loading to any apparent dissolved metals concentration increases in the downgradient Blackfoot River and monitoring wells, the data suggest that while the Blackfoot River does not appear to be gaining any appreciable dissolved cadmium concentrations, the Carbonate Mine site does appear to contribute a dissolved cadmium load that is sufficient to increase the dissolved cadmium concentrations in downgradient monitoring well LCMW-1.

Furthermore, the estimated attenuation factors (Dolhopf, 1988) assume minimal attenuation of cadmium in groundwater (0.3 percent) as it travels from the Carbonate Mine site, through the Lower Marsh wetlands, and into the Blackfoot River. While the attenuation rate by the wetland matter may be accurate, it is likely that the combined dilution/dispersion/attenuation factor is significantly higher, and could approach upwards of 80 percent reduction of dissolved cadmium concentrations. It is possible that additional attenuation of dissolved cadmium is occurring in groundwater, at the groundwater-surface water interface, or in the Blackfoot River. A flow estimate of 14.2 gpm of impacted groundwater is assumed for the Carbonate Mine to develop the remedial alternatives.

6.2.4 Mike Horse Mine (EU 8) Adit Discharge and Seeps

The Mike Horse Mine site includes a groundwater/adit plug that was constructed as an interim action in 1994 to control adit flow and convey it to the WWTS. Two new seep collection systems were constructed in 2008 during the construction of the new WTP, and water from these seep collection systems is conveyed to the WTP. The upper Mike Horse seep collection system collects impacted groundwater from the upper Mike Horse Mine waste rock areas. Captured water is pumped from a constructed vault back into the Mike Horse 200-level adit for flow equalization and to precipitate aluminum inside of the mine workings.

The Mike Horse Repository seep capture system collects water from a seep at the toe of the repository that exceeds discharge limits for cadmium, copper, and lead. The seep water is routed to the WTP. During spring runoff, the capture system collects water not intended for treatment. Surface water runoff from snow melt flows into the capture trench and runs down to the vaults causing groundwater to run into the vaults around the outside of the conduit penetrations (Roll, 2013). Because of these runoff issues, it is questionable if the system is completely capturing seepage from the site in its current configuration. The ongoing EE/CA removal action and the ongoing interim action at the Mike Horse (Section 5.2) involve significant work that is intended to alleviate some of these issues and includes the following:

- Removal of the Mike Horse Repository.
- Removal of remaining waste within the Mike Horse Creek channel and floodplain down to the alluvial/bedrock interface.
- Construction of a seal to minimize the infiltration of surface water into mine workings and the bedrock aquifer.
- Reconstruction of the Mike Horse Creek channel and floodplain.
- Reconstruction and modification of the seep capture system.

Average water quality parameters for the adit and seeps were measured in 2008 in the WTP Final Design Report (CDM, 2008) and are summarized in

Table 6-6.

Table 6-6 Mike Horse Adit and Seep Water Quality Parameters

	Parameter				
	Flow (gpm)	pH	Sulfate (mg/L)	Conductivity (µS/cm)	Hardness (mg/L CaCO3)
Mike Horse Adit Average	35	5.9	2417	5805.7	2327.5
Mike Horse Creek Seep Average	10	4.3	1676	3448	242.8
Mike Horse Repository Seep Average	10	6.4	141	557.4	227.4

Average COC concentration for the adit and seeps (CDM, 2008) are summarized in Table 6-7.

Table 6-7 Mike Horse Adit and Seep COC Concentrations

	Contaminant of Concern (mg/L)							
	Al	As	Cd	Cu	Fe	Pb	Mn	Zn
Mike Horse Adit, Average	0.7	**0.017**	**0.1**	**1.5**	**121.2**	**0.2**	**69.3**	**79.3**
Mike Horse Creek Seep, Average	**85.3**	**0.012**	**1.15**	**41.2**	1.5	**1.82**	**66.5**	**132.0**
Mike Horse Repository Seep, Average	0.26*	<0.005*	**0.012**	0.011	0.54*	**0.068**	0.7	**3.3**

Bold values exceed groundwater SSCLs (Table 4-2 Summary of Groundwater SSCLs).
*Seep average concentrations for Al, As, and Fe were included in later seep analysis (Anderson, 2008).

Adit and seep groundwater COC concentrations exceed DEQ-7 standards for arsenic, cadmium, copper, lead, and zinc and SSCLs for aluminum, iron, and manganese. Flow rates vary for each of these sources, with the maximum flow from the repository seep of approximately 42.7 gpm occurring on May 17, 2011 (Roll, 2013). However, some of this variability is expected to improve following the interim action at the Mike Horse. A total average design flow estimate of 55 gpm of impacted groundwater to the WTP is assumed for the adit and seeps for purposes of developing remedial alternatives. The WTP processes are described in Section 7.5.7 and Section 7.5.8.

6.2.5 Upper Mike Horse Mine (EU 8) Bedrock Aquifer

The Mike Horse Mine area exhibits Class II groundwater characteristics (ARM 17.30.1006). The groundwater in the upper Mike Horse Mine bedrock aquifer was sampled during the RI (Figure 22). Water quality in this aquifer is affected by the mineralized ore body, the extensive network of mine workings, and interaction with surface water via the mine workings. Water quality data from the RI is summarized in Table 6-8.

Table 6-8 Upper Mike Horse Groundwater COC Concentrations

Sampling Location	Contaminant of Concern (mg/L)							
	Al	As	Cd	Cu	Fe	Pb	Mn	Zn
MHMW-8 (bedrock)								
Oct 2007	<0.03	<0.002	**0.06788**	0.05	0.03	0.0006	0.059	**14.9**
July 2008	<0.03	<0.002	**0.0669**	0.046	<0.03	0.0009	0.033	**18.21**
UMHMW-1S (alluvial)								
Oct 2007 (Dry)	--	--	--	--	--	--	--	--
July 2008	**58.52**	0.006	**1.061**	**46.5**	0.05	**1.01**	**148.8**	**194.8**

Sampling Location	Contaminant of Concern (mg/L)							
	Al	As	Cd	Cu	Fe	Pb	Mn	Zn
UMHMW-2S (alluvial)								
Oct 2007	**54.55**	0.003	**1.209**	**50.4**	0.12	**1.191**	**66.05**	**149**
July 2008	**21.58**	0.005	**0.6406**	**27.38**	0.12	**0.7229**	**37.36**	**83.7**
MW-1 (bedrock)								
Oct 2007	<0.03	<0.002	0.0002	0.001	<0.03	<0.0005	0.005	0.04
July 2008	<0.03	0.004	0.00041	0.001	<0.03	<0.0005	0.377	0.07
UMHMW-1D (bedrock)								
Oct 2007	<0.03	**0.01**	**0.01535**	0.006	12.54	0.0032	**16.46**	**3.98**
July 2008	<0.03	<0.002	**0.01552**	0.02	1.46	0.006	**15**	**4.42**
UMHMW-2D (bedrock)								
Oct 2007	<0.03	0.008	**0.2139**	0.037	10.12	**0.0231**	**26.64**	**50.84**
July 2008	<0.03	0.008	**0.2491**	0.023	12.7	**0.0296**	**33.58**	**62.14**
UMHMW-3 (bedrock)								
Oct 2007	<0.03	<0.002	0.00043	0.005	<0.03	<0.0005	0.007	0.04
July 2008	<0.03	<0.002	0.00036	0.002	<0.03	<0.0005	0.005	0.01
MHGW-112 (alluvial)								
Oct 2007	<0.03	<0.002	**0.00957**	0.002	<0.03	0.001	**1.12**	1.79
July 2008	<0.03	<0.002	**0.0073**	0.002	<0.03	<0.0005	ND	1.79
MHGW-113 (bedrock)								
Oct 2007	0.18	<0.002	<0.00008	<0.001	<0.03	<0.0005	0.177	0.01
July 2008	<0.03	<0.002	<0.00008	<0.001	<0.03	<0.0005	0.174	<0.01

Bold values exceed groundwater SSCLs (Table 4-2 Summary of Groundwater SSCLs).

In general, groundwater in the upper Mike Horse Creek area is high in aluminum, cadmium, lead, manganese, and zinc. However, groundwater from well MW-1 in upper Mike Horse Creek does not exceed DEQ-7 standards for any metals analyzed and it appears that groundwater discharge from the two major faults crossing the area do not increase metals concentrations in groundwater in the area (Tetra Tech, 2013a).

Groundwater monitoring wells downgradient from MW-1 (Figure 22) demonstrated that historical mining activities in the upper Mike Horse Creek area continue to be a primary contributing source of metals to groundwater. Groundwater from both the bedrock and alluvial aquifers in the Mike Horse Creek area exceeded the DEQ-7 standards for cadmium, copper, lead, and zinc and SSCLs for manganese and aluminum. The highest concentrations of cadmium, copper, lead, and zinc were observed in samples from wells UMHMW-2D and UMHMW-2S. All of these wells monitor groundwater quality related to mine seepage (Tetra Tech, 2013a). Concentrations of the metals were lower in groundwater samples from bedrock and alluvial wells farther downstream, in the lower Mike Horse Creek area. Wells MHGW-112 and MHGW-113 monitor groundwater in alluvium and bedrock directly downgradient of the Mike Horse Repository. Groundwater concentrations from MHGW-112 exceed cadmium and manganese standards. However, cadmium, copper, and lead concentrations from the repository seep were generally an order of magnitude higher with slightly higher concentrations for manganese and zinc (CDM, 2008). Shallow alluvial well MHGW-112 likely represents local valley fill deposits with some influence of the upgradient seep while MHGW-113 (bedrock well) likely represents the area-wide deeper groundwater (Tetra Tech, 2013a).

The ongoing interim action at the Mike Horse Mine Area will address the alluvial aquifer through the removal of waste sources and reconstruction of the Mike Horse Creek channel and floodplain. However, the bedrock aquifer will likely continue to be influenced by the mineralized geology and mine workings in this area. Although the area exceeds groundwater SSCLs for several COCs, the relative impacts of surface water recharge, mine workings, and mineralized geology on this chemistry are not fully understood and are a data gap that should be addressed during design. It is possible the chemistry at these locations is representative of background conditions for the bedrock aquifer. Additionally, the hydraulic properties (hydraulic conductivity, gradient, thickness) of the aquifer are unknown, making it difficult to estimate a flow rate for treatment. For the purpose of evaluating remedial alternatives, the following parameters were estimated for the aquifer:

- Hydraulic conductivity (K) of 10 ft/day (mid-range value for fractured igneous and metamorphic rock; Table 2.2, Freeze and Cherry, 1979).
- Gradient (i) of 0.015 ft/ft (estimated as $1/10^{th}$ of the ground surface slope).
- Thickness of 100 feet and width of 325 feet (average width of the valley).

Using these assumed parameters and applying Darcy's equation, a remediation flow estimate of 24.6 gpm is estimated for the upper Mike Horse bedrock aquifer.

6.2.6 Summary of EA 2 Remediation Volume Estimates

Remediation volume estimates for locations within EA 2 at the UBMC requiring remedial actions based on the SSCLs are summarized in Table 6-9.

Table 6-9 Remediation Volume Estimates for EA 2 - Groundwater

UBMC Location	Volume Exceeding SSCLs			
	Mine Waste/ Impacted Soil	Sediment	Surface Water	Groundwater
Anaconda Mine Adit	N/A[1]	N/A	N/A	4.1 gpm
Capital Mine Adit	N/A	N/A	N/A	--
Carbonate Mine	See §6.1.4	N/A	N/A	14.2 gpm
Mike Horse Mine Adit and Seeps	See §6.1.8	N/A	N/A	55 gpm
Upper Mike Horse Mine Bedrock Aquifer	N/A	N/A	N/A	24.6 gpm
Total	**---**	**---**	**---**	**98 gpm**

[1] N/A - Not a media of concern based on the RI.

6.3 *Evaluation Area 3 – Streams*

Surface water and its associated sediment are evaluated in EA 3 and include the following features:

- Blackfoot River from the inlet of the Upper Marsh downstream to the confluence with Hogum Creek (EU 13). The reach of the Blackfoot River that runs through the Upper Marsh (EU 12) is discussed in EA 4 (Section 6.4), but the remediation volume estimates are included in EA 3.
- Stevens Creek.
- Porcupine Creek, Paymaster Creek, Shave Creek, and an unnamed tributary to the Blackfoot River above the WTP.
- Discharges, seeps, or springs identified at mining-related features along the Blackfoot River and within the Paymaster Gulch, Pass Creek, Porcupine Creek, Shave Gulch, and Stevens Gulch drainages.

Within the RI, the main focus for streams and sediment was the Blackfoot River and as such there is more information for this stream than for any other surface water feature within the UBMC. The other features included in EA 3 were added because of exceedances of SSCLs in either the surface water or sediment as determined by sample collection during the abandoned mine feature inventory work in the RI. The SSCLs determined for the Blackfoot River (EU 13) and DEQ-7 standards were used to determine COC exceedances for all the sites within this evaluation area. Details, including sample results, for sites within EA 3 other than the Blackfoot River are included in Appendix C.

6.3.1 Blackfoot River (EU 13)

In 2007 and 2008, sediment, surface water, benthic invertebrate tissue, and macroinvertebrate community samples were collected in the Blackfoot River from the Upper Marsh downstream to Highway 279. In 2011, additional surface water and sediment samples were collected downstream from Highway 279 to Hogum Creek to further delineate the nature and extent of surface water and sediment impacts in the Blackfoot River channel (Figure 24). Detailed topographic data surveys of the floodplain have not been completed for all reaches of the river.

6.3.1.1 Biota

The stream sediments ranked highest of the 13 EUs with a Risk Driver Index (RDI) of 5.25 (out of a possible 6.0) in the BERA. Aquatic invertebrates, fish, and the American dipper were given the highest overall risk; these species are exposed only to stream habitat (Tetra Tech, 2013b). While fish and aquatic invertebrates are continually immersed within contaminated media, the dipper is immersed only during feeding, but is continuously exposed to water due to its nesting and resting locations (Tetra Tech, 2013b).

Risk changes from upstream in the UBMC (Beartrap and Mike Horse Creeks) to downstream in the Blackfoot River and the RDI (calculated as a single value for the entirety of EU13) may not reflect the risks in the downstream reaches of the Blackfoot River. Sediment metal concentrations near Highway 279 were from one-quarter to one-tenth of those near the Mary P Mine above the Upper Marsh. Surface water metal concentrations at low stream flows were one-half to one-thirtieth at the same locations. In 2007, microinvertebrate taxonomic community data were analyzed at five locations below the Upper Marsh (Tetra Tech, 2013a). These biota are the most readily impacted by metal concentrations in water and sediment because of their constant exposure and are critical transport links from abiotic media to higher vertebrates (Tetra Tech, 2013b). All biota samples received an "unimpaired" determination. Additionally, bioassay results within the Lower Marsh, the only bioassay performed below the Upper Marsh, showed a statistically higher rate of survival for biota than those found in the Pass Creek reference reach. Contrary to the RDI applied to the sediments, the relative risks to biota appear to become progressively lower in the Blackfoot River from upstream to downstream and reach a point in the Lower Marsh where biologic health indicators are better than the upstream reference location.

6.3.1.2 Stream Flows and Water Quality

Stream flows measured within the stream course of the Blackfoot River during the RI are listed in Table 6-10 for five representative locations, from above the Upper Marsh to the Highway 279 bridge. Stream flows downstream of Highway 279 to the end of the UBMC at Hogum Creek were measured under different conditions in November of 2011 and are included for comparison.

Table 6-10 Blackfoot River Stream Flows

Sampling Location	Flow (cfs)		
	October 2007	June 2008	November 2011
Above Upper Marsh Inlet BRSW- 12	1.76	--	--
Upper Marsh Outlet BRSW-107	3.5	106.5	--
Porcupine Creek Confluence BRSW-31	3.00	61.42	--
Below Lower Marsh Outlet BRSW-17	3.19	65.49	--
Highway 279 Bridge BRSW-101	5.04	105.28	--
Horsefly Creek BRSW-203	--	--	24.16
End of UBMC at Hogum Creek BRSW-201	--	--	19.63

Conclusions reached in the RI suggest that losing stream reaches of the Blackfoot River where flow is lost to the shallow groundwater system are just downstream of the Upper Marsh and within or adjacent to the Middle and Lower marshes. However, it was noted in the RI that not all of the surface flow may have been accounted for due to the dispersion of stream flow in various directions and channels within the marsh areas and the decrease may be due to measurement limitations rather than losses to groundwater (Tetra Tech, 2013a).

During the RI, surface water samples were collected in 2007, 2008, and 2011 at 15 locations from below the Upper Marsh to Hogum Creek (Figure 24). Analytical results are listed for comparison in Table 6-11 at three locations representing upstream, mid-point, and downstream conditions and at the Pass Creek reference location. Surface water samples collected within the reach of the Blackfoot River within the Upper Marsh are included in the EA 4 discussion in Section 6.4.3.

Table 6-11 Blackfoot River Surface Water Concentrations

Sampling Location	Contaminant of Concern (mg/L)							
	Al	As	Cd	Cu	Fe	Pb	Mn	Zn
Blackfoot River at Porcupine Creek (upstream) BRSW-31								
October 2007	<0.03	<0.002	**0.00225**	**0.022**	**1.03**	**0.0055**	0.273	**0.81**
June 2008	<0.03	<0.002	**0.00149**	**0.012**	0.13	**0.0042**	0.055	**0.39**
Blackfoot River at Highway 279 (mid-point) BRSW-101								
October 2007	<0.03	<0.002	0.00015	<0.001	0.05	<0.0005	0.004	0.09
June 2008	<0.03	<0.002	**0.0005**	0.003	0.07	0.0006	0.015	**0.24**
Blackfoot River at Horsefly Creek (downstream) BRSW-204								
November 2011	<0.03	<0.002	<0.00008	<0.001	<0.05	<0.0005	0.008	0.01
Blackfoot River at Hogum Creek (end of UBMC) BRSW-201								
November 2011	<0.03	<0.002	<0.00008	<0.001	<0.05	<0.0005	<0.005	0.01
Pass Creek Reference BRSW-11								
October 2007	<0.03	<0.002	<0.00008	<0.001	0.61	<0.0005	0.126	<0.01

Bold values exceed SSCLs for human health or aquatic standards (Table 4-3 Summary of Surface Water SSCLs).

Surface water COC concentrations did not exceed DEQ-7 human health standards below the Upper Marsh. Acute and chronic aquatic life standards were exceeded for cadmium, copper, lead, and zinc near the Upper Marsh outlet, but were not exceeded in other samples taken below Highway 279 (Tetra Tech, 2013a).

Groundwater samples were collected from an alluvial monitoring well (LCMW-1) and a bedrock monitoring well (BRGW-101) downstream of the Upper Marsh outlet during the RI in 2007 and 2008 (Figure 24). Results from this sampling and reference sampling within Pass Creek are presented in Table 6-12.

Table 6-12 Groundwater Downstream of the Upper Marsh

Sampling Location	Contaminant of Concern (mg/L)							
	Al	As	Cd	Cu	Fe	Pb	Mn	Zn
LCMW-1 (Alluvial)								
Oct 2007	<0.03	<0.002	**0.00965**	0.019	0.04	<0.0005	0.119	0.2
July 2008	<0.03	<0.002	0.00325	0.02	0.17	<0.0005	0.122	0.2
BRGW-101 (Bedrock)								
Oct 2007	<0.03	<0.002	<0.00008	<0.001	0.25	<0.0005	0.184	<0.01
July 2008	<0.03	<0.002	<0.00008	<0.001	0.5	<0.0005	0.213	<0.01
Pass Creek Reference PDGW-101 (Alluvial)								
July 2008	3.47	<0.002	0.0014	0.08	8.7	0.0027	0.668	0.3
Pass Creek Reference PDGW-102 (Bedrock)								
July 2008	6.63	0.003	<0.00008	0.275	12.73	0.0007	0.376	0.26

Bold values exceed SSCLs (Table 4-2 Summary of Groundwater SSCLs).

All wells had concentrations below SSCLs with the exception of one cadmium exceedance in the alluvial downstream well (LCMW-1). Three domestic wells downstream of the Upper Marsh and in immediate proximity of the Blackfoot River have been sampled by DEQ twice per year since March 2009. Metals concentrations in these three domestic wells were below their respective DEQ-7 standards, suggesting that domestic wells downstream of the Upper Marsh are not impacted by historic mining activities (Tetra Tech, 2013a).

Near the lower end of the Upper Marsh, the relative concentrations between groundwater (LCMW-1 and BRGW-101) and surface water (BRSW-31) change as flow conditions change. During low stream flow in October, surface water metal concentrations were higher in the surface water than in the alluvial and bedrock groundwater, with the trend reversing in June during high stream flow. This reach of the Blackfoot River gains flow from the groundwater system, so during low stream flow periods, the groundwater contribution would have a diluting effect on the higher contaminant concentrations in the surface water. No definitive conclusion can be made regarding the balance of contaminant transfer during high stream-flow periods (Tetra Tech, 2013a).

6.3.1.3 Background Sediment Sampling

Unconsolidated deposits within the Blackfoot drainage of the UBMC consist of glacial end moraines and stream-reworked outwash materials in the valley bottoms, and colluvial slope-wash sediments on slopes transitional between ridge crests and valley bottoms. Alluvial sediments have been contaminated with mine wastes ranging from rather thick deposits of mine tailings with lateral and vertical continuity in the upper end of the drainage below the Mike Horse tailings dam, to inter-bedded alluvial and tailings deposits, to thinner over-bank deposits in downstream and marsh locations.

Sediment samples collected in 2007 during the RI within Pass Creek and Paymaster Creek (Figure 24) were compared with samples collected in the Blackfoot River upstream and downstream of the drainages to determine possible sediment impacts on the Blackfoot River from the drainages (Table 6-13). Sediment samples were collected from three different sediment depths (0 to 2 inches, 2 to 6 inches, and 6 to 12 inches) in Paymaster Creek and from 0 to 2 inches at the stream sediment background reference location in Pass Creek. No sediment samples were collected from within the Swamp Gulch drainage. Analytical results are combined as a range of values for the comparison in Table 6-13. Aluminum and iron were not included in the sample analysis.

Table 6-13 Blackfoot River Sediment Comparison

Sampling Location	Contaminant of Concern (mg/kg)					
	As	Cd	Cu	Pb	Mn	Zn
Blackfoot River Upstream BRSW-12 SE	19 - 26.2	9.97 - 13.3	253 - 334	474 - 530	2,540 – 3,140	1,890 - 2,350
Pass Creek Reference BFSW-11 SE	7.87	<0.5	29.4	47.5	408	136
Blackfoot River Downstream BRSW-110 SE	12.9 - 14.8	4.35 - 5.48	127 - 158	351 - 395	979 – 1,200	865 - 994
Blackfoot River Upstream BRSW-12 SE	19 - 26.2	9.97 - 13.3	253 - 334	474 - 530	2,540 – 3,140	1,890 - 2,350
Paymaster Creek BRSW-13 SE	33.9 - 86.8	0.5 - 1.37	83.6 - 247	68.5 - 235	31.3 - 54.7	15.3 - 275
Blackfoot River Downstream BRSW-110 SE	12.9 - 14.8	4.35 - 5.48	127 - 158	351 - 395	979 – 1,200	865 - 994

SE = Sediment

Concentration of the Blackfoot River sediments were lower downstream of the two drainages when compared with upstream results and lead to the conclusion that the tributaries had minimal to no effect on concentrations within the Blackfoot River. The impact of sediment from the Swamp Gulch drainage to the Blackfoot River has not been investigated and is a data gap that should be addressed during design.

6.3.1.4 Sediments

Stream sediments were sampled below the Upper Marsh to Hogum Creek during the RI in 2007, 2008, and 2011 (Figure 24). Data are summarized in Table 6-14 for locations sampled within the same time period (2008) and to the same depths (0 to 2 inches and 2 to 6 inches). Results are reported in milligrams per kilograms (mg/kg). Not included in the table are 2011 locations, which were only sampled to 2 inches (collection of 2 to 6 inch samples was not possible due to shallow sediment depth), and the reference location in Pass Creek, which was only sampled in 2007. The data indicate that COC concentrations were similar or slightly increase (BRSW-104) with depth to the maximum depth sampled within the reach of stream from below the Upper Marsh to below the Lower Marsh, but then decrease with depth (and in general) to Highway 279.

Table 6-14 Stream Sediment COC Concentrations vs Depth Blackfoot River

Sampling Location	Contaminant of Concern (mg/kg)							
	Al	As	Cd	Cu	Fe	Pb	Mn	Zn
0 to 2 inches Depth (upstream to downstream)								
Downstream of Upper Marsh BRSW-106	7,850	14.7	3.51	**214**	28,500	**131**	**1,270**	**878**
Upstream of Middle Marsh BRSW-105	8,740	14.2	**7.49**	**251**	24,600	**198**	**2,360**	**1,660**
Downstream of Middle Marsh BRSW-104	**22,800**	16.9	**18.2**	**2,630**	35,400	59.6	**10,100**	**2,370**
Downstream of Lower Marsh BRSW-102	4,550	4.86	1.21	46.5	11,400	27.8	**750**	**481**
2 to 6 inches Depth (upstream to downstream)								
Downstream of Upper Marsh BRSW-106	8,400	11	3.08	192	27,000	**138**	**1,190**	**852**
Upstream of Middle Marsh BRSW-105	8,440	14.1	**6.97**	**231**	23,600	**293**	**2,250**	**1,560**
Downstream of Middle Marsh BRSW-104	**23,000**	**18.1**	**20.3**	**3,030**	35,800	67.1	**11,300**	**2,350**
Downstream of Lower Marsh BRSW-102	3,920	3.03	0.767	33.8	9,650	17.4	511	**361**

Bold values exceed EU 13 SSCLs (Table 4-1 Summary of Soil and Sediment SSCLs).

Although stream sediment samples were not collected from below the Upper Marsh to Hogum Creek during the same time period, the available 0 to 2 inch depth data are summarized in Table 6-15 at representative locations for the entire length of the stream to estimate areas exceeding SSCLs and remedial volumes. The data indicate that COC concentrations generally decreased downstream from below the Upper Marsh to Hogum Creek, and from the confluence of the Blackfoot River with Alice Creek at BRSW-205 no SSCL exceedances were noted.

Table 6-15 Stream Sediments COC Concentrations Upper Marsh to Hogum Creek

Sampling Location	Contaminant of Concern (mg/kg)							
	Al	As	Cd	Cu	Fe	Pb	Mn	Zn
Below Upper Marsh BRSW-107								
Oct 2007	--	**20.9**	**10.5**	**620**	--	**716**	**2,580**	**2,350**
June 2008	**10,200**	**19.7**	1.93	**372**	29,600	**409**	**555**	**782**
Below Middle Marsh BRSW-104								
October 2007	--	13.9	**9.39**	**298**	--	**101**	**3,760**	**1,850**
June 2008	**22,800**	16.9	**18.2**	**2,630**	35,400	59.6	**10,100**	**2,370**
Below Lower Marsh BRSW-17								
October 2007	--	6.22	**3.86**	51	--	69.2	**2,280**	**936**
June 2008	--	--	--	--	--	--	--	--
Highway 279 BRSW-101								
October 2007	--	8.88	1.91	27.6	--	19.8	**767**	**612**
June 2008	5,130	9.87	0.839	36.2	13,300	28.9	**589**	**396**
Highway 279 to Hogum Creek (2011)								
BRSW-206	5,360	5.7	1.3	38.6	12,500	18	**749**	**534**
BRSW-205	5,070	8.0	<0.5	30.0	13,100	21	396	202
BRSW-204	4,570	4.4	<0.5	29.8	11,800	11	259	125
BRSW-203	4,840	5.3	<0.5	41.2	14,400	14	247	126
BRSW-202	4,230	3.6	<0.5	35.1	14,600	11	218	146
BRSW-201	4,710	4.0	<0.5	39.5	16,300	13	311	150

Bold values exceed EU 13 SSCLs (Table 4-1 Summary of Soil and Sediment SSCLs).

The exact quantity of contaminated stream sediment within EU 13 likely varies with cyclical changes in hydrology and sediment transport processes. Remobilization, transport, mixing, sorting, reworking, and deposition of sediments in response to increases and decreases in flows are expected. These processes make it difficult to determine exactly the extent of the contaminated sediments within this reach of the Blackfoot River because the sediment sampling locations are continually reworked in response to the hydrologic fluctuations. These same factors also affect the potential inputs to the river from upstream sources of both clean and contaminated sediments. The FS uses a remediation volume estimate of 17,800 cy of sediment, based on a 1-

foot removal depth across 4 feet of stream channel and 12 feet of floodplain on each bank for the 3.25 river miles within the stream corridor from the inlet of the Upper Marsh to Alice Creek. An average flow estimate of 84.7 cfs (38,020 gpm) of surface water is assumed for the Blackfoot River for purposes of developing remedial alternatives.

6.3.2 Stevens Creek

Stevens Gulch, which runs for more than a mile north from the top of the ridge towards the Blackfoot River, is a forested area of steep, rugged terrain crisscrossed with jeep trails and old logging and/or exploration roads that are mostly inaccessible. Mining-related features and impacts were observed along the length of the gulch. The watershed for Stevens Creek encompasses approximately 350 acres.

Stevens Creek first surfaces intermittently above the Capital Mine site (EU 3) and its surface flow terminates before reaching the main stem of the Blackfoot River. Surface water samples collected along Stevens Gulch in 2001 (after interim actions at the Capital Mine) were analyzed in the 2007 DSR (Tetra Tech, 2007) and showed that water quality improved in the areas immediately downstream of the Capital Mine. However, water quality in the lower reaches of Stevens Gulch did not show the same improvement. The DSR concluded *"the mineralized groundwater may be a likely source of loading to the lower segment of Stevens Gulch"* (Tetra Tech, 2007).

Stevens Creek was examined in 2007 and 2008 as part of the mine feature inventory investigation in the RI. Numerous mine and interim action related disturbances were observed along stretches of the Stevens Creek channel below the Capital Mine interim action area making it likely that multiple or diffuse sources influence water quality at each sampling location, rather than a discrete source. Surface water and streambed sediment samples were collected from seven locations along the creek (Figure 25 and Figure 26). The DEQ-7 aquatic life standards were exceeded in all surface water samples collected during the RI, except for a sample collected downgradient of the Capital Mine waste removal area at SGSW-102, which did not exceed any DEQ-7 water quality standards. None of the surface water samples collected within the stream or groundwater samples collected during the RI showed exceedances of DEQ-7 human health standards. Stream flow in the drainage was measured in July 2008 at several locations along the creek and ranged from 0.001 to 21.4 cfs in Table 24b of the RI (Tetra Tech, 2013a). Significant streams were characterized in Table 5 of the RI and indicate a range of flow for Stevens Gulch at 0.001 to 2.0 cfs; the recorded reading of 21.4 cfs at SGSW-103 reported in Table 24b of the RI report appears to be an error. An average flow of 0.5 cfs is used for purposes of the FS.

Groundwater sampling results from one alluvial well (SGGW-101) and one bedrock well (SGGW-102) in the lower part of Stevens Gulch (Figure 25) showed no water quality exceedances. The RI concluded that "water levels within SGGW-101 and SGGW-102 indicate a strong upward hydraulic gradient at this location (lower most segment of the gulch) such that bedrock groundwater is likely recharging the overlying alluvial aquifer" and confirmed "the infiltration of all the flow from the lowermost portion of Stevens Gulch into the alluvial aquifer between station BRSW-108 on Stevens Gulch and the Blackfoot River." (Tetra Tech, 2013a).

Several COCs in the sediment samples collected (Figure 26) show exceedances of SSCLs for the entire sampling corridor (Table 6-16).

Table 6-16 Stream Sediments COC Concentrations Stevens Creek

Sampling Location	Contaminant of Concern (mg/kg)							
	Al	As	Cd	Cu	Fe	Pb	Mn	Zn
0 to 2 inch Depth (upstream to downstream)								
SGSE-102	3,740	**324**	**11**	**500**	147,000	**2,300**	436	**2,170**
SGSE-103	4,450	**300**	**10.9**	**588**	159,000	**1,220**	370	**2,320**
SGSE-105	5,000	**196**	**4.12**	**375**	91,400	**1,070**	481	**895**
SGSE-106	5,870	**145**	1.29	**336**	58,000	**674**	383	**369**
SGSE-107	6,460	**168**	1.84	**341**	73,400	**694**	259	**415**

Bold values exceed EU 13 SSCLs (Table 4-1 Summary of Soil and Sediment SSCLs).

The exact quantity of stream sediment within Stevens Gulch is difficult to determine and likely varies with cyclical changes in hydrology and sediment transport processes. During the RI, 100 mine features were identified in Stevens Gulch, many related to drilling or exploration, and the mineralization in the near-surface soils has prevented the re-establishment of vegetation at these sites. The RI concluded that in some stretches of Stevens Gulch, "despite efforts to locate surface water and streambed sediment sample locations such that impacts from discreet sources could be monitored, it is likely that multiple or diffuse sources influenced water quality at each sampling location" (Tetra Tech, 2013a). Remedial actions at selected features, while possibly improving the localized surface water quality, may not improve the overall water quality along Stevens Gulch. Remobilization, transport, mixing, sorting, reworking, and deposition of sediments in response to increases and decreases in flows are expected, making it difficult to exactly determine the extent of the contaminated sediments. The FS uses a remediation volume estimate of 550 cy of sediment, based on a 1-foot removal depth across 4 feet of stream channel for the 0.7 miles of creek running the length of the gulch. An average flow estimate of 0.50 cfs (224 gpm) of surface water is assumed for Stevens Creek for purposes of developing remedial alternatives.

6.3.3 Other Streams

6.3.3.1 Porcupine Creek

Porcupine Creek, located immediately to the west of the Meadow Creek drainage, flows into the Blackfoot River just downstream from Meadow Creek Road. The Porcupine Creek drainage encompasses approximately 370 acres.

Surface water and sediment in Porcupine Creek was sampled in 2011 during the RI in the vicinity of the mining-related feature PBBS, identified as an abandoned mine with a collapsed adit discharging onto a vegetated waste rock pile located adjacent to the creek (Figure 25 and

Figure 26). Surface water sampling at PBBS-200 (upstream from PBBS) and PBBS-201 (downstream of PBBS) did not exceed any DEQ-7 standards for human health or aquatic life (chronic or acute). However, stream sediment from the downstream location (PBBS Sed 200) exceeded SSCLs for arsenic, cadmium, lead, manganese, and zinc. Surface water and sediment samples collected from the collapsed adit are discussed in Section 6.3.4. Because of the close proximity of the mining-related feature PBBS to the impacted Porcupine Creek sediment a remediation volume for the impacted section of Porcupine Creek is included in the evaluation of PBBS in Section 6.3.4.

6.3.3.2 Paymaster Creek

The Paymaster Gulch drainage, encompassing approximately 400 acres, is located east of Meadow Creek and discharges into the Upper Marsh. Several mining-related features were identified in this drainage, extending from the Paymaster waste removal areas near the mouth of the drainage to the top of the divide between Paymaster and Stevens gulches.

Surface water and streambed sediment samples were collected from eight locations along the creek (Figure 24 through Figure 26). Stream flow at sample location PMSW-102, approximately 0.25 miles upstream from the Paymaster Waste Areas (EU 9A), was measured during the RI at 0.634 cfs in July 2008. Surface water samples collected during the RI downgradient from the Paymaster waste removal areas at BRSW-13 and upgradient at BRSW-21 (sampled in October 2007), PMSW-102, and PMSW-103 (sampled in July 2008) did not exceed any DEQ-7 water quality standards for human health (Figure 25). Cadmium, copper, iron, and zinc exceeded their respective DEQ-7 aquatic life standards (chronic and/or acute) at all four sampling stations. All four locations had acidic water with a pH ranging from 2.6 to 3.22, and cadmium, copper, iron, lead, manganese, and zinc concentrations increased from upstream at BRSW-21 to downstream at BRSW-13. Sediment samples collected during the RI at the PMSE-102 and PMSE-103 (Figure 26) locations did not exceed SSCLs. The RI summarizes Paymaster Creek as follows (Tetra Tech, 2013a):

> "Water from Paymaster Creek differed from the infrequent, low-concentration detections of metals measured in samples from other streams. Paymaster Gulch had slightly higher than detectable concentrations of aluminum, copper, and zinc, higher concentrations of iron, manganese, and sulfate, and a pH below 7.0. Furniss (1998) postulated that the Mike Horse Fault System contributes groundwater with lower pH and higher metals concentrations to the surface flow in this segment of Paymaster Creek, as evidenced by ferricrete deposits at mid-stream locations near the fault zone. In addition, the 2007 mine waste inventory identified historical workings and mine wastes upstream of this area. Therefore, the Paymaster Gulch background location may be impacted by naturally occurring acid rock drainage and/or the historical mining activities."

The BRSW-13 sediment sample, the sample location immediately downstream of the Paymaster Mine area, is the only one of the four samples collected (Figure 24 and Figure 26) that shows exceedances of COCs. Arsenic exceeds sediment cleanup level at 0 to 2 inches, 2 to 6 inches, and 6 to 12 inches; lead exceeds the cleanup level at 2 to 6 inches and 6 to 12 inches; and copper exceeds cleanup level at 6 to 12 inches. It should be noted that Paymaster Creek was rerouted and reconstructed around the passive wetland treatment system. The extent of sediment contamination in this area is a data gap that should be addressed during design. The FS uses a remediation volume estimate of 30 cy of sediment, based on engineering judgment assuming a 1-foot removal depth across 4 feet of stream channel for 200 feet of creek. An average flow estimate of 0.634 cfs (293 gpm) of surface water is assumed for Paymaster Creek for purposes of developing remedial alternatives.

6.3.3.3 Shave Creek

Shave Gulch, located on the north side of the Blackfoot River, has a drainage area of approximately 2,130 acres and includes Chambers Gulch, which flows into Shave Creek approximately 1 mile upstream from the Blackfoot River. Stream flow at sample location SHSW-101 was measured during the RI at 0.51 cfs in July 2008.

Sample location SHSW-101, downgradient from mining-related feature SH-17, exceeded DEQ-7 aquatic life standards for chronic and acute copper. Sample SHSW-102, located upgradient of feature SH-17, had no DEQ-7 exceedances for surface water quality but did exceed sediment SSCLs for arsenic, lead, and manganese in sample SHSE-102 (Figure 25 and Figure 26). Sediment in sample SHSE-101 showed no SSCL exceedances. Remobilization, transport, mixing, sorting, and deposition of sediments in response to increases and decreases in flows are expected, making it difficult to exactly determine the extent of the contaminated sediments. The FS uses a remediation volume estimate of 30 cy of sediment, based on engineering judgment assuming a 1-foot removal depth across 4 feet of stream channel for 200 feet of creek. An average flow estimate of 0.51 cfs (229 gpm) of surface water is assumed for Shave Creek for purposes of developing remedial alternatives.

6.3.3.4 Unnamed Tributary above WTP

This unnamed tributary located west of the Upper Anaconda Mine Waste Piles (EU 1B) has a drainage area of approximately 75 acres and drains south to the WTP (Figure 25). Flow in the tributary was sampled during the RI immediately downgradient from mining-related feature BR-39 a collapsed adit and waste rock pile situated approximately 700 feet uphill from the WTP. The sampled water at BTSW-101 exceeded DEQ-7 aquatic life standards for chronic cadmium and zinc, and acute zinc. The flow rate was measured in the RI at less than 0.039 cfs. No sediment samples were collected. An average flow estimate of 0.039 cfs (17.5 gpm) of surface water is assumed for this unnamed tributary for purposes of developing remedial alternatives.

6.3.4 Mining-related Feature Discharges, Seeps, or Springs

Several mining-related features inventoried during the RI had discharges, seeps, or springs (Figure 25 and Figure 26). Any mining-related waste identified at these features is included in Section 6.5. The surface water and/or sediment associated with these features include the following (Tetra Tech, 2013a):

- Mining-related feature BR-01: an intermittent spring, approximately 150 square feet in size at the toe of slope. No flow or water quality data were collected.

- Mining-related feature BR-14: a collapsed adit with leaking water supporting vegetation that was pooled near the adit entrance. No flow or water quality data were collected.
- Mining-related feature PBBS: the former Bobby Boy Mine that included a seep from a collapsed adit. Surface water exceeded the DEQ-7 human health standards for cadmium, lead, and zinc; aquatic standards (chronic and/or acute) for cadmium, copper, iron, lead, and zinc; and the SSCL for manganese. No flow data were collected. Sediment associated with the seep (PBBS Sed 201) exceeded SSCLs for arsenic, cadmium, lead, manganese, and zinc. The FS uses a remediation volume estimate of 50 cy of sediment, based on engineering judgment assuming a 1-foot removal depth across 4 feet of stream channel for 200 feet of creek and includes 20 cy of sediment from the seep.
- Mining-related feature PC-11: a collapsed and leaking adit estimated at 1 gpm. Surface water sampled in 2008 during the RI at PCSW-101 exceeded the DEQ-7 aquatic standards (chronic and/or acute) for cadmium and zinc.
- Mining-related feature PC-22: a collapsed adit with a marshy area at the entrance, indicating adit discharge. No flowing water was observed and no water quality data collected.
- Mining-related feature SH-43: a collapsed and leaking adit estimated at 2 to 5 gpm with additional flow contributed by seeps between the adit and observed mined rock pile. Surface water sampled in 2008 during the RI at SHSW-103 exceeded the DEQ-7 aquatic standards (chronic and/or acute) for arsenic, cadmium, copper, iron, lead, and zinc and the SSCL for manganese. Sediment associated with the seep (SHSE-103) exceeded SSCLs for arsenic, cadmium, lead, manganese, and zinc. The FS uses a remediation volume estimate of 30 cy of sediment from the seep based on estimates made in the RI and engineering judgment.
- Mining-related feature SG-55: a 4-inch diameter pipe protruding from the toe of a cut-slope that was observed leaking small amounts of water. Surface water sampled in 2008 during the RI at SGSW-55 exceeded the DEQ-7 human health standards for arsenic, aquatic standards (chronic) for iron, and the SSCL for manganese. No flow data were collected.
- Mining-related feature SG-71: a spring at a possible adit location approximately 70 feet from Stevens Creek. Water had pooled from the spring to a depth of 6 inches. No flow or water quality data were collected.
- Mining-related feature SG-94: an iron precipitate, cone-forming spring. During the RI, the flow rate was estimated at 2 to 5 gpm and sediment was observed. Surface water sampled in 2008 during the RI at SGSW-104 exceeded the DEQ-7 human health standards for arsenic and iron, and the aquatic standards (chronic and/or acute) for iron and zinc. Sediment associated with the cone (SGSE-104) exceeded SSCLs for arsenic. The FS uses a remediation volume estimate of 30 cy of sediment from the seep based on estimates made in the RI and engineering judgment.
- Mining-related feature SG-98: a collapsed adit with iron oxide staining, suggesting historic adit flow at some point. During the RI, the feature was observed to be dry and no data were collected.

A table describing the mining-related features in detail is provided in Appendix C.

6.3.5 Summary of EA 3 Remediation Volume Estimates

Remediation volume estimates for locations within EA 3 at the UBMC requiring remedial actions based on the SSCLs is presented in Table 6-17.

Table 6-17 Remediation Volume Estimates for EA 3 - Surface Water

UBMC Location	Volume Exceeding SSCLs			
	Mine Waste/ Impacted Soil	Sediment	Surface Water	Groundwater
Blackfoot River (EU 13)	N/A[1]	17,800 cy	84.7 cfs	N/A
Stevens Creek	See §6.5.2	550 cy	0.5 cfs	N/A
Porcupine Creek	--	See § 6.3.4	--	N/A
Paymaster Creek	See §6.5.2	30 cy	0.634 cfs	N/A
Shave Creek	See §6.5.2	30 cy	0.51 cfs	N/A
Unnamed Tributary above the WTP	See §6.5.2	--	0.039 cfs	N/A
Mining-related Features	See §6.5.2	110 cy	0.01 cfs[2]	N/A
Total	**---**	**18,520 cy**	**84.7 cfs[3]**	**---**

[1] N/A - Not a media of concern based on the RI.
[2] Average flow at features SH-43 and SG-94.
[3] Average flow for the Blackfoot River is representative for EA 3.

6.4 *Evaluation Area 4 – Upper Marsh*

The Upper Marsh evaluation area, a 62.3-acre wetland at the confluence of Pass Creek with the Blackfoot River (Figure 5), is part of a larger 300-acre marsh that includes the Middle Marsh and Lower Marsh. The Upper Marsh receives its largest water inputs from Pass Creek and the Blackfoot River, but also receives significant inputs from Paymaster Gulch and Swamp Gulch and a significant volume of groundwater discharge from side drainages and other wetland areas. Surface water-groundwater interaction within the Upper Marsh is complex as some portions receive input from the various water sources, while other portions lose water and recharge the aquifer during portions of the year.

Sediment deposits in the Upper Marsh are a mixture of tailings and sediments from upstream tributaries of the Blackfoot River, with the 1975 flood event and tailings impoundment breach providing a significant tailings input. Subsequent heavy rain and high flow events dispersed the tailings downstream; sediments and tailings are redistributed periodically during high flow events. In general, vegetation in much of the Upper Marsh appears healthy, exceeding one foot in height in most areas and typically has a robust root system.

6.4.1 Site Description

Beaver activity within the Upper Marsh continually alters the landscape and causes changes to the inundated areas and acreage; recent beaver activity has caused submersion of previously exposed sediment deposits in the wetland complex. Water flow is dispersed across the landscape and the original stream channel has become a series of features, fully connected with the marsh areas and wetland features in the floodplain. Mike Horse Road acts as a spreader dike and further widens Pass Creek at its juncture with the Blackfoot River, inundating additional areas and causing flows to overtop the road in places. A possible headcut feature or “nick point” is present within the main stem of the Blackfoot River, at the point where the river becomes entrenched (Figure 27). It is possible that loss or disruption of beaver activity in the Upper Marsh could allow the nick point to advance upstream over time, which may result in rerouting or lowering the main channel and draining flooded areas and, in turn, allow the oxidation of currently saturated or flooded sediments.

Two large fens are located within the Upper Marsh at the inlets of Paymaster Creek and Swamp Gulch (Figure 27), approximately 11 and 12 acres in size, respectively. Ecologically significant because of their unique vegetation and slow rate of peat accumulation, fens require a minimum of 1,000 years for development, indicate geologic and hydrologic stability, and commonly accumulate iron, copper, manganese, and other metals. These iron-rich fen wetlands, which are typically acidic, saturated, and located at low points in the landscape or side-hill areas (Field Guide, 2014), tend to be seepage-fed with an organic peat layer greater than 15 inches deep and an organic carbon content of at least 12 to 18 percent (Colorado Natural Heritage Program, 2005). The fens in the Upper Marsh are located immediately downstream of the Paymaster and Carbonate ore deposits and given the time required for fens to develop, have been present in their current location since well before mining practices at the UBMC. The Army Corps of Engineers, Helena Regulatory Office, considers the fens to be special aquatic sites because of their critical functions, as well as low resilience to disturbance (Geum, 2013). Disturbance of these fen areas should be avoided if possible.

6.4.2 Sediment

The Upper Marsh has been divided into two areas: the eastern (upstream) portion at 28.0 acres and the western (downstream) portion at 34.3 acres. This division, also used in the BERA, is based on the location of an old drill road constructed within the area prior to the 1975 breach of the Mike Horse tailings impoundment (Figure 27). The drill road provided a containment feature for initial deposition of the tailings and fluvial sediment materials in the eastern portion of the marsh. Over time, the finer materials have been transported downstream into the western portion.

Natural weathering of the quartz monzonite porphyry and diorite ore bodies in the mineralized areas within Pass Creek, Paymaster Gulch, and Swamp Gulch drainages (Figure 3) contributes to the elevated COC concentrations from these sediment sources. Particle sizes in the sediments typically range from gravels to clays. Poorly graded gravels underlay up to five feet of sediment in some areas. The bioavailability parameters assessed in the BERA (grain size, pH, total organic carbon, and solubility) indicate with a high likelihood that lethal and sub-lethal effects could occur in the Upper Marsh. The pH data suggests that the metals may be bioavailable throughout the wetland, and grain size and solubility indicate that the bioavailability may be higher in the eastern (upstream) portion. Fine-grained sediment, found more commonly in the western portion of the marsh, tends to carry more organic carbon and better supports the binding of metals to the deposits. Metals in the marsh are generally more mobile and bioavailable in the medium-grained sand with lower particle surface area that is more common in the eastern portion when compared to the fine-grained sediments more common in the west (Tetra Tech, 2012).

The potential for marsh sediments to generate acid and mobilize metals may be inhibited by reducing chemical conditions and overlying saturated or flooded organic mats. Areas having contact with oxygen in the air have a higher potential to leach metals than those that are continually saturated or inundated. Organic matter also acts as a sink for metals, further reducing their mobility. If kept inundated, the wetland acts as a sink where the metals are chemically reduced and form complexes with other metals and organics thereby becoming relatively stable (Tetra Tech, 2013a).

6.4.2.1 Marsh Sediment Sampling

Samples from three different sediment depths (0 to 2 inches, 2 to 6 inches, and 6 to 12 inches) were collected at 41 sampling locations in the Upper Marsh in 2007 and 2008 during the RI. In addition, more than 200 samples were collected from test pits along transects spaced approximately 750 to 1000 feet apart in the Upper Marsh during the 2012 floodplain study (Spectrum and Pioneer, 2013). Sample locations for the 2007 and 2008 sampling are shown on Figure 28 as an overview of the marsh sampling. Because of the large number of 2012 test pit sampling locations and the close spacing along transects , test pit locations are not shown on Figure 28 to maintain legibility of the map.

Comparison of the analytical results for the sediment samples collected during the RI and floodplain study against the EU 12 SSCLs in Table 4-1 indicates that aluminum, arsenic, cadmium, copper, iron, lead, manganese, and zinc are present in the Upper Marsh at concentrations above the cleanup levels. Based on the data presented in the RI, much of the mine waste is deposited within the Blackfoot River floodplain upstream of the confluence with Pass Creek, creating areas with high levels of COCs. These areas could be as deep as 3 feet thick and are generally thickest in the area above the old drill road. Concentration versus sampling depth is shown for all COCs in the Upper Marsh on Figure 29 through Figure 32. Elevated concentrations of COCs are confined by the Mike Horse Road and do not extend up Pass Creek as originally portrayed in Figure 11a through Figure 11c in the RI (Tetra Tech, 2013a).

Sediment COC concentrations upstream of Mike Horse Road in Pass Creek are identified as background in the RI and as a “reference reach” in the subsequent BERA. Comparison of sediment metals concentration data from both sides of the Mike Horse Road, especially between BRSD-2 and BRSD-5, demonstrate a significant difference between the two sides for all of the COCs. The Upper Marsh arsenic concentrations (BRSD-2) range from 73 to 177 mg/kg, while across the road in Pass Creek (BRSD-5) the range for arsenic is 17.2 to 24.6 mg/kg. The Pass Creek collocated surface water and sediment samples COC concentrations are all below reference and cleanup numbers. The two Pass Creek monitoring wells (background bedrock and alluvial wells) and piezometer contained elevated concentrations of iron (>1 mg/L) reflecting the nature of the highly mineralized area and relatively small to moderate concentrations of the other COCs. Analytical data from these locations are discussed in Section 6.4.4 and summarized in Table 6-18. Sediment metal concentrations are generally higher in the eastern (upstream) region of the Upper Marsh than in the western (downstream) portion.

Remediation volume estimates of 90,345 cy and 110,676 cy were calculated for the areas of exceedance with the eastern and western portion of the Upper Marsh, respectively, assuming a removal depth of 2 feet bgs (Figure 33). The total remediation volume estimate for the Upper Marsh as a whole is 201,021 cy**.** The combined COC isopleth figure created for the Upper Marsh indicates areas of exceedance.

6.4.3 Surface Water

Surface water samples were collected in 2007 at BRSW-11 in Pass Creek, just upstream of the Upper Marsh at BRSW-12, mid-point in the marsh at BRSW-110, and further downstream as the Blackfoot River exits the wetland at BRSW-107 (Figure 34). Analytical data from these locations are summarized in Table 6-18. Cadmium, manganese, and zinc concentrations decrease from upriver to downriver, while copper concentrations increase downriver. Lead concentrations increase toward the middle of the marsh compared with upstream and downstream, and arsenic was below detection levels in all the samples. Pass Creek background concentrations were generally lower than the surface water concentrations in this section of the Blackfoot River. These data suggest that impacts to surface water in the Upper Marsh are minor, as concentrations of some metals decline through the marsh during periods where the metals would be expected to mobilize (Tetra Tech, 2013a). Remediation volume estimates for the reach of the Blackfoot River through the Upper Marsh are included in Section 6.3.1.2.

Table 6-18 Blackfoot River (Upper Marsh) Surface Water COC Concentrations

Sampling Location	Contaminant of Concern (mg/L)							
	Al	As	Cd	Cu	Fe	Pb	Mn	Zn
BRSW-12 (upstream)								
October 2007	<0.03	<0.002	**0.00511**	0.012	0.09	0.0019	0.33	**1.75**
BRSW-110 (mid-point)								
October 2007	<0.03	<0.002	**0.00316**	**0.015**	**3.18**	**0.0156**	0.278	**1.04**
BRSW-107 (downstream)								
October 2007	<0.03	<0.002	**0.00228**	**0.027**	0.81	0.0048	0.256	**0.93**
Pass Creek Reference BRSW-11								
October 2007	<0.03	<0.002	<0.00008	<0.001	0.61	<0.0005	0.126	<0.01

Bold values exceed SSCLs for human health or aquatic standards (Table 4-3 Summary of Surface Water SSCLs).

6.4.4 Groundwater

Groundwater sampling data collected in 2008 during the RI from piezometers or wells within or near the Upper Marsh are summarized in Table 6-19. Four piezometers (UMPZ-1, UMPZ-2, UMPZ-3, and UMPZ-5) are located within the marsh; piezometer UMPZ-4 is set downstream of the outlet for the Upper Marsh; and the other three (PGPZ-1, PDGW-101, and PDGW-102) are set within the Pass Creek drainage for reference (Figure 34).

Table 6-19 Upper Marsh Alluvial Aquifer Metals Concentrations

Sampling Location	Contaminant of Concern (mg/L)							
	Al	As	Cd	Cu	Fe	Pb	Mn	Zn
Pass Creek Reference Area								
PGPZ-1	<0.03	**0.04**	<0.00008	<0.001	**18.56**	<0.0005	**2.149**	0.02
PDGW-101	3.47	<0.002	0.00014	0.08	8.7	0.0027	0.668	0.3
PDGW-102	6.63	0.003	<0.00008	0.275	12.73	0.0007	0.376	0.26
Marsh Interior								
UMPZ-1	<0.03	<0.002	**0.00955**	0.003	<0.03	<0.0005	0.055	**4.08**
UMPZ-2	<0.03	<0.002	<0.00008	<0.001	**27.8**	0.0006	**1.503**	0.01
UMPZ-3	<0.03	**0.011**	<0.00008	0.002	**28.84**	0.0019	**3.074**	0.08
UMPZ-5	0.85	<0.002	0.00009	0.002	**24.63**	0.0006	0.756	0.25
Downstream of Marsh								
UMPZ-4	<0.03	<0.002	0.00191	0.001	1.67	0.0005	**3.027**	0.3

Bold values exceed groundwater SSCLs (Table 4-2 Summary of Groundwater SSCLs).

Arsenic exceeded the DEQ-7 groundwater standard and iron and manganese exceeded the SSCLs in the single piezometer sample from the Pass Creek drainage. Sample UMPZ-1, located nearest to the inlet of the marsh, exceeded DEQ-7 standards for cadmium and zinc and UMPZ-3 had a slight exceedance of arsenic, but was lower than the arsenic exceedance for the Pass Creek background sample. Several of the interior and downstream groundwater samples exceeded SSCLs for iron and manganese. These results are similar to data recorded in the late 1980s as appended to the Comprehensive Data Summary Report for the Upper Blackfoot Mining Complex (Tetra Tech, 2007). For the purpose of evaluating remedial alternatives, the following parameters were used to estimate a quantity of groundwater flow in the Upper Marsh:

- Hydraulic conductivity (K) of 3.8 ft/day (well LCMW-1 from the RI).
- Gradient (i) of 0.6467 ft/ft (average hydraulic gradient from the potentiometric map, (Figure 21).
- Width of 1300 feet (average width of the valley in the middle of the Upper Marsh).
- Depth of 53 feet (well log for BRGW-101 from the RI).

Using these assumed parameters and applying Darcy's equation, a groundwater flow estimate of 63.5 gpm is estimated for this alluvial aquifer.

6.4.5 Biota

Analysis of plant, invertebrate, and small mammal tissues collected during the RI indicate that metal exposure and uptake is occurring in the Upper Marsh. Invertebrate tissues show a clear decreasing trend of cadmium, copper, and lead from east to west; arsenic and manganese show a similar but less pronounced trend. No identifiable trend was identified for zinc. Mammal tissue concentrations in the eastern portion of the Upper Marsh were elevated above background for all COCs and species compared, indicating that the generally higher metals concentrations in soils, sediment, and surface water within the eastern portion of the marsh are a source of metals uptake to biota in the wetland (DEQ, 2014a).

Bioassay tests were completed to determine impacts on survival of amphipods compared with the reference location. Results show severe lethal impacts in the eastern portion of the Upper Marsh. The western-most stations showed the least toxicity overall, but organisms at all stations showed at least sub-lethal impacts. Survival was zero percent in both locations where copper, lead, manganese, and zinc exceeded severe effect level (SEL) screening benchmarks in the Eastern Upper Marsh (DEQ, 2014a). Western areas were affected to a lesser degree, with survival ranging from 56 percent upstream (near the eastern half) to 91 percent downstream. The reference reach survival of amphipods was 96 percent.

6.4.6 Summary of EA 4 Remediation Volume Estimates

A summary of the remediation volume estimates for the Upper Marsh requiring remedial actions based on the SSCLs is presented in Table 6-20.

Table 6-20 Remediation Volume Estimates for EA 4 - Upper Marsh

UBMC Location	Volume Exceeding SSCLs			
	Mine Waste/ Impacted Soil	Sediment	Surface Water	Groundwater
Eastern Upper Marsh	N/A[1]	90,345 cy	See § 6.3.1	63.5 gpm (combined)
Western Upper Marsh	N/A	110,676 cy	See § 6.3.1	63.5 gpm (combined)
Total	**---**	**201,021 cy**	**---**	**63.5 gpm**

[1] N/A - Not a media of concern based on the RI.

6.5 *Evaluation Area 5 - Mining-related Features*

Sampling events in 2007, 2008, and 2011 at the UBMC identified 269 mining-related features, including mine waste piles, adits, and exploratory drill pads. Based on visual observations of runoff channels and/or other erosion features extending from the mine features to downgradient streams or floodplains, it was determined that some of the identified mine features could potentially impact surface water during times of high runoff, precipitation, or snow melt. Mine waste or associated material, stream sediment, and surface water samples were collected and analyzed at 20 of the features identified as potential sources of contamination to nearby surface water. Dry site conditions were encountered at many of the features during the mine inventory evaluation work, and transport of acidic or metal rich leachate, runoff, or sediment loading from mine wastes into nearby streams was not observed. Of the 269 features evaluated in the RI, 197 features were assigned a finding of "no significant disturbance" based on the following criteria:

- No threat to physical safety.
- No hazardous material or less than 100 cy of excavated rock present.
- No discharge to or contact with surface water.

Of the remaining 72 features, BR-36, BR-37, and BR-38 are located within the footprint of EU 1B and are included in the analysis of that exposure unit (Section 6.1.2). BC-01 is located within EU 11 and is included as part of the EE/CA removal. These four features, plus two other features discovered after the field inventory and sampling to be located on an active patented mining claim (CG-02 and CG-03), were eliminated from the FS mining-related feature inventory review. Features CG-02 and CG-03 will be addressed in the proposed plan.

Four additional features in Shave Gulch (SG-13, SG-14, SG-49, and SG-50) were combined into two features based on GPS locations and RI field notes. SG-13 and SG-14, each described in the RI as a disturbed area, had the same GPS coordinates and were combined as SG-13/14. Described in the RI as a collapsed adit, SG-50 was combined with feature SG-49, an adjacent disturbed area associated with the collapsed adit, as SG-49/50.

Analytical results from the features sampled in the RI were compared against the SSCLs in Table 4-1 to determine areas of exceedance. Because there are no SSCLs that specifically address the mining-related features, SSCLs for the closest and most applicable EU were used to determine exceedances. Feature SG-100 was eliminated from further evaluation because mine waste or associated material sampled in Shave Gulch at SG-100 had no exceedances when compared to the soil SSCLs for EU 3.

6.5.1 Mining-related Feature Evaluation

For purposes of the FS, 63 mining-related features (Figure 35 and Figure 36) were retained to develop remedial alternatives. A majority of the features were not sampled as part of the RI. The FS assumes that the observed mine waste, disturbed areas, discharges, seeps, or springs at these features exceed the SSCLs for the closest and most applicable EU.

A review of historic and current aerial photographs, RI field notes and site photographs, and comparison of the RI sampling results with SSCLs in Table 4-1 redefines several of the mining-related features into the following eight categories:

1) <u>Collapsed adit with waste rock</u> – includes 24 features identified in the RI as adit, adit and rock pile, rock, adit and pile, or mined rock.
2) <u>Collapsed adit with waste rock and discharge, seep, or spring</u> – includes six features identified in the RI as adit or adit and rock pile and that had water from springs, adit discharge, seepage, or historical signs of water.

3) Collapsed adit with discharge, seep, or spring – includes two features identified in the RI as adit and that had water from springs, adit discharge, seepage, or historical signs of water.
4) Disturbed area – includes 24 features identified in the RI as adit, exploratory pit, trench, rock, water quality, rock pile, exploratory drill pad, tailings edge, drill cuttings, or possible staging area. Although several of these features were labeled as adits in the RI, no observation of an actual adit was noted in the supporting field notes or available site photos.
5) Disturbed area with discharge, seep, or spring – includes two features identified in the RI as exploratory drill pad or spring and that had water from springs, adit discharge, seepage, or historical signs of water.
6) Physical hazard – includes three features identified in the RI as adit, adit with rock pile, or exploratory drill pad. Review of field notes and available site photos indicate that these features could allow human entry and present a safety hazard.
7) Physical hazard with waste rock – includes one feature identified in the RI as open adit portal. Review of field notes and available site photos indicated that this feature could allow human entry and present a safety hazard within an area of waste rock.
8) Surface water/sediment – includes one feature identified in the RI as adit and pile. Mine waste or associated material sampled at this feature had no exceedances when compared to the soil SSCLs. Surface water and sediment samples were collected from Stevens Creek, not the adit. These samples exceeded surface water and sediment SSCLs and are included in the discussion of Stevens Creek in Section 6.3.2 .

A spreadsheet describing the mining-related features in detail is provided in Appendix C and summarized in Table 6-21.

Table 6-21 Mining-related Features Included in the FS

UBMC Drainage	Mine Feature ID	FS Site Type
Anaconda Creek	AC-01[1,2]	Collapsed adit with waste rock
Blackfoot River	BR-16[3], BR-20[3], BR-29, BR-32, BR-39[1,3]	Collapsed adit with waste rock
	BR-01, BR-14	Collapsed adit with waste rock and discharge, seep, or spring
Pass Creek	PC-01[1,2,3], PC-21	Physical hazard (open adit)
	PC-06	Collapsed adit with waste rock
	PC-11[1,3]	Collapsed adit with waste rock and discharge, seep, or spring
	PC-22	Collapsed adit with discharge, seep, or spring
Paymaster Gulch	PM-12, PM-26, PM-35[1,2,3], PM-37[1]	Collapsed adit with waste rock
	JM-01, PM-04, PM-06, PM-28	Disturbed area
Porcupine Gulch	PBBS[1,2,3]	Collapsed adit with discharge, seep, or spring
Shave Gulch	SH-06	Physical hazard (open adit) with waste rock
	SH-07, SH-13, SH-14, SH-17[1,2] SH-23, SH-29, SH-37, SH-44	Collapsed adit with waste rock
	SH-43[1,2,3]	Collapsed adit with waste rock and discharge, seep, or spring
Stevens Gulch	SG-01	Physical hazard (open pipe)
	SG-44, SG-47, SG-48 SG-49/50, SG-99[1,2]	Collapsed adit with waste rock
	SG-71, SG-98[3]	Collapsed adit with waste rock and discharge, seep, or spring
	SG-55[1], SG-94[1,2,3]	Disturbed area with discharge, seep, or spring
	SG-13/14, SG-16, SG-24, SG-31, SG-33 SG-35, SG-41, SG-43, SG-51, SG-53 SG-56, SG-58, SG-67, SG-78, SG-82 SG-86, SG-89, SG-95, SG-96[1,2,3]	Disturbed area
	SG-93[1,2,3]	Surface water/sediment
Swamp Gulch	SWG-02	Disturbed area

[1]Surface water sample collected in 2007, 2008 or 2011.
[2]Sediment sample collected in 2007, 2008 or 2011.
[3]Soil/waste area sample collected in 2007, 2008 or 2011.

6.5.2 Summary of EA 5 Remediation Volume Estimates

Mining-related features were grouped within a drainage basin by proximity and/or common access road to limit duplication of remedial action efforts, including construction of access roads, deployment of equipment, and material hauling. A summary of the remediation volume estimates for grouped locations within EA 5 requiring remedial actions based on the SSCLs (sampled and assumed) is presented in Table 6-22.

Table 6-22 Remediation Volume Estimates for EA 5 - Mining-related Features

UBMC Location	Volume Exceeding SSCLs			
	Mine Waste/ Impacted Soil[1]	Sediment	Surface Water	Groundwater
Anaconda Creek Drainage				
AC-01	500 cy	--	--	--
Blackfoot River Drainage				
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	5,017 cy	--	See §6.3.4	--
BR-29	280 cy	--	--	--
Pass Creek Drainage				
PC-01, PC-06, PC-11, PC-21, PC-22	2,200 cy	--	See §6.3.4	--
Paymaster Gulch Drainage				
PM-04, PM-06, PM-12 PM-35, PM-37, JM-01	3,304 cy	--	--	--
PM-26, PM-28	2,856 cy	--	--	--
Porcupine Creek Drainage				
PBBS	--	See §6.3.4	See §6.3.4	--
Shave Gulch Drainage				
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	11,620 cy	See §6.3.4	See §6.3.4	--
SH-06, SH-07, SH-13, SH-14	14,970 cy	--	--	--
Stevens Gulch Drainage				
SG-13/14, SG-16, SG-43	6,662 cy	--	--	--
SG-24, SG-44, SG-53, SG-55 SG-56, SG-58, SG-67, SG-98	45,131 cy	--	See §6.3.4	--
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78, SG-82, SG-93 SG-94, SG-95, SG-96, SG-99	7,479 cy	See §6.3.4	See §6.3.4	--
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	2,850 cy	--	--	--
Swamp Gulch Drainage				
SWG-02	244 cy	--	--	--
Total	**103,113 cy**	**---**	**---**	**---**

[1] Volume estimated in the RI or based on engineering judgment.

6.6 *Summary of Remediation Volume Estimates*

Remediation volume estimates for areas within the five EAs at the UBMC requiring remedial actions based on the SSCLs are presented in Table 6-23.

Table 6-23 Remediation Volume Estimates for UBMC

UBMC Location	Volume Exceeding SSCLs			
	Mine Waste/ Impacted Soil	Sediment	Surface Water	Groundwater
EA 1 - Upland Waste Areas	57,781 cy	--	--	--
EA 2 - Groundwater	--	--	--	98 gpm
EA 3 - Streams	--	18,520 cy	84.7 cfs	--
EA 4 - Upper Marsh	--	201,021 cy	--	63.5 gpm
EA 5 - Mining-related Features	103,113 cy	--	--	--
Total	**160,894 cy**	**219,541 cy**	**84.7 cfs**	**161.5 gpm**

7 GENERAL REMEDIAL ACTIONS

This section summarizes the development and screening of remedial technologies and process options as potential remedial actions to address contaminated media at the UBMC. For the UBMC, general remedial actions include institutional controls (ICs), engineering controls, land disposal, treatment (active and passive), and monitored natural attenuation (MNA)/monitored natural recovery (MNR). Each general remedial action can be achieved by one or several remedial technology types implemented by specific process options. Additionally, a No Action alternative was included as a baseline for comparison of other remedial alternatives.

7.1 *Initial Alternatives Screening Document*

A comprehensive list of potential remedial technologies and process options was compiled and evaluated in *UBMC Final IASD Technical Memorandum* (Appendix D). The IASD used Federal Remediation Technology Roundtable (FRTR) criteria for effectiveness, implementability, and cost in an Initial Alternative Screening Matrix (IASM) to evaluate all potential remedial technologies and identify those technologies requiring further analysis. The FRTR criteria were applied to the technologies as described below.

Effectiveness. The effectiveness criteria refer to how well the remedial technology can address the COCs with consideration to the site-specific conditions: i.e., meeting the PRAOs. Process options were rated as high (highly effective), medium (moderately effective), or low (slightly effective).

Implementability. The implementability criteria refer to how readily the technology can be implemented at the site with consideration to known site conditions. Process options were rated as high (easy to implement), medium (moderate effort to implement), or low (difficult to implement).

Cost. The cost criteria were examined as both a capital cost and Operations and Maintenance (O&M) associated costs. Capital costs for each process option were rated from low (inexpensive) to high (expensive) and O&M costs were rated from significant (high degree of O&M) to minimal (low degree of O&M).

Results of the initial screening are listed in the IASD (Table 1 of Appendix D). Process options retained from the IASM were generally those options that met two of the three criteria, i.e., high effectiveness, high implementability, and minimal capital cost/O&M. For example, technologies that were evaluated as high for cost, high for implementability, and low for effectiveness were not retained. Engineering judgment eliminated or retained technologies that did not meet two criteria, i.e., medium effectiveness, medium implementability, and moderate capital cost/O&M. The remedial technologies retained were evaluated in greater detail in a secondary screening matrix. The secondary screening matrix added the following FRTR criteria factors for availability and reliability and maintainability to the original three criteria:

Availability. The availability criteria refer to the number of vendors that can design, construct, and maintain the technology or provide specialized equipment. Process options were rated from high (more than four vendors) to low (fewer than two vendors).

Reliability and Maintainability. The reliability and maintainability criteria refer to the expected range of demonstrated reliability and maintenance relative to other technologies. Process options were rated as high (high reliability and low maintenance), medium (average reliability and average maintenance), or low (low reliability and high maintenance).

Results of the secondary screening are presented in the IASD (Table 2 of Appendix D). For the secondary screening, media at the UBMC were regrouped from five categories (physical hazards, waste rock/tailings and associated soils, floodplain contaminants, surface water, and groundwater) into two categories (physical hazards/solid media and surface water/groundwater). Remedial technologies were evaluated using a weighted scoring system for all five criteria. Certain criteria (effectiveness and implementability) were assigned larger weighting factors to reflect a greater importance of these criteria within the evaluation. A detailed description of the scoring process and criteria analysis is in the IASD (Table 2 of Appendix D). Remedial technologies with a total (weighted) score below a screening threshold level were not retained for use in the FS.

7.2 *Retained Technology Options*

Based on the results from the initial and secondary screening processes, applicable remedial technologies and process options were retained for further analysis as remedial alternatives for the UBMC FS. Citations and references for all retained technologies are included in the IASD (Table 2 of Appendix D). The following applicable remedial technologies and process options were retained:

Physical Hazards/Solid Media

- No Action
- Institutional Controls
  - Land Use Controls
    - Deed Restrictions, Easements, Covenants, Reservations
- Engineering Controls
  - Access Restrictions
    - Fencing, Warning Signs, Gates
  - Physical Barriers
    - Bat Gates, Backfills, Plugs, Bulkheads
  - Removal
    - Remove to Physical Indicator or SSCLs
  - Containment
    - Earthen Vegetative Cover
- Monitored Natural Recovery (sediment only) – discussed in Section 7.5.10
- Land Disposal
  - On-site Repository
  - Off-site Repository
- In-Situ Treatment
  - Neutralization with Alkaline Amendment
- Ex-Situ Treatment
  - Blending and Co-Disposal
  - Neutralization with Alkaline Amendment

Surface Water/Groundwater

- No Action
- Monitored Natural Attenuation (groundwater only)
- Institutional Controls
  - Land Use Controls
    - Deed Restrictions, Easements, Covenants, Reservations
- Engineering Controls
  - Containment
    - Retention Pond

  - Detention
    - Settling Pond
  - Hydrologic and Hydraulic Control
    - Diversion, Fracture /Fault Grouting, Piping, Stream Realignment
  - Inundation
    - Bulkhead/Wet Mine Seal, Plug
- Active Treatment
  - Chemical Reagent
    - Neutralization, Oxidation, Precipitation
  - Physical/Mechanical Treatment
    - Electrocoagulation, Ceramic Microfiltration
- Passive Treatment
  - Chemical Reagent
    - Permeable Reactive Barrier (PRB)
- Monitored Natural Recovery (sediment only)

7.3 *Site-Wide Elements*

All remedial alternatives, with the exception of No Action, are expected to incorporate at least some site-wide elements including institutional controls, engineering controls, and long-term monitoring and maintenance. These site-wide elements are described in the following sections and are not included in the alternative analysis.

7.3.1 ICs – Deed Restrictions, Easements, Covenants, Reservations

The ICs are non-engineering remedial alternatives designed to reduce potential human exposure to physical hazards or contamination and protect the integrity of chosen remedies. Land use controls, including deed restrictions, easements, covenants, and reservations, which limit future land uses, are required where waste is left in place as part of the remediation. These ICs have low effectiveness in directly meeting the PRAOs, but can be effective in preventing residential and occupational exposures. The ICs are typically less effective at eliminating recreational or trespass exposures, but are somewhat effective in reducing these exposures. ICs are also used to supplement other treatments or controls that do not fully meet PRAOs to enhance their overall effectiveness.

Implementation of ICs typically includes administrative, legal, enforcement, and filing costs. Persistent management and enforcement are required to ensure that the ICs remain in place and are fully enforced. Past Pioneer project experience on similar sites indicates that the motivation to enforce ICs generally diminishes with time and long-term funding is needed to ensure that ICs employed at a site remain in force and effective. Administrative monitoring of ICs is needed in almost all cases to ensure that all implemented ICs remain in place and are effective. Private parties and state and federal agencies may need to rely on local government assistance and management of certain land records or restrictive covenants.

Restrictions are relatively easy to implement on Trust lands but rely on local government recordkeeping to ensure that all applicable restrictions carry through on any future land transfers and/or transactions. Restrictions are more difficult to administer on USFS lands because of the administrative difficulty associated with limiting public access to public lands.

7.3.2 Engineering Controls – Access Restrictions

Engineering controls such as fencing, warning signs, and gates can be used in conjunction with all alternatives considered. Fencing and gates are typically installed to control access to the site during construction and limit livestock and wildlife access during the early grow-in period following remediation efforts. Where applicable, fencing may be left in place and warning signs added to gates and typical access locations to warn recreational users of the potential hazards. At an appropriate time, i.e., after vegetation is successfully established and where dispersed foot traffic or non-motorized use is allowed, control gates may be replaced with access gates to allow hiker and horse access. Periodic inspection and replacement of the signs, gates, fencing, and other controls is needed.

Access restrictions are more difficult to implement on USFS lands. The USFS would typically need to revise applicable travel plans and include public participation in fencing or closing areas on USFS property.

7.3.3 Long-Term Monitoring and Maintenance

Long-term monitoring and maintenance is used to assess the remedial action effectiveness, determine if additional actions are needed, and to identify areas needing maintenance. Sampling, vegetation monitoring, and visual inspections would normally be conducted at least annually.

Routine inspection and maintenance of fences, warning signs, and gates is needed. Adjustments to gate closures and openings should be completed seasonally to ensure that appropriate controls for the various seasonal recreational use changes are in place (e.g., motorized or non-motorized use, hunting, trapping).

7.4 *Physical Hazards/Solid Media*

Nine technology options were retained to address safety issues for physical hazards (e.g., adits, subsidence areas, shafts) and remedial actions for contaminated solid media (waste rock, tailings, contaminated sediment, and impacted soil) at the UBMC. The following sections generally describe each option and its applicability at the UBMC.

7.4.1 No Action

Under the No Action Alternative, no remedial activities would be conducted at the UBMC to reduce the risk from physical hazards or contaminated media. All contaminated media would remain in place. No Action serves as a baseline to compare other alternatives and help understand risk levels at the facility.

7.4.2 Engineering Controls – Physical Barriers

Installing bat gates, plugs, or bulkheads in adits or backfilling the openings reduces or prohibits entry by humans. The plug option involves installing a polyurethane foam or concrete mass in the entrance and covering the site with clean backfill or rock. Bulkhead development includes a concrete plug with piping and valves for hydraulic controls installed within an adit. The bat gate option involves installing a sturdy, steel grate system over the adit entrance. The bat gate is designed with openings sized large enough to allow bat access and egress but small enough to prevent entrance by humans and large animals.

These technologies are widely used, highly reliable, easy to maintain, and effectively seal or block unauthorized access to mine entrances. These structures provide no remediation to reduce toxicity, mobility, or volume of COCs but are often used in conjunction with other alternatives and reduce the risks posed by physical hazards.

Physical barriers can typically be installed using standard construction planning, manufacturing, equipment, and practices. Installation costs are usually driven by accessibility issues and the physical size of the opening to be closed.

Bulkheads installed inside mine entrances usually require periodic inspection, maintenance, and/or repair. Improvement, stabilization, and periodic maintenance of the mine entrance are typically required to provide safe access for bulkhead inspection and maintenance. Improvements to the mine entrance would also include installing a secure mine entrance gate. Subsidence behind the bulkheads is a possibility and may adversely impact the intended function of the bulkheads (i.e., drainage piping, if installed). The exterior portions of the access controls are often subject to vandalism and need to be inspected and repaired as needed.

7.4.3 Engineering Controls – Removal

Removal actions typically call for wastes to be excavated to an established SSCL, or excavated to a physical/visual indicator such as groundwater, underlying native lithologic unit, pre-determined over-excavation depth, or bedrock. Removal actions may be applied to any solid media at the facility including, but not limited to, waste rock, tailings, metals laden overburden, spoils, contaminated sediments, or contaminated underlying soils.

The measure is typically very effective for both large volume sources and smaller concentrated sources located close to or in direct contact with water. The excavated material is removed to a location away from surface water and other sensitive receptors and capped and/or isolated within a repository, making repository construction and capping co-alternatives. Removal is also effective for small quantities, which may be removed and disposed at an off-site or on-site repository.

Removal is a proven remediation option that is typically highly effective and may be capable of meeting applicable PRAOs. The option is best suited for areas with adequate access; removal of small and/or isolated areas located away from good access roads is typically not cost effective. The impacts from road construction to reach sources, particularly in mineralized areas, may offset or exceed the benefits of removal. Standard equipment, survey activities, and construction oversight are required and numerous experienced contractors are available to complete the work.

Temporary stream diversion and dewatering may be required if the source is located immediately adjacent to surface water or extends below the ground surface to groundwater. Over-excavation of material beneath the waste source is often required to ensure leached metals are adequately removed from underlying soils. Removal verification sampling can also verify removal effectiveness. Because over-excavation of native materials below the waste source is often necessary, clean backfill and cover material is typically required to reestablish natural grades and to provide suitable growth media for revegetation efforts.

Removal costs vary greatly depending on availability of on-site disposal areas, additional off-site disposal costs, site accessibility, effort required to dewater or dry materials, haul distance to disposal areas, and availability and cost of suitable backfill and/or cover material. Additional sampling analyses, construction oversight, and monitoring of remediated areas and disposal sites also contribute to the total costs, but are typically small in comparison to the other factors.

7.4.4 Engineering Controls – Containment

Earthen vegetative covers include placing a soil and plant cover over the area to reduce the direct contact exposure pathway and establishing a self-sustaining plant cover to minimize erosion. The measure provides no remediation to reduce the toxicity, concentration, or volume of COCs and does not eliminate water infiltration and acid drainage, but may reduce the amount of infiltration and thus the volume of acid drainage. Containment may be more effective if waste is amended to reduce the toxicity and mobility of COCs before placing the cover. EPA's presumptive remedy guidance for metals-in-soils indicates containment may be appropriate for low-hazard wastes, such as those that do not exhibit leaching potential or are near the applicable SSCL (EPA, 2009).

In some areas where removal is not feasible and slopes are too steep (greater than 3:1 horizontal:vertical [3H:1V]) to establish a vegetative cover, applying an angular rock cover reduces direct contact, rain-drop impact energy with contaminated soils, and the associated erosion and transport of contaminated media. Rock covers can also be used to break up long slope lengths to reduce soil erosion and aid in establishing vegetation on portions of the slope.

Containment does not fully isolate or eliminate metal loads in acid-generating rock. It is most applicable to areas of lower levels of contamination, where other actions are not feasible, or where covering native high metals materials is necessary. The action can be applied in a wide variety of situations to enhance slope stability and reduce erosion. Additional erosion control measures such as slope drains, benching, cross-slope drains, erosion control blankets, check dams, and sediment traps may be required. Costs are driven by access, waste volume and area, and availability of a suitable source of cover material. Containment does not eliminate infiltration and may require a high level of maintenance in terms of erosion and weed control.

7.4.5 Land Disposal – On-Site Repository

Disposal of mine waste in an on-site repository is a conventional, widely used, and highly effective technology. The technology involves excavating (and typically drying) mine wastes and placing them within an engineered repository. The measure is highly effective and capable of meeting applicable PRAOs and reducing or effectively eliminating human and environmental exposures. Repositories typically incorporate an engineered cap with a vegetated earthen-cover soil layer, drainage layers, and a synthetic membrane cap liner to prevent water from infiltrating into and passing through the waste materials. In some cases, if waste materials are particularly reactive or highly metals laden, drainage layers, membrane bottom liners, clay liners, and leachate collection systems can also be employed to provide additional protection of groundwater resources at the repository site. It is also common for the repository excavation to serve as the cover soil borrow source for other site reclamation activities.

Implementability is driven by space, geology, groundwater, waste volume, and transport logistics. Repository construction typically only requires standard construction equipment, survey activities, and management practices and numerous experienced contractors are available regionally. There is a risk of spills during transport, but planning to address rapid response and cleanup activities is simple and typically available via the construction contractor. Long-term monitoring of the repository to verify vegetation establishment and to ensure protection of local groundwater is typical. Existing repositories are available within the UBMC at the Paymaster Mine and the Carbonate Mine; the Mike Horse Mine Repository is being removed as part of the 2014-2015 interim action. In addition, the USFS selected the on-site repository currently being constructed at Section 35 under its Action Memorandum, as amended. Use of the Paymaster and/or Carbonate Repository would require additional engineering.

7.4.6 Land Disposal – Off-Site Repository

Disposal of contaminated solid media at an off-site repository is a commonly used conventional technology and involves excavating (and sometimes drying) mine wastes and placing them within an engineered repository. The off-site repository may be constructed to serve a single specific mine site, designed as a regional repository to service multiple sites, or may be a separate existing permitted facility not associated with the cleanup project. The measure can be highly effective in meeting PRAOs and decreasing risk of exposure at the remediation site. Typically, designing an off-site repository follows the same general procedures and criteria used to site and design an on-site repository. Off-site repositories may be used if a suitable repository site is not available on-site.

Disposal of solid media associated with mining waste at an off-site repository is typically limited to disposal of small volumes of highly contaminated solid media or treatment residues from treatment facilities. High transportation costs and landfill disposal fees make disposal of large volumes of mine waste too costly to be practical in most cases. If the waste to be disposed of fails the Toxicity Characteristic Leaching Procedure (TCLP) test, disposal in a permitted RCRA Type C facility may be required. Currently there are no such facilities in Montana and wastes would have to be disposed of out of state, making transportation and disposal at such a facility expensive.

Implementability is driven by space, geology, groundwater, volume, and transport logistics. However, repository construction typically only requires standard construction equipment, survey activities, and management practices. Numerous experienced contractors are available regionally. There is a risk of spills during transport, but planning to address rapid response and cleanup is simple and typically available via the construction contractor. Long-term monitoring of the repository to verify vegetation establishment and to ensure protection of local groundwater is typical.

7.4.7 In-Situ Treatment – Neutralization with Alkaline Amendment

In-situ neutralization involves adding cement kiln dust, lime, or other alkaline material to mine waste and mixing the materials to neutralize acid-producing wastes. EPA's presumptive remedy guidance for metals-in-soils indicates that neutralization is a presumptive remedy for source materials, soils containing high levels of contaminants, and highly mobile contaminants (EPA, 2009). Acid mine drainage (AMD) is reduced by increasing the pH of the mixed materials and providing excess buffering capacity to minimize or eliminate acid production in the mine waste. Because most metals are typically only mobile or bio-available at low pH, increasing the pH decreases the mobility and bio-availability of the metals in the mine waste materials. Effectiveness is limited to the tillage depth and by the ability to get complete and uniform mixing of the amendments with the waste material. At the UBMC, in-situ neutralization is applicable to waste deposits less than 2 feet thick, or treatment of residual soil contamination following the removal of waste piles.

This treatment can be a very effective method to reduce the mobility of residual metals in underlying soils after removal of overlying contaminated materials. While treatment does not reduce the concentration of metals in the treated soils, it can effectively immobilize the metals to prevent migration to surface water and groundwater as well reduce the bioavailability of the metals for environmental receptors. It is difficult to safely operate tilling and mixing equipment on steep slopes (greater than 3 to 1 H:V).

Typically, excess amendment is added to wastes to address active acidity as well as the future acid-generating potential of the materials. Amendment materials need to be carefully selected to ensure an appropriate fine-size fraction to facilitate maximum soil particle contact and chemical reaction surface area. Amendment materials must also provide sufficient alkalinity to provide an initial pH increase to precipitate metals already in solution within the soil. An equilibrating period is usually required after treatment to allow the pH to return to near neutral conditions to allow successful revegetation.

Treatment of materials in close proximity to groundwater or surface water is typically not recommended. Frequent rewetting can cause separation of the amendment from the soil particles and render the treatment ineffective. Erosion of treated materials may result in separation or segregation of the amendment material from the soil particles, thereby reducing the overall effectiveness of the treatment; therefore, this is not recommended for remediation of wastes in a floodplain or stream channel migration zone (CMZ).

Lime and other amendment sources may be limited and/or expensive due to current market conditions. Consideration of the cost and availability of lime materials is necessary during design to determine the availability of suitable sources and long-term contracts are sometimes required. Mine waste sources are typically heterogeneous and frequent testing is needed to determine the properties of the materials as they are treated and to adjust amendment rates as needed. Over-treatment of materials can inhibit vegetation establishment and/or cause the mobility of arsenic to increase. Additional construction oversight and testing would help to manage these issues during construction. The technology can be effective if used in conjunction with other alternatives.

7.4.8 Ex-Situ Treatment – Blending and Co-Disposal

Blending and co-disposal treatments involve blending mine wastes of varying acid-generation and neutralization potentials to produce a mixed material mass with reduced contaminant mobility potential. Detailed testing of tailings and mine waste chemistry could determine the acid and neutralizing potentials of various materials and determine appropriate blending ratios.

Materials need to be selectively tested, excavated, and handled to ensure that the materials are mixed with another complementary material. Most mine waste sources are heterogeneous and routine testing is needed to identify changes or variations in acid/neutralization potential as the materials are excavated. Therefore, blending ratios need to be adjusted as necessary during construction. Thorough mixing of the materials ensures adequate soil particle contact and viability of the stabilizing chemical reactions.

If the treatment is intended to stabilize soils in a consolidation area without an engineered cap or cover system, rigorous testing is needed during construction to adjust blending ratios as needed. In situations where insufficient neutralizing materials are available on-site, alkaline amendments may be required to supplement blending efforts. If the treatment is used to enhance the effectiveness of a repository by generally blending compatible waste sources, less testing is needed during construction, but sufficient testing is needed to develop a sufficiently detailed general waste excavation, blending, and placement sequence. Blending in the repository can effectively reduce the COC concentrations in leachate, increase geotechnical material strength and stability, and enhance the geochemical stability of the repository in the long-term.

Experienced regional contractors are available and special construction techniques are not required. However, increased geochemical testing, planning, and construction oversight are typically necessary. Blending materials can help reduce long-term operation and maintenance costs if used with other technology options and can be very cost effective. The technology would generally be included as a design enhancement to be used in conjunction with other technology options.

7.4.9 Ex-Situ Treatment – Neutralization with Alkaline Amendment

This treatment action requires excavating and removing wastes to a mixing location, adding alkaline amendments (cement kiln dust, lime, or other alkaline material), and thoroughly mixing the amendment with the waste materials to neutralize acids and enhance the long-term geochemical stability of the treated waste mass. EPA's presumptive remedy guidance for metals-in-soils indicates that neutralization is a presumptive remedy for source materials, soils containing high levels of contaminants, and highly mobile contaminants (EPA, 2009). AMD is reduced by neutralizing the acid-generating potential of the wastes and through the associated decrease in metals mobility with increased pH. The neutralized waste material may be returned to the original excavation area, placed in a separate consolidation area, or placed in a repository.

This conventional technology is commonly used regionally and was applied at the Paymaster and Carbonate Mine repositories, as well as numerous other mine waste sites in Montana. If the technique is intended to stabilize soils in a consolidation area without an engineered cap or cover system, rigorous testing is needed during construction to adjust amendment ratios as needed to ensure adequate neutralization. Lime and other amendment sources may be limited and/or expensive due to current market conditions. Consideration of the cost and availability of lime materials is necessary during design to determine the availability of suitable sources and long-term contracts are sometimes required.

7.5 *Surface Water/Groundwater*

Nine technology options were retained to address remedial actions for surface water and groundwater at the UBMC. The following sections discuss each option and its applicability at the UBMC.

7.5.1 No Action

Under the No Action Alternative, contaminated media would be left in its current condition at the UBMC and reduction of contaminant exposure beyond the current site conditions would not be provided. The WTP would no longer operate. No Action serves as a baseline to compare other alternatives and help understand risk levels at the facility.

7.5.2 Monitored Natural Attenuation

Monitored Natural Attenuation (MNA) for groundwater is typically used in conjunction with source removal. After source removal, groundwater quality would be monitored regularly to confirm that COC concentrations are improving over time and will reach SSCLs. The alternative relies on natural processes and source remediation efforts to reduce concentrations of COCs through time. The alternative alone would not meet PRAOs.

The measure would be easily implemented using the existing groundwater monitoring wells at the facility; however, it requires a comprehensive, long-term monitoring and data management and assessment plan. Monitoring for this alternative could be effectively combined with the site-wide long-term monitoring described in Section 7.3.3 to reduce costs. The option can be used in conjunction with other alternatives and is applicable to some features that have already been reclaimed if implementing additional remedial actions is not deemed necessary. The MNA alternative can also be used in conjunction with site-wide ICs and to determine how and when ICs for portions of the facility may be revised.

Contaminant sources for surface water are being removed within the floodplain upstream of the Upper Marsh and the water treatment plant is treating contaminated water before it is discharged to surface water. As these sources are removed and clean water enters the system, surface water contaminant concentrations will decrease through dispersion and dilution. DEQ-7 standards may be achieved within 30 to 40 years, when combined with other alternatives or through natural attenuation, based on experience at other similar sites such as Silver Bow Creek near Butte, Montana. This timeframe could vary due to a fluctuating groundwater table or other continuing migration of contamination.

7.5.3 Engineering Controls – Containment (Retention Pond)

This measure uses a lined pond constructed near a drainage or seepage source to capture and retain AMD. Treatment usually relies on evaporation and is therefore applicable only to low flows and not applicable to surface runoff flows with highly variable seasonal flows.

Evaporation of the water concentrates the metals in the water and leaves behind a residue of soluble metal salts. Periodic cleaning of the pond may be required to remove the residues. In some cases it may be necessary to remove and haul the water to a water treatment facility for treatment prior to disposal. The high concentrations and typically low pH of the water in the ponds may present high exposure risks to birds and other receptors; fencing, netting, or other engineering controls are needed to minimize receptors coming into direct contact with the AMD. Because the technology relies on evaporation, the effectiveness is greatly reduced at high elevations, cool climates, and on north-facing slopes.

For this option, design and construction are relatively easy and require only common construction techniques. The ponds require periodic inspections and can be prone to failure. If not covered with soils, the synthetic liner systems pose physical hazards to wildlife, deteriorate over time with exposure to sunlight, and may require periodic replacement. Ponds with exposed liners should be fenced and signed to prevent human and wildlife access. This option is best used in conjunction with other treatment options that use the containment systems for temporary storage or provide overflow capacity prior to water treatment.

7.5.4 Engineering Controls – Detention (Settling Pond)

The detention (settling ponds) measure aids in the removal of suspended solids and can serve to oxygenate water to help settle metals within the ponds. The measure is a widely-used conventional technology but requires a relatively large area to obtain adequate detention time and settling. The option is often used in conjunction with other alternatives and can be effective as a pretreatment and/or equalization step in an active treatment system. The method is also commonly used to control storm water runoff during construction, during vegetation establishment, and in areas where remediation and revegetation may not be feasible (e.g., steep slopes in mining areas, pit highwalls).

Settling ponds are usually most effective for water with high total suspended solids (TSS) and near neutral pH waters. Maintenance requires dam and outlet inspections, outlet cleaning, sediment chemistry testing, and periodic removal of accumulated sediments. If sediments are metals laden, on-site or off-site land disposal may be required. If the waste to be disposed of fails the TCLP test, disposal in a permitted RCRA Type C facility may be required. There are currently no such facilities in Montana and wastes would have to be disposed of out of state, making transportation and disposal at such a facility expensive.

7.5.5 Engineering Controls – Hydrologic and Hydraulic Controls

Hydrologic and hydraulic controls (diversion, fracture/fault grouting, piping, and stream alignment) are used to intercept surface and/or groundwater and to divert water away from mine workings. Diversion channels are installed to intercept and divert surface water around waste or to prevent runoff from entering mine workings. Piping can be used to capture and convey flows around wastes and/or to specific discharge points. Piping or impermeable channels are less effective on gaining streams, but can be very effective at preventing losing streams from contributing water to underlying waste materials or mine workings.

Grouting includes injecting slurry into fractures or faults to prevent groundwater from traveling through mineralized zones and can also be used to seal near-surface faults, fractures, drill holes, or other mine openings to prevent surface water from entering mine workings. The technology can reduce groundwater degradation by restricting flow through fractured rock and reducing the amount of water in contact with acid-producing materials in the mine workings, in turn reducing the volume of AMD produced. The effectiveness of reducing AMD depends on fracture and fault characteristics and the relative success of the grouting program. Borehole drilling for slurry injection may lead to increased fracturing of the rock and complicate grouting efforts.

Stream realignment/reconstruction involves construction of a new stream channel to convey flows around wastes left in place or to create a suitable new stream channel after mine waste removal. Careful design is required for stream realignment to ensure that the channel and floodplain will be stable in the long term; water may attempt to return to the original channel in time and adequate engineered elements (e.g., grade controls, lateral migration controls) must be incorporated into the design.

Hydrologic controls can be implemented in areas with acid-producing soils or rock to reduce erosion and percolation through wastes and reduce the production and magnitude of AMD, but can be difficult to construct in space-constrained and access-limited areas. The measures require long-term inspection, especially following runoff events, and may require routine maintenance to ensure that they continue to function as intended. These technologies are not independently effective for contaminant removal and risk reduction, but are effective for reducing contaminant mobility when used in conjunction with other technologies.

7.5.6 Engineering Controls – Inundation

Inundation controls (bulkhead/wet mine seal and plug) do not address or treat contamination, but raising the water level in the mine/adit and inundating the mine workings may reduce AMD through the reduction of acid production. A bulkhead/wet mine seal is a wall installed in a mine opening that allows water to leave a flooded adit but prevents air from entering. Inundation through use of a plug involves installing reinforced polyurethane foam or a concrete plug in the mine entrance to completely block water and/or AMD from exiting the mine opening.

Extensive research and planning, including adit investigation, site characterization, and engineering options, are required for proper design of these controls. Repairs and modification of the mine opening may be required to provide safe and adequate access for equipment and personnel to install the seals; a complete seal can be difficult to obtain. Installation of a bulkhead/wet seal or plug will increase the water elevation within the mine and often results in creating new seeps or increasing the flow in other connected mine workings.

Local, experienced contractors can complete the design and installation. Inundation technology costs are generally high due to materials, the remoteness of the site, difficult access, and the potential need for costly mine opening improvements. Long-term reliability includes risk of leakage or failure due to low compressive strength in the plug, no/low gas release, and pressure buildup behind the plugs. Currently, this technology is being used at the UBMC to control adit discharges (Capital adit) as well as to collect, store, mix, and equalize mine water in the mine workings before routing to the WTP (Mike Horse and Anaconda adits). Routine inspections, monitoring, and maintenance of the controls are required to ensure that they continue to function as intended.

7.5.7 Active Treatment – Chemical Reagent

Active treatment for AMD involves adding a neutralizing agent, such as lime (calcium oxide or calcium hydroxide), followed by a settling pond for metals precipitation. This is a proven technology that is currently being used within the UBMC at the WTP. The oxidation option is typically added to enhance treatment efficiency and requires a chemical oxidant, such as hydrogen peroxide or potassium permanganate, to be added to increase metal hydroxide precipitation and reduce metal floc (sludge) volume. Metals will generally precipitate at a higher pH if water is oxidized, requiring less lime for treatment and decreased sludge production.

Precipitation technology entails adding a chemical reagent, such as sodium hydroxide or calcium hydroxide, directly to groundwater as it exits the mine workings to promote the precipitation of metal hydroxides. A settling reach or pond is constructed to allow the metals to settle from the water column before entering a surface water body. The settling reach or pond is cleaned periodically to remove the sludge or residue to prevent re-entrainment and redistribution downstream. Sludges from precipitation processes are typically stable chemically and could be disposed of in an on-site or off-site repository.

Active treatment can be highly effective and is capable of reducing metals concentrations to levels below acute and chronic exposure criteria for human and ecological receptors. However, treating to these levels requires a carefully designed and operated facility, usually with full-time operation and maintenance to meet all applicable criteria. Because of the seasonal variability typical for most mine discharges, continuous monitoring and adjustment of the treatment system train is needed. Water treatment can be effective as a stand-alone technology, but is usually combined with other technologies.

Simpler technologies with a continuous lime feed employed near the discharge source can also be effective at reducing metals concentrations. The specific metals that precipitate via treatment are driven by the pH adjustment system. This technology may be applicable to some features, but would require constructing settling ponds and periodic sludge removal and disposal. The effectiveness would likely vary seasonally dependent on flow rate, water volume, and contaminant concentrations. The COCs can be removed with up to 90 percent effectiveness during the periods that the system is in operation. However, greater than 90 percent removal is typically required to meet applicable discharge standards.

These technologies are most cost effective for treating large flows where a central treatment plant is available or can be constructed. Smaller, non-powered systems located near the discharge point may freeze and not function in the winter months. Reagents require replenishment, and lime and other amendment sources may be limited and/or expensive due to current market conditions. Consideration of the cost and availability of lime materials is necessary during design to determine the availability of suitable sources and long-term contracts are sometimes required. Construction and installation are feasible. Local, experienced contractors are available to provide these services. Once the system is operational, diligent oversight and maintenance are required. The treatment process produces a sludge or residue that may exceed the TCLP standards for metals, in which case the sludge must be stabilized with an amendment or disposed of off-site in a permitted, RCRA Type C disposal facility. Less concentrated residues could be disposed of in an on-site or off-site repository or at a suitable municipal solid waste facility.

7.5.8 Active Treatment – Physical/Mechanical Treatment

The applicability of the technology and effectiveness of the treatment depends on the chemical and physical properties of the water. Conductivity, pH, COC concentrations, and particle size all can have significant impacts on how well the process works. Ceramic microfiltration is a multi-stage system involving pre-treatment with sodium hydroxide and pumping through a ceramic membrane. In conjunction with chemical treatment, ceramic microfiltration is currently used as a polishing step at the WTP.

Ceramic microfiltration is an effective process that produces a high quality effluent. The filter presses must be cleaned frequently and the filter residue may exceed the TCLP standards for metals, in which case the filter residue must be stabilized with an amendment or disposed of off-site in a permitted, RCRA Type C disposal facility. The residue can also be treated in-stream to stabilize it and then disposed of in an on-site or off-site repository or at a suitable municipal solid waste facility. Less concentrated residues could be disposed in an on-site or off-site repository or at a suitable municipal solid waste facility.

Electrocoagulation involves applying an electrical current to promote coagulation of organics and suspended solids in water and can achieve high removal rates of copper and zinc. Pretreatment is required to ready the treated water for electrocoagulation. Energy and maintenance costs are high and the process requires full-time operators. The process can generate one-third less sludge than conventional chemical precipitation methods, but because of these efficiencies, metals in the sludge can be highly concentrated or fail the TCLP test.

Numerous vendors are available to design and install these treatment systems. Construction requires installation of pre-manufactured components. Local, experienced contractors are available to install the components.

7.5.9 Passive Treatment – Chemical Reagent

Permeable reactive barrier technology involves a flow-through barrier that is usually filled with organic matter or iron metal fillings. The barriers are usually installed underground to treat groundwater as it flows through the barrier. The barrier sequesters oxygen and supports sulfate-reducing bacteria that reduce sulfate to sulfide. A narrow pH range is necessary to target specific metals and, although the system is most useful in removing selenium and uranium from groundwater, the technology is effective for removal of COCs present at the UBMC. The success of the treatment depends greatly on the ability of the groundwater capture system to control groundwater flows and to promote the desired chemical reaction.

Substrate materials are readily available and would require replacement approximately every seven years. The longevity of the technology and the substrate material varies with the metals loading and the capacity of the reactive barrier material.

Systems are typically designed with a groundwater control system to guide flows through a substrate gallery (“notch”) containing the reactive substrate. The notches can be constructed from concrete or other durable materials. Sheet piling or slurry walls can be constructed to force groundwater to flow through the notches. Notches may be installed at several locations and should be designed to facilitate easy removal and replacement of substrate when needed. Groundwater wells and/or monitoring systems need to be installed up and downstream of the substrate galleries to determine if metals concentrations are being adequately reduced and to detect breakthrough as the substrate wears out.

Clogging and/or development of preferential flow pathways in the barriers is common and reduces their effectiveness. The process depends on the reactivity, hydraulic conductivity, and material stability in the barrier system. The barrier can be constructed with conventional construction equipment and methods using available, experienced local contractors.

7.5.10 Monitored Natural Recovery

Although not evaluated in the IASD, monitored natural recovery (MNR) is a remedy for contaminated sediment that typically uses ongoing, naturally occurring processes to contain, destroy, or reduce the bioavailability or toxicity of contaminants in sediment and applies to the UBMC. EPA’s Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (EPA, 2005) indicates that MNR is similar in some ways to MNA used for groundwater and that the key difference between MNA for groundwater and MNR for sediment is in the type of processes most often being relied upon to reduce risk. “Isolation and mixing of contaminants through natural sedimentation is the process most frequently relied upon for contaminated sediment” (EPA, 2005). Under the MNR alternative, sediment is regularly monitored to track changes in COC concentrations with time after source removal or control actions. MNR relies on the mixing and isolation of contaminants through natural sedimentation processes without active treatment.

Although monitored as part of MNR, this alternative is not directly applicable to remediation of surface water. For surface water, the sources of contamination are being removed through source removals and water treatment. As clean water enters the surface water system, contaminant concentrations are diluted, dispersed, and decrease over time. Based on experience at other similar sites such as Silver Bow Creek near Butte, Montana, with removal of sources and natural recovery processes for sediment, the COC levels in surface water may approach DEQ-7 standards within 30 to 40 years. This timeframe could vary due to a fluctuating groundwater table or other continuing migration of contamination.

8 Development of Remedial Alternatives

The remedial technologies and representative process options discussed in Section 7 were assembled into remedial alternatives for each EA at the UBMC. The ICs, access restrictions, and long-term monitoring and maintenance were retained as site-wide elements separate from the media-based technologies. In addition to a site-wide no action alternative, the applicability of 16 remedial alternatives were evaluated against the site characterizations in Section 6 and are presented in Table 8-1 through Table 8-5 on the following pages. Since removal of contaminated solid media is not a stand-alone alternative, it was combined with the land disposal options to create two alternatives: 1) removal and on-site disposal, and 2) removal and off-site disposal. The other alternatives are evaluated as stand-alone alternatives but may be combined with other alternatives in the ROD.

Table 8-1 Alternatives for EA 1 - Upland Waste Areas

EVALUATION AREA EA 1 Upland Waste Areas	REMEDIAL ALTERNATIVE								COMMENTS
		PHYSICAL HAZARDS/SOLID MEDIA							
		ENGINEERING CONTROLS/LAND DISPOSAL				TREATMENT			
						In-situ	Ex-situ		
	No Action	Physical Barriers	Containment	Removal and On-site Disposal	Removal and Off-site Disposal	Neutralization W/Alkaline Amendment	Blending and Co-Disposal	Neutralization W/Alkaline Amendment	
Upper Anaconda Mine (EU 1A) Waste Areas	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Anaconda adit water is addressed in EA 2. Waste removal areas previously reclaimed using lime and cover. Steep, rocky terrain makes access difficult. No apparent impacts to GW or SW.
Upper Anaconda Mine (EU 1B) Waste Piles	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Anaconda adit water is addressed in EA 2. Waste removal areas previously reclaimed using lime and cover. Steep, rocky terrain makes access difficult. In-situ treatment will be difficult due to rocky soil. No apparent impacts to GW or SW.
Capital Mine (EU 3) Waste Area	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Site is bisected by Stevens Creek. Waste removal areas previously reclaimed using lime and cover. No apparent impact to SW at downgradient SGSW-102. Coarse rock and steep terrain will make in-situ treatment difficult. Access very difficult on narrow, windy road.
Carbonate Mine (EU 4) Waste Area	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Groundwater issues are addressed in EA 2. Waste removal areas previously reclaimed using lime and cover. Located in the Swamp Gulch drainage adjacent to Hwy 200. Removal will likely require stream diversion and dewatering.
Edith Mine (EU 5) Waste Area	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Waste removal areas previously reclaimed using lime and cover. Relatively easy access to this site. No apparent impacts to GW or SW associated with these removal areas.
Consolation Mine (EU 6) Waste Area	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Waste removal areas previously reclaimed using lime and cover. Relatively easy access to the site, but the removal area is on a partially timbered slope. Rocky surface soils would make in-situ treatment difficult.
Mary P Mine (EU 7) Waste Pile	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Site located adjacent to Blackfoot River floodplain wastes, with easy access. Relatively small volume of waste; would require regrading for in-situ treatment. Potential susceptibility to erosion from high water if left in place.
Mike Horse Mine (EU 8) Waste Area	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Mike Horse adit and seep water, and Mike Horse bedrock GW are addressed in EA 2. Waste removal areas previously reclaimed using lime and cover. Previous removals left bare rock and in some areas ore-body exposed, making in-situ treatment difficult. Steep slopes in areas will make containment difficult.
Paymaster Mine (EU 9A) Waste Area -Surface	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Paymaster Gulch GW is addressed in EA 2. SW has metals exceedances both upstream and downstream of known mine disturbances. Waste removal areas previously reclaimed using lime and cover. Relatively easy access to site.
Paymaster Mine (EU 9B) Waste Area -Subsurface	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Paymaster Gulch GW is addressed in EA 2. SW has metals exceedances both upstream and downstream of known mine disturbances. Relatively easy access to site. Impacted soils are below the surface, requiring uncovering or removal for in-situ treatment.
No. 3 Tunnel Mine (EU 10) Waste Area	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Waste removal areas previously reclaimed using lime and cover. Relatively easy access to the site. Vegetative cover at the site is good. Area of exceedance is relatively small.

GW: Groundwater. SW: Surface Water.

Table 8-2 Alternatives for EA 2 - Groundwater

EVALUATION AREA EA 2 Groundwater	REMEDIAL ALTERNATIVE									COMMENTS
		GROUNDWATER								
			ENGINEERING CONTROLS				TREATMENT			
							Active		Passive	
	No Action	Monitored Natural Attenuation	Containment (Retention)	Detention	Hydrologic and Hydraulic Control	Inundation	Chemical Reagent	Physical/ Mechanical	Chemical Reagent	
Anaconda Mine (EU 1) Adit Discharge	Yes	Yes	No	No	No	No	Yes	Yes	Yes	Mine waste areas addressed in EA 1. Adit discharge currently routed to and treated at the WTP. Site constraints (access, steep terrain) may preclude passive treatment.
Carbonate Mine (EU 4) Groundwater	Yes	Yes	No	No	Yes	No	Yes	Yes	Yes	Mine waste areas addressed in EA 1. Capturing and conveying the GW to the WTP (Active Treatment) would require constructing a new capture and conveyance system, constructing a pump station, and expanding the WTP. SW/GW diversion (Hydraulic control) could reduce the quantity of impacted GW.
Mike Horse Mine (EU 8) Adit Discharge and Seeps	Yes	Yes	No	No	No	No	Yes	Yes	Yes	Mine waste areas addressed in EA 1. GW collection system currently conveys this water to the existing WTP for treatment. Construction of passive treatment may be difficult due to the complexity of the site and the chemistry of the water.
Upper Mike Horse Mine Bedrock Groundwater Aquifer	Yes	Yes	No	No	No	No	Yes	Yes	No	Unknown quantity of water. Capturing all of the impacted water will be difficult. Conveying to WTP would require new system and expansion of the WTP. Use of passive treatment (PRB) is not applicable for this bedrock aquifer with complex underground workings and the chemistry of the water.
Capital Mine Adit Plug	Yes	No	No	No	No	Yes	No	No	No	Leaking mine adit was closed with a grout seal and backfilled as part of a 1997 interim action. No mention of plugged adit site condition in the RI field notes.

GW: Groundwater. SW: Surface Water.

Table 8-3 Alternatives for EA 3 - Surface Water and Sediment

EVALUATION AREA EA 3 Surface Water and Sediment	REMEDIAL ALTERNATIVE															
	No Action	PHYSICAL HAZARDS/SOLID MEDIA								SURFACE WATER						
		Monitored Natural Recovery	ENGINEERING CONTROLS/ LAND DISPOSAL				TREATMENT			ENGINEERING CONTROLS				TREATMENT		
							In-situ	Ex-situ						Active		Passive
			Physical Barriers	Containment	Removal and On-site Disposal	Removal and Off-site Disposal	Neutralization w/Alkaline Amendment	Blending and Co-Disposal	Neutralization w/Alkaline Amendment	Containment (Retention)	Detention	Hydrologic and Hydraulic Control	Inundation	Chemical Reagent	Physical/ Mechanical	Chemical Reagent
Blackfoot River (EU 13) [1]	Yes	Yes	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No
Comments	Several variables make water treatment problematic including: quantity of water, variable flow rate, and variable water quality. Removal and disposal alternatives refer to stream sediments. Removal of sediment will require stream channel reconstruction, multiple temporary stream diversions and dewatering systems. Anticipate that both water quality and sediment COC levels will improve with time, following the upstream floodplain sediment removals conducted within the EE/CA area.															
Stevens Creek	Yes	Yes	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No
Comments	Several variables make water treatment problematic including: quantity of water, variable flow rate, and variable water quality. Removal and disposal alternatives refer to stream sediments. Removal of sediment will require stream channel reconstruction, multiple temporary stream diversions, dewatering systems, and extensive road building in steep, timbered terrain and mineralized rock. Multiple sources along Stevens Creek contribute to water quality exceedances. Waste source removals are addressed in EA 1 and EA 5.															
Other Streams																
Porcupine Creek	Yes	Yes	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No
Comments	Surface water samples in Porcupine Creek (PBBS-200, PBBS-202) showed no exceedances; however, the corresponding sediment samples showed exceedances. Therefore only solid media alternatives are applicable. Remediation volume estimates and costs are included with mining-related feature PBBS.															
Paymaster Creek	Yes	Yes	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No
Comments	Surface water quality at the downstream end of Paymaster Gulch (BRSW-13) exceeded DEQ-7 aquatic life standards. Paymaster Creek flows through a highly mineralized zone with ferricrete deposits and other evidence off natural high metals concentrations. Several variables make water treatment problematic including: quantity of water, variable flow rate, and variable water quality. The BRSW-13 sediment sample showed exceedances. Removal and disposal alternatives refer to stream sediments. Removal of sediments will require stream channel reconstruction, multiple temporary stream diversions and dewatering systems.															
Shave Creek	Yes	Yes	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No
Comments	Several variables make water treatment problematic including: quantity of water, variable flow rate, and variable water quality. A sediment sample showed exceedances. Removal and disposal alternatives refer to stream sediments. Removal of sediments will require stream channel reconstruction, multiple temporary stream diversions and dewatering systems.															
Unnamed Tributary above WTP	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Comments	Surface water exceedances (Chronic: Cd, Zn; Acute: Zn) in one sample of this intermittent drainage – possibly runoff or seep. . No sediment data.															

EVALUATION AREA EA 3 Surface Water and Sediment	REMEDIAL ALTERNATIVE															
		PHYSICAL HAZARDS/SOLID MEDIA								SURFACE WATER						
			ENGINEERING CONTROLS/ LAND DISPOSAL				TREATMENT			ENGINEERING CONTROLS				TREATMENT		
							In-situ	Ex-situ						Active		Passive
	No Action	Monitored Natural Recovery	Physical Barriers	Containment	Removal and On-site Disposal	Removal and Off-site Disposal	Neutralization w/Alkaline Amendment	Blending and Co-Disposal	Neutralization w/Alkaline Amendment	Containment (Retention)	Detention	Hydrologic and Hydraulic Control	Inundation	Chemical Reagent	Physical/ Mechanical	Chemical Reagent
Mining-related Feature Discharge, Seep or Spring																
Mine Feature BR-01 Discharge, seep, or spring	Yes	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No
Comments	Intermittent spring (150 square feet) at the toe of slope. No flow or water quality data.															
Mine Feature BR-14 Discharge, seep, or spring	Yes	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No
Comments	Collapsed adit with leaking water that is pooled near entrance supporting vegetation. No flow or water quality data.															
Mine Feature PBBS Discharge, seep, or spring	Yes	No	No	No	Yes	Yes	No	No	No	Yes	No	No	No	No	No	No
Comments	Seep from collapsed adit. Surface water exceeds HH: Cd, Pb, Mn, Zn; Chronic: Cd, Cu, Fe, Pb, Zn; Acute: Cd, Cu, Pb, Zn. No flow data. Sediment exceeds for As, Cd, Pb, Mn, Zn.															
Mine Feature PC-11 Discharge, seep, or spring	Yes	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No
Comments	Seep from collapsed adit. Surface water exceeds Chronic: Cd, Zn; Acute: Zn.															
Mine Feature PC-22 Discharge, seep, or spring	Yes	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No
Comments	PC-22 was identified as PC-21 in the RI but is a separate feature and includes a collapsed adit with a marshy area at the entrance, indicating adit discharge. No waste rock piles observed. No flowing water was observed and no water quality data were collected.															
Mine Feature SH-43 Discharge, seep, or spring	Yes	No	No	No	Yes	Yes	No	No	No	Yes	No	No	No	No	No	No
Comments	Collapsed and leaking adit (2 to 5 gpm estimate) with additional flow contributed by seeps between adit and mined rock pile. Surface water (SHSW-103) exceeds HH: Mn; Chronic: As, Cd, Cu, Fe, Pb, Zn; Acute: Cd, Cu, Pb, Zn. Sediment exceeds for As, Cd, Pb, Mn, Zn.															
Mine Feature SG-55 Discharge, seep, or spring	Yes	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No
Comments	Pipe (4 inch) protruding from toe of cut-slope leaking small amounts of water. Surface water exceeds HH: As, Mn; Chronic: Fe; Acute: No exceedances. No flow rate measured.															

EVALUATION AREA EA 3 Surface Water and Sediment	REMEDIAL ALTERNATIVE															
	No Action	PHYSICAL HAZARDS/SOLID MEDIA								SURFACE WATER						
		Monitored Natural Recovery	ENGINEERING CONTROLS/ LAND DISPOSAL				TREATMENT			ENGINEERING CONTROLS				TREATMENT		
							In-situ	Ex-situ						Active		Passive
			Physical Barriers	Containment	Removal and On-site Disposal	Removal and Off-site Disposal	Neutralization w/Alkaline Amendment	Blending and Co-Disposal	Neutralization w/Alkaline Amendment	Containment (Retention)	Detention	Hydrologic and Hydraulic Control	Inundation	Chemical Reagent	Physical/ Mechanical	Chemical Reagent
Mine Feature SG-71 Discharge, seep, or spring	Yes	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No
Comments	Spring at possible adit location 70 feet from creek. Water has pooled and is 6 inches deep. No flow or water quality data.															
Mine Feature SG-94 Discharge, seep, or spring	Yes	No	No	No	Yes	Yes	No	No	No	Yes	No	No	No	No	No	No
Comments	Iron precipitate, cone-forming spring. Flow estimated at 2 to 5 gpm. Surface water (SGSW-104) exceeds HH: As, Fe; Chronic: Fe, Zn; Acute: Zn. Sediment exceeds for As.															
Mine Feature SG-98 Discharge, seep, or spring	Yes	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No
Comments	Adit apparently had flow at some point as evidenced by strong iron oxide staining but was dry at the time of the field investigation in 2008. No flow or water quality data.															
Historic Paymaster Adit Discharge	Yes	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No
Comments	Adit was plugged and a discharge collection system and wetland treatment system were installed in 1996-1997 with the intent to discharge water into the upper wetlands cell. Water is currently seeping out of the slope toe on to the road next to the plugged adit. Wetland cells solid media addressed as Paymaster Mine Waste Areas in EA 1.															

[1]From the Upper Marsh to Hogum Creek.
Acute: DEQ-7 Acute Aquatic Standard and Chronic: DEQ-7 Chronic Aquatic Standard.

Table 8-4 Alternatives for EA 4 - Upper Marsh

EVALUATION AREA EA 4 Upper Marsh	REMEDIAL ALTERNATIVE																
	No Action	PHYSICAL HAZARDS/SOLID MEDIA								GROUNDWATER/SURFACE WATER							
		Monitored Natural Recovery	ENGINEERING CONTROLS/ LAND DISPOSAL				TREATMENT			Monitored Natural Attenuation (Groundwater only)	ENGINEERING CONTROLS				TREATMENT		
							In-situ	Ex-situ							Active		Passive
			Physical Barriers	Containment	Removal and On-site Disposal	Removal and Off-site Disposal	Neutralization w/Alkaline Amendment	Blending and Co-Disposal	Neutralization w/Alkaline Amendment		Containment (Retention)	Detention	Hydrologic and Hydraulic Control	Inundation	Chemical Reagent	Physical/ Mechanical	Chemical Reagent
Upper Marsh (EU 12) Eastern Area	Yes	Yes	No	Yes	Yes	Yes	No	No	No	Yes	No	No	No	No	No	No	No
Comments:	Containment of marsh sediments may require special permitting for fill within jurisdictional wetlands and the floodplain and would require extensive design engineered measures to control flood flows and prevent erosion from flood events. Removal of marsh sediments will require stream channel reconstruction, wetland reconstruction, extensive temporary stream diversions, dewatering systems, and haul road network construction. The eastern area generally contains higher concentrations of As, Cd, Cu, Pb, and Zn in the upper 12 inches than in the western area of the Upper Marsh, with some exceptions downstream of the Carbonate Mine site. The Upper Marsh contains sensitive areas including two large fens and one large emergent forested wetland, considered as special aquatic sites by the Army Corps of Engineers that should be protected from impacts associated with remedial activities.																
Upper Marsh (EU 12) Western Area	Yes	Yes	No	Yes	Yes	Yes	No	No	No	Yes	No	No	No	No	No	No	No
Comments:	Containment of marsh sediments may require special permitting for fill within jurisdictional wetlands and the floodplain and would require extensive design engineered measures to control flood flows and prevent erosion from flood events. Removal of marsh sediments will require stream channel reconstruction, wetland reconstruction, extensive temporary stream diversions, dewatering systems, and haul road network construction. The western area generally contains lower concentrations of As, Cd, Cu, Pb, and Zn in the upper 12 inches than in the eastern area of the Upper Marsh, with some exceptions downstream of the Carbonate Mine site. The Upper Marsh contains sensitive areas including two large fens and one large emergent forested wetland, considered as special aquatic sites by the Army Corps of Engineers that should be protected from impacts associated with remedial activities.																

Table 8-5 Alternatives for EA 5 - Mining-related Features

EVALUATION AREA EA 5 Mining-related Features[4]	REMEDIAL ALTERNATIVE								COMMENTS
	No Action	PHYSICAL HAZARDS/SOLID MEDIA							
		ENGINEERING CONTROLS/LAND DISPOSAL				TREATMENT			
						In-situ	Ex-situ		
		Physical Barriers	Containment	Removal and On-site Disposal	Removal and Off-site Disposal	Neutralization W/Alkaline Amendment	Blending and Co-Disposal	Neutralization W/Alkaline Amendment	
Anaconda Creek Drainage									
AC-01	Yes	No	Yes	Yes	Yes	Yes	No	No	Mine waste is incorporated into road fill slope, the toe of slope contacts Anaconda Creek. Access to this site will be moderately difficult.
Blackfoot River Drainage									
BR-01, BR-14, BR-16 BR-20, BR-32, BR-39	Yes	No	Yes	Yes	Yes	Yes	No	No	BR-39 is a caved adit and waste pile along edge of unnamed creek. BR-01 and BR-14 are collapsed adits with seeps. Access to BR-01, adjacent to the Blackfoot River, is relatively easy, but access to the other sites will be difficult on the steep, timbered slope. Seepage water and unnamed creek water quality are addressed in EA 3.
BR-29	Yes	No	Yes	Yes	Yes	Yes	No	No	Located approximately 350 feet uphill from Mary P Mine in heavy timber on steep slopes. There are no roads to this feature; access difficult.
Pass Creek Drainage									
PC-01, PC-06, PC-11, PC-21, PC-22	Yes	Yes	Yes	Yes	Yes	Yes	No	No	PC-01 includes an open timber shaft with water which creates a physical hazard requiring a physical barrier. Water quality (PCSW-102) meets DEQ-7 GW Standards. PC-11 is a collapsed adit with a seep. Water from PC-11 is addressed in EA 3. PC-21 is an open adit requiring a physical barrier. PC-06 is a collapsed adit with waste rock. Water from PC-22 is address in EA 3.
Porcupine Gulch Drainage									
PBBS	Yes	No	No	No	No	No	No	No	Site includes collapsed adit with a discharge, waste rock pile in close proximity to Porcupine Creek. No exceedances in the sampled waste. Access is moderately difficult on unmaintained road. Water from the adit is addressed in EA 3.
Paymaster Gulch Drainage									
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	Yes	No	Yes	Yes	Yes	Yes	No	No	Access to each of these sites will be moderately difficult as there are no maintained roads and the features are located on heavily timbered slopes on either side of Paymaster Creek.
PM-26, PM-28	Yes	No	Yes	Yes	Yes	Yes	No	No	PM-26 is located high up in the drainage and PM-28 is located at the very top of the drainage – access will be difficult for both.
Shave Gulch Drainage									
SH-17, SH-23, SH-29, SH-37 SH-43, SH-44	Yes	No	Yes	Yes	Yes	Yes	No	No	Features SH-17 and SH-23 are located on the west side of Shave Gulch Road, near Shave Creek. SH-29, 37, 43, and 44 are located on the east side of Shave Gulch, uphill from the creek. SH-43 is a collapsed and leaking adit. Water from SH-43 is addressed in EA 3.
SH-06, SH-07, SH-13, SH-14	Yes	Yes	Yes	Yes	Yes	Yes	No	No	These features are located on the east side of Midnight Hill, with poor or no road access. SH-06 is an open adit with waste rock requiring a physical barrier.

EVALUATION AREA EA 5 Mining-related Features[4]	REMEDIAL ALTERNATIVE								COMMENTS
		PHYSICAL HAZARDS/SOLID MEDIA							
		ENGINEERING CONTROLS/LAND DISPOSAL				TREATMENT			
						In-situ	Ex-situ		
	No Action	Physical Barriers	Containment	Removal and On-site Disposal	Removal and Off-site Disposal	Neutralization W/Alkaline Amendment	Blending and Co-Disposal	Neutralization W/Alkaline Amendment	
Stevens Gulch Drainage									
SG-13/14, SG-16, SG-43	Yes	No	Yes	Yes	Yes	Yes	No	No	These features are all located at the top of the ridge dividing Mike Horse and Stevens Gulches. Access will require construction of an extensive road network in steep, heavily timbered areas.
SG-24, SG-44, SG-53, SG-55 SG-56, SG-58, SG-67, SG-98	Yes	No	Yes	Yes	Yes	Yes	No	No	These sites are located fairly high up in the drainage, with SG-44 and SG-98 being associated with the Viking mine site, situated near the top of the drainage. Access will require constructing an extensive network of roads along the west side of Stevens Gulch.
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78, SG-82 SG-94, SG-95, SG-96, SG-99	Yes	No	Yes	Yes	Yes	Yes	No	No	All of these sites are located along Stevens Creek. Access will be difficult and may require pioneering a road directly alongside the stream, or constructing multiple, switch-back roads along the steep valley slopes.
SG-01, SG-31, SG-33, SG-35 SG-86, SG-89	Yes	Yes	Yes	Yes	Yes	Yes	No	No	SG-01 is a partially open 8-inch well requiring a physical barrier. Relatively easy access to all sites. SG-31, 33, and 35 are in close proximity to Stevens Creek.
Swamp Gulch Drainage									
SWG-02	Yes	No	Yes	Yes	Yes	Yes	No	No	No existing roads to access this waste rock site, located 300 feet NE of Highway 200 on a heavily timbered, steep slope.

[4]Mine features are grouped by drainage basin. Within each basin, the features are grouped by proximity and/or common access road.

9 REMEDIAL ALTERNATIVES ANALYSES

This section further evaluates the retained alternatives based on the seven criteria in § 75-10-721(1) and (2), MCA. The criteria are listed and described below. For cost estimation purposes, the removal and on-site disposal alternative considers the UBMC (Section 35) repository as the disposal site since the USFS already selected the Section 35 repository in its Action Memorandum, as amended, and that repository is under construction. Since the USFS already selected that repository and it is currently being constructed under the USFS Action Memorandum, as amended, costs associated with construction of the repository are not included with the on-site repository estimates. In evaluating costs for the off-site repository option, conceptual costs for the State Section 18 site in the UBMC RSS (Pioneer, 2011) were utilized.

Two of the alternatives were retained in Section 8 for consideration but were determined to be not applicable for further analysis:

- Physical Hazards/Solid Media – Ex-situ Treatment - Blending and Co-Disposal. As described in the IASD (Appendix D), this alternative was considered most applicable as a design consideration for the blending of waste within an on-site or off-site repository. Analysis of this alternative at locations identified within the UBMC EAs determined that there were no locations where it would be advantageous to blend and co-dispose of wastes.
- Groundwater/Surface Water – Engineering Controls – Detention. This alternative would involve temporarily storing water in a pond and releasing it slowly, with the goal of removing suspended sediment to improve water quality. For groundwater, this technology would offer no benefit for water quality since there is no effect on dissolved COCs. For small surface water flows (i.e., adit discharges) it would not be desirable to release the flow downstream from a detention area. For larger surface water flows (i.e., streams) the size of a pond required to offer any benefit to water quality would not fit within the UBMC topographic constraints. Analysis of this alternative at locations identified within the UBMC EAs determined that there were no locations where it would be advantageous or practical to use detention.

As discussed in Section 7.5.10, MNR was added as a potential remedy for sediment. Similar to MNA for groundwater, MNR is a remedy for contaminated sediment that typically uses ongoing, naturally occurring processes to contain, destroy, or reduce the bioavailability or toxicity of contaminants in sediment. The key difference between MNA for groundwater and MNR for sediment is in the type of processes most often being relied upon to reduce risk. Transformation of contaminants is usually the major attenuating process for contaminated groundwater; these processes are frequently too slow for the persistent COCs in sediment to provide for remediation in a reasonable time frame. Therefore, isolation and mixing of contaminants through natural sedimentation is the process most frequently relied upon for contaminated sediment (EPA, 2005).

9.1 *Cleanup Criteria*

Section 75-10-721, MCA, identifies the criteria DEQ must evaluate in selecting a final remedy for the facility. DEQ also considers current and reasonably anticipated future uses of the UBMC and considers institutional controls when evaluating and selecting a remedy. The remedy selection criteria can be generally summarized as follows:

Protectiveness. Overall protection of human health and the environment addresses whether an alternative provides adequate protection in both the short-term and the long-term from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the facility by eliminating, reducing, or controlling exposure to protective levels. This criterion is a threshold that must be met by the selected alternative or combinations of alternatives.

Compliance with ERCLs. This criterion evaluates whether each alternative will meet applicable or relevant state and federal ERCLs. This criterion is a threshold that must be met by the selected alternative or combination of alternatives unless an applicable ERCL is waived by DEQ as provided for in § 75-10-721(4), MCA. (ERCLS under CECRA are similar to ARARs, which are evaluated by the USFS under CERCLA and the NCP.)

Mitigation of Risk. This criterion evaluates mitigation of exposure to risks to public health, safety, and welfare and the environment to acceptable levels.

Effectiveness and Reliability. Each alternative is evaluated, in the short-term and the long-term, based on whether acceptable risk levels are maintained and further releases are prevented.

Practicability and Implementability. Under this criterion, alternatives are evaluated with respect to whether this technology and approach could be applied at the facility.

Treatment or Resource Recovery Technologies. This criterion addresses use of treatment technologies or resource recovery technologies, if practicable, giving due consideration to engineering controls. These technologies are generally preferred to simple disposal options.

Cost Effectiveness. Cost effectiveness is evaluated through an analysis of incremental costs and incremental risk reduction and other benefits of alternatives considered. This analysis includes taking into account the total anticipated short-term and long-term costs, including operation and maintenance (O&M) activities. The cost estimate for each alternative is based on present worth estimates of capital and O&M costs for a specific time period. The costs are developed using environmental costing software and vendor information. The types of costs that are assessed include the following:

- Capital costs, including both direct and indirect costs
- Annual O&M costs, including long-term effectiveness monitoring cost
- Periodic cost
- Enforcement of ICs
- Net present worth of capital, O&M costs, periodic costs, and enforcement of ICs

Detailed cost estimates for each alternative are included in Appendix E. A summary of costs for each alternative is provided in Table E-1 of Appendix E.

9.2 *Site-Wide Elements*

Three site-wide elements are evaluated for all media and physical hazards at the UBMC:

- ICs - Deed Restrictions, Easements, Covenants, Reservations
- Access Restrictions
- Long-term Monitoring and Maintenance

9.2.1 ICs - Deed Restrictions, Easements, Covenants, Reservations

Institutional controls, placed upon real property to mitigate the risk to public health, safety and welfare, and the environment include but are not limited to: a) deed restrictions; b) easements; c) reservations; d) covenants, either restrictive or affirmative; and e) other mechanisms or restrictions for controlling present and future land use, such as a controlled groundwater area. ICs do not remediate the contamination. For solid media, ICs prohibiting excavation in areas of capped or contained waste may be necessary.

For purposes of the FS, the estimated cost of implementing an IC is approximately $5,000, including attorney and filing fees, and it is assumed that five ICs will be necessary for a total cost of $25,000. This estimate does not include the cost of enforcing violations of the IC or the cost of additional remediation that may be necessitated by a violation of an IC.

9.2.2 Access Restrictions

Although access restrictions limit exposure pathways, all identified contamination remains at the UBMC at concentrations exceeding the SSCLs and continues to impact soil, groundwater and surface water quality, and environmental receptors. Access restrictions include the installation of fencing and gates and posting of signage.

Fencing and gates provide some short-term protection from unacceptable risks for public health and safety by limiting physical access to contaminated soil or physical hazards, such as subsidence. Protection would depend on the durability of the control and compliance from the general public, regular monitoring, and maintenance. Access restrictions would be most effective for areas with solid media impact. Fencing and signage is less effective for surface water due to the dynamic nature of the streams and difficulty in fencing in a floodplain.

For purposes of the FS, the estimated cost of the access restrictions includes constructing fencing and installing gates and warning signs and is $507,514.

9.2.3 Long-term Monitoring and Maintenance

A long-term monitoring and maintenance program evaluates the effectiveness of any remediation and ensures the protection of public health and the environment. At present, a long-term monitoring program for the UBMC includes semiannual sampling of an existing groundwater monitoring well network of 10 wells and vegetative cover inspections at the Mike Horse, Paymaster and Carbonate Repositories. Since removal of the Mike Horse Repository is included under an interim action (Section 5.2), the repository is not included for purposes of determining long-term monitoring and maintenance costs in the FS.

For FS cost estimation purposes of this site-wide element, the existing monitoring program is expanded to include surface water monitoring at six stations along the Blackfoot River and at the Carbonate Mine and vegetative cover inspections at areas within the UBMC where waste is treated in place. Long-term monitoring and maintenance costs are calculated for a period of 30 years, taking into account the anticipated compliance of the remedy with applicable standards. Long-term monitoring and maintenance of the existing adit plugs and repositories to ensure their integrity is also included. Performance monitoring, if required, is included with the applicable alternative and not as a site-wide element. The estimated cost of long-term monitoring and maintenance is $1,979,427.

9.2.4 Site-Wide Elements Cost Estimate

Costs associated with these common elements are provided in Appendix E. The net present value for the site-wide elements is $2,511,941.

9.3 *Site-Wide Alternatives*

9.3.1 Alternative 1 - No Action

Under the no action alternative, all identified contamination remains at the UBMC and continues to impact soil, groundwater and surface water quality, and environmental receptors. Operation of the WTP is discontinued. Contaminants could become more mobile under hydrological changes such as flood events, changes in the stream channel, or drying of the currently flooded areas due to loss of beaver activity. COCs would remain mobile within the food chain.

<u>Protectiveness</u> - This alternative does not provide any protection from unacceptable risks in either the short-term or long-term for human health or the environment. All contaminated media remains in place and SSCLs would continue to be exceeded. Although present inundated conditions have reduced the mobility of metals in the marsh, the COCs would continue to be taken up within the food chain and contaminated sediments could be subject to erosion if a large flood occurs or beaver activity is significantly reduced.

<u>Compliance with ERCLs</u> - Since all contamination remains in place under this alternative and taking into account the nature of the contamination, contaminated soil and sediment would continue to impact groundwater and surface water. Groundwater and surface water would not comply with applicable ERCLs and it is reasonable to assume compliance with ERCLs would not be achievable within any timeframe.

<u>Mitigation of Risk</u> - There is no mitigation of exposures to risk under this alternative. SSCLs continue to be exceeded site-wide.

Effectiveness and Reliability - There is no short-term or long-term effectiveness or reliability in maintaining acceptable risk levels under this alternative.

Practicability and Implementability – This alternative could be easily implemented site-wide at the UBMC.

Treatment or Resource Recovery Technologies - This alternative does not rely on treatment or resource recovery technologies.

Cost Effectiveness – The estimated total present worth cost for implementing this alternative at the UBMC is $0.

9.4 *Solid Media and Physical Hazard Alternatives Evaluation*

Seven alternatives are evaluated for solid media and physical hazards at the UBMC:

- Alternative 2: Monitored Natural Recovery
- Alternative 3: Physical Barriers
- Alternative 4: Containment
- Alternative 5: Removal and On-site Disposal
- Alternative 6: Removal and Off-site Disposal
- Alternative 7: In-situ Neutralization with Alkaline Amendment
- Alternative 8: Ex-situ Neutralization with Alkaline Amendment

9.4.1 Alternative 2 – Monitored Natural Recovery

Under the MNR alternative, contaminated sediment are regularly monitored to track changes in COC concentrations with time after source removal or control actions. MNR relies on the mixing and isolation of contaminants through natural sedimentation processes without active treatment and is applicable to areas within EA 3 (Table 8-3), and EA 4 (Table 8-4). For marsh sediments, present inundated conditions have helped to immobilize the metals; however, the COCs are still being taken up within the food chain and are subject to mobilization under high flow events. Loss of beaver activity could result in dewatering of the inundated areas and result in increased contaminant mobility and availability throughout the Upper Marsh. Although surface water concentrations meet DEQ-7 standards for humans, concentrations upstream of State Highway 279 would continue to exceed standards for aquatic life until natural recovery reduces levels to acceptable standards. Performance monitoring would be conducted to measure the success of upstream source removals.

Protectiveness - This alternative provides no protection from unacceptable risks in the short-term for public health and safety or the welfare or the environment but may become protective over the long-term. SSCLs will continue to be exceeded within sediment until concentrations decrease through natural recovery processes. The effectiveness of MNR would largely be determined by the success of source removal or control actions.

Compliance with ERCLs - Under this alternative, contamination remains in place at concentrations exceeding SSCLs and may serve as a continuing source to groundwater, surface water and other receptors in the short-term. However, combined with successful upstream removal actions, and based on experience at other similar sites such as Silver Bow Creek near Butte, Montana, compliance with surface water ERCLs may be achieved within 30 to 40 years. This timeframe could vary due to a fluctuating groundwater table or other continuing migration of contamination.

Mitigation of Risk - There is little to no immediate mitigation of exposures to risk under this alternative. Contaminants left in place at concentrations exceeding the SSCLs may become more mobile under hydrological changes such as flood events, channel erosion, or dewatering of the currently flooded marsh areas due to loss of beaver activity. COCs would remain mobile within the food chain as well until concentrations are naturally reduced over time. Monitoring could be used to identify areas that have recovered sufficiently to lift or reduce ICs or access controls.

Effectiveness and Reliability – This alternative by itself is not an effective remedy for limiting human exposure. There is no effectiveness or reliability in protection of the environment, nor protection of human health downstream. This alternative can be effective and reliable when combined with other source control or removal actions.

Practicability and Implementability - This alternative could be easily implemented at the UBMC in areas where adequate source control or removal was performed. Access to the existing monitoring points would remain the same or similar to current conditions. This alternative is practicable and implementable at the UBMC.

Treatment or Resource Recovery Technologies - This alternative does not rely on treatment or resource recovery technologies.

Cost Effectiveness – The estimated total present worth cost for implementing this alternative at the UBMC is $2,545,823. Cost details and calculations for this alternative are included in Appendix E.

9.4.2 Alternative 3 – Physical Barriers

Under this alternative, adit openings or other physical hazards associated with mining-related features (Table 8-5) would be closed using a physical barrier to prevent human entry. Installation of a bat gate, plugging with foam or a bulkhead, or backfilling would eliminate the open adit hazards at PC-01, PC-21, and SH-06. The partially open well casing at SG-01 would be plugged or backfilled. This alternative only addresses the safety hazards associated with open adits and well casings. The waste rock at SH-06 is addressed under other alternatives.

Protectiveness –This alternative is protective of the public safety, associated with open adits and well casings because the openings would be closed to prevent human entry. This alternative does not address risk to human health and the environment posed by exposure to COCs and would need to be combined with other alternatives to address the exceedances of SSCLs at SH-06.

Compliance with ERCLs – This alternative only addresses the safety hazards associated with open adits and well casings. There are no ERCLs applicable to this alternative. As noted above, the waste rock at SH-06 would be addressed under other alternatives.

Mitigation of Risk – By eliminating purposeful or accidental access to the adit opening and other physical hazards, risks to public safety, would be mitigated under this alternative. This alternative does not address risk to human health and the environment posed by exposure to COCs and would need to be combined with other alternatives to address the exceedances of SSCLs at SH-06.

Effectiveness and Reliability – This alternative involves proven technology that is effective and reliable in the short- and long-term for eliminating access to open adits and other physical hazards. Adit closure has been used to limit access at other mining-related features at the UBMC and other mining sites with success.

Practicability and Implementability - Adit and hazard closure is a standard mining construction practice. Physical barriers could be easily implemented at the four mining-related features under this alternative.

Treatment or Resource Recovery Technologies – This alternative does not rely on treatment or resource recovery technologies.

Cost Effectiveness – The estimated total present worth cost for implementing this alternative at the UBMC is $193,845. Cost details and calculations for this alternative are included in Appendix E.

9.4.3 Alternative 4 – Containment

Under this alternative, solid media (soil and marsh sediment) would be contained by covering with vegetated cover or rock to eliminate risk of direct exposure, reduce sediment migration and limit water infiltration. Containment is applicable to areas within EA 1 (Table 8-1), EA 4 (Table 8-4), and most of the mining-related features in EA 5 (Table 8-5).

Protectiveness – This alternative would eliminate the potential for direct contact with contamination, stabilize the exposed surfaces of waste rock or impacted soil with respect to migration of impacted sediment to surface water, and slow or reduce the infiltration of precipitation. This alternative would significantly reduce direct exposure to contamination and would reduce to some extent the leaching of contamination to groundwater. However, it may not be protective of human health and the environment in the short-term and long-term by itself because contamination would remain in place at concentrations exceeding protection to groundwater SSCLs and could serve as a continued source of contamination to groundwater.

Compliance with ERCLs - Under this alternative, contamination remains in place at concentrations exceeding protection of groundwater SSCLs and may serve as a continuing source to groundwater. Depending on conditions at the source area, groundwater and surface water may not achieve applicable ERCLs within any timeframe due to a fluctuating groundwater table or other continuing migration of contamination. In areas where waste is not in contact with surface water or groundwater, compliance with surface water and groundwater ERCLs may be achieved within 30 to 40 years, due to the reduction in infiltration provided, based on experience at other similar sites such as Silver Bow Creek near Butte, Montana. This timeframe could vary due to a fluctuating groundwater table or other continuing migration of contamination. The remedy would be designed to ensure adequate revegetation and cover material that meets relevant reclamation ERCLs.

Mitigation of Risk – Containment provides some mitigation of the risks to human health and the environment. While the risk posed by direct contact with the contamination may be reduced, contamination left in place at concentrations exceeding the protection to groundwater SSCLs may continue to leach to groundwater, and therefore this alternative does not adequately mitigate risk to human health and the environment.

Effectiveness and Reliability – This alternative provides adequate short-term effectiveness and reliability in limiting contact with contamination. Short-term water quality impacts to the surrounding environment could occur at those sites where construction of roads or re-grading of waste occurs in close proximity to surface water. Construction Best Management Practices (BMPs) would be employed to effectively reduce adverse short-term impacts on surface water from the construction activities. Containment may be susceptible to weathering and erosion, reducing the long-term effectiveness and reliability of the cover. O&M would be required to maintain the integrity of the cover.

Practicability and Implementability – The grading, placement of soil or cover, and revegetation steps required for containment are considered standard and conventional construction practices. Engineering and construction contractors with the experience and equipment necessary to complete the work are available regionally. This alternative is practicable and implementable at the UBMC.

Treatment or Resource Recovery Technologies - This alternative does not rely on treatment or resource recovery technologies.

Cost Effectiveness – The estimated total present worth cost for implementing this alternative at the UBMC is $16,064,459. Cost details and calculations for this alternative are included in Appendix E.

9.4.4 Alternative 5 – Removal and On-site Disposal

Under this alternative all solid media (soil and sediment) exceeding the SSCLs would be removed, transported, and disposed of at an engineered on-site repository. Removal is applicable to areas within EA 1 (Table 8-1), EA 3 (Table 8-3), EA 4 (Table 8-4), and most of the mining-related features in EA 5 (Table 8-5).

Protectiveness –The removal and disposal of contaminated solid media would eliminate the waste sources and provide protectiveness for human health and the environment. In areas of impacted groundwater and/or surface water, this alternative would eliminate the continuing source, allowing groundwater and/or surface water quality to improve. Removal of marsh sediments will require disturbance of large areas of the sensitive wetland ecosystem.

Compliance with ERCLs –Since the contamination exceeding the SSCLs is removed, there is no continuing waste source that could impact groundwater and surface water. Therefore, in areas where groundwater and surface water standards are currently met, this alternative would achieve ERCLs immediately. In locations of impacted groundwater and/or surface water, compliance with surface water and groundwater ERCLs may be achieved within 30 to 40 years, when combined other alternatives or through natural attenuation, based on experience at other similar sites such as Silver Bow Creek near Butte, Montana. This timeframe could vary due to a fluctuating groundwater table or other continuing migration of contamination. In addition, the repository would be sited in an area that meets location-specific ERCLs and would be designed and constructed to comply with solid waste ERCLs, including a minimum of 24 inches of cover material. The remedy would be designed to ensure adequate revegetation and cover material that meets relevant reclamation ERCLs.

Mitigation of Risk - Removal and proper disposal of contamination at concentrations exceeding the SSCLs provides mitigation of the risks to human health and the environment.

Effectiveness and Reliability – This alternative is considered highly effective and reliable in both the short-term and long-term. Short-term water quality impacts to the surrounding environment could occur at those sites where construction of roads and excavation of waste occurs in close proximity to surface water or in the marsh. Construction BMPs would be employed to effectively reduce adverse short-term impacts on surface water and the marsh from the construction activities.

Practicability and Implementability – The excavation and disposal of wastes and revegetation steps required for removal are considered standard and conventional construction practices. Construction and reclamation of upland wastes and mining-related features could be difficult in some locations at the UBMC because of the steep terrain, remoteness and inadequate access, and special equipment may be required. Removal of sediment in the marsh and streams is dependent upon dewatering operations and access into wet or saturated areas. Mike Horse Creek Road and an abandoned drill testing road provide the only serviceable access to the Upper Marsh. Certain stream reaches are difficult to access because of steep terrain, remoteness, and inadequate roads in these areas. Engineering and construction contractors with the experience and equipment necessary to complete the work are available regionally. While this alternative is practicable and implementable at the UBMC, removal would be difficult in certain locations for the reasons stated.

Treatment or Resource Recovery Technologies - This alternative does not rely on treatment or resource recovery technologies.

Cost Effectiveness - The estimated total present worth cost for implementing this alternative at the UBMC is $23,436,794. Cost details and calculations for this alternative are included in Appendix E.

9.4.5 Alternative 6 – Removal and Off-site Disposal

Under this alternative all solid media (soil and sediment) exceeding the SSCLs would be removed, transported, and disposed of at an engineered off-site repository. Removal is applicable to areas within EA 1 (Table 8-1), EA 3 (Table 8-3), EA 4 (Table 8-4), and most of the mining-related features in EA 5 (Table 8-5).

Protectiveness –The removal and disposal of contaminated solid media would eliminate the waste sources and provide protectiveness for human health and the environment. In areas of impacted groundwater and/or surface water, this alternative would eliminate the continuing source, allowing groundwater and/or surface water quality to improve. Removal of marsh sediments will require disturbance of large areas of the sensitive wetland ecosystem.

Compliance with ERCLs – Since the contamination exceeding the SSCLs is removed, there is no continuing waste source that could impact groundwater and surface water. Therefore, in areas where groundwater and surface water standards are currently met, this alternative would achieve ERCLs immediately. In locations of impacted groundwater and/or surface water, compliance with surface water and groundwater ERCLs may be achieved within 30 to 40 years, when combined other alternatives or through natural attenuation, based on experience at other similar sites such as Silver Bow Creek near Butte, Montana. This timeframe could vary due to a fluctuating groundwater table or other continuing migration of contamination. In addition, the repository would be sited in an area that meets location-specific ERCLs and would be designed and constructed to comply with solid waste ERCLs, including a minimum of 24 inches of cover material. The remedy would be designed to ensure adequate revegetation and cover material that meets relevant reclamation ERCLs.

Mitigation of Risk - Removal and proper disposal of contamination at concentrations exceeding the SSCLs provides mitigation of the risks to human health and the environment.

Effectiveness and Reliability – This alternative is considered highly effective and reliable in both the short-term and long-term. Short-term water quality impacts to the surrounding environment could occur at those sites where construction of roads and excavation of waste occurs in close proximity to surface water or in the marsh. Construction BMPs would be employed to effectively reduce adverse short-term impacts on surface water and the marsh from the construction activities.

Practicability and Implementability – The excavation and disposal of wastes and revegetation steps required for removal are considered standard and conventional construction practices. Construction and reclamation of upland wastes and mining-related features could be difficult in some locations at the UBMC because of the steep terrain, remoteness and inadequate access, and special equipment may be required. Removal of sediment in the marsh and streams is dependent upon dewatering operations and access into wet or saturated areas. Mike Horse Creek Road and an abandoned drill testing road provide the only serviceable access to the Upper Marsh. Certain stream reaches are difficult to access because of steep terrain, remoteness, and inadequate roads in these areas. Engineering and construction contractors with the experience and equipment necessary to complete the work are available regionally. While this alternative is practicable and implementable at the UBMC, removal would be difficult in certain locations for the reasons stated.

Treatment or Resource Recovery Technologies - This alternative does not rely on treatment or resource recovery technologies.

Cost Effectiveness - The estimated total present worth cost for implementing this alternative at the UBMC is $29,625,091. Cost details and calculations for this alternative are included in Appendix E.

9.4.6 Alternative 7– In Situ Neutralization with Alkaline Amendment

Under this alternative, all solid media (soil) exceeding the SSCLs would remain in place but the pH of the soil would be increased through the application of lime, and the mobility and bio-availability of metals within the soil reduced. Concentration of metals in the soil is unchanged. In-situ neutralization is applicable to areas within EA1 (Table 8-1) and most of the mining-related features in EA-5 (Table 8-5).

Protectiveness – This alternative is a treatment that is protective for human health and the environment by reducing the bioavailability of the metals to environmental receptors. While this alternative would reduce the leaching of contamination to groundwater, it may not be protective of human health and the environment in the short-term and long-term by itself because contamination would remain in place at concentrations exceeding protection to groundwater SSCLs.

Compliance with ERCLs - Under this alternative, contamination remains in place at concentrations exceeding protection to groundwater SSCLs. In areas of impacted groundwater or surface water, compliance with surface water and groundwater ERCLs may be achieved within 30 to 40 years, when combined other alternatives or through natural attenuation, based on experience at other similar sites such as Silver Bow Creek near Butte, Montana. This timeframe could vary due to a fluctuating groundwater table or other continuing migration of contamination below the treatment zone. The remedy would be designed to ensure adequate revegetation and cover material that meets relevant reclamation ERCLs.

Mitigation of Risk - In-situ neutralization provides some mitigation of the risks to human health and the environment. While the risk posed by direct contact with the contamination may be reduced, contamination would be left in place at concentrations exceeding the protection to groundwater SSCLs, and therefore this alternative does not adequately mitigate risk to human health and the environment.

Effectiveness and Reliability - This alternative provides adequate short-term effectiveness and reliability in limiting contact with contamination and reduces leaching to groundwater. Short-term water quality impacts to the surrounding environment could occur at those sites where construction of roads, re-grading of waste, and treatment occurs in close proximity to surface water. Construction BMPs would be employed to effectively reduce adverse short-term impacts on surface water from the construction activities.

Practicability and Implementability - The grading, lime incorporation and revegetation steps required for in-situ neutralization are considered standard and conventional construction practices. Construction may be moderately difficult because of the steep terrain and remoteness of some locations and may require special equipment. Incorporation of lime requires specialized equipment and expertise and will require additional sampling and investigation to determine proper liming rates at each location. A suitable off-site source of lime is required and will involve hauling of these materials on public roads. This alternative is practicable and implementable at the UBMC to waste deposits less than 2 feet in thickness, or treatment of residual soil contamination in previously reclaimed areas. While this alternative is practicable and implementable at the UBMC, neutralization would be difficult in certain locations for the reasons stated. This technology was used during interim remedial actions at the UBMC, in combination with containment.

Treatment or Resource Recovery Technologies - This alternative relies on the treatment technology of alkaline amendment of soil, which raises the pH of the amended material, thus reducing the mobility of the metals.

Cost Effectiveness - The estimated total present worth cost for implementing this alternative at the UBMC is $4,311,101. Cost details and calculations for this alternative are included in Appendix E.

9.4.7 Alternative 8 - Ex-situ Neutralization with Alkaline Amendment

Under this alternative, all solid media (soil) exceeding the SSCLs would be excavated, mixed with lime, and returned to the original excavation site. Ex-situ neutralization is applicable to areas within EA1 (Table 8-1).

Protectiveness – This alternative is a treatment that is protective of human health and the environment by reducing the bioavailability of the metals to environmental receptors. While this alternative would reduce the leaching of contamination to groundwater, it may not be protective of human health and the environment in the short-term and long-term by itself because the contamination would remain in place at concentrations exceeding protection to groundwater SSCLs.

Compliance with ERCLs - Under this alternative, contamination remains in place at concentrations exceeding protection to groundwater SSCLs. In areas of impacted groundwater or surface water, compliance with surface water and groundwater ERCLs may be achieved within 30 to 40 years, when combined other alternatives or through natural attenuation. Although not used at similar sites such as Silver Bow Creek near Butte, Montana, the technology supporting this alternative is the same as in-situ neutralization and similar results in achieving ERCLS are expected. This timeframe could vary due to a fluctuating groundwater table or other continuing migration of contamination. The remedy would be designed to ensure adequate revegetation and cover material that meets relevant reclamation ERCLs

Mitigation of Risk - Ex-situ neutralization provides some mitigation of the risks to human health and the environment. While the risk posed by direct contact with the contamination may be reduced, contamination would be left in place at concentrations exceeding the protection to groundwater SSCLs, and therefore this alternative does not adequately mitigate risk to human health and the environment.

Effectiveness and Reliability - This alternative provides some short-term effectiveness and reliability in reducing leaching to groundwater. Short-term water quality impacts to the surrounding environment could occur at those sites where construction of roads, excavating, mixing, and handling of waste occurs in close proximity to surface water. BMPs would be employed to effectively reduce adverse short-term impacts on surface water from the construction activities. This alternative may be more effective when combined with other alternatives.

Practicability and Implementability - The excavation, mixing, lime incorporation, mixing, replacing, and revegetation steps required for ex-situ neutralization are considered standard and conventional construction practices. Construction may be moderately difficult because of the steep terrain and remoteness of some locations and may require special equipment. Incorporation of lime requires specialized equipment and expertise and will require additional sampling and investigation to determine proper liming rates at each location. A suitable source of lime is required and will involve hauling of these materials on public roads. This alternative is practicable and implementable at the UBMC to large areas of previous removal that exceed SSCLs. Removal of waste and mixing of lime may possibly impact surrounding areas, increasing the volume of material requiring treatment. In larger areas, removal and mixing could be performed within the footprint of the identified area exceeding SSCLs, minimizing impacts.

Treatment or Resource Recovery Technologies - This alternative relies on the treatment technology of alkaline amendment of soil, which raises the pH of the amended material, thus reducing the mobility of the metals.

Cost Effectiveness - The estimated total present worth cost for implementing this alternative at the UBMC is $2,317,210. Cost details and calculations for this alternative are included in Appendix E.

9.5 *Groundwater and Surface Water Alternatives Evaluation*

Seven alternatives are evaluated for groundwater and surface water at the UBMC:

- Alternative 9: MNA
- Alternative 10: Containment (Retention Pond)
- Alternative 11: Hydrologic and Hydraulic Control
- Alternative 12: Inundation
- Alternative 13: Active Chemical Reagent
- Alternative 14: Active Physical/Mechanical Treatment
- Alternative 15: Passive Chemical Reagent

9.5.1 Alternative 9 - Monitored Natural Attenuation

Under the MNA alternative, groundwater is regularly monitored to track changes in COC concentrations with time after source removal. MNA relies on dilution, sorption, and/or dispersion without active treatment and is applicable to areas within EA 2 (Table 8-2) and EA 4 (Table 8-4). The site-wide monitoring element tracks the overall effectiveness of remediation at the facility as described in Section 9.2.3 and does not include the monitoring for MNA at specific locations that may vary with time depending on the success of source removal and other site-specific factors. Monitoring for this alternative could be effectively combined with the site-wide long-term monitoring described in Section 7.3.3 and Section 9.2.3 to reduce costs.

Protectiveness -This alternative provides no protection from unacceptable risks in the short-term for human health or the environment. When combined with other alternatives, it can provide long-term protection for public health, safety, and welfare and the environment, although it is a slow natural process. The effectiveness of MNA would largely be determined by the success of source removal or control actions.

Compliance with ERCLs - Based on experience at other similar sites such as Silver Bow Creek in Butte, Montana, compliance with groundwater ERCLs through natural attenuation may be achieved within 30 to 40 years, when combined with source removal. This timeframe could vary due to a fluctuating groundwater table or other continuing migration of contamination. However, based on this experience and engineering judgment, and depending on conditions at the source area and successful removal of source materials, compliance with applicable ERCLs for groundwater may not be achieved for 50 years at certain areas of the facility due to mineralized geology in the bedrock aquifer, presence of mine workings, a fluctuating groundwater table or other continuing migration of contamination. Natural attenuation process, in association with source removal, will act to reduce mass, toxicity, mobility, volume, or concentrations of COCs in groundwater.

Mitigation of Risk - There is little to no immediate mitigation of exposures to risk under this alternative alone. Contaminated groundwater remains in place, untreated, and may continue to migrate off-site. Depending on subsurface geology and geochemistry, the mechanisms for reducing concentrations of the inorganic COCs are complex and difficult to predict with any certainty.

Effectiveness and Reliability – This alternative by itself is not an effective remedy for limiting human exposure. There is no effectiveness or reliability in protection of the environment, or protection of human health downgradient.

Practicability and Implementability - This alternative could be easily implemented at the UBMC. Access to the existing monitoring points would remain the same or similar to current conditions. This alternative is practicable and implementable at the UBMC.

Treatment or Resource Recovery Technologies - This alternative does not rely on treatment or resource recovery technologies.

Cost Effectiveness – The estimated total present worth cost for implementing this alternative at the UBMC is $2,311,332. Cost details and calculations for this alternative are included in Appendix E.

9.5.2 Alternative 10 – Containment (Retention Pond)

Under the containment (retention pond) alternative, surface water would be captured and stored in a retention pond. Retention relies on evaporation and infiltration without active treatment and is applicable to mining-related features areas within EA 3 (Table 8-3).

Protectiveness - This alternative would provide a means of containing impacted surface water and preventing migration beyond the area of the retention pond. This alternative would significantly reduce direct exposure to contamination downstream of the retention pond. However, it may not be protective of human health and the environment in the short-term and long-term by itself because contamination would remain in place at concentrations exceeding SSCLs and could serve as a source of exposure to human health and the environment in the retention area.

Compliance with ERCLs – Under this alternative, contamination remains in place at concentrations exceeding SSCLs. Depending on conditions at the source area, surface water from the source area (e.g., seep or adit discharge) and the retention pond may not achieve applicable ERCLs because of continuing inputs of contamination. Based on engineering judgment and review of guidance documentation (EPA, 2015), surface water downstream of the retention pond may comply with ERCLs following implementation of the remedy in combination with other alternatives, such as upstream source removal and natural attenuation.

Mitigation of Risk – Exposures to risk in the vicinity of the surface water discharge would not be mitigated by retention as the water at concentrations exceeding the SSCLs may remain on the surface and become concentrated within the retention pond. Downstream of the pond, however, risk exposure would be mitigated.

Effectiveness and Reliability – Containment of water in a retention pond will reduce the extent of impacts resulting from human and ecological exposure to the contaminants. Retention must retain the entire volume of water to be effective, and therefore higher flow rates require larger areas. Retention ponds may be susceptible to erosion and other damage, reducing the long-term effectiveness and reliability of the alternative. O&M would be required to maintain the integrity of the remedy and ensure continued performance as designed.

Practicability and Implementability –The excavation, filling, lining, grading, and revegetation steps required are considered standard and conventional construction practices. Construction at some of the mining-related features could be difficult in some locations at the UBMC because of the steep terrain, remoteness and inadequate access, and special equipment may be required. Engineering and construction contractors with the experience and equipment necessary to complete the work are available regionally. While this alternative is practicable and implementable at the UBMC, retention would be difficult in certain locations for the reasons stated.

Treatment or Resource Recovery Technologies - This alternative does not rely on treatment or resource recovery technologies.

Cost Effectiveness - The estimated total present worth cost to implement this alternative at the UBMC is $1,116,380. Cost details and calculations for this alternative are included in Appendix E.

9.5.3 Alternative 11 – Hydrologic and Hydraulic Control

Under this alternative, upgradient groundwater and surface water at the Carbonate Mine site would be captured and diverted around the waste removal area. While this alternative would reduce the quantity of groundwater impacted by metals, it would not reduce the quantity of metals leaving the Carbonate Mine site, and therefore is not anticipated to reduce the impact of the Carbonate Mine site on downgradient groundwater and surface water quality. If used in conjunction with passive treatment with a chemical reagent (PRB) this alternative could provide an optimization and significant reduction in long-term costs by reducing the size and increasing the effectiveness of the PRB.

Protectiveness – This alternative would not significantly reduce the contribution of metals from the Carbonate Mine site and does not provide protectiveness for the short-term and long-term for human health or the environment. Protectiveness may be met if combined with other alternatives.

Compliance with ERCLs –Since mine workings would continue to generate groundwater with concentrations exceeding SSCLs that would continue to migrate downgradient of the Carbonate Mine site, sources to groundwater would remain in place. With this alternative alone, it is reasonable to assume compliance with groundwater ERCLs will not be achievable in any timeframe in downgradient groundwater based on engineering judgment. However, when combined with other treatment alternatives, such as passive treatment (PRB) at the

Carbonate site, compliance with ERCLs for downgradient groundwater would be achievable following implementation of the PRB within 5 to 10 years as discussed in Section 9.5.7.

Mitigation of Risk - There is no mitigation of exposures to risk to human health and the environment under this alternative.

Effectiveness and Reliability – This alternative does not reduce contamination and has no short-term and long-term effectiveness or reliability in maintaining acceptable risk levels for exposure risks to groundwater exceeding SSCLs. In conjunction with passive treatment with chemical reagent, this alternative could provide a significant increase in effectiveness and reliability by reducing the quantity of groundwater that would need to be treated.

Practicability and Implementability – The capture and diversion of water are considered standard and conventional construction practices. Engineering and construction contractors with the experience and equipment necessary to complete the work are available regionally. This alternative is practicable and implementable at the UBMC.

Treatment or Resource Recovery Technologies - This alternative does not rely on treatment or resource recovery technologies.

Cost Effectiveness – The estimated total present worth cost to implement this alternative at the UBMC is $464,514. Cost details and calculations for this alternative are included in Appendix E.

9.5.4 Alternative 12 - Inundation

Under this alternative, an inundation control (bulkhead/wet mine seal or plug) is installed to raise the water level within a mine or adit, reducing AMD through the reduction of acid production. An adit at the Capital Mine was plugged with a grout seal to reduce seasonal discharge of water from the adit as an interim action in 1997 (Hydrometrics, 1998a). Inundation is applicable to this adit within EA 2.

Protectiveness – This alternative would eliminate the potential for direct contact with contamination at the adit and is protective of human health and the environment in the short-term and long-term. The increased hydraulic head behind the plug may cause groundwater to create new seeps or increase groundwater gradients in the area.

Compliance with ERCLs - Under this alternative, potentially impacted groundwater remains within the mine workings. Groundwater that exceeds SSCLs would not be remediated although it would be contained.

Mitigation of Risk – Inundation of an adit with discharge concentrations exceeding the SSCLs provides complete mitigation of the risks to human health and the environment related to the adit discharge. Continued risk may be present if new uncontrolled seeps develop.

Effectiveness and Reliability – This alternative is considered highly effective and reliable in both the short-term and long-term. The alternative can be very effective if combined with water collection and treatment alternatives.

Practicability and Implementability – The sealing of an adit and resultant inundation are considered standard and conventional mining practices. This alternative is practicable and implementable at the UBMC. Adit sealing and inundation has been used at other locations within the UBMC with success.

Treatment or Resource Recovery Technologies - This alternative does not rely on treatment or resource recovery technologies.

Cost Effectiveness – The estimated total present worth cost for implementing this alternative at the UBMC is $10,124. Cost details and calculations for this alternative are included in Appendix E.

9.5.5 Alternative 13 - Active Chemical Reagent

As described in Section 7.5.7 this alternative involves adding a neutralizing agent, such as lime (calcium oxide or calcium hydroxide) to impacted water, followed by a settling pond for metals precipitation. The addition of sodium hydroxide or calcium hydroxide directly to water promotes the precipitation of metal hydroxides, thus reducing the amount of metals in the water. This alternative is applicable to the groundwater sites listed in EA 2, with exception of the Capital Mine adit plug (Table 8-2). The process is being used as part of the existing WTP system and when combined with ceramic microfiltration has proven effective. By itself, the alternative will not effectively remove COCs to DEQ-7 standards or SSCLs. Because of the complexity and unknowns associated with the underground workings at the Carbonate, Paymaster, and Upper Mike Horse bedrock aquifer sites, it may not be feasible to capture all of the groundwater at each of these sites. Additional data collection and bench-scale tests would be necessary as part of remedial design.

Implementation of the alternative requires a capture and conveyance system to either a common treatment plant for all sources, or to individual treatment plants. For the purpose of this FS, it is assumed that all waters would be conveyed to the WTP for treatment and the WTP would be expanded accordingly to accommodate the increased flows. There is currently a capture and conveyance system in place for the Mike Horse adit discharge and seep water and for the Anaconda adit water. A new system would be required at the Carbonate, Paymaster, and Upper Mike Horse bedrock aquifer sites. At each of these sites, the system would involve an interception trench and/or series of wells to capture the water, and a pumping station and pipeline to convey flows to the WTP. Design of the capture systems would require the collection of additional data on the aquifer properties (e.g., extents, geology, hydraulic conductivity).

Protectiveness – This alternative by itself is not protective of human health and the environment because contamination would remain in place at concentrations exceeding SSCLs. However, if combined with other alternatives, active chemical reagent could provide protection from elevated metals within groundwater migrating off-site. A combination of the alternatives would minimize exposure risks for metals within downgradient groundwater and surface water for the short-term and long-term for public health, safety or welfare or the environment.

Compliance with ERCLs - Under this alternative, groundwater would be intercepted and treated at a centralized location. Contaminated groundwater exceeding SSCLs would remain at each site prior to interception and without removal of the contamination source, would not comply with ERCLs within any timeframe based on engineering judgment. Compliance with ERCLs may be achieved at the outflow of the WTP when combined with other active treatment alternatives based on the operation of the existing WTP.

Mitigation of Risk – There would be no mitigation of risk from exposure to contaminated groundwater with this alternative, but if combined with other alternatives, some mitigation of risk may be achieved.

Effectiveness and Reliability – Because this alternative by itself would not remove COCs to standards, it is not effective or reliable in either the short-term or long-term, unless combined with active physical/mechanical treatment. This alternative, combined with ceramic microfiltration, has proven to be effective and reliable at the existing WTP.

Practicability and Implementability – This alternative has proven practicable and implementable for the Anaconda Adit water and the Mike Horse Adit discharge and seep water. Because of the complexity and unknowns associated with the underground workings at the Carbonate, Paymaster, and Upper Mike Horse bedrock aquifer, it is likely not feasible to capture all of the groundwater at each of the sites. It is also uncertain whether or not the existing WTP site could accommodate the expansion necessary to treat these waters.

Treatment or Resource Recovery Technologies - This alternative does rely on treatment technologies. The treatment may produce sludges or byproducts that require disposal at a suitable on- or off-site facility, depending on the TCLP samples.

Cost Effectiveness – The estimated total present worth cost for implementing this alternative at the UBMC is $20,394,855. Cost details and calculations for this alternative are included in Appendix E. In estimating costs for waters not currently treated at the WTP, the estimated construction cost for the WTP of $3,000,000 was used as a basis for proportioning costs for treating additional water, based on flow rates.

9.5.6 Alternative 14 - Active Physical/Mechanical Treatment

As described in Section 7.5.8, this alternative involves the use of ceramic microfiltration to filter contaminants out of the water by pumping through a ceramic membrane. This alternative is applicable to the groundwater sites listed in EA 2, except for the Capital Mine adit plug (Table 8-2). The process is currently being used as part of the existing WTP system and is effective when combined with pretreatment with a chemical reagent. By itself, the alternative will not effectively remove COCs to DEQ-7 standards. Determining the effectiveness for groundwater at the Carbonate and Paymaster sites and the Upper Mike Horse bedrock aquifer will require additional data collection and bench-scale tests to assess as part of remedial design.

Implementation of the alternative requires a capture and conveyance system to either a common treatment plant for all sources, or to individual treatment plants. For the purpose of this FS, it is assumed that all waters would be conveyed to the WTP for treatment and the WTP would be expanded accordingly to accommodate the increased flows. There is currently a capture and conveyance system in place for the Mike Horse adit discharge and seep water and for the Anaconda adit water; a new system would be required at the Carbonate, Paymaster, and Upper Mike Horse bedrock aquifer sites. At each of these sites, the system would involve an interception trench and/or series of wells to capture the water, and a pumping station and pipeline to convey flows to the WTP. Design of the capture systems would require the collection of additional data on the aquifer properties (e.g., extents, geology, hydraulic conductivity).

Protectiveness – This alternative by itself is not protective of human health and the environment. However, if combined with other alternatives, active physical/mechanical treatment could provide protection in certain areas from elevated metals within groundwater. These actions together would minimize exposure risks for metals within downgradient groundwater and surface water for the short-term and long-term for public health, safety or welfare or the environment.

Compliance with ERCLs - Under this alternative, groundwater would be intercepted and treated at a centralized location. Contaminated groundwater exceeding SSCLs would remain at each site prior to interception and without removal of the contamination source, would not comply with ERCLs within any timeframe based on engineering judgment. Compliance with ERCLs may be achieved at the outflow of the WTP when combined with other active treatment alternatives based on the operation of the existing WTP.

Mitigation of Risk – There would be no mitigation of risk from exposure to contaminated groundwater with this alternative, but if combined with other alternatives, partial or complete mitigation of risk outside of the source area may be achieved.

Effectiveness and Reliability – Because this alternative by itself would not remove COCs to standards, it is not effective or reliable in either the short-term or long-term, unless combined with active chemical treatment. This alternative, combined with alkaline amendment, has proven to be effective and reliable at the existing WTP.

Practicability and Implementability – This alternative has proven practicable and implementable for the Anaconda Adit water and the Mike Horse Adit discharge and seep water. Because of the complexity and unknowns associated with the underground workings, it is likely not feasible to capture all of the groundwater at each of the sites. It is also uncertain whether or not the existing WTP site could accommodate the expansion necessary to treat these waters.

Treatment or Resource Recovery Technologies - This alternative does rely on treatment technologies. The treatment may produce sludges or byproducts that require disposal at a suitable on- or off-site facility, depending on the TCLP samples.

Cost Effectiveness – The estimated total present worth cost for implementing this alternative at the UBMC is $20,394,855. Cost details and calculations for this alternative are included in Appendix E. In estimating costs for waters not currently treated at the WTP, the estimated construction cost for the WTP of $3,000,000 was used as a basis for proportioning costs for treating additional water, based on flow rates.

9.5.7 Alternative 15 - Passive Chemical Reagent: Permeable Reactive Barrier

This alternative consists of installing a PRB and cutoff wall to remove metals from contaminated groundwater. This technology is potentially applicable to sites requiring treatment of near-surface groundwater. Treatment of the Upper Mike Horse bedrock aquifer groundwater with this technology is not practicable because of the depth to water and the difficulties in intercepting water in a complex bedrock environment. Therefore, it is potentially applicable to the Anaconda adit discharge, the Carbonate Mine, the Mike Horse adit discharge and seeps, and the Paymaster alluvial aquifer in EA 2. Because this alternative requires interception of all contaminated water, the use of this alternative at each of these sites will require additional investigation and data to characterize the extents of contamination, water quality chemistry, and the aquifer properties at each site to maximize effectiveness. The CSM for the Carbonate Mine groundwater (Section 6.2.3) suggests that PRB may be a viable alternative at that location.

Protectiveness – This alternative could provide protection from elevated metals within groundwater migrating beyond the source area and could therefore minimize exposure risks for metals within downgradient groundwater and surface water for the short-term and long-term for human health and the environment.

Compliance with ERCLs – Under this alternative, groundwater leaving the Carbonate Mine site may comply with DEQ-7 drinking water standards and compliance with ERCLs could be expected to be achieved within 5 to10 years, based on performance at sites such as the Success Mine and Mill site in Idaho, where a PRB utilizing phosphate-induced metal stabilization successfully reduced concentrations of lead, cadmium, nitrate, and sulfate to below detection levels and lead to near background levels within 2 years (Conca, et. al, 2003). Compliance with ERCLs through implementation of this alternative for the other locations will require additional data to maximize effectiveness of the remedy. It is unlikely that this alternative would meet ERCLs in these areas unless combined with source removal.

Mitigation of Risk – The Carbonate Mine site CSM estimates that the Carbonate Mine site has the potential to contribute enough cadmium to the Blackfoot River during base flow to increase in-stream concentrations to more than twice the applicable DEQ-7 standard. There is significant mitigation of exposures to risk under this alternative at that site because concentrations of cadmium and other metals in the groundwater leaving the Carbonate Mine site would be significantly reduced. Potential mitigation of risk within the Paymaster alluvial aquifer is unknown, due to lack of data.

Effectiveness and Reliability – This alternative could have significant short-term and long-term effectiveness or reliability in maintaining acceptable risk levels for exposure risks to downstream groundwater and surface water at the Carbonate Mine site. Effectiveness and reliability for the other sites is uncertain, due to lack of data. Because of the complexity and unknowns associated with the underground workings, it is likely not feasible to capture all of the groundwater at each of the sites. Periodic replacement of the PRB substrate will be required to ensure long-term effectiveness.

Practicability and Implementability – This alternative would require additional site investigations and pilot studies to ensure optimization of the designs.

Treatment or Resource Recovery Technologies - This alternative does rely on the use of PRB, a treatment technology.

Cost Effectiveness – The estimated total present worth cost for implementing this alternative at the UBMC is $7,827,027. Cost details and calculations for this alternative are included in Appendix E.

9.6 *Comparative Analysis of Alternatives*

The alternatives were evaluated and compared against the seven cleanup criteria identified in § 75-10-721, MCA. Protectiveness and compliance with ERCLs are threshold criteria that must be met for any remedy. In the comparative analysis, the remaining criteria are weighed and evaluated to identify the best overall alternatives for each media, and include considerations of present and reasonably anticipated future uses of the UBMC and the use of institutional controls. Each criterion is listed individually below.

Protectiveness – Alternative 1 provides no protection to human health and the environment. Alternative 2 provides no protection from unacceptable risks in the short-term for public health, safety or welfare or the environment, but may become protective in the long-term. Alternative 3 does provide protection from unacceptable risks in the short-term and long-term for public health, safety or welfare or the environment by addressing the safety hazards associated with mine openings. Alternatives 4, 7, and 8 provide some protectiveness by covering or reducing the mobility of COCs in solid media. However, because the contaminated media remains in place, there will continue to be a risk of exposure. If Alternative 4 were combined with Alternative 7 or 8, the protectiveness would be increased. Alternatives 5 and 6 provide the greatest level of protectiveness for the solid media options because all waste material exceeding SSCLs would be removed. Alternative 9 provides no protection from unacceptable risks in the short-term for public health, safety or welfare or the environment, but may become protective in the long-term. Alternative 10 is protective downstream of the remedy but not within the retention area. Alternative11 provides no protection from risks in either the short-term or long-term for public health, safety, and welfare or the environment. Alternative 12 is protective, provided the adit plug remains intact. Alternatives 13 and 14, by themselves are not fully protective, but, if combined, could provide protectiveness by treating water to meet standards before it leaves the source area.

Alternative 15 could provide protectiveness by preventing contaminated groundwater from migrating beyond the source area.

Compliance with ERCLs – Alternative 1 does not comply with ERCLs. Alternative 2 would not meet surface water ERCLs in the short-term but does in the long-term. Alternative 3 only address safety hazards so it does not comply with ERCLs by itself. Under Alternatives 4, 7, and 8, contaminated soils remain in place and could continue to leach COCs to groundwater so compliance with ERCLs would not be met. Alternatives 5 and 6 would achieve ERCLs compliance within a short period through removal of contaminated soils that leach to groundwater or impact surface water, and placement in a repository that complies with ERCLs. Alternatives 9 and 11 would not improve the quality of surface water or groundwater and would not comply with applicable ERCLs. Alternative 10 would not improve compliance with ERCLs at the point of discharge but will improve compliance downstream. Alternative 12 provides compliance with ERCLs within the adit but does not address groundwater quality in other areas. Alternatives 13 and 14, if combined, would meet groundwater ERCLs. Alternative 15 could also comply with groundwater ERCLs at the Carbonate site and improve the compliance of surface water in the downgradient Blackfoot River (ERCLS under CECRA are similar to ARARs, which will be evaluated by the USFS under CERCLA and the NCP.)

Mitigation of Risk – Alternative 1 does not mitigate risk. Mitigation of risk may be achieved through Alternative 2 over a long period as natural recovery processes occur within stream sediments, although the success of this remedy is dependent on source removal and control. Alternative 3 provides mitigation of safety risks through physical barriers. Alternative 4 provides mitigation of the risk presented by direct contact, but may not completely mitigate the risks to surface water or groundwater. Alternatives 5 and 6 provide the greatest level of risk mitigation for the solid media alternatives through removal of the waste sources to meet SSCLs. Alternatives 7 and 8 provide some mitigation of risk through the reduction of metals mobility in the soils. There is no mitigation of exposures to risk under Alternatives 9, 10, and 11, although Alternative 10 provides mitigation downstream of the point of discharge. Alternative 12 provides mitigation of risk through maintaining an effective seal on the Capital Mine adit. Alternatives 13, 14, and 15 mitigate risk by treating contaminated groundwater to meet DEQ-7 standards.

Effectiveness and Reliability – Alternative 1 provides no short-term effectiveness or reliability. Alternatives 2 and 9 are not effective or reliable in the short-term but are effective and reliable in the long-term when combined with source removal and control. Alternative 3 has proven to be effective and reliable for addressing physical hazards at the UBMC and other mining sites. Alternative 4 is effective and reliable in the short-term by limiting contact with contamination but is less effective and reliable in the long-term due to weathering and erosion. Alternatives 5 and 6 provide the most effectiveness and reliability because waste materials are removed and placed in an engineered repository. Alternatives 7 and 8 may be effective and reliable in limiting contact with contamination and reducing leaching to groundwater. Alternative 9 is effective and reliable in the long-term provided there is adequate source removal and control. There is significant short-term and long-term effectiveness and reliability in maintaining acceptable risk levels under Alternatives 10 and

12; however, Alternative 12 has limited use. Alternatives 13 and 14, if combined, have proven to be effective and reliable at reducing COC levels to SSCLs at the existing WTP. By itself, Alternative 11 has no short-term or long-term effectiveness or reliability in maintaining acceptable risk levels; however when combined with other alternatives, it can be effective by reducing the quantity of groundwater that would need to be treated. Alternative 15 may be effective but has limited use.

Practicability and Implementability – Alternative 1 is easily implementable. Alternatives 2 and 9 are technically practicable and implementable utilizing and expanding the existing monitoring network. Alternatives 3, 4, 5, and 6 are each technically practicable and implementable. Alternatives 7 and 8 are technically practicable at some sites within EA 1 and EA 5 provided that a suitable source of lime is available. Alternatives 10, 11, and 12 are practicable and implementable at sites within EA 2 and EA 3. Alternatives 13 and 14 have proven to be technically practicable and implementable at the existing WTP for treating water from the Anaconda Mine adit and Mike Horse Mine adit and seeps. Implementation of Alternative 15 is practicable and implementable at the Carbonate Mine site.

Treatment or Resource Recovery Technologies - Alternatives 1, 2, 3, 4, 5, 6, 9, 10, 11, and 12 do not rely on treatment or resource recovery technologies. Alternatives 7 and 8 rely on soil amendment with lime treatment. Alternative 13 relies on traditional lime addition treatment. Alternative 14 relies on proven filtration treatment technology. Alternative 15 relies on readily accessible PRB technology.

Cost Effectiveness - The estimated total present worth cost for implementing each alternative in Table E-1 in Appendix E. Not all alternatives apply to all media or sites within the UBMC. Cost effectiveness is determined through an analysis of incremental costs and incremental risk reduction and other benefits of alternatives considered, taking into account the total anticipated short-term and long-term costs of remedial action alternatives, including the total anticipated cost of O&M. Alternative 1 is the least expensive alternative but provides no risk reduction. Alternatives 2, 3, 4, 7, and 8 provide some risk reduction but do not address all contamination. Alternative 5 and 6 provide the same risk reduction but Alternative 6 is more expensive that Alternative 5. Alternative 9 provides long-term risk reduction but is only effective when combined with a removal and source control alternative. Alternatives 10, 11, and 12 provide some risk reduction and are less expensive than other groundwater treatment alternatives, but do not address all contamination. Alternatives 13 and 14 provide risk reduction and are near the same cost. Alternative 15 is less expensive than Alternatives 13 and 14 but likely would not reduce risk in groundwater throughout the UBMC.

9.7 *Summary*

The process options and alternatives retained for consideration in this FS were evaluated for their effectiveness for the UBMC. Based on this evaluation, an effective combination of technologies for the UBMC will be developed and documented by DEQ in the Proposed Plan and ROD.

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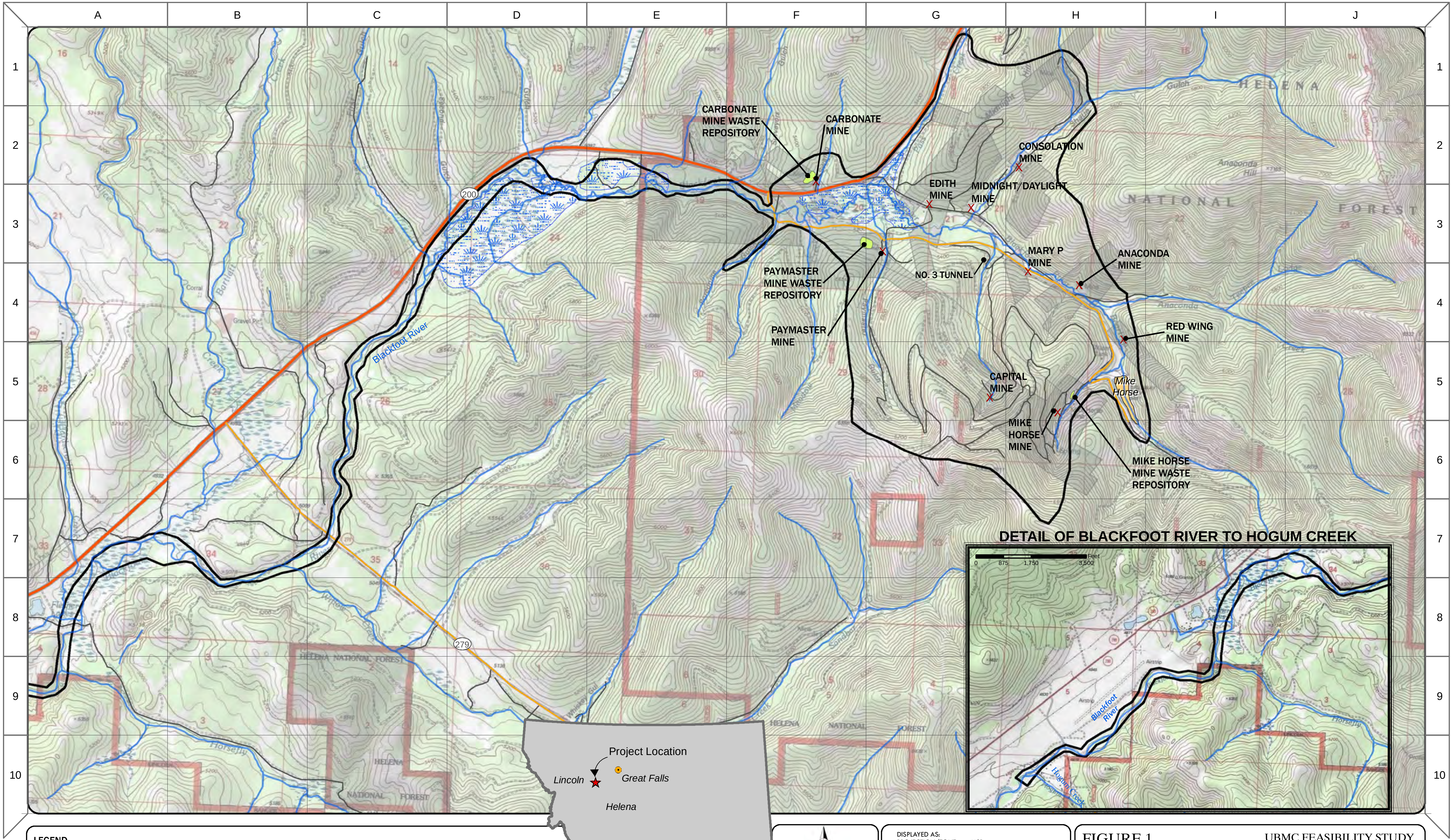

LEGEND

- X MINE
- STREAM
- EXTENT OF UBMC
- STATE HIGHWAY
- MAJOR ROAD
- LOCAL ROAD
- MINE WASTE REPOSITORY
- MIKE HORSE TAILINGS IMPOUNDMENT
- MARSH
- FOREST SERVICE PROPERY BOUNDARY

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

Feet
0 1,200 2,400 4,800

FIGURE 1

UBMC FEASIBILITY STUDY
SITE LOCATION MAP

PIONEER TECHNICAL SERVICES, INC.

DATE: 1/9/2015

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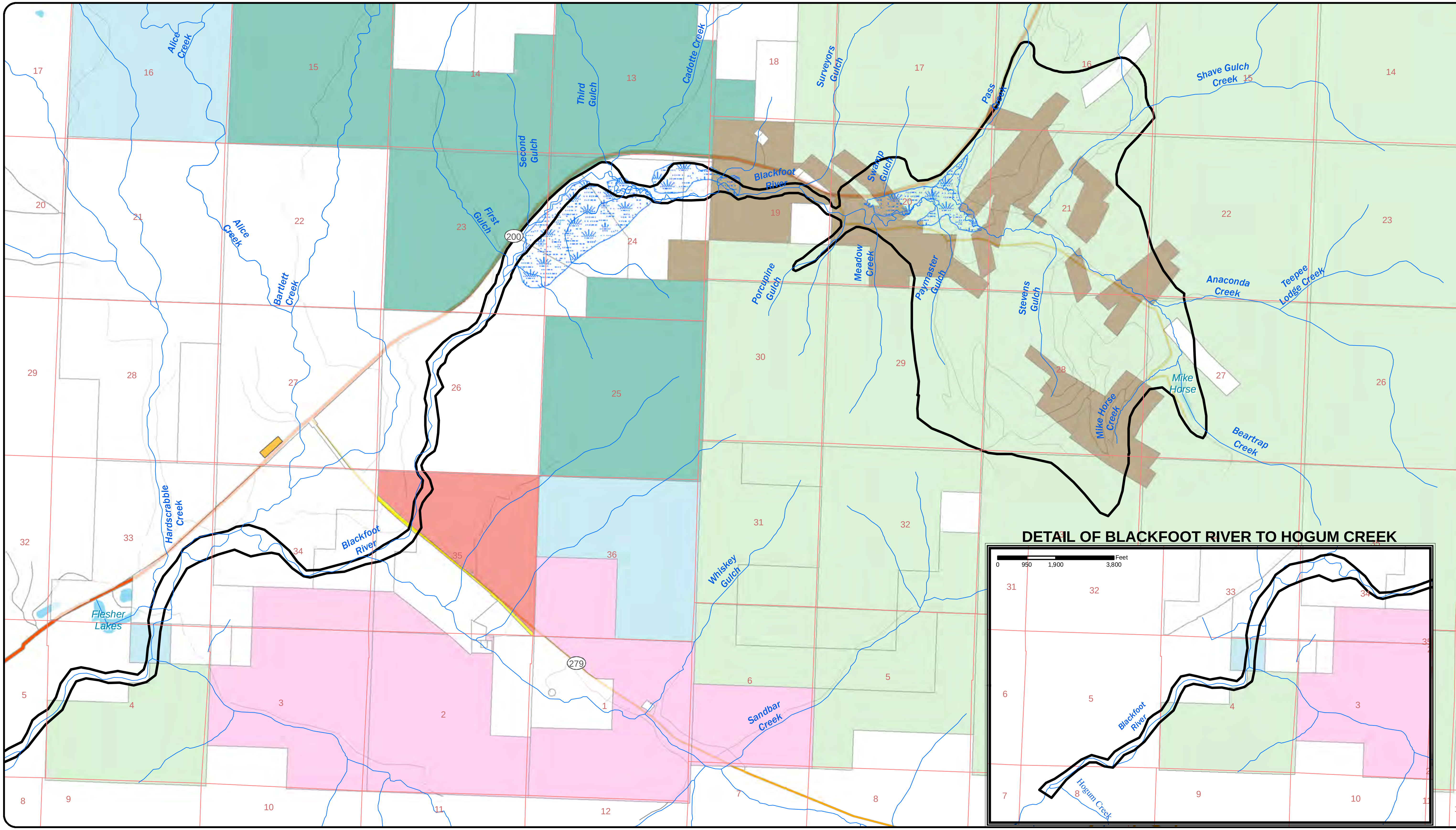

LEGEND

STREAM

SECTION LINES

EXTENT OF UBMC

MARSH

LAKE

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

0 1,500 3,000 6,000
Feet

FIGURE 2

UBMC FEASIBILITY STUDY
LAND OWNERSHIP AND
SURFACE WATER

PIONEER TECHNICAL SERVICES, INC.

DATE: 1/9/2015

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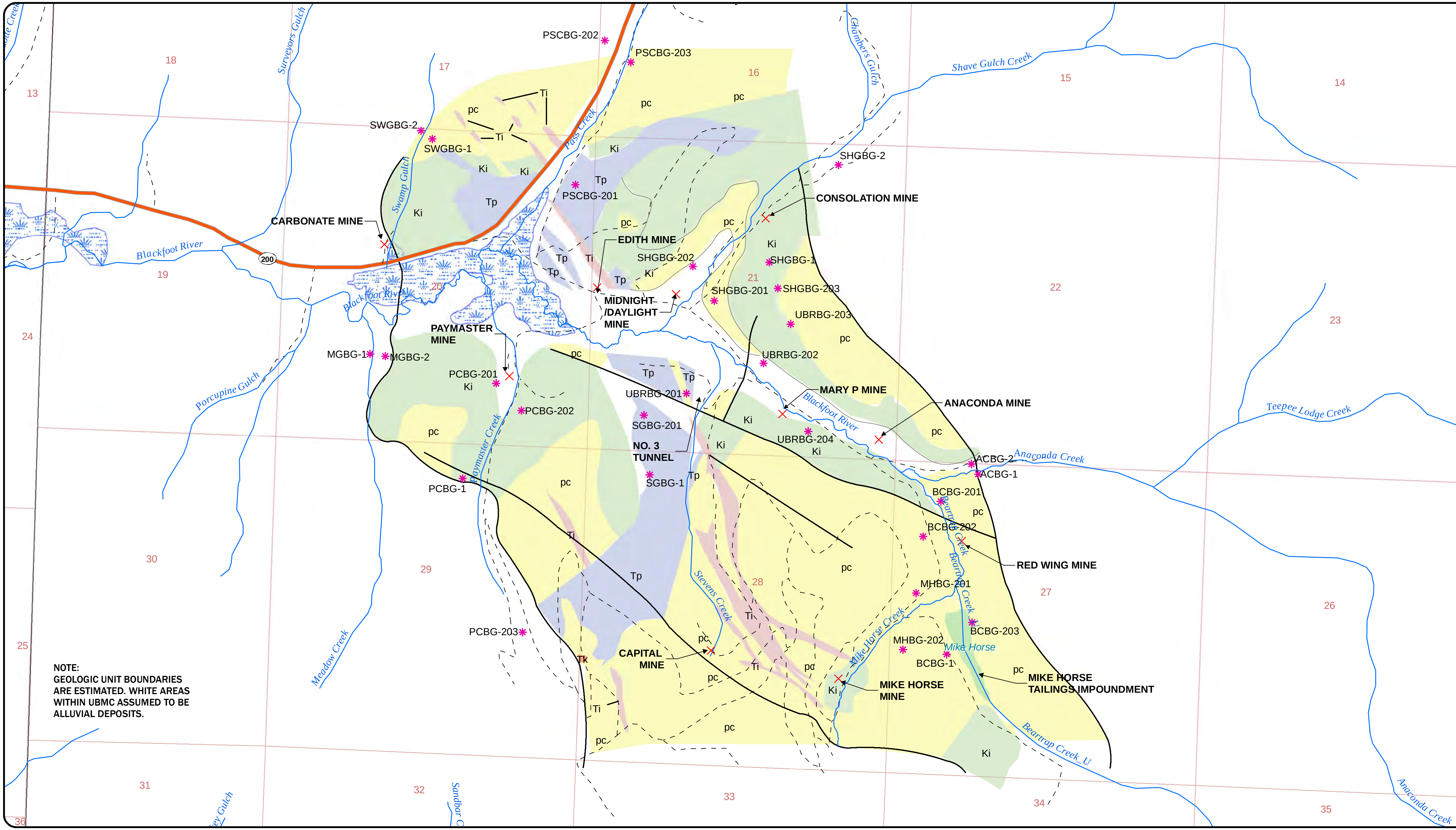

LEGEND

- ✱ BACKGROUND SOIL SAMPLE
- ✕ MINE
- FAULT
- LOCAL ROAD
- STATE HIGHWAY
- Ki DIORITE (GABBFRO) SILL
- Ti QUARTZ MONZONITE PORPHYRY DIKES
- Tk KLEINSCHMIDT BRECCIA PIPE
- Tp QUARTZ MONZONITE PORPHYRY AND QUARTZ PORPHYRY INTRUSIVES
- pc SPOKANE SHALE (BELT SUPERGROUP)
- MARSH
- STREAM

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

Feet: 0 | 650 | 1,300 | 2,600

FIGURE 3

UBMC FEASIBILITY STUDY
GEOLOGIC MAP

PIONEER TECHNICAL SERVICES, INC.

DATE: 1/9/2015

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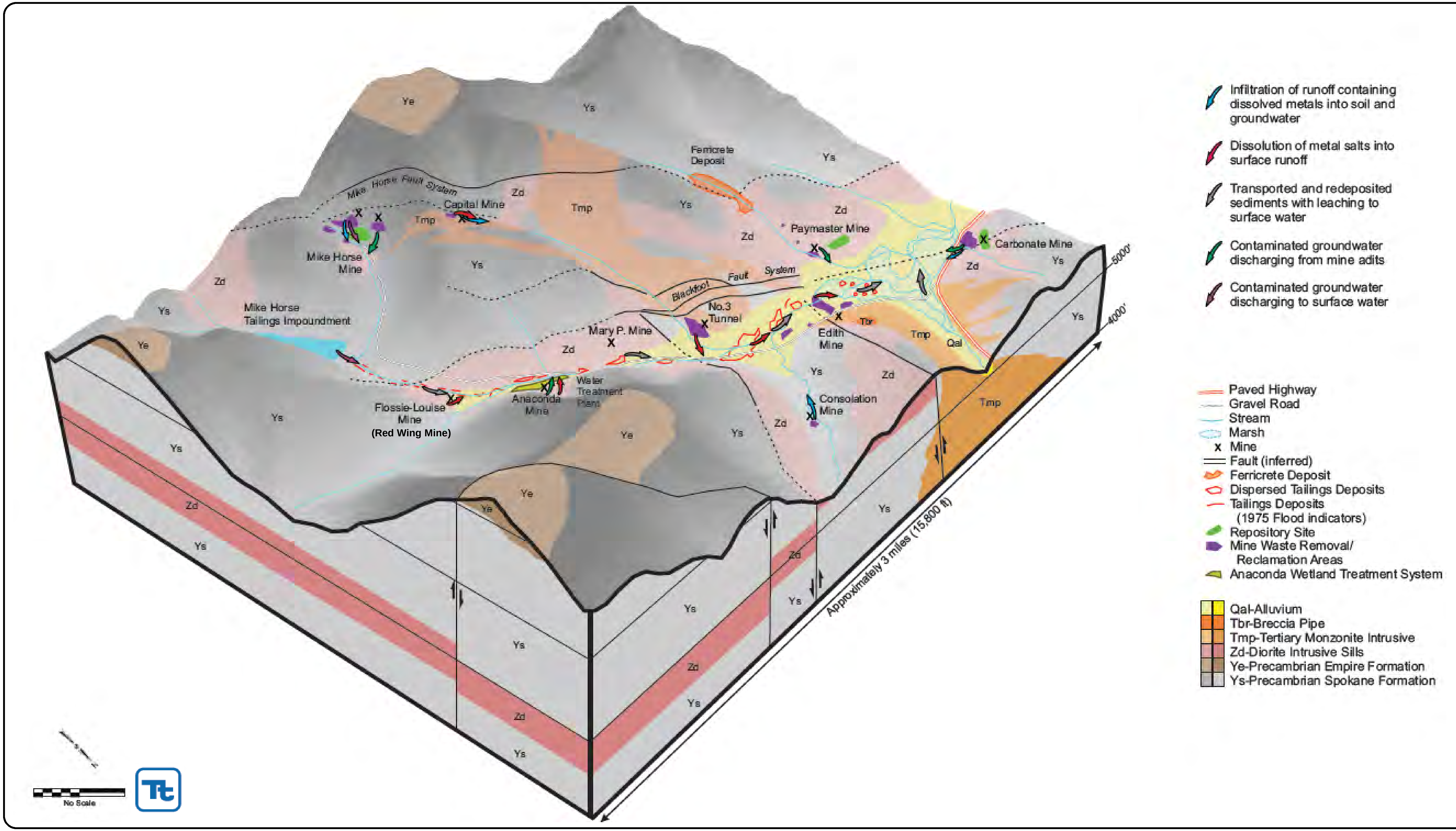

FIGURE CREATED BY TETRA TECH
JANUARY 2013
FIGURE 60
GRAPHICAL-CONCEPTUAL MODEL
REMEDIAL INVESTIGATION
UPPER BLACKFOOT MINING COMPLEX

DISPLAYED AS:
PROJECTION/ZONE:
DATUM:
UNITS:
SOURCE:

FIGURE 4

PIONEER TECHNICAL SERVICES, INC.

UBMC FEASIBILITY STUDY
CONCEPTUAL SITE EXPOSURE
MODEL GRAPHIC

DATE: 1/9/2015

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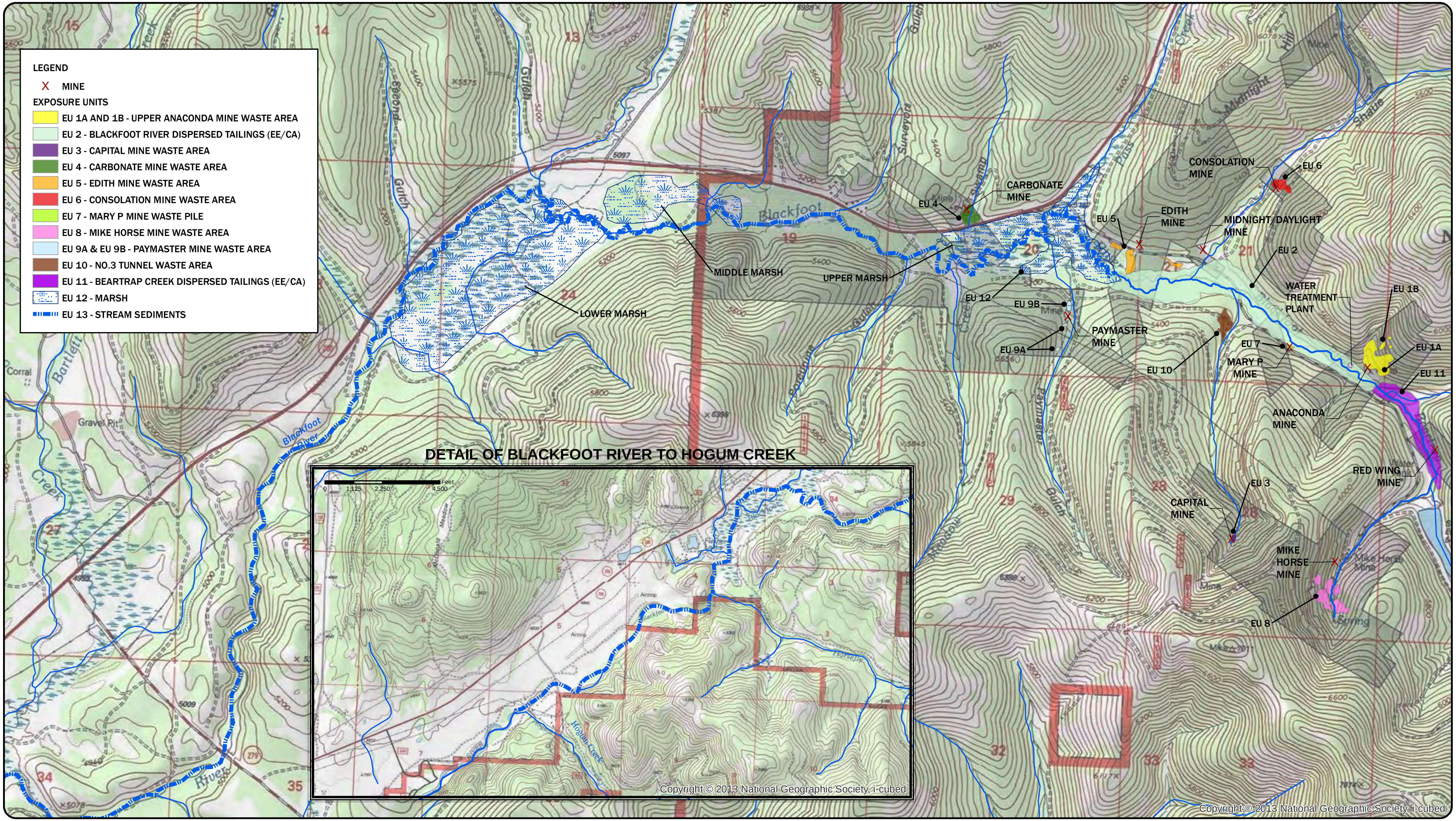

LEGEND

- HIGHWAY
- MAJOR ROAD
- LOCAL ROAD
- STREAM
- FOREST SERVICE
- METG/PRIVATE
- LAKE

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

0 1,000 2,000 4,000
Feet

FIGURE 5

UBMC FEASIBILITY STUDY
EXPOSURE UNIT
LOCATIONS

PIONEER TECHNICAL SERVICES, INC.

DATE: 2/11/2015

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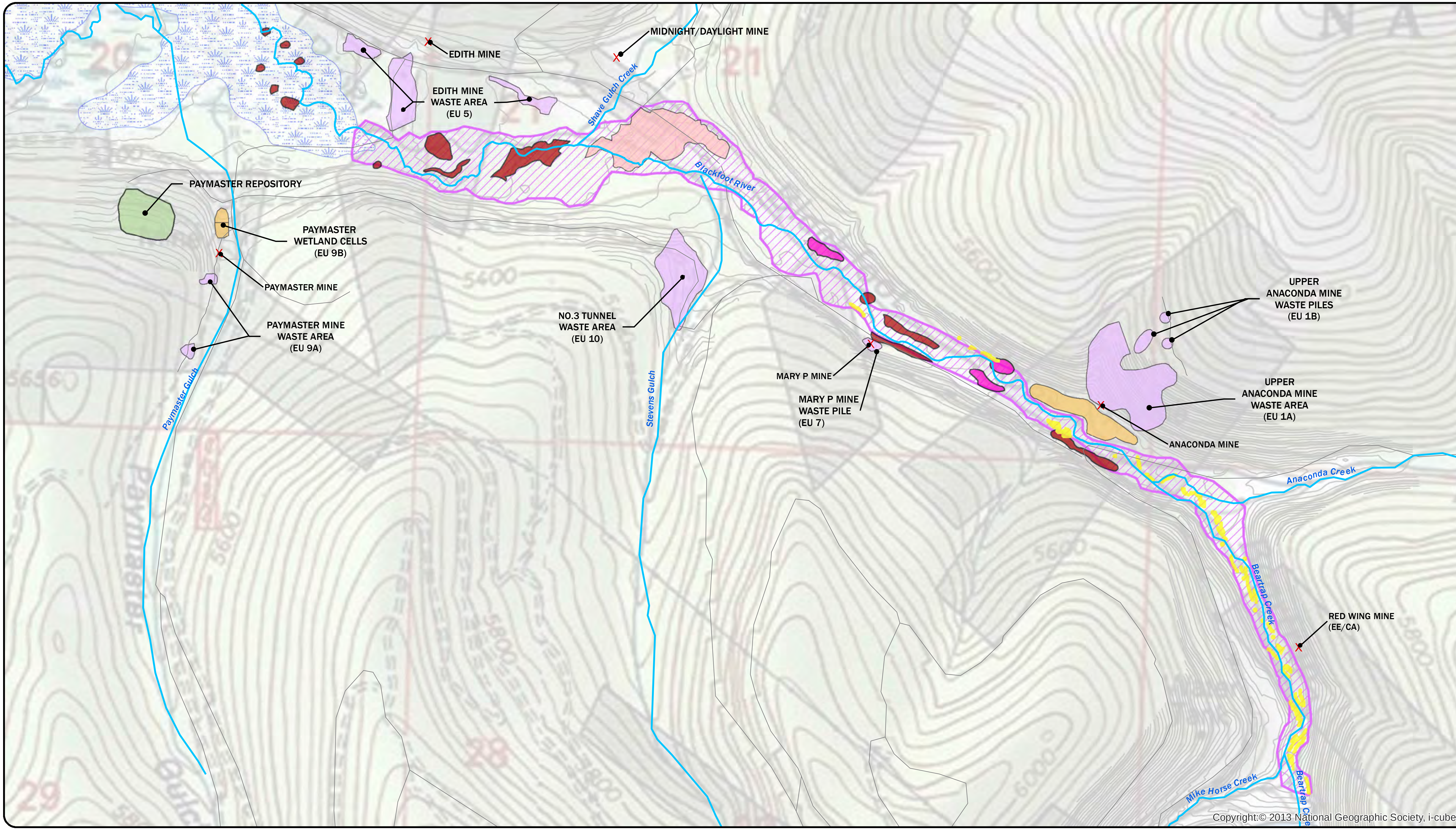

LEGEND

- ✕ MINE
- STREAM
- ROAD
- 1975 BREACH FLOOD STAGE INDICATORS
- AREA OF CONCENTRATED TAILINGS/MINE WASTE
- AREA OF DISPERSED COARSE-GRAINED TAILINGS
- AREA OF DISPERSED SANDY (FINE) TAILINGS
- FORMER WETLAND TREATMENT CELLS
- MINE WASTE REPOSITORY
- ESTIMATED EXTENT OF RIVER FLOODPLAIN SEDIMENTS
- FOREST SERVICE
- METG

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/GEUM/ESRI

Feet
0 265 530 1,060

FIGURE 6

UBMC FEASIBILITY STUDY
EE/CA OVERLAP AREA

PIONEER TECHNICAL SERVICES, INC.

DATE: 1/9/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-008-15.mxd

LEGEND

MINE	ESTIMATED EXTENT OF MINE WASTE AREA	MINE WASTE REMOVAL/RECLAIMED AREA
2007 SAMPLES	UNRECLAIMED MINE WASTE AREA	STREAM
2008 SAMPLES	FORMER WETLAND TREATMENT CELLS	

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

0 70 140 280 Feet

FIGURE 7

UBMC FEASIBILITY STUDY
EU 1A AND EU 1B UPPER ANACONDA
MINE WASTE PILES
SOIL SAMPLE LOCATIONS

PIONEER TECHNICAL SERVICES, INC.

DATE: 1/9/2015

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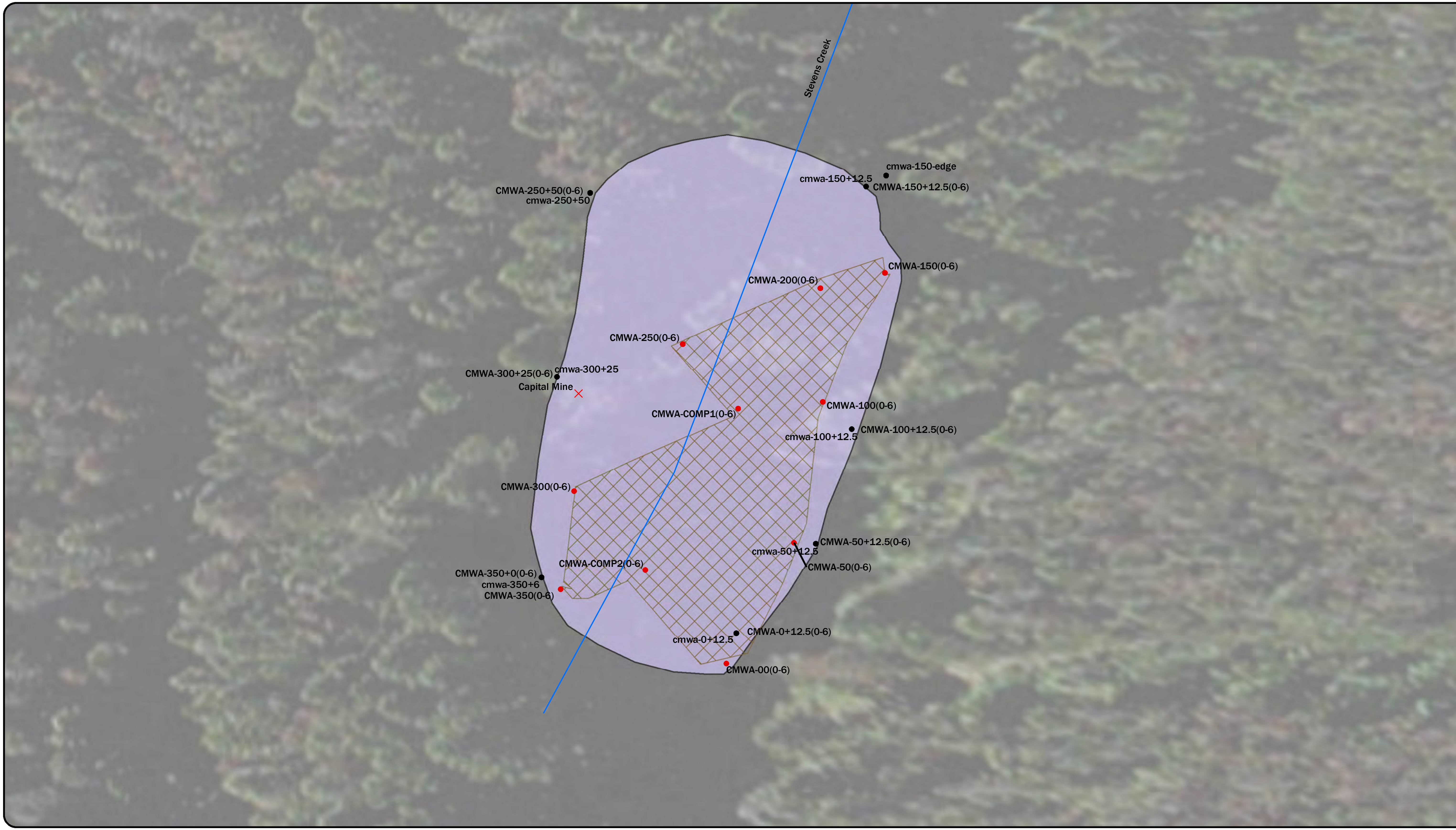

LEGEND

- MINE
- 2007 SAMPLE
- 2008 SAMPLE
- ESTIMATED EXTENT OF MINE WASTE AREA
- MINE WASTE REMOVAL/RECLAIMED AREA
- STREAM

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

0 15 30 60 Feet

FIGURE 8

PIONEER TECHNICAL SERVICES, INC.

UBMC FEASIBILITY STUDY
EU 3 CAPITAL MINE WASTE AREA
SOIL SAMPLE LOCATIONS

DATE: 1/9/2015

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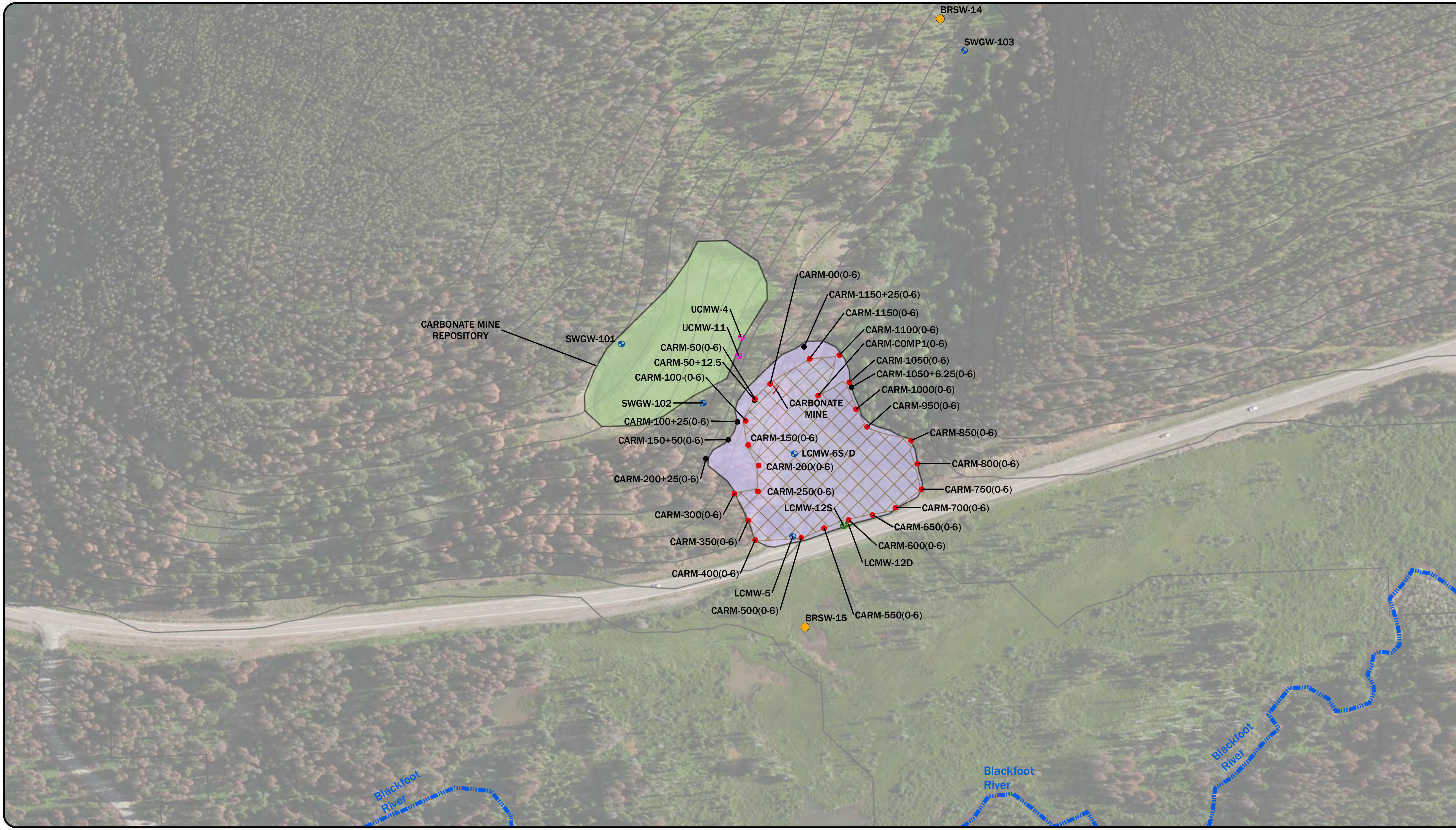

LEGEND

- X MINE
- SURFACE WATER SAMPLING LOCATION
- 2007 SAMPLE
- 2008 SAMPLE
- STREAM (EU 13)
- MONITORING WELL - ALLUVIAL/BEDROCK PAIR
- MONITORING WELL - ALLUVIAL
- MONITORING WELL - BEDROCK
- ESTIMATED EXTENT OF MINE WASTE AREA
- MINE WASTE REMOVAL/RECLAIMED AREA
- MINE WASTE REPOSITORY

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

0 110 220 440 Feet

FIGURE 9

PIONEER TECHNICAL SERVICES, INC.

UBMC FEASIBILITY STUDY
EU 4 CARBONATE
MINE WASTE AREA
SOIL SAMPLE LOCATIONS

DATE: 1/9/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-032-15.mxd

LEGEND

- MINE
- 2007 SAMPLE
- ESTIMATED EXTENT OF MINE WASTE AREA
- STREAM

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

0 65 130 260 Feet

FIGURE 10

UBMC FEASIBILITY STUDY
EU 5 EDITH MINE WASTE AREA
SOIL SAMPLE LOCATIONS

PIONEER TECHNICAL SERVICES, INC.

DATE: 1/9/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-012-15.mxd

LEGEND

- MINE
- 2007 SAMPLE
- 2008 SAMPLE
- ESTIMATED EXTENT OF MINE WASTE AREA
- MINE WASTE REMOVAL/RECLAIMED AREA

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

0 35 70 140 Feet

FIGURE 11

PIONEER TECHNICAL SERVICES, INC.

UBMC FEASIBILITY STUDY
EU 6 CONSOLATION MINE WASTE AREA
SOIL SAMPLE LOCATIONS

DATE: 1/9/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-013-15.mxd

LEGEND

- MINE
- ESTIMATED EXTENT OF MINE WASTE AREA

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

0 50 100 200
Feet

FIGURE 12

UBMC FEASIBILITY STUDY
EU 7 MARY P MINE WASTE PILE

PIONEER TECHNICAL SERVICES, INC.

DATE: 1/9/2015

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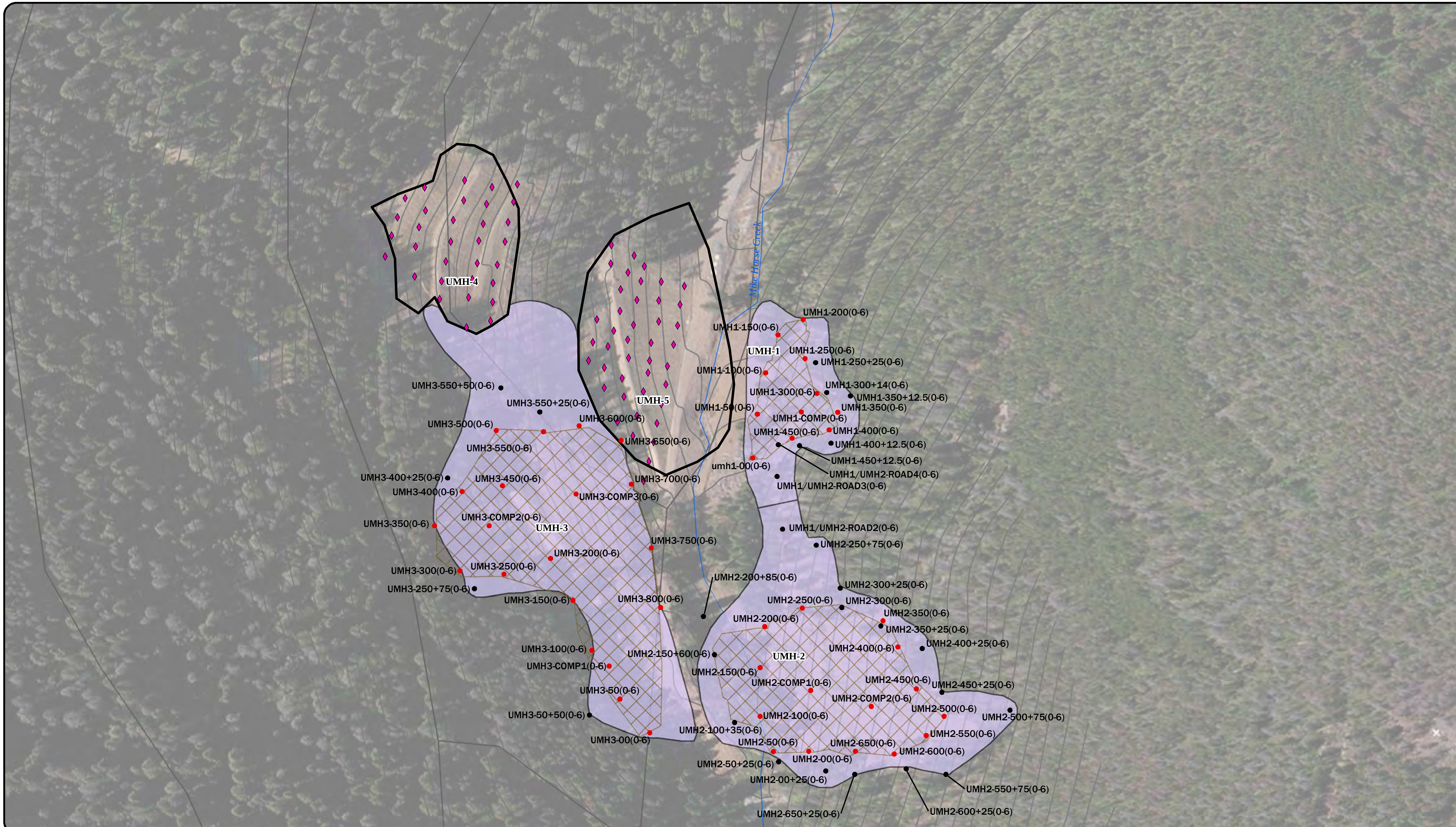

LEGEND

- MINE
- 2006 SAMPLE
- 2007 SAMPLE
- 2008 SAMPLE
- ESTIMATED EXTENT OF MINE WASTE AREA
- MINE WASTE REMOVAL/RECLAIMED AREA
- STREAM
- ROAD

NOTE:
THE SAMPLE LOCATIONS (DIAMONDS) ARE NOT OUTSIDE THE EXTENT OF MINE WASTE AREA; THESE TWO AREAS (UMH-4 AND UMH-5)WERE NOT INCLUDED IN THE 2007 AND 2008 THAT DEFINED THE ESTIMATED EXTENT OF THE MINE WASTE AREAS FOR THE OTHER THREE.

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

0 80 160 320 Feet

FIGURE 13

PIONEER TECHNICAL SERVICES, INC.

UBMC FEASIBILITY STUDY
EU 8 UPPER MIKE HORSE MINE WASTE AREA
SOIL SAMPLE LOCATIONS

DATE: 1/9/2015

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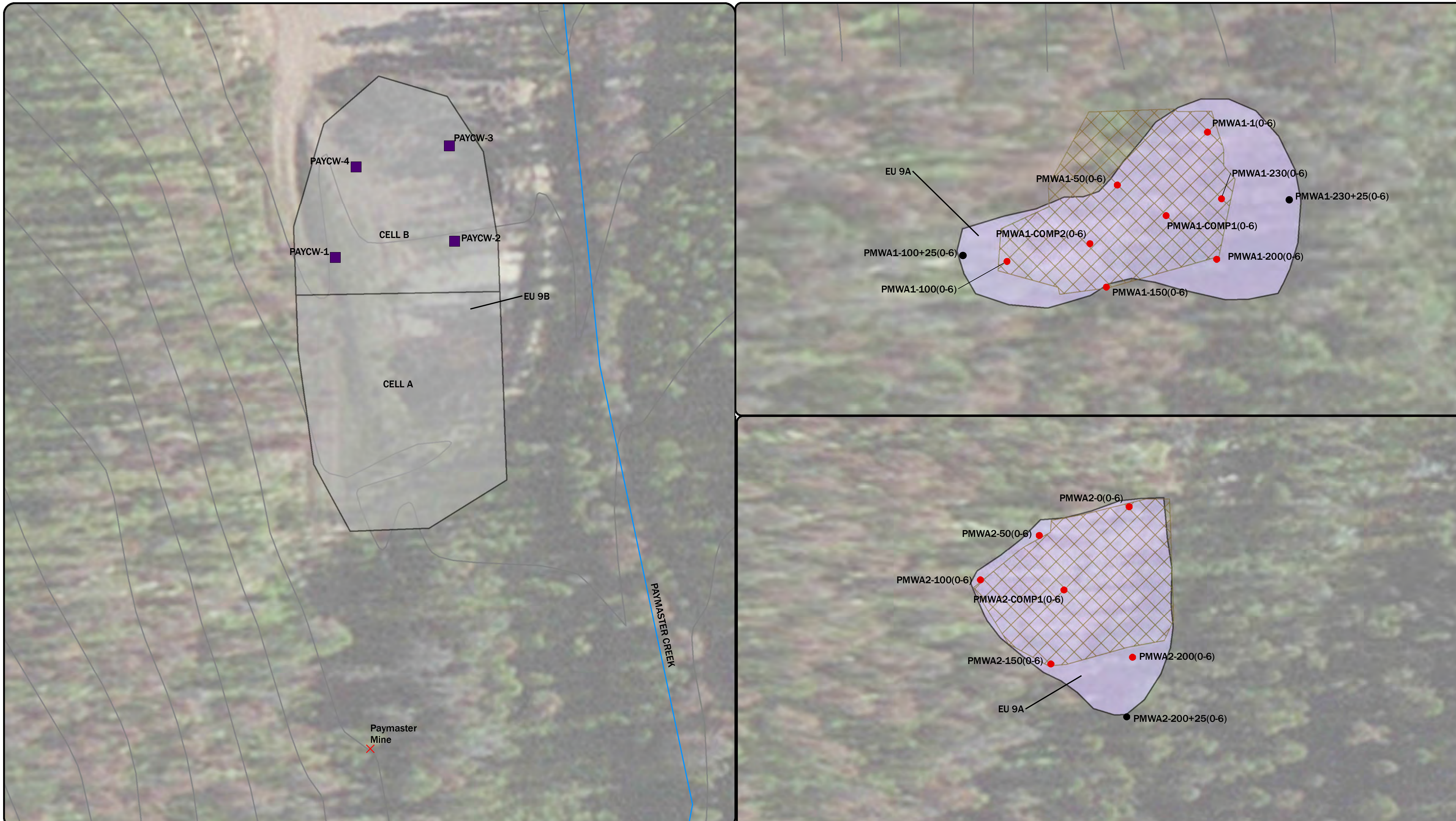


LEGEND

- MINE
- 2007 SAMPLE
- 2008 SAMPLE
- PAYMASTER SUBSURFACE SOIL SAMPLE
- ESTIMATED EXTENT OF MINE WASTE AREA
- CONSTRUCTED WETLAND TREATMENT CELLS
- MINE WASTE REMOVAL/RECLAIMED AREA
- STREAM

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

0 25 50 100 Feet

FIGURE 14

PIONEER TECHNICAL SERVICES, INC.

UBMC FEASIBILITY STUDY
EU 9A AND EU 9B PAYMASTER
MINE WASTE AREA
SOIL SAMPLE LOCATIONS

DATE: 1/9/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-017-15.mxd

LEGEND

- MINE
- 2007 SAMPLE
- ESTIMATED EXTENT OF MINE WASTE AREA

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

0 55 110 220 Feet

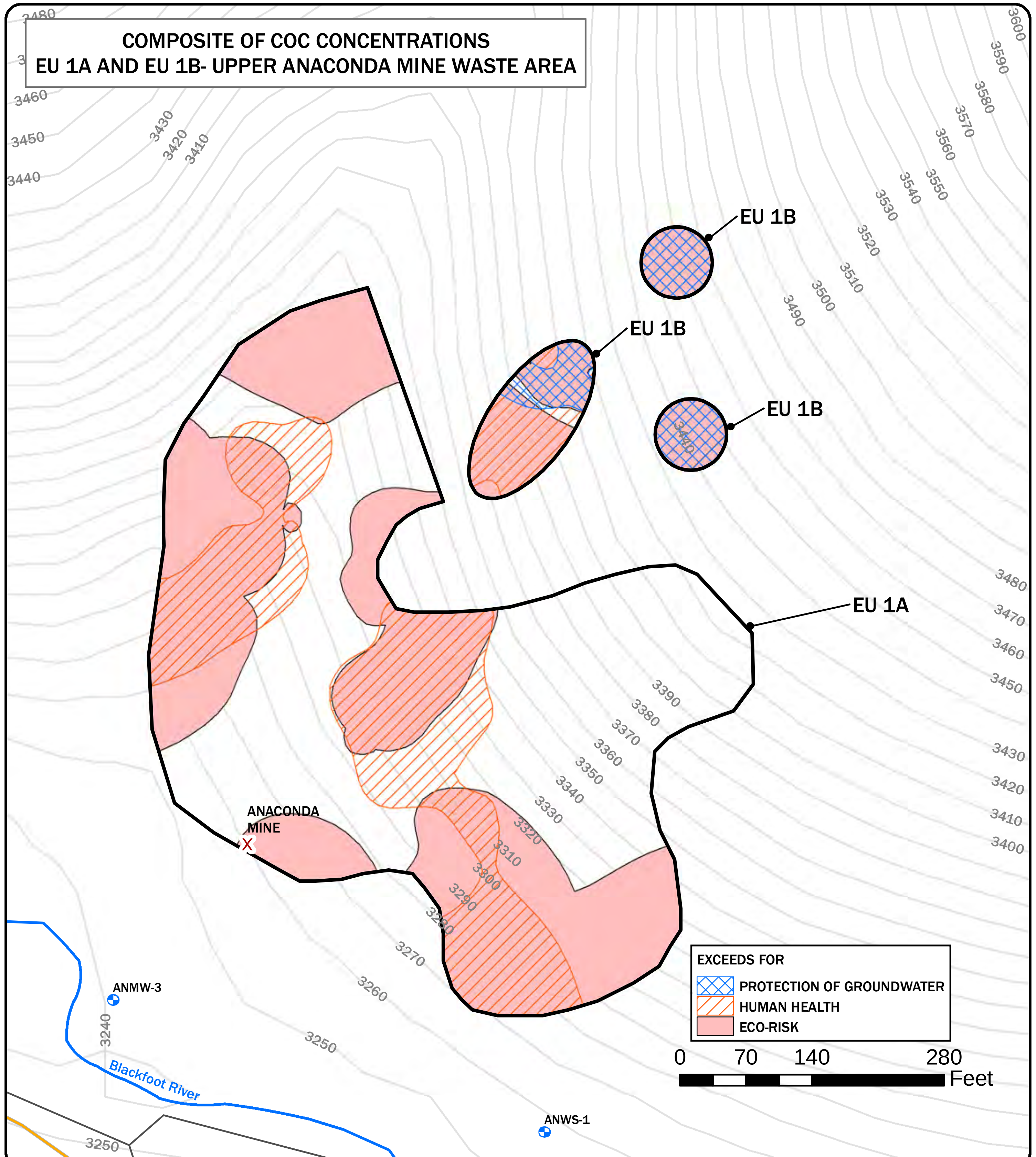
FIGURE 15

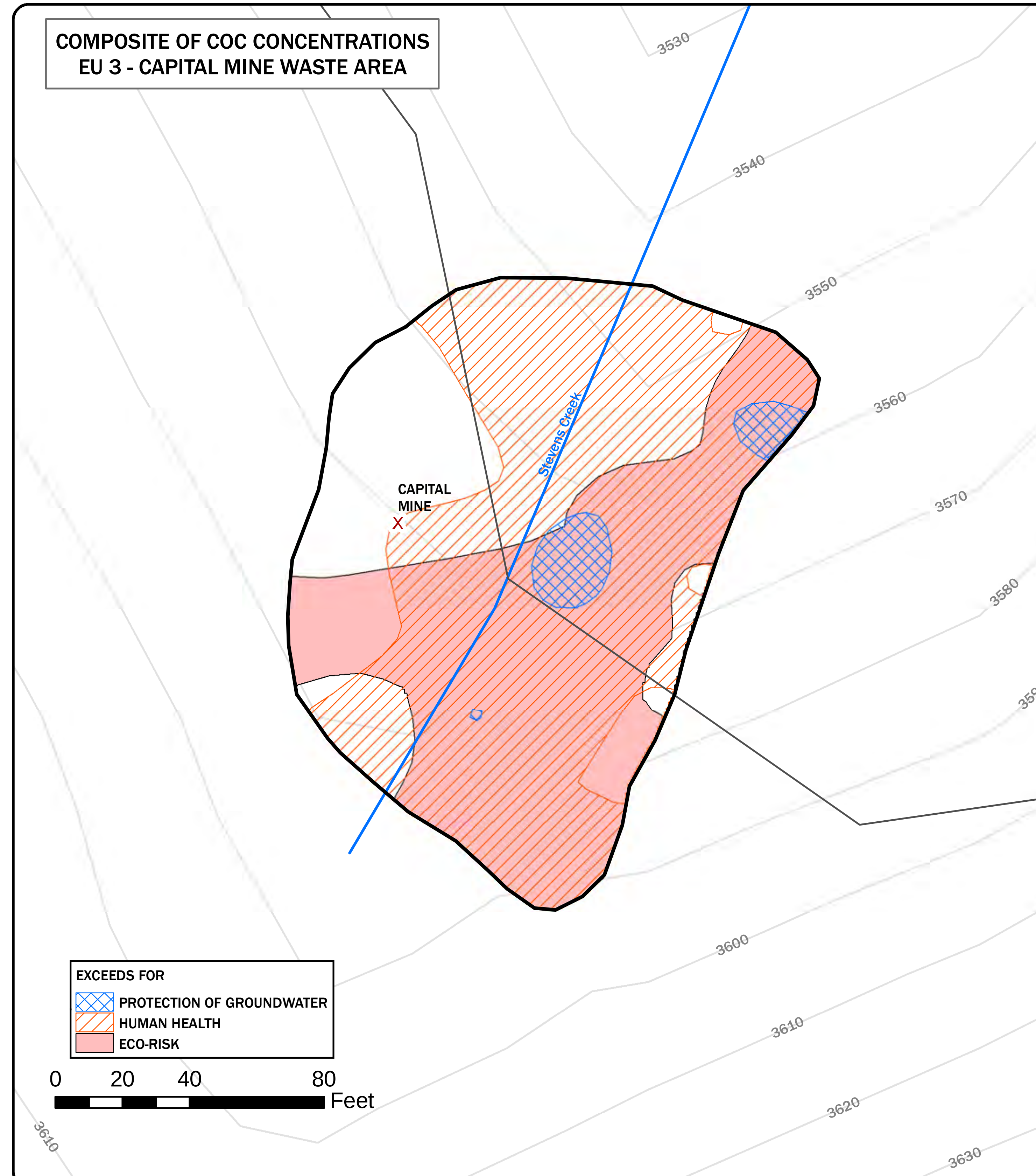
PIONEER TECHNICAL SERVICES, INC.

UBMC FEASIBILITY STUDY
EU 10 NO. 3 TUNNEL WASTE AREA
SOIL SAMPLE LOCATIONS

DATE: 1/9/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-018-15.mxd





LEGEND

- X MINE
- GROUNDWATER MONITORING WELL
- STREAM
- MARSH
- HIGHWAY
- MAJOR ROAD
- LOCAL ROAD

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

FIGURE 16

PIONEER TECHNICAL SERVICES, INC.

DATE: 1/9/2015

UBMC FEASIBILITY STUDY
EU 1A AND EU 1B - UPPER ANACONDA MINE AND EU - 3 CAPITAL MINE WASTE AREAS EXCEEDING SSCLS

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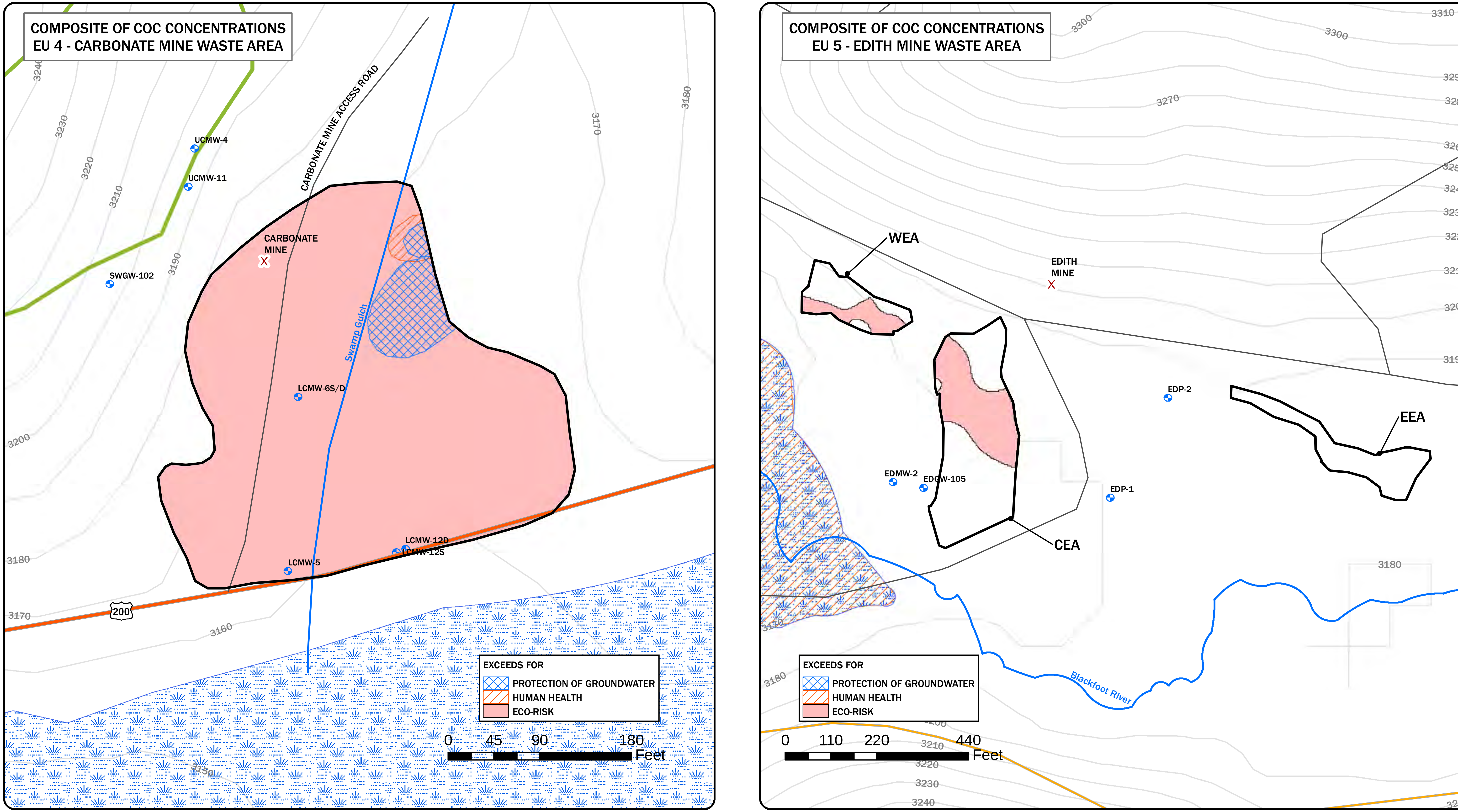


LEGEND

- MINE
- STREAM
- GROUNDWATER MONITORING WELL
- MARSH
- MINE WASTE REPOSITORY
- HIGHWAY
- MAJOR ROAD
- LOCAL ROAD

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

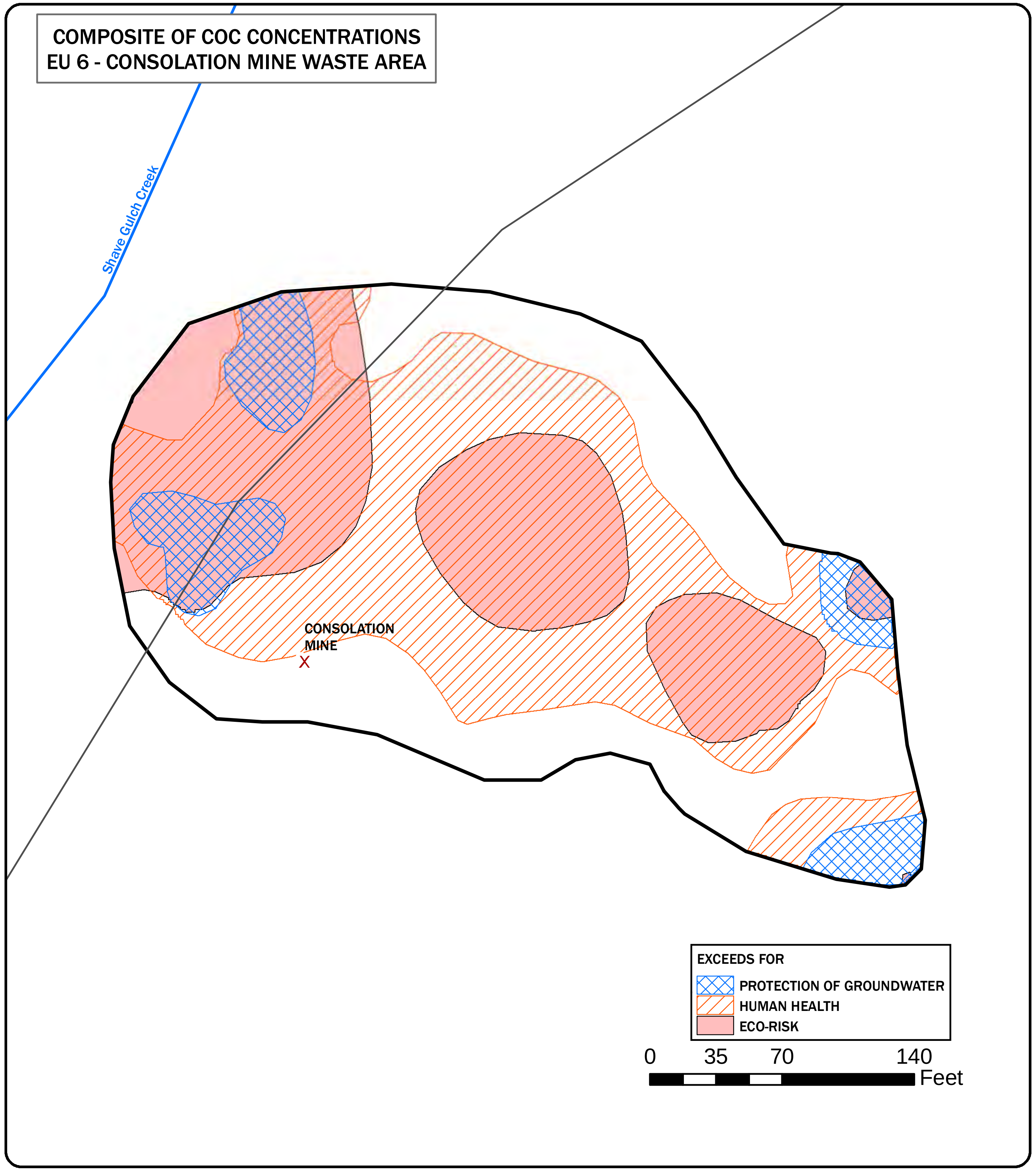
FIGURE 17

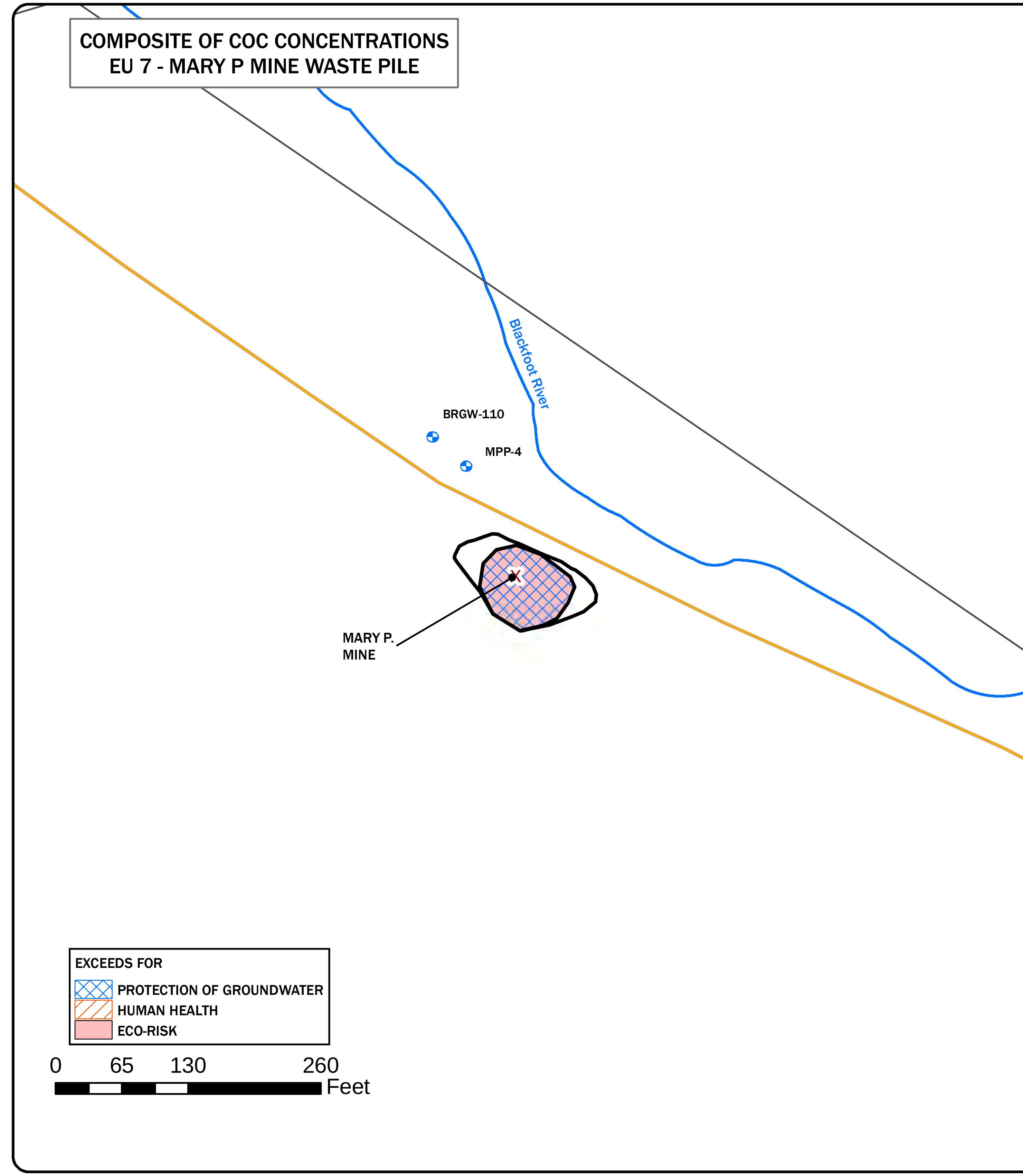
PIONEER TECHNICAL SERVICES, INC.

UBMC FEASIBILITY STUDY
EU 4 - CARBONATE MINE
AND EU 5 - EDITH MINE WASTE
AREAS EXCEEDING SSCLS

DATE: 1/9/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-021-15.mxd





LEGEND

- X MINE
- GROUNDWATER MONITORING WELL
- STREAM
- MARSH
- HIGHWAY
- MAJOR ROAD
- LOCAL ROAD

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

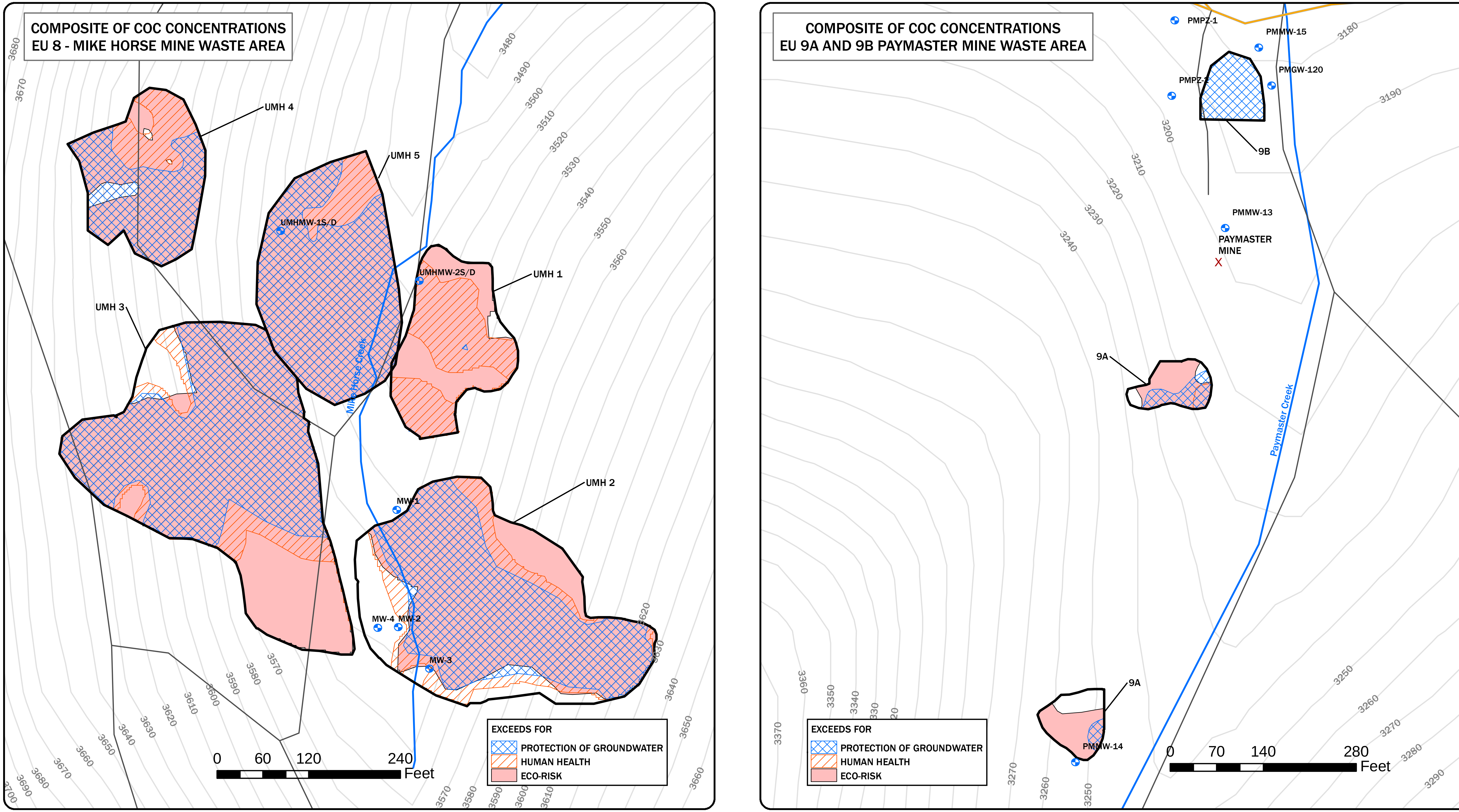
FIGURE 18

UBMC FEASIBILITY STUDY
EU 6 - CONSOLATION MINE AND
EU 7 - MARY P MINE
AREAS EXCEEDING SSCLS

PIONEER TECHNICAL SERVICES, INC.

DATE: 1/9/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-022-15.mxd



LEGEND

- X MINE
- GROUNDWATER MONITORING WELL
- STREAM
- MARSH
- HIGHWAY
- MAJOR ROAD
- LOCAL ROAD

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

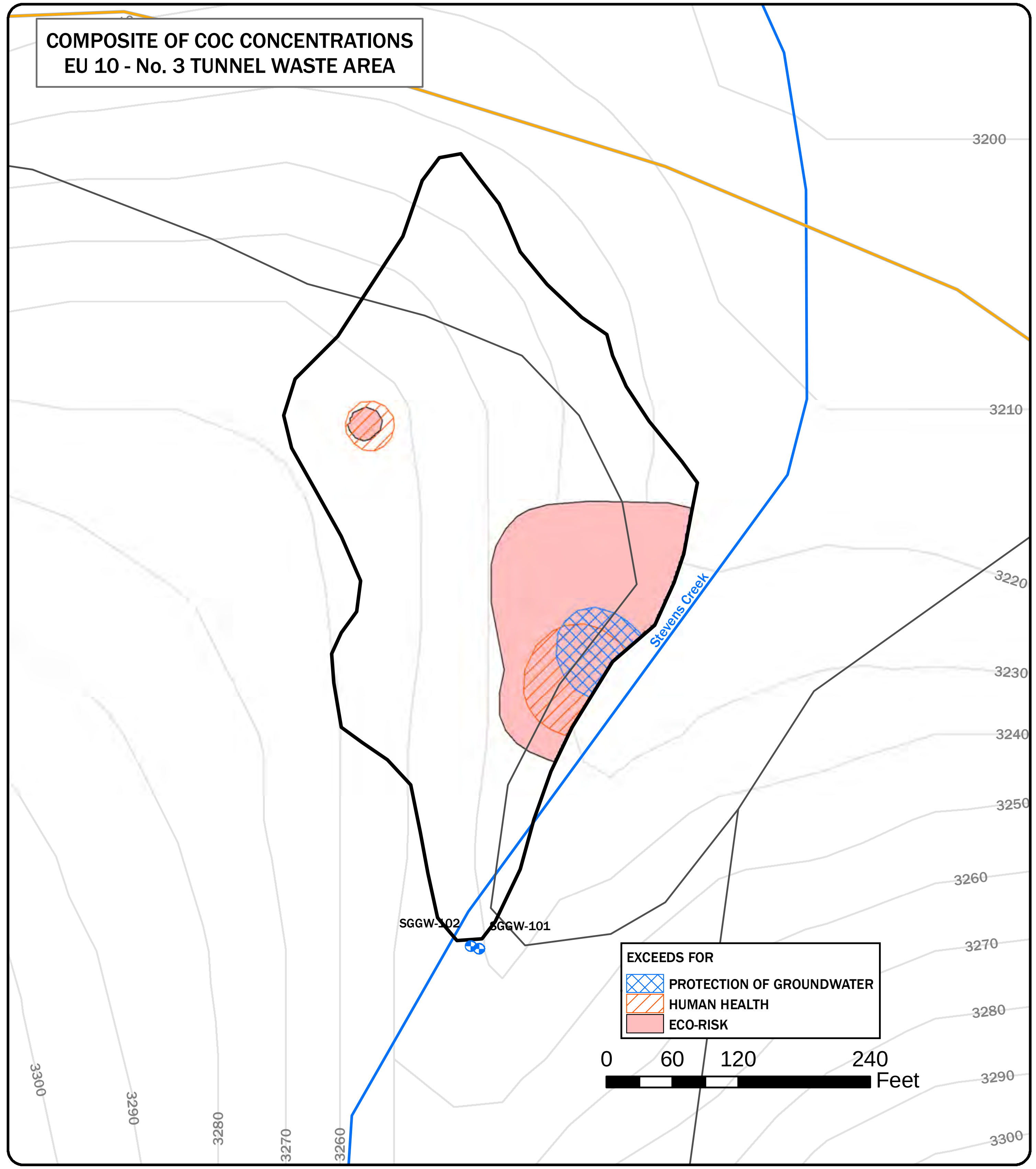
FIGURE 19

UBMC FEASIBILITY STUDY
EU 8 - MIKE HORSE MINE AND
EU 9A AND 9B PAYMASTER MINE WASTE
AREAS EXCEEDING SSCLS

PIONEER TECHNICAL SERVICES, INC.

DATE: 2/4/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-023-15.mxd



LEGEND

- MINE
- GROUNDWATER MONITORING WELL
- STREAM
- MARSH
- HIGHWAY
- MAJOR ROAD
- LOCAL ROAD

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

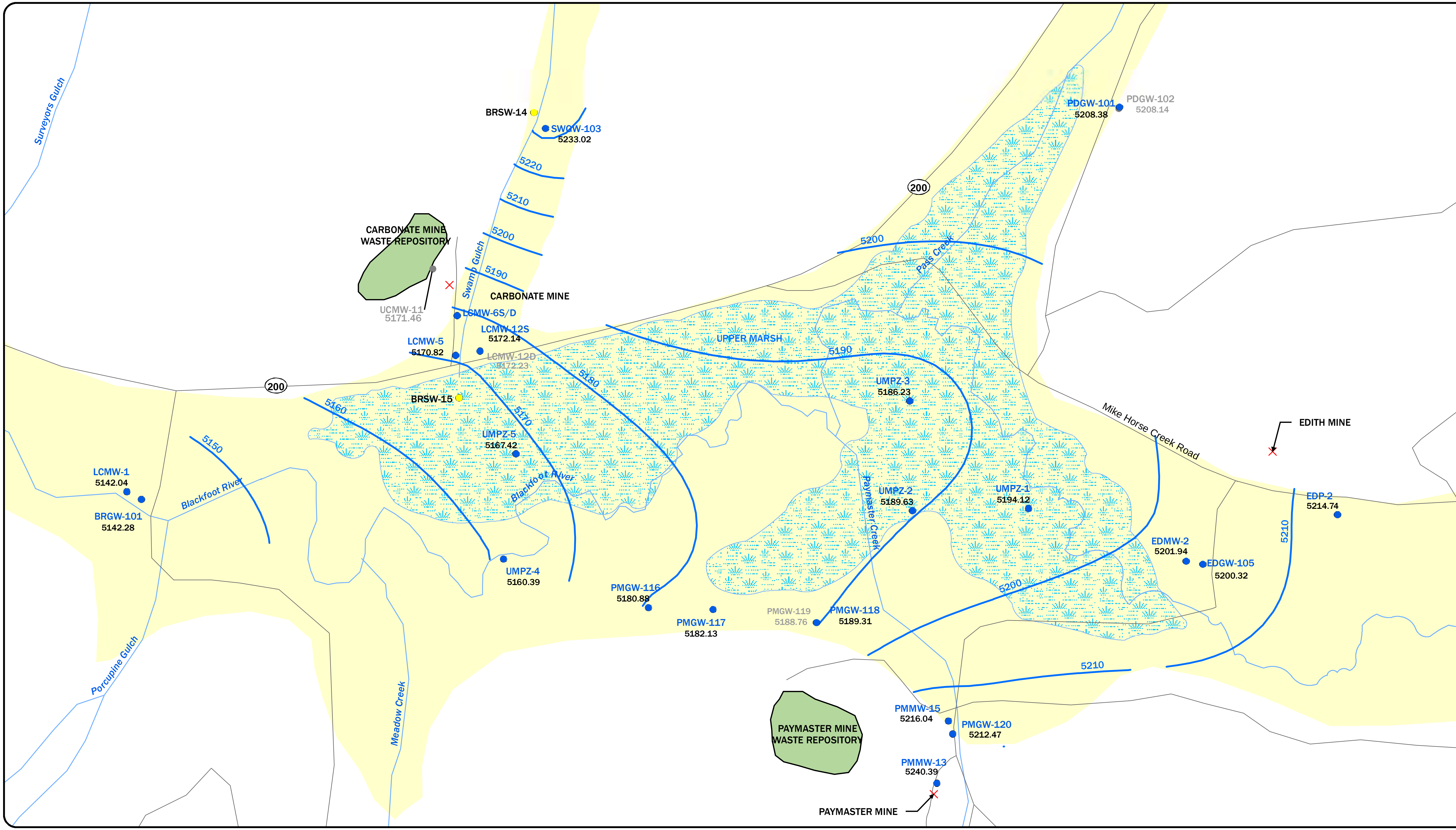
FIGURE 20

PIONEER TECHNICAL SERVICES, INC.

DATE: 1/9/2015

UBMC FEASIBILITY STUDY
EU 10 - No. 3 TUNNEL WASTE
AREAS EXCEEDING SSCLS

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-045-15.mxd



LEGEND

- MINE
- SURFACE WATER SAMPLING LOCATION
- SHALLOW ALLUVIAL GROUNDWATER ELEVATIONS 2008
- BEDROCK OR DEEP ALLUVIAL GROUNDWATER ELEVATIONS 2008
- APPROXIMATE SHALLOW POTENTIOMETRIC SURFACE (ELEVATION IN FEET)
- ROADS
- APPROXIMATE ALLUVIAL BOUNDARY (USGS, 1987)
- MINE WASTE REPOSITORY
- STREAM
- MARSH

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

0 175 350 700 Feet

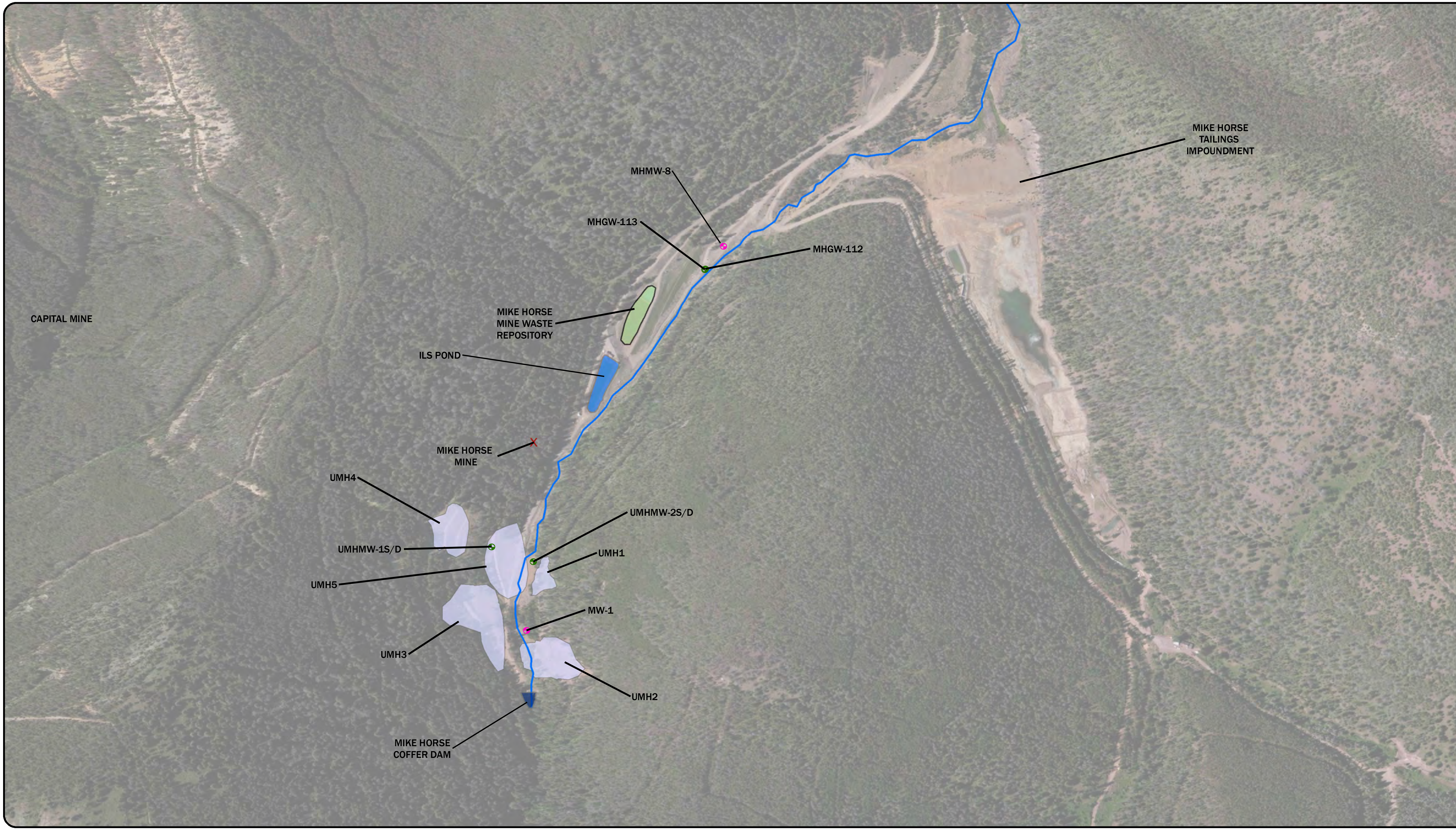
FIGURE 21

UBMC FEASIBILITY STUDY
EU 4 CARBONATE MINE
POTENTIOMETRIC MAP

PIONEER TECHNICAL SERVICES, INC.

DATE: 1/9/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-033-15.mxd



LEGEND

- X MINE
- STREAM
- MINE WASTE REPOSITORY
- MONITORING WELL - ALLUVIAL/BEDROCK PAIR
- MONITORING WELL - ALLUVIAL
- MONITORING WELL - BEDROCK

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

0 200 400 800
Feet

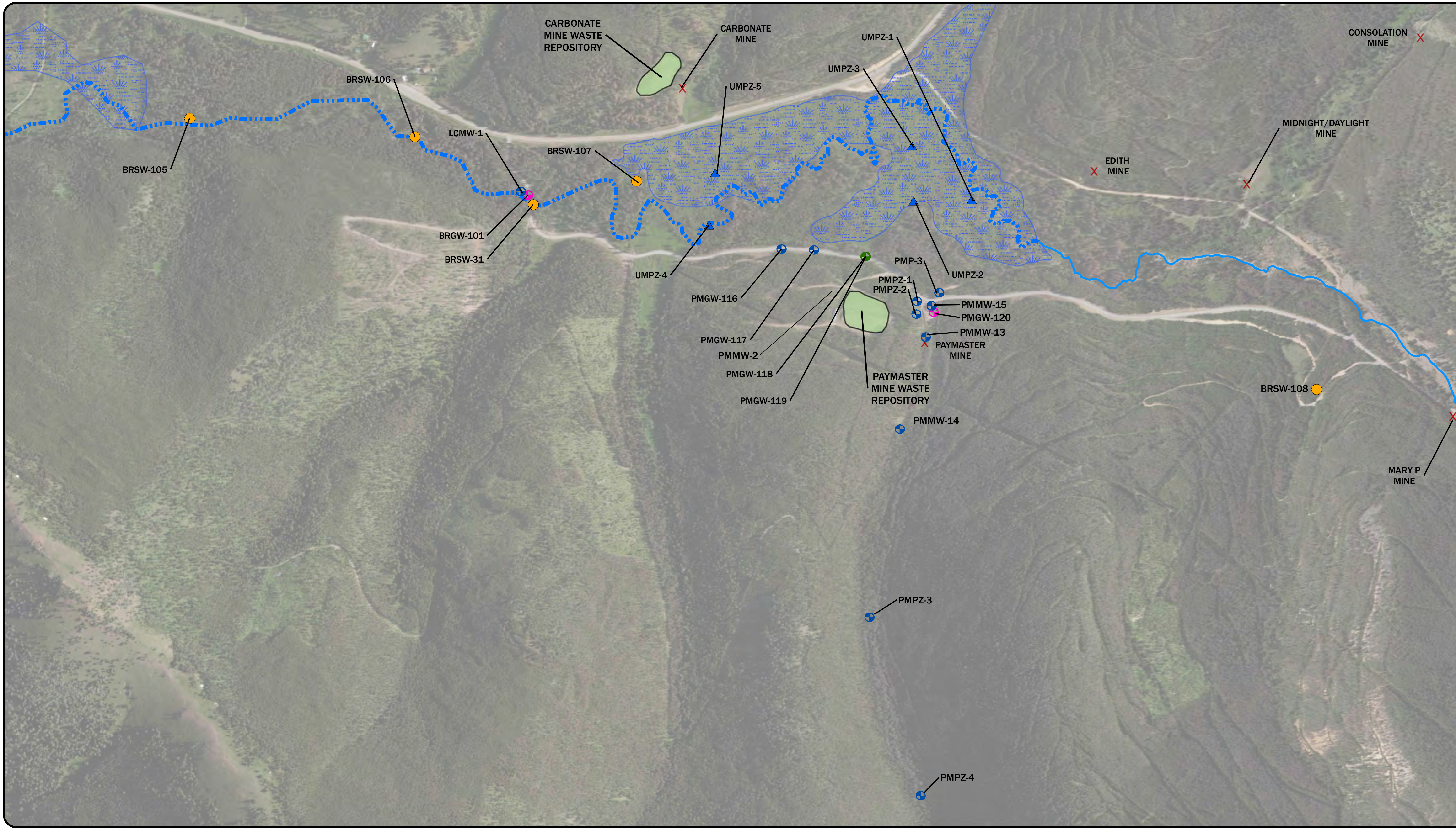
FIGURE 22

PIONEER TECHNICAL SERVICES, INC.

UBMC FEASIBILITY STUDY
EU 8 MIKE HORSE MINE
GROUNDWATER SAMPLE
LOCATIONS

DATE: 2/5/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-026-15.mxd



LEGEND

- MINE
- 2007 AND/OR 2008 SURFACE WATER SAMPLING LOCATION
- 2011 SURFACE WATER SAMPLING LOCATION
- SURFACE WATER SAMPLE LOCATION
- 2008 ALLUVIAL PIEZOMETER
- GROUNDWATER SAMPLE LOCATION - ALLUVIAL/BEDROCK PAIR
- GROUNDWATER SAMPLE LOCATION - ALLUVIAL
- GROUNDWATER SAMPLE LOCATION - BEDROCK
- STREAM
- STREAM (EU 13)
- MARSH
- MINE WASTE REPOSITORY

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

0 400 800 1,600
Feet

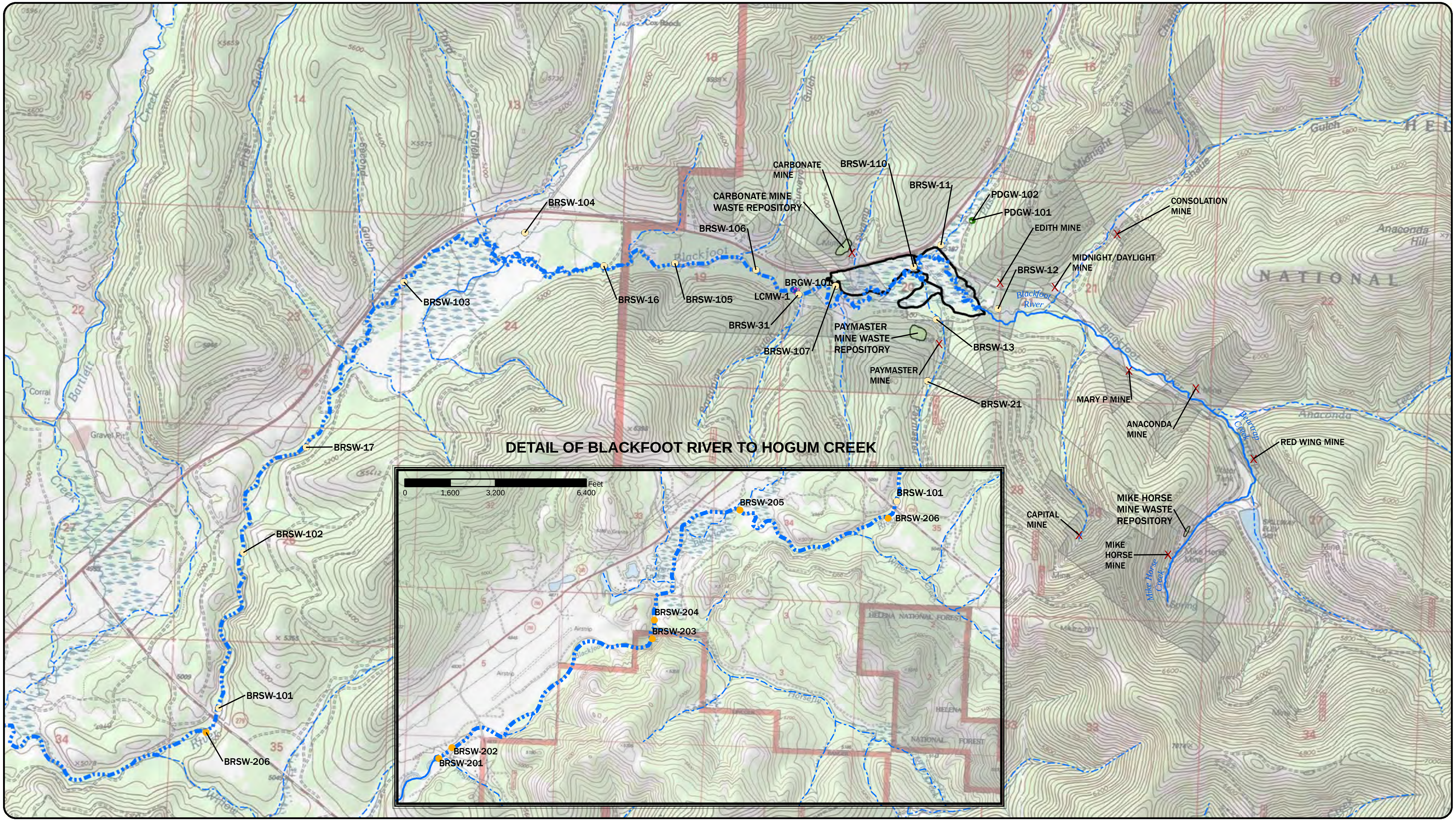
FIGURE 23

UBMC FEASIBILITY STUDY
PAYMASTER GULCH
AQUIFER GROUNDWATER
SAMPLE LOCATIONS

PIONEER TECHNICAL SERVICES, INC.

DATE: 1/9/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-047-15.mxd



LEGEND:

- HIGHWAY
- MAJOR ROAD
- LOCAL ROAD
- STREAM
- FOREST SERVICE PROPERTY BOUNDARY
- METG/PRIVATE
- LAKE
- MINE
- EU 13 STREAM
- MINE WASTE REPOSITORY
- 2007/2008 SAMPLE LOCATION (SEDIMENT AND SURFACE WATER)
- 2011 SAMPLE LOCATION (SEDIMENT AND SURFACE WATER)

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

0 1,100 2,200 4,400
Feet

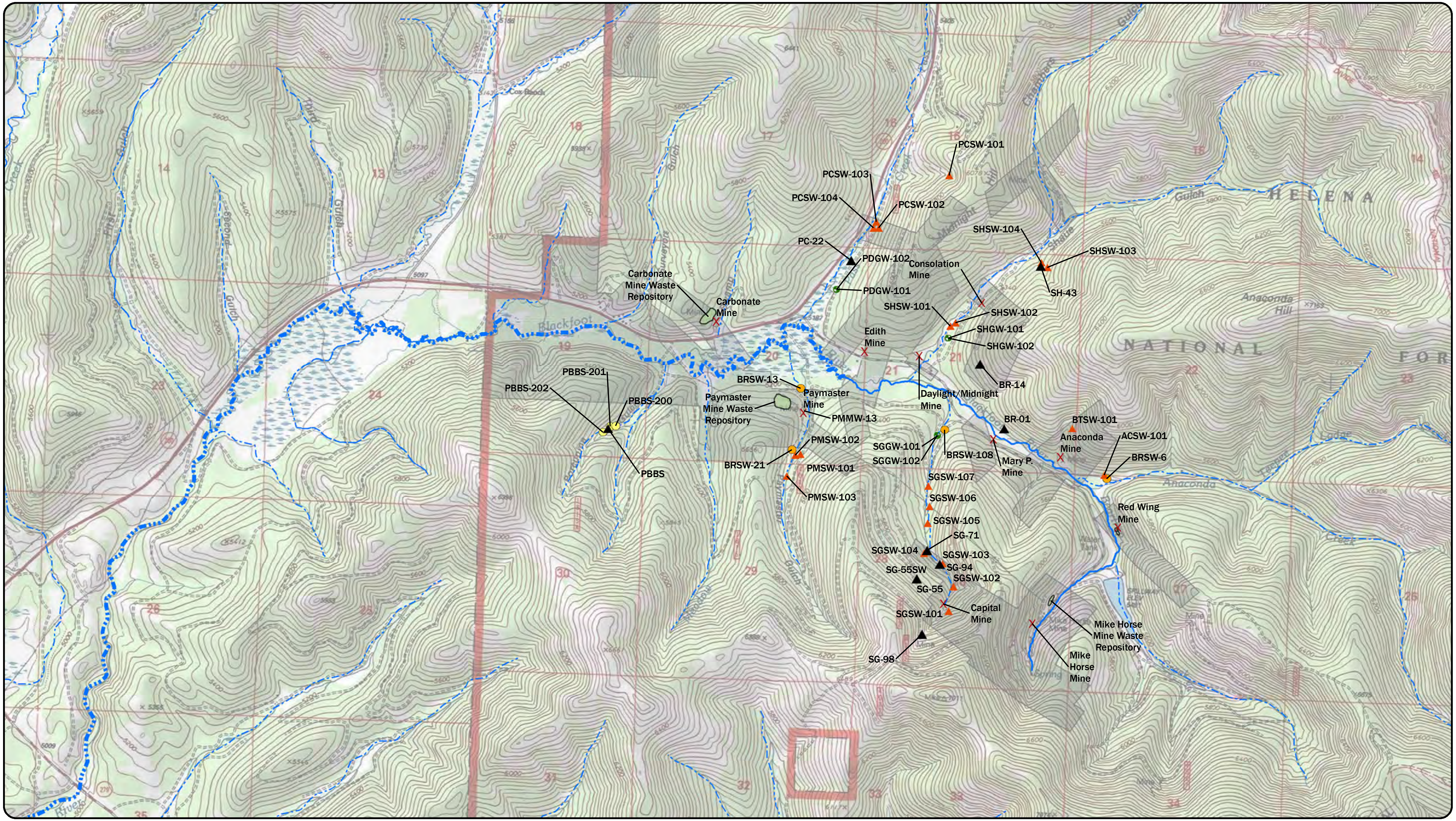
FIGURE 24

PIONEER TECHNICAL SERVICES, INC.

UBMC FEASIBILITY STUDY
BLACKFOOT RIVER
SURFACE WATER AND SEDIMENT
SAMPLE LOCATIONS

DATE: 1/9/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-043-15.mxd



LEGEND:

- HIGHWAY
- MAJOR ROAD
- LOCAL ROAD
- LAKE
- METG/PRIVATE
- FOREST SERVICE PROPERTY BOUNDARY
- 2011 SURFACE WATER SAMPLE LOCATIONS
- SURFACE WATER SAMPLE LOCATION
- 2007 AND/OR 2008 SURFACE WATER SAMPLING LOCATION
- MINE
- MINE WASTE REPOSITORY
- MINING RELATED SAMPLE LOCATION
- EU 13 STREAM

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

0 1,100 2,200 4,400
Feet

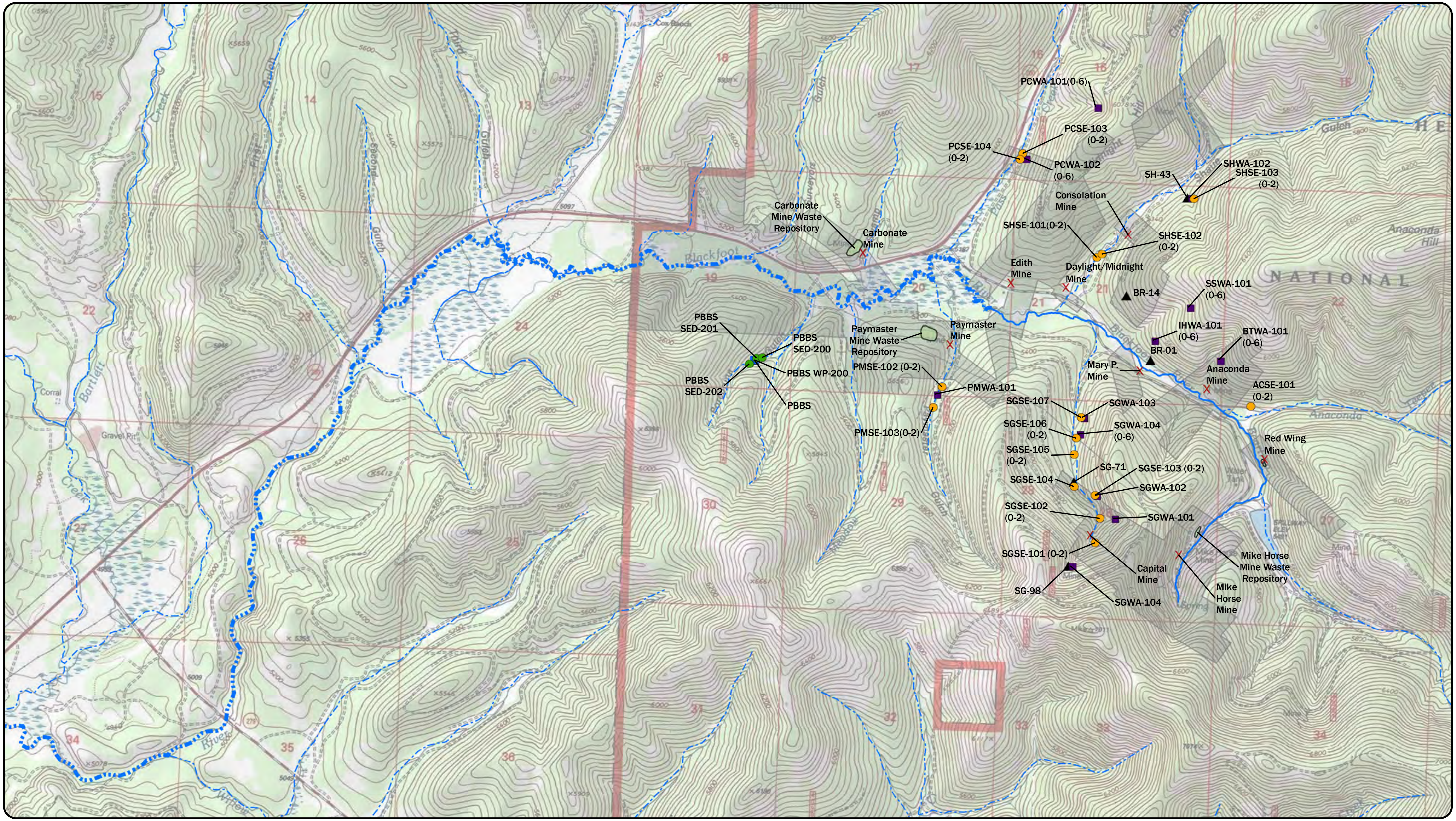
FIGURE 25

UBMC FEASIBILITY STUDY
EA 3 SURFACE WATER
SAMPLE LOCATIONS

PIONEER TECHNICAL SERVICES, INC.

DATE: 1/9/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-051-15.mxd



LEGEND:

- HIGHWAY
- MAJOR ROAD
- LOCAL ROAD
- LAKE
- METG/PRIVATE
- FOREST SERVICE PROPERTY BOUNDARY
- MINE
- MINE WASTE REPOSITORY
- 2008 MINE INVENTORY SEDIMENT SAMPLE LOCATIONS
- 2008 MINE INVENTORY MINE WASTE SAMPLE LOCATIONS
- 2011 MINE INVENTORY SEDIMENT SAMPLE LOCATIONS
- 2011 MINE INVENTORY MINE WASTE SAMPLE LOCATIONS
- MINING RELATED SAMPLE LOCATIONS
- EU 13 STREAM

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

0 1,100 2,200 4,400
Feet

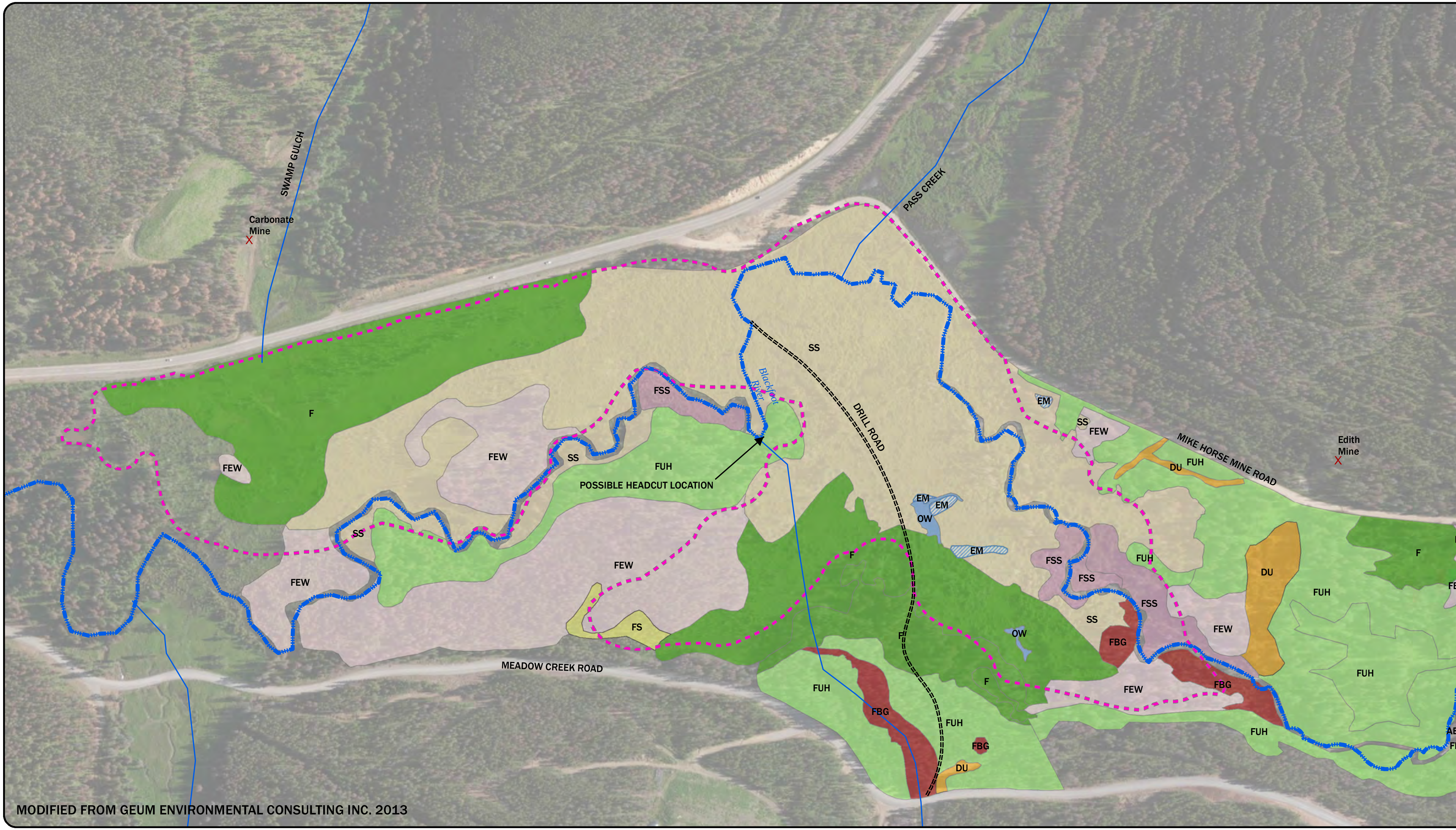
FIGURE 26

UBMC FEASIBILITY STUDY
EA 3 SEDIMENT
SAMPLE LOCATIONS

PIONEER TECHNICAL SERVICES, INC.

DATE: 1/9/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-052-15.mxd



LEGEND

DU DISTURBED UPLAND	FSS FILLED SCRUB SHRUB	FS FORESTED SHRUB WETLAND
EM EMERGENT MARSH	FBG FORESTED BARE GROUND	FUH FORESTED UPLAND HERBACEOUS
F FEN	FEW FORESTED EMERGENT WETLAND	OW OPEN WATER
SS SHRUB WETLAND	MARSH BOUNDARY (EU 12)	
DRILL ROAD	MINE	
STREAM	STREAM - EU 13	

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/GEUM/ESRI

0 125 250 500 Feet

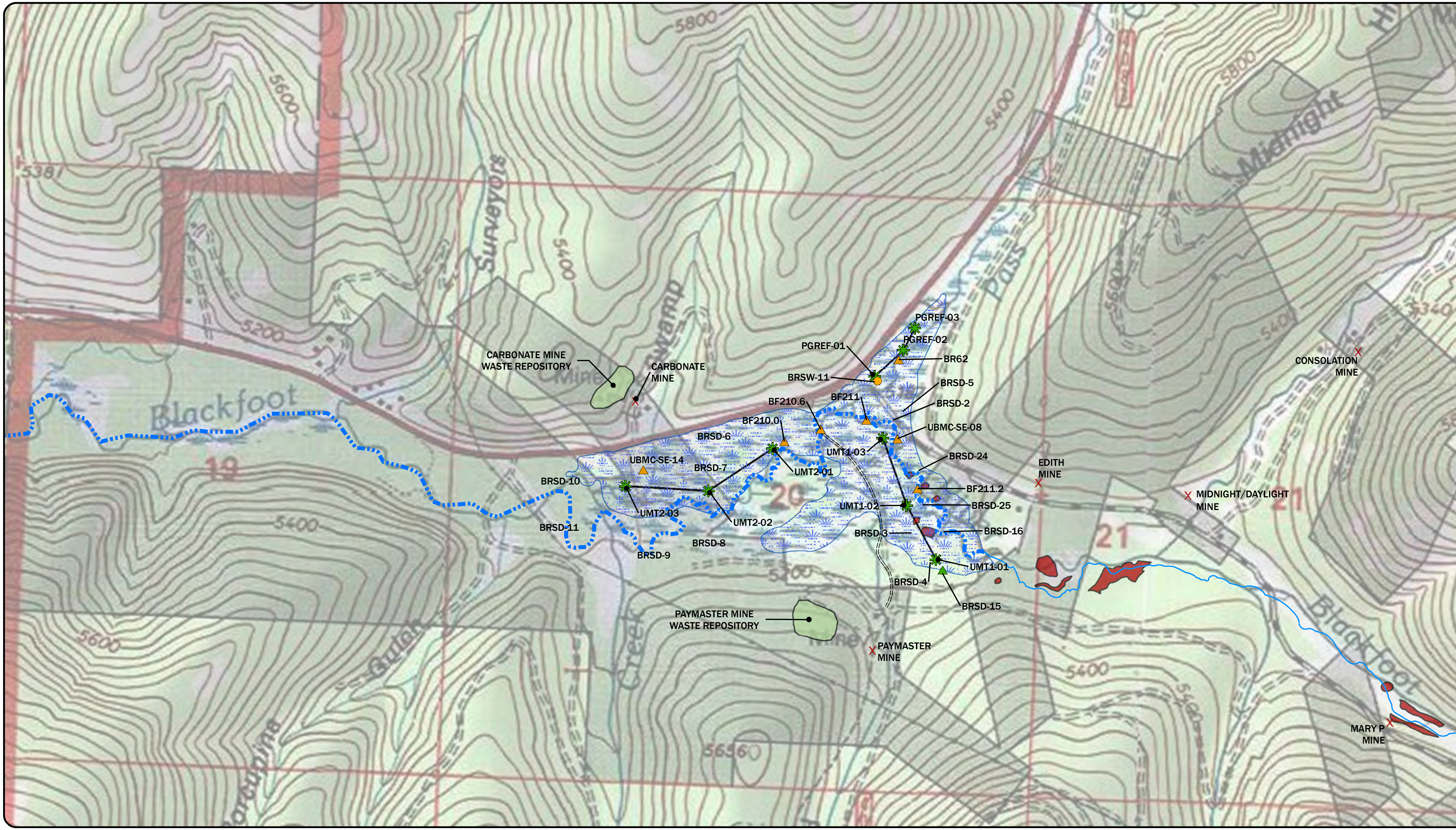
FIGURE 27

UBMC FEASIBILITY STUDY
EA 4 MARSH
VEGETATION MAPPING

PIONEER TECHNICAL SERVICES, INC.

DATE: 1/9/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-036-15.mxd



LEGEND

- MINES
- ECO-RISK SAMPLE LOCATION
- MARSH SURFACE TRANSECT
- 2007 BACKGROUND STREAM SEDIMENT
- HISTORIC SEDIMENT SAMPLE LOCATION
- HISTORIC SEDIMENT SAMPLE LOCATION (SAMPLED 2008)
- DRILL ROAD
- AREA OF DISPERSED SANDY (FINE) TAILINGS
- MINE WASTE REPOSITORY
- STREAM (EU 13)
- STREAM

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

0 400 800 1,600
Feet

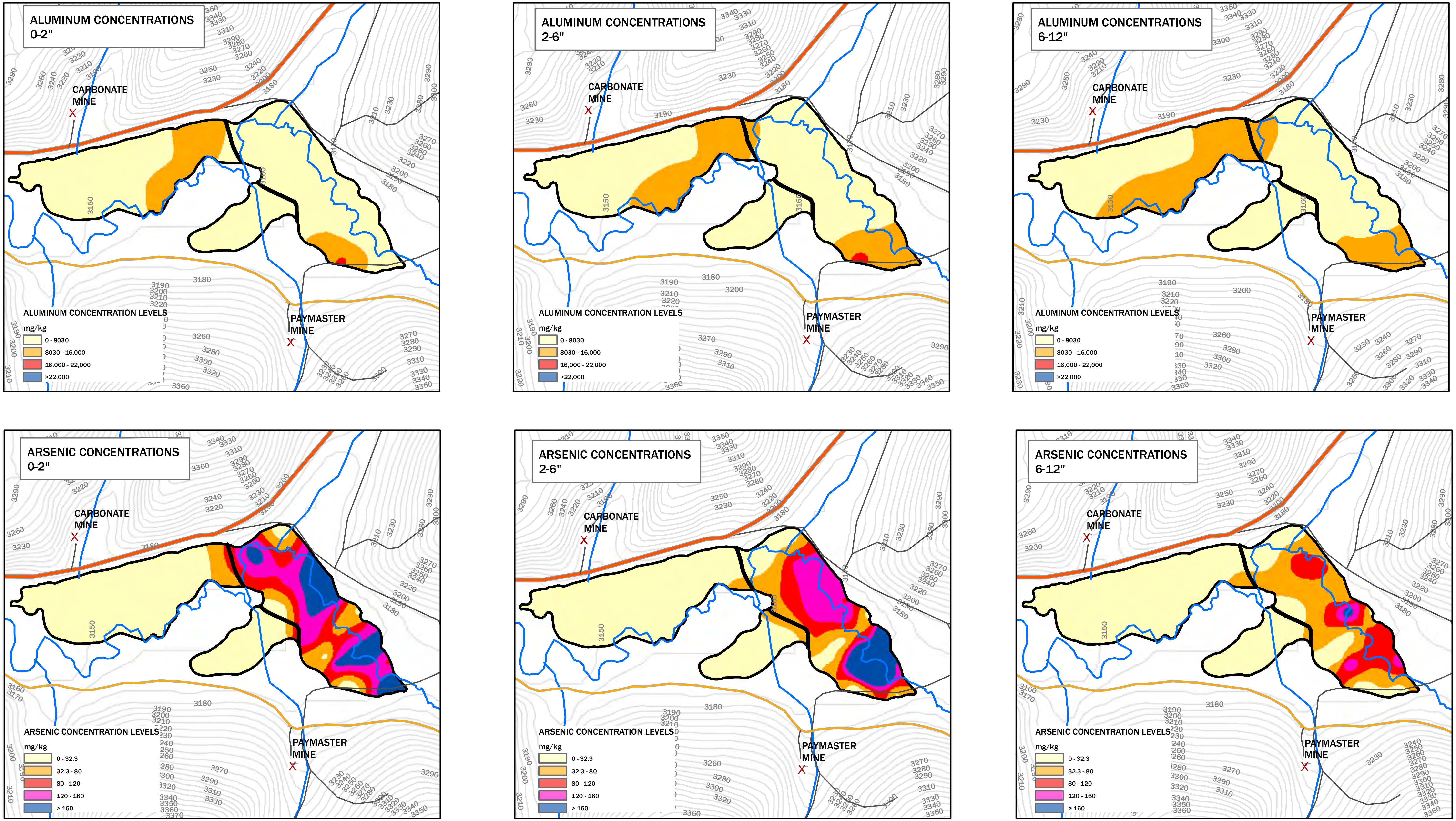
FIGURE 28

PIONEER TECHNICAL SERVICES, INC.

UBMC FEASIBILITY STUDY
EA 4 MARSH
SEDIMENT SAMPLE LOCATIONS

DATE: 1/9/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-034-15.mxd



DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

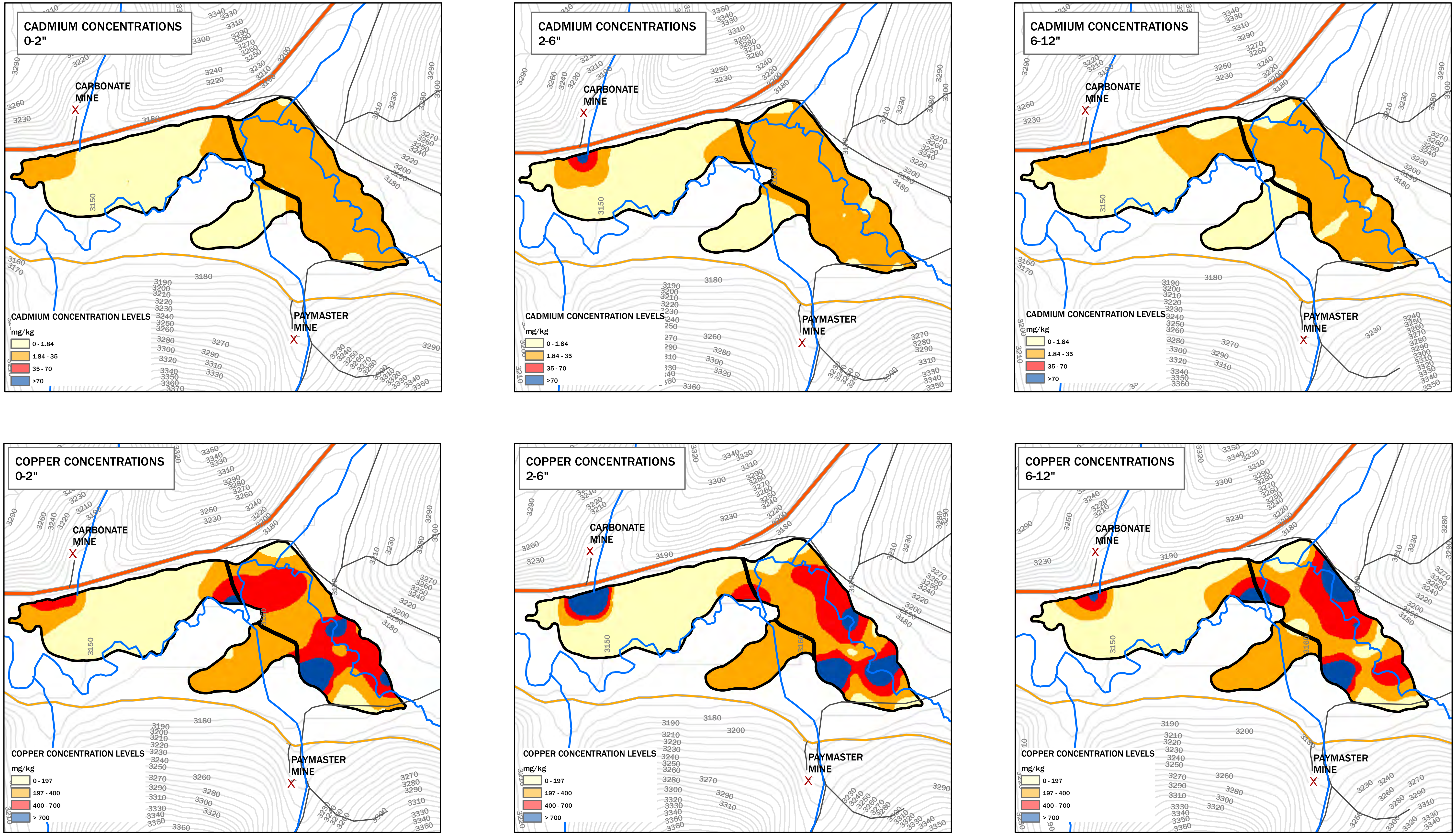
FIGURE 29

PIONEER TECHNICAL SERVICES, INC.

UBMC FEASIBILITY STUDY
EA 4 UPPER MARSH AREAS OF EXCEEDING SSCLS - Al AND As

DATE: 1/9/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-037-15.mxd



DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

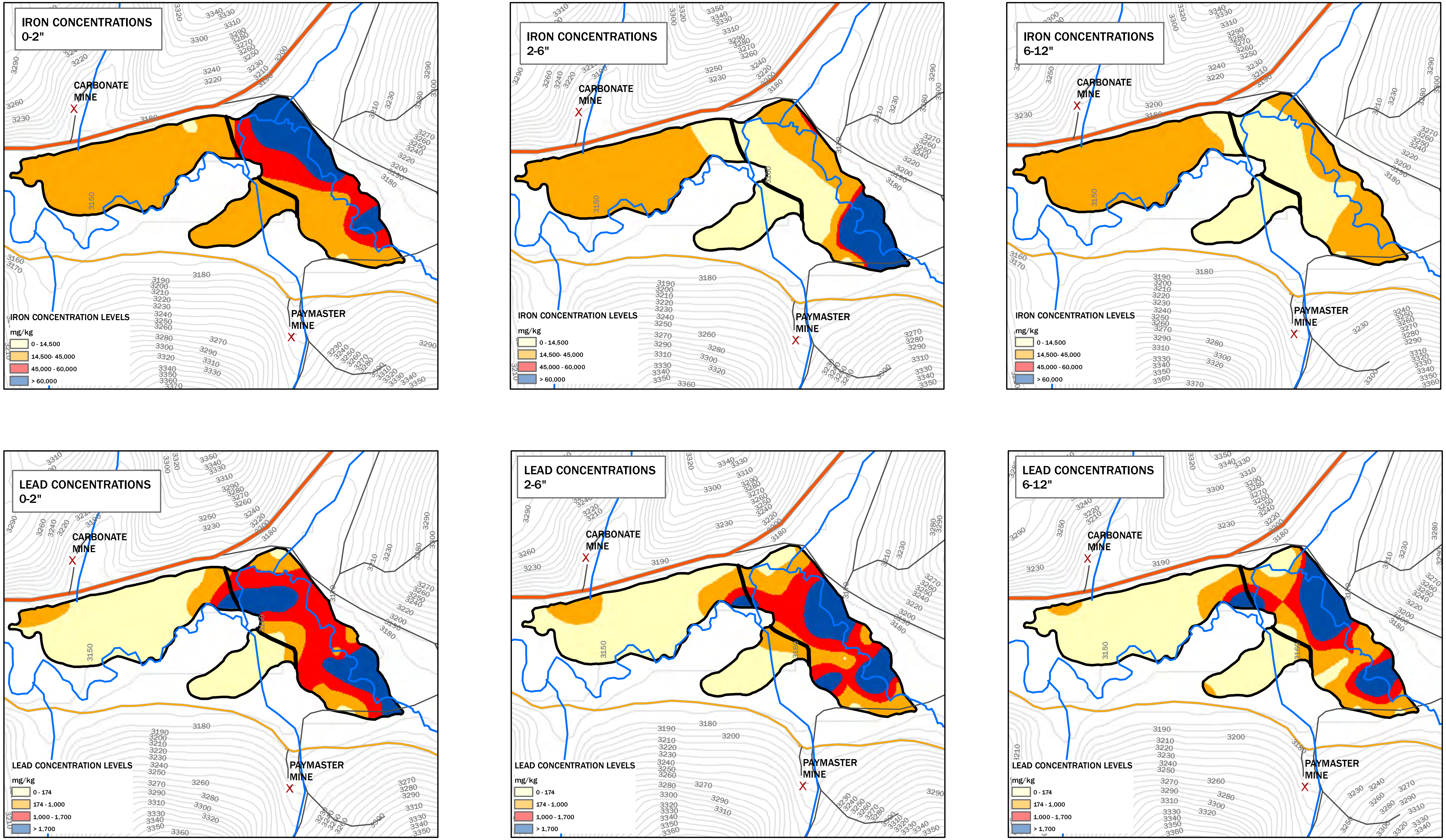
FIGURE 30

UBMC FEASIBILITY STUDY
EA 4 UPPER MARSH AREAS OF
EXCEEDING SSCLS - Cd AND Cu

PIONEER TECHNICAL SERVICES, INC

DATE: 1/9/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-038-15.mxd



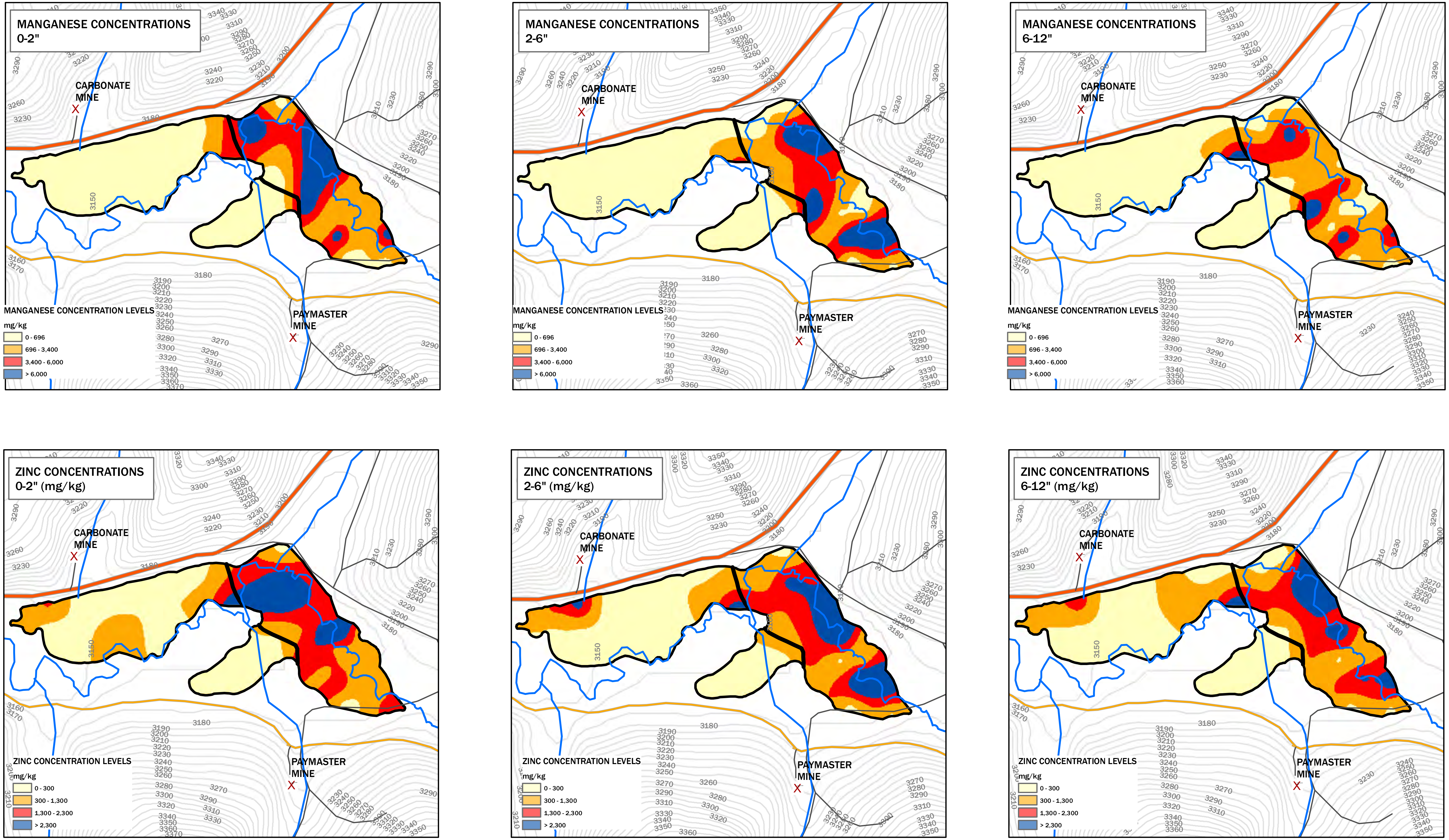
DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

FIGURE 31

UBMC FEASIBILITY STUDY
EA 4 UPPER MARSH AREAS OF
EXCEEDING SSCLS - Fe AND Pb

PIONEER TECHNICAL SERVICES, INC.
DATE: 1/9/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-039-15.mxd



DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

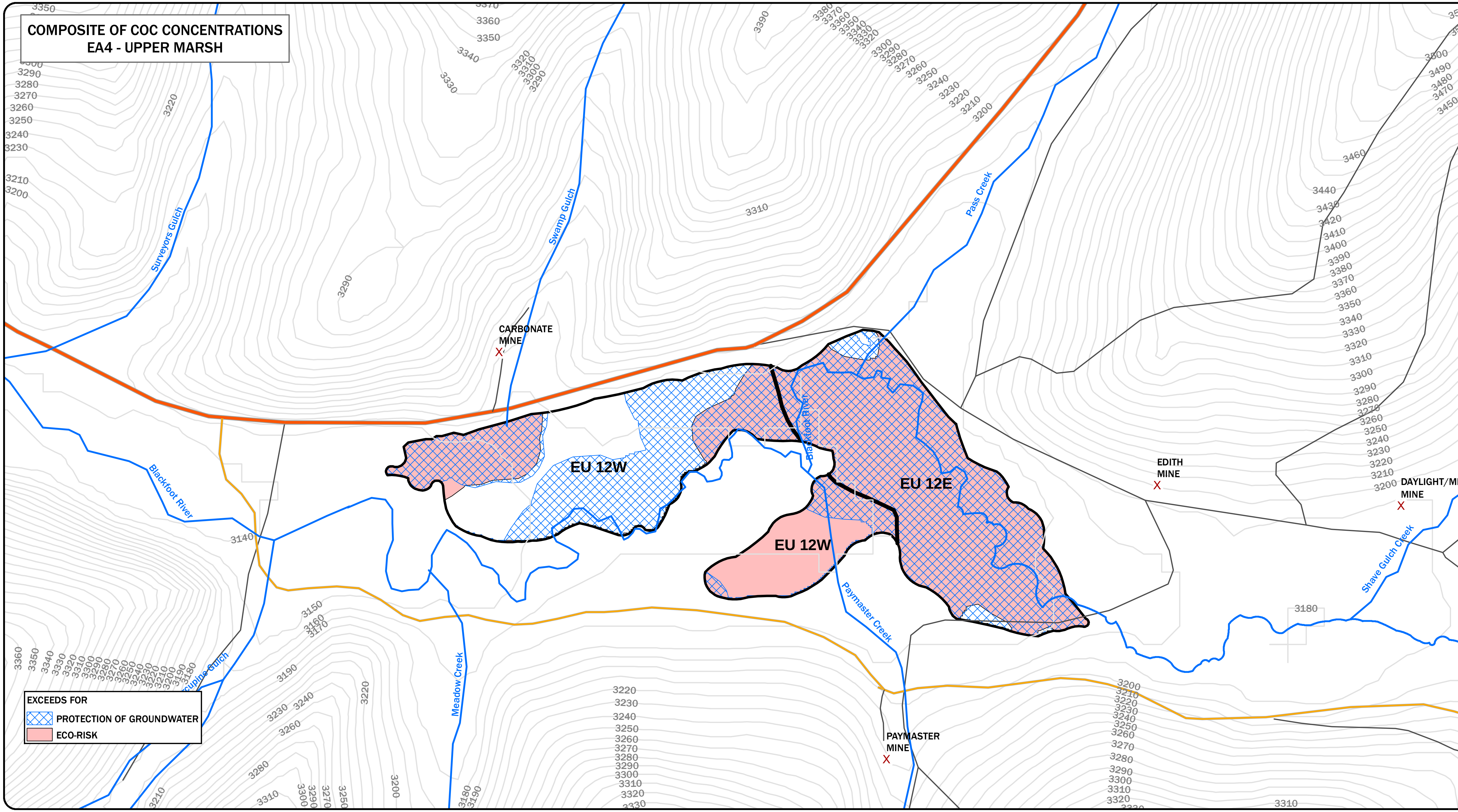
FIGURE 32

UBMC FEASIBILITY STUDY
EA 4 UPPER MARSH AREAS OF
EXCEEDING SSCLS - Mn AND Zn

PIONEER TECHNICAL SERVICES, INC.

DATE: 2/4/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-040-15.mxd



LEGEND

MARSH
STREAM
MINES
GROUNDWATER MONITORING WELL
HIGHWAY
MAJOR ROAD
LOCAL ROAD

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

0 250 500 1,000
Feet

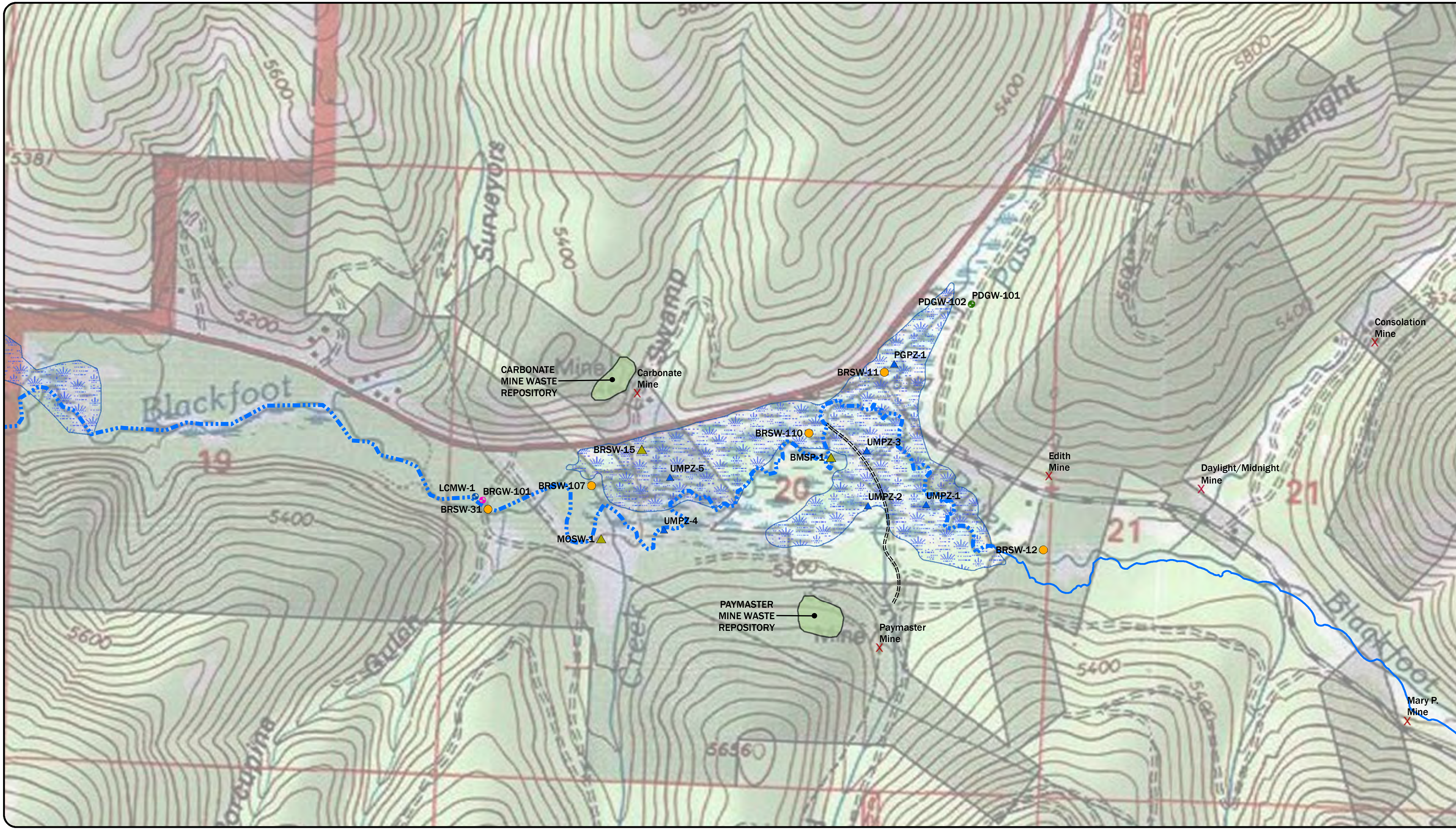
FIGURE 33

PIONEER TECHNICAL SERVICES, INC.

DATE: 2/4/2015

UBMC FEASIBILITY STUDY
EA4-UPPER MARSH
AREAS EXCEEDING SSCLS -
COMBINED

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-041-13.mxd



LEGEND

- X MINE
- == DRILL ROAD
- STREAM
- STREAM (EU 13)
- MARSH
- HISTORIC SURFACE WATER SAMPLING LOCATION
- 2007 AND/OR 2008 SURFACE WATER SAMPLING LOCATION
- 2008 ALLUVIAL PIEZOMETER
- MONITORING WELL - ALLUVIAL/BEDROCK PAIR
- MONITORING WELL - ALLUVIAL
- MONITORING WELL - BEDROCK
- MINE WASTE REPOSITORY

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

0 400 800 1,600
Feet

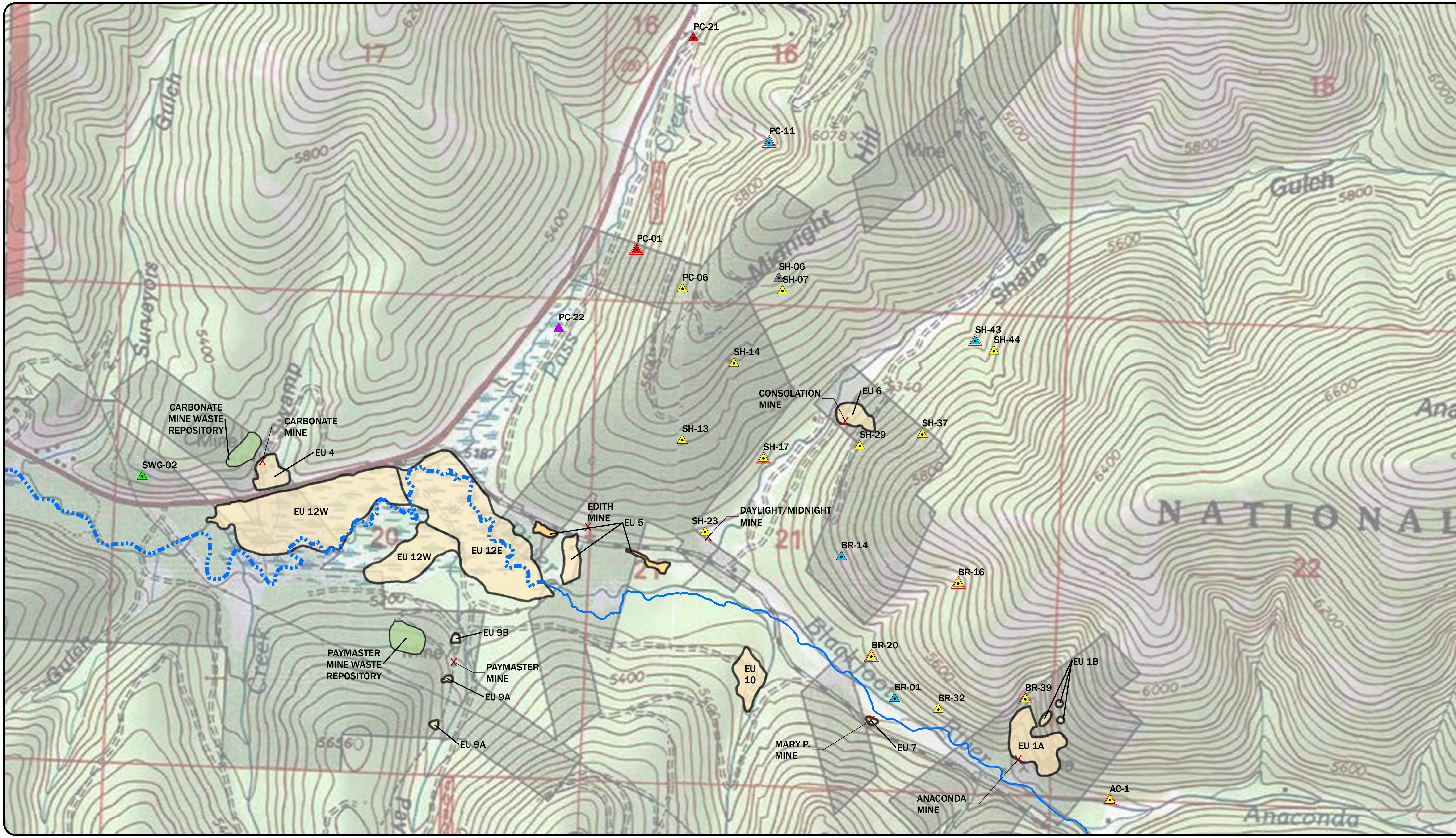
FIGURE 34

PIONEER TECHNICAL SERVICES, INC.

UBMC FEASIBILITY STUDY
EA 4 MARSH SURFACE WATER AND GROUNDWATER SAMPLE LOCATIONS

DATE: 1/9/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-035-15.mxd



LEGEND

- EXPOSURE UNITS
- MINE WASTE REPOSITORY
- METG/PRIVATE
- SAMPLE COLLECTED
- COLLAPSED ADIT WITH DISCHARGE
- COLLAPSED ADIT WITH WASTE ROCK
- COLLAPSED ADIT WITH WASTE ROCK AND DISCHARGE
- DISTURBED AREA
- DISTURBED AREA WITH DISCHARGE
- PHYSICAL HAZARD
- PHYSICAL HAZARD WITH WASTE ROCK
- SURFACE WATER/SEDIMENT
- X MINE
- STREAM
- STREAM (EU 13)

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

0 500 1,000 2,000
Feet

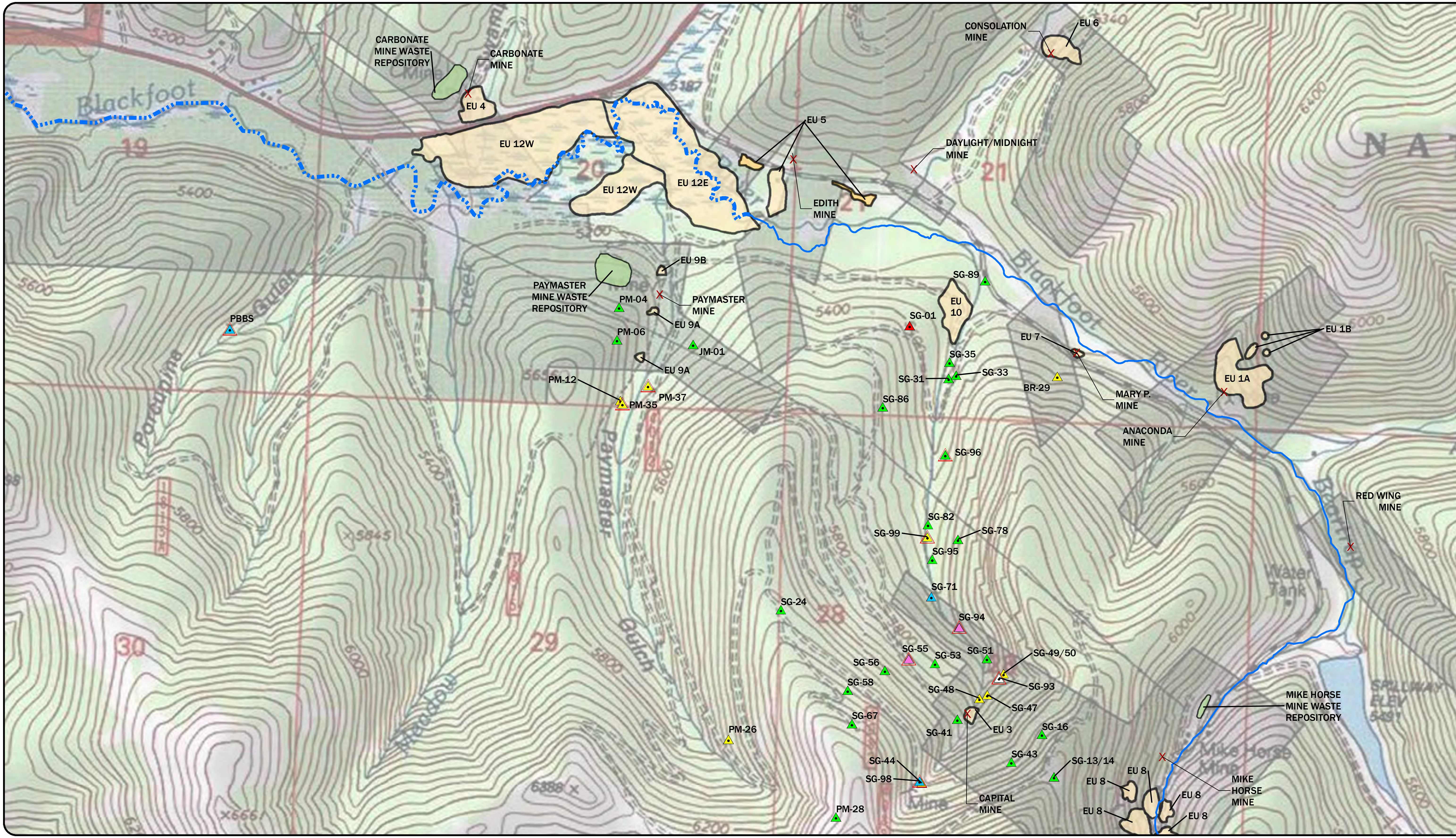
FIGURE 35

UBMC FEASIBILITY STUDY
EA5 MINING-RELATED
FEATURE LOCATIONS
NORTH OF BLACKFOOT RIVER

PIONEER TECHNICAL SERVICES, INC.

DATE: 2/3/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-048-15.mxd



LEGEND

- EXPOSURE LIMITS
- MINE WASTE REPOSITORY
- METG/PRIVATE
- SAMPLE COLLECTED
- COLLAPSED ADIT WITH DISCHARGE
- COLLAPSED ADIT WITH WASTE ROCK
- COLLAPSED ADIT WITH WASTE ROCK AND DISCHARGE
- DISTURBED AREA
- DISTURBED AREA WITH DISCHARGE
- PHYSICAL HAZARD
- PHYSICAL HAZARD WITH WASTE ROCK
- SURFACE WATER/SEDIMENT
- MINE
- STREAM
- STREAM (EU 13)

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/SPECTRUM

0 500 1,000 2,000
Feet

FIGURE 36

PIONEER TECHNICAL SERVICES, INC.

UBMC FEASIBILITY STUDY
EA5 MINING-RELATED
FEATURE LOCATIONS
SOUTH OF BLACKFOOT RIVER

DATE: 1/9/2015

Path: P:\DEQ\UBMC\FeasibilityStudy\Project\Final\UBMC_FS-GI-PLN-049-15.mxd

PRELIMINARY IDENTIFICATION OF
ENVIRONMENTAL REQUIREMENTS, CRITERIA, OR LIMITATIONS
UPPER BLACKFOOT MINING COMPLEX
July 2013

Remedial actions undertaken pursuant to the Comprehensive Environmental Cleanup and Responsibility Act (CECRA), §§ 75-10-701, et seq., MCA, must "attain a degree of cleanup of the hazardous or deleterious substance and control of a threatened release or further release of that substance that assures protection of public health, safety, and welfare and of the environment." Section 75-10-721(1), MCA. Additionally, §§ 75-10-721(2)(a) and (b), MCA, provide that the Montana Department of Environmental Quality (DEQ) must require cleanup consistent with applicable state or federal environmental requirements, criteria, or limitations (ERCLs). The statute also provides for DEQ consideration of substantive ERCLs that are relevant to the site conditions. In order to assist DEQ in ensuring that the required cleanup is consistent with ERCLs, DEQ identifies those laws or regulations that have been promulgated which are applicable or relevant to the facility.

ERCLs are grouped into three categories: action-specific, contaminant-specific, and location-specific. Action-specific requirements are those that are relevant to implementation of a particular remedy. Action-specific requirements do not in themselves determine the remedy but rather indicate the manner in which the remedy must be implemented. Contaminant-specific requirements are those that establish an allowable level or concentration of a hazardous or deleterious substance in the environment or that prescribe a level or method of treatment for a hazardous or deleterious substance. Location-specific requirements are those that serve as restrictions on the concentration of a hazardous or deleterious substance or the conduct of activities solely because they are in specific locations. Some ERCLs could be categorized in more than one way; in this case, they are generally not duplicated within the document.

CECRA defines cleanup requirements as only state and federal ERCLs. Remedial designs, implementation, operation, and maintenance must, nevertheless, comply with all other applicable laws, including local, state, and federal. Many such laws, while not strictly environmental, have environmental impacts. It remains the responsibility of the person implementing the remedy to identify and comply with all laws.

Many requirements listed here are promulgated as identical or nearly identical requirements in both federal and state law, usually pursuant to a delegated environmental program administered by the Environmental Protection Agency and the states, such as the requirements of the federal Clean Water Act and the Montana Water Quality Act. ERCLs and other laws which are unique to state law are also identified.

Within this document, DEQ has preliminarily identified applicable or relevant state and federal environmental requirements for the remedial actions at the Upper Blackfoot Mining Complex (UBMC). These ERCLs may change as DEQ develops the final remedy for the facility and DEQ will identify the final ERCLs in the Record of Decision. The description of applicable and relevant federal and state requirements that follows includes summaries of the legal requirements which set out the requirement in a concise fashion that is useful in evaluating compliance with the requirement. These descriptions are provided to allow the user a basic indication of the requirement without having to refer back to the statute or regulation itself. However, in the event of any inconsistency between the law itself and the summaries provided in this document, the actual requirement as set out in the law is ultimately the requirement, rather than any paraphrase of the law provided here.

ACTION SPECIFIC REQUIREMENTS

Point Source Controls: Section 402 of the Clean Water Act, 33 USC § 1342, et seq., authorizes the issuance of permits for the "discharge" of any "pollutant." This includes storm water discharges associated with "industrial activity." 40 CFR § 122.1(b)(2)(iv). "Industrial activity includes inactive mining operations that discharge storm water contaminated by contact with or that has come into contact with any overburden, raw material, intermediate products, finished products, byproducts or waste products located on the site of such operations, 40 CFR § 122.26(b)(14)(iii); landfills, land application sites, and open dumps that receive or have received any industrial wastes including those subject to regulation under RCRA subtitle D, 40 CFR § 122.26(b)(14)(v); and construction activity including clearing, grading, and excavation activities, 40 CFR § 122.26(b)(14)(x).

Because the State of Montana has been delegated the authority to implement the Clean Water Act, these requirements are enforced in Montana through the Montana Pollutant Discharge Elimination System (MPDES) (ARM 17.30.1342-1344). If such a point source is retained or created, applicable Clean Water Act standards, including the requirement to properly operate and maintain all facilities and systems of treatment and control, would apply to those discharges. See ARM 17.30.1201 et seq., (standards) and ARM 17.30.1301 et seq. (permits).

Dredge and Fill Requirements: If the selected remedy involves depositing dredge and fill material into water of the United States, remediation activities associated with waste removal and creek restoration may necessitate compliance with Section 404 Permit requirements.

Air Quality Regulations: Dust suppression and control of certain substances likely to be released into the air as a result of earth moving, transportation and similar actions may be necessary to meet air quality requirements. Additional air quality regulations under the state Clean Air Act, §§ 75-2-101 et seq., MCA, promulgated pursuant to the Clean Air Act, 42 U.S.C. §§ 7401, et seq., are discussed below. These standards are applicable to cleanup activities.

ARM 17.8.220 (Applicable): Settled particulate matter shall not exceed a 30-day average of 10 grams per square meter.

ARM 17.8.222 (Applicable): Lead in the ambient air shall not exceed a 90-day average of 1.5 micrograms per cubic meter.

ARM 17.8.223 (Applicable): PM-10 concentrations in ambient air shall not exceed a 24 hour average of 150 micrograms per cubic meter of air and an annual average of 50 micrograms per cubic meter of air.

Ambient air standards under section 109 of the Clean Air Act are also promulgated for sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, and hydrogen sulfide. If emissions of these compounds were to occur at the UBMC in connection with any cleanup action, these standards would also be applicable. See ARM 17.8.210, 17.8.211, 17.8.212, 17.8.213, and 17.8.214.

ARM 17.8.304 and 17.8.308 (Applicable): No person shall cause or authorize the production, handling, transportation or storage of any material; or cause or authorize the use of any street, road, or parking lot; or operate a construction site or demolition project, unless reasonable precautions to control emissions of airborne particulate matter are taken. Emissions of airborne particulate matter must be controlled so that they do not "exhibit an opacity of twenty percent (20%) or greater averaged over six consecutive minutes."

ARM 17.8.604 (Applicable): Certain wastes may not be disposed of by open burning, including oil or petroleum products, hazardous wastes, chemicals, and treated lumber and timbers.

ARM 17.24.761 (Relevant): Specifies a range of measures for controlling fugitive dust emissions during mining and reclamation activities and requires that a fugitive dust control program be implemented. Some of these measures could be considered relevant to control fugitive dust emissions in connection with excavation, earth moving and transportation activities conducted as part of the remedy at the site. Such measures include, for example, paving, watering, chemically stabilizing, or frequently compacting and scraping roads, promptly removing rock, soil or other dust-forming debris from roads, restricting vehicles speeds, revegetating, mulching, or otherwise stabilizing the surface of areas adjoining roads, restricting unauthorized vehicle travel, minimizing the area of disturbed land, and promptly revegetating regraded lands.

Groundwater Act (Applicable): § 85-2-505, MCA, precludes the wasting of groundwater. Any well producing waters that contaminate other waters must be plugged or capped, and wells must be constructed and maintained so as to prevent waste, contamination, or pollution of groundwater.

Section 85-2-516, MCA (Applicable): Within 60 days after any well is completed a well log report must be filed by the driller with the Montana Bureau of Mines and Geology.

ARM 17.30.641 (Applicable): Provides standards for sampling and analysis of water.

ARM 17.30.646 (Applicable): Requires that bioassay tolerance concentrations be determined in a specified manner.

ARM 36.21.670-678 and 810 (Applicable): Specifies certain requirements that must be fulfilled when abandoning monitoring wells.

Storm Water Runoff: ARM 17.30.1341 to 1344 (Applicable) requires a Storm Water Discharge General Permit for stormwater point sources. Generally, the permit requires the permittee to implement Best Management Practices and to take all reasonable steps to minimize or prevent any discharge which has a reasonable likelihood of adversely affecting human health or the environment. However, if there is evidence indicating potential or realized impacts on water quality due to any storm water discharge associated with the activity, additional protections may be required.

ARM 17.24.633 (Relevant): All surface drainage from a disturbed area must be treated by the best technology currently available.

The Resource Conservation and Recovery Act (RCRA) Subtitle C Requirements and corresponding State Requirements, 42 U.S.C. §§ 6901 et seq., (Applicable, as incorporated by the Montana Hazardous Waste Act), the Montana Hazardous Waste Act, §§ 75-10-401 et seq., MCA, (Applicable) and the regulations under these acts establish a regulatory structure for the generation, transportation, treatment, storage and disposal of hazardous wastes. One provision of RCRA, 42 USC §6921(b)(3)(A)(ii), known as the Bevill exclusion, excludes "[s]olid waste from the extraction, beneficiation, and processing of ores and minerals" from regulation as hazardous waste under Subtitle C of RCRA. Therefore, the only potential media at the UBMC that may require compliance with RCRA Subtitle C requirements is the filter cake sludge generated at the UBMC water treatment plant which, in the past, has been characterized as hazardous waste.

Characteristic wastes are those that by virtue of concentrations of hazardous constituents demonstrate the characteristic of ignitability, corrosivity, reactivity or toxicity, as described at 40 CFR Part 261, Subpart C (Applicable, as incorporated by the Montana Hazardous Waste Act). However, current processes at the water treatment plan provide for stabilization of the filter cake sludge in situ and, more recently, none of the filter cake sludge has been characterized as hazardous waste. Based upon this information, the UBMC does not contain RCRA hazardous waste and no additional RCRA hazardous waste regulations are identified. However, the waste generator has the responsibility for determining if a waste is a RCRA hazardous waste (40 CFR 262.11) and if, in the future, the filter cake sludge is identified as characteristic hazardous waste, compliance with RCRA/Montana Hazardous Waste Act requirements will be necessary.

Montana Solid Waste Management Act and regulations, §§ 75-10-201, et seq., MCA, ARM 17.50.501 et seq. (Applicable): Regulations promulgated under the Solid Waste Management Act, § 75-10-201, et seq., MCA, and pursuant to the federal Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act, 42 U.S.C. §§ 6901 et seq. (RCRA Subtitle D). They specify requirements that apply to the location of any solid waste management facility.

ARM 17.50.505 (Applicable): Provides that a facility for the treatment, storage or disposal of solid wastes:

1. must be located where a sufficient acreage of suitable land is available for solid waste management;
2. may not be located in a 100-year floodplain;
3. may be located only in areas which will prevent the pollution of ground and surface waters and public and private water supply systems;
4. must be located to allow for reclamation and reuse of the land;
5. drainage structures must be installed where necessary to prevent surface runoff from entering waste management areas; and
6. where underlying geological formations contain rock fractures or fissures which may lead to pollution of the ground water or areas in which springs exist that are hydraulically connected to a proposed disposal facility, only Class III disposal facilities may be approved.

ARM 17.50.505(2) (Applicable): Specifies standards for solid waste management facilities, including the requirements that:

1. Class II[1] landfills must confine solid waste and leachate to the disposal facility. (Leachate is defined as a liquid which has contacted, passed through, or emerged from solid waste and contains soluble, suspended, or miscible materials removed from the waste. (ARM 17.50.502(29)) If there is the potential for leachate migration, it must be demonstrated that leachate will only migrate to underlying formations which have no hydraulic continuity with any state waters;
2. adequate separation of group II wastes from underlying or adjacent water must be provided[2]; and
3. no new disposal units or lateral expansions may be located in wetlands.

ARM 17.50.506 (Applicable): Specifies design requirements for landfills, which is defined in ARM 17.50.502(27) as an area of land or an excavation where wastes are placed for permanent disposal, and that is not a land application unit, surface impoundment, injection well, or waste pile. Landfills must either be designed to ensure that EPA maximum contaminant levels (MCLs) are not exceeded or the landfill must contain a composite liner and leachate collection system which comply with specified criteria.

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1 Generally Class II landfills are licensed to receive Group II and Group III waste, but not regulated hazardous waste. Class III landfills may only receive Group III waste. Class IV landfills may receive Group III or IV waste.

2 The extent of separation shall be established on a case-by-case basis, considering terrain and the type of underlying soil formations, and facility design. The Waste Management Section of DEQ has generally construed this to require a 10 to 20 foot separation from groundwater.

ARM 17.50.511 (Applicable): Sets forth general operational and maintenance and design requirements for solid waste management systems. Specific operational and maintenance requirements include requirements for run-on and runoff control systems, requirements that sites be fenced to prevent unauthorized access, and prohibitions of point source and nonpoint source discharges which would violate Clean Water Act requirements.

ARM 17.50.523 (Applicable): Requires that waste be transported in such a manner as to prevent its discharge, dumping, spilling or leaking from the transport vehicle.

ARM 17.50.525 (Applicable): States that DEQ may inspect at reasonable hours.

ARM 17.50.530 (Applicable): Sets forth the closure requirements for landfills. This includes the requirement that a repository cap be a minimum of 24 inches thick and other criteria, as follows:

1. install a cover that is designed to minimize infiltration and erosion;
2. design and construct the final cover system to minimize infiltration through the closed unit by the use of an infiltration layer that contains a minimum 18 inches of earthen material and has a permeability less than or equal to the permeability of any bottom liner, barrier layer, or natural subsoils or a permeability no greater than 1 x 10-5 cm/sec, whichever is less;
3. minimize erosion of the final cover by the use of a seed bed layer that contains a minimum of six inches of earthen material that is capable of sustaining native plant growth and protecting the infiltration layer from frost effects and rooting damage; and
4. revegetate the final cover with native plant growth within one year of placement of the final cover.

ARM 17.50.530(1)(b) (Applicable): Allows an alternative final cover design if the infiltration layer achieves reduction in infiltration at least equivalent to the stated criteria and the erosion layer provides protection equivalent to the stated criteria.

ARM 17.50.531 (Applicable): Sets forth post closure care requirements for Class II landfills and is applicable to the dioxin/furan contaminated soil repository. Post closure care must be conducted for a period sufficient to protect human health and the environment. Post closure care requires maintenance of the integrity and effectiveness of any final cover, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the cover and comply with the groundwater monitoring requirements found at ARM Title 17, chapter 50, subchapter 7.

Section 75-10-212, MCA (Applicable): Prohibits dumping or leaving any debris or refuse upon or within 200 yards of any highway, road, street, or alley of the State or other public property, or on privately owned property where hunting, fishing, or other recreation is permitted. However, the restriction relating to privately owned property does not apply to the owner, his agents, or those disposing of debris or refuse with the owner's consent.

Underground Injection Control Program
All injection wells are regulated under the Underground Injection Control Program in accordance with 40 CFR 144 and 146 (Applicable) which set forth the standards and criteria for the injection of substances into aquifers. Wells are classified as Class I through V, depending on the location and the type of substance injected. For all classes, no owner may construct, operate or maintain an injection well in a manner that results in the contamination of an underground source of drinking water at levels that violate MCLs or otherwise adversely affect the health of persons. Each classification may also contain further specific standards, depending on the classification. If underground injection is part of the remedy, compliance with these regulations may be necessary.

Montana Dam Safety Act and regulations, §§ 85-15-105, et seq., MCA, ARM 36.14.501 et seq. (Applicable): The Montana Dam Safety Act and regulations address risks to public safety associated with dams and provide requirements for repair and removal. This act and regulations apply to removal of the UBMC Mike Horse Tailings Impoundment, which is being addressed under authority of the U.S. Forest Service.

Reclamation Requirements (Relevant): Certain portions of the Montana Strip and Underground Mining Reclamation Act and Montana Metal Mining Act as outlined below are relevant for activities at the UBMC. Significant mining activities occurred at the UBMC and these requirements are relevant for the management and reclamation of areas disturbed by excavation, grading, or similar actions. For those areas at the UBMC which require revegetation, grading, etc., the following are relevant when developing the reclamation and revegetation plan.

Section 82-4-231, MCA: Requires operators to reclaim and revegetate affected lands using the most modern technology available. Operators must grade, backfill, topsoil, reduce high walls, stabilize subsidence, control water, minimize erosion, subsidence, landslides, and water pollution.

Section 82-4-233, MCA: Operators must plant vegetation that will yield a diverse, effective, and permanent vegetative cover of the same seasonal variety native to the area and capable of self-regeneration.

Section 82-4-336, MCA: Disturbed areas must be reclaimed to the utility and stability comparable to areas adjacent.

ARM 17.24.501: Provides general backfilling and grading requirements to minimize sedimentation, erosion, and leaching. Final grading must be to the approximate original contour of the land and must minimize settlement.

ARM 17.24.631(1), (2), (3)(a) and (b): Disturbances to the prevailing hydrologic balance will be minimized. Changes in water quality and quantity, in the depth to groundwater and in the location of surface water drainage channels will be minimized, to the extent consistent with the selected remedial action. Other pollution minimization devices must be used if appropriate, including stabilizing disturbed areas through land shaping, diverting runoff, planting quickly germinating and growing stands of temporary vegetation, regulating channel velocity of water, lining drainage channels with rock or vegetation, mulching, and control of acid-forming, and toxic-forming waste materials.

ARM 17.24.632: Each prospecting hole, other drilled hole, borehole, or well must be permanently sealed according to the procedures in ARM 17.24.1005. Other exposed underground openings must also be abandoned or cased, sealed, or otherwise managed to prevent acid or other toxic drainage from entering the groundwater or surface water, to minimize disturbance to the hydrologic balance, and to ensure safety.

ARM 17.24.633: Surface drainage from a disturbed area must be treated by the best technology currently available. Treatment must continue until the area is stabilized.

ARM 17.24.634: Drainage system design must emphasize pre-mining channel and floodplain configurations that blend with the undisturbed drainage above and below; will meander naturally; remain in dynamic equilibrium with the system; improve unstable pre-mining conditions, provide for floods, provide for long-term stability of the landscape, and establish a pre-mining diversity of aquatic habitats and riparian vegetation.

ARM 17.24.635 through 17.24.637: Set forth requirements for temporary and permanent diversions.

ARM 17.24.638: Sediment control measures must be implemented during operations.

ARM 17.24.639: Provides specific design requirements for detention time, flood flow, etc. for temporary and permanent sedimentation ponds.

ARM 17.24.640: Discharges from diversions must be controlled to reduce erosion and enlargement of stream channels, and to minimize disturbance of the hydrologic balance.

ARM 17.24.641: Practices to prevent drainage from acid or toxic forming spoil material into ground and surface water will be employed.

ARM 17.24.642: Prohibits permanent impoundments with certain exceptions, and sets standards for temporary and permanent impoundments.

ARM 17.24.643: Provides groundwater protection by controlling the discharge of acid, toxic, or otherwise harmful mine drainage waters into groundwater and requires that any backfill material be placed to minimize adverse effects on groundwater flow and quality.

ARM 17.24.644: Provides for protection of groundwater recharge. The groundwater recharge shall be restored to pre-mining conditions.

ARM 17.24.645: Provides requirements for groundwater monitoring prior to permit issuance, during mining, and post-mining.

ARM 17.24.646: Provides requirements for surface water monitoring prior to permit issuance, during mining, and post-mining.

ARM 17.24.649: Prohibits the discharge, diversion, or infiltration of surface and groundwater into existing underground mine workings.

ARM 17.24.650: All permanent sedimentation ponds, diversions, impoundments, and treatment facilities must be renovated post-mining, to meet criteria specified in the design plan. All temporary structures shall be regarded to the approximate original contour.

ARM 17.24.701 and 702: Provides requirements for redistributing and stockpiling of soil for reclamation. Also outlines practices to prevent compaction, slippage, erosion, and deterioration of biological properties of soil.

ARM 17.24.703: When using materials other than, or along with, soil for final surfacing in reclamation, the operator must demonstrate that the material (1) is at least as capable as the soil of supporting the approved vegetation and subsequent land use; and (2) the medium must be the best available in the area to support vegetation. Such substitutes must be used in a manner consistent with the requirements for redistribution of soil in ARM 17.24.701 and 702.

ARM 17.24.711: Requires that a diverse, effective and permanent vegetative cover of the same seasonal variety and utility as the vegetation native to the area of land to be affected must be established.

ARM 17.24.713: Seeding and planting of disturbed areas must be conducted during the first appropriate period for favorable planting after final seedbed.

ARM 17.24.714: Mulch or cover crop or both must be used until adequate permanent cover can be established.

ARM 17.24.716: Establishes method of revegetation.

ARM 17.24.717: Relates to the planting of trees and other woody species if necessary, as provided in § 82-4-233, MCA, to establish a diverse, effective, and permanent vegetative cover.

ARM 17.24.718: Requires soil amendments if necessary to establish a permanent vegetative cover.

ARM 17.24.721: Specifies that rills or gullies must be stabilized and the area reseeded and replanted if the rills and gullies are disrupting the reestablishment of the vegetative cover or causing or contributing to a violation of water quality standards for a receiving stream.

ARM 17.24.723: Requires periodic monitoring of vegetation, soils, water, and wildlife.

ARM 17.24.724: Specifies how revegetation success is measured.

ARM 17.24.726: Sets the required methods for measuring vegetative success.

ARM 17.24.731: If toxicity to plants or animals is suspected, comparative chemical analyses may be required.

ARM 17.24.751: Measures to prevent degradation of fish and wildlife habitat will be employed.

ARM 17.24.761: This specifies fugitive dust control measures that will be employed during excavation and construction activities to minimize the emission of fugitive dust.

Noxious Weeds (Applicable): Section 7-22-2101(8)(a), MCA defines "noxious weeds" as any exotic plant species established or that may be introduced in the state which may render land unfit for agriculture, forestry, livestock, wildlife, or other beneficial uses or that may harm native plant communities and that is designated: (i) as a statewide noxious weed by rule of the department of agriculture; or (ii) as a district noxious weed by a district weed board, following public notice of intent and a public hearing. Designated noxious weeds are listed in ARM 4.5.206 through 4.5.210 and must be managed consistent with weed management criteria developed under § 7-22-2109(2)(b), MCA. Section 7-22-2152, MCA, requires that any person proposing certain actions including but not limited to a solid waste facility, a highway or road, a commercial, industrial, or government development, or any other development that needs state or local approval and that results in the potential for noxious weed infestation within a district shall notify the district weed board at least 15 days prior to the activity. The board will require that the areas be seeded, planted, or otherwise managed to reestablish a cover of beneficial plants. The person committing the action shall submit to the board a written plan specifying the methods to be used to accomplish revegetation at least 15 days prior to the activity. The plan must describe the time and method of seeding, fertilization practices, recommended plant species, use of weed-free seed, and the weed management procedures to be used. The plan is subject to approval by the board, which may require revisions to bring the revegetation plan into compliance with the district weed management plan. The activity for which notice is given may not occur until the plan is approved by the board and signed by the presiding officer of the board and by the person or a representative of the agency responsible for the action. The signed plan constitutes a binding agreement between the board and the person or agency. The plan must be approved, with revisions if necessary, within 10 days of receipt by the board.

CONTAMINANT SPECIFIC REQUIREMENTS

GROUNDWATER

The Safe Drinking Water Act, 42 USC §§ 300f et seq., and the National Primary Drinking Water Regulations (40 CFR Part 141) (Relevant) establish MCLs and maximum contaminant level goals (MCLGs) for contaminants in drinking water distributed in public water systems. These requirements were evaluated during this ERCLs analysis in conjunction with the groundwater and surface water classification standards promulgated by the State of Montana. The MCLs and MCLGs are identified because the groundwater and surface water at the UBMC is a potential source of drinking water. In addition, the Secondary Maximum Contaminant Levels (SMCLs) specified in 40 CFR Part 143.3 contains standards for iron, manganese, color, odor, and corrosivity that are relevant to the remedial actions.

The Montana Water Quality Act, § 75-5-605, MCA (Applicable): Provides that it is unlawful to cause pollution of any state waters and § 75-6-112, MCA (Applicable) provides that it is unlawful to discharge drainage or other waste that will cause pollution of state waters used as a source for a public water supply or for domestic use as well as prohibits other unlawful actions.

Section 75-5-605, MCA (Applicable): It is unlawful to place or cause to be placed any wastes where they will cause pollution of any state waters.

Section 75-5-303, MCA (Applicable): Requires that existing uses of state waters and the level of water quality necessary to protect the uses must be maintained and protected.

ARM 17.30.1006 (Applicable): Classifies groundwater into Classes I through IV based upon its specific conductance and establishes the groundwater quality standards applicable with respect to each groundwater classification. Class I is the highest quality class; class IV the lowest. Based on its specific conductance, groundwater at the UBMC has been classified as Class I groundwater.

Concentrations of substances in groundwater within Class I may not exceed the human health standards for groundwater listed in DEQ Circular DEQ-7, Montana Numeric Water Quality Standards, October 2012 (Applicable). In addition, no increase of a parameter may cause a violation of § 75-5-303, MCA (Applicable). For concentrations of parameters for which human health standards are not listed in DEQ-7, ARM 17.30.1006 allows no increase of a parameter to a level that renders the waters harmful, detrimental or injurious to the beneficial uses listed for that class of water.

Human health standards for the primary contaminants of concern (COCs) in groundwater are listed below and are based on the standards outlined in DEQ-7. However, compliance with all DEQ-7 standards is required and remedial actions must meet the DEQ-7 standards for all contaminants at the UBMC, including any breakdown products generated during remedial actions.

Chemical	**DEQ-7 Standard for Groundwater**
Arsenic	10 ug/L
Cadmium	5 ug/L
Copper	1,300 ug/L
Lead	15 ug/L
Zinc	2,000 ug/L

ARM 17.30.1011 (Applicable): Provides that any groundwater whose existing quality is higher than the standard for its classification must be maintained at that high quality in accordance with § 75-5-303, MCA, and ARM Title 17, chapter 30, subchapter 7.

An additional concern with respect to ERCLs for groundwater is the impact of groundwater upon surface water. If significant loadings of contaminants from groundwater sources to any surface water body contribute to the inability of the surface water to meet its applicable class standards, (i.e., the DEQ-7 levels described in the Surface Water section below), then alternatives to alleviate such groundwater loading must be evaluated and, if appropriate, implemented.

SURFACE WATER

The federal Clean Water Act, 33 U.S.C. § 1251, et seq., provides the authority for each state to adopt water quality standards (40 CFR Part 131) designed to protect beneficial uses of each water body and requires each state to designate uses for each water body. Under the state Water Quality Act, §§ 75-5-101, et seq., MCA, Montana has promulgated regulations, ARM 17.30.601 et seq., (Applicable), to protect, maintain, and improve the quality of surface waters in the state. The State has the authority to adopt water quality standards designed to protect beneficial uses of each water body and to designate uses for each water body. Montana's regulations classify State waters according to quality, place restrictions on the discharge of pollutants to State waters, and prohibit degradation of State waters.

Pursuant to this authority and the criteria established by Montana surface water quality regulations, Montana has established the water-use classification system. ARM 17.30.607 (Applicable) classifies surface water for the Clark Fork River drainage as B-1.

ARM 17.30.623 (Applicable): Provides the classification standards and beneficial uses for the B-1 classification and provides that concentrations of carcinogenic, bioconcentrating, toxic, or harmful parameters in the water may not exceed DEQ-7 standards. The section also provides the specific water quality standards for water classified as B-1 which must be met.

In addition, the following criteria apply:

1. Dissolved oxygen concentration must not be reduced below the levels given in DEQ-7, as provided in the following table (in milligrams per liter):

	Early Life Stages[1,2]	**Other Life Stages**
30 Day Mean	n/a[3]	6.5
7 Day Mean	9.5 (6.5)	n/a[3]
7 Day Mean Minimum	n/a[3]	5.0
1 Day Minimum[4]	8.0 (5.0)	4.0

1 These are water column concentrations recommended to achieve the required inter-gravel dissolved oxygen concentrations shown in parentheses. For species that have early life stages exposed directly to the water column, the figures in parentheses apply.
2 Includes all embryonic and larval stages and all juvenile forms of fish to 30 days following hatching.
3 not applicable
4 All minima should be considered instantaneous concentrations to be achieved at all times.

2. Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 8.5 must be maintained less than 0.5 pH unit. Natural pH outside this range must be maintained without change. Natural pH above 7.0 must be maintained above 7.0;
3. The maximum allowable increase above naturally occurring turbidity is 5 nephelometric turbidity units, except as permitted by § 75-5-318, MCA;
4. Temperature increases must be kept within prescribed limits;
5. No increase is allowed above naturally occurring concentrations of sediment, settleable solids, oils, or floating solids which will or is likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish or other wildlife;
6. True color must be kept within specified limits; and
7. E-coli must be kept below specified limits.

For the primary COCs, the DEQ-7 surface water standards are listed below. However, compliance with all DEQ-7 standards is required. If both Aquatic Life Standards and Surface Water Human Health Standards exist for the same analyte, the more restrictive of these values will be used as the applicable numeric standard.

Chemical	DEQ-7 Human Health Standard	Aquatic Life Standard*
Aluminum	none	87 ug/L
Arsenic	10 ug/L	150 ug/L
Cadmium	5 ug/L	.097 ug/L**
Copper	1,300 ug/L	2.85 ug/L**
Iron	none	1,000 ug/L
Lead	15 ug/L	.545 ug/L**
Zinc	2,000 ug/L	37 ug/L**

* - all are based on chronic except zinc, which is based upon chronic and acute
** - based upon 25 mg/L hardness

Creeks, rivers, ditches, and certain other bodies of surface water must meet these requirements.[3]

ARM 17.30.637 (Applicable): Requires state surface waters to be free from substances attributable to municipal, industrial, agricultural practices, or other discharges that will:

1. settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines;
2. create floating debris, scum, a visible oil film (or be present in concentrations at or in excess of 10 milligrams per liter) or globules of grease or other floating materials;
3. produce odors, colors or other conditions as to which create a nuisance or render undesirable tastes to fish flesh or make fish inedible;
4. create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life; and
5. create conditions which produce undesirable aquatic life.

ARM 17.30.637 also states that no waste may be discharged and no activities conducted which, either along or in combination with other waste activities, will cause violation of surface water quality standards.

ARM 17.30.705 (Applicable): This provides that for any surface water, existing and anticipated uses and the water quality necessary to protect these uses must be maintained and protected unless degradation is allowed under the nondegradation rules at ARM 17.30.708.

AIR QUALITY

The Clean Air Act (42 USC §§ 7401 et seq.): Provides limitations on air emissions resulting from cleanup activities or emissions resulting from wind erosion of exposed hazardous

[3] As provided under ARM 17.30.602(33), "'surface waters' means any waters on the earth's surface, including, but not limited to, streams, lakes, ponds, and reservoirs; and irrigation and drainage systems discharging directly into a stream, lake, pond, reservoir or other surface water. Water bodies used solely for treating, transporting or impounding pollutants shall not be considered surface water."

substances. Sections 75-2-101, et seq., MCA (Applicable) provides that state emission standards are enforceable under the Montana Clean Air Act.

ARM 17.8.204 and 206 (Applicable): Establishes monitoring, data collection and analytical requirements to ensure compliance with ambient air quality standards and requires compliance with the Montana Quality Assurance Project Plan except when more stringent requirements are determined by DEQ to be necessary.

ARM 17.8.220 (Applicable): Settled particulate matter shall not exceed a 30 day average of 10 grams per square meter.

ARM 17.8.223 (Applicable): PM-10 concentrations in ambient air shall not exceed a 24 hour average of 150 micrograms per cubic meter of air and an annual average of 50 micrograms per cubic meter of air.

Ambient air standards are also promulgated for carbon monoxide, hydrogen sulfide, nitrogen dioxide, sulfur dioxide, and ozone. If emissions of these compounds were to occur at the UBMC in connection with any remedial action, these standards would also be applicable. See ARM 17.8.210, 17.8.211, 17.8.212, 17.8.213, and 17.8.214.

LOCATION SPECIFIC REQUIREMENTS

The Endangered Species Act (Relevant): This statute and implementing regulations (16 U.S.C. § 1531 et seq., 50 CFR Part 402, 40 CFR § 6.302(h), and 40 CFR § 257.3-2) require that any federal activity or federally authorized activity may not jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify a critical habitat. Compliance with this requirement involves consultation with the U.S. Fish and Wildlife Service (USFWS), a determination of whether there are listed or proposed species or critical habitats present at the UBMC, and, if so, whether any proposed activities will impact such wildlife or habitat.

Montana Nongame and Endangered Species Act, §§ 87-5-101 et seq. (Applicable): Endangered species should be protected in order to maintain and to the extent possible enhance their numbers. These sections list endangered species, prohibited acts and penalties. See also, § 87-5-201, MCA, (Applicable) concerning protection of wild birds, nests and eggs; and ARM 12.5.201 (Applicable) prohibiting certain activities with respect to specified endangered species.

Migratory Bird Treaty Act (Relevant): This requirement (16 U.S.C. § 703 et seq.) establishes a federal responsibility for the protection of the international migratory bird resource and requires continued consultation with the USFWS during remedial design and remedial construction to ensure that the cleanup of the UBMC does not unnecessarily impact migratory birds. Specific mitigative measures may be identified for compliance with this requirement.

Bald Eagle Protection Act (Relevant): This requirement (16 U.S.C. § 668 et seq.) establishes a federal responsibility for protection of bald and golden eagles, and requires continued consultation with the USFWS during remedial design and remedial construction to ensure that remediation activities at the UBMC do not unnecessarily adversely affect the bald and golden eagle.

Protection of Wetlands Order (Relevant): There are wetlands within the UBMC. 40 CFR Part 6, Appendix A, Executive Order No. 11,990 mandates that federal agencies and potentially responsible parties avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid new construction in wetlands if a practicable alternative exists. Section 404(b)(1), 33 U.S.C. § 1344(b)(1) (Relevant) also prohibits the discharge of dredged or fill material into waters of the United States. Together, these requirements create a "no net loss" of wetlands standard.

Historic Sites, Buildings, Objects and Antiquities Act (Relevant): These requirements, found at 16 U.S.C. 461 et seq., provide that, in conducting an environmental review of a proposed action, the responsible official shall consider the existence and location of natural landmarks using information provided by the National Park Service pursuant to 36 CFR 62.6(d) to avoid undesirable impacts upon such landmarks.

Montana Human Skeletal Remains and Burial Site Protection Act (Applicable): Sections 22-3-801 et seq., MCA, prohibits purposefully or knowingly disturbing or destroying human skeletal remains or burial sites. If human skeletal remains or burial sites are encountered during remedial activities, compliance with these requirements is required.

Resource Conservation and Recovery Act (Relevant): 40 CFR 264.18 provides location standards for owners and operators of hazardous waste management units. Portions of new management units must not be located within 200 feet of a fault which has had displacement in Holocene time and management units in or near a 100 year floodplain must be designed, constructed, operated, and maintained to avoid washout.

Fish and Wildlife Coordination Act (Relevant): These standards are found at 16 U.S.C. § 661 et seq. and 40 CFR 6 and require that federally funded or authorized projects ensure that any modification of any stream or other water body affected by a funded or authorized action provide for adequate protection of fish and wildlife resources.

Floodplain Management Order (Relevant): Executive Order 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. Implementing regulations for this executive order are found at 40 CFR 6. The executive order and regulations are relevant because a portion of the UBMC is in a floodplain; however, application of the Montana floodplain requirements (see below) addresses protection of the floodplain.

Montana Floodplain and Floodway Management Act and Regulations, §§ 76-5-401, et seq., MCA, ARM 36.15.601, et seq. (Applicable): The Floodway Management Act and regulations specify types of uses and structures that are allowed or prohibited in the designated 100-year floodway and floodplain.

Section 76-5-401, MCA and ARM 36.15.601 (Applicable): Certain open-space uses are allowed in a floodway.

ARM 36.15.701 (Applicable): Certain activities are allowed in the flood fringe.

ARM 36.15.605(2) and 36.15.703 (Applicable): Prohibits certain uses anywhere in either the floodway or the flood fringe.

Section 76-5-402, MCA (Applicable): Allows uses in the floodplain outside the flood way.

Section 76-5-404, MCA (Applicable): Establishes that it is unlawful to alter an artificial obstruction or designated floodway without a permit. This section applies to any remedial action in the designated floodplain or designated floodway where such action requires more than maintenance. The substantive requirements of a Floodplain Development Permit are applicable to activities planned in the floodway.

The substantive requirements specify factors that must be considered in allowing diversions of the stream, changes in place of diversion of the stream, flood control works, new construction or alteration of artificial obstructions, or any other nonconforming use within the floodplain or floodway. Many of these requirements are set forth as factors that must be considered in determining whether a permit can be issued for certain obstructions or uses. Factors which must be considered in addressing any obstruction or use within the floodway or floodplain include:

1. the danger to life and property from backwater or diverted flow caused by the obstruction or use;
2. the danger that the obstruction or use will be swept downstream to the injury of others;
3. the availability of alternate locations;
4. the construction or alteration of the obstruction or use in such a manner as to lessen the danger;
5. the permanence of the obstruction or use; and
6. the anticipated development in the foreseeable future of the area which may be affected by the obstruction or use.

See § 76-5-406, MCA; ARM 36.15.216 (Applicable): Conditions or restrictions that generally apply to specific activities within the floodway or floodplain are:

1. the proposed activity, construction, or use cannot increase the upstream elevation of the 100-year flood a significant amount (0.5 foot or as otherwise determined by the permit-issuing authority) or significantly increase flood velocities, ARM 36.15.604 (Applicable); and
2. the proposed activity, construction, or use must be designed and constructed to minimize potential erosion.

For the substantive conditions and restrictions applicable to specific obstructions or uses, see the following applicable regulations:

Excavation of material from pits or pools - ARM 36.15.602(1).

Storage of materials must be readily removable – ARM 36.15.602(5)(b).

Water diversions or changes in place of diversion - ARM 36.15.603.

Flood control works (levees, floodwalls, and riprap must comply with specified safety standards) - ARM 36.15.606.

Roads, streets, highways and rail lines (must be designed to minimize increases in flood heights) - ARM 36.15.701(3)(c).

Structures and facilities for liquid or solid waste treatment and disposal (must be flood-proofed to ensure that no pollutants enter flood waters and may be allowed and approved only in accordance with DEQ regulations, which include certain additional prohibitions on such disposal) - ARM 36.15.701(3)(d).

Structures -ARM 36.15.702(1)(2).

<u>Montana Natural Streambed and Land Preservation Act and Regulations, §§ 75-7-101, et seq., MCA, and ARM 36.2.401 et seq. (Applicable):</u> Applies if a remedial action alters or affects a streambed (including a river) or its banks. The adverse effects of any such action must be minimized.

ARM 36.2.410 (Applicable): Establishes minimum standards which would be applicable if a remedial action alters or affects a streambed, including any channel change, new diversion, riprap or other streambank protection project, jetty, new dam or reservoir or other commercial, industrial or residential development. Projects must be designed and constructed using methods that minimize adverse impacts to the stream (both upstream and downstream) and future disturbances to the stream. All disturbed areas must be managed during construction and reclaimed after construction to minimize erosion. Temporary structures used during construction must be designed to handle high flows reasonably anticipated during the construction period. Temporary structures must be completely removed from the stream channel at the conclusion of

construction, and the area must be restored to a natural or stable condition. Channel alterations must be designed to retain original stream length or otherwise provide hydrologic stability. Streambank vegetation must be protected except where removal of such vegetation is necessary for the completion of the project. When removal of vegetation is necessary, it must be kept to a minimum. Riprap, rock, and other material used in a project must be of adequate size, shape, and density and must be properly placed to protect the streambank from erosion. The placement of road fill material in a stream, the placement of debris or other materials in a stream where it can erode or float into the stream, projects that permanently prevent fish migration, operation of construction equipment in a stream, and excavation of streambed gravels are prohibited unless specifically authorized by the district. Such projects must also protect the use of water for any useful or beneficial purpose. See § 75-7-102, MCA.

Section 75-7-111, MCA (Applicable): Provides that a person planning to engage in any activity that will physically alter or modify the bed or banks of a stream must give written notice to the Board of Supervisors of a Conservation District, the Directors of a Grass Conservation District, or the Board of County Commissioners if the proposed project is not within a district.

OTHER LAWS (NON-EXCLUSIVE LIST)

CECRA defines as ERCLs only applicable or relevant state and federal environmental laws. It is the responsibility of the person implementing the remedial action to comply with all other applicable laws during to remedial design, implementation, and operation and maintenance.

The following "other laws" are identified here to provide the person implementing the remedial action a reminder of other legal requirements that may apply to actions being conducted at the UBMC. They do not purport to be an exhaustive list of such legal requirements, but are included because they set out related concerns that must be addressed and, in some cases, may require some advance planning. They are not included as ERCLs because they are not “environmental laws."

Other Federal Laws

Occupational Safety and Health Regulations

The federal Occupational Safety and Health Act regulations found at 29 CFR 1910 are applicable to worker protection during conduct of all remedial activities.

Other Montana Laws

1. Well Driller Licensing

Sections 37-43-101 to 402, MCA, provide regulations and licensing for drillers or makers of water wells and monitoring wells.

2. Water Rights

Section 85-2-101, MCA, declares that all waters within the state are the state's property, and may be appropriated for beneficial uses. The wise use of water resources is encouraged for the maximum benefit to the people and with minimum degradation of natural aquatic ecosystems.

Parts 3 and 4 of Title 85, Chapter 2, MCA, set out requirements for obtaining water rights and appropriating and utilizing water. All requirements of these parts are laws which must be complied with in any action using or affecting waters of the state. Some of the specific requirements are set forth below.

Section 85-2-301, MCA, provides that a person may only appropriate water for a beneficial use.

Section 85-2-302, MCA, specifies that a person may not appropriate water or commence construction of diversion, impoundment, withdrawal or distribution works therefore except by applying for and receiving a permit from the Montana Department of Natural Resources and Conservation.

Section 85-2-306, MCA, specifies the conditions on which groundwater may be appropriated, and, at a minimum, requires notice of completion and appropriation within 60 days of well completion.

Section 85-2-311, MCA, specifies the criteria which must be met in order to appropriate water and includes requirements that:

1. there are unappropriated waters in the source of supply;
2. the proposed use of water is a beneficial use; and
3. the proposed use will not interfere unreasonably with other planned uses or developments.

Section 85-2-402, MCA, specifies that an appropriator may not change an appropriated right except as provided in this section with the approval of the DNRC.

Section 85-2-412, MCA, provides that, where a person has diverted all of the water of a stream by virtue of prior appropriation and there is a surplus of water, over and above what is actually and necessarily used, such surplus must be returned to the stream.

3. Occupational Health Act, §§ 50-70-101 et seq., MCA.

ARM 17.74.101 addresses occupational noise. In accordance with this section, no worker shall be exposed to noise levels in excess of the levels specified in this regulation. This regulation is applicable only to limited categories of workers and for most workers the similar federal standard in 29 CFR 1910.95 applies.

ARM 17.74.102 addresses occupational air contaminants. The purpose of this rule is to establish maximum threshold limit values for air contaminants under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects. In accordance with this rule, no worker shall be exposed to air contaminant levels in excess of the threshold limit values listed in the regulation.

This regulation is applicable only to limited categories of workers and for most workers the similar federal standard in 29 CFR 1910.1000 applies.

4. Montana Safety Act

Sections 50-71-201, 202 and 203, MCA, state that every employer must provide and maintain a safe place of employment, provide and require use of safety devices and safeguards, and ensure that operations and processes are reasonably adequate to render the place of employment safe. The employer must also do every other thing reasonably necessary to protect the life and safety of its employees. Employees are prohibited from refusing to use or interfering with the use of safety devices.

5. Employee and Community Hazardous Chemical Information

Sections 50-78-201, 202, and 204, MCA, state that each employer must post notice of employee rights, maintain at the work place a list of chemical names of each chemical in the work place, and indicate the work area where the chemical is stored or used. Employees must be informed of the chemicals at the work place and trained in the proper handling of the chemicals.

Table B-1: Carbonate Mine Site EU-3 Conceptual Site Model

LINE	IN	Abrev. (units)	Value						Calculation	Notes
1	Flow		Flow							
2	Stream flow in	Q_{swin} (gpm)	18.8							Average base flow at BRSW-14
3	Groundwater flow in									
4	Flow from seep 1 in	$Q_{seep1in}$ (gpm)	0.5							1993 lower Carbonate seep (MFG, 1994)
5	Flow from seep 2 in	$Q_{seep2in}$ (gpm)	0.07							seep located below the Carbonate Mine adit portal (MFG,1994)
6	Total groundwater flow in	$GWFlow_{in}$ (gpm)	0.57						*$GWFlow_{in}$* (gpm) (See Equation 1)	
7	TOTAL FLOW IN	Q_{in} (gpm)	19.4							$Q_{swin} + Q_{seep1in} + Q_{seep2in} = Q_{in}$
8										
9	DISSOLVED METALS CONCENTRATIONS IN		cadmium	copper	iron	lead	manganese	zinc		
10	Concentration of dissolved metals from surface water in	C_{swin} (mg/L)	0.001	0.005	0.042	0.0026	0.0122	0.0107	*{COC}* (mg/L)	From BRSW-14
11	Concentration of dissolved metals from groundwater in	C_{gwin} (mg/L)	0.00156	0.043	1.56	0.0013	0.90	0.11		From SWGW-103
12	Concentration of dissolved metals from seeps in	C_{seepin} (mg/L)	0.207	0.010	131	0.006	99.665	20.1		From UCMW-11
13										
14	LOAD IN - DISSOLVED METALS									
15	Load from surface water in	L_{swin} (#/day)	0.00023	0.0011	0.0094	0.00059	0.0027	0.0024	See Equation 1	
16	Load from surface water to groundwater in	$L_{swtogwin}$ (#/day)	0.00016	0.00082	0.0068	0.00043	0.0020	0.0017		
17	Load from seep 1 in	$L_{seep1in}$ (#/day)	0.0012	0.000063	0.78	0.000036	0.60	0.12		
18	Load from seep 2 in	$L_{seep2in}$ (#/day)	0.0002	0.000009	0.11	0.000005	0.080	0.02		
19	SUM OF DISSOLVED METALS LOAD IN (#/DAY)		0.00163	0.00199	0.91	0.00106	0.68	0.14	-	Surface water and groundwater dissolved metals load
20	SUM OF DISSOLVED GW METALS LOAD IN (#/DAY)		0.00156	0.00089	0.89680	0.00047	0.68	0.14170	-	Groundwater dissolved metals load only
21										
22	**OUT**									
23	FLOW OUT		Flow							
24	Stream flow out	(gpm)	5.2						-	Average base flow at BRSW-15
25	Average stream flow loss	(gpm)	13.6						-	Average base flow at BRSW-15
26	Groundwater flow out	(gpm)	14.2						*$GWFlow_{Out}$* (gpm) (See Equations 2 and 3)	Loss of surface water to groundwater plus seep 1 and seep 2
27	TOTAL OUT	(gpm)	33.0						-	Total water out (estimated through mass balance)
28									-	
29	DISSOLVED METALS CONCENTRATIONS OUT		cadmium	copper	iron	lead	manganese	zinc	-	
30	Concentration of dissolved metals in surface water out	C_{swout} (mg/L)	0.001	0.037	0.14	0.0026	0.47	0.033	-	Average base flow dissolved metals concentrations at BRSW-15
31	Concentration of dissolved metals in groundwater out	C_{gwout} (mg/L)	0.044	0.097	57.6	0.0047	40	2.18	-	Average base flow dissolved metal concentrations at LCGW-5, LCGW-12S, and LCGW-12D
32									-	
33	DISSOLVED METALS LOAD OUT								-	
34	Load out from surface water	L_{swout} (#/day)	0.000062	0.0023	0.0087	0.00016	0.029	0.0021	See Equation 2 = Load_Out(#/day)	
35	Load out from groundwater	L_{gwout} (#/day)	0.0074	0.016	9.8	0.00080	6.9	0.37		
36										
37	**NET (OUT-IN)**									Determine net increase in dissolved metals load at Carbonate Mine Site
38	Net dissolved metal load from surface water out	ΔL_{swout} (#/day)	-0.000168	0.0012	-0.0007	-0.00043	0.0263	-0.0003	-	Net increase in dissolved metals load at BRSW-15
39	Net dissolved metal load from groundwater out	ΔL_{gwout} (#/day)	0.0058	0.0151	8.9	0.0003	6.2	0.23	-	Net increase in dissolved metals load at Highway 200
40	Metals increase, out over in (percent)		529%	22222%	1101%	1951%	1015%	264%	-	Load of dissolved metals out divided by load of dissolved metals in
41	Metals increase out over in (x)		5 x	222 x	11 x	20 x	10 x	3 x		Mass of metals out divided by mass of metals in
42	**LOWER MARSH ATTENUATION**									Determine net dissolved metals removal efficiency on Groundwater Load Out
43	Wetlands Removal Efficiency (Dolhopf, 1988)	(%)	0.30%	14%	70%	100%	0.70%	5.8%	-	% Removal of dissolved metals from groundwater throughflow
44	Remaining Load to Blackfoot River	(#/day)	0.0074	0.0138	2.9	0	6.9	0.35	-	Remaining dissolved metals load mixed with baseflow Blackfoot River flows
45										
49	**ESTIMATED AFFECTS ON BLACKFOOT RIVER**									
50	Q									
51	Blackfoot River Baseflow	$Q_{baseflow}$ (cfs)	2.64						*$Baseflow_{BlackfootRiver}$* (See Equation 3)	Post Carbonate Remedial Action base flow
52		$Q_{baseflow}$ (gpm)	1,186							
53			cadmium	copper	iron	lead	manganese	zinc		
54	Net Increase in Blackfoot River Dissolved Metals Concentrations	ΔC_{sw} (mg/L)	0.00051	0.00095	0.204	-	0.47	0.024	See Equation 3	Increase in dissolved metal concentrations in Blackfoot river
55		ΔC_{sw} (µg/L)	0.51	0.95	204	-	475	24		
56	DEQ-7 Chronic Aquatic Std.	(µg/L)	0.097	2.85	1000	0.545		37	-	DEQ-7 standard at 25 mg/L hardness
57	Federal Secondary Drinking Water Std.	(µg/L)			300		50		-	
58	Hardness	(mg/L)				87.5			-	Average baseflow hardness at BRSW-31
59	Hardness Adjusted DEQ-7 Chronic Aquatic Std.	(µg/L)	0.25	8.3		2.68		107	-	Hardness adjusted in-stream standard (no adjustment for iron)
60			cadmium	copper	iron	lead	manganese	zinc	-	
61	**Percent increase of DEQ7 in Blackfoot River**		**209%**	**11%**	**20%**	**0%**	**No standard**	**23%**	-	**Net increase in DEQ-7 Standards in Blackfoot River**
62	**Percent increase of Federal Secondary Drinking Water Standards**		**-**	**-**	**68%**	**-**	**950%**	**-**	-	**Net percentage increase compared to Federal Secondary Drinking Water Standards**

Equations:

Equation 1:

$$\text{Load\_In}\left(\#/_{day}\right) = \left(GWflow_{in}\ {}^{gal}/_{min} \times 1440\ {}^{min}/_{day} \times \frac{3.785L}{1gal}\right) \times \left(\{COC\}\ {}^{mg}/_{L} \times \frac{1\ \#}{453{,}592mg}\right)$$

Equation 2:

$$\text{Load\_Out}\left(\#/_{day}\right) = \left(GWflow_{out}\ {}^{gal}/_{min} \times 1440\ {}^{min}/_{day} \times \frac{3.785L}{1gal}\right) \times \left(\{COC\}\ {}^{mg}/_{L} \times \frac{1\ \#}{453{,}592mg}\right)$$

Equation 3:

$$\{COC\}_{BlackfootRiver}\left({}^{mg}/_{L}\right) = \left(load_{Out}\ {}^{\#}/_{day} \times \frac{453{,}592mg}{1\#}\right) \div \left(\left(Baseflow_{BlackfootRiver}\,gpm + GWFlow_{Out}\right) \times 1440\ {}^{min}/_{day} \times \frac{1ft^3}{7.48gal} \times \frac{1\ L}{0.0353\ cf}\right)$$

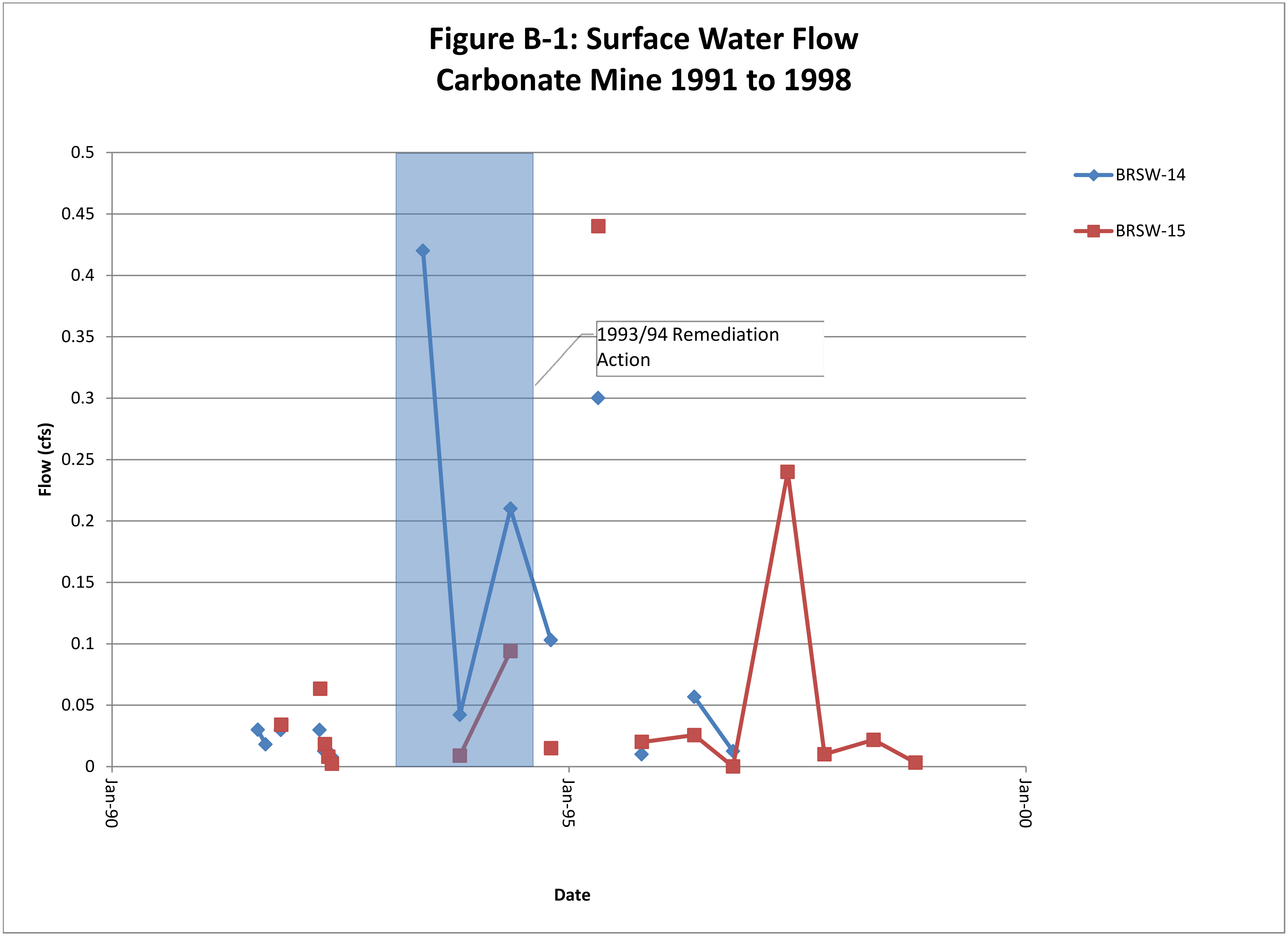
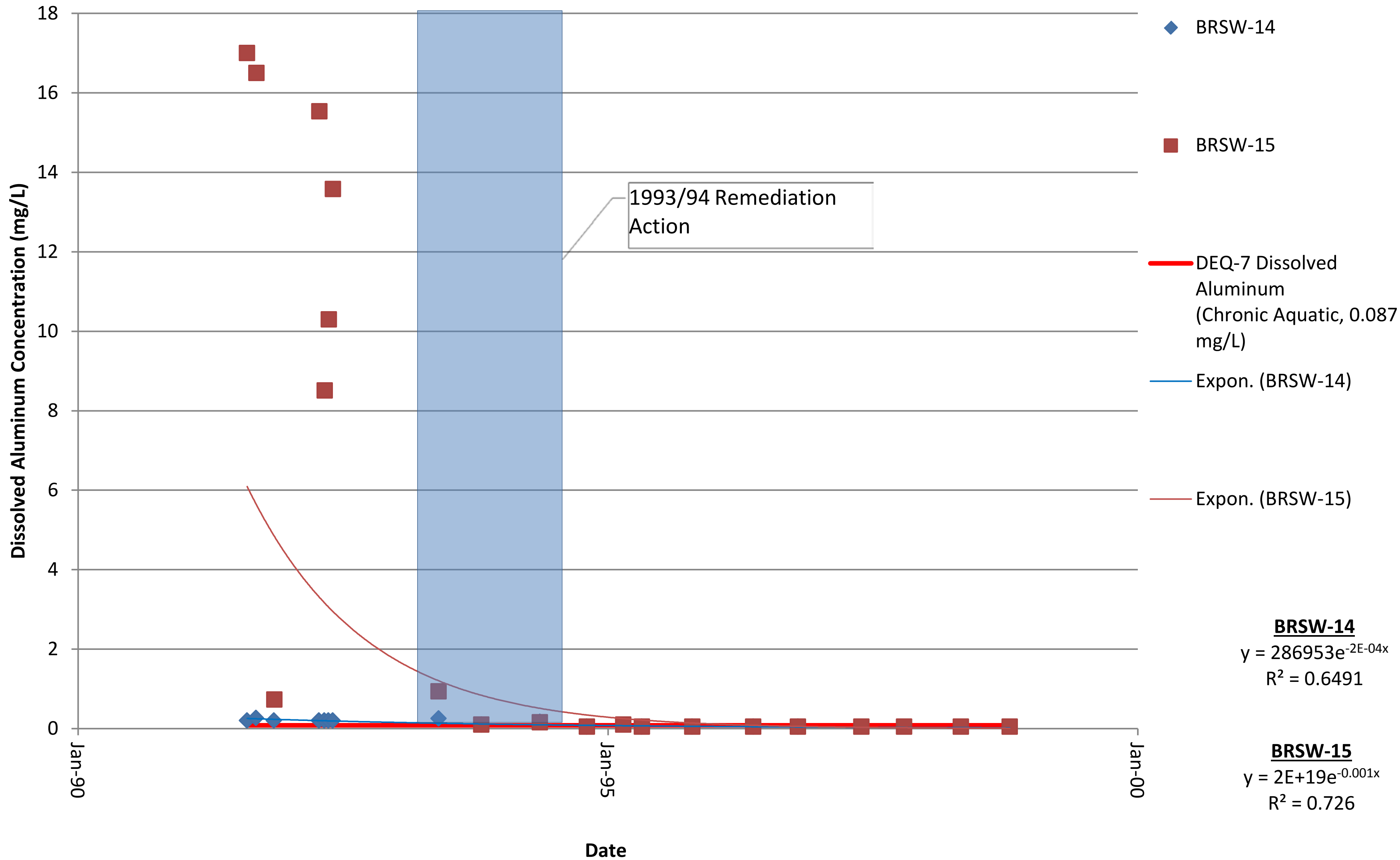


Figure B-1: Surface Water Flow
Carbonate Mine 1991 to 1998
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Flow (cfs)
1993/94 Remediation Action
Jan-90
Jan-95
Jan-00
Date
BRSW-14
BRSW-15

Figure B-2: Dissolved Aluminum Surface Water Concentrations Carbonate Mine 1991 to 1998



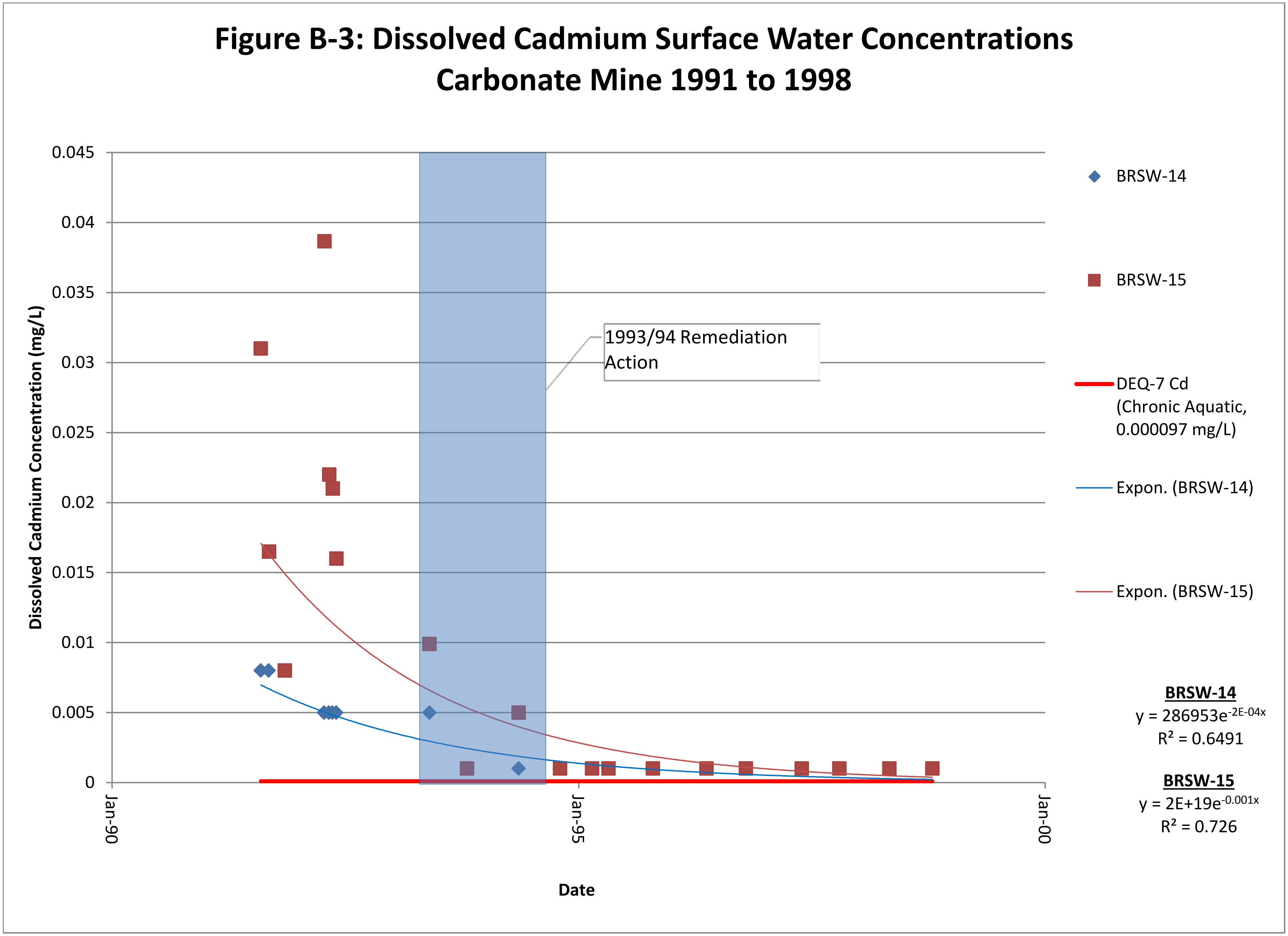


Figure B-3: Dissolved Cadmium Surface Water Concentrations
Carbonate Mine 1991 to 1998
Dissolved Cadmium Concentration (mg/L)
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
Jan-90
Jan-95
Jan-00
Date
1993/94 Remediation Action
BRSW-14
BRSW-15
DEQ-7 Cd (Chronic Aquatic, 0.000097 mg/L)
Expon. (BRSW-14)
Expon. (BRSW-15)
BRSW-14
y = 286953e^-2E-04x
R² = 0.6491
BRSW-15
y = 2E+19e^-0.001x
R² = 0.726

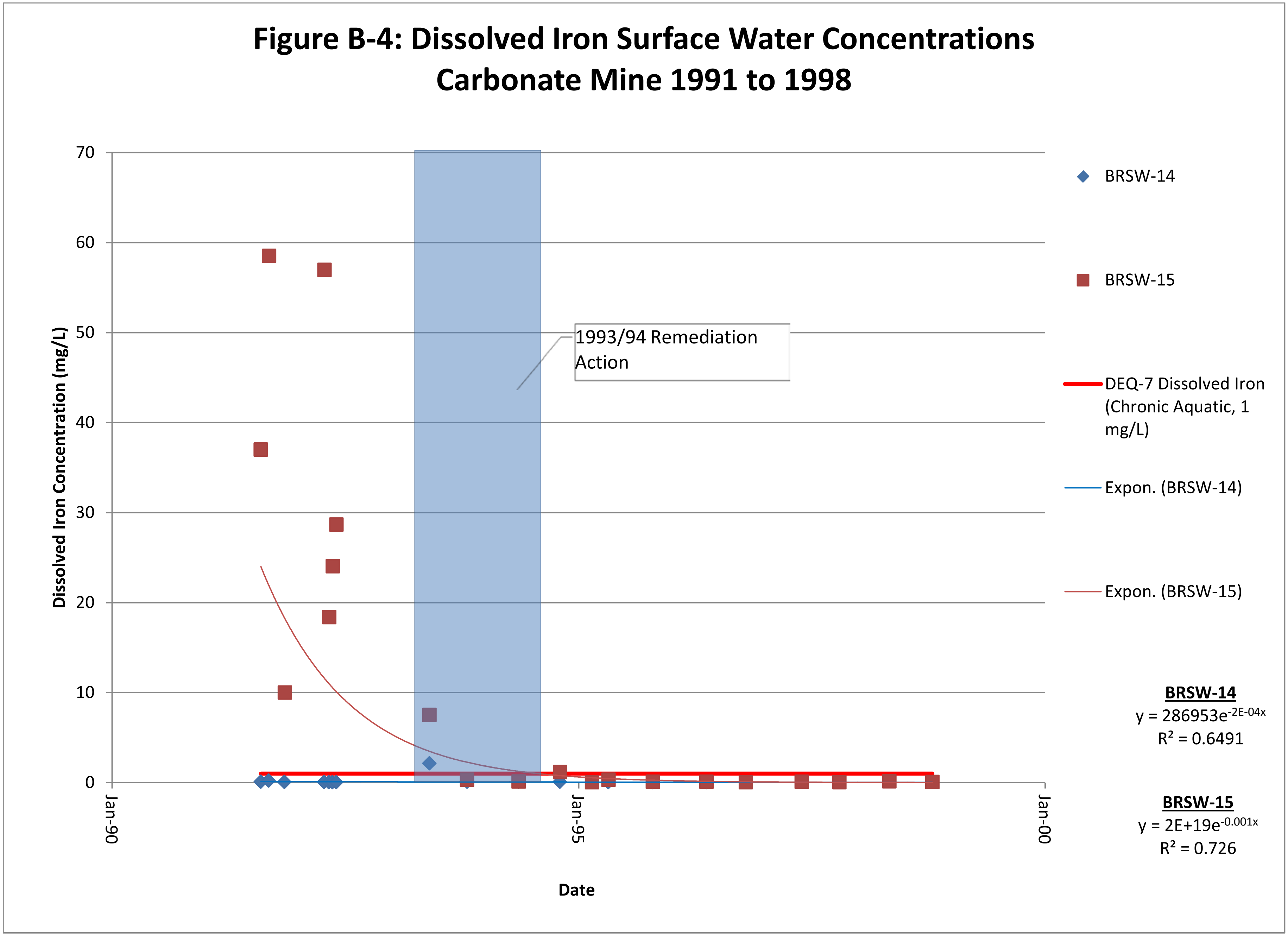


Figure B-4: Dissolved Iron Surface Water Concentrations
Carbonate Mine 1991 to 1998
Dissolved Iron Concentration (mg/L)
70
60
50
40
30
20
10
0
Jan-90
Jan-95
Jan-00
Date
1993/94 Remediation Action
BRSW-14
BRSW-15
DEQ-7 Dissolved Iron (Chronic Aquatic, 1 mg/L)
Expon. (BRSW-14)
Expon. (BRSW-15)
BRSW-14
y = 286953e-2E-04x
R² = 0.6491
BRSW-15
y = 2E+19e-0.001x
R² = 0.726

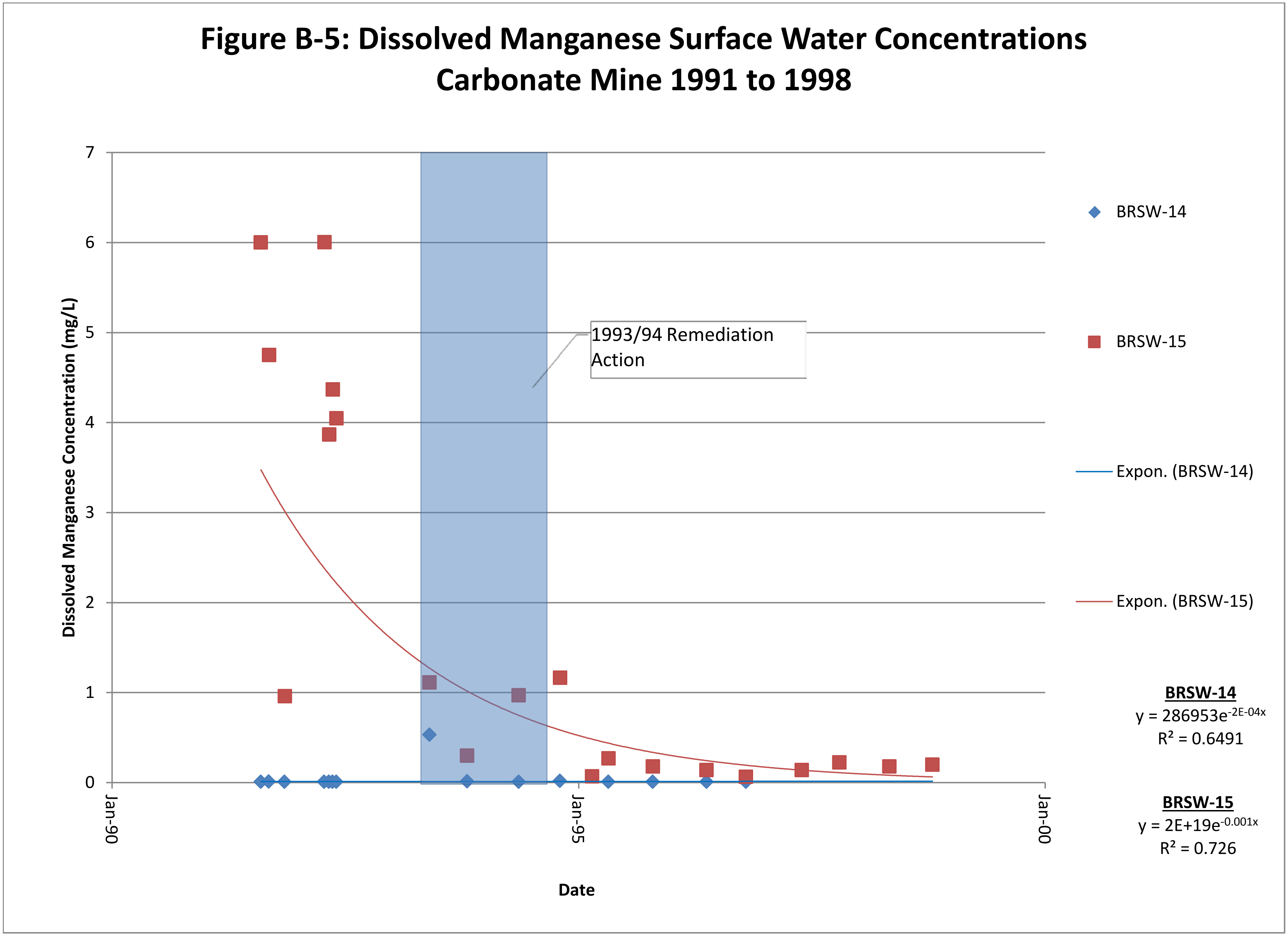


Figure B-5: Dissolved Manganese Surface Water Concentrations
Carbonate Mine 1991 to 1998
Dissolved Manganese Concentration (mg/L)
7
6
5
4
3
2
1
0
Jan-90
Jan-95
Jan-00
Date
1993/94 Remediation Action
BRSW-14
BRSW-15
Expon. (BRSW-14)
Expon. (BRSW-15)
BRSW-14
y = 286953e^-2E-04x
R² = 0.6491
BRSW-15
y = 2E+19e^-0.001x
R² = 0.726

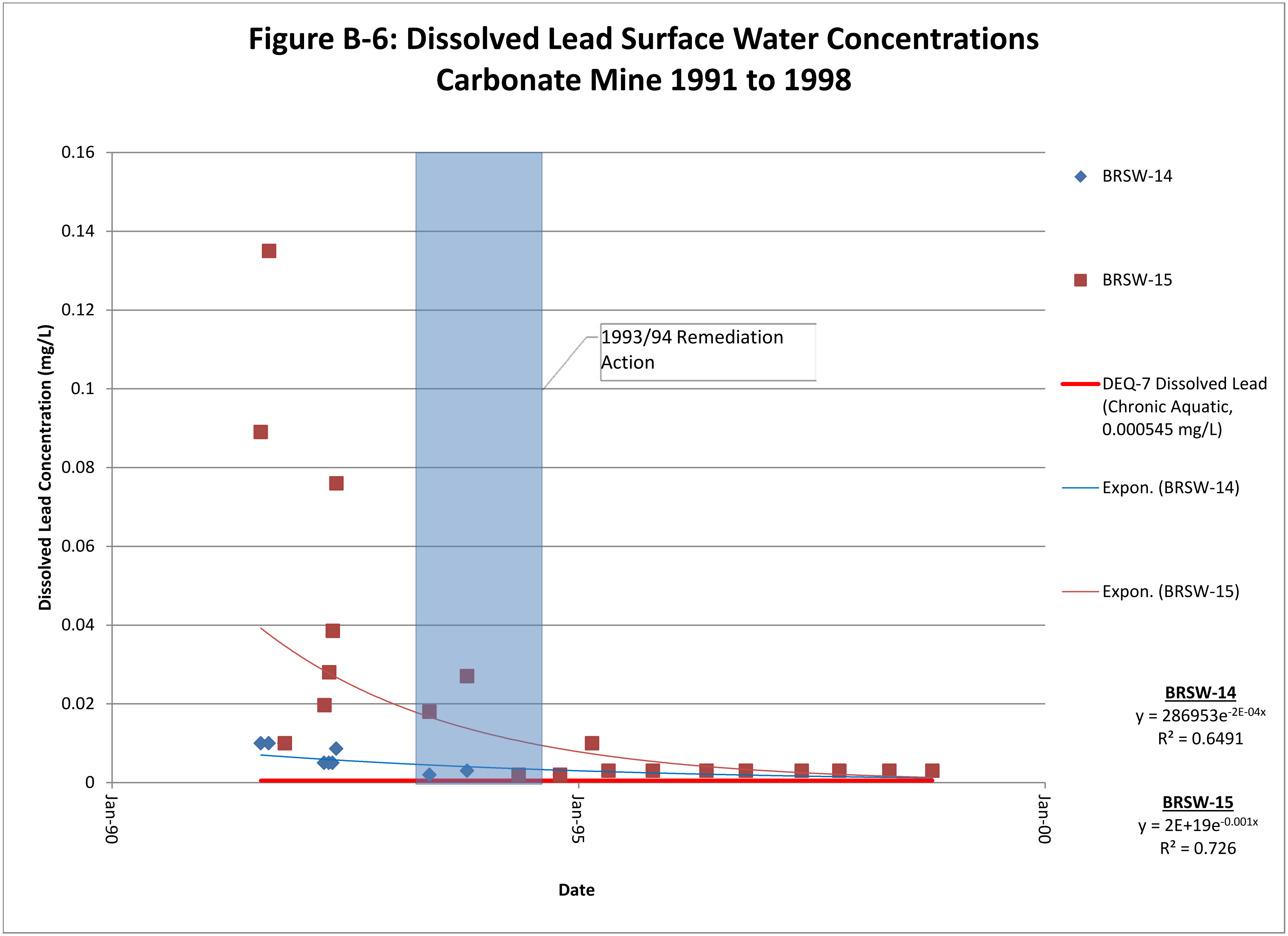


Figure B-6: Dissolved Lead Surface Water Concentrations
Carbonate Mine 1991 to 1998
Dissolved Lead Concentration (mg/L)
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Jan-90
Jan-95
Jan-00
Date
1993/94 Remediation Action
BRSW-14
BRSW-15
DEQ-7 Dissolved Lead (Chronic Aquatic, 0.000545 mg/L)
Expon. (BRSW-14)
Expon. (BRSW-15)
BRSW-14
y = 286953e^-2E-04x
R² = 0.6491
BRSW-15
y = 2E+19e^-0.001x
R² = 0.726

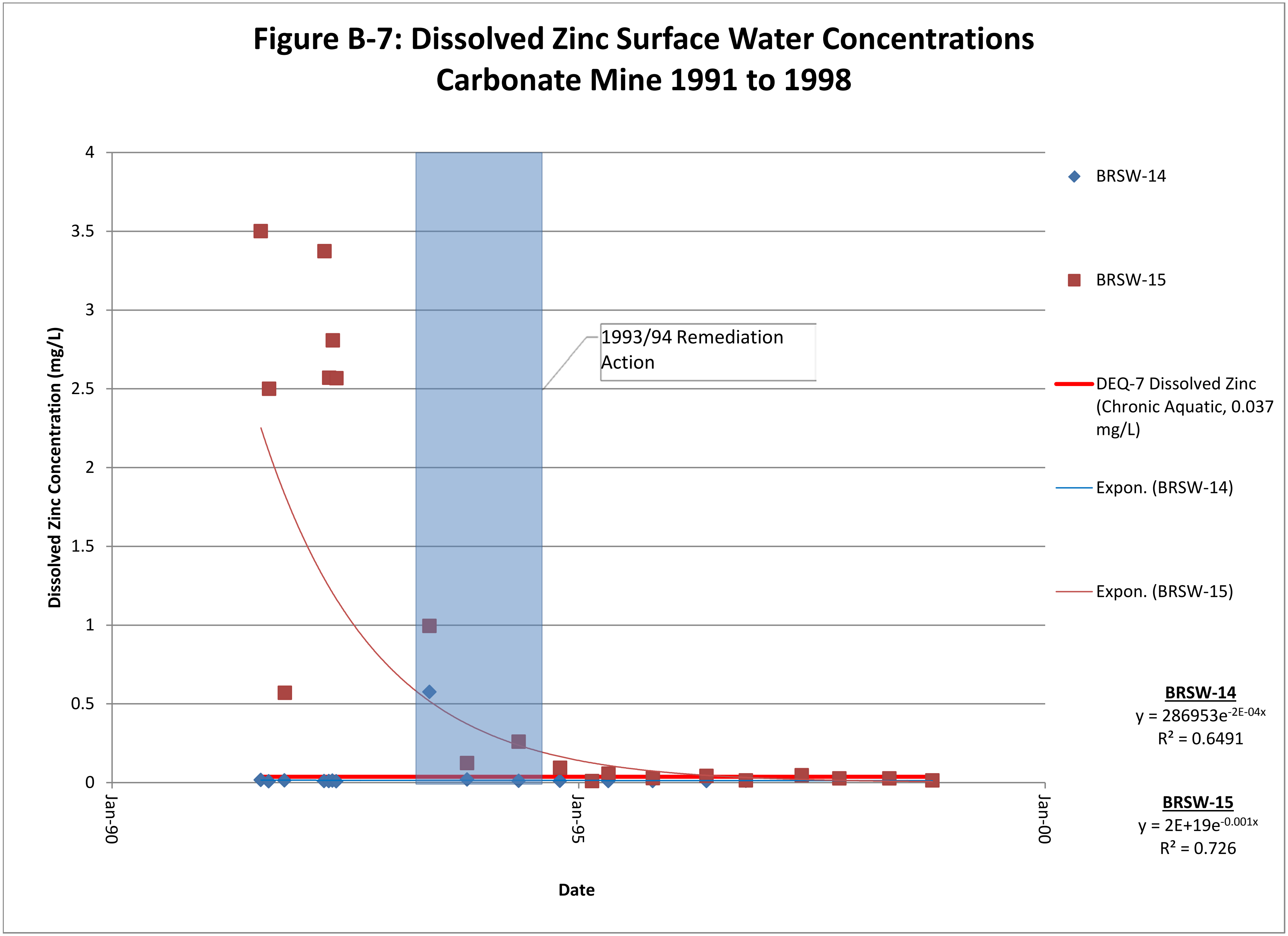


Figure B-7: Dissolved Zinc Surface Water Concentrations
Carbonate Mine 1991 to 1998
Dissolved Zinc Concentration (mg/L)
4
3.5
3
2.5
2
1.5
1
0.5
0
Jan-90
Jan-95
Jan-00
Date
1993/94 Remediation Action
BRSW-14
BRSW-15
DEQ-7 Dissolved Zinc (Chronic Aquatic, 0.037 mg/L)
Expon. (BRSW-14)
Expon. (BRSW-15)
BRSW-14
y = 286953e-2E-04x
R² = 0.6491
BRSW-15
y = 2E+19e-0.001x
R² = 0.726

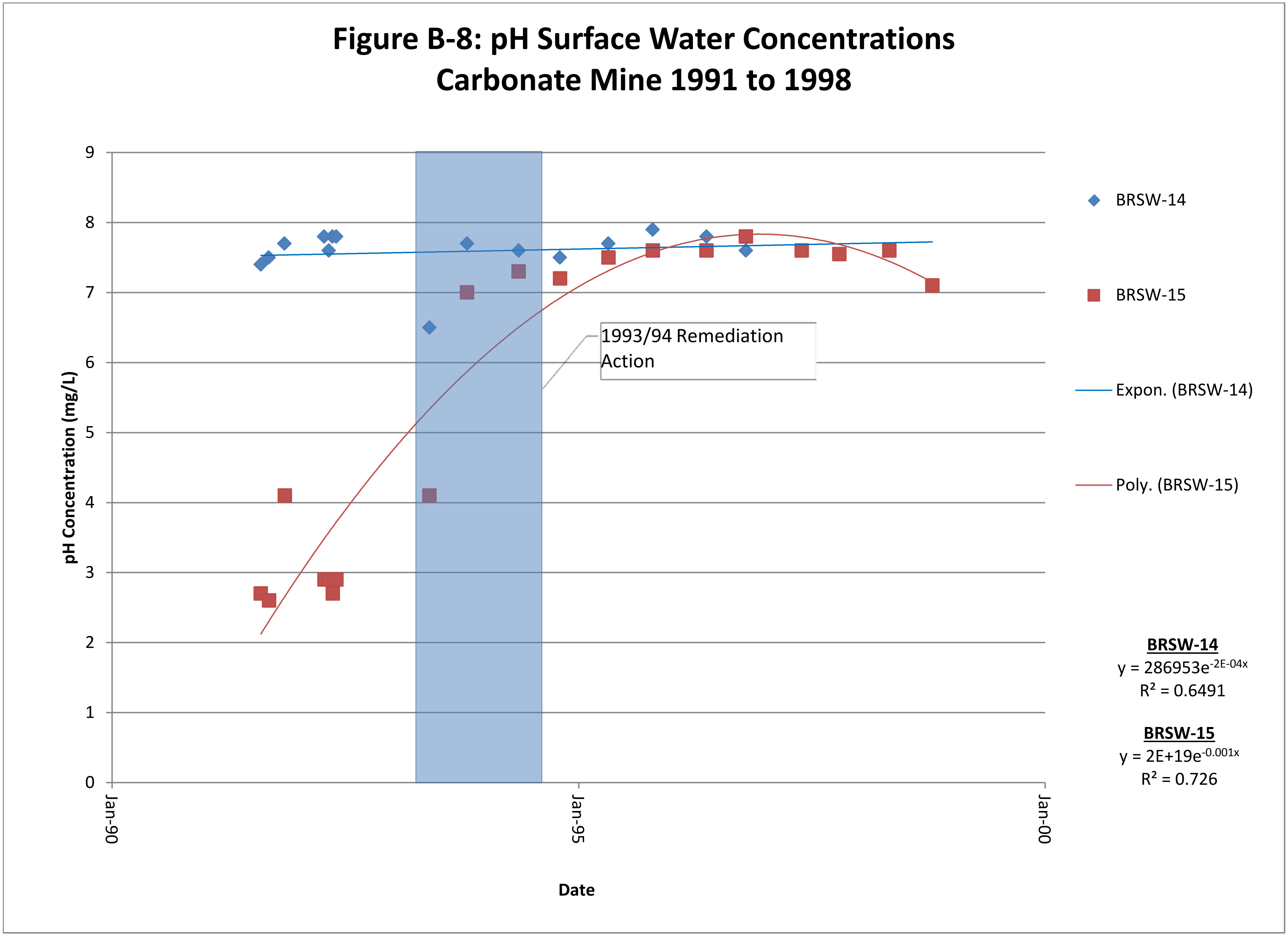


Figure B-8: pH Surface Water Concentrations
Carbonate Mine 1991 to 1998
pH Concentration (mg/L)
9
8
7
6
5
4
3
2
1
0
Jan-90
Jan-95
Jan-00
Date
1993/94 Remediation Action
BRSW-14
BRSW-15
Expon. (BRSW-14)
Poly. (BRSW-15)
BRSW-14
y = 286953e^-2E-04x
R² = 0.6491
BRSW-15
y = 2E+19e^-0.001x
R² = 0.726

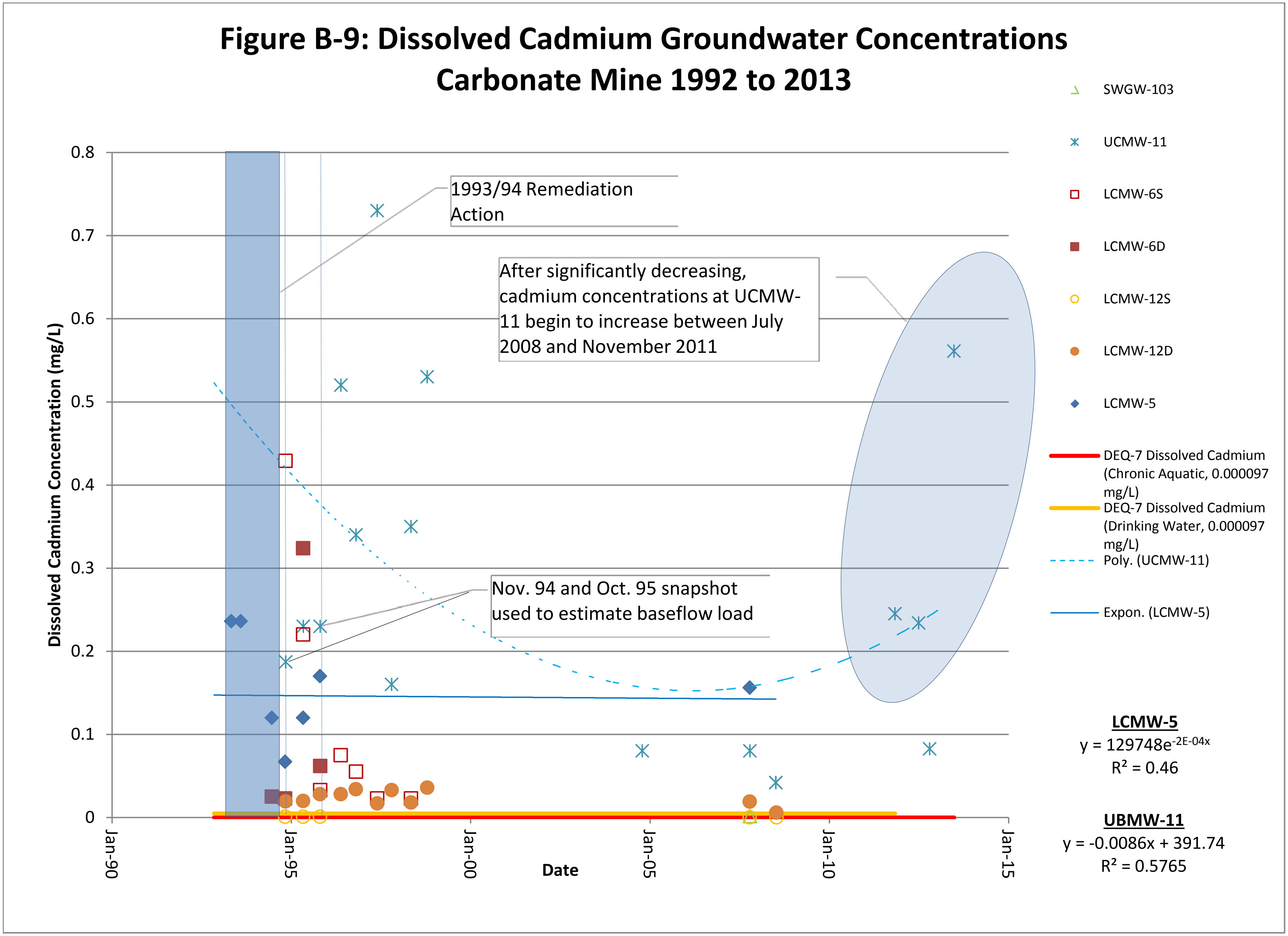


Figure B-9: Dissolved Cadmium Groundwater Concentrations
Carbonate Mine 1992 to 2013
Dissolved Cadmium Concentration (mg/L)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Jan-90
Jan-95
Jan-00
Jan-05
Jan-10
Jan-15
Date
1993/94 Remediation Action
After significantly decreasing, cadmium concentrations at UCMW-11 begin to increase between July 2008 and November 2011
Nov. 94 and Oct. 95 snapshot used to estimate baseflow load
SWGW-103
UCMW-11
LCMW-6S
LCMW-6D
LCMW-12S
LCMW-12D
LCMW-5
DEQ-7 Dissolved Cadmium (Chronic Aquatic, 0.000097 mg/L)
DEQ-7 Dissolved Cadmium (Drinking Water, 0.000097 mg/L)
Poly. (UCMW-11)
Expon. (LCMW-5)
LCMW-5
y = 129748e^-2E-04x
R² = 0.46
UBMW-11
y = -0.0086x + 391.74
R² = 0.5765

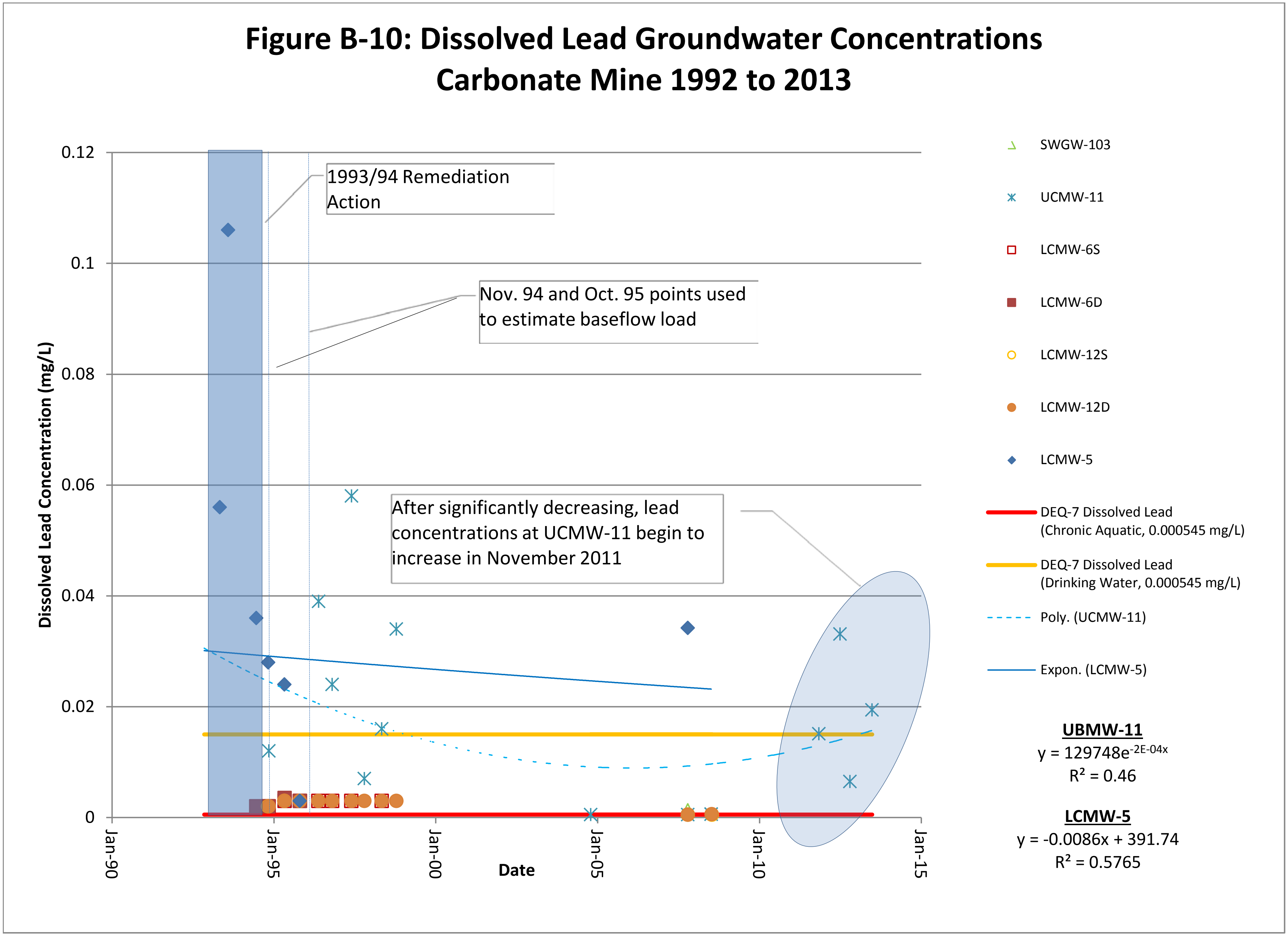


Figure B-10: Dissolved Lead Groundwater Concentrations
Carbonate Mine 1992 to 2013
0.12
0.1
0.08
0.06
0.04
0.02
0
Dissolved Lead Concentration (mg/L)
Jan-90
Jan-95
Jan-00
Jan-05
Jan-10
Jan-15
Date
1993/94 Remediation Action
Nov. 94 and Oct. 95 points used to estimate baseflow load
After significantly decreasing, lead concentrations at UCMW-11 begin to increase in November 2011
SWGW-103
UCMW-11
LCMW-6S
LCMW-6D
LCMW-12S
LCMW-12D
LCMW-5
DEQ-7 Dissolved Lead (Chronic Aquatic, 0.000545 mg/L)
DEQ-7 Dissolved Lead (Drinking Water, 0.000545 mg/L)
Poly. (UCMW-11)
Expon. (LCMW-5)
UBMW-11
y = 129748e^-2E-04x
R² = 0.46
LCMW-5
y = -0.0086x + 391.74
R² = 0.5765

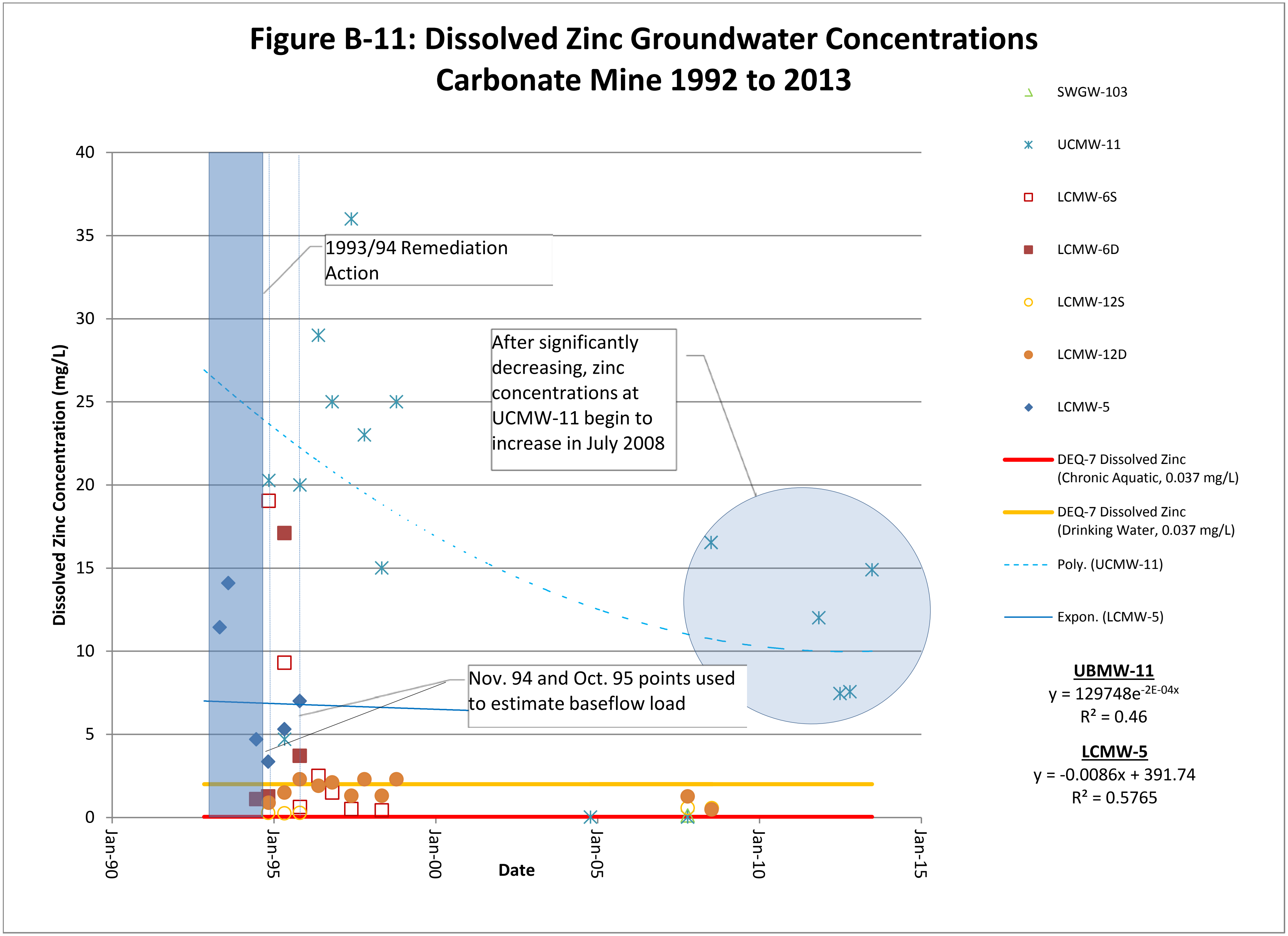


Figure B-11: Dissolved Zinc Groundwater Concentrations
Carbonate Mine 1992 to 2013
Dissolved Zinc Concentration (mg/L)
40
35
30
25
20
15
10
5
0
Jan-90
Jan-95
Jan-00
Jan-05
Jan-10
Jan-15
Date
1993/94 Remediation Action
After significantly decreasing, zinc concentrations at UCMW-11 begin to increase in July 2008
Nov. 94 and Oct. 95 points used to estimate baseflow load
SWGW-103
UCMW-11
LCMW-6S
LCMW-6D
LCMW-12S
LCMW-12D
LCMW-5
DEQ-7 Dissolved Zinc (Chronic Aquatic, 0.037 mg/L)
DEQ-7 Dissolved Zinc (Drinking Water, 0.037 mg/L)
Poly. (UCMW-11)
Expon. (LCMW-5)
UBMW-11
y = 129748e^-2E-04x
R² = 0.46
LCMW-5
y = -0.0086x + 391.74
R² = 0.5765

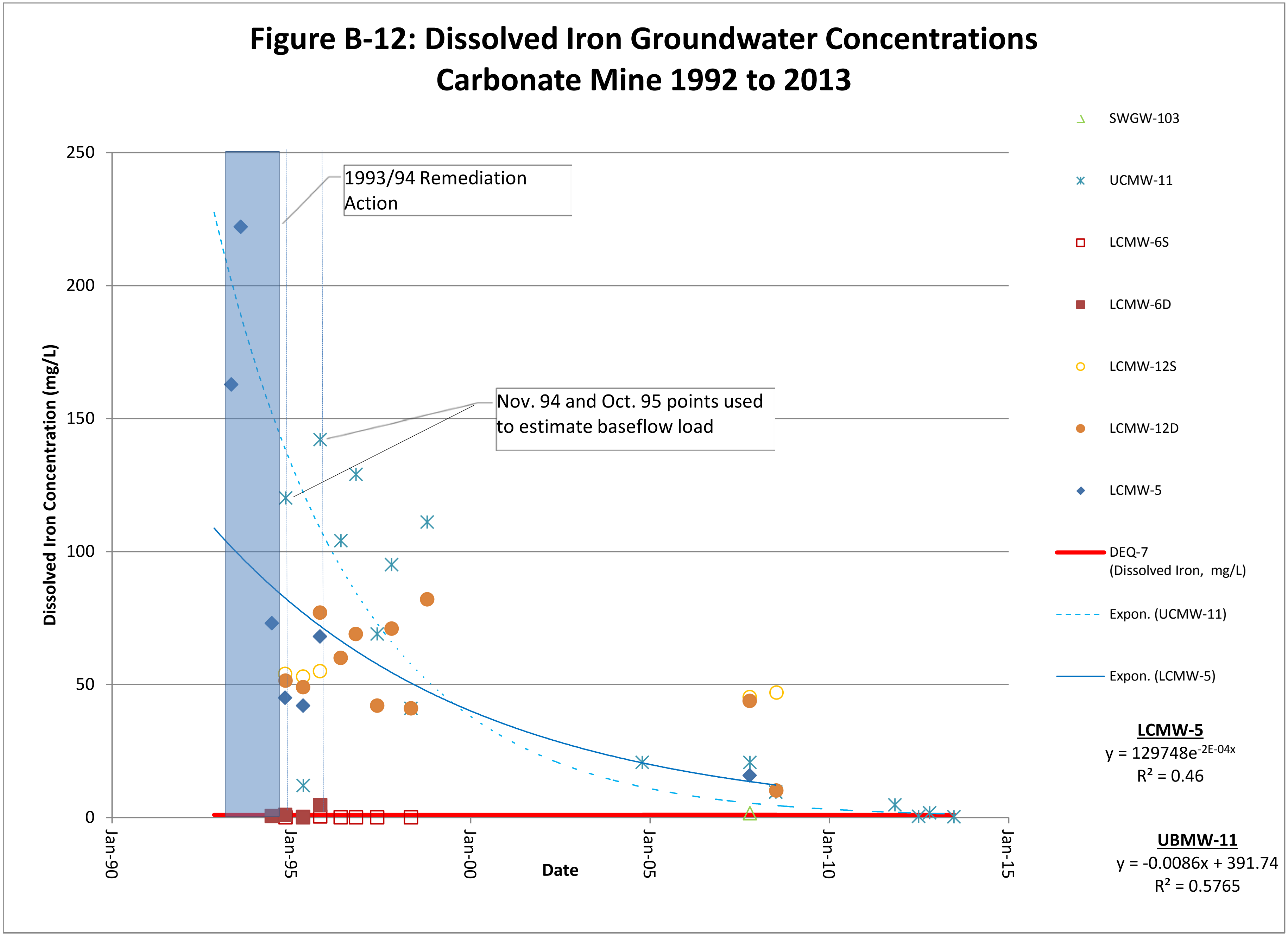


Figure B-12: Dissolved Iron Groundwater Concentrations
Carbonate Mine 1992 to 2013
1993/94 Remediation Action
Nov. 94 and Oct. 95 points used to estimate baseflow load
Dissolved Iron Concentration (mg/L)
250
200
150
100
50
0
Jan-90
Jan-95
Jan-00
Jan-05
Jan-10
Jan-15
Date
SWGW-103
UCMW-11
LCMW-6S
LCMW-6D
LCMW-12S
LCMW-12D
LCMW-5
DEQ-7 (Dissolved Iron, mg/L)
Expon. (UCMW-11)
Expon. (LCMW-5)
LCMW-5
y = 129748e^-2E-04x
R² = 0.46
UBMW-11
y = -0.0086x + 391.74
R² = 0.5765

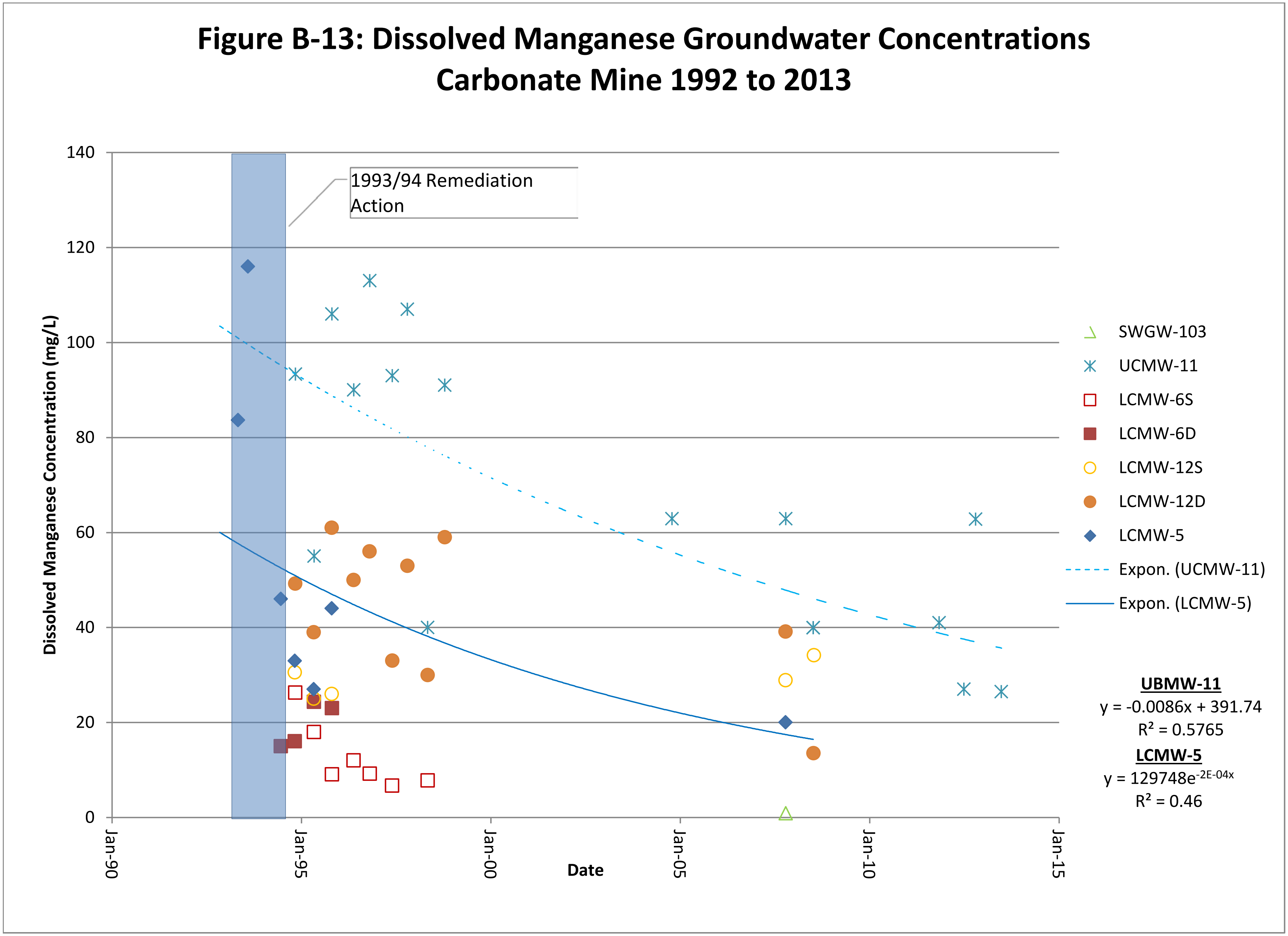


Figure B-13: Dissolved Manganese Groundwater Concentrations
Carbonate Mine 1992 to 2013
1993/94 Remediation Action
Dissolved Manganese Concentration (mg/L)
140
120
100
80
60
40
20
0
Jan-90
Jan-95
Jan-00
Jan-05
Jan-10
Jan-15
Date
SWGW-103
UCMW-11
LCMW-6S
LCMW-6D
LCMW-12S
LCMW-12D
LCMW-5
Expon. (UCMW-11)
Expon. (LCMW-5)
UBMW-11
y = -0.0086x + 391.74
R² = 0.5765
LCMW-5
y = 129748e-2E-04x
R² = 0.46

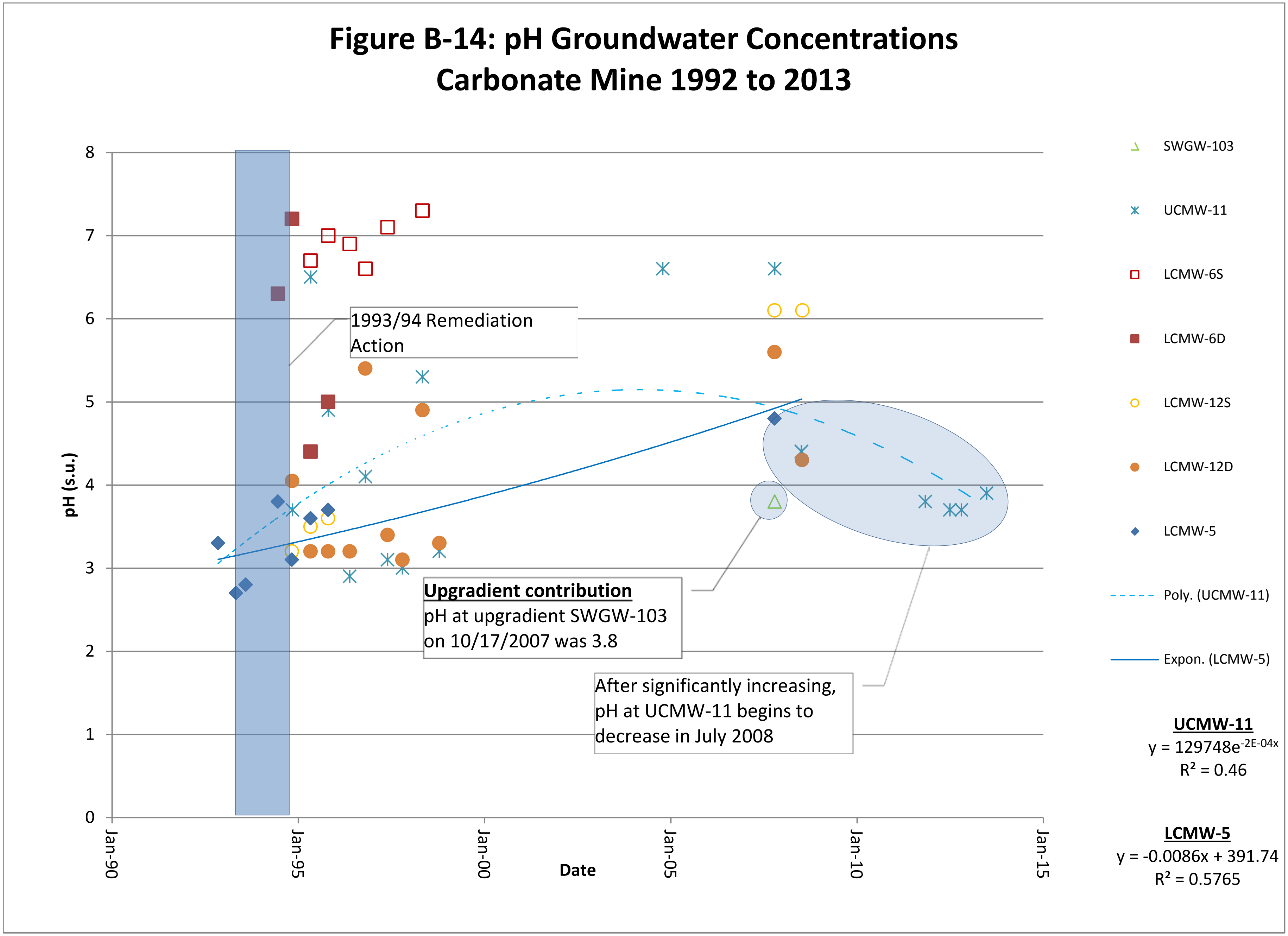
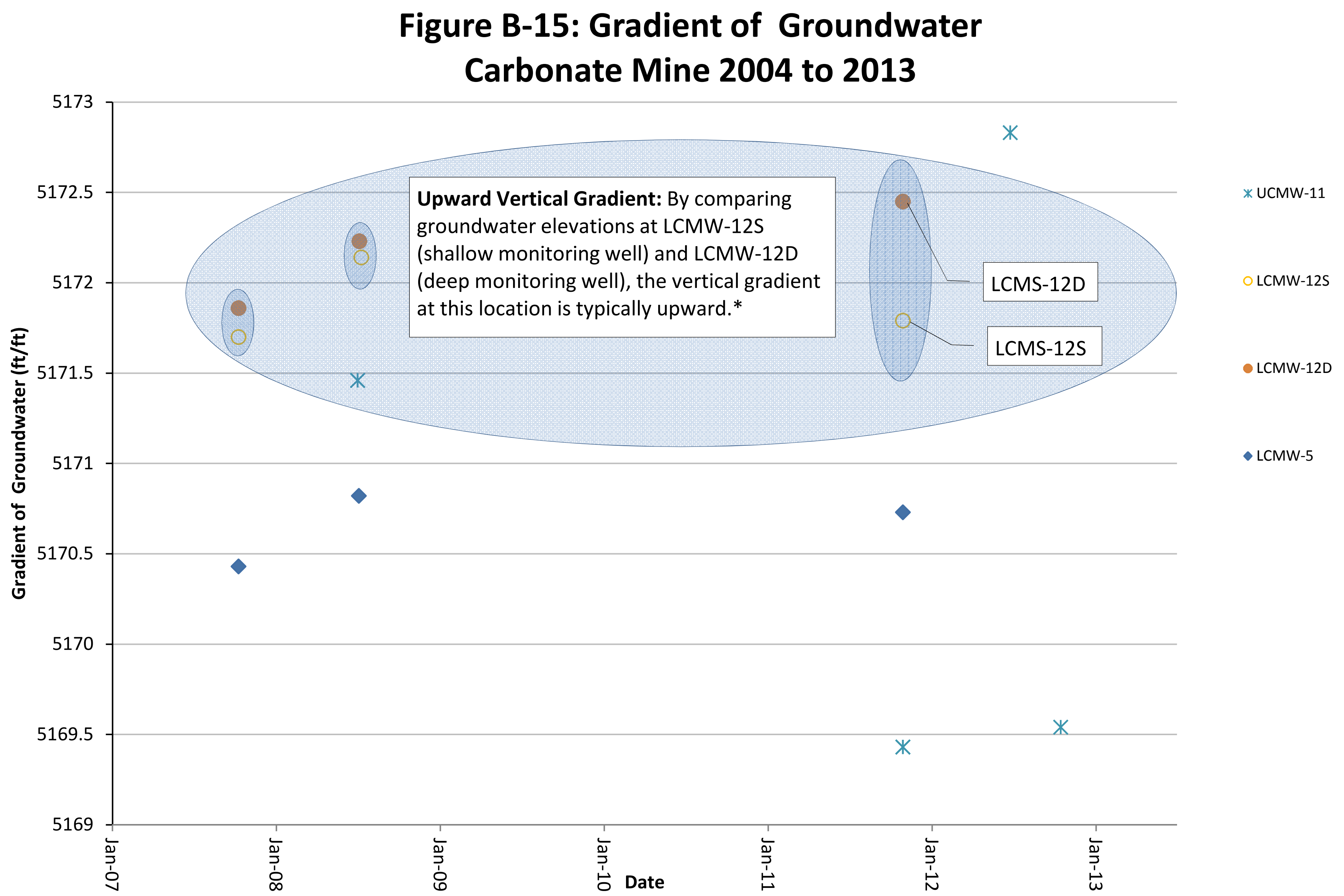


Figure B-14: pH Groundwater Concentrations
Carbonate Mine 1992 to 2013
pH (s.u.)
8
7
6
5
4
3
2
1
0
Jan-90
Jan-95
Jan-00
Jan-05
Jan-10
Jan-15
Date
1993/94 Remediation Action
Upgradient contribution
pH at upgradient SWGW-103 on 10/17/2007 was 3.8
After significantly increasing, pH at UCMW-11 begins to decrease in July 2008
SWGW-103
UCMW-11
LCMW-6S
LCMW-6D
LCMW-12S
LCMW-12D
LCMW-5
Poly. (UCMW-11)
Expon. (LCMW-5)
UCMW-11
y = 129748e^-2E-04x
R² = 0.46
LCMW-5
y = -0.0086x + 391.74
R² = 0.5765



*Vertical gradient refers to the potential for groundwater to move upwards or downwards within an aquifer (or between two aquifers). At LCMW-12S and -12D, the groundwater elevation in the deeper well (LCMW-12D) is typically higher than in the shallower well (LCMW-12S), indicating higher pressure in the deeper portion of the aquifer than in the shallower portion. Because water (and all things affected by energy) flows from areas of high pressure to low pressure, groundwater from the deeper aquifer has the potential to flow upward toward the shallower aquifer, and is refered to as an "upward gradient."

Figure B-16: Location of Surface Water Stations Adjacent to the Carbonate Mine Site

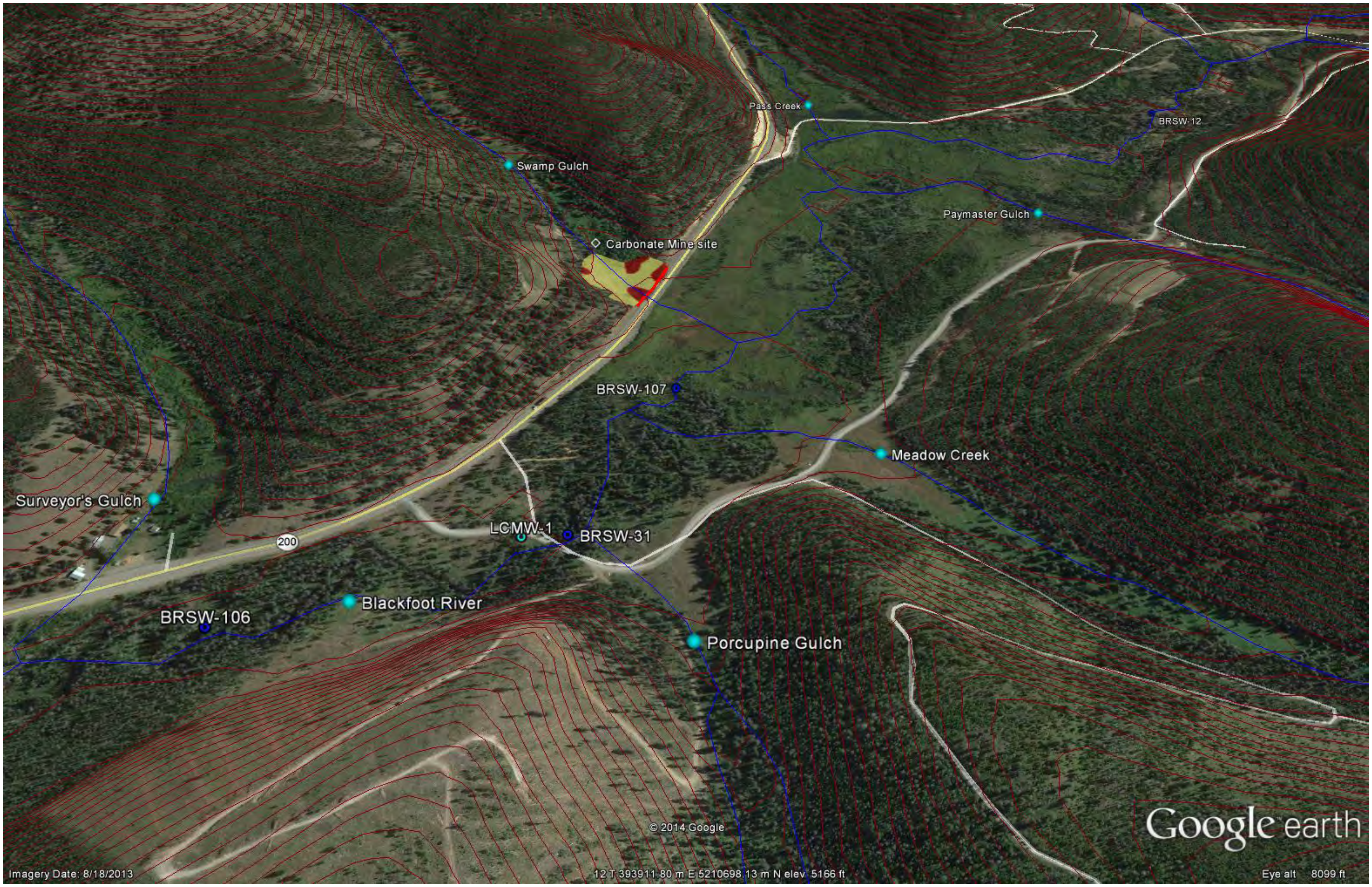


Figure B-17: Downgradient Mixing Zone – Carbonate Mine Site

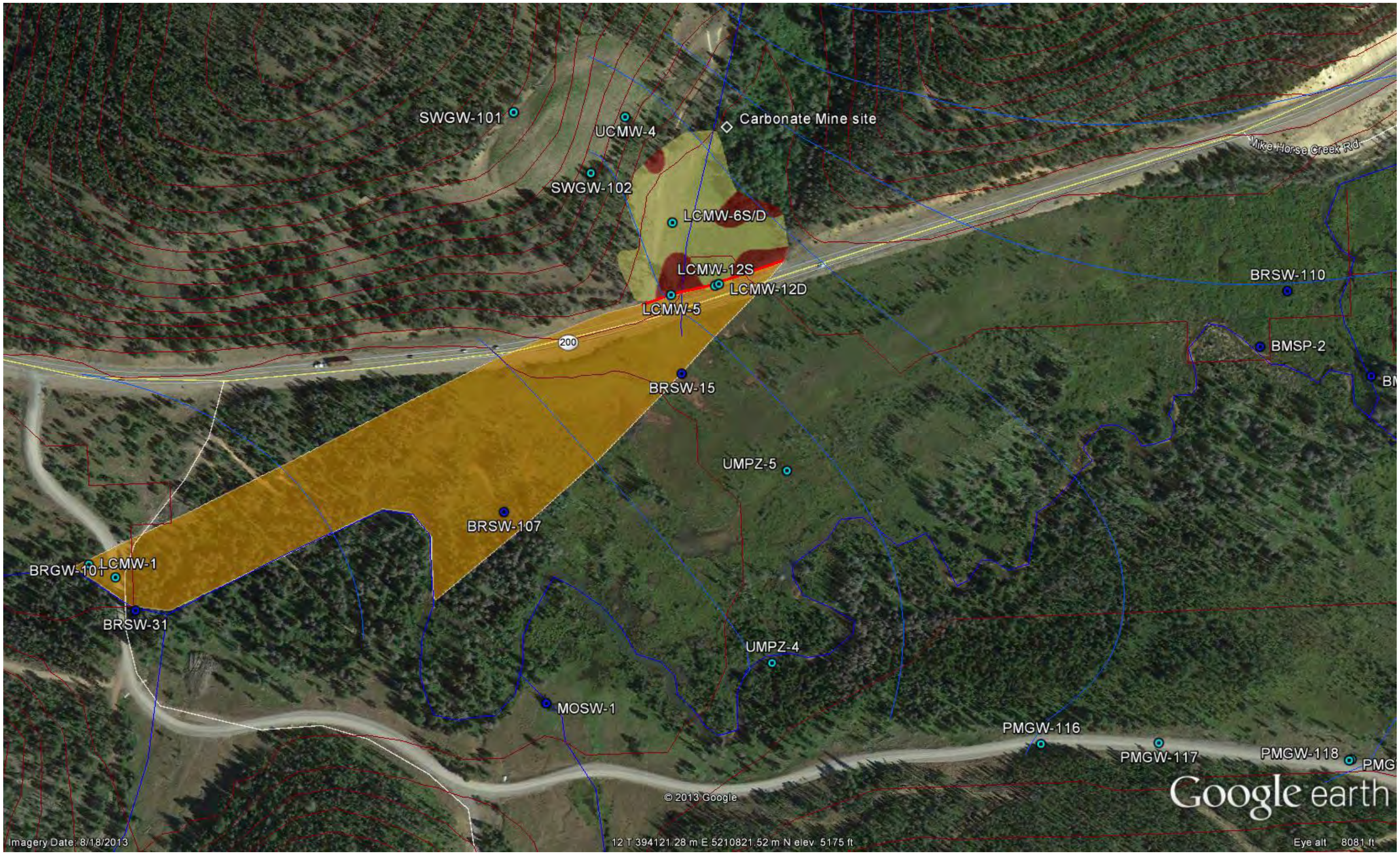
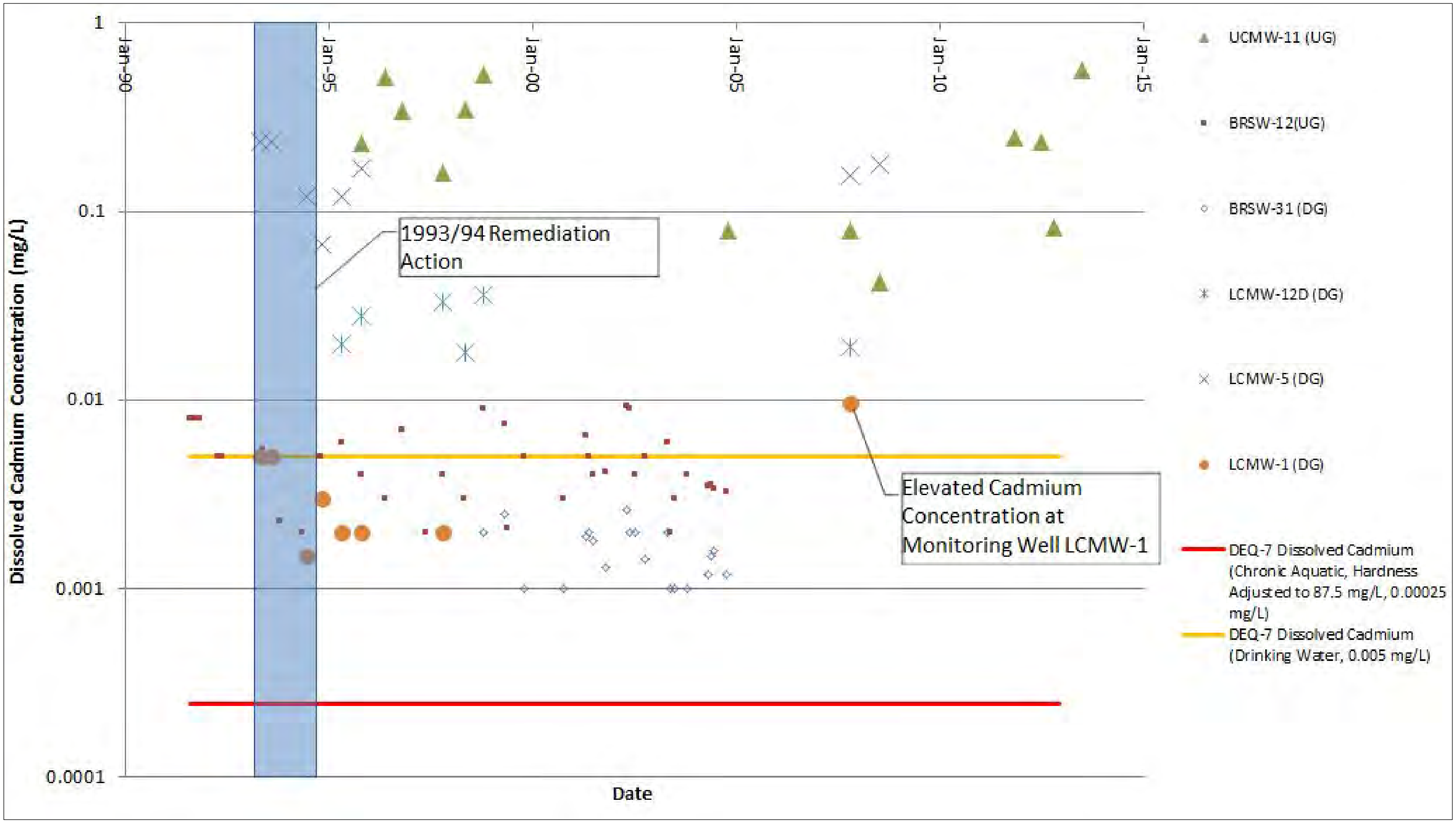


Figure B-18: Cadmium Concentrations At and Downgradient of the Carbonate Mine Site



HYDROMETRICS INC.

Consulting Scientists and Engineers
2727 Airport Rd. Helena Mt, 59601

WELL LOG AND CONSTRUCTION DIAGRAM

Hole Name: LCMW-12D

State: Montana	County: Lewis and Clark	Date Hole Started: 10/26/94	Date Hole Finished: 10/26/94

Project: Upper Blackfoot
Legal Description:
Descriptive Location: In wetlands reclaim area at Lower Carbon
Recorded By: WR Wilson
Drilling Company: H&L
Driller: M Miller
Drilling Method: Air Rotary
Drilling Fluids Used: Water
Pilot Hole Dia: 8-inch   Reamed Hole Dia: 8-inch
Total Depth Drilled: 30.00   Total Depth Reamed: 30.00
Purpose of Hole: Install monitoring Well
Purpose of Well: Water Quality Sampling
Target Aquifer: Alluvium Below Reclaim

	Y/N	TYPE-DESCRIPTION
Well Installed?	Y	4-inch, Flush Thread, PVC
Surface Casing Used?	Y	8-inch PVC
Casing Perforated?	N	
Screen Used?	Y	0.020 slot, PVC
Well Developed?	Y	Submersible pump
Well Yield Tested?	N	
Water Samples Taken?	Y	Water Quality Samples
Boring Samples Taken?	N	

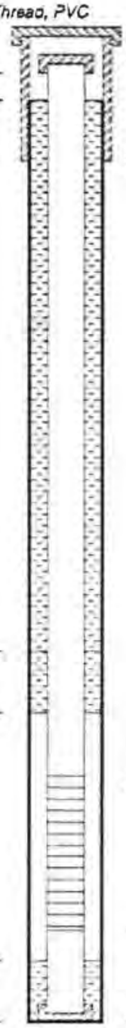
Static Water Level: 1.35   Date: 10/26/94
Well Seal Description: 10/20 Sand Pack; Bentonite Chips
MP Description: Top of PVC   Measuring Point (MP) Elevation: 5167.04
MP Height Above or Below Ground? (+ / -) : +1.0

Remarks: Color notation (10YR 5/4) from Munsel Color System
Material size fraction percentages based on field visual estimates
PVC surface casings used to provide break-away stickup next to highway

Well Construction

Elev Top of Surface Casing: Ground Surface Elev:
Elev Top of Riser:
Borehole Dia: 8-inch

Riser Type: 4-inch, Flush Thread, PVC



Locking Lid — Top Sur. Case. +
8-inch PVC — Top of Well +
0.00 Bentonite Chips — Ground Surface 0.00
▼ 1.35
Bottom of Surface Casing 2.00
18.00 Bentonite Pellets
20.00 10/20 Silica Sand
0.020 Slot, PVC 22.00
27.00
28.00 Bentonite Chips
30.00 — Bottom of Hole 30.00

GRAPHICS

Geological Description and Notes

0.00
Clayey Gravel; 10YR 5/2, Grayish Brown
Gravel 60% fine to coarse, subrounded; Fines 30% Clay, non plastic, soft; Sand 10% fine to coarse; Soft; Moist
[Fill Material for Drill Pad]

4.00
Clayey Gravel; 10YR 2/1, Black
Gravel 50%, fine to coarse, subrounded to rounded argillite; Fines 40% Clay, low plasticity, soft, mottled, reduced; Sand 10% fine; Very Soft; Wet
[Reduced Marsh Alluvium]

17.00
Clayey Gravel with Sand, 10YR 5/4, Yellowish Brown
Gravel 40%, fine to medium, subrounded to rounded igneous and argillitic; Fines 40% Clay, low plasticity, soft; Sand 20% fine to coarse; Medium Dense, Wet
[Alluvium]

30.00

HYDROMETRICS INC.
Consulting Scientists and Engineers
2727 Airport Rd. Helena Mt, 59601

WELL LOG AND CONSTRUCTION DIAGRAM

Hole Name: LCMW-12S

State: Montana | County: Lewis and Clark | Date Hole Started: 10/26/94 | Date Hole Finished: 10/26/94

Project: Upper Blackfoot
Legal Description:
Descriptive Location: In wetlands reclaim area at Lower Carbon
Recorded By: WR Wilson
Drilling Company: H&L
Driller: M Miller
Drilling Method: Air Rotary
Drilling Fluids Used: Water
Pilot Hole Dia: 8-inch   Reamed Hole Dia: 8-inch
Total Depth Drilled: 17.00   Total Depth Reamed: 17.00
Purpose of Hole: Install monitoring Well
Purpose of Well: Water Quality Sampling
Target Aquifer: Alluvium Below Reclaim

	Y/N	TYPE-DESCRIPTION
Well Installed?	Y	4-inch, Flush Thread, PVC
Surface Casing Used?	Y	8-inch PVC
Casing Perforated?	N	
Screen Used?	Y	0.020 slot, PVC
Well Developed?	Y	Submersible pump
Well Yield Tested?	N	
Water Samples Taken?	Y	Water Quality Samples
Boring Samples Taken?	N	

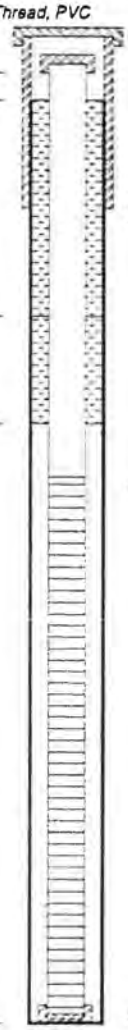
Static Water Level: 1.94   Date: 10/26/94
Well Seal Description: 10/20 Sand Pack; Bentonite Chips
MP Description: Top of PVC   Measuring Point (MP) Elevation: 5167.59
MP Height Above or Below Ground? (+/-) : +1.0

Remarks: Color notation (10YR 5/4) from Munsel Color System
Material size fraction percentages based on field visual estimates
PVC surface casings used to provide break-away stickup next to highway

Well Construction

Elev Top of Surface Casing: Ground Surface Elev:
Elev Top of Riser:
Borehole Dia: 8-inch

Riser Type: 4-inch, Flush Thread, PVC



Locking Lid
8-inch PVC
Top Sur. Case. +0.00
Top of Well +0.00
0.00 Bentonite Chips
Ground Surface 0.00
▼ 1.94
Bottom of Surface Casing 2.00
4.00 Bentonite Pellets
6.00 10/20 Silica Sand
0.020 Slot, PVC 7.00
17.00
Bottom of Hole 17.00

GRAPHICS

Geological Description and Notes

0.00
Clayey Gravel; 10YR 5/2, Grayish Brown
Gravel 60% fine to coarse, subrounded; Fines 30% Clay, non plastic, soft
Sand 10% fine to coarse; Soft; Moist
[Fill Material for Drill Pad]

4.00
Clayey Gravel; 10YR 2/1, Black
Gravel 50%, fine to coarse, subrounded to rounded argillite; Fines 40% Clay, low plasticity, soft, mottled, reduced; Sand 10% fine; Very Soft; Wet
[Reduced Marsh Alluvium]

17.00

TETRA TECH, INC.

MONITORING WELL LITHOLOGIC AND COMPLETION LOG

JOB NO: 7561589   WELL NO: PDGW-102

PROJECT: UBMC   STATE: MT   COUNTY: Lewis&Clark   LOGGED BY: D May

LEGAL LOCATION: T 15N R 6W S 20 TRACT   DESCRIPTIVE LOCATION: 1/5 Mile N of M Horse Road up Pass Creek

DATE STARTED: 7/25/2008   DATE COMPLETED: 7/25/2008   DRILLING CO. & DRILLER: Boland/James

DRILLING METHOD: Air Rotary   BOREHOLE DIAM (IN): 6"   DRILL FLUIDS USED: Air

TOTAL DEPTH DRILLED: 67   TOTAL DEPTH CASED: 67   INTERVAL PERFORATED FROM OR SCREENED (FT:): 47 / 67   DIAMETER: 2" Flush Tread   CASING TYPE: sch 40 PVC

METHOD OF PERFORATION:

	Open Hole
	Open Bottom
	Saw Slotted
X	Factory .020__ (size)
	Other_____

DURING WELL CONSTRUCTION WAS/WERE:

	YES	NO
Well Developed		X
Well Pumped		X
Water Samples Collected		X
Material Samples Collected	X	

ANNULAR COMPLETION CHARACTERISTICS

WELL PROTECTOR: LENGTH: 27 DIAM: 6"

LOCK NO:

		FROM:	TO:
SURFACE SEAL TYPE:			
BACKFILL MATERIAL:	3/8 Bent	1	44.5
FILTER PACK TYPE:	10/20 sand	44.5	67

STATIC WATER LEVEL: 9.88   DATE: 7/28/2008

MEASURING POINT DESCRIPTION/ ELEVATION: Top of Steel

MEASURING POINT RELATIVE TO GROUND SURFACE (+) _ 2.85

REMARKS:

INTERVAL(FT) below ground surface	**LITHOLOGIC DESCRIPTION**
0-.3	Organics
.3-6'	Silt, tan
6-26	Gravels, subangular in silt, yellowish orange, moist @ 15'
26-27	Minor gravels in silt, light grey, water @ 28
27-38	Bedrock, cuttings are coarse grain sand size, light brown with quartz, not real hard - easy drilling
38-50	As above with less brown
50-67	Bedrock, grey, cuttings are coarse grain sand size, Granite

MONTANA WELL LOG REPORT

Form No. 603 R2-99

Well ID# PDGW-102

15N 06W 20 AB

This log reports the activities of a licensed Montana well driller and serves as the official record of work done within the borehole and casing and describes the amount of water encountered. **This form is to be completed by the driller and filed with DNRC within 60 days of completion of the work. Acquiring Water Rights is the well owner's responsibility and is not accomplished by the filing of this report.** Well log information is stored in the Groundwater Information Center at the Montana Bureau of Mines and Geology (Butte) and water right information is stored in the Water Rights Bureau records (Helena). For fields that are not applicable, enter NA. ***Optional fields are in italics.*** Record additional information in the REMARKS section.

1. WELL OWNER:
Name DEQ
Mailing address PO Box 200901 Helena, MT. 59620-0901

2. WELL LOCATION: List ¼ from smallest to largest
____ ¼ ____ ¼ NW ¼ NE ¼, Section 20
Township 15 N Range 6 W County Lewis & Clark
Lot ____ Tract/Blk ____ Subdivision Name ____
Well Address See Township and Range
GPS ☐ *Yes* X *No*
Latitude 47.04655705910 Longitude -112.38261565700
Error as reported by GPS locator (± feet)
Horizontal datum x *NAD83* ☐ *WGS84*

3. PROPOSED USE: ☐ Domestic ☐ Stock ☐ Irrigation
☐ Public water supply X Monitoring Well ☐ Other: ____

3. TYPE OF WORK:
X New well ☐ Deepen existing well ☐ Abandon existing well
Method: ☐ Cable X Rotary ☐ Other: ____

5. WELL CONSTRUCTION DETAILS:

Borehole:
Dia. 6 in. from 0 ft. to 67 ft.
Dia. ____ in. from ____ ft. to ____ ft.
Dia. ____ in. from ____ ft. to ____ ft.

Casing:
Steel: Wall thickness ☐ Threaded X Welded
Dia. 6 in. from +2.85 ft. to 27 ft.
Dia. ____ in. from ____ ft. to ____ ft.

Plastic: Pressure Rating Sch 40 lbs. X Threaded ☐ Welded
Dia. 2 in. from +2.85 ft. to 67 ft.

Perforations/Slotted Pipe:
Type of perforator used ____
Size of perforations/slots ____ in. by ____ in.
____ no. of perforations/slots from ____ ft. to ____ ft.
____ no. of perforations/slots from ____ ft. to ____ ft.

Screens: X Yes ☐ No
Material PVC
Dia. 2" Slot size 0.20 from 47 ft. to 67 ft.
Dia. ____ Slot size ____ from ____ ft. to ____ ft.

Gravel Packed: X Yes ☐ No
Size of gravel 10/20 Sand
Gravel placed from 44.5 ft. to 67 ft.

Packer: ☐ Yes ☐ No
Type ____ Depth(s) ____

Grout: Material used: Steel/Bentonite
Depth from 1 ft. to 44.5 ft. OR ☐ Continuous feed

6. WELL TEST DATA:
A well test is required for all wells. *(See details on well log report cover.)*
☐ Static water level 9.88 ft. below top of casing **or**
☐ Closed-in artesian pressure ____ psi.
How was test flow measured:
bucket/stopwatch, weir, flume, flowmeter, etc ____
Yellowstone groundwater closure area only - Water Temperature ____ °F
☐ AQUIFER TEST DATA FORM ATTACHED
Test - 1 hour minimum
Drawdown is the amount water level is lowered below static level.
All depth measurements shall be from the top of the well casing.

Time of recovery is hours/minutes since pumping stopped.

Air test*
____ gpm with drill stem set at ____ ft. for ____ hours
Time of recovery ____ hrs/min. Recovery water level ____ ft.

OR Bailer test*
____ gpm with ____ ft. of drawdown after ____ hours
Time of recovery ____ hrs/min. Recovery water level ____ ft.

OR Pump test*
Depth pump set for test ____ ft.
____ gpm pump rate with ____ ft. of drawdown after ____ hrs pumping
Time of recovery ____ hrs/min. Recovery water level ____ ft.

OR Flowing Artesian*
____ gpm for ____ hours
Flow controlled by ____

**During the well test the discharge rate shall be as uniform as possible. This rate may or may not be the sustainable yield of the well. Sustainable yield does not include the reservoir of the well casing.*

7. WELL LOG:

Depth, Feet		Material: Color/rock and type/descriptor (example: blue/shale/hard, or brown gravel/water, or brown/sand/heaving)
From	To	
0	0.3	Organics
0.3	6	Silt, tan
6	26	Gravels, sub angular in silt, yellowish orange, moist @15
26	27	Minor gravels in silt, light grey, water @ 28'
27	38	Bedrock, cuttings are coarse grain sand size, light brown with quartz, not hard – easy drilling
38	50	As above with less brown
50	67	Bedrock, grey, cuttings are coarse grain sand size, granite.

RECEIVED
NOV 2 1 2008
M.B.M.G.

☐ ADDITIONAL SHEETS ATTACHED

8. DATE WELL COMPLETED: 07-25-08

9. *REMARKS*: Well drilled by Boland Drilling of Great Falls under the direction of Tetra Tech

10. DRILLER/CONTRACTOR'S CERTIFICATION:
All work performed and reported in this well log is in compliance with the Montana well construction standards. This report is true to the best of my knowledge.
Name, firm, or corporation (print) Tetra Tech
Address 303 Irene St. Helena, MT. 59601
Signature Jim Maus
Date 07-31-08 License no. ____

MBMG ID #
248279

Montana DNRC P.O. BOX 201601 HELENA, MT 59620-1601 444-6610

TETRA TECH

November 19, 2008

Montana Bureau of Mines and Geology
Groundwater Information Center
1300 West Park Street
Butte, Montana 59701-8997

RE: Monitoring Well Logs
Upper Blackfoot Mining Complex
East of Lincoln, Montana

Enclosed please find well construction logs for 23 monitoring wells at the above referenced site. All 23 were previously submitted with either incorrect or incomplete location information. The wells were installed for and with the prior approval of the Montana Department of Environmental Quality.

Please feel free to contact me if you have any questions.

Respectfully submitted,

Jim Maus
Staff Hydrogeologist

Enclosures: 23 well logs

Tetra Tech
303 Irene Street, Helena, MT 59601
Tel 406.443.5210 Fax 406.449.3729 www.tetratech.com

MONTANA WELL LOG REPORT

Form No. 603 R2-99

15N 6W 20 DB

Well ID# PMGW-119

This log reports the activities of a licensed Montana well driller and serves as the official record of work done within the borehole and casing and describes the amount of water encountered. **This form is to be completed by the driller and filed with DNRC within 60 days of completion of the work. Acquiring Water Rights is the well owner's responsibility and is not accomplished by the filing of this report.** Well log information is stored in the Groundwater Information Center at the Montana Bureau of Mines and Geology (Butte) and water right information is stored in the Water Rights Bureau records (Helena). For fields that are not applicable, enter NA. ***Optional fields are in italics.*** Record additional information in the REMARKS section.

1. **WELL OWNER:**
   Name DEQ
   Mailing address PO Box 200901 Helena, MT 59620-0901

2. **WELL LOCATION:** List ¼ from smallest to largest
   ____ ¼ ____ ¼ NW ¼ SE ¼, Section 20
   Township 15 N Range 6W County Lewis & Clark
   Lot ____ *Tract/Blk* ____ *Subdivision Name* ____
   Well Address See Township and Range
   GPS ☐Yes X No
   Latitude 47.04027829760 *Longitude* -112.38755306500
   Error as reported by GPS locator (± feet)
   Horizontal datum x NAD83 ☐ WGS84

3. **PROPOSED USE:** ☐ Domestic ☐ Stock ☐ Irrigation ☐ Public water supply X Monitoring Well ☐Other: ____

3. **TYPE OF WORK:**
   X New well ☐ Deepen existing well ☐ Abandon existing well
   Method: ☐ Cable X Rotary ☐ Other: Air and Water

5. **WELL CONSTRUCTION DETAILS:**
   Borehole:
   Dia. 6" in. from 0 ft. to 90 ft.
   Dia. ____ in. from ____ ft. to ____ ft.
   Dia. ____ in. from ____ ft. to ____ ft.
   Casing:
   Steel: Wall thickness ☐ Threaded X Welded
   Dia. 6 in. from +2 ft. to 55 ft.
   Dia. ____ in. from ____ ft. to ____ ft.
   Plastic: Pressure Rating Sch 40 lbs. X Threaded ☐ Welded
   Dia. 2 in. from 0 ft. to 61 ft.
   Perforations/Slotted Pipe:
   Type of perforator used ____
   Size of perforations/slots ____ in. by ____ in.
   ____ no. of perforations/slots from ____ ft. to ____ ft.
   ____ no. of perforations/slots from ____ ft. to ____ ft.
   Screens: X Yes ☐ No
   Material PVC
   Dia. 2" Slot size 0.20 from 61 ft. to 81 ft.
   Dia. ____ Slot size ____ from ____ ft. to ____ ft.
   Gravel Packed: X Yes ☐ No
   Size of gravel 10/20 sand
   Gravel placed from 59 ft. to 81 ft.
   Packer: X Yes ☐ No
   Type 3/8 Bentonite Depth(s) 0-59'
   Grout: Material used: Steel/Bentonite
   Depth from 0 ft. to 55 ft. OR ☐ Continuous feed

6. **WELL TEST DATA:**
   A well test is required for all wells. *(See details on well log report cover.)*
   X Static water level 11.01 ft. below top of casing **or**
   ☐Closed-in artesian pressure ____ psi.
   How was test flow measured:
   bucket/stopwatch, weir, flume, flowmeter, etc ____
   Yellowstone groundwater closure area only - Water Temperature ____ °F
   ☐AQUIFER TEST DATA FORM ATTACHED
   Test - 1 hour minimum
   Drawdown is the amount water level is lowered below static level.
   All depth measurements shall be from the top of the well casing.
   Time of recovery is hours/minutes since pumping stopped.

Air test*
____ gpm with drill stem set at ____ ft. for ____ hours
Time of recovery ____ hrs/min. Recovery water level ____ ft.

OR Bailer test*
____ gpm with ____ ft. of drawdown after ____ hours
Time of recovery ____ hrs/min. Recovery water level ____ ft.

OR Pump test*
Depth pump set for test ____ ft.
____ gpm pump rate with ____ ft. of drawdown after ____ hrs pumping
Time of recovery ____ hrs/min. Recovery water level ____ ft.

OR Flowing Artesian*
____ gpm for ____ hours
Flow controlled by ____

**During the well test the discharge rate shall be as uniform as possible. This rate may or may not be the sustainable yield of the well. Sustainable yield does not include the reservoir of the well casing.*

7. **WELL LOG:**

Depth, Feet From	Depth, Feet To	Material: Color/rock and type/descriptor (example: blue/shale/hard, or brown gravel/water, or brown/sand/heaving)
0	6	Tan silt with some gravel (6'-20' No cuttings)
6	20	(Tan silt clay? No cuttings)
20	45	Red/Brown white angular gravel (at about 35' making approximately 100gpm)
45	53	Reddish/Brown clayey silt with fine sand (little to no water)
53	70	Bluish grey silt stone (soft clay like) with pyrite cubes to 0.5cm
70	80	Purple/Black sandy silt stone abundant pyrite to >1cm
80	90	Light grey dolomite-soft with pyrite < 0.5cm highly fractured little water hole is caving

RECEIVED
NOV 21 2008
M.B.M.G.

☐ADDITIONAL SHEETS ATTACHED

8. **DATE WELL COMPLETED:** 10-16-07
9. ***REMARKS:*** Well Drilled by Boland Drilling of Great Falls under the direction of Tetra Tech

10. **DRILLER/CONTRACTOR'S CERTIFICATION:**
All work performed and reported in this well log is in compliance with the Montana well construction standards. This report is true to the best of my knowledge.
Name, firm, or corporation (print) Tetra Tech
Address 303 Irene St. Helena, MT 59601
Signature Jim Maus
Date 10-16-07 License no. ____

MBMG ID # 241887

Montana DNRC P.O. BOX 201601 HELENA, MT 59620-1601 444-6610

TETRA TECH

November 19, 2008

Montana Bureau of Mines and Geology
Groundwater Information Center
1300 West Park Street
Butte, Montana 59701-8997

RE: Monitoring Well Logs
Upper Blackfoot Mining Complex
East of Lincoln, Montana

Enclosed please find well construction logs for 23 monitoring wells at the above referenced site. All 23 were previously submitted with either incorrect or incomplete location information. The wells were installed for and with the prior approval of the Montana Department of Environmental Quality.

Please feel free to contact me if you have any questions.

Respectfully submitted,

Jim Maus
Staff Hydrogeologist

Enclosures: 23 well logs

Tetra Tech
303 Irene Street, Helena, MT 59601
Tel 406.443.5210 Fax 406.449.3729 www.tetratech.com

TETRA TECH, INC.

MONITORING WELL LITHOLOGIC AND COMPLETION LOG

JOB NO: 7561589 WELL NO: PMGW-119

PROJECT: UBMC STATE: MT COUNTY: Lewis & Clark LOGGED BY: Jim Maus

LEGAL LOCATION: **T** 15N **R** 6W **S** 20 TRACT

DESCRIPTIVE LOCATION: Below Paymaster Repository along edge of marsh

DATE STARTED: 10/15/2007 DATE COMPLETED: 10/16/2007 DRILLING CO. & DRILLER: Boland/James

DRILLING METHOD: Air Rotary BOREHOLE DIAM (IN): 6" DRILL FLUIDS USED: Air and Water

TOTAL DEPTH DRILLED: 90' TOTAL DEPTH CASED: 81' INTERVAL PERFORATED FROM OR SCREENED (FT:) 61' 81' DIAMETER: 2" Flush Thread CASING TYPE: PVC

METHOD OF PERFORATION:

	Open Hole
	Open Bottom
	Saw Slotted
X	Factory _.20_ (size)
	Other_____

DURING WELL CONSTRUCTION WAS/WERE:

	YES	NO
Well Developed		X
Well Pumped		X
Water Samples Collected		X
Material Samples Collected		X

ANNULAR COMPLETION CHARACTERISTICS

WELL PROTECTOR: LENGTH: 57' DIAM: 6'

LOCK NO:

SURFACE SEAL TYPE:	Steel	FROM: +2	TO: 55
BACKFILL MATERIAL:	Bentonite	FROM: 0	TO: 59'
FILTER PACK TYPE:	10/20 sand	FROM: 59'	TO: 81'

STATIC WATER LEVEL: 11.01 DATE: 10/18/2007

MEASURING POINT DESCRIPTION/ ELEVATION: Top of PVC N side

MEASURING POINT RELATIVE TO GROUND SURFACE (+/-) 2

REMARKS: 6" steel casing used to 55'

INTERVAL(FT) below ground surface	**LITHOLOGIC DESCRIPTION**
0’-6’	Tan silt with some angular gravel (6’-20’ No cuttings)
6’-20’	(Tan silt clay? no cuttings)
20’-45’	Red/Brown white angular gravel (at about 35’ making approximately 100gpm)
45’-53’	Reddish/Brown clayey silt with fine sand (little to no water)
53’-70’	Bluish grey siltstone (soft clay like) with pyrite cubes to 0.5cm
70’-80’	Purple/Black sandy siltstone abundant pyrite to >1cm
80’-90’	Light grey Dolomite-soft with pyrite <0.5cm highly fractured little water hole is caving

MONITORING WELL LITHOLOGIC AND COMPLETION LOG (Cont'd)

JOB NO: ____________________

PROJECT: ____________________ WELL NO: ____________

INTERVAL(FT) below ground surface	**LITHOLOGIC DESCRIPTION**	

HYDROMETRICS INC.

Consulting Scientists and Engineers

2727 Airport Rd. Helena Mt, 59601

WELL LOG AND CONSTRUCTION DIAGRAM

Hole Name: UCMW-11

State: Montana	County: Lewis and Clark
Project: Upper Blackfoot	
Legal Description:	
Descriptive Location: In road below Upper Carbonate Repository	
Recorded By: WR Wilson	
Drilling Company: H&L	
Driller: M Miller	
Drilling Method: Air Rotary	
Drilling Fluids Used: Water	
Pilot Hole Dia: 8-inch	Reamed Hole Dia: 8-inch
Total Depth Drilled: 82.00	Total Depth Reamed: 82.00
Purpose of Hole: Install monitoring Well	
Purpose of Well: Water Quality Sampling	
Target Aquifer: Bedrock	

Date Hole Started: 10/26/94 | Date Hole Finished: 10/26/94

	Y/N	TYPE-DESCRIPTION
Well Installed?	Y	4-inch, Flush Thread, PVC
Surface Casing Used?	Y	8-inch Steel
Casing Perforated?	N	
Screen Used?	Y	0.020 slot, PVC
Well Developed?	Y	Submersible pump
Well Yield Tested?	N	
Water Samples Taken?	Y	Water Quality Samples
Boring Samples Taken?	N	

Static Water Level: 75.00 | Date: 10/26/94

Well Seal Description: Neoprene Packer, Bentonite Chips

MP Description: Top of PVC | Measuring Point (MP) Elevation: 5235.79

MP Height Above or Below Ground? (+ / -) : -1.0

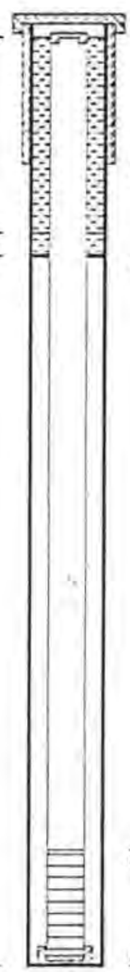
Remarks: Color notation (10YR 5/4) from Munsel Color System

Material size fraction percentages based on field visual estimates

Well Construction

Elev Top of Surface Casing: 5236.79
Elev Top of Riser: 5235.79
Borehole Dia: 8-inch

Riser Type: 4-inch, Flush Thread, PVC



Ground Surface 0.00

2.00 Bentonite Chips

Bottom of Surface Casing 13.00

19.00
21.00 Bentonite Pellets

Neoprene Packer 21.00

0.020 Slot, PVC 72.00

▼ 75.00

82.00 Bottom of Hole 82.00

GRAPHICS

Geological Description and Notes

0.00
Clayey Gravel; Dark Yellowish Brown
Gravel 60%, fine to coarse, angular weathered porphyry; Fines 40% Clay, soft;
Soft; Moist
[Road Grade Material]
- poor cuttings return

13.00
Porphyry; Olive Grey
Fine grained porphyry, massive, highly fractured; Weathered with oxidized clays in fractures and joints; Soft; Dry
[Weather Bedrock]

20.00
Porphyry; Olive Gray to Very Dark Gray
Fine grained porphyry; Massive; Fractured; Moderate oxide staining; Hard;
Dry to Wet
[Bedrock]
- approx. .75 feet/min drill rate
- making approx. 1 gpm at 80'

82.00

APPENDIX C
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SITE ID	SITE TYPE	ESTIMATED VOLUME OF WASTE MATERIAL (cy)	WATER OBSERVED	DISTANCE TO NEAREST OBSERVED SURFACE WATER (ft)	PROXIMITY TO EXISTING ACCESS[1]	SAMPLE COLLECTED[2] OBSERVED WATER	SAMPLE COLLECTED[2] SEDIMENT	SAMPLE COLLECTED[2] WASTE AREA	RI COMMENTS/NOTES/HAZARDS	FS EVALUATION NOTES
AC-1	Collapsed adit with waste rock	500 [3]	X (Anaconda Creek)	0	Moderate	ACSW-101 (SW)	ACSE-101 (0-2)	--	Caved or reclaimed adit on road cut-slope. Mine waste (if present) is incorporated into road fill slope, the toe of slope contacts Anaconda Creek.	Located approximately 400 ft upgradient of floodplain on timbered slope.
BR-01	Collapsed adit with waste rock, and discharge, seep, or spring	700	X (spring)	200	Easy	--	--	--	Intermittent spring (150 square feet) at toe of slope where adit was likely located. Large floodplain bench which is possible tailings. Older trees in mined rock piles are dead while younger shrubs have established. Potential intermittent adit seep may have poor quality water. Floodplain bench may consist of tailings or mined rock. Mined rock may impact vegetation.	Located close to edge of floodplain in heavily timbered area, approximately 200 ft north of Blackfoot River.
BR-14	Collapsed adit with waste rock, and discharge, seep, or spring	2,000	X (discharge or seep)	--	Difficult	--	--	--	Collapsed adit with leaking water that is pooled near entrance supporting vegetation. Collapsed tipple and woody debris is present. Mined rock difficult to distinguish from road fill slope and has been graded for structure footings. Adit seepage may be of poor quality for wildlife use.	Located along old road grade approximately 900 ft upgradient from floodplain. A surface water feature was not observed at the time of the inventory. Area is in a highly mineralized geology zone has some shrubs and trees on a south facing slope. Interaction of the adit seep with surface water was not observed.
BR-16	Collapsed adit with waste rock	25	--	--	Difficult	--	--	**SSWA-101 (0-6) (As, Pb, Zn)**	Caved adit with collapsed and rotted wooden shoring. Small vegetated mined rock pile in direct communication with seasonal run-off channel (dry at time of visit). Potential for impacts to surface water when seasonal run-off channel is flowing and in contact with mined rock.	Located approximately 0.3 miles northeast of floodplain, may be accessible by an old road grade in heavy timber. Looks well vegetated with plants, shrubs, and trees from photos. Unable to verify water; seasonal runoff channel.
BR-20	Collapsed adit with waste rock	2,100	--	--	Difficult	--	--	**IHWA-101 (0-6) (As, Cu)**	Large rock dump and caved adit with railroad tracks leading out of it. Woody debris scattered about and impacted vegetation below rock dump.	Located approximately 250 ft from edge of floodplain. Likely in a mineralized area on a south facing slope. Large waste pile is present with no plant growth.
BR-29	Collapsed adit with waste rock	280	--	--	Difficult	--	--	--	Collapsed adit and rock pile located in center of gully that may be a seasonal drainage (dry at time of visit). Some potential for impact to surface water during flooding or high run-off events.	Located approximately 350 ft uphill from Mary P Mine in heavy timber on steep slopes, in highly mineralized area. No photos. Unable to verify water; seasonal runoff channel. No proximity to existing roads making access difficult.
BR-32	Collapsed adit with waste rock	160	--	--	Difficult	--	--	--	Collapsed portal. Impacted vegetation below rock dump. Seasonal run-off from rock pile is impacting vegetation.	Located 200 ft northeast of floodplain on steep rocky slope.
BR-39	Collapsed adit with waste rock	32	X (Unnamed tributary to Blackfoot River)	5	Difficult	**BTSW-101 (SW) Chronic: Cd, Zn Acute: Zn**	--	**BTWA-101 (0-6) (As, Pb, Mn, Zn)**	Caved adit and waste pile along edge of unnamed creek. No impacts to vegetation were observed and bushes grew from rock pile.	Located approximately 700 ft uphill from WTP, may be accessible by old road grade. Surface water sample collected from unnamed tributary to Blackfoot River.
PC-01	Physical hazard - open adit (well)	--	X (well)	--	Difficult	PCSW-102 (GW) PCSW-103 (SW) PCSW-104 (SW)	PCSE-103 (0-2) PCSE-104 (0-2)	PCWA-102 (0-6)	Collapsed adit with timber and associated rock pile. A shallow, square, timber-framed "shaft" is nearby with dimensions 5x5x2 ft (possible drinking water well), filled with water.	Located approximately 500 ft east of highway on a steep forested slope. Sediment and surface water samples PCSW-103/104 are located upstream and downstream of the site. Water sample PCSW-102 was collected from an adit seep.
PC-06	Collapsed adit with waste rock	1,700	--	--	Difficult	--	--	--	Collapsed adit portal with large non-vegetated mined rock dump and scattered timbers and metal debris. Mined rock appears phytotoxic and may present metal mobility hazard.	Located approximately 1 mile up Pass Creek Road on a steep heavily timbered slope. May be accessible through old road grades but is in a remote location.
PC-11	Collapsed adit with waste rock, and discharge, seep, or spring	500 [3]	X (runoff channel, possible seep)	20	Moderate	**PCSW-101 (SW) Chronic: Cd, Zn Acute: Zn**	--	**PCWA-101 (0-6) (Cd, Zn)**	Possible caved adit at base of large disturbance. No visible adit flow but runoff channel passes near area. No rock pile is present, possibly reclaimed and regraded previously.	Located 0.6 miles from highway entrance on an old road grade; unknown access road conditions. PCWA-101 is noted in the RI field notebooks as both rock and sediment and may have been sampled from a large area of disturbance noted in the RI. Visual flow estimate of 1 gpm in field notes.
PC-21	Physical hazard - open adit	--	--	--	Easy	--	--	--	Open adit (3x3 foot) in sandstone face near highway. Evidence of animal use. Open Adit. Human entry is clearly possible.	This open adit presents a human safety hazard by allowing human entry and is located close to Highway 200.
PC-22	Collapsed adit with discharge, seep, or spring	--	X (possible discharge)	--	Moderate	--	--	--	Inventoried in 2011. This site was identified as PC-21 in the RI but is a separate feature in a different location.	Added to FS as PC-22. The feature consists of a collapsed adit and marshy area near adit entrance, indicative of potential adit discharge. No flowing water was observed at the time. No waste rock pile was observed.

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PM-04	Disturbed area	106	--	--	Moderate	--	--	--	Exploratory pit. Possible tailings and metal mobility or phytotoxicity from rock pile.	Located 200 ft south of upper edge of Paymaster Repository road and 450 ft upgradient from Paymaster Creek. Disturbed area with no other signs of mining activities and no roads to the site.
PM-06	Disturbed area	423	--	--	Difficult	--	--	--	Two trenches located near digout. Possible tailings. Possible metal mobility or phytotoxicity from rock pile.	Located 500 ft south of upper edge of Paymaster Repository road and 400 ft upslope from Paymaster Creek, on a steep slope with heavy timber not close to any existing roads for easy accessibility. A disturbed area with no other signs of mining activities and no roads to the site.
PM-12	Collapsed adit with waste rock	1,288	X (Paymaster Creek)	5	Difficult	--	--	--	Collapsed adit entrance and large rock pile within 5 ft of the creek (Paymaster). Possible metal mobility and sedimentation from mined rock.	Located 1500 ft south of the Paymaster wetland cells near an unmaintained road, and 150 ft upslope from Paymaster Creek, in heavy timber on a steep slope. Not easily accessible.
PM-26	Collapsed adit with waste rock	2,689	--	--	Difficult	--	--	--	Large tailings pile with access road at its toe which bisects the intermittent Paymaster creek channel. Possible metal mobility or phytotoxicity from tailings material or mined rock.	Located 1 mile up Paymaster Gulch up old road grades that are difficult to access, and 250 ft upslope of Paymaster Creek. Site is in a remote location on steep heavily timbered slopes. Water was not observed at the time, and Paymaster is intermittent at this location.
PM-28	Disturbed area	167	--	--	Difficult	--	--	--	Trench remaining from an old adit. Three lupine plants observed growing along the edge of the rock pile. Possible metal mobility or phytotoxicity from rock pile.	Located 1.5 miles up Paymaster Gulch on old road grades that are difficult to access, and 650 ft upslope from Paymaster Creek. Site is in a remote location on steep heavily timbered slopes.
PM-35	Collapsed adit with waste rock	500 [3]	X (Paymaster Creek)	180	Difficult	**PMSW-102 (SW)** **Chronic: Cd, Cu, Fe, Zn** **Acute: Cu, Zn** **PMSW-103 (SW)** **Chronic: Cu, Fe, Zn** **Acute: Zn**	PMSE-102 (0-2) PMSE-103 (0-2)	**PMWA-101** **(As, Pb)** PMWA-102	Some potential for impact to surface water from rock pile during flooding or high run-off events.	Located approximately 1500 ft above Meadow Creek Road south of wetland cells on unmaintained road. This site is located near an old road grade in the bottom of the gulch, approximately 180 ft upgradient of Paymaster Creek. The area is heavily timbered. Sediment samples PMSE-102/103 collected in Paymaster Creek had exceedances for mercury, however no receptors were shown to be at risk from exposure to mercury in the UBMC BERA..
PM-37	Collapsed adit with waste rock	445	X (seep)	30 (from Paymaster Creek)	Difficult	**PMSW-101 (SW)** **Chronic: Cd, Cu, Fe, Pb, Zn** **Acute: Cu, Pb, Zn**	--	--	Adit is caved and on opposite side of road from mined rock pile. Seep present on top of rock pile. Some potential for impact to surface water during flooding or high run-off events. Rock pile is in very wet floodplain despite distance from flowing creek channel.	Located approximately 1500 ft above Meadow Creek Road on existing unmaintained roads south of Paymaster wetland cells near an old road grade in the bottom of the gulch, approximately 30 ft from Paymaster Creek. The area is heavily timbered. Interaction of the adit seep with surface water was not observed in the RI.
JM-01	Disturbed area	542	--	--	Difficult	--	--	--	Adit trench and waste pile onsite. Possible metal mobility or phytotoxicity from rock pile.	Located 0.2 miles from Paymaster wetland cells on forested slopes, may be accessible by old roads grade.
PBBS	Collapsed adit with discharge, seep, or spring	--	X (Porcupine Creek)	0	Moderate	PBBS-200 (SW) **PBBS-201 (SW)** **HH: Cd, Pb, Mn, Zn** **Chronic: Cd, Cu, Fe, Pb, Zn** **Acute: Cd, Cu, Pb, Zn** PBBS-202 (SW)	**PBBS Sed 200** **As, Cd, Pb, Mn, Zn** **PBBS Sed 201** **As, Pb, Mn, Zn** PBBS Sed 202	PBBS WP 200	Possible mine waste dump with adit water, streambed sediment, and mine waste.	Located approximately 1700 ft south of Meadow Creek Road along an old road that is accessible by vehicle. Mine waste dump was observed below the adit with trees growing from it, but no other plants or shrubs were observed growing on the waste pile. Stream channel is observed around the toe of the waste pile. Water goes below surface south of the waste pile and then reemerges north of the pile. Surface water was observed at the time of site visit above and below stream, and did not exceed standards (PBBS-200/202). Exceedances in adit seep (PBBS-201). Interaction of the adit seep with surface water was not observed.
SH-06	Physical hazard - open adit - with waste rock	780	--	--	Difficult	--	--	--	Open adit portal and associated mined rock pile. Rock is vegetated with evergreens with trunks measuring 1 to 3 inches in diameter. Open Adit.	Located 1.25 miles from Mike Horse Mine Road along Pass Creek Shave Gulch ridgeline unmaintained road and 0.25 miles from nearest road grade. Site is 0.3 miles upgradient from Shave Creek. Slope is steep, with heavy timber. Area is vegetated with trees and shrubs. Appears to be waste rock piles. Open adit portal is not visible from site photos.
SH-07	Collapsed adit with waste rock	590	--	--	Difficult	--	--	--	Collapsed adit. Possible phytotoxicity from excavated rock.	Located 1.25 miles from Mike Horse Mine Road along Pass Creek Shave Gulch ridgeline unmaintained road and 0.25 miles from nearest road grade. Site is 0.25 miles upgradient from Shave Creek. Slope is steep, with heavy timber. Area is vegetated with trees and shrubs.

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SH-13	Collapsed adit with waste rock	5,600	--	--	Moderate	--	--	--	Little to no vegetation on mined rock or near toe. Faint sulfur smell was detected. Possible metal mobility and acid generation from mined rock. Rock is impacting vegetation.	Located 0.75 miles up Pass Creek Shave Gulch ridgeline road, 90 ft downslope from old road grade, 0.2 miles upgradient from Shave Creek. Slope is steep, with heavy timber, and no maintained roads. Area surrounding the site is vegetated with trees and shrubs.
SH-14	Collapsed adit with waste rock	8,000	--	--	Difficult	--	--	--	Very large mined rock dump and possibly three collapsed adits. Two collapsed wooden structures. Sulfur smell and impacted vegetation extending 75 ft below rock pile. Erosion channel cut into ground below rock pile but area is far from surface water. Possible metal mobility and acid generation from mined rock. Rock is impacting vegetation.	Located 1 mile from Mike Horse Mine Road along Pass Creek Shave Gulch ridgeline unmaintained road and 0.25 miles from nearest road grade. Site is 0.3 miles upgradient from Shave Creek. Vegetation is observed from site photo, and area surrounding the site is vegetated with trees and shrubs.
SH-17	Collapsed adit with waste rock	9,200	X (Shave Creek)	75	Easy	**SHSW-101 (SW)** **Chronic: Cu** **Acute: Cu** SHSW-102 (SW)	SHSE-101 (0-2) **SHSE-102 (0-2)** **As, Pb, Mn**	--	Collapsed adit with mined rock pile.	Located 200 ft from road in the bottom of Shave Gulch, would require stream crossing. Easy access along road in Shave Gulch. Vegetation is observed from site photo, and area surrounding the site is vegetated with trees and shrubs. Site is 75 ft west and upgradient of Shave Creek.
SH-23	Collapsed adit with waste rock	330	--	--	Easy	--	--	--	Collapsed adit portal and sparsely vegetated rock pile. Possible metal mobility or phytotoxicity from rock pile	Located 200 ft from Mike Horse Road. Easy access along road in Shave Gulch, 350 ft upgradient of Shave Creek. Vegetation is observed from site photo, and area surrounding the site is vegetated with trees and shrubs.
SH-29	Collapsed adit with waste rock	125	--	--	Moderate	--	--	--	Collapsed Upper Consolation adit. With up to 7 small prospect pits nearby. Possible metal mobility or phytotoxicity from rock pile	Located 0.5 ft along existing accessible road and additional 0.1 miles upslope without any roads, near Consolation Mine. Vegetation is observed from site photo, and area surrounding the site is vegetated with heavy timber and shrubs.
SH-37	Collapsed adit with waste rock	55	--	--	Difficult	--	--	--	Rock pile located at head of seasonal drainage/run-off channel. Channel was dry at time of visit. Potential for impacts to surface water when seasonal run-off channel is flowing.	Located 0.5 ft along existing accessible road and additional 0.2 miles along unmaintained road grade, near Consolation Mine. Located 900 ft upslope from bottom of Shave Gulch Road and 1000 ft from Shave Creek, on steep timbered slope, near Consolation Mine. Remote location, not in close proximity to any old road grades. Vegetation is observed in site photo. Site is located in seasonal runoff channel but no evidence of runoff during inventory.
SH-43	Collapsed adit with waste rock, and discharge, seep, or spring	1,800	X (Shave Creek)	0	Moderate	**SHSW-103 (SW)** **HH: Mn** **Chronic: As, Cd, Cu, Fe, Pb, Zn** **Acute: Cd, Cu, Pb, Zn** **SHSW-104 (SW): iron seep** **Chronic: Cd, Pb**	**SHSE-103 (0-2)** **As, Cd, Pb, Mn, Zn**	**SHWA-102 (0-6)** **As, Cd, Cu,Pb,Zn**	Collapsed and leaking adit (2 to 5 gpm estimate) with additional flow contributed by seeps between adit and mined rock pile. Stream flows along top of dump.	Located 0.5 miles along existing road from Mike Horse Road up Shave Gulch, the remaining 0.25 miles is an unmaintained road grade. Site is 400 ft upgradient of Shave Creek. Vegetation is observed in site photo, and area surrounding the site is vegetated with trees and shrubs. Adit seepage mixes with natural seepage above the waste rock pile, flows across the waste, and into a small unnamed tributary that appears to have perennial flow into Shave Gulch.
SH-44	Collapsed adit with waste rock	110	X (Tributary to Shave Creek)	20	Moderate	--	--	--	Series of caved adits and/or prospect pits and trenches. Possible metal mobility or phytotoxicity from rock pile.	Located 0.5 miles along existing road from Mike Horse Road up Shave Gulch, the remaining 0.25 miles is an unmaintained road grade. Site is 700 ft upgradient of Shave Creek. Close proximity to SH-43 and unnamed tributary.
SG-01	Physical hazard - open pipe	--	--	--	Moderate	--	--	--	Open well casing (8 inches). Possible safety hazard.	Located approximately 2700 ft up maintained road from Meadow Creek road. Site is located 100 ft downslope of existing road. Review of site photo shows casing is partially collapsed, actual opening is less than 8 inches.

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SG-13/14	Disturbed area	5,551	--	--	Difficult	--	--	--	Large waste rock pile up to 20 ft deep and trench. Possible metal mobility or phytotoxicity from rock pile.	Located 1.8 miles from Meadow Creek road on unmaintained access roads and 0.25 miles from Stevens Creek, on the ridge top between Stevens Gulch and Mike Horse Mine. Site is located on very steep timbered slopes with no maintained roads. Features SG-13 and SG-14 have the same field GPS location in the RI and were combined as one feature for the FS.
SG-16	Disturbed area	333	--	--	Difficult	--	--	--	Trench above possible adit location with large rock piles associated with both sites. Possible metal mobility or phytotoxicity from rock pile.	Located 1.8 miles from Meadow Creek road on unmaintained access roads and 0.20 miles upslope from Stevens Creek. Located near the ridgetop between Stevens Gulch and Mike Horse Mine on steep timbered slopes.
SG-24	Disturbed area	293	--	--	Difficult	--	--	--	Two trenches that intersect at rock pile. No tailings evident. Possible metal mobility or phytotoxicity from rock pile.	Located 2.25 miles from Meadow Creek road on an unmaintained access roads and 0.3 miles upgradient from Stevens Creek, on the ridgetop between Stevens Gulch and Paymaster Gulch. Slopes are steep with heavy timber.
SG-31	Disturbed area	22 [4]	X (Stevens Creek)	20	Moderate	--	--	--	Deposit of iron rich soil impacting water quality. Likely native material. Iron rich soil in contact with surface water.	Located approximately 0.25 miles from Meadow Creek road along existing maintained road. Site is located in close proximity to existing road in the bottom of Stevens Gulch and less than 20 ft from Stevens Creek. RI field notes are contradictory concerning proximity to water, however aerial photographs suggest possible contact with surface water channel.
SG-33	Disturbed area	104	X (Stevens Creek)	50	Moderate	--	--	--	Possible tailings in excavated rock. Possible metal mobility from waste rock potentially interspersed with tailings.	Located approximately 0.25 miles from Meadow Creek road along existing maintained road. Site is located in close proximity to existing road in the bottom of Stevens Gulch approximately 50 ft from Stevens Creek. RI field notes are contradictory concerning proximity to water, however aerial photographs suggest possible contact with surface water channel.
SG-35	Disturbed area	119	X (Stevens Creek)	0	Moderate	--	--	--	Standing water in trench adjacent to creek. No staining evident. Possible metal mobility or phytotoxicity from rock pile.	Located approximately 1000 ft from Meadow Creek road, and 100 ft from existing maintained road. Site is in the valley bottom of heavily timbered Stevens gulch and may be in contact with creek. Distance to Stevens Creek is not noted.
SG-41	Disturbed area	2,444	--	--	Difficult	--	--	--	Exploratory trench with possible tailings. Possible metal mobility or phytotoxicity from excavated rock and/or tailings.	Located 1.6 miles from Meadow Creek road on unmaintained access roads and 150 ft from Stevens Creek Steep slopes in heavy timber.
SG-43	Disturbed area	778	--	--	Difficult	--	--	--	Exploratory pit with possible tailings. Photo 78 of ridge to the NE, no mining activity evident. Numerous roadcuts. Possible metal mobility or phytotoxicity from rock pile.	Located 1.8 miles from Meadow Creek road on unmaintained access roads and 600 ft from Stevens Creek, near the ridge top between Stevens Gulch and Mike Horse Mine. Site is located on very steep timbered slopes with no maintained roads.
SG-44	Collapsed adit with waste rock	20,000	X (Stevens Creek)	0	Difficult	--	--	--	Mined rock pile in contact with intermittent portion of Stevens Creek. Possible metal mobility or phytotoxicity from rock pile.	Located 1.8 miles from Meadow Creek road on unmaintained access roads near the mouth of Stevens Creek. Site is located on very steep timbered slopes with no maintained roads. This feature is in contact with an intermittent portions of Stevens Creek. Site of abandoned Viking Mine.
SG-47	Collapsed adit with waste rock	278	X (Stevens Creek)	0	Difficult	--	--	--	Potential adit location. Tailings material in creek. Open Adit. Potential metal loading to creek.	Located 1.5 miles up Stevens Gulch from Meadow Creek road on unmaintained access road. Slope is very steep with no accessible roads and heavy timber. Waste rock pile is contact with an intermittent portions of Stevens Creek, based on site photos; tailings are not evident in photo. This feature is no longer an open adit and is collapsed.

AC = Anaconda Creek BR = Blackfoot River PC = Pass Creek PM = Paymaster Gulch JM = Jumbo Mine/Paymaster
PBBS = Porcupine Gulch SH = Shave Gulch SG = Stevens Gulch SWG = Swamp Gulch

SITE ID	SITE TYPE	ESTIMATED VOLUME OF WASTE MATERIAL (cy)	WATER OBSERVED	DISTANCE TO NEAREST OBSERVED SURFACE WATER (ft)	PROXIMITY TO EXISTING ACCESS[1]	SAMPLE COLLECTED[2] OBSERVED WATER	SAMPLE COLLECTED[2] SEDIMENT	SAMPLE COLLECTED[2] WASTE AREA	RI COMMENTS/NOTES/HAZARDS	FS EVALUATION NOTES
SG-48	Collapsed adit with waste rock	28	X (Stevens Creek)	0	Difficult	--	--	--	Adit in rock face adjacent to creek. Tailings material in creek. Open Adit. Potential metal loading to creek.	Located 1 mile up Stevens Gulch, 20 ft east of nearest road grade. Slope is very steep with no accessible roads and heavy timber. Area is vegetated with trees, shrubs, and plants. Waste rock pile may be in contact with an intermittent portions of Stevens Creek, based on site photos. Tailings are not evident. This feature is no longer an open adit and is collapsed.
SG-49/50	Collapsed adit with waste rock	999	X (ephemeral creek)	0	Difficult	--	--	--	Mined rock associated with adit SG-51. Located adjacent to ephemeral creek. Possible metal mobility or phytotoxicity from rock pile.	Located 1.4 miles up Stevens Gulch 200 ft from Stevens Creek on unmaintained access road. Slope is steep with unmaintained roads and heavy timber. Waste rock pile may be in contact with an intermittent portions of ephemeral creek, based on site photos. This feature is no longer an open adit and is collapsed. The area surrounding the collapsed opening is covered with moss, plant litter, and shrubs. Adit is associated with SG-50, not SG-51; features SG-49 and SG-50 are related and combined as one feature for FS.
SG-51	Disturbed area	370	X (Stevens Creek)	0	Difficult	--	--	--	Large cutslope with rock pushed into creek. Possible metal mobility or sediment loading from fill material.	Located 1.5 miles up Stevens Gulch from Meadow Creek road on unmaintained roads in close proximity to Stevens Creek. Slope is very steep with no accessible roads and heavy timber. Based on site photos, this looks like a disturbed area and the surroundings areas are vegetated. Photos do not show rock pushed into the creek.
SG-53	Disturbed area	2,843	--	--	Difficult	--	--	--	Three rock piles and a large dig out area. Possible metal mobility or phytotoxicity from rock pile.	Located 1.25 miles mile up Stevens Gulch from Meadow Creek Road on unmaintained roads and 500 ft upgradient from Stevens Creek. Slope is steep, with heavy timber.
SG-55	Disturbed area and discharge, seep, or spring	200	X (Well)	--	Difficult	**SG-55SW (SW) HH: As, Mn Chronic: Fe**	--	--	Pipe (4 inch) protruding from toe of cutslope leaking small amounts of water, possible artesian well.	Located 1.25 miles up Stevens Gulch from Meadow Creek Road on unmaintained roads and 600 ft upgradient of Stevens Creek. Slope is steep, with heavy timber, and unmaintained roads. This feature is not in close proximity to any surface water based on field evaluation, but there was water evident from a pipe, possibly a drill pipe.
SG-56	Disturbed area	370	--	--	Difficult	--	--	--	Possible tailings in excavated rock. Possible metal mobility or phytotoxicity from rock pile.	Located 1.25 miles up Stevens Gulch from Meadow Creek Road on unmaintained roads and 600 ft upgradient of Stevens Creek. Slope is steep, with heavy timber, and unmaintained roads. Based on the site photos, this looks like a pile of waste rock, and tailings are not evident.
SG-58	Disturbed area	1,481	--	--	Difficult	--	--	--	Possible tailings in excavated rock. Possible metal mobility or phytotoxicity from rock pile.	Located 2 miles up Stevens Gulch on unmaintained access roads, 200 ft northeast of nearest road grade, and 0.25 miles upgradient of Stevens Creek. Slope is steep, with heavy timber. Trees are growing around the site.
SG-67	Disturbed area	19,444	--	--	Difficult	--	--	--	Large amount of excavated rock associated with two cut slopes. Possible tailings in rock piles. Possible metal mobility or phytotoxicity from rock pile.	Located 2 miles up Stevens Gulch on unmaintained roads , 400 ft southwest of nearest road grade, and 0.3 miles upgradient of Stevens Creek. Slope is steep, with heavy timber, and no accessible roads to the site. Trees are growing around the site. Appears to be a disturbed area with rock piles present. Waste rock estimate may include road cut material.
SG-71	Collapsed adit with waste rock, and discharge, seep, or spring	463	X (spring)	70 (from Stevens Creek)	Difficult	--	--	--	Spring at possible adit location 70 ft from creek. Water has pooled and is 6 inches deep. Vegetation is in good condition adjacent to pond.	Located 1.3 miles up Stevens Gulch road along west side of draw from Meadow Creek road, and an additional 200 ft downgradient from road grade, 80 ft upgradient of Stevens Creek. Slope is steep, with heavy timber, and no maintained roads. Trees are growing around the site.

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SITE ID	SITE TYPE	ESTIMATED VOLUME OF WASTE MATERIAL (cy)	WATER OBSERVED	DISTANCE TO NEAREST OBSERVED SURFACE WATER (ft)	PROXIMITY TO EXISTING ACCESS[1]	SAMPLE COLLECTED[2] OBSERVED WATER	SAMPLE COLLECTED[2] SEDIMENT	SAMPLE COLLECTED[2] WASTE AREA	RI COMMENTS/NOTES/HAZARDS	FS EVALUATION NOTES
SG-78	Disturbed area	741	--	--	Difficult	--	--	--	Possible adit location with tailings in rock pile. Possible metal mobility or phytotoxicity from rock pile.	Located 1600 ft from Meadow Creek road up Stevens Gulch road, and an additional 1500 ft (crow flies) along bottom of Stevens Gulch, and 60 ft upgradient of Stevens Creek. There are numerous historic unmaintained road cuts along the east side of the draw with heavy timber. Slope is steep, with heavy timber, and no maintained roads. Trees are growing around the site.
SG-82	Disturbed area	156	--	--	Difficult	--	--	--	Soil contributing to iron staining in creek, likely native material. Iron and sediment loading from excavated material.	Located 1600 ft from Meadow Creek road up Stevens Gulch road, and an additional 1500 ft (crow flies) along bottom of Stevens Gulch, and 150 ft upgradient of Stevens Creek. Slope is steep, with heavy timber, and no accessible roads.
SG-86	Disturbed area	2,105	--	--	Difficult	--	--	--	Two rock piles with possible tailings. Possible metal mobility or phytotoxicity from rock pile.	Located 0.9 miles up Stevens Gulch on existing road, 10 ft east of nearest road grade, and 0.1 miles upgradient of Stevens Creek. Slope is steep with heavy timber. Area is heavily vegetated with trees and shrubs. Appears to be waste rock piles that are not in proximity to surface water features.
SG-89	Disturbed area	500 [3]	X (Stevens Creek)	0	Easy	--	--	--	Apparent west edge of tailings along Steven's Creek. Other edges bound by roads. Possible metal and sediment loading from tailings.	Located 160 ft NW or Mike Horse Crk Rd and Meadow Crk Road. Possible edge of tailings located along the road, heavily forested. Although this feature is noted in contact with surface water, water is not observed in aerial photo.
SG-93	Surface Water/Sediment	--	X (Stevens Creek)	50	Difficult	**SGSW-101 (SW)** **Chronic: Cu, Pb** **Acute: Cu** SGSW-102 (SW)	**SGSE-102 (0-6)** **As, Cd, Cu, Pb, Zn**	SGWA-101	--	Located 1.4 miles up Stevens Gulch from Meadow Creek Road on unmaintained road, waste pile is 200 ft upgradient from Stevens Creek on unmaintained access road. Slope is steep with heavy timber.
SG-94	Disturbed area with discharge, seep, or spring	500 [3]	X (spring)	--	Difficult	**SGSW-103 (SW)** **Chronic: Cd, Cu, Zn** **Acute: Cu, Zn** **SGSW-104 (SW)** **HH: As, Fe** **Chronic: Fe, Zn** **Acute: Zn**	**SGSE-103 (0-2)** **As, Cd, Cu, Pb, Zn** **SGSE-104 (0-2)** **As**	SGWA-102	Iron precipitate cone-forming spring. Actually located about 250 ft downstream of SG-94 location.	Located 1.4 miles up Stevens Gulch from Meadow Creek road on unmaintained roads in close proximity to Stevens Creek. Slope is very steep with no accessible roads and heavy timber. Located 200 ft east of nearest road grade. This feature is a spring in a highly mineralized area, and not in close proximity to any surface water.
SG-95	Disturbed area	500 [3]	X (Stevens Creek)	0	Difficult	--	--	--	Fine grained yellow material in contact with stream. Metal mobility or sediment loading from drill cuttings material.	Located 1600 ft from Meadow Creek road up Stevens Gulch road, and an additional 1500 ft (crow flies) along bottom of Stevens Gulch, and 30 ft upgradient of Stevens Creek. There are numerous historic unmaintained road cuts along the east side of the draw with heavy timber. Slope is steep, with heavy timber, and no maintained roads.
SG-96	Disturbed area	500 [3]	X (Stevens Creek)	5	Difficult	**SGSW-107 (SW)** **Chronic: Cd, Cu, Pb, Zn** **Acute: Cu, Zn**	**SGSE-107 (0-2)** **As, Cu, Pb, Zn**	**SGWA-103** **As, Cu**	Flat area with wood and metal debris. Yellow orange fine grained material in area typically 1 to 4 inches thick (likely to be tailings). Dispersed tailings impacting surface water.	Located 1600 ft from Meadow Creek road up Stevens Gulch road, and an additional 400 ft (crow flies) along bottom of Stevens Gulch, and 50 ft upgradient of Stevens Creek. There are numerous historic unmaintained road cuts along the east side of the draw with heavy timber. Slope is steep, with heavy timber.. Located 400 ft from nearest existing accessible road in Stevens Gulch.
SG-98	Collapsed adit with waste rock, and discharge, seep, or spring	500 [3]	X (possible discharge)	--	Difficult	--	--	**SGWA-104** **As, Pb**	Adit had flow at some point as evidenced by strong iron oxide staining but is now dry.	Located 1.8 miles from Meadow Creek road on unmaintained access roads near the mouth of Stevens Creek. Site is located on very steep timbered slopes without any maintained roads. Slope is very steep with heavy timber and no maintained access roads. This feature is in contact with an intermittent portions of Stevens Creek. Located near abandoned Viking Mine. Assume potential of discharge from adit or associated seep.

APPENDIX C
MINING-RELATED FEATURE EVALUATION

AC = Anaconda Creek BR = Blackfoot River PC = Pass Creek PM = Paymaster Gulch JM = Jumbo Mine/Paymaster
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SITE ID	SITE TYPE	ESTIMATED VOLUME OF WASTE MATERIAL (cy)	WATER OBSERVED	DISTANCE TO NEAREST OBSERVED SURFACE WATER (ft)	PROXIMITY TO EXISTING ACCESS[1]	SAMPLE COLLECTED[2] OBSERVED WATER	SAMPLE COLLECTED[2] SEDIMENT	SAMPLE COLLECTED[2] WASTE AREA	RI COMMENTS/NOTES/HAZARDS	FS EVALUATION NOTES
SG-99	Collapsed adit with waste rock	500 [3]	X (Stevens Creek)	5	Difficult	**SGSW-105 (SW) Chronic: Cd, Cu, Pb, Zn Acute: Cu, Zn** **SGSW-106 (SW) Chronic: Cd, Cu, Pb, Zn Acute: Cu, Zn**	**SGSE-105 (0-2) As, Cd, Cu, Pb, Zn** **SGSE-106 (0-2) As, Cu, Pb, Zn**	--	Collapsed adit. Excavated rock , if present, has been worked by stream and is indistinguishable from other materials.	Located 1600 ft from Meadow Creek road up Stevens Gulch road, and an additional 1500 ft (crow flies) along bottom of Stevens Gulch, and 150 ft upgradient of Stevens Creek. Slope is steep, with heavy timber, and no accessible roads. Site is located 600 ft downgradient from old road grade.
SWG-02	Disturbed area	244		--	Difficult	--	--	--	Possible tailings in rock piles. Excavated rock may present metal mobility or other phytotoxicity hazard.	Located 300 ft northeast of the Meadow Creek Road to WTP on steep slopes with heavy timber. This site is not accessible by any road grades. Area has established vegetation including shrubs and trees.

Notes: cy: cubic yard. ft: feet. gmp: gallons per minute

[1]**Access Definitions**

Easy - Located close to existing road.

Moderate - Located close to old road grade on mild slopes with less timber.

Difficult - Remotely located due to inaccessibility (steep timber slopes or unmaintained roads), may be in proximity to other mine features that are difficult to access.

[2] Sample identification listed for areas where sample was collected. **Bold** text indicates that sample exceeded SSCLs.

[3] Volume was not recorded in field notes and is an estimation.

[4] Volume was estimated based on area from Table 12 of Remedial Investigation (RI).

RESTORING OUR ENVIRONMENT• DESIGNING OUR FUTURE

UBMC Final IASD

Technical Memorandum

Montana Department of Environmental Quality
Remediation Division

July 23, 2013

Pioneer Technical Services, Inc.

RESTORING OUR ENVIRONMENT• DESIGNING OUR FUTURE

UBMC Final IASD

Technical Memorandum

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July 23, 2013

Table of Contents

List of Tables

List of Acronyms

CECRA	Comprehensive Environmental Cleanup and Responsibility Act
COCs	Contaminants of Concern
DEQ	Montana Department of Environmental Quality
ERCLs	Environmental Requirements, Criteria, or Limitations
FRTR	Federal Remediation Technology Roundtable
FS	Feasibility Study
IASD	Initial Alternatives Screening Document
MNA	Monitored Natural Attenuation
O&M	Operation and Maintenance
Pioneer	Pioneer Technical Services, Inc.
RO	Remediation Objectives
UBMC	Upper Blackfoot Mining Complex

1 INTRODUCTION

1.1 Background

The Upper Blackfoot Mining Complex (UBMC) includes a mixture of National Forest and private lands that lie within a portion of the historic Heddleston Mining District in the Rocky Mountains of Lewis and Clark County, Montana. Located approximately 15 miles east of Lincoln, Montana, in the headwaters area of the Upper Blackfoot River, the UBMC covers an area of approximately six square miles. The UBMC is comprised of a number of individual historic underground mines that developed deposits occurring principally as narrow, fault-controlled, base-metal (silver, lead, copper, and zinc) veins.

Historic mining activity at the UBMC has resulted in hard-rock mining wastes and acidic discharges that impact the environment. Human health and environmental issues are primarily related to elevated levels of heavy metals present in mine waste piles, tailings, acidic metal-bearing surface water, groundwater, sediments, water discharging from mine adits, and contaminated waste re-deposited as stream sediments. Numerous investigations have been conducted over the last 20 years to characterize contamination in the mine wastes. Contaminants at the facility include, but are not limited to, arsenic, cadmium, copper, lead, iron, manganese, and zinc.

The Montana Department of Environmental Quality (DEQ) is completing a Feasibility Study (FS) at the UBMC to evaluate alternatives for remediating the mine waste and associated contamination. The Initial Alternatives Screening Document (IASD) is a precursor to the FS used in the evaluation of potential treatment alternatives. The UBMC FS will incorporate selected individual alternatives from the IASD into complete treatment trains within a Proposed Plan.

1.2 Scope of Work

Pioneer Technical Services, Inc. (Pioneer) was tasked by DEQ to evaluate and review potential remediation treatment technologies and prepare this IASD in accordance with DEQ Contract 407038 Task Order No. 81. Work completed by Pioneer included:

- Review the previously prepared draft IASD and complete identification of potential remedial alternatives for physical hazards, floodplain, mine waste, surface water, and groundwater (Table 1).
- Selection of evaluation criteria for the initial screening of alternatives (Table 1).
- Additional evaluation of the alternatives retained in Table 1 using scored criteria for effectiveness, implementability, cost, availability, and reliability and maintainability (Table 2).
- Identification of potential remedial alternatives to be retained for subsequent evaluation in the FS (Table 2).

This document summarizes the screening criteria, the weighted scoring system, responses to DEQ's comments to Tables 1 and 2, and a brief summary of those alternatives deleted and retained.

2 INITIAL ALTERNATIVES SCREENING MATRIX

An Initial Alternatives Screening Matrix was prepared to evaluate feasible remediation alternatives at the UBMC. Development and screening of remediation alternatives included identifying the following:

- Applicable or relevant State and Federal Environmental Requirements, Criteria, or Limitations (ERCLs).
- Preliminary Remedial Objectives (ROs), Contaminants of Concern (COCs), media of interest (e.g. surface water, tailings), exposure pathways, and remediation goals.
- Potential treatments and technologies applicable to remediating contaminated media into compliance with the goals.
- Screening treatments and technologies based on their effectiveness, implementablity, cost (including capital and operation and maintenance [O&M]), availability, and reliability and maintainability.
- Treatment and technology alternatives to further evaluate in the FS to meet the RO and goals.

Remedial alternatives in the FS will be evaluated using Comprehensive Environmental Cleanup and Responsibility Act (CECRA) remedy selection criteria (§75-10-721, MCA). To be retained, an alternative must (1) attain a degree of cleanup that assures protection of public health, safety, and welfare and of the environment; and (2) meet applicable or relevant state and federal ERCLs. In addition, each retained alternative is evaluated and compared to evaluate how that alternative:

- Demonstrates acceptable mitigation of exposure to risks to the public health, safety, and welfare and the environment;
- Demonstrates effectiveness and reliability in the short and long term;
- Demonstrates technical practicability and implementability;
- Implements treatment technologies giving due consideration to engineering controls; and
- Demonstrates cost-effectiveness.

A comprehensive list of applicable remedial alternatives (or process options) was compiled in Table 1-Initial Remedial Alternatives Screening Matrix, for physical hazards, waste rock/tailings piles, floodplain contaminants, surface water, and groundwater. Each general category was further subdivided into the following types of technology:

- No Action;
- Monitored Natural Attenuation (MNA);
- Institutional Controls;
- Engineering Controls;

- Land Disposal;
- Active Treatment; and
- Passive Treatment.

All process options in Table 1 were evaluated based on the Federal Remediation Technology Roundtable (FRTR) factors of effectiveness, implementability, cost (capital) and cost for O&M [FRTR 2007] (see section 4 below for further detail on FRTR criteria).

The pros and cons were listed for each process option and used to make a recommendation for retaining or deleting the option for consideration at the UBMC. A draft version of Table 1 was submitted to DEQ for review and comment. Subsequent to that, a meeting was held to discuss those comments and any other issues with Table 1. All comments were incorporated and a final version of Table 1 was prepared and submitted. The discussions, comments, and decisions regarding Table 1 through this process are summarized in Table 1A.

3 Secondary Alternatives Screening Matrix

Following DEQ comment and approval of Table 1, the retained technologies were further evaluated in Table 2-Remedial Technology and Process Options for Contaminated Media: Secondary Screening Matrix, with the goal of eliminating remedial actions not feasible or suitable for use at the UBMC. Process options in Table 2 were evaluated using the FRTR factors of effectiveness, implementability, availability, cost (capital and O&M combined), and reliability and maintainability (see FRTR discussion in Section 4 below). Individual treatment options were scored for each criteria; the decision to retain an option was based on the total overall score. A more detailed discussion of the scoring system used in Table 2 is presented in Section 5.2 of this IASD.

An initial draft of Table 2 was submitted to DEQ for review in late June 2013. As a result of a meeting between DEQ and Pioneer to discuss DEQ's comments, it was decided that Table 2 would combine the options retained from Table 1 into two categories - physical hazards/solid media and surface water/groundwater - rather than the five categories used previously in Table 1. A draft of this new version of Table 2 was submitted for review to DEQ. The discussions, comments, and decisions regarding Table 2 are summarized in Table 2A. All comments and decisions are incorporated into the updated version of Table 2.

4 FRTR Discussion

The FRTR provides a basic guidance document to evaluate remediation alternatives based on the five guiding factors in the Treatment Technologies Screening Matrix (FRTR 2007). Several of these factors were used to evaluate treatment alternatives in Table 1 and all were used to evaluate and score process options in Table 2. The five guiding factors are defined below:

Effectiveness - Refers to how well the alternative can address the COCs, considering the site specific conditions.

High = highly effective
Medium = moderately effective
Low = slightly or not effective.

Implementability - Refers to how readily an alternative can be implemented at the site.

High = easy to implement
Medium = moderate effort required to implement
Low = difficult to implement.

Cost - Refers to the estimated cost of implementing and constructing a technology based on published prices and engineering judgment, and the estimated cost of maintaining, monitoring, or operating a technology beyond construction, based on published prices and engineering judgment.

High = high degree of capital investment and O&M intensity
Medium = average degree of capital investment and O&M intensity
Low = low degree of capital investment and O&M intensity.

Availability - Refers to the number of vendors that can design, construct, and maintain the technology or provide specialized equipment/materials. In terms of institutional controls, availability refers to the number of landowners involved or affected.

High = More than four vendors or less than two property owners
Medium = Two to four vendors or property owners
Low = fewer than two vendors or more than four property owners.

Reliability & Maintainability - Refers to the expected range of demonstrated reliability and maintenance relative to other technologies.

High = high reliability and low maintenance
Medium = average reliability and average maintenance
Low = low reliability and high maintenance.

5 IASD SUMMARY

5.1 Table 1 - Initial Remedial Alternatives Screening Matrix - UBMC

A total of 137 process options were evaluated in Table 1 for the five categories of media type. Some of these process options were repeated for several media types:

Physical Hazards – All 7 process options that were evaluated were retained for further review in Table 2.

Waste rock/tailings piles areas and associated soils – A total of 39 process options were evaluated: 15 options were retained and 23 options were not retained.

Floodplain Contaminants – A total of 19 process options were evaluated: 12 options were retained and 9 options were not retained.

Surface Water – A total of 41 process options were evaluated: 20 options were retained and 21 options were not retained.

Groundwater – A total of 32 process options were evaluated: 20 options were retained and 12 options were not retained.

5.2 Table 2 - Remedial Technology and Process Options for Contaminated Media: Secondary Screening Matrix

Table 2 was categorized differently than Table 1. Physical Hazards, Waste rock/tailings piles areas and associated soils, and Floodplain Contaminants were grouped together into one option called Physical Hazard/Solid Media for evaluation and scoring. For example, Engineering Controls (bat gate, backfill, plug, and bulkhead) were grouped together as one process option. Surface Water and Groundwater options were grouped together into a single Surface Water/Groundwater option.

The following table summarizes the rankings for each factor and how factors were scored in Table 2:

Rating	Effectiveness	Implementability	Cost	Availability	Reliability
3	High	High	Low	High	High
2	Medium	Medium	Medium	Medium	Medium
1	Low	Low	High	Low	Low

Based on engineering judgment, a weighting factor was assigned to each criteria as follows: 4x for effectiveness, 4x for implementability, 3x for cost, 2x for availability, 1x for reliability and maintainability. The weighting factors were chosen to reflect greatest importance to effectiveness and implementability. These factors were applied to the individual ratings and the total score for each option was calculated as the sum of these weighted scores.

In general, process options that scored less than 25 were not retained for further consideration. However, a process option that scored less than a 25 could be retained if, through engineering judgment, it was considered a valid technology for remediation or part of a treatment train. Treatment alternatives that permanently and significantly reduce contaminant volume, toxicity, or mobility were preferred over those that do not (e.g. no-action), when practicable. The less proactive treatment options could be used to supplement other remedial actions. The following is a summary of the options retained and deleted:

Physical Hazards/Solid Media

A total of 14 process options were evaluated and scored. Eleven options were retained and 3 options were deleted. All options retained received a score of 25 or greater. All options deleted received scores of 24 or less. The 3 options not retained were Engineered Cover, Solid Waste Landfill, and Re-use/Re-processing and respectively scored 23, 24, and 24.

Surface Water/Groundwater

A total of 16 treatment alternatives were evaluated and scored in Table 2. Eleven alternatives were retained and 5 alternatives were deleted. Options that were retained had a range of scores from 25 to 36. Four alternatives that scored less than 25 were deleted. One alternative (Interceptor Trench) that scored 25 was not retained due to low implementability and inapplicability for surface water. The 4 other options that were not retained were Aeration, Reverse Osmosis/Ion Exchange, Vertical Flow Reactors/Subsurface Wetlands/SAPS, and Aquafix, and respectively scored 20, 22, 20, and 18.

6 REFERENCES

FRTR 2007. Federal Remediation Technologies Roundtable (FRTR), Remediation Technologies Screening Matrix and Reference Guide, Version 4, http://www.frtr.gov, last updated in 2007.

TABLE 1
INITIAL REMEDIAL ALTERNATIVES SCREENING MATRIX
UPPER BLACKFOOT MINING COMPLEX

General Response Action	Technology Type	Process Option	Description	Effectiveness[1]	Implementability[2]	Cost[3]	Operations and Maintenance Cost[4]	Pros	Cons	Retain?	Notes	Reference
Physical Hazards												
No Action	No Action	No Action	Feature(s) are left "as is."	Low	N/A	Low	None	Easiest; no cost.	No risk reduction.	Yes	Used as a baseline to compare other alternatives, provide an understanding of current and future potential risks.	EPA 1988, EPA 1989
Institutional Controls	Land Use Controls	Deed restrictions, easements, covenants, and reservations	Limits future land uses.	Low to high	High - issue regarding whether they can be used on public land.	Low	Enforcement	Easy; minimal cost; most effective in preventing residential exposures or exposure to groundwater.	Not very effective in limiting recreational or trespass exposures.	Yes	Commonly used in conjunction with other remedies.	EPA 2000
Engineering Controls	Access restrictions	Warning signs, fencing, and road closure	Access to areas with waste is limited through the use of posted signs warning of potential risks, fencing, and gates.	Low	High	Low	Minimal; subject to vandalism.	Simple; low cost.	Prevents some access; moderate impediment; hazards still accessible by foot.	Yes	May be used to supplement remedial actions.	EPA 2000
	Physical barrier	Bat gate/culvert	Bat gates or culverts are installed in open adits; cupolas in open shafts.	Medium	High	Medium	Minimal; inspect for vandalism.	Maintains bat habitat; allows re-entry if needed.	Vandalism to gate or culvert could allow access to adit/shaft.	Yes	Conventional technology; widely used.	CDMG 2002
		Backfill	Hazard is backfilled using surrounding mine waste, rock, or soil.	High	Medium	High	Minimal; inspect for subsidence.	Eliminates physical hazard; may be able to use waste rock for fill material if it meets clean-up level requirements.	Potential for subsidence or future collapse; eliminates potential bat habitat.	Yes	Conventional technology; widely used.	CDMG 2002
		Plug	A polyurethane foam or concrete plug is installed in adit or shaft and covered with clean backfill or rock.	High	Medium	Medium	Minimal; inspect for vandalism.	Eliminates physical hazard.	Eliminates potential bat habitat; prone to leaking or failure.	Yes	Conventional technology; widely used.	CDMG 2002
		Bulkhead	A concrete bulkhead with piping and valves for hydraulic control is installed in adit.	High	Medium	High	Moderate; maintain piping and valves.	Eliminates physical hazard; allows control of hydraulic head; less prone to failure.	Eliminates potential bat habitat; requires maintaining hydraulic controls.	Yes	Conventional technology; widely used.	CDMG 2002
Waste rock/tailings piles areas and associated soils												
No Action	No Action	No Action	Feature(s) are left "as is."	Low	N/A	Low	None	Easiest; no cost.	No risk reduction.	Yes	Used as a baseline to compare other alternatives, provide an understanding of current and future potential risks.	EPA 1988, EPA 1989
Monitoring	Monitoring	Monitoring and maintenance	Features and/or sources are monitored and maintained as needed.	Low	Medium	Low	Minimal-depends on level of maintenance required.	Easy; minimal cost; most applicable to previously reclaimed areas that meet site-specific cleanup levels (SSCLs)[5] and natural systems that are already accessible.	Focus is on maintaining rather than improving conditions; reactive rather than proactive.	Yes	May be applicable to features that have already been reclaimed/remediated that meet SSCLs.	N/A
Institutional Controls	Land Use Controls	Deed restrictions, easements, covenants, and reservations	Limits future land uses.	Low to high	High	Low	Enforcement	Easy; minimal cost; most effective in preventing residential exposures or exposure to groundwater.	Not very effective in limiting recreational or trespass exposures.	Yes	Commonly used in conjunction with other remedies.	EPA 2000

TABLE 1
INITIAL REMEDIAL ALTERNATIVES SCREENING MATRIX
UPPER BLACKFOOT MINING COMPLEX

General Response Action	Technology Type	Process Option	Description	Effectiveness[1]	Implementability[2]	Cost[3]	Operations and Maintenance Cost[4]	Pros	Cons	Retain?	Notes	Reference
Engineering Controls	Access restrictions	Warning signs, fencing and road closure	Access to areas with waste is limited through the use of posted signs warning of potential risks, fencing, and gates.	Low	High	Low	Minimal; subject to vandalism.	Simple; low cost.	Prevents some access; moderate impediment; hazards still accessible by foot.	Yes	May be used to supplement remedial actions.	EPA 2000
	Solids containment/ encapsulation	Earthen vegetative cover	Minimal soil and plant cover to eliminate direct exposure pathway and prevent erosion.	Medium	Medium	Medium	Moderate; inspect for erosion.	Easy to construct; permanent; eliminates surface exposure.	Requires cover soil source; not effective in limiting infiltration. Flood events may cause mobilization.	Yes	May be effective in areas not requiring excavation; ie. depends on characterization of the waste.	EPA 2004, INAP 2010
		Rock cover	Coarse durable rock placed directly over waste or a synthetic liner.	Low	Medium	Medium	Moderate; inspect for erosion.	More durable than earthen vegetative cover.	Requires rock source; not effective in limiting infiltration.	No	Low efficacy; better suited to arid environments.	EPA 2000, EPA 2006
		Evapotranspiration (ET or store-and-release) cover	Soil, rock, and plant cover designed to minimize infiltration by storing precipitation until it is transpired through vegetation or evaporated from the soil surface.	Low	Low	High	Minimal; inspect for erosion.	Installation permanent. Less prone to deterioration than other covers.	Most suitable for arid/semi-arid climates; requires very thick cover in high precipitation areas.	No	Not applicable to UBMC. Increased percolation and decreased evapotranspiration in areas with significant snowfall.	EPA 2006, INAP 2010
		Clay cover	Low permeability compacted clay covered with soil and vegetation.	Medium	Low	High	Significant; clay subject to desiccation in semi-arid climate.	Significantly reduces infiltration; more forgiving installation than geosynthetic liners.	Clay prone to decomposition from desiccation and freeze/thaw; requires a clay source.	No	Low efficacy; better suited to warmer climates.	ITRC 2010, INAP 2010
		Geosynthetic cover	Geosynthetic clay liner (GCL) typically covered with soil and vegetation.	High	Low	High	Moderate; inspect for desiccation.	Significantly reduces infiltration; more forgiving installation than synthetic liners; easy to install.	GCL may be prone to decomposition from desiccation and freeze/thaw if not properly designed or specified.	Yes	Conventional technology; widely used. May be applicable at UBMC for in-place wastes on relatively flat slopes.	INAP 2010
		Synthetic cover	Synthetic liner (PVC, HDPE, LLDPE) typically covered with drain rock, soil, and vegetation.	High	Low	High	Minimal; inspect for damage and erosion.	Effective at eliminating infiltration through waste material.	Must be installed/tested correctly; expensive; has finite life.	Yes	Conventional technology; widely used. May be applicable at UBMC for in-place wastes on relatively flat slopes.	EPA 2006, INAP 2010
		Engineered cover	Engineered multi-layer cover with a synthetic liner (GCL, HDPE, LLDPE), soil, and vegetation.	High	Low	High	Minimal; inspect for damage and erosion.	Most effective and protective; offers options depending on cost and availability of cover materials.	Must be properly designed and installed/tested correctly; expensive; has finite life.	Yes	Conventional technology; widely used. May be applicable at UBMC for in-place wastes on relatively flat slopes.	EPA 2006, INAP 2010
		Biological cover	Carbohydrate– or protein–based nutrient mixes added to cover soil.	Low	Low	High	Minimal; inspect for erosion.	Minimizes acid generation by consuming oxygen in infiltrating water.	Strongly depends on mixture and waste chemistry; limited evidence of success at hard rock mines.	No	Innovative technology with limited evidence of success; long-term efficacy and longevity not well documented.	EPA 2001, EPA 2004
		Cementitious cover	Fiber–reinforced concrete/mortar cover.	Medium	Low	High	Moderate; inspect for cracking.	Prevents infiltration into waste material.	Subject to cracking; not natural looking.	No	Expensive and subject to cracking from freeze/thaw.	EPA 2000
		Polyurethane grout	Polyurethane grout sprayed on mine waste to form an impermeable cover.	Medium	Low	High	Moderate; inspect for integrity.	Reduces infiltration; more plastic than cement grouts.	Long-term stability unproven; may need reapplication. High costs.	No	Very limited use at mine sites; long-term efficacy and longevity unknown.	EPA 2000

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UPPER BLACKFOOT MINING COMPLEX

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Land Disposal	On-Site disposal	On-Site repository	Mine waste is excavated and placed in an on-site repository.	High	High	Medium	Moderate; inspect cap and analyze leachate; inspect reclaimed areas.	Eliminates or reduces direct exposure by putting waste in an engineered disposal location.	Risk of spills during transportation; waste remains on-site; potential for re-exposure; may require leachate collection and treatment; may require land acquisition.	Yes	Conventional technology; widely used.	EPA 2000
		Underground disposal	Mine waste is excavated and used to backfill underground mine workings.	Low to high	Low	High	Minimal; monitor groundwater.	Eliminates direct exposure; can limit acid production.	High cost; potential for groundwater contamination or increased AMD[6].	No	Commonly used for small waste quantities. Not retained. See USFS Analysis[7].	ITRC 2010
		Subaqueous disposal/water cover	Mine waste is excavated and placed in a natural or man-made lake or pond.	High	Low	Medium	Minimal; monitor surface water.	Eliminates direct exposure; prevents oxidation and release of most metals.	Requires natural or man-made water body; may still release problematic contaminants.	No	Not applicable at UBMC for tailings; existing water bodies and available land are in floodplain; expensive. Not retained. See USFS Analysis[8].	ITRC 2010, EPA 2006, INAP 2010
	Off-Site disposal	Off-site repository	Mine waste is excavated and placed in an off-site repository.	High	High	High	Minimal; material hauled off site; inspect reclaimed areas.	Eliminates direct exposure by removing waste from site.	Risk of spills during transport; may require leachate collection and treatment; requires land acquisition.	Yes	Conventional technology; widely used.	EPA 2000
		Solid waste landfill	Mine waste is excavated and placed in a solid waste landfill.	High	High	High	Minimal; material hauled off site; inspect reclaimed areas.	Eliminates direct exposure by removing waste from site.	Risk of spills during transport; high transport and disposal cost.	Yes	Use local landfill.	EHSO 2013
		Re-use/ Re-processing	Mine waste is excavated and re-processed for metals recovery or re-used for other purposes.	High	Medium	High	None	Removes mine waste from site; resource recovery may offset remediation costs; reduces waste volume.	Requires excavation and hauling off-site; some disposal required; depends on waste material characteristics.	Yes	May be applicable to some wastes at UBMC.	ITRC 2010, EPA 2004
		Emulsification	Mine waste is excavated and mixed with water-based asphalt emulsion.	Medium	Low	High	Minimal	Removes mine waste from site; potential waste re-use may offset remediation costs.	Requires excavation, hauling off-site, and processing; applicable to Pb-contaminated wastes.	No	Not applicable to UBMC. Difficult to mobilize necessary equipment and materials to the site.	ESTCP 2006
Treatment	In-situ Treatment	Solidification/ stabilization/ fixation	Waste rock is injected with cement or other material to physically stabilize.	Medium to High	High	High	Minimal; inspect for cracking and erosion.	Does not require waste excavation; reduces contaminant mobility.	Waste remains on site; solid matrix may eventually break down; increases overall waste volume; high cost.	No	Subject to breakdown from freeze/thaw; expensive; not commonly used.	EPA 2000, ESTCP 2006
		Vitrification	Waste rock is heated to greater than 2800 °F to melt minerals.	High	Low	High	Minimal; inspect for cracking and erosion.	Does not require waste excavation.	Requires high energy source; high cost; waste remains on site.	No	Requires power source; very expensive; not commonly used at mine sites.	EPA 2000
		Neutralization/ Alkaline amendment	Cement kiln dust, lime, or other alkaline material is tilled into the mine waste to neutralize acid-producing materials.	Medium	Medium to High	High	Moderate; monitor for effectiveness.	Decreases mobility of metals in acidic soils; prevents acid generation.	Surficial treatment; not effective at depth. May require complex design/modeling.	Yes	May be applicable to thin waste deposits.	Costello 2003, EPA 2006

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UPPER BLACKFOOT MINING COMPLEX

General Response Action	Technology Type	Process Option	Description	Effectiveness[1]	Implementability[2]	Cost[3]	Operations and Maintenance Cost[4]	Pros	Cons	Retain?	Notes	Reference
Treatment	In-situ Treatment	Biosolids/organic wastes	Biosolids or organic wastes consisting of treated municipal sludge or manure are added to the mine waste to inhibit pyrite oxidation.	Low	Medium	High	Moderate; monitor for effectiveness.	Coats pyrite surfaces, decreases acid production; supports vegetation.	Limited applicability; requires biosolids source; waste remains on site.	No	May be applicable to thin waste deposits, but cost and availability of bio-solids is prohibitive.	ITRC 2010, INAP 2010
		Bactericides	Liquid ionic surfactant is applied to acid-generating mine waste to control pyritic oxidation.	Low	Medium	Medium	Moderate; monitor for effectiveness.	Decreases acid production by limiting pyritic oxidation and reduces metals leaching.	Most effective when applied to fresh, unoxidized sulfide-rich waste; limited by preferential flow in waste rock; may need reapplication.	No	Low efficacy for aged mine waste.	ADTI 1998, INAP 2010
		Electrokinetics	Electric current is applied to the waste material to mobilize and extract metal ions.	Low	Low	High	Significant; maintain system and replace anodes.	Little surface disturbance; most efficient in low-permeability soils.	Unproven; requires power source; high O&M and cost.	No	Not commonly used at mine sites; expensive; low efficacy on non-clayey granular soils.	ITRC 2010
		Passivation	Waste rock is rinsed with chemical solution then treated with a chemically inert protective surface layer (e.g., potassium permanganate).	Low	Medium	High	Moderate; monitor for effectiveness.	Prevents oxidation of the treated waste rock and reduces acid generation.	Unproven; longevity unknown; complete coverage difficult; may need reapplication.	No	Innovative technology with limited evidence of success; long-term efficacy and longevity not well documented.	EPA 2006, INAP 2010, ITRC 2010
		Ecobond®	Waste rock is coated with a phosphate-based solution to form a stable, insoluble coating.	Low	Medium	High	Moderate; monitor for effectiveness.	Prevents oxidation of the treated waste rock and reduces acid generation.	Unproven; longevity unknown; complete coverage difficult.	No	Innovative technology with limited evidence of success; long-term efficacy and longevity not well documented.	EPA 2006, ITRC 2010
		Phosphate-induced metal stabilization (PIMS)/Apatite II™	Proprietary phosphate material is mixed into waste to incorporate metals into stable, non-leachable phosphate phases.	Low	Low	Medium	Minimal	Minimal amendment (1 to 3%) required; effective for Pb-contaminated waste.	Waste remains on site; longevity unknown.	No	Long-term efficacy and longevity unknown; mixing of materials not applicable at UBMC.	ESTCP 2006
		Silica micro encapsulation (SME)	Combined physical and chemical process involving pH adjustment, electrokinetic reaction, and metal hydroxyl formation which encapsulates metals in an impervious silica matrix.	High	Low	High	Significant	Very robust technology in wastewater treatment.	High cost; complex process; generates secondary waste; solid matrix may eventually break down; unproven in mining industry.	No	Innovative technology with limited evidence of success; not commonly used at mine sites; long-term efficacy and longevity not well documented.	EPA 2004
		Bioremediation	Biological nutrients are applied to the mine waste to stimulate natural microorganisms for the biological attenuation and stabilization of metals.	Low	Medium	High	Moderate; monitor for effectiveness.	Microorganisms can aid or accelerate metals oxidation reactions.	Surficial treatment; longevity and effectiveness in cold climates unknown.	No	Long-term efficacy and longevity unknown; expensive.	EPA 2004, ADTI 1998
		Phytoremediation	Plant systems are used to extract, stabilize, or detoxify heavy metals in the mine waste.	Low	Medium	Medium	Moderate; monitor for effectiveness.	Natural system; does not require chemical reagents.	Limited effectiveness; shallow treatment only; requires processing the plants. May need re-seeding.	No	Not effective in cold climates or practical at as a stand-alone treatment at UBMC.	ITRC 2010

TABLE 1
INITIAL REMEDIAL ALTERNATIVES SCREENING MATRIX
UPPER BLACKFOOT MINING COMPLEX

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Treatment	Ex-situ Treatment	Solvent extraction	Mine waste is excavated and a nonaqueous liquid solvent is applied to extract metals.	Medium	Low	High	Moderate; monitor for effectiveness.	Reduces waste toxicity; potential for resource recovery.	More applicable to organic contaminants; generates concentrated waste stream.	No	Complex, expensive process; not commonly used on mine wastes; waste still requires disposal after processing.	EPA 2004
		Blending/Co-disposal	Waste rock of varying acid-generation and neutralization potentials are mixed to create a blend that generates a discharge of acceptable quality.	Medium	Low	High	Moderate; monitor for effectiveness.	Does not require chemical management and application; does not increase waste volume.	Requires a balance of acid-generating and neutralizing waste rock; requires thorough mixing.	No	Depends on the tailings and mine waste chemistry; to be used in conjunction with other alternatives onsite such as earthen vegetative cover.	INAP 2010
		Blending/Co-disposal at Repository	Waste rock of varying acid-generation and neutralization potentials are mixed to create a blend that generates a discharge of acceptable quality.	Medium	Low	Medium	Moderate; monitor for effectiveness.	Does not require chemical management and application; does not increase waste volume.	Requires a balance of acid-generating and neutralizing waste rock; requires thorough mixing.	Yes	Alternative is accomplished through placement in repository.	INAP 2010
		Neutralization/ Alkaline amendment	Cement kiln dust, lime, or other alkaline material is tilled into the mine waste to neutralize acid-producing materials.	Medium	Medium to High	High	Moderate; monitor for effectiveness.	Decreases mobility of metals in acidic soils; prevents acid generation.	Requires thorough mixing; increases waste volume.	Yes	Conventional technology that is commonly used to neutralize acid-generating mine waste.	Costello 2003, EPA 2006
		Washing	Mine waste is excavated, screened, and washed with an acidic aqueous solution to remove metals.	Medium	Low	High	Moderate; monitor for effectiveness.	Reduces waste toxicity; potential for resource recovery.	Requires water source; significant waste handling and chemical disposal.	No	Complex, expensive process; not commonly used on mine wastes; waste still requires disposal after processing.	ESTCP 2006, EPA 2000
Floodplain Contaminants												
No Action	No Action	No Action	Feature(s) are left "as is."	Low	N/A	Low	None	Easiest; no cost.	No risk reduction.	Yes	Used as a baseline to compare other alternatives, provide an understanding of current and future potential risks.	EPA 1988, EPA 1989
Monitoring	Monitoring	Monitoring & maintenance	Features are monitored and maintained as needed.	Low	High	Low	Minimal - depends on level of maintenance required.	Easy; minimal cost; most applicable to previously reclaimed areas and natural systems that are already accessible.	Focus is on maintaining rather than improving conditions; reactive rather than proactive.	Yes	May be applicable to features that have already been reclaimed/remediated that meet SSCLs.	N/A
Institutional Controls	Land Use Controls	Deed restrictions, easements, covenants, and reservations.	Limits future land uses.	Low to high	High	Low	Enforcement	Easy; minimal cost; most effective in preventing residential exposures or exposure to groundwater.	Not very effective in limiting recreational or trespass exposures.	Yes	Commonly used in conjunction with other remedies.	EPA 2000

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UPPER BLACKFOOT MINING COMPLEX

General Response Action	Technology Type	Process Option	Description	Effectiveness[1]	Implementability[2]	Cost[3]	Operations and Maintenance Cost[4]	Pros	Cons	Retain?	Notes	Reference
Engineering Controls	Access restrictions	Warning signs, fencing, and road closure.	Access to areas with waste is limited through the use of posted signs warning of potential risks, fencing, and gates.	Low	High	Low	Minimal; subject to vandalism.	Simple; low cost.	Prevents some access; moderate impediment; hazards still accessible by foot.	Yes	May be used to supplement remedial actions.	EPA 2000
	Removal of contaminated floodplain material	Remove to an indicator	Wastes are removed to cleanup levels or designated concentrations, or to a physical/visual indicator such as groundwater or bedrock.	High	Medium	High	Minimal	Thorough; high efficacy; easy to implement.	May require removal of a significant volume of floodplain soils. May not achieve RAOs if removing to depth only.	Yes	Vertical extents based on RI and 2012 investigations.	CDMG 2002
		Remove within CMZ[10]	Removal of concentrated and mixed tailings within the CMZ.	Medium	High	Medium	Moderate; monitor for contaminants left in place.	None	Difficult to clearly define CMZ in some cases; not necessarily complete removal.	Yes	Removal horizontal extents defined for floodplain areas.	CDMG 2002
	Solids containment/ encapsulation	Earthen vegetative cover	Minimal soil and plant cover to eliminate direct exposure pathway and prevent erosion.	Medium	Medium	Medium	Moderate; inspect and maintain cover.	Easy to construct; permanent; eliminates surface exposure.	Requires cover soil source; not effective in limiting infiltration. Flood events may cause mobilization.	Yes	May be effective in areas with a discrete characterized waste source. Does not involve excavation.	EPA 2004, INAP 2010
Land Disposal	On-site disposal	On-site repository	Mine waste is excavated and placed in an on–site repository.	High	High	Medium	Moderate; inspect cap and analyze leachate; inspect reclaimed areas.	Eliminates or reduces direct exposure by putting waste in an engineered disposal location.	Risk of spills during transportation; waste remains on site; potential for re-exposure; may require leachate collection and treatment; may require land acquisition.	Yes	Conventional technology; widely used.	CDMG 2002
		Subaqueous disposal/water cover	Mine waste is excavated and placed in a natural or man-made lake or pond.	High	Low	High	Minimal; monitor surface water.	Eliminates direct exposure; prevents oxidation and release of most metals.	Requires natural or man-made water body; may still release problematic contaminants.	No	Not applicable at UBMC for floodplain deposits; existing water bodies and available land are in floodplain; expensive.	ITRC 2010, EPA 2006, INAP 2010
	Off-site disposal	Off-site repository	Mine waste is excavated and placed in an off-site repository.	High	High	High	Minimal; material hauled off site; inspect reclaimed areas.	Eliminates direct exposure by removing waste in an engineered disposal location.	Risk of spills during transportation; may require leachate collection and treatment; requires land acquisition.	Yes	Conventional technology; widely used.	CDMG 2002
Treatment	In-situ Treatment	Neutralization/ Alkaline amendment	Cement kiln dust, lime, or other alkaline material is tilled into the mine waste to neutralize acid-producing materials.	Medium	Medium to High	Medium	Moderate; monitor for effectiveness.	Decreases mobility of metals in acidic soils; prevents acid generation.	Surficial treatment; not effective at depth. May require complex design/modeling. Increased soil alkalinity may increase the mobilization of arsenic compounds.	Yes	May be applicable to thin waste deposits.	Costello 2003, EPA 2006
		Biosolids/organic wastes	Biosolids or organic wastes consisting of treated municipal sludge or manure are added to the mine waste to inhibit pyrite oxidation.	Low	Medium	High	Moderate; monitor for effectiveness.	Coats pyrite surfaces, decreases acid production; supports vegetation.	Limited applicability; requires biosolids source; waste remains on site.	No	May be applicable to thin waste deposits, but cost and availability of bio-solids is prohibitive. Not applicable at UBMC.	ITRC 2010, INAP 2010
		Phosphate-induced metal stabilization (PIMS)/Apatite II™	Proprietary phosphate material is mixed into waste to incorporate metals into stable, non-leachable phosphate phases.	Low	Medium	High	Minimal	Minimal amendment (1 to 3%) required; effective for Pb-contaminated waste.	Waste remains on site; longevity unknown.	No	Long-term efficacy and longevity unknown; mixing of materials not applicable at UBMC.	ESTCP 2006

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INITIAL REMEDIAL ALTERNATIVES SCREENING MATRIX
UPPER BLACKFOOT MINING COMPLEX

General Response Action	Technology Type	Process Option	Description	Effectiveness[1]	Implementability[2]	Cost[3]	Operations and Maintenance Cost[4]	Pros	Cons	Retain?	Notes	Reference
Treatment	In-situ Treatment	Bioremediation	Biological nutrients are applied to the mine waste to stimulate natural microorganisms for the biological attenuation and stabilization of metals.	Low	Medium	High	Moderate; monitor for effectiveness.	Microorganisms can aid or accelerate metals oxidation reactions.	Surficial treatment; longevity and effectiveness in cold climates unknown.	No	Long-term efficacy and longevity unknown; expensive.	EPA 2004, ADTI 1998
		Phytoremediation	Plant systems are used to extract, stabilize or detoxify heavy metals in the mine waste.	Low	Medium	Medium	Moderate; harvest and process plants.	Low cost; easy; creates aesthetic habitat.	Limited effectiveness; shallow treatment only; requires processing the plants. May need re-seeding.	No	Not effective in cold climates or practical at as a stand-alone treatment at UBMC.	ITRC 2010
	Ex-situ Treatment	Blending/Co-disposal	Waste rock of varying acid-generation and neutralization potentials are mixed to create a blend that generates a discharge of acceptable quality.	Medium	Low	High	Moderate; monitor for effectiveness.	Does not require chemical management and application; does not increase waste volume.	Requires a balance of acid-generating and neutralizing waste rock; requires thorough mixing.	No	Depends on the tailings and mine waste chemistry; to be used in conjunction with other alternatives onsite such as earthen vegetative cover.	INAP 2010
		Blending/Co-disposal at Repository	Waste rock of varying acid-generation and neutralization potentials are mixed to create a blend that generates a discharge of acceptable quality.	Medium	Low	Medium	Moderate; monitor for effectiveness.	Does not require chemical management and application; does not increase waste volume.	Requires a balance of acid-generating and neutralizing waste rock; requires thorough mixing.	Yes	Alternative is accomplished through placement in repository.	INAP 2010
		Neutralization/ Alkaline amendment	Cement kiln dust, lime, or other alkaline material is blended with the mine waste to neutralize acid-producing materials.	Medium	Medium to High	High	Moderate; monitor for effectiveness.	Decreases mobility of metals in acidic soils; prevents acid generation.	Requires thorough mixing; increases waste volume. Increased soil alkalinity may increase the mobilization of arsenic compounds.	Yes	Conventional technology that is commonly used to neutralize acid-generating mine waste.	Costello 2003, EPA 2006
		Washing	Mine waste is excavated, screened, and washed with acidic aqueous solution to remove metals.	Medium	Low	High	Moderate; monitor for effectiveness.	Reduces waste toxicity; potential for resource recovery.	Requires water source; significant waste handling and chemical disposal.	No	Complex, expensive process; not commonly used on mine wastes; waste still requires disposal after processing.	ESTCP 2006, EPA 2004
Surface Water												
No Action	No Action	No Action	Feature(s) are left "as is."	Low	N/A	Low	None	Easiest; no cost.	No risk reduction.	Yes	Used as a baseline to compare other alternatives, provide an understanding of current and future potential risks.	EPA 1988, EPA 1989
Monitoring Natural Attenuation	Monitoring Natural Attenuation (MNA)	Water quality monitoring	MNA is used in conjunction with active remediation (source control or removal) or as a follow-up measure after active remediation. It relies on natural physical, chemical, and biological processes to reduce the concentrations of contaminants.	Low	High	Low	Minimal; depends on level of monitoring required.	Easy; minimal cost; most applicable to previously reclaimed areas and natural systems.	Relies on the success of previous reclamation efforts.	Yes	May be applicable to some features that have already been reclaimed or remediated if SSCLs are met.	EPA 1999
Institutional Controls	Administrative control	Fish advisories & closures	Areas are closed to fishing as needed, public is warned of potential dangers about fishing through public notices.	Low	High	Low	Minimal; update public of any changes as needed or as conditions change.	Easy; minimal cost.	Slight risk reduction, subject to public knowledge.	Yes	Most advisories involve five primary contaminants: mercury, PCBs, chlordane, dioxins, and DDT.	EPA 2012

TABLE 1
INITIAL REMEDIAL ALTERNATIVES SCREENING MATRIX
UPPER BLACKFOOT MINING COMPLEX

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Engineering Controls	Containment	Retention pond	Retention pond is constructed on site to retain AMD, depends on evaporation and/or infiltration.	Medium	High	Low	Minimal; inspect for overflow.	Easy to construct; retains AMD on site; applicable for very low flows.	Does not treat AMD; creates contaminant source and exposure pathway.	Yes	May be used for retention of AMD at smaller remote features.	EPA 2000, EPA 2006
	Hydraulic control	Diversion	Diversion channels are installed to intercept surface water run-on and divert around mine waste.	High	High	Low	Minimal; inspect for erosion.	Reduces erosion and percolation of water through waste rock.	Not independently effective.	Yes	Successful under the right conditions. May be used to supplement other alternatives.	EPA 2000, EPA 2006, INAP 2010
		Piping	Piping is installed to convey stream flows around mine waste or workings.	Medium	Medium	Low	Minimal; inspect piping.	Eliminates contact with waste; reduces erosion of waste pile.	Not independently effective; less effective along a gaining surface water reach.	Yes	Conventional technology currently in use at UBMC. May be used to supplement other alternatives.	ITRC 2010
		Stream realignment	A new stream channel is constructed to convey flows around mine waste or workings.	Medium	Medium	Medium	Minimal; inspect for erosion.	Eliminates contact with waste; reduces erosion of waste pile.	Not independently effective.	Yes	May be applicable for some features. May be used to supplement other alternatives.	CDMG 2002
	Detention	Settling pond	Settling pond is constructed to remove solids and promote metals precipitation.	Medium	High	Medium	Moderate; excavate and dispose of sediments every few years.	Reduces sediment load to stream; use as pretreatment.	Requires large surface area; usually only used for pre-treatment. Only reduces sediments and precipitates formed on air contact.	Yes	Effective when used in combination with other options.	CDMG 2002, EPA 2004
	Infiltration	Infiltration gallery	A gallery/basin is constructed to infiltrate AMD.	Low	Low	Medium	Minimal; inspect for plugging.	Removes contaminant source and exposure pathway.	Unlikely to remove dissolved metals or affect solids precipitated upon air contact.	No	Plugging of gallery likely and not effective. Not applicable at UBMC.	Creighton 2012
	Prevention/ minimization	Alkaline recharge structure/diversion well	Upgradient surface water is diverted to flow through trenches or pits filled with porous alkaline material to induce alkaline water into mine waste.	Low	Low	High	Moderate; replenish limestone.	Reduces acid generation and metals leaching from the mine waste.	Generates more flow through waste than diverting the water around waste.	No	Plugging/flooding could lead to serious problems; expensive; difficult; low efficacy.	EPA 2004
		Inert gas blanket	Underground mine workings are filled with an inert gas, such as carbon dioxide or nitrogen, to displace oxygen, and sealed to prevent oxidation.	Low	Medium	High	Moderate; monitor gas levels.	Prevents oxidation of acid material and production of AMD; no by-product or residue.	Mine must be completely sealed; requires large volume of gas. May require refilling and resealing.	No	Very low efficacy for mines with large underground networks, multiple surface openings, fractured bedrock, and exposed faults.	ADTI 1998, INAP 2010

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INITIAL REMEDIAL ALTERNATIVES SCREENING MATRIX
UPPER BLACKFOOT MINING COMPLEX

General Response Action	Technology Type	Process Option	Description	Effectiveness[1]	Implementability[2]	Cost[3]	Operations and Maintenance Cost[4]	Pros	Cons	Retain?	Notes	Reference
Active Treatment	Chemical/ reagent	Mechanical lime injection	Mechanical feeder dispenses neutralizing agents (lime or hydrated lime) to AMD followed by a settling pond for metals precipitation.	High	Medium	Medium	Significant; replenish lime and dispose of sludge.	Cost-effective method for treating large AMD flows.	Requires settling pond and sludge disposal; less cost effective for small flows.	Yes	May be applicable for some features.	CDMG 2002, EPA 2006
		Aeration	Air is introduced into the water using gravity or mechanical devices to promote oxidation of Fe and Mn.	Medium	High	Low	Minimal for passive, significant for active.	Simple; usually combined with other technologies to improve efficiency.	Not a stand-alone technology; only effective at pH > 5.	Yes	Effective when used in combination with other options.	ADTI 1998, ITRC 2010, INAP 2010
		Oxidation	A chemical oxidant, such as hydrogen peroxide or potassium permanganate, is added to enhance metal hydroxide precipitation and reduce metal flocculent volume.	Medium	Medium	High	Significant; replenish oxidant and dispose of sludge.	Usually combined with other technologies to improve efficiency.	Requires chemical delivery system, sludge removal and disposal.	Yes	Currently in use at UBMC.	ADTI 1998
		Precipitation	A chemical reagent, such as sodium hydroxide or calcium carbonate, is added to promote precipitation of metals as hydroxides.	High	Medium	High	Significant; replenish reagent.	Proven effective; immediate results; usually combined with other technologies.	Requires chemical delivery system, sludge removal and disposal.	Yes	Effective when used in combination with other options.	ITRC 2010
	Physical/ mechanical	Reverse osmosis	Water is forced through a semi-permeable membrane to remove metals and other contaminants.	High	Medium	High	Moderate	Effective; produces high quality effluent.	Produces a highly concentrated waste stream; expensive.	Yes	May be applicable for polish treatment.	ADTI 1998, EPA 2004
		Electrocoagulation	An electrical current is applied to promote coagulation of organics and suspended solids in water.	Medium	Low	High	Moderate	Potentially recoverable metals; alternative to chemical precipitation; One-third less sludge compared to conventional precipitation.	Unproven; expensive.	Yes	Under consideration for use at the UBMC Water Treatment Plant (WTP) when combined with other alternatives. New methodology may increase effectiveness.	ITRC 2010
		Ion exchange	Water is passed through a bed of ion-exchange material to transfer metals ions onto the material.	High	Low	High	Significant; replenish ion-exchange material.	Effective; produces high quality effluent.	Produces a highly concentrated waste stream; expensive.	Yes	May be applicable for polish treatment.	ADTI 1998, FRTR 2007, INAP 2010
		Silica micro encapsulation (SME)	Combined physical and chemical process involving pH adjustment, electrokinetic reaction, and metal hydroxyl formation which encapsulates metals in an impervious silica matrix.	High	Low	High	Significant; replenish silica matrix.	Metals are encapsulated in the matrix; resists degradation.	High cost; complex process; generates secondary waste, unproven.	No	Complex, expensive process with only limited use at mine sites; long-term efficacy and longevity unknown.	EPA 2004
		Ceramic microfiltration	Multi-stage system involving pre-treatment with sodium hydroxide and pumping through a ceramic membrane.	High	Low	High	Significant; replace or wash membranes.	Effective; can produce high quality effluent.	High cost; complex process; generates secondary waste.	Yes	Currently in use at the WTP.	EPA 2004
		Ionic state modification process	Multi-stage system involving pre-treatment with a proprietary chemical and pumping through a electromagnetic reactor.	Medium	Medium	High	Significant	High quality effluent is possible.	Requires power source and conventional precipitation step and sludge disposal; unproven.	No	Not widely used; only limited information available; expensive.	EPA 2004

TABLE 1
INITIAL REMEDIAL ALTERNATIVES SCREENING MATRIX
UPPER BLACKFOOT MINING COMPLEX

General Response Action	Technology Type	Process Option	Description	Effectiveness[1]	Implementability[2]	Cost[3]	Operations and Maintenance Cost[4]	Pros	Cons	Retain?	Notes	Reference
Passive Treatment	Biotreatment	Anaerobic wetland (reducing)	Shallow downflow through wetland consisting of 1 to 2 feet of organic matter and 6 to 12 inches of limestone substrate; neutralize acidity and reduce metals to the sulfide form.	Low	Medium	High	Moderate; replace substrate and manage sediment.	No pumps/motors; efficient for a wide range of metals.	Less effective in winter; requires large area and pH >5.	No	Not effective in cold climates or practical at UBMC; expensive.	H&H 2003, BLM 2003, EPA 2006, INAP 2010
		Aerobic wetland (oxidizing)	Shallow surface flow over wetland consisting of 1 to 3 feet of vegetated gravel/organic matter; pre-aeration improves efficiency; facilitates natural oxidation of metals and precipitate Fe, Mn, and other metals.	Low	Medium	High	Moderate; replace substrate and manage sediment.	Requires less area than anaerobic wetland; mimics natural system.	Less effective in winter; requires large area, long residence time, and near neutral pH; only effective for select metals.	No	Not effective in cold climates or practical at UBMC; expensive.	CDMG 2002, BLM 2003, EPA 2006, INAP 2010
		Sulfate reducing bioreactor (SRB)	Lined pond or series of buried trenches or tanks containing organic matter (e.g., manure), sulfate-reducing bacteria, and limestone.	Low	Low	Medium to High	Moderate; requires carbon source and disposal of sludge.	No pumps/motors; subsurface; can be engineered for cold climates.	Subject to freezing and plugging; requires very large area for high flows and pH >5; not effective for Mn removal.	No	Not effective in cold climates or practical at UBMC; expensive.	EPA 2000, EPA 2006, INAP 2010
		Vertical flow reactors	Treatment cell composed of ponded water over organic substrate and limestone drainage layer, usually combined with settling pond and aerobic wetland.	Medium	Medium	Medium	Moderate; may require flushing and replacing substrate.	Requires less area than other methods; treats highly acidic water; can be constructed subsurface.	Requires long retention time; requires replacing organics and flushing system; low efficacy for Mn removal.	Yes	May be applicable for some features.	Zipper 2001, ITRC 2010
		Subsurface flow wetlands	Water is routed through a series of buried organic and gravel substrates for metals removal; surface left vegetated and dry.	Medium	Medium	Medium	Moderate; may require flushing and replacing substrate.	Can support simultaneous aerobic and anaerobic conditions; not as vulnerable to freezing.	Subject to plugging.	Yes	May be applicable for some features.	H&H 2003
		Sulfate reducing wetland	3 to 6 feet of organic substrate to feed bacteria for metals removal, over drain gravel and perforated pipe.	Low	Medium	High	Moderate; may require flushing and replacing substrate.	Requires less area than some other treatment methods.	Malodorous; less efficient in cold climates; best for pH > 5.5; not effective for Mn removal.	No	Not effective in cold climates or practical at UBMC; expensive.	CDMG 2002, BLM 2003
		Successive alkalinity producing system (SAPS)	Water is ponded over organic material and limestone drainage layer; similar to vertical flow reactor; combines an anoxic limestone drain and anaerobic wetland; 3 to 6 feet of water over 6 to 12 inches of organic matter, over 1 to 2 feet of limestone drainage layer.	Medium	Medium	Medium	Moderate; may require flushing and replacing substrate.	May be more effective and require less space than anaerobic wetlands; less prone to freezing.	Requires flushing to prevent clogging and formation of preferential flow paths; less effective for Mn removal.	Yes	May be applicable for some features.	Costello 2003, ITRC 2010, EPA 2004, EPA 2006, BLM 2003
		Pyrolusite® Limestone Beds	Limestone–filled beds inoculated with proprietary aerobic microorganism population.	Low	Medium	High	Moderate; sludge removal.	Claims 99.97% Fe/Mn removal; no pumps/motors.	Subject to clogging and freezing; requires carbon source (e.g., upstream wetland).	No	Not effective in cold climates or practical at UBMC; expensive.	ACMER 2005
		Gas-fed sulfate-reducing bacteria treatment	Employs hydrogen gas from partial oxidation of natural gas and other fuels as an electron donor, changes sulfides to sulfates.	Medium	Medium	High	Significant	Potential for resource recovery.	Requires hydrogen gas source; unproven.	No	Innovative technology with limited evidence of success; long-term efficacy and longevity not well documented; expensive.	EPA 2004
		Bioremediation	Microbiota are applied to degrade inorganics to innocuous materials.	Medium	Medium	Medium	Moderate; replenish carbon source.	Natural process; does not require chemical reagents.	Requires carbon source; less effective for large flows and in cold climates.	No	Not effective in cold climates or practical at UBMC.	EPA 2004

TABLE 1
INITIAL REMEDIAL ALTERNATIVES SCREENING MATRIX
UPPER BLACKFOOT MINING COMPLEX

General Response Action	Technology Type	Process Option	Description	Effectiveness[1]	Implementability[2]	Cost[3]	Operations and Maintenance Cost[4]	Pros	Cons	Retain?	Notes	Reference
Passive Treatment	Biotreatment	Phytoremediation	Plant systems are used to remove metal contamination from water.	Low	Medium	Medium	Moderate; harvest and process plants.	Natural system; does not require chemical reagents.	Limited effectiveness in cold climates; slow process.	No	Not effective in cold climates or practical at as a stand-alone treatment at UBMC.	EPA 2004
		Redox-mediated biotransformation	Process involving lime and nutrients addition to stimulate bacterial activity and promote precipitation of sulfides.	Medium	Medium	Medium	Moderate; replenish redox materials and dispose of sludge.	Semi-natural process involving innocuous nutrients.	Requires nutrient addition and sludge disposal; unproven.	No	Innovative technology applied to mine pit lakes; only limited information available.	EPA 2004
	Chemical/ reagent	Aqueous lime injection	Pass clean water though pond of high pH material (lime), mix with AMD and send to a settling pond.	Medium	Medium	High	Moderate; replenish alkaline material.	Similar to dilution.	Low efficacy, especially for Mn and Zn; prone to freezing.	No	Not effective in cold climates or practical at as a stand-alone treatment at UBMC; expensive.	CDMG 2002
		Bauxsol/ ViroMine™	Proprietary blend of reagents (Fe & Al oxyhydroxides) applied via a flow-through structure such as a permeable reactive barrier or gabion.	Low	Medium	Low	Moderate to significant- remove clogging sediment and reapply reagents.	High metal removal efficiency.	More suitable for low flow conditions; may require large area because of high flows.	No	Innovative technology with limited evidence of success; long-term efficacy and longevity not well documented.	EPA 2004
		Limestone pond	Pond constructed over an AMD seep or discharge point and filled with 1 to 3 feet of limestone to add alkalinity and promote metals precipitation.	Low	High	High	Moderate; replace or breakup limestone periodically.	Easy to construct.	Efficacy decreases as limestone coating occurs or is depleted; may require large area; not as effective for Cd, Cu, and Zn.	No	Not effective in cold climates or practical at UBMC; expensive.	EPA 2004, EPA 2006, BLM 2003, INAP 2010
		Open limestone channel	Open channel filled with coarse limestone; minimum slope at > 20% to maintain velocities; increases pH and promotes metals precipitation.	Low	High	Medium	Moderate; replace limestone periodically.	Easy to construct.	Slow dissolution time; decreasing efficacy with time as limestone coating occurs or is depleted; not as effective for Cd, Cu, and Zn.	No	Not effective in cold climates or practical at UBMC.	CDMG 2002, BLM 2003, EPA 2006
		Anoxic limestone drain (ALD)	Water is routed through a buried trench or pipes containing limestone to increase alkalinity/pH.	Low	Medium	Low	Moderate; replace limestone periodically.	Easy to construct.	Potential for armoring and plugging if air gets into the system; requires low oxygen and Al concentrations.	No	Plugging of pipes could lead to serious problems; not practical at UBMC.	CDMG 2002, EPA 2004, EPA 2006, BLM 2003
		Manganese oxidation bed (MOB)	Shallow flow through a constructed bed filled with coarse limestone that supports bacterial/algal organisms and promotes Mn oxidation.	Low	Medium	Medium	Moderate; replace limestone periodically.	Removes Mn; potentially low maintenance.	Only functions as a polishing step after Fe has been removed and near neutral pH.	No	Not effective or practical at UBMC.	INAP 2010
		Aluminator®	A limestone drain in which Al hydroxide accumulates and is recovered.	Medium	Medium	Medium	Moderate; replace lime and maintain drain.	Similar to an ALD but less prone to armoring and plugging.	Requires more maintenance than ALD.	No	Efficacy limited to Al removal, can be problematic with other metals.	EPA 2006, INAP 2010
		Aquafix	Gravity feed mechanical device for in-stream AMD neutralization.	High	High	Medium	Moderate; replace lime or other material.	Does not require power; low maintenance.	Prone to vandalism; not suitable for large flows.	Yes	May be applicable for some features.	BLM 2003

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UPPER BLACKFOOT MINING COMPLEX

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Groundwater												
No Action	No Action	No Action	Feature(s) are left "as is."	Low	N/A	Low	None	Easiest; no cost.	No risk reduction.	Yes	Used as a baseline to compare other alternatives, provide an understanding of current and future potential risks.	EPA 1988, EPA 1989
Institutional Controls	Land Use Controls	Deed restrictions, easements, covenants and reservations	Limits future land uses or uses of groundwater.	Low to high	High	Low	Enforcement	Easy; minimal cost; most effective in preventing residential exposures or exposure to groundwater.	Not very effective in limiting recreational or trespass exposures.	Yes	Commonly used in conjunction with other remedies.	EPA 2000
Monitoring Natural Attenuation	Monitoring Natural Attenuation (MNA)	Water quality monitoring	MNA is used in conjunction with active remediation (source control or removal) or as a follow up measure after active remediation. It relies on natural physical, chemical, and biological processes to reduce the concentrations of contaminants.	Low	High	Low	Minimal-depends on level of monitoring required.	Easy; minimal cost; most applicable to previously reclaimed areas and natural systems.	Relies on the success of previous reclamation efforts.	Yes	May be applicable to some features that have already been reclaimed or remediated if SSCLs are met.	EPA 1999
Engineering Controls	Containment	Plug	Polyurethane foam or concrete plug is installed in adit to block AMD discharge.	Low	Medium	High	Minimal; inspect for leakage.	Simple; eliminates or reduces AMD flow.	Risk of failure or leakage.	Yes	Successful at some features under the right conditions.	EPA 2006, INAP 2010
	Hydrologic control	Grout curtain/slurry wall	Soil-bentonite or cement slurry mixture is injected into the ground to form a barrier preventing groundwater from moving through mine waste or underground workings.	Low	Low	High	Minimal; monitor for effectiveness.	Minimizes groundwater degradation by preventing contact with acid-producing rock.	May develop leaks; difficult to construct and expensive.	No	Attempted and abandoned at UBMC; effectiveness unsubstantiated and hard to achieve.	EPA 2004, INAP 2010
		Fracture/fault grouting	Soil-bentonite or soil-cement slurry mixture is injected into the ground fractures/faults to prevent groundwater from flowing through heavily mineralized zones. Reduces infiltration and direct flow.	Medium	Medium	Medium	Minimal; monitor for effectiveness.	More applicable for rocky areas with significant fractured flow; can significantly reduce groundwater degradation.	Does not impede interstitial groundwater flow.	Yes	May be applicable along fault zones; possible use at Mike Horse mine site to control groundwater by reducing flow.	INAP 2010
	Hydraulic control	Interceptor trench	A trench is excavated and filled with permeable material, such as gravel, to intercept and divert groundwater around mine waste or underground workings.	Medium	Medium	Low	Minimal; monitor for effectiveness and plugging.	Minimizes groundwater degradation by diverting groundwater around acid-producing rock.	Potential for plugging; difficult to install in rocky areas; may not stop all flow.	Yes	May be applicable for some features.	INAP 2010
		Dewatering	Extraction wells are installed to lower the groundwater table below reactive waste or underground workings.	Medium	Low	High	Significant; monitor and maintain pumps.	Maintains groundwater quality by avoiding contact with acid-producing rock.	Requires power source and perpetual pumping.	No	Not effective or practical at UBMC; expensive.	INAP 2010
	Detention	Settling pond	Groundwater is pumped to a settling pond for removal of suspended solids and to oxygenate and promote metals precipitation.	Medium	High	Low to medium	Moderate; excavate and dispose of sediments every few years.	Pretreatment to remove suspended solids and increase dissolved oxygen.	Requires large surface area; usually only used for pre-treatment. Only reduces sediments and precipitates formed on air contact.	Yes	Effective when used in combination with other options.	CDMG 2002, EPA 2004

TABLE 1
INITIAL REMEDIAL ALTERNATIVES SCREENING MATRIX
UPPER BLACKFOOT MINING COMPLEX

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Engineering Controls	Inundation	Bulkhead/wet mine seal	A plug is installed that allows water to flow from the adit but prevents air from entering the underground workings.	High	Medium	High	Moderate; maintain piping and valves.	Provides hydraulic control; can decrease acid generation and groundwater degradation by preventing oxidation of sulfide materials.	Does not eliminate AMD; requires managing flows; subject to water table fluctuations.	Yes	Currently in use at the UBMC to control adit discharge.	EPA 2004, INAP 2010
	Infiltration	Infiltration gallery	A gallery/basin is constructed to infiltrate treated groundwater.	Low	Low	Medium	Minimal	Recharges aquifer.	Requires relatively large area; and soils in which to infiltrate.	No	Would require a large area and suitable subsoils - neither available at UBMC.	Creighton 2012
Active Treatment [11] **(Pump & Treat)**	Chemical/ reagent	Mechanical lime injection	Mechanical feeder dispenses neutralizing agents (lime or hydrated lime), followed by a settling pond for metals precipitation.	High	Medium	Low to high	Significant; replenish lime and dispose of sludge.	Cost-effective method for treating large flows.	Requires settling pond and sludge disposal; less cost effective for small flows.	Yes	Effective when used in combination with other options.	CDMG 2002, EPA 2006
		Aeration	Air is introduced into the water using gravity or mechanical devices to promote oxidation of Fe and Mn.	Medium	High	Low	Minimal for passive, significant for active.	Simple; usually combined with other technologies to improve efficiency.	Not a stand-alone technology; only effective at pH > 5.	Yes	Effective when used in combination with other options.	ADTI 1998, ITRC 2010, INAP 2010
		Oxidation	A chemical oxidant, such as hydrogen peroxide or potassium permanganate, is added to enhance metal hydroxide precipitation and reduce metal flocculent volume.	Medium	Medium	High	Significant; replenish oxidant and dispose of sludge.	Usually combined with other technologies to improve efficiency.	Requires chemical delivery system, sludge removal and disposal.	Yes	Currently in use at UBMC for treatment of surface water. Effective when used in combination with other options.	ADTI 1998
		Precipitation	A chemical reagent, such as sodium hydroxide or calcium carbonate, is added to promote precipitation of metals as hydroxides.	High	Medium	High	Significant; replenish reagent.	Proven effective; immediate results; usually combined with other technologies.	Requires chemical delivery system, sludge removal and disposal.	Yes	Effective when used in combination with other options.	ITRC 2010
	Physical/ mechanical	Reverse osmosis	Water is forced through a semi-permeable membrane to remove metals and other contaminants.	High	Medium	High	Moderate	Effective; produces high quality effluent.	Produces a highly concentrated waste stream; expensive.	Yes	May be applicable for polish treatment.	ADTI 1998, EPA 2004
		Electrocoagulation	An electrical current is applied to promote coagulation of organics and suspended solids in water.	Medium	Low	High	Moderate	Potentially recoverable metals; alternative to chemical precipitation; One-third less sludge compared to conventional precipitation.	Requires power source; unproven; expensive.	Yes	Under consideration for use at the WTP when combined with other alternatives. New methodology may increase effectiveness.	ITRC 2010
		Ion exchange	Water is passed through a bed of ion-exchange material to transfer metals ions onto the material.	High	Low	High	Significant; replenish ion-exchange material.	Effective; produces high quality effluent.	Produces a highly concentrated waste stream; expensive.	Yes	May be applicable for polish treatment.	ADTI 1998, FRTR 2007, INAP 2010
		Ceramic microfiltration	Multi-stage system involving pre-treatment with sodium hydroxide and pumping through a ceramic membrane.	High	Low	High	Significant; replace or wash membranes.	Effective; can produce high quality effluent.	High cost; complex process; generates secondary waste.	Yes	Currently in use at the WTP.	EPA 2004

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INITIAL REMEDIAL ALTERNATIVES SCREENING MATRIX
UPPER BLACKFOOT MINING COMPLEX

General Response Action	Technology Type	Process Option	Description	Effectiveness[1]	Implementability[2]	Cost[3]	Operations and Maintenance Cost[4]	Pros	Cons	Retain?	Notes	Reference
Passive Treatment[11]	Biotreatment	Anaerobic wetland (reducing)	Shallow downflow through wetland consisting of 1 to 2 feet of organic matter and 6 to 12 inches of limestone substrate; neutralize acidity and reduce metals to sulfide form.	Low	Medium	High	Moderate; replace substrate and manage sediment.	No pumps/motors; efficient for a wide range of metals.	Less effective in winter; requires large area and pH >5.	No	Not effective in cold climates or practical at UBMC; expensive.	H&H 2003, BLM 2003, EPA 2006, INAP 2010
		Aerobic wetland (oxidizing)	Shallow surface flow over wetland consisting of 1 to 3 feet of vegetated gravel/organic matter; pre-aeration improves efficiency; facilitates natural oxidation of metals and precipitate Fe, Mn, and other metals.	Low	Medium	High	Moderate; replace substrate and manage sediment.	Requires less area than anaerobic wetland; mimics natural system.	Less effective in winter; requires large area, long residence time, and near neutral pH; only effective for select metals.	No	Not effective in cold climates or practical at UBMC; expensive.	CDMG 2002, BLM 2003, EPA 2006, INAP 2010
		Sulfate reducing bioreactor (SRB)	Lined pond or series of buried trenches or tanks containing organic matter (e.g., manure), sulfate-reducing bacteria and limestone.	Low	Low	Medium to high	Moderate; requires carbon source and disposal of sludge.	No pumps/motors; subsurface; can be engineered for cold climates.	Subject to freezing and plugging; requires very large area for high flows and pH >5; not effective for Mn removal.	No	Not effective in cold climates or practical at UBMC; expensive.	EPA 2000, EPA 2006, INAP 2010
		Vertical flow reactors	Treatment cell composed of ponded water over organic substrate and limestone drainage layer, usually combined with settling pond and aerobic wetland.	Medium	Medium	Medium	Moderate; may require flushing and replacing substrate.	Requires less area than other methods; treats highly acidic water; can be constructed subsurface.	Requires long retention time; requires replacing organics and flushing system; low efficacy for Mn removal.	Yes	May be applicable for some features.	Zipper 2001, ITRC 2010
		Subsurface flow wetlands	Water is routed through a series of buried organic and gravel substrates for metals removal; surface left vegetated and dry.	Medium	Medium	Medium	Moderate; may require flushing and replacing substrate.	Can support simultaneous aerobic and anaerobic conditions; not as vulnerable to freezing.	Subject to plugging.	Yes	May be applicable for some features.	H&H 2003
		Successive alkalinity producing system (SAPS)	Water is ponded over organic material and limestone drainage layer; similar to vertical flow reactor; combines an anoxic limestone drain and anaerobic wetland; 3 to 6 feet of water over 6 to 12 inches of organic matter, over 1 to 2 feet of limestone drainage layer.	Medium	Medium	Medium	Moderate; may require flushing and replacing substrate.	May be more effective and require less space than anaerobic wetlands; less prone to freezing.	Requires flushing to prevent clogging and formation of preferential flow paths; less effective for Mn removal.	Yes	May be applicable for some features.	Costello 2003, ITRC 2010, EPA 2004, EPA 2006, BLM 2003
		Pyrolusite® Limestone Beds	Limestone–filled beds inoculated with proprietary aerobic microorganism population.	Low	Medium	High	Moderate; sludge removal.	Claims 99.97% Fe/Mn removal; no pumps/motors.	Subject to clogging and freezing; requires carbon source (e.g., upstream wetland).	No	Not effective in cold climates or practical at UBMC; expensive.	ACMER 2005
		Phytoremediation	Plant systems are used to remove metal contamination from water.	Low	Medium	Medium	Moderate; harvest and process plants.	Natural system; does not require chemical reagents.	Limited effectiveness in cold climates; slow process.	No	Not effective in cold climates or practical at as a stand-alone treatment at UBMC.	EPA 2004

TABLE 1
INITIAL REMEDIAL ALTERNATIVES SCREENING MATRIX
UPPER BLACKFOOT MINING COMPLEX

General Response Action	Technology Type	Process Option	Description	Effectiveness[1]	Implementability[2]	Cost[3]	Operations and Maintenance Cost[4]	Pros	Cons	Retain?	Notes	Reference
Passive Treatment[11]	Chemical/ reagent	Aqueous lime injection	Pass clean water though pond of high pH material (lime), mix with AMD, and send to a settling pond.	Medium	Medium	High	Moderate; replenish alkaline material.	Similar to dilution.	Low efficacy, especially for Mn and Zn; prone to freezing.	No	Not effective in cold climates or practical at as a stand-alone treatment at UBMC; expensive.	CDMG 2002
		Open limestone channel	Open channel filled with coarse limestone; minimum slope at > 20% to maintain velocities; increases pH and promotes metals precipitation.	Low	High	Medium	Moderate; replace limestone periodically.	Easy to construct.	Slow dissolution time; decreasing efficacy with time as limestone coating occurs or is depleted; not as effective for Cd, Cu, and Zn.	No	Not effective in cold climates or practical at UBMC.	CDMG 2002, BLM 2003, EPA 2006
		Anoxic limestone drain (ALD)	Water is routed through a buried trench or pipes containing limestone to increase alkalinity/pH.	Low	Medium	Medium	Moderate; replace limestone periodically.	Easy to construct.	Potential for armoring and plugging if air gets into the system; requires low oxygen and Al concentrations.	No	Plugging of pipes could lead to serious problems; not practical at UBMC.	CDMG 2002, EPA 2004, EPA 2006, BLM 2003
		Manganese oxidation bed (MOB)	Shallow flow through a constructed bed filled with coarse limestone that supports bacterial/algal organisms and promotes Mn oxidation.	Low	Medium	Medium	Moderate; replace limestone periodically.	Removes Mn; potentially low maintenance.	Only functions as a polishing step after Fe has been removed and near neutral pH.	No	Not effective or practical at UBMC.	INAP 2010
		Permeable reactive barrier	Flow-through barrier typically filled with organic matter or Fe metal shavings; sequesters oxygen and supports sulfate-reducing bacteria.	Medium	Medium	Medium	Moderate; replace reactive material.	Useful for removing difficult metals such as Se and U.	Must keep air out to avoid oxidation and mobilization of metals; potential clogging; longevity unknown.	Yes	May be applicable for some features.	Costello 2003, EPA 2004, EPA 2006

TABLE 1
INITIAL REMEDIAL ALTERNATIVES SCREENING MATRIX
UPPER BLACKFOOT MINING COMPLEX

Notes:

[1]Effectiveness refers to how well the alternative can address the contaminants of concern, considering site specific conditions. High = highly effective; Medium = moderately effective; Low = slightly effective.

[2]Implementability refers to how readily an alternative can be implemented at the site. High = easy to implement; Medium = moderate effort required to implement; Low =difficult to implement.

[3]Cost refers to the capital cost of an alternative.

[4]Operations and Maintenance Cost refers to the continued costs associated with an alternative. Minimal = low degree of O & M; Moderate = average degree of O & M; Significant = high degree of O & M.

[5]SSCLs - Site-Specific Cleanup Levels

[6]AMD - Acid Rock Drainage

[7]USFS Alternative Analysis for Underground Disposal: The concept of placing wastes back into the mine has been examined and is not feasible, protective, or cost-effective. Many of the old workings are collapsed; therefore, not enough of the mine is accessible, and significant safety concerns exist with trying to reopen any area of the mine. The old workings are generally much smaller than the current standard of practice, and smaller equipment would be needed. These issues make reopening the mine for use as a repository unsafe and inordinately costly. Additionally, much of the mine is underwater. There is no way to accurately predict what adding the tailings to the mine would do to the chemistry of the mine water, and it could make matters worse. There is no way to predict where the mine water would report/seep out of the ground and discharge to surface water. If watercourses within the mine are blocked and water can no longer reach its current controlled discharge point, the mine water would escape the mine at another location and in an uncontrolled manner. This could contaminate other areas or drainages. This approach would not provide a solution that is protective of human health and the environment. (AMENDMENT 1 to the JULY 2007 ACTION MEMORANDUM FOR THE REMOVAL ACTION FOR THE MIKE HORSE DAM AND IMPOUNDED TAILINGS, LOWER MIKE HORSE CREEK, BEARTRAP CREEK, AND THE

[8] The current impoundment is built from mine impacted waste rock and tailings. The impound is unstable and at risk of failure if exposed to extreme precipitation events. There are currently seeps under the impoundment that are impacting Beartrap Creek and the Blackfoot River.

[9]The RAOs (Remedial Action Objectives) have not been identified for the screening process.

[10]CMZ - Channel Migration Zone

[11]Groundwater treatment options assume a pump-and-treat scenario; treatment technologies eliminated under surface water were not repeated.

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TABLE 1A
SPECIFIC DISCUSSION AND DECISIONS FOR IASD TABLE 1
UPPER BLACKFOOT MINING COMPLEX

ALTERNATIVE	DISCUSSION	DECISION
Decisions reached during the meeting (04/17/13) and DEQ comments.		
General Formatting	Add high/med/low definitions for effectiveness, implementability, cost, and operation and maintenance.	Revised as requested.
General Formatting	Please develop one site-wide table and eliminate table specific to Mike Horse.	Revised as requested; all alternatives combined into a site-wide table that includes Mike Horse.
All Alternatives	Please add references for each alternative in table.	References checked and added.
All Alternatives	DEQ provided comments on typographical and grammatical edits within Table 1 and offered suggestions for minor changes to wording within the table.	Revised as requested.
All Alternatives	No Action - Please add EPA FS guidance for retaining.	Added standard language to all categories.
All Alternatives	Combine fencing and warning signs into one process option.	Combined into one option.
Table 1b - Mike Horse Mine Area	Please remove the Mike Horse Mine area table from the alternatives analysis.	Removed this section and combined with others.
Physical Hazards - Deed Restrictions	If Trust owns areas of significant impacts, would medium implementability rating change?	Changed to high rating.
Physical Hazards - Warning Signs	Warning signs are not considered institutional controls - ICs are deed restrictions.	Revised throughout table as engineering controls.
Waste Rock - Engineering Controls	Why are these Engineering Controls separate from the Engineering Controls used earlier in this section on page 2? Please revise accordingly.	Combined all engineering controls into one section.
Waste Rock - Education	Delete Education as a remedial alternative.	Deleted this process option.
Waste Rock - Physical Barriers	Do these really apply to tailings & mine waste? Please revise accordingly. Provide brief explanation if kept as options.	Deleted this category.

TABLE 1A
SPECIFIC DISCUSSION AND DECISIONS FOR IASD TABLE 1
UPPER BLACKFOOT MINING COMPLEX

ALTERNATIVE	DISCUSSION	DECISION
Waste Rock - Monitoring	Some waste piles are not readily accessible by road. Will this change implementability rating from high?	Did not retain this alternative.
Waste Rock - Deed Restrictions	Not limited to just private lands, revise to include public and private lands.	Revised as requested.
Waste Rock - Deed Restrictions	If Trust owns areas of significant impacts would medium implementability rating change?	Changed to high rating.
Waste Rock - Warning Signs	Warning signs are not considered institutional controls - ICs are deed restrictions.	Revised throughout table as engineering controls.
Waste Rock - Fencing	Fencing is considered an engineering control, not IC.	Changed to engineering control.
Waste Rock - Earthen Vegetative Cover	Why retain alternative if low effectiveness?	Changed to medium effectiveness.
Waste Rock - Evapotranspiration	Why retain alternative if low effectiveness and implementability?	Did not retain this alternative.
Waste Rock - Geosynthetic Cover	Doesn't the GCL have a finite life?	Requires proper installation and design to be effective.
Waste Rock - Onsite Repository	See USFS response to proposal and change to "no" due to USFS analysis.	Did not retain this alternative.
Waste Rock - Onsite Repository	Why would an onsite repository cost less than subaqueous disposal/water cover?	Changed both costs to medium.
Waste Rock - Underground Disposal	The concept of placing the wastes back into the mine has been examined and is not feasible, protective, or cost-effective.	Not retained; see footnote in table for USFS analysis.
Waste Rock - Subaqueous Disposal	In a footnote, please explain why the existing impoundment won't work.	Revised as requested.
Waste Rock - Emulsification	Are we certain that cost is medium and not high?	Changed to high cost.

TABLE 1A
SPECIFIC DISCUSSION AND DECISIONS FOR IASD TABLE 1
UPPER BLACKFOOT MINING COMPLEX

ALTERNATIVE	DISCUSSION	DECISION
Waste Rock - Neutralization (in situ)	Why retain alternative if low effectiveness?	May be applicable to thin waste deposits.
Waste Rock - Phytoremediation	Why retain alternative if low effectiveness?	Did not retain this alternative.
Waste Rock - Blending/Co-disposal	Please provide clarification so that this option is not confused with the blending/co-disposal that will take place at the repository.	Added process option "blending/co-disposal at repository" as an ex-situ treatment.
Floodplain Contaminant Removals	Please delete "Removals" and treat the Floodplain Contaminants as one section.	Combined Floodplain Contaminant Removal and "left in place" into one section.
Floodplain - Deed Restrictions	If Trust owns areas of significant impacts, would medium implementability rating change?	Changed to high rating.
Floodplain - Education	Delete Education as a remedial alternative.	Alternative deleted.
Floodplain Contaminants (left in place) - Monitoring	Why retain alternative if low effectiveness?	May be applicable to features that have already been remediated.
Floodplain - Warning Signs	Warning signs are not considered institutional controls - ICs are deed restrictions.	Revised as engineering controls.
Floodplain - Warning Signs	Why retain alternative if low effectiveness?	Used to supplement other alternatives.
Floodplain - Fencing	Fencing is considered an engineering control, not IC.	Revised as engineering controls.
Floodplain - Fencing	Why retain alternative if low effectiveness?	Used to supplement other alternatives.
Floodplain - Road Closure	Why is road closure a "no" when warning signs/fencing is a "yes"?	Changed to "yes"; used to supplement other alternatives.
Floodplain - Remove to Concentration	Combine "remove to concentration" with "remove to indicator."	Revised as requested.

TABLE 1A
SPECIFIC DISCUSSION AND DECISIONS FOR IASD TABLE 1
UPPER BLACKFOOT MINING COMPLEX

ALTERNATIVE	DISCUSSION	DECISION
Floodplain - Remove to Indicator	Add clarification regarding physical and visual indicators.	Revised as requested.
Floodplain - Remove to Indicator	Why is effectiveness rated high?	High efficacy and easy to implement.
Floodplain - Remove to Indicator	Elaborate on why implementability would be difficult.	Changed to medium implementability.
Floodplain - Remove to Indicator	RAOs haven't been identified for the screening process. Please add to footnotes.	Revised as requested.
Floodplain - Remove to Depth	Combine "remove to depth" with "remove to indicator."	Revised as requested.
Floodplain - Remove to Other	Without clarifying "other", doesn't make sense to include this alternative. Please delete.	Deleted this alternative.
Floodplain Contaminants (left in place) - Earthen Vegetative Cover	How does this differ from land disposal? Please move to engineering controls grouping for this section.	Effective in areas with discrete characterized waste source; does not involve excavation. Moved to engineering controls.
Floodplain Contaminants (left in place) - Earthen Vegetative Cover	What about mobilization during flood events?	Added comment "flood events may cause mobilization."
Floodplain Contaminants (left in place) - Earthen Vegetative Cover	Why retain alternative if low effectiveness?	Changed to medium effectiveness. Effective in areas with discrete characterized waste source.
Floodplain Contaminants - Bioremediation	This option was not retained previously in the Waste rock/tailings section. Is this in error? If not, please explain why it should be retained here.	Did not retain this alternative.
Floodplain Contaminants - Phytoremediation	Notes say cost is expensive, shouldn't the rating for cost be "high"? Please revise accordingly.	Deleted "expensive" in notes; left cost rating as medium.
Floodplain Contaminants (left in place) - Consolidation	There isn't a clear delineation between "consolidation" and placement of waste in an engineered repository. Please delete this row unless a clarification can be made.	Deleted this alternative.
Floodplain Contaminants (left in place) - Ex-situ Blending	Please clarify the risk of some metals mobilization with arsenic brought on by higher pH in soil.	Added comment "requires a balance of acid-generating and neutralizing waste rock."

TABLE 1A
SPECIFIC DISCUSSION AND DECISIONS FOR IASD TABLE 1
UPPER BLACKFOOT MINING COMPLEX

ALTERNATIVE	DISCUSSION	DECISION
Floodplain Contaminants (left in place) – In-situ Neutralization	Please clarify the risk of some metals mobilization with arsenic brought on by higher pH in soil.	Added comment "increased soil alkalinity may increase the mobilization of arsenic compounds."
Floodplain Contaminants (left in place) - Neutralization	Please clarify the risk of some metals mobilization with arsenic brought on by higher pH in soil	Added comment "increased soil alkalinity may increase the mobilization of arsenic compounds."
Floodplain Contaminants (left in place)- Phytoremediation	Why retain alternative if low effectiveness?	Did not retain this alternative.
Groundwater	Add institutional controls and MNA for groundwater.	Revised as requested.
Groundwater - Deed Restrictions	If Trust owns areas of significant impacts, would medium implementability rating change?	Changed to high rating.
Groundwater - Monitored Natural Attenuation	Please add standard MNA language regarding source removal, adsorption, dispersion, etc.	Revised as requested.
Groundwater - Active Treatment	Since pump and treat is a presumptive remedy, it should be included specifically for groundwater rather than just the footnote 9 reference.	Added Pump and Treat to general response action.
Groundwater - Anaerobic Wetland	Why retain the alternative if it grades out as "low" for effectiveness? The UBMC already had an anaerobic wetland system that was ineffective. Under what conditions may a system work?	Did not retain this alternative.
Groundwater - Dewatering	There is an inconsistency between O&M comment and cons regarding degree of O&M.	Changed O&M cost to significant.
Groundwater - Electrocoagulation	Why retain alternative if low effectiveness?	Changed to medium effectiveness; under consideration for use at WTP.
Groundwater - Infiltration	How does this differ from surface water discharge of treated water? If it's different, then surface water discharge should be added as a separate item.	Added this category to surface water.

TABLE 1A
SPECIFIC DISCUSSION AND DECISIONS FOR IASD TABLE 1
UPPER BLACKFOOT MINING COMPLEX

ALTERNATIVE	DISCUSSION	DECISION
Groundwater - Infiltration Gallery	Why retain alternative if low effectiveness?	Did not retain this alternative.
Groundwater - Open Limestone Channel	Notes say cost is expensive, shouldn't the rating for cost be “high”? Please revise accordingly.	Deleted expensive language, left cost as medium ranking.
Groundwater - Open Limestone Channel	Why retain alternative if low effectiveness?	Did not retain this alternative.
Groundwater - Oxidation	Add comment “currently in use at the site for treatment of surface water.”	Revised as requested.
Groundwater - Phytoremediation	Notes say cost is expensive, shouldn't the rating for cost be “high”? Please revise accordingly.	Deleted expensive, left cost as medium ranking
Groundwater - Phytoremediation	Why retain alternative if low effectiveness?	Did not retain this alternative.
Groundwater - Anoxic Limestone Drain	Notes say cost is expensive, shouldn't the rating for cost be “high”? Please revise accordingly.	Deleted expensive, left cost as medium ranking.
Groundwater - Manganese Oxidation Bed	Notes say cost is expensive, shouldn't the rating for cost be “high”? Please revise accordingly.	Deleted expensive, left cost as medium ranking.
Groundwater - Manganese Oxidation Bed	Why retain alternative if low effectiveness?	Did not retain this alternative.
Surface Water	Please add an IC option to this section. Institutional controls for surface water would include fish advisories, fishing access closures, etc.	Revised as requested.
Surface Water - Monitored Natural Attenuation	Please add standard MNA language regarding source removal, adsorption, dispersion, etc.	Revised as requested.
Surface Water - Anaerobic Wetland	Why retain alternative if low effectiveness? Had an anaerobic wetland that was ineffective - under what conditions may the system work?	Did not retain this alternative.
Surface Water - Bioremediation	Notes say cost is expensive, shouldn't the rating for cost be “high”? Please revise accordingly.	Delete expensive, leave cost as medium ranking.

TABLE 1A
SPECIFIC DISCUSSION AND DECISIONS FOR IASD TABLE 1
UPPER BLACKFOOT MINING COMPLEX

ALTERNATIVE	DISCUSSION	DECISION
Surface Water - Gas-fed Sulfate-Reducing Bacteria Treatment	Notes say cost is expensive, shouldn't the rating for cost be “high”? Please revise accordingly.	Revised notes to “expensive.”
Surface Water - Infiltration Gallery	Why retain alternative if low effectiveness and implementability?	Did not retain this alternative.
Surface Water - Phytoremediation	Notes say cost is expensive, shouldn't the rating for cost be “high”? Please revise accordingly.	Delete expensive, leave cost as medium ranking.
Surface Water - Phytoremediation	Why retain alternative if low effectiveness?	Did not retain this alternative.
Surface Water - Plug	Please remove from this section and move to the groundwater section.	Added to groundwater section.
Surface Water - Sulfate-Reducing Bioreactor	Delete “not as prone to vandalism.”	Did not retain this alternative.
Surface Water – Sulfate Reducing Wetland	Notes say cost is expensive, shouldn't the rating for cost be “high”? Please revise accordingly.	Revised notes to “expensive.”
Surface Water - Aluminator®	Notes say cost is expensive, shouldn't the rating for cost be “high”? Please revise accordingly.	Deleted expensive, left cost as medium ranking.
Surface Water - Anoxic limestone drain	Notes say cost is expensive, shouldn't the rating for cost be “high”? Please revise accordingly.	Deleted expensive, left cost as medium ranking.
Surface Water - Dilution	Delete dilution row from the table.	Deleted alternative.
Surface Water - Manganese Oxidation Bed	Why retain alternative if low effectiveness?	Did not retain this alternative.
Surface Water - Open Limestone Channel	Why retain alternative if low effectiveness?	Did not retain this alternative.
Surface Water - Open Limestone Channel	Notes say cost is expensive, shouldn't the rating for cost be “high”? Please revise accordingly.	Deleted expensive, left cost as medium ranking.

TABLE 2
REMEDIAL TECHNOLOGY AND PROCESS OPTIONS FOR CONTAMINATED MEDIA: SECONDARY SCREENING SUMMARY
UPPER BLACKFOOT MINING COMPLEX

	TECHNOLOGY TYPE	PROCESS OPTIONS/ DESCRIPTION	EFFECTIVENESS[1] (x4)	IMPLEMENTABILITY[2] (x4)	COST[3] (x3)	AVAILABILITY[4] (x2)	RELIABILITY & MAINTAINABILITY[5] (x1)	OPTION RETAINED?
Physical Hazards/ Solid Media[6]	**No Action**	**No Action** Physical hazards and features are left "as is."	**Low** •Provides no further remediation to reduce toxicity, mobility, or volume of COCs[7]. •Relies on existing implemented measures. •No controls limiting exposure to COCs are provided. •Does not meet RAOs[8].	**High** •Requires no implementation.	**Low** •Maintains existing costs.	**High** •Maintains status quo (see evaluation/comments).	**Low** •Maintains status quo.	**Yes** Use as a baseline to compare with other alternatives. Provides an understanding of current and future potential risks.
		Raw Score	**1**	**3**	**3**	**3**	**1**	
		Weighted Score	**4**	**12**	**9**	**6**	**1**	**32**
			Evaluation/Comments: Required for consideration by DEQ[9]. Does not remove contamination or reduce risk to human health and the environment. Limited effectiveness for risk mitigation. Easy to maintain, but reliability is low. Availability for this technology is rated "high" to reflect the required inclusion, rather than the number of vendors available to provide services.				**References:** EPA 1988, EPA 1989	
Physical Hazards/ Solid Media	**Institutional Controls** **Land Use Controls**	**Deed Restrictions, Easements, Covenants, and Reservations** Limits future land use.	**Low** •Protects human health by limiting access to exposure pathways and risk of future exposures. •Provides no remediation to reduce toxicity, mobility, or volume of COCs. •Most effective in preventing residential exposure. •Can enhance effectiveness of other options by limiting access. •Effectiveness depends on the compliance of the property owner and the enforcement of the federal, state, or local agency. •Not effective in limiting recreational or trespass exposures. •Does not meet RAOs.	**Medium** •Issue regarding whether process options can be used on public land. •Intended to supplement treatment or engineering controls, not the sole remedy. •Requires legal documents (deed restrictions, easements, covenants, etc.).	**Low** •Administrative costs to implement. •Enforcement costs can range from low to high. •Persistent management. •Requires long-term maintenance and land-use control enforcement.	**Low** •Several property owners are affected (see evaluation/ comments).	**Medium** •Requires some form of persistent management on the part of the property owner, or the federal, state, or local agency. •Legally binding. •Motivation to enforce these regulations may diminish as time passes.	**Yes** Use to supplement other remediation alternatives.
		Raw Score	**1**	**2**	**3**	**1**	**2**	
		Weighted Score	**4**	**8**	**9**	**2**	**2**	**25**
			Evaluation/Comments: Institutional control technology is a widely used standard practice. The effectiveness of the technology was changed from a rating of "low to high" in Table 1 to a rating of "low" to provide a conservative scoring estimate. Although easy to administer on Trust Lands, the technology may be more difficult to administer on Forest Service land and the implementability of the technology was changed from a rating of "high" in Table 1 to a rating of "medium" for scoring. Availability for this technology is based on the number of property owners affected by the remediation, rather than the number of vendors available to provide services. The rating for availability was changed from a rating of "high" in Table 1 to a rating of "low" to reflect that several property owners would be involved in the process.				**References:** EPA 2000, ITRC 2010	

TABLE 2
REMEDIAL TECHNOLOGY AND PROCESS OPTIONS FOR CONTAMINATED MEDIA: SECONDARY SCREENING SUMMARY
UPPER BLACKFOOT MINING COMPLEX

	TECHNOLOGY TYPE	PROCESS OPTIONS/ DESCRIPTION	EFFECTIVENESS[1] (x4)	IMPLEMENTABILITY[2] (x4)	COST[3] (x3)	AVAILABILITY[4] (x2)	RELIABILITY & MAINTAINABILITY[5] (x1)	OPTION RETAINED?
Physical Hazards/ Solid Media	**Engineering Controls** **Access Restrictions**	**Fencing, Warning Signs, and Gate Installation** Signs, fencing, and gates are installed to notify public of hazards and to block access to certain features. **Road Closure** Closure of access roads.	**Low** •Provides no remediation to reduce toxicity, mobility, or volume of COCs. •Reduces human exposure. •Does not prevent trespass exposure. •May enhance effectiveness of other alternatives via limiting access. •Does not meet RAOs. •Only a mild impediment; low efficacy.	**High** •Involves common construction. •Requires periodic maintenance.	**Low** •Costs include planning, material procurement, and posting.	**High** •Experienced contractors and supplies available locally.	**Medium** •Easy to maintain. •Subject to trespass and vandalism.	**Yes** Use to supplement other remediation alternatives.
		Raw Score	**1**	**3**	**3**	**3**	**2**	
		Weighted Score	**4**	**12**	**9**	**6**	**2**	**33**
			Evaluation/Comments: Access restrictions are widely used standard practices.				**References**: EPA 2000	
Physical Hazards/ Solid Media	**Engineering Controls** **Physical Barrier**	**Bat Gate/Culvert** Installed in open adits; cupolas in open shafts. **Backfill** Hazard is backfilled using surrounding mine waste, rock, or soil. **Plug** A polyurethane foam or concrete plug is installed in adit or shaft and covered with clean backfill or rock. **Bulkhead** A concrete bulkhead with piping and valves for hydraulic control is installed in adit.	**Medium** •Provides no remediation to reduce toxicity, mobility, or volume of COCs. •Prevents direct human exposure. •Eliminates physical hazard (backfill, plug and bulkhead). •May be used to dispose of waste rock (backfill). •Eliminates/reduces AMD[10] flow (plug). •Allows control of hydraulic head (bulkhead).	**Medium** •Dependent on location and size/required material. •Easy installation (plug). •Install properly to prevent void spaces (plug). •Prevent water pressure on plug during construction.	**Medium** •Costs may range from low to high depending on accessibility to remote locations. •Dependent on material type, volume, and transportation costs. •High concrete transport costs (bulkhead, plug). •Piping and valves costs for bulkhead. •Dependent on movement of material; possible subsidence repair (backfill).	**High** •Experienced contractors and supplies available locally.	**Medium** •Easy to maintain (bat gate). •Risk of failure or leakage due to subsidence, ground movement, future collapse or erosion. •Less prone to failure (bulkhead). •Subject to vandalism. •May require maintaining hydraulic controls (bulkhead). •Periodic inspection for leakage (plug).	**Yes** Use in conjunction with other alternatives.
		Raw Score	**2**	**2**	**2**	**3**	**2**	
		Weighted Score	**8**	**8**	**6**	**6**	**2**	**30**
			Evaluation/Comments: Physical barriers are a widely used, conventional technology. A rating of "medium" was applied to the technology for effectiveness, implementability, cost, and reliability/maintainability to provide a scoring estimate for the process options combined as one technology.				**References**: CDMG 2002	

TABLE 2
REMEDIAL TECHNOLOGY AND PROCESS OPTIONS FOR CONTAMINATED MEDIA: SECONDARY SCREENING SUMMARY
UPPER BLACKFOOT MINING COMPLEX

	TECHNOLOGY TYPE	PROCESS OPTIONS/ DESCRIPTION	EFFECTIVENESS[1] (x4)	IMPLEMENTABILITY[2] (x4)	COST[3] (x3)	AVAILABILITY[4] (x2)	RELIABILITY & MAINTAINABILITY[5] (x1)	OPTION RETAINED?
Physical Hazards/ Solid Media	**Engineering Controls** **Removal**	**Removal to Physical Indicator, COC Concentration, or Site-Specific Clean-up Levels (SSCL)[11]** Wastes are removed to clean-up levels or designated concentrations, or to a physical indicator such as groundwater or bedrock. Applies to the removal of concentrated and mixed tailings within the CMZ.[12]	**High** •Diverse removal criteria allows for effective removal of waste areas. •Removed material is usually isolated in a repository. •Effective in meeting RAOs to reduce human and environmental exposures. •Proven engineering control.	**Medium** •Limited site accessibility for equipment; dependent on location. •May be difficult to carry out at remote or discrete locations. •May require borrow material to provide a cover. •In some locations it is hard to distinguish between highly mineralized soil versus mine waste containing high metals concentrations. •Would require extensive dewatering (floodplain). •Floodplain stability issues could arise from increased volume of fill required for floodplain restoration.	**High** •Costs included sampling collection and/or analysis for concentration or clean-up indicators. •Disposal quantities dependent on wastes encountered in removal to indicator; material volume could increase repository size and design complexity. •Dependent on need for cover material.	**High** •Experienced contractors available regionally.	**High** •Generally requires low maintenance. •Install lateral mitigation controls within the CMZ.	**Yes** Use in conjunction with other alternatives.
		Raw Score	3	2	1	3	3	
		Weighted Score	12	8	3	6	3	32
			Evaluation/Comments: Proven technology, widely used. May result in the removal of excess materials not associated with mine waste activities. Vertical removal extents based on the Remedial Investigation and 2012 investigations. Ratings from Table 1 for effectiveness, implementability and cost were changed for an individual process to provide a scoring estimate for the process options combined as one technology.				**References:** CDMG 2002	
Physical Hazards/ Solid Media	**Engineering Controls** **Containment**	**Earthen Vegetative Cover** Material is left in place and covered with minimal soil and plant cover to eliminate direct exposure pathway and prevent erosion.	**Medium** •Provides no remediation to reduce toxicity or volume of COCs. •Some areas may require soil amendment to be conducive to vegetation. •Limits contact with waste and reduces rate of release of metals from waste. •Applicable to areas of low-level contamination. •Provides dust/erosion control and contaminant release control. •Limits infiltration and chemical reactions; may not stop acid drainage.	**Medium** •Dependent on slope stability and waste sources. •May require erosion control measures. •Requires borrow material to provide a cover. •May be difficult to carry out at remote, discrete, onsite locations, or steep slopes. •Use a seed mix that is tolerant of low pH/moisture/fertility soils.	**Medium** •Dependent on design, waste volume, COC characterization, and source of cover soil. •Long-term monitoring of area stability for erosion. •May require reseeding.	**High** •Experienced contractors and supplies available locally.	**Medium** •Does not prevent water infiltration. •Subject to erosion. •Requires periodic maintenance and weed control. •Growth medium for plants important to protect against erosion, exposure to sunlight, root penetration, and other processes.	**Yes**
		Raw Score	2	2	2	3	2	
		Weighted Score	8	8	6	6	2	30
			Evaluation/Comments: Earthen covers, a widely used, proven technology, are currently in use at the site as part of the interim actions and have met with mixed results. Although applicable at the site in-place wastes on relatively flat slopes, the process option is not appropriate for use in the floodplain. Use of an earthen cover in the floodplain is inconsistent with the remedy for Forest Service waste that specifies removal.				**References:** EPA 2004, INAP 2010	

TABLE 2
REMEDIAL TECHNOLOGY AND PROCESS OPTIONS FOR CONTAMINATED MEDIA: SECONDARY SCREENING SUMMARY
UPPER BLACKFOOT MINING COMPLEX

	TECHNOLOGY TYPE	PROCESS OPTIONS/ DESCRIPTION	EFFECTIVENESS[1] (x4)	IMPLEMENTABILITY[2] (x4)	COST[3] (x3)	AVAILABILITY[4] (x2)	RELIABILITY & MAINTAINABILITY[5] (x1)	OPTION RETAINED?
Physical Hazards/ Solid Media	**Engineering Controls** **Containment**	**Engineered Cover** Material is left in place and covered with an engineered multi-layer cover with a synthetic liner (GCL[13], HDPE[14], LLDPE[15]), soil, and vegetation to eliminate direct exposure pathway and prevent erosion.	**Medium** •Provides no remediation to reduce toxicity or volume of COCs. •Some areas may require soil amendment to be conducive to vegetation. •Limits contact with waste and significantly reduces rate of release of metals from waste. •Must be properly designed and installed/tested correctly. •Effectiveness dependent on design and installation of materials; clay (GCL) prone to decomposition from desiccation and freeze/thaw. •Provides dust/erosion control and contaminant release control. •Significantly reduces infiltration and chemical reactions; may not stop acid drainage. •Not effective for floodplain use.	**Low** •Dependent on slope stability and waste sources. •May require erosion control measures. •May require borrow material to provide a cover. •Difficult to carry out at remote, discrete, onsite locations, or steep slopes. •Site geography and slope may be too steep to be effective.	**High** •Dependent on design, waste volume, characterization of COCs, and source of cover soil. •Long-term monitoring of area stability for erosion and damage. •May require reseeding. •Liners are expensive, including shipping and transportation costs. •Equipment and construction methods associated with containment are readily available. •Additional layers above waste are more expensive.	**High** •Experienced contractors and supplies available locally.	**Medium** •Reliable when designed/installed correctly. •Subject to erosion. •Requires periodic maintenance and weed control. •Growth medium for plants important to protect against erosion, exposure to sunlight, root penetration, and other processes. •Lifetime of synthetics is approximately 50 years with soil cover.	**No**
		Raw Score	**2**	**1**	**1**	**3**	**2**	
		Weighted Score	**8**	**4**	**3**	**6**	**2**	**23**
			Evaluation/Comments: Engineered covers are a widely used proven technology, most effective for in-place wastes on relatively flat slopes. The steep topography at the UBMC[16] would significantly limit the effectiveness of the cover, making the technology inappropriate for use at the site. The effectiveness of the process option was changed from a rating of "high" in Table 1 to a rating of "medium" to account for the influence of site topography in calculating the score.				**References:** ACMER 2005, ADTI 1998, CDMG 2002, Costello 2003, EPA 2000, EPA 2006, INAP 2010	

TABLE 2
REMEDIAL TECHNOLOGY AND PROCESS OPTIONS FOR CONTAMINATED MEDIA: SECONDARY SCREENING SUMMARY
UPPER BLACKFOOT MINING COMPLEX

	TECHNOLOGY TYPE	PROCESS OPTIONS/ DESCRIPTION	EFFECTIVENESS[1] (x4)	IMPLEMENTABILITY[2] (x4)	COST[3] (x3)	AVAILABILITY[4] (x2)	RELIABILITY & MAINTAINABILITY[5] (x1)	OPTION RETAINED?
Physical Hazards/ Solid Media	**Land Disposal** **Onsite Disposal**	**Onsite Repository** Mine waste is excavated and placed in an engineered onsite repository.	**High** •Highly effective in meeting RAOs of reduced human and environmental exposures. •Decreases exposure risk by placing material in an engineered repository, with synthetic liner(s) and soil cover. •Waste is removed, reducing potential for AMD; high efficacy. •Waste remains onsite.	**High** •Dependent on volume and location of waste. •Limited site capacity of existing repositories. •Cover soil requirements may be an issue. •Requires dewatering or drying of waste prior to hauling. •Travel on public roads, if necessary, would require additional management and controls. •Transport of waste requires enclosed trucks with liners or covers. •Risk of spills during transportation.	**Medium** •Monitoring costs of remediation area and repository include inspecting cap, analyzing leachate, and evaluating floodplain risk. •Existing onsite repositories may require redesign. •Involves removal and placement of large quantities of material. •Dewatering expensive. •Traffic control on public roads.	**High** •Experienced contractors and supplies available locally.	**High** •Generally requires low maintenance. •Proven technology that is reliable when designed and installed correctly. •Growth medium for plants important to protect against erosion, exposure to sunlight, root penetration, and other processes. •Lifetime of synthetics is approximately 50 years with soil cover.	**Yes**
		Raw Score	**3**	**3**	**2**	**3**	**3**	
		Weighted Score	**12**	**12**	**6**	**6**	**3**	**39**
			Evaluation/Comments: Repositories are a widely used, conventional technology. Disposal may require the redesign of an existing onsite repository or the design of a new onsite repository.				**References:** CDMG 2002, EPA 2000, ITRC 2010	
Physical Hazards/ Solid Media	**Land Disposal** **Offsite Disposal**	**Offsite Repository** Mine waste is excavated and placed in an engineered offsite repository.	**High** •Highly effective in meeting RAOs of reduced human and environmental exposures. •Decreases exposure risk by placing material in an engineered repository, with synthetic liner(s) and soil cover. •Waste is removed from site, eliminating potential for AMD; high efficacy	**High** •Dependent on volume and location of waste. •Cover soil requirements may be an issue. •Travel on public roads would require additional management and controls. •Transport of waste requires enclosed trucks with liners or covers. •Risk of spills during transportation. •Requires dewatering or drying of waste prior to hauling. •May require permits. •Land acquisition may be necessary.	**High** •Monitoring costs of remediation area and repository include inspecting cap, analyzing leachate, and evaluating floodplain risk. •Transportation costs for moving waste. •Involves removal and placement of large quantities of material. •Dewatering expensive. •Traffic control on public roads. •Land acquisition may be necessary.	**High** •Experienced contractors and supplies available locally.	**High** •Generally requires low maintenance. •Proven technology that is reliable when designed and installed correctly. •Growth medium for plants important to protect against erosion, exposure to sunlight, root penetration, and other processes. •Lifetime of synthetics is approximately 50 years with soil cover.	**Yes**
		Raw Score	**3**	**3**	**1**	**3**	**3**	
		Weighted Score	**12**	**12**	**3**	**6**	**3**	**36**
			Evaluation/Comments: Repositories are a widely used, conventional technology. May require the redesign of an existing offsite repository.				**References:** CDM2 2000, EPA 2000	

TABLE 2
REMEDIAL TECHNOLOGY AND PROCESS OPTIONS FOR CONTAMINATED MEDIA: SECONDARY SCREENING SUMMARY
UPPER BLACKFOOT MINING COMPLEX

	TECHNOLOGY TYPE	PROCESS OPTIONS/ DESCRIPTION	EFFECTIVENESS[1] (x4)	IMPLEMENTABILITY[2] (x4)	COST[3] (x3)	AVAILABILITY[4] (x2)	RELIABILITY & MAINTAINABILITY[5] (x1)	OPTION RETAINED?
Physical Hazards/ Solid Media	**Land Disposal** **Offsite Disposal**	**Solid Waste Landfill** Mine waste is excavated and placed in a solid waste landfill. **Re-use/ Re-processing** Mine waste is excavated, hauled offsite, and re-processed for metals recovery or re-used for other purposes.	**High** •Eliminates direct exposure by removing waste from site. •Reduces waste volume, but still requires disposal of some waste (re-use/re-processing).	**Low** •Transport of contaminated soil requires enclosed trucks with liners or covers. •Risk of spills during transportation. •Requires dewatering or drying of waste prior to hauling. •Transportation through populated areas may raise community and regulatory concerns. •May only apply to site-specific wastes, not site-wide (re-use/re-processing). •Driven by market and economic considerations which can change rapidly (re-use/re-processing).	**High** •High transportation and disposal costs due to distance from landfill. •The nearest landfill site is approximately 70 miles from site. •Costs are directly related to volume to be disposed. •Waste managed by landfill facility. •Resource recovery may offset part of remediation costs; will require some disposal costs (re-use/re-processing).	**Low** •Local landfills or processing facilities may not accept waste due to quantities, characteristics, and market demand.	**High** •Removes contamination from site to a licensed facility. •Less long-term O&M[17] than waste remaining at the site.	**No**
		Raw Score	3	1	1	1	3	
		Weighted Score	12	4	3	2	3	24
			Evaluation/Comments: Although the technology removes the waste from the site, the transportation and disposal costs are prohibitive, eliminating the process option from use at the site. A rating of "low" was applied to the technology for implementability to account for the uncertainty in the applicability of the technology site-wide and the uncertainty in landfill/processing facility acceptance of waste.				**References:** EHSO 2013, EPA 2004, ITRC 2010	
Physical Hazards/ Solid Media	**In-situ Treatment**	**Neutralization/ Alkaline Amendment** Cement kiln dust, lime, or other alkaline material is tilled into the mine waste to neutralize acid-producing materials.	**Medium** •Decreases mobility of most metals in acidic soils; increased risk for arsenic mobility. •Controls AMD from soil and waste. •May be applicable on thin, isolated wastes or residual soil under removed waste piles, but not on a broad scale. •Surficial treatment (not effective at depth). •Increases volume of material to dispose.	**Medium** •Results achieved thorough blending, mixing, layering, trenches, surface application, or chemical cap. •Applies only to potential acid-producing material. •Difficult to implement on coarse waste, steep slopes, or excessively wet material. •Not suitable where water is within two feet of treatment zone (floodplain). •Alkaline amendment source could be difficult to locate.	**High** •Cost of lime may fluctuate due to regional market demand. •High transportation cost to deliver amendment to the site.	**Medium** •Availability of lime may be limited due to regional market demand. •Experienced contractors available regionally.	**Medium** •Difficult to thoroughly mix and achieve acid neutralization. •Risk of lime shortage during treatment. •Channel migration (floodplain).	**Yes** Use in conjunction with other alternatives. Not effective treatment in floodplains.
		Raw Score	2	2	1	2	2	
		Weighted Score	8	8	3	4	2	25
			Evaluation/Comments: Conventional technology that is currently in use onsite at the Paymaster repository. The implementability of the technology was changed from a rating of "medium to high" in Table 1 to a rating of "medium" for scoring calculations. Cost is rated "high" due to fluctuations in the price and availability of lime. The technology is retained as an option for treatment of waste rock, tailings, and associated soil, but is not applicable to treatment of waste materials in the floodplain.				**References:** Costello 2003, EPA 2006	

TABLE 2
REMEDIAL TECHNOLOGY AND PROCESS OPTIONS FOR CONTAMINATED MEDIA: SECONDARY SCREENING SUMMARY
UPPER BLACKFOOT MINING COMPLEX

	TECHNOLOGY TYPE	PROCESS OPTIONS/ DESCRIPTION	EFFECTIVENESS[1] (x4)	IMPLEMENTABILITY[2] (x4)	COST[3] (x3)	AVAILABILITY[4] (x2)	RELIABILITY & MAINTAINABILITY[5] (x1)	OPTION RETAINED?
Physical Hazards/ Solid Media	**Ex-situ treatment**	**Blending/Co-disposal** Mine wastes of varying acid-generation and neutralization potentials are removed and mixed to create a blend that reduces contaminant mobility. **Neutralization/ Alkaline Amendment** Waste is removed and cement kiln dust, lime, or other alkaline material is mixed into the mine waste to neutralize acid-producing materials.	**Medium** •Dependent on tailings and mine waste chemistry. •Requires a balance of acid-generating and neutralizing materials being thoroughly mixed (blending/co-disposal). •Increases effectiveness of repository through geotechnical and geochemical stability (blending/co-disposal). •Volume reduction by combining and compacting coarse material with fine material (blending/co-disposal). •Decreases mobility of most metals in acidic soils; increased risk for arsenic mobility (neutralization). •Controls AMD from soil and waste; surficial treatment (neutralization). •Increases volume of material to dispose (neutralization).	**Medium** •Requires characterization of tailings and waste rock; formula for mixing must be predetermined (blending/co-disposal). •Requires increased construction management. •Results achieved thorough blending, mixing, layering, trenches, surface application, or chemical cap (neutralization). •Applies only to potential acid-producing material (neutralization). •Difficult to implement on coarse waste or excessively wet material (neutralization). •Alkaline amendment source could be difficult to locate.	**High** •Requires materials evaluation; may require double-handling of waste (blending/co-disposal). •Cost of lime may fluctuate due to regional market demand. •High transportation cost to deliver amendment to the site.	**Medium** •Availability of lime may be limited due to regional market demand. •Experienced contractors available regionally.	**Medium** •Generally requires low maintenance (blending/co-disposal). •Difficult to thoroughly mix and achieve acid neutralization. •Risk of lime shortage during treatment.	**Yes** Use in conjunction with repository for select waste.
		Raw Score	**2**	**2**	**1**	**2**	**2**	
		Weighted Score	**8**	**8**	**3**	**4**	**2**	**25**
			Evaluation/Comments: Conventional technology that is currently in use onsite at the Paymaster repository. A rating of "medium" was applied to the technology for implementability and a rating of "high" for cost to provide a scoring estimate for the process options combined as one technology. The process option is not applicable to waste located in the floodplain.				**References:** Costello 2003, EPA 2006, INAP 2010	
Surface Water/ Groundwater[18]	**No Action**	**No Action** Features are left "as is."	**Low** •Provides no further remediation to reduce toxicity, mobility, or volume of COCs. •Relies on existing implemented measures. •No controls limiting exposure to COCs are provided. •Does not meet RAOs.	**High** •Requires no implementation.	**Low** •Maintains existing costs.	**High** •Maintains status quo (see evaluation/comments).	**Low** •Maintains status quo.	**Yes** Use as a baseline to compare other alternatives. Provides an understanding of current and future potential risks.
		Raw Score	**1**	**3**	**3**	**3**	**1**	
		Weighted Score	**4**	**12**	**9**	**6**	**1**	**32**
			Evaluation/Comments: Required for consideration by DEQ. Does not remove contamination or reduce risk to human health and the environment. Limited effectiveness for risk mitigation. Easy to maintain, but reliability is low. Availability for this technology is rated "high" to reflect the required inclusion, rather than the number of vendors available to provide services.				**References:** EPA 1988, EPA 1989	

TABLE 2
REMEDIAL TECHNOLOGY AND PROCESS OPTIONS FOR CONTAMINATED MEDIA: SECONDARY SCREENING SUMMARY
UPPER BLACKFOOT MINING COMPLEX

	TECHNOLOGY TYPE	PROCESS OPTIONS/ DESCRIPTION	EFFECTIVENESS[1] (x4)	IMPLEMENTABILITY[2] (x4)	COST[3] (x3)	AVAILABILITY[4] (x2)	RELIABILITY & MAINTAINABILITY[5] (x1)	OPTION RETAINED?
Surface Water/ Groundwater[18]	**Monitored Natural Attenuation (MNA)**	**MNA** Relies on natural physical, chemical, and biological processes to reduce the concentrations of contaminants.	**Low** •Relies on the success of previous remediation efforts. •Limited effectiveness for contaminant removal and reduction of risk to human health and the environment in the short term. •Uncertainty of effectiveness of processes on metals. •May take considerable time to achieve cleanup.	**High** •Monitoring only. •Involves a comprehensive monitoring system. •Institutional controls may be required to prevent exposure during attenuation processes.	**Low** •Monitoring and maintenance costs included with other O&M.	**High** •Maintains status quo (see evaluation/comments).	**Low** •Easily maintained, but low reliability.	**Yes** Use in conjunction with other alternatives.
		Raw Score	**1**	**3**	**3**	**3**	**1**	
		Weighted Score	**4**	**12**	**9**	**6**	**1**	**32**
			Evaluation/Comments: Used in conjunction with active remediation (source control or removal) or as a follow-up measure after active remediation (EPA 1999). May be applicable to previously reclaimed/remediated areas if SSCLs are met. Availability for this technology is rated "high" to reflect the inherent nature of the technology, rather than the number of vendors available to provide services.				**References:** EPA 1999	
Surface Water/ Groundwater[18]	**Institutional Controls** **Land Use Controls**	**Deed Restrictions, Easements, Covenants, and Reservations** Limits future land use.	**Low** •Protects human health by limiting access to exposure pathways and risk of future exposures. •Provides no remediation to reduce toxicity, mobility, or volume of COCs. •Most effective in preventing exposure to groundwater. •Can enhance effectiveness of other options by limiting access. •Effectiveness depends on the compliance of the property owner and the enforcement of the federal, state, or local agency. •Not effective in limiting recreational or trespass exposures. •Does not meet RAOs.	**Medium** •Issue regarding whether process options can be used on public land. •Intended to supplement treatment or engineering controls, not the sole remedy. •Requires legal documents (deed restrictions, easements, covenants, etc.).	**Low** •Administrative costs to implement. •Enforcement costs can range from low to high. •Persistent management. •Requires long-term maintenance and land-use control enforcement.	Low •Several property owners are affected (see evaluation/comments).	**Medium** •Requires some form of persistent management on the part of the property owner, or the federal, state, or local agency. •Legally binding. •Motivation to enforce these regulations may diminish as time passes.	**Yes** Use to supplement other remediation alternatives.
		Raw Score	**1**	**2**	**3**	**1**	**2**	
		Weighted Score	**4**	**8**	**9**	**2**	**2**	**25**
			Evaluation/Comments: Institutional control technology is a widely used standard practice. The effectiveness of the technology was changed from a rating of "low to high" in Table 1 to a rating of "low" to provide a conservative scoring estimate. Although easy to administer on Trust Lands, the technology may be more difficult to administer on Forest Service land. Therefore, the implementability of the technology was changed from a rating of "high" in Table 1 to a rating of "medium" for scoring. Availability for this technology is based on the number of property owners affected by the remediation, rather than the number of vendors available to provide services. The rating for availability was changed from a rating of "high" in Table 1 to a rating of "low" to reflect that several property owners would be involved in the process.				**References:** EPA 2000, ITRC 2010	

TABLE 2
REMEDIAL TECHNOLOGY AND PROCESS OPTIONS FOR CONTAMINATED MEDIA: SECONDARY SCREENING SUMMARY
UPPER BLACKFOOT MINING COMPLEX

	TECHNOLOGY TYPE	PROCESS OPTIONS/ DESCRIPTION	EFFECTIVENESS[1] (x4)	IMPLEMENTABILITY[2] (x4)	COST[3] (x3)	AVAILABILITY[4] (x2)	RELIABILITY & MAINTAINABILITY[5] (x1)	OPTION RETAINED?
Surface Water/ Groundwater[18]	**Institutional Controls** **Administrative Controls**	**Fish Advisories and Closures** Areas are closed to fishing as needed. Public is warned through public notices of potential dangers concerning fishing.	**Low** •Provides no remediation to reduce toxicity, mobility, or volume of COCs. •Not effective in limiting recreational or trespass exposures. •Notices do not generally include heavy metals other than mercury.	**Low** •Advisories are issued by Montana Fish, Wildlife and Parks and updated through public announcements and signage.	**Low** •Monitoring and maintenance costs (signs, public ads, etc.).	**Medium** •Advisories are posted on-line by issuing agency and signage is placed in highly visible areas onsite, subject to public knowledge.	**Low** •No risk reduction.	**No**
		Raw Score	**1**	**1**	**3**	**2**	**1**	
		Weighted Score	**4**	**4**	**9**	**4**	**1**	**22**
			Evaluation/Comments: Most fish advisories involve contaminants that bio-accumulate. With the exception of mercury, high metal concentrations result in fish kills and do not bio-accumulate. Availability for this technology is based on the visibility of the advisories, rather than the number of vendors available to provide services.				**References:** EPA 2012	
Surface Water/ Groundwater[18]	**Engineering Controls** **Containment**	**Retention Pond** Constructed onsite to retain AMD or otherwise manage surface water/groundwater. Treatment depends on evaporation and/or infiltration.	**Medium** •Applicable to low flows, i.e. small groundwater seeps.	**High** •Use may be limited on site due to space constraint and site conditions. •Potential for attractive nuisance for the public and wildlife.	**Low** •Cost dependent on the number of ponds installed. •Overflow inspection.	**High** •Experienced contractors and supplies available locally.	**Low** •Requires periodic inspections for erosion and leakage. •Creates contaminant source and exposure pathway. •Prone to failure.	**Yes** Use in conjunction with other alternatives.
		Raw Score	**2**	**3**	**3**	**3**	**1**	
		Weighted Score	**8**	**12**	**9**	**6**	**1**	**36**
			Evaluation/Comments: Retention ponds are a widely used, conventional technology. Technology may be applicable as part of a treatment process for small groundwater seeps. Retention ponds are not applicable for treatment of surface waters at the site due to high, variable flows.				**References:** EPA 2000, EPA 2006	
Surface Water/ Groundwater[18]	**Engineering Controls** **Detention**	**Settling Pond** Constructed onsite for removal of suspended solids and to oxygenate and promote metals precipitation. Groundwater is pumped to the pond.	**Medium** •May be used as a pretreatment. •Reduces sediment load to streams and precipitates that form with air contact. •Requires water to remain in cell long enough (at least 24 hours) to promote precipitation of metals. •Best for high TSS[19] and near neutral pH values.	**High** •Requires water chemistry testing to determine if technology is appropriate at the site. •Use may be limited on site due to space constraint and site conditions. •Depending on inflow amount, may require large surface area. •Potential for attractive nuisance for the public and wildlife.	**Medium** •Requires a pond liner with a finite life. •Periodically clean pond, excavate, and dispose of sediments. •Generates a waste sludge with associated disposal costs.	**High** •Experienced contractors and supplies available locally.	**Low** •Requires periodic inspections for erosion and leakage and sludge disposal. •Liner has limited working life (15 to 20 years); will require replacement. •Creates contaminant source and exposure pathway. •Prone to failure.	**Yes** Use in conjunction with other alternatives.
		Raw Score	**2**	**3**	**2**	**3**	**1**	
		Weighted Score	**8**	**12**	**6**	**6**	**1**	**33**
			Evaluation/Comments: Settling ponds are a widely used conventional technology that is currently in use onsite. The process option may be applicable for use with the existing WTP[20] or for treatment at remote features. The cost of the process option was changed from a rating of "low to medium" in Table 1 to a rating of "medium" for scoring calculations.				**References:** CDMG 2002, EPA 2004	

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UPPER BLACKFOOT MINING COMPLEX

	TECHNOLOGY TYPE	PROCESS OPTIONS/ DESCRIPTION	EFFECTIVENESS[1] (x4)	IMPLEMENTABILITY[2] (x4)	COST[3] (x3)	AVAILABILITY[4] (x2)	RELIABILITY & MAINTAINABILITY[5] (x1)	OPTION RETAINED?
Surface Water/ Groundwater[18]	**Engineering Controls** **Hydrologic and Hydraulic Control[21]**	**Hydrologic Control - Diversion** Diversion channels are installed to intercept surface water run-on and divert around mine waste. **Hydrologic Control - Fracture/Fault Grouting** A soil-bentonite or soil-cement slurry mixture is injected into ground fractures/faults to prevent groundwater from flowing through heavily mineralized zones. **Hydraulic Control - Piping** Pipe is installed to convey surface water around mine waste or into workings. **Hydraulic Control - Stream Realignment** A new stream channel is constructed to convey flows around mine waste or into workings.	**Medium** •Not independently effective for contaminant removal and reduction of risk to human health and the environment in the short term. •Use to control volume, direction, and contact time to minimize AMD contact. •Recommended in acid-producing areas. Eliminates contact with waste and reduces erosion of waste piles. •Reduces amount of contaminated water. •Reduces groundwater degradation by restricting groundwater flow through fracture/fault zone (fracture/fault grouting). •Effectiveness most dependent on fracture/fault characteristics and grout injection pressures (fracture/fault grouting). •Less effective along a gaining surface water reach (piping). •Phase I of a fracture/fault grouting demonstration project was completed onsite in 1994 with some success. Phase II of the project was planned but not executed due to loss of funding.	**Medium** •Requires proper design to maintain stability, encourage water flow, and prevent erosion with riprap. •May be difficult to construct in some areas due to steep slopes, limited access, and space constraints. •Installed pipe is trenched and covered with soil to prevent freezing and cracking due to temperature changes. •Grout bore holes are drilled to intercept the fault zone; may inadvertently increase fracturing and seepage (fracture/fault grouting). •Requires temporary diversion (stream realignment, fracture/fault grouting). •Requires careful engineering and extensive channel stabilization with riprap (stream realignment).	**Medium** •Requires long-term inspection for erosion, especially following precipitation events. •Difficult to construct due to steep slopes and space constraints. •Inspect piping for leaks.	**High** •Experienced contractors and supplies available regionally.	**Medium** •Prevents and reduces ongoing impacts to sensitive environments. •Long-term inspections for erosion and leakage especially following precipitation events. •Reduces risks and mitigates adverse impacts. •Maintenance includes removal of debris from diversion channel. •Reliable when grouting can "fill" the fracture or fault, effectively reducing infiltration; may require additional grouting as new fractures appear. •Monitor groundwater for increase flows suggesting grout failure and increased infiltration (fracture/fault grouting). •Stream may move back to original channel following heavy precipitation events (stream realignment).	**Yes** Use in conjunction with other alternatives.
		Raw Score	2	2	2	3	2	
		Weighted Score	8	8	6	9	2	33
			Evaluation/Comments: Hydrologic and hydraulic controls are widely used conventional technologies that are currently in use onsite as an interim action. Grouting may be applicable at the Mike Horse Mine Site to limit groundwater degradation by reducing the groundwater infiltration through faults and fractures in the mineralized zones. Ratings from Table 1 for effectiveness, implementability and cost were changed for an individual process to provide a scoring estimate for the process options combined as one technology.				**References:** CDMG 2002, EPA 2000, EPA 2006, INAP 2010, ITRC 2010, Medhurst, et.al 2008	

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REMEDIAL TECHNOLOGY AND PROCESS OPTIONS FOR CONTAMINATED MEDIA: SECONDARY SCREENING SUMMARY
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	TECHNOLOGY TYPE	PROCESS OPTIONS/ DESCRIPTION	EFFECTIVENESS[1] (x4)	IMPLEMENTABILITY[2] (x4)	COST[3] (x3)	AVAILABILITY[4] (x2)	RELIABILITY & MAINTAINABILITY[5] (x1)	OPTION RETAINED?
Surface Water/ Groundwater[18]	**Engineering Controls** **Hydrologic and Hydraulic Control**	**Interceptor Trench** A trench is excavated and filled with permeable material, such as gravel, to intercept and divert groundwater around mine waste or underground workings.	**Medium** •Minimizes groundwater degradation by diverting groundwater around acid-producing rock •Effective if permeable material has greater permeability than native material. •Not applicable to surface water.	**Low** •Limited access due to site conditions; difficult to install in rocky areas. •May not completely stop flow.	**Medium** •Dependent on availability of materials. •Inspect for effectiveness, metal precipitation, and plugging.	**High** •Experienced contractors and supplies available locally.	**Low** •Potential plugging. •Some groundwater may "escape" trench. •Requires cleaning to prevent plugging and replacement of permeable materials over time.	**No** (see evaluation/ comments).
		Raw Score	**2**	**1**	**2**	**3**	**1**	
		Weighted Score	**8**	**4**	**6**	**6**	**1**	**25**
			Evaluation/Comments: Although the technology is proven and the weighted score meets the minimum criteria, best engineering judgment with regards to the low implementability and inapplicability for surface water eliminates the technology from consideration at the site. Ratings from Table 1 for implementability and cost have been changed to reflect this engineering judgment.				**References:** INAP 2010, EPA 2000	
Surface Water/ Groundwater[18]	**Engineering Controls** **Inundation**	**Bulkhead/Wet Mine Seal** A plug is installed in adit that allows water to flow from the flooded underground workings, but prevents air from entering. **Plug** A polyurethane foam or concrete plug is installed in adit to block AMD discharge from the flooded underground workings.	**Medium** •Does not address or treat contamination. •Provides hydraulic control. •Reduces AMD by flooding underground workings, limiting outflow. •Allows control of hydraulic head (bulkhead). •Not effective for surface water.	**Medium** •Subject to water table fluctuations. •Requires extensive research to design properly for site conditions. •Use may be limited onsite due to remote locations and heavy equipment requirements for installation. •Difficult to obtain complete seal. •Install properly to prevent void spaces (plug). •Prevent water pressure on the plug during construction.	**High** •Costs may range from low to high depending on accessibility to remote locations. •Dependent on material type, volume, and transportation costs. •Piping and valves costs for bulkhead. •Requires considerable geologic characterization and engineering investigation.	**High** •Experienced contractors and supplies available locally.	**Medium** •Risk of failure or leakage due to subsidence, ground movement, future collapse. •Periodic inspection for leakage or erosion. •Maintenance of piping and valves; flow management. •Less prone to failure (bulkhead).	**Yes**
		Raw Score	**2**	**2**	**1**	**3**	**2**	
		Weighted Score	**8**	**8**	**3**	**6**	**2**	**27**
			Evaluation/Comments: Widely used conventional technology that is currently in use onsite as an interim action to control adit discharge**.** For some features, inundation process options may be the only implementable alternative. A rating of "medium" was applied to the technology for effectiveness and reliability/maintainability to provide a scoring estimate for the process options combined as one technology. The technology is not effective for surface water.				**References:** EPA 2004, EPA 2006, INAP 2010	

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UPPER BLACKFOOT MINING COMPLEX

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Surface Water/ Groundwater[18]	**Active Treatment** **Chemical Reagent**	**Aeration** Air is introduced into the water using gravity or mechanical devices to promote oxidation of iron (Fe) and manganese (Mn).	**Medium** •Simple process. •Effective when used in combination with other alternatives. •Effective if pH is greater than 5. •Increases chemical treatment efficiency. •Done before or during treatment using mixing devices. •Improves removal of Fe and Mn. •Not effective for variable or high surface water flows.	**Low** •Limited site accessibility for equipment; dependent on location. •Use of atmospheric air eliminates permitting, management, handling, and disposal of other chemical reagents. •May require pH adjustment to achieve desired oxidation rate. •Requires power source for operation; not feasible in remote locations.	**High** •Requires monitoring, management, and power source.	**Medium** •Few experienced contractors and supplies available regionally.	**Low** •Precipitate build-up. •Requires frequent maintenance. •Subject to freezing during cold months.	**No**
		Raw Score	**2**	**1**	**1**	**2**	**1**	
		Weighted Score	**8**	**4**	**3**	**4**	**1**	**20**
			Evaluation/Comments: Aeration is not applicable to variable and high surface water flows, and the high power requirements for active treatment eliminates the option from use at the site. The implementability of the process option was changed from a rating of "medium" in Table 1 to a rating of "low" and cost was changed from a rating of "medium" to a rating of "high" to account for the high energy needs for active treatment in determining a score.				**References:** ADTI 1998, ITRC 2010, INAP 2010	

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UPPER BLACKFOOT MINING COMPLEX

	TECHNOLOGY TYPE	PROCESS OPTIONS/ DESCRIPTION	EFFECTIVENESS[1] (x4)	IMPLEMENTABILITY[2] (x4)	COST[3] (x3)	AVAILABILITY[4] (x2)	RELIABILITY & MAINTAINABILITY[5] (x1)	OPTION RETAINED?
Surface Water/ Groundwater[18]	**Active Treatment** **Chemical Reagent**	**Neutralization** A neutralizing agent, such as lime, is added to AMD followed by a settling pond for metals precipitation. **Oxidation** A chemical oxidant, such as hydrogen peroxide or potassium permanganate, is added to enhance metal hydroxide precipitation and reduce metal floc volume. **Precipitation** A chemical reagent, such as sodium hydroxide or calcium hydroxide, is added to promote precipitation of metals as hydroxides.	**Medium** •Dependent on flow rate, volume, contaminant concentrations, and discharge criteria. •Requires proper system design with a chemical delivery system to be effective. •Removes aluminum (Al), iron (Fe), copper (Cu), cadmium (Cd), lead (Pb), and zinc (Zn). Studies have shown up to 90% effectiveness. •Unlikely to meet discharge limits on its own. •Helps to complete oxidation process, enhance metal hydroxide precipitation, and reduce metal floc volume. Metals will generally precipitate at lower pH values if water is oxidized (oxidation). •Usually combined with other technologies to improve efficacy (oxidation). •Proven effective, immediate results, easily implemented, easy to monitor (precipitation).	**Medium** •Technology may be able to be incorporated into existing WTP operations. •Requires a chemical delivery system and power supply. •Difficult to implement on variable or high surface water flows.	**High** •Costs include incorporation of technology into existing WTP. •Reagents require replenishment; high transportation costs for delivery of reagents. •Cost of lime may fluctuate due to regional market demand. •Sludge disposal costs. •Requires monitoring and controlling system. •Cost effective method for treating large AMD flows; less cost effective for small flows. •Cost effective for concentrated flows; less cost effective for more diluted flows.	**Medium** •Availability of lime and other reagents may be limited due to regional market demand. •Experienced contractors available regionally.	**Medium** •Risk of lime shortage during treatment. •Requires equipment maintenance and diligent oversight to ensure that system is running effectively. •Precipitate build-up. •Subject to freezing during cold months.	**Yes**
		Raw Score	**2**	**2**	**1**	**2**	**2**	
		Weighted Score	**8**	**8**	**3**	**4**	**2**	**25**
			Evaluation/Comments: Active treatment with a chemical reagent is a widely used conventional technology that is currently in use onsite. Mechanical Lime Injection (from Table 1) was renamed Neutralization to represent the chemical process rather than delivery method. Ratings from Table 1 for effectiveness, implementability, and cost were changed for an individual process to provide a scoring estimate for the process options combined as one technology. May be applicable for some features. Not effective for high surface water flows; requires a large surface area for treatment. Implementation of this technology includes the use of chemical reagents; proper safety precautions should be observed to prevent spills and limit worker exposure.				**References:** ADTI 1998, CDMG 2002, Costello 2003, EPA 2006, FRTR 2007, ITRC 2010	

TABLE 2
REMEDIAL TECHNOLOGY AND PROCESS OPTIONS FOR CONTAMINATED MEDIA: SECONDARY SCREENING SUMMARY
UPPER BLACKFOOT MINING COMPLEX

	TECHNOLOGY TYPE	PROCESS OPTIONS/ DESCRIPTION	EFFECTIVENESS[1] (x4)	IMPLEMENTABILITY[2] (x4)	COST[3] (x3)	AVAILABILITY[4] (x2)	RELIABILITY & MAINTAINABILITY[5] (x1)	OPTION RETAINED?
Surface Water/ Groundwater[18]	**Active Treatment** **Physical/ Mechanical**	**Reverse Osmosis** Water is forced through a semi-permeable membrane to remove metals and other contaminants. **Ion Exchange** Water is passed through a bed of ion-exchange material to transfer metal ions onto the material.	**Medium** •Produces high quality effluent. •Not effective for surface water, due to higher, variable flows, and variable water quality (reverse osmosis). •Most effective for water with a pH range of 4 to 8, low suspended solids, and low concentrations of Fe and Al (ion exchange). •Difficult to remove all metals effectively from a complex mixture (ion exchange). •Immediate results (ion exchange). •Resins can be designed to target specific groups (e.g., trace metals), but within these groups there is a hierarchy of removal (ion exchange).	**Medium** •Not used often for the treatment of high strength liquid effluents due to high operating costs, pre-treatment requirements, gypsum scaling, and the need for downstream treatment of concentrate brines (reverse osmosis). •Use as a secondary treatment to remove specific contaminants (ion exchange). •Ion exchange media selected based on the AMD specific metals that need to be removed. •Large flows generally require a full-scale treatment plant; for small to intermediate flows, standard tank sizes are available (ion exchange). •Quick system installation (ion exchange).	**High** •Pre-treatment systems can be expensive; may include desalination (reverse osmosis). •Requires cleaning, maintenance, and replacement costs for membranes and ion-exchange material. •Increased energy requirements. •Not feasible for treating large volumes of water (ion exchange). •Requires treatment of a concentrated regeneration brine (ion exchange). •Requires new WTP or extensive modification of existing WTP.	**Low** •Few vendors available regionally.	**Low** • Membranes subject to particulate fouling. •Produces a highly concentrated brine that requires treatment and special disposal of dried salts (reverse osmosis). •Requires weekly maintenance of Fe and Al pre-filters and pH adjustment (ion exchange). •Supplier may be able to handle waste disposal (ion exchange). •Produces a highly concentrated brine that requires treatment and special disposal of dried salts (reverse osmosis). •May require pretreatment of feed.	**No**
		Raw Score	**2**	**2**	**1**	**1**	**1**	
		Weighted Score	**8**	**8**	**3**	**2**	**1**	**22**
			Evaluation/Comments: Although the technology is effective for water treatment, high costs, limited vendor availability and low reliability/maintainability eliminate the technology from consideration at the site. Ratings from Table 1 for effectiveness were changed for an individual process to provide a scoring estimate for the process options combined as one technology type.				**References:** ADTI 1998, EPA 2004, FRTR 2007, INAP 2010, ITRC 2010	

TABLE 2
REMEDIAL TECHNOLOGY AND PROCESS OPTIONS FOR CONTAMINATED MEDIA: SECONDARY SCREENING SUMMARY
UPPER BLACKFOOT MINING COMPLEX

	TECHNOLOGY TYPE	PROCESS OPTIONS/ DESCRIPTION	EFFECTIVENESS[1] (x4)	IMPLEMENTABILITY[2] (x4)	COST[3] (x3)	AVAILABILITY[4] (x2)	RELIABILITY & MAINTAINABILITY[5] (x1)	OPTION RETAINED?
Surface Water/ Groundwater[18]	**Active Treatment** **Physical/ Mechanical**	**Electrocoagulation** An electrical current is applied to promote coagulation of organics and suspended solids in water. **Ceramic Microfiltration** Multi-stage system involving pre-treatment of the water with sodium hydroxide and pumping through a ceramic membrane.	**High** •Dependent on properties of the wastewater being treated (conductivity, pH, chemical concentrations, and particle size). Requires high conductivity for effectiveness (electrocoagulation). •High removal rates of Cu and Zn (electrocoagulation). •Complex and effective process that produces a high quality effluent (ceramic microfiltration). •Neither technology is effective for treatment of surface water.	**Medium** •Requires pretreatment. •Requires large-scale modifications to existing water treatment plant (electrocoagulation). •Complex technology (ceramic microfiltration).	**High** •High energy costs. •Electrode replacement, multiple parameters to monitor and adjust for optimal treatment (electrocoagulation). •Online cleaning process, requires chemical to clean ceramic elements (ceramic microfiltration). •Requires a large scale treatment system for varying surface water flows (ceramic filtration). •Ceramic filtration is currently in use at site for groundwater.	**Medium** •Contractors and supplies are available regionally.	**Medium** •Parameters need to be adjusted for optimal treatment. •Requires regular maintenance and cleaning. •Creates one-third less sludge than conventional precipitation.	**Yes**
		Raw Score	**2**	**2**	**1**	**2**	**2**	
		Weighted Score	**8**	**8**	**3**	**4**	**2**	**25**
			Evaluation/Comments: Active physical or mechanical treatment is a widely used conventional technology that is currently in use onsite. Ceramic microfiltration is in use at the existing WTP at the site; electrocoagulation is under consideration for future use at the WTP. Neither technology is applicable to the treatment of surface water at the site. The rating for Implementability was changed from a "low" in Table 1 to "medium" to account for the current use of the technology at the site. Ratings from Table 1 for effectiveness were changed for an individual process to provide a scoring estimate for the process options combined as one technology type.				**References:** ADTI 1998, EPA 2004, ITRC 2010	

TABLE 2
REMEDIAL TECHNOLOGY AND PROCESS OPTIONS FOR CONTAMINATED MEDIA: SECONDARY SCREENING SUMMARY
UPPER BLACKFOOT MINING COMPLEX

	TECHNOLOGY TYPE	PROCESS OPTIONS/ DESCRIPTION	EFFECTIVENESS[1] (x4)	IMPLEMENTABILITY[2] (x4)	COST[3] (x3)	AVAILABILITY[4] (x2)	RELIABILITY & MAINTAINABILITY[5] (x1)	OPTION RETAINED?
Surface Water/ Groundwater[18]	**Passive Treatment** **Biotreatment**	**Vertical Flow Reactors** A treatment cell comprised of ponded water over an organic substrate and limestone drainage layer. Usually combined with a settling pond and aerobic wetland. **Subsurface Flow Wetlands** Water is routed through a series of buried organic and gravel substrates for metals removal. Surface is left vegetated and dry. **Successive Alkalinity Producing System (SAPS)** Three to six feet of water is ponded over organic material (6 to 12 inches thick) and a limestone drainage layer (1 to 2 feet thick); similar to vertical flow reactor. Combines an anoxic limestone drain and an anaerobic wetland.	**Low** •Typically not effective in cold climates. •Treats highly acidic water (vertical flow reactor, SAPS). •Increases interaction of water with organic matter and limestone (vertical flow reactor, SAPS). •Neutralizes acidity and promotes metal precipitation in difficult treatment situations. Low efficacy for Mn removal (vertical flow reactor). •Metal floc accumulation and organic layer degradation decrease efficacy. •Can be constructed subsurface (subsurface flow wetlands). •Technologies are not feasible for large surface flow or require a large-scale system for variable surface flows. •Metal removal dependent on influent concentration and mass loading rate.	**Medium** •Wildlife (i.e., muskrat, beaver) may block system (vertical flow reactor). •Water may form preferential path, reducing retention time. •Requires certain amount of retention time; longer time for SAPS. •Can support simultaneous aerobic and anaerobic conditions (subsurface flow wetlands). •Subsurface water and plant debris provides thermal protection in cold climates (subsurface flow wetlands). •Tends to be more effective than anaerobic wetlands and requires less space (SAPS). •May require pre-treatment to prevent clogging (SAPS). •Evaluate climate conditions to determine year-round effectiveness. May be less prone to freezing (SAPS).	**High** •Requires periodic flushing, sludge removal, and replacing substrate. •Cost dependent on detention time, treatment goals, media type and availability, bed depth, pre-treatment, number of cells, and terrain. •Requires influent and effluent sampling and testing. •Water level adjustment.	**Medium** •Availability of limestone may be limited due to regional market demand. •Experienced contractors available regionally.	**Low** •Subject to plugging. •Requires periodic flushing, sludge removal and replacing substrate. •Requires certain amount of retention time. Higher removal rates require longer detention times (larger wetlands). •Metal floc accumulation and organic layer degradation decrease efficacy. •Accumulation of Fe and Al floc over time; armoring of limestone (vertical flow reactor, SAPS). •Subject to freezing during cold months.	**No**
		Raw Score	**1**	**2**	**1**	**2**	**1**	
		Weighted Score	**4**	**8**	**3**	**4**	**1**	**20**
			Evaluation/Comments: Technology has little applicability at the site due to high cost and limited effectiveness in colder climates. Ratings for effectiveness were changed from "medium" in Table 1 to "low" for score calculation to account for the limitations of the process options for large surface water flows and colder climates. The overall scoring of the technology eliminates the process options from consideration at the site. Ratings for implementability and cost were changed from Table 1 for an individual process to provide a scoring estimate for the process options combined as one technology type.				**References:** BLM 2003, Costello 2003, EPA 2004, EPA 2006, H&H 2003, ITRC 2010, Zipper 2001	

TABLE 2
REMEDIAL TECHNOLOGY AND PROCESS OPTIONS FOR CONTAMINATED MEDIA: SECONDARY SCREENING SUMMARY
UPPER BLACKFOOT MINING COMPLEX

	TECHNOLOGY TYPE	PROCESS OPTIONS/ DESCRIPTION	EFFECTIVENESS[1] (x4)	IMPLEMENTABILITY[2] (x4)	COST[3] (x3)	AVAILABILITY[4] (x2)	RELIABILITY & MAINTAINABILITY[5] (x1)	OPTION RETAINED?
Surface Water/ Groundwater[18]	**Passive Treatment** **Chemical Reagent**	**Aquafix™** Gravity-fed mechanical device that delivers a reagent (typically lime) for in-stream AMD neutralization.	**Medium** •High metal removal rates when maintained. •Does not require power to treat water. •Not applicable for groundwater or large surface flows. •Not effective during winter unless enclosed in silo or shed.	**Low** •Mobile and useful for various site conditions. •Not suitable for large flows. •Requires a 75- to 150-foot ditch or channel where the quicklime can disperse on the bottom of the channel.	**High** •Reagent cost dependent on type (i.e., pebble quicklime, caustic soda, ammonia). •Requires sludge removal and reagent replacement. •Requires an enclosed heated building to operate in cold weather.	**Low** •Availability of lime may be limited due to regional market demand. •Experienced vendors unavailable regionally.	**Low** •May be prone to vandalism. •Weekly checks to ensure operating correctly. •Requires long-term and frequent maintenance. •Requires sludge disposal.	**No**
		Raw Score	2	1	1	1	1	
		Weighted Score	8	4	3	2	1	18
			Evaluation/Comments: Technology has little applicability at the site due to high cost, vendor availability, and limited effectiveness in colder climates. Ratings for effectiveness and cost were changed from Table 1 to provide a scoring estimate reflective of the limitations of treating groundwater or large surface flows, and the increased cost to house the device.				**References:** BLM 2003	
Surface Water/ Groundwater[18]	**Passive Treatment** **Chemical Reagent**	**Permeable Reactive Barrier (PRB)** Flow-through barrier typically filled with organic matter or Fe metal shavings; sequesters oxygen and supports sulfate-reducing bacteria.	**Medium** •Longevity unknown; actual lifetime of barrier is considerably shorter due to the presence of other reactive substances in the environment. •Dependent on ability to capture contaminated groundwater and ability to promote desired chemical reaction. •Physical clogging or preferential path flow reduces effectiveness. •Precipitation of metals may reduce flow through barrier. •Not applicable for surface water.	**Medium** •Requires suitable organic carbon substrate. •May requires the use of a lime to facilitate metal precipitation. •Unknown ability of system to maintain hydraulic conductivity properties. •Requires a narrow pH range to be effective and target certain metals. •Dependent on substrate reactivity, hydraulic conductivity, environmental capability, cost, and material stability.	**High** •Barrier cost dependent on type of substrate (i.e., organic carbon, zero valent iron, ion exchange), barrier zone, and chemicals to be treated. •Replace reactive material; media life of approximately 7 years. •A groundwater monitoring system is recommended to monitor performance.	**Medium** •Experienced vendors and substrate materials are available regionally. •Availability of lime may be limited due to regional market demand.	**Medium** •Unknown longevity of barrier based on reactivity. •Chemical reactions can be slowed due to depletion of reactive component of the barrier. •Precipitation of a secondary reactive precipitate can reduce the reactive surface area. •Maintain hydraulic conductivity throughout reactive zone. •Must keep out air to avoid oxidation and mobilization of metals.	**Yes**
		Raw Score	2	2	1	2	2	
		Weighted Score	8	8	3	4	2	25
			Evaluation/Comments: PRB, a widely used conventional technology, is applicable for treatment of groundwater at specific locations onsite (i.e., the Carbonate Mine). The technology encourages the proliferation of sulfate-reducing bacteria that reduce sulfate to sulfide. Stability of metal sulfides is a concern in design; sulfides have a low solubility in anaerobic conditions. If oxidation were to occur, metals could be released from their metal sulfide form into the environment. The technology does not apply to surface water.				**References:** Costello 2003, EPA 2004, EPA 2006	

TABLE 2
REMEDIAL TECHNOLOGY AND PROCESS OPTIONS FOR CONTAMINATED MEDIA: SECONDARY SCREENING SUMMARY
UPPER BLACKFOOT MINING COMPLEX

Notes:

[1]Effectiveness refers to how well the alternative can address the contaminants of concern, taking into consideration site-specific conditions.

[2]Implementability refers to how readily an alternative can be implemented at the site, taking into consideration site conditions, location, equipment, and materials required.

[3]Cost refers to the estimated cost of implementing/constructing a technology based on published prices and engineering judgment, and the estimated cost of maintaining, monitoring, or operating a technology beyond the initial construction, based on published prices and engineering judgment.

[4]Availability refers to the number of vendors that can design, construct, and maintain the technology or provide specialized equipment/materials. In terms of institutional controls, availability refers to the number of landowners involved or affected.

[5]Reliability & Maintainability refers to the expected range of demonstrated reliability and maintenance relative to other technologies.

Ranking	Effectiveness	Implementability	Cost	Availability	Reliability & Maintainability
3	High Significantly reduces the quantity of COCs released	High Readily available, easy to construct	Low Low degree of capital investment and O&M intensity	High More than 4 vendors or less than 2 property owners	High High reliability and low maintenance
2	Medium Moderately reduces the quantity of COCs released	Medium Moderately available, moderately constructible	Medium Average degree of capital investment and O&M intensity	Medium 2 to 4 vendors or property owners	Medium Average reliability and average maintenance
1	Low Does not reduce the quantity of COCs released	Low Low or not available, difficult to construct	High High degree of capital investment and O&M intensity	Low Fewer than 2 vendors or more than 4 property owners	Low Low reliability and high maintenance

Based on engineering judgment, a weighting factor was assigned to each criteria as follows: 4x for effectiveness, 4x for implementability, 3x for cost, 2x for availability, 1x for reliability and maintainability. In general, process options with a total weighted score of less than 25 were not retained for further consideration. However, a process option that scored lower than 25 may be retained if engineering judgment considers the technology valid for remediation, or as part of a treatment train. In addition, a "No Action" alternative was retained for each media as a baseline for comparison.

[6]Physical Hazards/Solid Media - Physical hazards, waste rock, tailings, associated soils, and floodplain contaminants were combined into one category in Table 2; listed as separate categories in Table 1.

[7]COC - Contaminants of Concern

[8]RAOs - Remedial Action Objectives (not identified for the screening process)

[9]DEQ - Montana Department of Environmental Quality

[10]AMD - Acid Mine Drainage

[11]SSCL - Site-Specific Cleanup Levels

[12]CMZ - Channel Migration Zone

[13]GCL - Geosynthetic Clay Liner

[14]HDPE - High-density polyethylene

[15]LLDPE - Low level density polyethylene

[16]UBMC - Upper Blackfoot Mining Complex

[17]O&M - Operations & Maintenance

TABLE 2
REMEDIAL TECHNOLOGY AND PROCESS OPTIONS FOR CONTAMINATED MEDIA: SECONDARY SCREENING SUMMARY
UPPER BLACKFOOT MINING COMPLEX

[18] Surface Water - ARM 17.30.602(31) defines "surface water" as "any waters on the earth's surface including, but not limited to, streams, lakes, ponds, and reservoirs; and irrigation and drainage systems discharging directly into a stream, lake, pond, reservoir, or other surface water. Water bodies used solely for treating, transporting, or impounding pollutants shall not be considered surface water." At the UBMC, this includes the water confined to an active stream channel or in a pond or lake.
Groundwater - ARM 17.30.702 defines "groundwater" as "water occupying the voids within a geologic stratum and within the zone of saturation." At the UBMC, DEQ considers groundwater to include all subsurface flow, including water in mine workings, seeps, etc. It is still considered groundwater, from a remedial perspective, after it has daylighted from its place of origin. If the groundwater daylights and flows into a stream, it becomes "surface water" once it enters that stream.

[19]TSS - Total Suspended Solids

[20]WTP - Water Treatment Plant

[21]Hydrologic Control - Controlling the quantity of water (i.e., Groundwater Interceptor Trench controls the amount of groundwater flowing through a waste area).
Hydraulic Control - Controlling the direction or containing the flow of water (i.e., Stream Realignment controls the direction of stream flow around an area).

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TABLE 2A
SPECIFIC DISCUSSION AND DECISIONS FOR IASD TABLE 2
UPPER BLACKFOOT MINING COMPLEX

ALTERNATIVE	DISCUSSION	DECISION
Decisions reached during the meeting (07/02/13) and DEQ comments.		
General Formatting	There is repetitiveness between the different media types and the treatment alternatives, as well as scoring differences. Combine similar process options into one category.	Combined all solid media (physical hazards, floodplain, and waste rock) into one category. Combined surface water and groundwater into one section.
All Alternatives	DEQ provided comments on typographical and grammatical edits within Table 2 and offered suggestions for minor changes to wording within the table.	Revised as requested.
All Alternatives	Monitoring and Maintenance: Retained in Table 1, not listed in Table 2. All alternatives have some degree of O&M.	Deleted as stand-alone alternative. Monitoring is included as a component of some alternatives and will be evaluated as a common element in the FS.
All Alternatives	Search globally and revise accordingly when using the term “proactive measures.” Search globally and replace “reclamation” with “remediation.”	Changed to “other remediation alternatives.” Revised as requested.
All Alternatives	DEQ questioned changes in rankings for effectiveness, implementability, cost, availability, reliability and maintainability.	If rankings were changed, justification was listed in the evaluation/comments section regarding why changes were made. Changes were also made to reflect a scoring estimate of process options combined as one technology.
Physical Hazards/Solid Media - Deed Restrictions	Deed Restrictions, easements, covenants and reservations: What institutional controls are currently ongoing at the site? Please revise to “Effectiveness depends on the compliance of the property owner and the enforcement of the federal, state, or local agency.”	There are no IC's in place; comment deleted from availability. Revised as requested.
Physical Hazards/Solid Media - Plug	Is there a risk of failure due to erosion (reliability and maintainability)? Please clarify.	Revised as requested.
Physical Hazards/Solid Media - Onsite Repository, Offsite Repository	Effectiveness: Potential for re-exposure and “Highly effective . . . reduced human and environmental exposures” appear to be conflicting attributes. Please clarify. Also explain “Thorough.”	Revised as requested; deleted “potential for re-exposure.”

TABLE 2A
SPECIFIC DISCUSSION AND DECISIONS FOR IASD TABLE 2
UPPER BLACKFOOT MINING COMPLEX

ALTERNATIVE	DISCUSSION	DECISION
Physical Hazards/Solid Media - Onsite Repository	Implementability: Also, why is "redesign" an implementability issue since any new repository would require design as well. Isn't it more of a cost issue? Please clarify.	Revised as requested; added redesign comment to cost factor.
Physical Hazards/Solid Media - Offsite Repository	Implementability: Shouldn't "Requires . . . Dewatering or drying" also be added to implementability for onsite disposal? If not, please clarify why it only applies to offsite disposal.	Revised as requested.
Physical Hazards/Solid Media - Offsite Repository	Cost: Doesn't "Large-scale construction project" apply to onsite as well since waste volumes are the same?	Revised as requested.
Physical Hazards/Solid Media - Solid Waste Landfill, Re-use/Re-processing	Implementability: Dewatering and drying here as well?	Revised as requested.
Physical Hazards/Solid Media - Solid Waste Landfill	"Transport of contaminated soil requires enclosed trucks with liners or covers" would seem to apply to all offsite disposal options. Please address accordingly where applicable.	Revised as requested; added comment to onsite and offsite repository.
Physical Hazards/Solid Media - Reuse/Reprocessing	Reliability: Please add "bulleted" justification for the ranking.	Added clarification as requested.
Physical Hazards/Solid Media - Remove to COC	Cost: What do you mean by "Costs would increase . . . COC or indicators used"? Please clarify. "Increased costs . . . construction management" - increased from what? All alternatives have sampling and construction management. Maybe change to "Cost of construction and daily operations"?	Added clarification as requested.
Physical Hazards/Solid Media - Remove to indicator/depth/CMZ	Cost: Please clarify how "Monitoring . . . " would differ from alternative costs found on page 11. Also, would this alternative also have concerns regarding floodplain stability due to removal volumes?	Added clarification as requested.
Physical Hazards/Solid Media - Remove to CMZ	Effectiveness: Is it accurate to say that RAOs are met when the removal isn't total removal in the floodplain?	Added clarification as requested.
Surface and Groundwater - Monitored Natural Attenuation	Please clarify reliability and maintainability - "reliable and easily maintained."	Added clarification as requested.

TABLE 2A
SPECIFIC DISCUSSION AND DECISIONS FOR IASD TABLE 2
UPPER BLACKFOOT MINING COMPLEX

ALTERNATIVE	DISCUSSION	DECISION
Surface and Groundwater - Deed Restrictions	Please revise to "Effectiveness depends on the compliance of the property owner and the enforcement of the federal, state, or local agency."	Revised as requested.
Surface and Groundwater - Fish Advisories	Explain "easy" implementability and rule-making process.	Added clarification as requested.
Surface and Groundwater - Retention Pond	Please retain this option for other areas; Paymaster adit seep. Following AMD in the process description, insert "or otherwise manage surface water/groundwater."	Retained option as requested.
Surface and Groundwater - Settling Pond	Please delete "as a pre-treatment interim action" in the process description.	Revised as requested.
Surface and Groundwater - Piping	How reliable is piping? Will it freeze or crack - please clarify.	Added clarification as requested regarding pipe installation, trenching, and backfill.
Surface and Groundwater - Bulkhead/Wet Mine Seal	Water in mine working is groundwater - use this option to evaluate groundwater.	Groundwater and surface water were combined. Option evaluated groundwater treatment options.
Surface and Groundwater - Bulkhead/Wet Mine Seal	Reliability: Why is this rated "Low" and a "PUF" is rated "Medium"? Please clarify or score the same.	Revised as requested.
Surface and Groundwater - Chemical Reagents	Please add a statement that recognizes potential for spills and worker exposure. Delete "standards" and replace with "limits on its own." The cost of all of the chemicals will fluctuate, not just for lime, please revise. Cost effective for concentrated flows, but less so for more diluted flows. Please revise accordingly. Delete "as an interim action" in the process description.	Revised as requested.
Surface and Groundwater - Chemical Reagent: Precipitation	Explain why precipitation is not effective for surface water.	Added clarification as requested.
Surface and Groundwater - Vertical Flow Reactors	Is Pioneer availability comment accurate? Previous wetlands at UBMC were undersized due to space limitations.	Revised as requested.
Surface and Groundwater - Aquafix®	Reliability: Why is this the only option prone to vandalism? Please clarify.	Revised as requested.

TABLE 2A
SPECIFIC DISCUSSION AND DECISIONS FOR IASD TABLE 2
UPPER BLACKFOOT MINING COMPLEX

ALTERNATIVE	DISCUSSION	DECISION
Surface and Groundwater - Fracture/Fault Grouting	Please note that Phase I of a demonstration project was completed in 1994 with some success. Phase II was planned but never executed due to loss of funding.	Revised as requested.
Surface and Groundwater - Settling Pond	The pretreatment pond at the Mike Horse is a "Settling Pond." This alternative should be retained unless the pretreatment pond is addressed elsewhere in Table 2.	Revised as requested.
Surface and Groundwater - Neutralization	Changed from "mechanical lime injection" in Table 1 to "neutralization" in Table 2.	Mechanical lime injection is addressed as "neutralization" in Table 2.
Surface and Groundwater - Neutralization	Why is alternative being retained if score is below 25?	Scoring changes were made to reflect a scoring estimate of process options combined as one technology. Combined process score is 25; alternative retained.
Surface and Groundwater - Ceramic Microfiltration	Delete "as an interim action" in the process description.	Revised as requested.
Notes Section	Added clarification for availability rankings in terms of institutional controls.	Revised as requested.

TABLE E-1: UBMC FS COST SUMMARY TABLE

	SITE-WIDE ELEMENTS			REMEDIAL ALTERNATIVE COSTS														
				No Action	PHYSICAL HAZARDS/SOLID MEDIA							SURFACE WATER/GROUNDWATER						
					Monitored Natural Recovery	ENGINEERING CONTROLS/LAND DISPOSAL				TREATMENT		Monitored Natural Attenuation	ENGINEERING CONTROLS			TREATMENT		
										In-situ	Ex-situ					Active		Passive
	ICs*	Access Restrictions	Long-term Monitoring and Maintenance**			Physical Barriers	Containment	Removal and On-site Disposal	Removal and Off-site Disposal	Neutralization W/Alkaline Amendment	Neutralization W/Alkaline Amendment		Containment (Retention Pond)	Hydrologic and Hydraulic Control	Inundation	Chemical Reagent	Physical/ Mechanical	Chemical Reagent
TOTAL COST	$25,000	$507,514	$1,979,427	$0	$2,545,823	$193,845	$16,064,459	$23,436,794	$29,625,091	$4,311,101	$2,317,210	$2,311,332	$1,116,380	$464,514	$10,124	$17,456,250	$17,456,250	$7,827,027

SITE-WIDE ELEMENTS TOTAL	$2,511,941

* Based on $5,000 per IC, Assumed total of 5 ICs

** Based on current monitoring annual budget of $130,000 continuing; Present Value at 3% discounted over 15 years + Long term monitoring & maintenance of fencing for 30 years.

EVALUATION AREA	SITE-WIDE ELEMENTS			REMEDIAL ALTERNATIVE COSTS						
EA 1				No Action	PHYSICAL HAZARDS/SOLID MEDIA					
Upland Waste Areas					ENGINEERING CONTROLS/LAND DISPOSAL				TREATMENT	
									In-situ	Ex-situ
	ICs	Access Restrictions	Long-term Monitoring and Maintenance		Physical Barriers	Containment	Removal and On-site Disposal	Removal and Off-site Disposal	Neutralization W/Alkaline Amendment	Neutralization W/Alkaline Amendment
Upper Anaconda Mine (EU 1A) Waste Area	$0	$16,310.47	$10,607.49	$0	N/A	$447,749	$387,715	$570,281	$193,581	$434,848
Upper Anaconda Mine (EU 1B) Waste Piles	$0	$8,941.78	$8,029.03	$0	N/A	$96,093	$109,495	$168,977	$40,886	$126,079
Capital Mine (EU 3) Waste Area	$0	$7,120.31	$7,391.66	$0	N/A	$184,095	$177,343	$197,877	$155,508	$182,644
Carbonate Mine (EU 4) Waste Area	$0	$14,406.20	$9,941.14	$0	N/A	$299,327	$254,686	$390,443	$110,326	$289,734
Edith Mine (EU 5) Waste Area	$0	$9,935.31	$8,376.68	$0	N/A	$125,326	$107,980	$160,730	$51,888	$121,599
Consolation Mine (EU 6) Waste Area	$0	$11,591.20	$8,956.11	$0	N/A	$221,279	$195,181	$274,547	$110,785	$215,670
Mary P Mine (EU 7) Waste Pile	$0	$5,381.63	$6,783.25	$0	N/A	$21,914	$24,615	$36,603	$10,787	$27,957
Mike Horse Mine (EU 8) Waste Area	$0	$20,781.36	$12,171.95	$0	N/A	$699,645	$594,424	$914,407	$254,166	$677,033
Paymaster Mine (EU 9A) Waste Area - Surface	$0	$6,375.16	$7,130.91	$0	N/A	$37,326	$32,527	$47,122	$17,007	$36,295
Paymaster Mine (EU 9B) Waste Area - Subsurface	$0	$5,795.60	$2,028.00	$0	N/A	$60,221	$105,737	$170,096	$28,605	$124,344
No. 3 Tunnel Mine (EU 10) Waste Area	$0	$8,693.40	$7,942.11	$0	N/A	$83,621	$71,461	$108,440	$32,140	$81,008
TOTAL COSTS	**$0**	**$115,332**	**$89,358**	**$0**	**N/A**	**$2,276,597**	**$2,061,165**	**$3,039,523**	**$1,005,680**	**$2,317,210**

EA 1 COSTS													
SITE-WIDE ELEMENTS	**Upper Anaconda Mine (EU 1A) Waste Area**	**Upper Anaconda Mine (EU 1B) Waste Piles**	**Capital Mine (EU 3) Waste Area**	**Carbonate Mine (EU 4) Waste Area**	**Edith Mine (EU 5) Waste Area**	**Consolation Mine (EU 6) Waste Area**	**Mary P Mine (EU 7) Waste Pile**	**Mike Horse Mine (EU 8) Waste Area**	**Paymaster Mine (EU 9A) Waste Area - Surface**	**Paymaster Mine (EU 9B) Waste Area - Subsurface**	**No. 3 Tunnel Mine (EU 10) Waste Area**		**TOTAL**
Access Restrictions													
Construct Fence	$ 9,185	$ 4,290	$ 3,080	$ 7,920	$ 4,950	$ 6,050	$ 1,925	$ 12,155	$ 2,585	$ 3,850	$ 4,125		**$ 60,115**
Install Gates	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ -	$ 1,500		**$ 15,000**
Install Warning Signs	$ 150	$ 150	$ 150	$ 150	$ 150	$ 150	$ 150	$ 150	$ 150	$ -	$ 150		**$ 1,500**
Subtotal	$ 10,835	$ 5,940	$ 4,730	$ 9,570	$ 6,600	$ 7,700	$ 3,575	$ 13,805	$ 4,235	$ 3,850	$ 5,775		**$ 76,615**
Mob/Demob (10%)	$ 1,084	$ 594	$ 473	$ 957	$ 660	$ 770	$ 358	$ 1,381	$ 424	$ 385	$ 578		**$ 7,662**
Subtotal	$ 11,919	$ 6,534	$ 5,203	$ 10,527	$ 7,260	$ 8,470	$ 3,933	$ 15,186	$ 4,659	$ 4,235	$ 6,353		**$ 84,277**
Contingencies (15%)	$ 1,788	$ 980	$ 780	$ 1,579	$ 1,089	$ 1,271	$ 590	$ 2,278	$ 699	$ 635	$ 953		**$ 12,641**
Subtotal	$ 13,706	$ 7,514	$ 5,983	$ 12,106	$ 8,349	$ 9,741	$ 4,522	$ 17,463	$ 5,357	$ 4,870	$ 7,305		**$ 96,918**
Project Management (5%)	$ 685	$ 376	$ 299	$ 605	$ 417	$ 487	$ 226	$ 873	$ 268	$ 244	$ 365		**$ 4,846**
Engineering (6%)	$ 822	$ 451	$ 359	$ 726	$ 501	$ 584	$ 271	$ 1,048	$ 321	$ 292	$ 438		**$ 5,815**
Construction Administration (8%)	$ 1,097	$ 601	$ 479	$ 968	$ 668	$ 779	$ 362	$ 1,397	$ 429	$ 390	$ 584		**$ 7,753**
Total, Capital Cost	$ 16,310	$ 8,942	$ 7,120	$ 14,406	$ 9,935	$ 11,591	$ 5,382	$ 20,781	$ 6,375	$ 5,796	$ 8,693		**$ 115,332**
Long Term Monitoring and Maintenance (M&M)													
Site Security, Fence and Sign Maintenance, Years 1-30 (Annual)	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ -	$ 250		**$ 2,500**
Periodic Replacement - Years 15 and 30	$ 5,418	$ 2,970	$ 2,365	$ 4,785	$ 3,300	$ 3,850	$ 1,788	$ 6,903	$ 2,118	$ 1,925	$ 2,888		**$ 38,308**
Total, 30-yr Present Worth, Long Term M&M (3%)	$ 10,607	$ 8,029	$ 7,392	$ 9,941	$ 8,377	$ 8,956	$ 6,783	$ 12,172	$ 7,131	$ 2,028	$ 7,942		**$ 89,358**
TOTAL CAPITAL COST + M&M	$ 26,918	$ 16,971	$ 14,512	$ 24,347	$ 18,312	$ 20,547	$ 12,165	$ 32,953	$ 13,506	$ 7,824	$ 16,636		**$ 204,691**
TOTAL SITE-WIDE ELEMENTS COSTS WITH 30-YR PRESENT WORTH LONG TERM M&M													**$ 204,691**

EA1 COST ESTIMATE DETAIL
SITE -WIDE ELEMENTS

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Mobilization, Bonding, Insurance	LS	$ 7,661.50	1	$ 7,662	10% of construction cost
Install Farm Fence - Total	LF	$ 5.50	10,930	$ 60,115	Based on Bald Butte/Great Divide
Upper Anaconda Mine (EU 1A) Waste Area	LF	$ 5.50	1,670	$ 9,185	
Upper Anaconda Mine (EU 1B) Waste Piles	LF	$ 5.50	780	$ 4,290	
Capital Mine (EU 3) Waste Area	LF	$ 5.50	560	$ 3,080	
Carbonate Mine (EU 4) Waste Area	LF	$ 5.50	1,440	$ 7,920	
Edith Mine (EU 5) Mine Waste	LF	$ 5.50	900	$ 4,950	
Consolation Mine (EU 6) Waste Area	LF	$ 5.50	1,100	$ 6,050	
Mary P Mine (EU 7) Waste Pile	LF	$ 5.50	350	$ 1,925	
Mike Horse Mine (EU 8) Waste Area	LF	$ 5.50	2,210	$ 12,155	
Paymaster Mine (EU 9A) Waste Area - Surface	LF	$ 5.50	470	$ 2,585	
Paymaster Mine (EU 9B) Waste Area - Subsurface	LF	$ 5.50	700	$ 3,850	
No. 3 Tunnel Mine (EU 10) Waste Area	LF	$ 5.50	750	$ 4,125	
Metal Security Gate - Total	EA	$ 1,500.00	10	$ 15,000	Based on Section 35 Bid Tabs
Upper Anaconda Mine (EU 1A) Waste Area	EA	$ 1,500.00	1	$ 1,500	
Upper Anaconda Mine (EU 1B) Waste Piles	EA	$ 1,500.00	1	$ 1,500	
Capital Mine (EU 3) Waste Area	EA	$ 1,500.00	1	$ 1,500	
Carbonate Mine (EU 4) Waste Area	EA	$ 1,500.00	1	$ 1,500	
Edith Mine (EU 5) Mine Waste	EA	$ 1,500.00	1	$ 1,500	
Consolation Mine (EU 6) Waste Area	EA	$ 1,500.00	1	$ 1,500	
Mary P Mine (EU 7) Waste Pile	EA	$ 1,500.00	1	$ 1,500	
Mike Horse Mine (EU 8) Waste Area	EA	$ 1,500.00	1	$ 1,500	
Paymaster Mine (EU 9A) Waste Area - Surface	EA	$ 1,500.00	1	$ 1,500	
Paymaster Mine (EU 9B) Waste Area - Subsurface	EA	$ 1,500.00	0	$ -	
No. 3 Tunnel Mine (EU 10) Waste Area	EA	$ 1,500.00	1	$ 1,500	
Metal Warning Signs - Total	EA	$ 150.00	10	$ 1,500	Engineer Estimate
Upper Anaconda Mine (EU 1A) Waste Area	EA	$ 150.00	1	$ 150	
Upper Anaconda Mine (EU 1B) Waste Piles	EA	$ 150.00	1	$ 150	
Capital Mine (EU 3) Waste Area	EA	$ 150.00	1	$ 150	
Carbonate Mine (EU 4) Waste Area	EA	$ 150.00	1	$ 150	
Edith Mine (EU 5) Mine Waste	EA	$ 150.00	1	$ 150	
Consolation Mine (EU 6) Waste Area	EA	$ 150.00	1	$ 150	
Mary P Mine (EU 7) Waste Pile	EA	$ 150.00	1	$ 150	
Mike Horse Mine (EU 8) Waste Area	EA	$ 150.00	1	$ 150	
Paymaster Mine (EU 9A) Waste Area - Surface	EA	$ 150.00	1	$ 150	
Paymaster Mine (EU 9B) Waste Area - Subsurface	EA	$ 150.00	0	$ -	
No. 3 Tunnel Mine (EU 10) Waste Area	EA	$ 150.00	1	$ 150	
			Subtotal	$ 84,277	
Contingencies		15%		$ 12,641.48	
			Subtotal	$ 96,918	
Project Management		5%		$ 4,846	
Engineering		6%		$ 5,815	
Construction Management		8%		$ 7,753	
TOTAL				$ 115,332	
			TOTAL CAPITAL COSTS	**$ 115,332**	

EA1 COST ESTIMATE DETAIL
SITE -WIDE ELEMENTS

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES

LONG TERM MONITORING AND MAINTENANCE (M & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Site Security, Fence and Sign Maintenance, Years 1-30	LS	$ 2,500.00	1	$ 2,500	Engineers Estimate
Periodic Replacement - Years 15 and 30	LS	$ 38,307.50	1	$ 38,308	1/2 of fence replaced
			Subtotal	$ 40,808	
30-YEAR NET PRESENT VALUE ANNUAL M&M COSTS				**$89,371**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (ICS + ACCESS RESTRICTIONS + M&M COSTS) **$204,704** Value for the EA as a whole is slightly different than value calculated by summing individual sites within the EA due to compounding rounding error.

EA 1 COSTS												
CONTAINMENT	**Upper Anaconda Mine (EU 1A) Waste Area**	**Upper Anaconda Mine (EU 1B) Waste Piles**	**Capital Mine (EU 3) Waste Area**	**Carbonate Mine (EU 4) Waste Area**	**Edith Mine (EU 5) Waste Area**	**Consolation Mine (EU 6) Waste Area**	**Mary P Mine (EU 7) Waste Pile**	**Mike Horse Mine (EU 8) Waste Area**	**Paymaster Mine (EU 9A) Waste Area - Surface**	**Paymaster Mine (EU 9B) Waste Area - Subsurface**	**No. 3 Tunnel Mine (EU 10) Waste Area**	**TOTAL**
Improve/Construct Access Roads	$ 36,000	$ 4,500	$ 90,000	$ 3,600	$ 5,400	$ 31,500	$ -	$ 9,000	$ 900	$ -	$ -	$ 180,900
Re-Grade Waste Piles, Prep for Cover Soil Placement	$ 48,520	$ 10,539	$ 5,457	$ 36,080	$ 14,019	$ 21,093	$ 2,124	$ 85,041	$ 3,879	$ 8,552	$ 9,828	$ 245,134
Load, Haul, Place Vegetative Cover	$ 161,734	$ 35,130	$ 18,191	$ 120,267	$ 46,731	$ 70,311	$ 7,080	$ 283,471	$ 12,930	$ 28,508	$ 32,759	$ 817,112
Seed, Fertilize, Mulch	$ 6,683	$ 1,452	$ 752	$ 4,970	$ 1,931	$ 2,905	$ 293	$ 11,714	$ 534	$ 1,178	$ 1,354	$ 33,765
Reclaim Cover Soil Borrow Area	$ 10,025	$ 2,177	$ 1,128	$ 7,455	$ 2,897	$ 4,358	$ 439	$ 17,571	$ 801	$ 1,767	$ 2,031	$ 50,647
Subtotal	$ 262,963	$ 53,798	$ 115,527	$ 172,371	$ 70,978	$ 130,167	$ 9,935	$ 406,797	$ 19,045	$ 40,005	$ 45,971	$ 1,327,558
Mob/Demob (10%)	$ 26,296	$ 5,380	$ 11,553	$ 17,237	$ 7,098	$ 13,017	$ 994	$ 40,680	$ 1,904	$ 4,000	$ 4,597	$ 132,756
Subtotal	$ 289,259	$ 59,178	$ 127,080	$ 189,608	$ 78,076	$ 143,184	$ 10,929	$ 447,477	$ 20,949	$ 44,005	$ 50,568	$ 1,460,314
Contingencies (15%)	$ 43,389	$ 8,877	$ 19,062	$ 28,441	$ 11,711	$ 21,478	$ 1,639	$ 67,122	$ 3,142	$ 6,601	$ 7,585	$ 219,047
Subtotal	$ 332,648	$ 68,055	$ 146,142	$ 218,050	$ 89,787	$ 164,662	$ 12,568	$ 514,598	$ 24,092	$ 50,606	$ 58,153	$ 1,679,361
Project Management (5%)	$ 16,632	$ 3,403	$ 7,307	$ 10,902	$ 4,489	$ 8,233	$ 628	$ 25,730	$ 1,205	$ 2,530	$ 2,908	$ 83,968
Engineering (6%)	$ 19,959	$ 4,083	$ 8,769	$ 13,083	$ 5,387	$ 9,880	$ 754	$ 30,876	$ 1,445	$ 3,036	$ 3,489	$ 100,762
Construction Administration (8%)	$ 26,612	$ 5,444	$ 11,691	$ 17,444	$ 7,183	$ 13,173	$ 1,005	$ 41,168	$ 1,927	$ 4,048	$ 4,652	$ 134,349
Total, Capital Cost	$ 395,851	$ 80,985	$ 173,909	$ 259,479	$ 106,847	$ 195,948	$ 14,956	$ 612,372	$ 28,669	$ 60,221	$ 69,202	$ 1,998,439
Operations and Maintenance (O & M)												
Site Inspections, Vegetation Maintenance and Repairs, Years 1-30	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ -	$ 250	$ 2,500
Periodic Repairs - Years 15 and 30 (1/4th remedial cost)	$ 44,611	$ 9,690	$ 5,018	$ 33,173	$ 12,890	$ 19,394	$ 1,953	$ 78,189	$ 3,566	$ -	$ 9,036	$ 217,518
Total, 30-yr Present Worth, O & M (3%)	$ 51,898	$ 15,108	$ 10,186	$ 39,848	$ 18,479	$ 25,331	$ 6,957	$ 87,273	$ 8,657	$ -	$ 14,419	$ 278,158
TOTAL CAPITAL COST + O & M	$ 447,749	$ 96,093	$ 184,095	$ 299,327	$ 125,326	$ 221,279	$ 21,914	$ 699,645	$ 37,326	$ 60,221	$ 83,621	$ 2,276,597
TOTAL EA1 CONTAINMENT COSTS WITH 30-YR PRESENT WORTH O & M												**$ 2,276,597**

EA1 COST ESTIMATE DETAIL
CONTAINMENT

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Mobilization, Bonding, Insurance	LS	$ 132,755.77	1	$ 132,756	10% of construction cost
Improve/Construct Access Roads - Total	LF	$ 18.00	10,050	$ 180,900	Includes Clear/Grub/Log, Reclamation
Upper Anaconda Mine (EU 1A) Waste Area	LF	$ 18.00	2,000	$ 36,000	
Upper Anaconda Mine (EU 1B) Waste Piles	LF	$ 18.00	250	$ 4,500	
Capital Mine (EU 3) Waste Area	LF	$ 18.00	5,000	$ 90,000	
Carbonate Mine (EU 4) Waste Area	LF	$ 18.00	200	$ 3,600	
Edith Mine (EU 5) Mine Waste	LF	$ 18.00	300	$ 5,400	
Consolation Mine (EU 6) Waste Area	LF	$ 18.00	1,750	$ 31,500	
Mary P Mine (EU 7) Waste Pile	LF	$ 18.00	0	$ -	
Mike Horse Mine (EU 8) Waste Area	LF	$ 18.00	500	$ 9,000	
Paymaster Mine (EU 9A) Waste Area - Surface	LF	$ 18.00	50	$ 900	
Paymaster Mine (EU 9B) Waste Area - Subsurface	LF	$ 18.00	0	$ -	
No. 3 Tunnel Mine (EU 10) Waste Area	LF	$ 18.00	0	$ -	
Re-Grade Waste Piles, Prep for Cover Soil Placement - Total	SY	$ 3.00	81,711	$ 245,134	Engineer Estimate
Upper Anaconda Mine (EU 1A) Waste Area	SY	$ 3.00	16,173	$ 48,520	
Upper Anaconda Mine (EU 1B) Waste Piles	SY	$ 3.00	3,513	$ 10,539	
Capital Mine (EU 3) Waste Area	SY	$ 3.00	1,819	$ 5,457	
Carbonate Mine (EU 4) Waste Area	SY	$ 3.00	12,027	$ 36,080	
Edith Mine (EU 5) Mine Waste	SY	$ 3.00	4,673	$ 14,019	
Consolation Mine (EU 6) Waste Area	SY	$ 3.00	7,031	$ 21,093	
Mary P Mine (EU 7) Waste Pile	SY	$ 3.00	708	$ 2,124	
Mike Horse Mine (EU 8) Waste Area	SY	$ 3.00	28,347	$ 85,041	
Paymaster Mine (EU 9A) Waste Area - Surface	SY	$ 3.00	1,293	$ 3,879	
Paymaster Mine (EU 9B) Waste Area - Subsurface	SY	$ 3.00	2,851	$ 8,552	
No. 3 Tunnel Mine (EU 10) Waste Area	SY	$ 3.00	3,276	$ 9,828	
Load, Haul, Place Vegetative Cover - Total	CY	$ 15.00	54,474	$ 817,112	Engineer Estimate
Upper Anaconda Mine (EU 1A) Waste Area	CY	$ 15.00	10,782	$ 161,734	
Upper Anaconda Mine (EU 1B) Waste Piles	CY	$ 15.00	2,342	$ 35,130	
Capital Mine (EU 3) Waste Area	CY	$ 15.00	1,213	$ 18,191	
Carbonate Mine (EU 4) Waste Area	CY	$ 15.00	8,018	$ 120,267	
Edith Mine (EU 5) Mine Waste	CY	$ 15.00	3,115	$ 46,731	
Consolation Mine (EU 6) Waste Area	CY	$ 15.00	4,687	$ 70,311	
Mary P Mine (EU 7) Waste Pile	CY	$ 15.00	472	$ 7,080	
Mike Horse Mine (EU 8) Waste Area	CY	$ 15.00	18,898	$ 283,471	
Paymaster Mine (EU 9A) Waste Area - Surface	CY	$ 15.00	862	$ 12,930	
Paymaster Mine (EU 9B) Waste Area - Subsurface	CY	$ 15.00	1,901	$ 28,508	
No. 3 Tunnel Mine (EU 10) Waste Area	CY	$ 15.00	2,184	$ 32,759	
Seed, Fertilize, Mulch - Total	AC	$ 2,000.00	16.9	$ 33,765	Engineer Estimate
Upper Anaconda Mine (EU 1A) Waste Area	AC	$ 2,000.00	3.3	$ 6,683	
Upper Anaconda Mine (EU 1B) Waste Piles	AC	$ 2,000.00	0.7	$ 1,452	
Capital Mine (EU 3) Waste Area	AC	$ 2,000.00	0.4	$ 752	
Carbonate Mine (EU 4) Waste Area	AC	$ 2,000.00	2.5	$ 4,970	
Edith Mine (EU 5) Mine Waste	AC	$ 2,000.00	1.0	$ 1,931	
Consolation Mine (EU 6) Waste Area	AC	$ 2,000.00	1.5	$ 2,905	
Mary P Mine (EU 7) Waste Pile	AC	$ 2,000.00	0.1	$ 293	
Mike Horse Mine (EU 8) Waste Area	AC	$ 2,000.00	5.9	$ 11,714	
Paymaster Mine (EU 9A) Waste Area - Surface	AC	$ 2,000.00	0.3	$ 534	
Paymaster Mine (EU 9B) Waste Area - Subsurface	AC	$ 2,000.00	0.6	$ 1,178	
No. 3 Tunnel Mine (EU 10) Waste Area	AC	$ 2,000.00	0.7	$ 1,354	

EA1 COST ESTIMATE DETAIL
CONTAINMENT

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Reclaim Cover Soil Borrow Area - Total	AC	$ 4,500.00	11.3	$ 50,647	Engineer Estimate
Upper Anaconda Mine (EU 1A) Waste Area	AC	$ 4,500.00	2.2	$ 10,025	
Upper Anaconda Mine (EU 1B) Waste Piles	AC	$ 4,500.00	0.5	$ 2,177	
Capital Mine (EU 3) Waste Area	AC	$ 4,500.00	0.3	$ 1,128	
Carbonate Mine (EU 4) Waste Area	AC	$ 4,500.00	1.7	$ 7,455	
Edith Mine (EU 5) Mine Waste	AC	$ 4,500.00	0.6	$ 2,897	
Consolation Mine (EU 6) Waste Area	AC	$ 4,500.00	1.0	$ 4,358	
Mary P Mine (EU 7) Waste Pile	AC	$ 4,500.00	0.1	$ 439	
Mike Horse Mine (EU 8) Waste Area	AC	$ 4,500.00	3.9	$ 17,571	
Paymaster Mine (EU 9A) Waste Area - Surface	AC	$ 4,500.00	0.2	$ 801	
Paymaster Mine (EU 9B) Waste Area - Subsurface	AC	$ 4,500.00	0.4	$ 1,767	
No. 3 Tunnel Mine (EU 10) Waste Area	AC	$ 4,500.00	0.5	$ 2,031	
			Subtotal	$ 1,460,314	
Contingencies		15%		$ 219,047	
			Subtotal	$ 1,679,361	
Project Management		5%		$ 83,968	
Engineering		6%		$ 100,762	
Construction Management		8%		$ 134,349	
TOTAL				$ 1,998,439	
			TOTAL CAPITAL COSTS	**$ 1,998,439**	

OPERATIONS AND MAINTENANCE (O & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Site Inspections, Vegetation Maintenance and Repairs, Years 1-30	LS	$ 2,500.00	1	$ 2,500	Engineers Estimate
Periodic Repairs - Years 15 and 30 (1/4th remedial cost, re-cover soil, reveg)	LS	$ 217,517.92	1	$ 217,518	Engineers Estimate
			Subtotal	$ 220,018	
30-YEAR NET PRESENT VALUE ANNUAL O & M COSTS				**$ 278,232**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O & M COSTS) $ 2,276,671 Value for the EA as a whole is slightly different than value calculated by summing individual sites within the EA due to compounding rounding error.

EA 1 COSTS													
REMOVAL AND ON-SITE DISPOSAL	**Upper Anaconda Mine (EU 1A) Waste Area**	**Upper Anaconda Mine (EU 1B) Waste Piles**	**Capital Mine (EU 3) Waste Area**	**Carbonate Mine (EU 4) Waste Area**	**Edith Mine (EU 5) Waste Area**	**Consolation Mine (EU 6) Waste Area**	**Mary P Mine (EU 7) Waste Pile**	**Mike Horse Mine (EU 8) Waste Area**	**Paymaster Mine (EU 9A) Waste Area - Surface**	**Paymaster Mine (EU 9B) Waste Area - Subsurface**	**No. 3 Tunnel Mine (EU 10) Waste Area**		**TOTAL**
Improve/Construct Access Roads	$ 36,000	$ 4,500	$ 90,000	$ 3,600	$ 5,400	$ 31,500	$ -	$ 9,000	$ 900	$ -	$ -		$ 180,900
Excavate, Load, Haul and Place Waste in Repository	$ 161,734	$ 52,695	$ 18,191	$ 120,267	$ 46,731	$ 70,311	$ 10,620	$ 283,471	$ 12,930	$ 57,015	$ 32,759		$ 866,724
Load, Haul, Place Vegetative Cover	$ 40,434	$ 8,783	$ 4,548	$ 30,067	$ 11,683	$ 17,578	$ 1,770	$ 70,868	$ 3,233	$ 7,127	$ 8,190		$ 204,278
Seed, Fertilize, Mulch	$ 6,683	$ 1,452	$ 752	$ 4,970	$ 1,931	$ 2,905	$ 293	$ 11,714	$ 534	$ 1,178	$ 1,354		$ 33,765
Reclaim Cover Soil Borrow Area	$ 2,506	$ 544	$ 282	$ 1,864	$ 724	$ 1,090	$ 110	$ 4,393	$ 200	$ 442	$ 508		$ 12,662
Subtotal	$ 247,358	$ 67,974	$ 113,772	$ 160,767	$ 66,469	$ 123,383	$ 12,792	$ 379,446	$ 17,797	$ 65,762	$ 42,810		$ 1,298,329
Mob/Demob (10%)	$ 24,736	$ 6,797	$ 11,377	$ 16,077	$ 6,647	$ 12,338	$ 1,279	$ 37,945	$ 1,780	$ 6,576	$ 4,281		$ 129,833
Subtotal	$ 272,093	$ 74,771	$ 125,149	$ 176,844	$ 73,116	$ 135,722	$ 14,072	$ 417,390	$ 19,577	$ 72,338	$ 47,091		$ 1,428,162
Contingencies (15%)	$ 40,814	$ 11,216	$ 18,772	$ 26,527	$ 10,967	$ 20,358	$ 2,111	$ 62,609	$ 2,937	$ 10,851	$ 7,064		$ 214,224
Subtotal	$ 312,907	$ 85,987	$ 143,922	$ 203,370	$ 84,083	$ 156,080	$ 16,182	$ 479,999	$ 22,513	$ 83,188	$ 54,154		$ 1,642,386
Project Management (5%)	$ 15,645	$ 4,299	$ 7,196	$ 10,169	$ 4,204	$ 7,804	$ 809	$ 24,000	$ 1,126	$ 4,159	$ 2,708		$ 82,119
Engineering (6%)	$ 18,774	$ 5,159	$ 8,635	$ 12,202	$ 5,045	$ 9,365	$ 971	$ 28,800	$ 1,351	$ 4,991	$ 3,249		$ 98,543
Construction Administration (8%)	$ 25,033	$ 6,879	$ 11,514	$ 16,270	$ 6,727	$ 12,486	$ 1,295	$ 38,400	$ 1,801	$ 6,655	$ 4,332		$ 131,391
Total, Capital Cost	$ 372,360	$ 102,324	$ 171,267	$ 242,011	$ 100,059	$ 185,735	$ 19,257	$ 571,198	$ 26,791	$ 98,994	$ 64,444		$ 1,954,440
Operations and Maintenance (O & M)													
Site Inspections, Vegetation Maintenance and Repairs, Years 1-30	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250		$ 2,750
Periodic Repairs - Years 15 and 30 (1/5th remedial cost)	$ 9,925	$ 2,156	$ 1,116	$ 7,380	$ 2,868	$ 4,315	$ 434	$ 17,395	$ 793	$ 1,749	$ 2,010		$ 50,141
Total, 30-yr Present Worth, O & M (3%)	$ 15,356	$ 7,171	$ 6,076	$ 12,675	$ 7,921	$ 9,445	$ 5,358	$ 23,226	$ 5,736	$ 6,743	$ 7,018		$ 106,725
TOTAL CAPITAL COST + O & M	$ 387,715	$ 109,495	$ 177,343	$ 254,686	$ 107,980	$ 195,181	$ 24,615	$ 594,424	$ 32,527	$ 105,737	$ 71,461		$ 2,061,165
TOTAL EA1 REMOVAL AND ON-SITE DISPOSAL COSTS WITH 30-YR PRESENT WORTH O & M													**$ 2,061,165**

EA1 COST ESTIMATE DETAIL

REMOVAL AND ON-SITE DISPOSAL

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Mobilization, Bonding, Insurance	LS	$ 129,832.91	1	$ 129,833	10% of construction cost
Improve/Construct Access Roads - Total	LF	$ 18.00	10,050	$ 180,900	Includes Clear/Grub/Log, Reclamation
Upper Anaconda Mine (EU 1A) Waste Area	LF	$ 18.00	2,000	$ 36,000	
Upper Anaconda Mine (EU 1B) Waste Piles	LF	$ 18.00	250	$ 4,500	
Capital Mine (EU 3) Waste Area	LF	$ 18.00	5,000	$ 90,000	
Carbonate Mine (EU 4) Waste Area	LF	$ 18.00	200	$ 3,600	
Edith Mine (EU 5) Mine Waste	LF	$ 18.00	300	$ 5,400	
Consolation Mine (EU 6) Waste Area	LF	$ 18.00	1,750	$ 31,500	
Mary P Mine (EU 7) Waste Pile	LF	$ 18.00	0	$ -	
Mike Horse Mine (EU 8) Waste Area	LF	$ 18.00	500	$ 9,000	
Paymaster Mine (EU 9A) Waste Area - Surface	LF	$ 18.00	50	$ 900	
Paymaster Mine (EU 9B) Waste Area - Subsurface	LF	$ 18.00	0	$ -	
No. 3 Tunnel Mine (EU 10) Waste Area	LF	$ 18.00	0	$ -	
Excavate, Load, Haul and Place Waste in Repository - Total	CY	$ 15.00	57,782	$ 866,724	Engineer Estimate
Upper Anaconda Mine (EU 1A) Waste Area	CY	$ 15.00	10,782	$ 161,734	
Upper Anaconda Mine (EU 1B) Waste Piles	CY	$ 15.00	3,513	$ 52,695	
Capital Mine (EU 3) Waste Area	CY	$ 15.00	1,213	$ 18,191	
Carbonate Mine (EU 4) Waste Area	CY	$ 15.00	8,018	$ 120,267	
Edith Mine (EU 5) Mine Waste	CY	$ 15.00	3,115	$ 46,731	
Consolation Mine (EU 6) Waste Area	CY	$ 15.00	4,687	$ 70,311	
Mary P Mine (EU 7) Waste Pile	CY	$ 15.00	708	$ 10,620	
Mike Horse Mine (EU 8) Waste Area	CY	$ 15.00	18,898	$ 283,471	
Paymaster Mine (EU 9A) Waste Area - Surface	CY	$ 15.00	862	$ 12,930	
Paymaster Mine (EU 9B) Waste Area - Subsurface	CY	$ 15.00	3,801	$ 57,015	
No. 3 Tunnel Mine (EU 10) Waste Area	CY	$ 15.00	2,184	$ 32,759	
Load, Haul, Place Vegetative Cover - Total	CY	$ 15.00	13,619	$ 204,278	6 inch cover imported over removal areas
Upper Anaconda Mine (EU 1A) Waste Area	CY	$ 15.00	2,696	$ 40,434	
Upper Anaconda Mine (EU 1B) Waste Piles	CY	$ 15.00	586	$ 8,783	
Capital Mine (EU 3) Waste Area	CY	$ 15.00	303	$ 4,548	
Carbonate Mine (EU 4) Waste Area	CY	$ 15.00	2,004	$ 30,067	
Edith Mine (EU 5) Mine Waste	CY	$ 15.00	779	$ 11,683	
Consolation Mine (EU 6) Waste Area	CY	$ 15.00	1,172	$ 17,578	
Mary P Mine (EU 7) Waste Pile	CY	$ 15.00	118	$ 1,770	
Mike Horse Mine (EU 8) Waste Area	CY	$ 15.00	4,725	$ 70,868	
Paymaster Mine (EU 9A) Waste Area - Surface	CY	$ 15.00	216	$ 3,233	
Paymaster Mine (EU 9B) Waste Area - Subsurface	CY	$ 15.00	475	$ 7,127	
No. 3 Tunnel Mine (EU 10) Waste Area	CY	$ 15.00	546	$ 8,190	
Seed, Fertilize, Mulch - Total	AC	$ 2,000.00	16.9	$ 33,765	Based on Bald Butte
Upper Anaconda Mine (EU 1A) Waste Area	AC	$ 2,000.00	3.3	$ 6,683	
Upper Anaconda Mine (EU 1B) Waste Piles	AC	$ 2,000.00	0.7	$ 1,452	
Capital Mine (EU 3) Waste Area	AC	$ 2,000.00	0.4	$ 752	
Carbonate Mine (EU 4) Waste Area	AC	$ 2,000.00	2.5	$ 4,970	
Edith Mine (EU 5) Mine Waste	AC	$ 2,000.00	1.0	$ 1,931	
Consolation Mine (EU 6) Waste Area	AC	$ 2,000.00	1.5	$ 2,905	
Mary P Mine (EU 7) Waste Pile	AC	$ 2,000.00	0.1	$ 293	
Mike Horse Mine (EU 8) Waste Area	AC	$ 2,000.00	5.9	$ 11,714	
Paymaster Mine (EU 9A) Waste Area - Surface	AC	$ 2,000.00	0.3	$ 534	
Paymaster Mine (EU 9B) Waste Area - Subsurface	AC	$ 2,000.00	0.6	$ 1,178	
No. 3 Tunnel Mine (EU 10) Waste Area	AC	$ 2,000.00	0.7	$ 1,354	

EA1 COST ESTIMATE DETAIL

REMOVAL AND ON-SITE DISPOSAL

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Reclaim Cover Soil Borrow Area - Total	AC	$ 4,500.00	2.8	$ 12,662	Based on Bald Butte
Upper Anaconda Mine (EU 1A) Waste Area	AC	$ 4,500.00	0.6	$ 2,506	
Upper Anaconda Mine (EU 1B) Waste Piles	AC	$ 4,500.00	0.1	$ 544	
Capital Mine (EU 3) Waste Area	AC	$ 4,500.00	0.1	$ 282	
Carbonate Mine (EU 4) Waste Area	AC	$ 4,500.00	0.4	$ 1,864	
Edith Mine (EU 5) Mine Waste	AC	$ 4,500.00	0.2	$ 724	
Consolation Mine (EU 6) Waste Area	AC	$ 4,500.00	0.2	$ 1,090	
Mary P Mine (EU 7) Waste Pile	AC	$ 4,500.00	0.0	$ 110	
Mike Horse Mine (EU 8) Waste Area	AC	$ 4,500.00	1.0	$ 4,393	
Paymaster Mine (EU 9A) Waste Area - Surface	AC	$ 4,500.00	0.0	$ 200	
Paymaster Mine (EU 9B) Waste Area - Subsurface	AC	$ 4,500.00	0.1	$ 442	
No. 3 Tunnel Mine (EU 10) Waste Area	AC	$ 4,500.00	0.1	$ 508	
			Subtotal	$ 1,428,162	
Contingencies		15%		$ 214,224	
			Subtotal	$ 1,642,386	
Project Management		5%		$ 82,119	
Engineering		6%		$ 98,543	
Construction Management		8%		$ 131,391	
TOTAL				$ 1,954,440	
			TOTAL CAPITAL COSTS	**$ 1,954,440**	

OPERATIONS AND MAINTENANCE (O & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Site Inspections, Vegetation Maintenance and Repairs, Years 1-30	LS	$ 2,750.00	1	$ 2,750	Engineers Estimate; O & M costs for the UBMC repository are not included.
Periodic Repairs - Years 15 and 30 (1/5th remedial cost)	LS	$ 50,140.95	1	$ 50,141	Engineers Estimate; O & M costs for the UBMC repository are not included.
			Subtotal	$ 52,891	
30-YEAR NET PRESENT VALUE ANNUAL O & M COSTS				**$106,742**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O & M COST) **$2,061,182**

Value for the EA as a whole is slightly different than value calculated by summing individual sites within the EA due to compounding rounding error.

EA 1 COSTS													
REMOVAL AND OFF-SITE DISPOSAL	**Upper Anaconda Mine (EU 1A) Waste Area**	**Upper Anaconda Mine (EU 1B) Waste Piles**	**Capital Mine (EU 3) Waste Area**	**Carbonate Mine (EU 4) Waste Area**	**Edith Mine (EU 5) Waste Area**	**Consolation Mine (EU 6) Waste Area**	**Mary P Mine (EU 7) Waste Pile**	**Mike Horse Mine (EU 8) Waste Area**	**Paymaster Mine (EU 9A) Waste Area - Surface**	**Paymaster Mine (EU 9B) Waste Area - Subsurface**	**No. 3 Tunnel Mine (EU 10) Waste Area**		**TOTAL**
Construct Off-site Repository	$ 109,130	$ 35,556	$ 12,274	$ 81,150	$ 31,532	$ 47,442	$ 7,166	$ 191,271	$ 8,724	$ 38,471	$ 22,104		$ 584,818
Improve/Construct Access Roads	$ 36,000	$ 4,500	$ 90,000	$ 3,600	$ 5,400	$ 31,500	$ -	$ 9,000	$ 900	$ -	$ -		$ 180,900
Excavate, Load, Haul and Place Waste in Repository	$ 161,734	$ 52,695	$ 18,191	$ 120,267	$ 46,731	$ 70,311	$ 10,620	$ 283,471	$ 12,930	$ 57,015	$ 32,759		$ 866,724
Load, Haul, Place Vegetative Cover	$ 40,434	$ 8,783	$ 4,548	$ 30,067	$ 11,683	$ 17,578	$ 1,770	$ 70,868	$ 3,233	$ 7,127	$ 8,190		$ 204,278
Seed, Fertilize, Mulch	$ 6,683	$ 1,452	$ 752	$ 4,970	$ 1,931	$ 2,905	$ 293	$ 11,714	$ 534	$ 1,178	$ 1,354		$ 33,765
Reclaim Cover Soil Borrow Area	$ 2,506	$ 544	$ 282	$ 1,864	$ 724	$ 1,090	$ 110	$ 4,393	$ 200	$ 442	$ 508		$ 12,662
Subtotal	$ 356,487	$ 103,529	$ 126,047	$ 241,917	$ 98,001	$ 170,825	$ 19,958	$ 570,717	$ 26,522	$ 104,232	$ 64,914		$ 1,883,147
Mob/Demob (10%)	$ 35,649	$ 10,353	$ 12,605	$ 24,192	$ 9,800	$ 17,083	$ 1,996	$ 57,072	$ 2,652	$ 10,423	$ 6,491		$ 188,315
Subtotal	$ 392,136	$ 113,882	$ 138,651	$ 266,108	$ 107,801	$ 187,908	$ 21,954	$ 627,788	$ 29,174	$ 114,655	$ 71,405		$ 2,071,462
Contingencies (15%)	$ 58,820	$ 17,082	$ 20,798	$ 39,916	$ 16,170	$ 28,186	$ 3,293	$ 94,168	$ 4,376	$ 17,198	$ 10,711		$ 310,719
Subtotal	$ 450,956	$ 130,964	$ 159,449	$ 306,025	$ 123,971	$ 216,094	$ 25,247	$ 721,957	$ 33,550	$ 131,854	$ 82,116		$ 2,382,181
Project Management (5%)	$ 22,548	$ 6,548	$ 7,972	$ 15,301	$ 6,199	$ 10,805	$ 1,262	$ 36,098	$ 1,677	$ 6,593	$ 4,106		$ 119,109
Engineering (6%)	$ 27,057	$ 7,858	$ 9,567	$ 18,361	$ 7,438	$ 12,966	$ 1,515	$ 43,317	$ 2,013	$ 7,911	$ 4,927		$ 142,931
Construction Administration (8%)	$ 36,076	$ 10,477	$ 12,756	$ 24,482	$ 9,918	$ 17,288	$ 2,020	$ 57,757	$ 2,684	$ 10,548	$ 6,569		$ 190,574
Total, Capital Cost	$ 536,638	$ 155,848	$ 189,744	$ 364,169	$ 147,525	$ 257,152	$ 30,044	$ 859,128	$ 39,924	$ 156,906	$ 97,718		$ 2,834,796
Operations and Maintenance (O & M)													
Site Inspections, Vegetation Maintenance and Repairs, Years 1-30	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250		$ 2,750
Periodic Repairs - Years 15 and 30 (1/5th remedial cost)	$ 9,925	$ 2,156	$ 1,116	$ 7,380	$ 2,868	$ 4,315	$ 434	$ 17,395	$ 793	$ 1,749	$ 2,010		$ 50,141
Off-site Repository O & M and Repairs, Years 1-30	$ 933	$ 304	$ 105	$ 694	$ 270	$ 406	$ 61	$ 1,635	$ 75	$ 329	$ 189		$ 5,000
Total, 30-yr Present Worth, O & M (3%)	$ 33,643	$ 13,129	$ 8,133	$ 26,274	$ 13,205	$ 17,396	$ 6,559	$ 55,278	$ 7,198	$ 13,190	$ 10,722		$ 204,727
TOTAL CAPITAL COST + O & M	$ 570,281	$ 168,977	$ 197,877	$ 390,443	$ 160,730	$ 274,547	$ 36,603	$ 914,407	$ 47,122	$ 170,096	$ 108,440		$ 3,039,523
TOTAL EA1 REMOVAL AND OFF-SITE DISPOSAL COSTS WITH 30-YR PRESENT WORTH O & M													**$ 3,039,523**

EA1 COST ESTIMATE DETAIL

REMOVAL AND OFF-SITE DISPOSAL

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Mobilization, Bonding, Insurance	LS	$ 188,314.72	1	$ 188,315	10% of construction cost
Construct Off-site Repository - Total	CY	$ 10.12	57,781.6	$ 584,818	State Section 18*
Upper Anaconda Mine (EU 1A) Waste Area	CY	$ 10.12	10,782.3	$ 109,130	
Upper Anaconda Mine (EU 1B) Waste Piles	CY	$ 10.12	3,513.0	$ 35,556	
Capital Mine (EU 3) Waste Area	CY	$ 10.12	1,212.7	$ 12,274	
Carbonate Mine (EU 4) Waste Area	CY	$ 10.12	8,017.8	$ 81,150	
Edith Mine (EU 5) Mine Waste	CY	$ 10.12	3,115.4	$ 31,532	
Consolation Mine (EU 6) Waste Area	CY	$ 10.12	4,687.4	$ 47,442	
Mary P Mine (EU 7) Waste Pile	CY	$ 10.12	708.0	$ 7,166	
Mike Horse Mine (EU 8) Waste Area	CY	$ 10.12	18,898.1	$ 191,271	
Paymaster Mine (EU 9A) Waste Area - Surface	CY	$ 10.12	862.0	$ 8,724	
Paymaster Mine (EU 9B) Waste Area - Subsurface	CY	$ 10.12	3,801.0	$ 38,471	
No. 3 Tunnel Mine (EU 10) Waste Area	CY	$ 10.12	2,183.9	$ 22,104	
Improve/Construct Access Roads - Total	LF	$ 18.00	10,050	$ 180,900	Includes Clear/Grub/Log, Reclamation
Upper Anaconda Mine (EU 1A) Waste Area	LF	$ 18.00	2,000	$ 36,000	
Upper Anaconda Mine (EU 1B) Waste Piles	LF	$ 18.00	250	$ 4,500	
Capital Mine (EU 3) Waste Area	LF	$ 18.00	5,000	$ 90,000	
Carbonate Mine (EU 4) Waste Area	LF	$ 18.00	200	$ 3,600	
Edith Mine (EU 5) Mine Waste	LF	$ 18.00	300	$ 5,400	
Consolation Mine (EU 6) Waste Area	LF	$ 18.00	1,750	$ 31,500	
Mary P Mine (EU 7) Waste Pile	LF	$ 18.00	0	$ -	
Mike Horse Mine (EU 8) Waste Area	LF	$ 18.00	500	$ 9,000	
Paymaster Mine (EU 9A) Waste Area - Surface	LF	$ 18.00	50	$ 900	
Paymaster Mine (EU 9B) Waste Area - Subsurface	LF	$ 18.00	0	$ -	
No. 3 Tunnel Mine (EU 10) Waste Area	LF	$ 18.00	0	$ -	
Excavate, Load, Haul and Place Waste in Repository - Total	CY	$ 15.00	57,782	$ 866,724	Engineer Estimate
Upper Anaconda Mine (EU 1A) Waste Area	CY	$ 15.00	10,782	$ 161,734	
Upper Anaconda Mine (EU 1B) Waste Piles	CY	$ 15.00	3,513	$ 52,695	
Capital Mine (EU 3) Waste Area	CY	$ 15.00	1,213	$ 18,191	
Carbonate Mine (EU 4) Waste Area	CY	$ 15.00	8,018	$ 120,267	
Edith Mine (EU 5) Mine Waste	CY	$ 15.00	3,115	$ 46,731	
Consolation Mine (EU 6) Waste Area	CY	$ 15.00	4,687	$ 70,311	
Mary P Mine (EU 7) Waste Pile	CY	$ 15.00	708	$ 10,620	
Mike Horse Mine (EU 8) Waste Area	CY	$ 15.00	18,898	$ 283,471	
Paymaster Mine (EU 9A) Waste Area - Surface	CY	$ 15.00	862	$ 12,930	
Paymaster Mine (EU 9B) Waste Area - Subsurface	CY	$ 15.00	3,801	$ 57,015	
No. 3 Tunnel Mine (EU 10) Waste Area	CY	$ 15.00	2,184	$ 32,759	
Load, Haul, Place Vegetative Cover - Total	CY	$ 15.00	13,619	$ 204,278	6 inch cover imported over removal areas
Upper Anaconda Mine (EU 1A) Waste Area	CY	$ 15.00	2,696	$ 40,434	
Upper Anaconda Mine (EU 1B) Waste Piles	CY	$ 15.00	586	$ 8,783	
Capital Mine (EU 3) Waste Area	CY	$ 15.00	303	$ 4,548	
Carbonate Mine (EU 4) Waste Area	CY	$ 15.00	2,004	$ 30,067	
Edith Mine (EU 5) Mine Waste	CY	$ 15.00	779	$ 11,683	
Consolation Mine (EU 6) Waste Area	CY	$ 15.00	1,172	$ 17,578	
Mary P Mine (EU 7) Waste Pile	CY	$ 15.00	118	$ 1,770	
Mike Horse Mine (EU 8) Waste Area	CY	$ 15.00	4,725	$ 70,868	
Paymaster Mine (EU 9A) Waste Area - Surface	CY	$ 15.00	216	$ 3,233	
Paymaster Mine (EU 9B) Waste Area - Subsurface	CY	$ 15.00	475	$ 7,127	
No. 3 Tunnel Mine (EU 10) Waste Area	CY	$ 15.00	546	$ 8,190	

EA1 COST ESTIMATE DETAIL

REMOVAL AND OFF-SITE DISPOSAL

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Seed, Fertilize, Mulch - Total	AC	$ 2,000.00	16.9	$ 33,765	Based on Bald Butte
Upper Anaconda Mine (EU 1A) Waste Area	AC	$ 2,000.00	3.3	$ 6,683	
Upper Anaconda Mine (EU 1B) Waste Piles	AC	$ 2,000.00	0.7	$ 1,452	
Capital Mine (EU 3) Waste Area	AC	$ 2,000.00	0.4	$ 752	
Carbonate Mine (EU 4) Waste Area	AC	$ 2,000.00	2.5	$ 4,970	
Edith Mine (EU 5) Mine Waste	AC	$ 2,000.00	1.0	$ 1,931	
Consolation Mine (EU 6) Waste Area	AC	$ 2,000.00	1.5	$ 2,905	
Mary P Mine (EU 7) Waste Pile	AC	$ 2,000.00	0.1	$ 293	
Mike Horse Mine (EU 8) Waste Area	AC	$ 2,000.00	5.9	$ 11,714	
Paymaster Mine (EU 9A) Waste Area - Surface	AC	$ 2,000.00	0.3	$ 534	
Paymaster Mine (EU 9B) Waste Area - Subsurface	AC	$ 2,000.00	0.6	$ 1,178	
No. 3 Tunnel Mine (EU 10) Waste Area	AC	$ 2,000.00	0.7	$ 1,354	
Reclaim Cover Soil Borrow Area - Total	AC	$ 4,500.00	2.8	$ 12,662	Based on Bald Butte
Upper Anaconda Mine (EU 1A) Waste Area	AC	$ 4,500.00	0.6	$ 2,506	
Upper Anaconda Mine (EU 1B) Waste Piles	AC	$ 4,500.00	0.1	$ 544	
Capital Mine (EU 3) Waste Area	AC	$ 4,500.00	0.1	$ 282	
Carbonate Mine (EU 4) Waste Area	AC	$ 4,500.00	0.4	$ 1,864	
Edith Mine (EU 5) Mine Waste	AC	$ 4,500.00	0.2	$ 724	
Consolation Mine (EU 6) Waste Area	AC	$ 4,500.00	0.2	$ 1,090	
Mary P Mine (EU 7) Waste Pile	AC	$ 4,500.00	0.0	$ 110	
Mike Horse Mine (EU 8) Waste Area	AC	$ 4,500.00	1.0	$ 4,393	
Paymaster Mine (EU 9A) Waste Area - Surface	AC	$ 4,500.00	0.0	$ 200	
Paymaster Mine (EU 9B) Waste Area - Subsurface	AC	$ 4,500.00	0.1	$ 442	
No. 3 Tunnel Mine (EU 10) Waste Area	AC	$ 4,500.00	0.1	$ 508	
			Subtotal	$ 2,071,462	
Contingencies		15%		$ 310,719	
			Subtotal	$ 2,382,181	
Project Management		5%		$ 119,109	
Engineering		6%		$ 142,931	
Construction Management		8%		$ 190,574	
TOTAL				$ 2,834,796	
			TOTAL CAPITAL COSTS	**$ 2,834,796**	

OPERATIONS AND MAINTENANCE (O & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Site Inspections, Vegetation Maintenance and Repairs, Years 1-30	LS	$ 2,750.00	1	$ 2,750	Engineers Estimate
Periodic Repairs - Years 15 and 30 (1/5th remedial cost)	LS	$ 50,140.95	1	$ 50,141	Engineers Estimate
Off-site Repository O & M and Repairs, Years 1-30	LS	$ 5,000.00	1	$ 5,000	Engineers Estimate
			Subtotal	$ 57,891	
30-YEAR NET PRESENT VALUE ANNUAL O & M COSTS				**$ 204,744**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O & M COSTS) $ 3,039,540 — Value for the EA as a whole is slightly different than value calculated by summing individual sites within the EA due to compounding rounding error.

* From the Repository Siting Study for UBMC - State Section 18 Site estimate was $15,034,436 for a 1,000,000 cy repository and includes wastes removed under the EE/CA actions. The total estimated cost included hauling and placement of waste. Construction costs for the repository were $4,048,472. For purposes of this feasibility study, estimated costs from the siting study are scaled to a 400,000 cy repository for a repository construction cost of $10.12/cy.

EA 1 COSTS													
IN-SITU NEUTRALIZATION WITH LIME	**Upper Anaconda Mine (EU 1A) Waste Area**	**Upper Anaconda Mine (EU 1B) Waste Piles**	**Capital Mine (EU 3) Waste Area**	**Carbonate Mine (EU 4) Waste Area**	**Edith Mine (EU 5) Waste Area**	**Consolation Mine (EU 6) Waste Area**	**Mary P Mine (EU 7) Waste Pile**	**Mike Horse Mine (EU 8) Waste Area**	**Paymaster Mine (EU 9A) Waste Area - Surface**	**Paymaster Mine (EU 9B) Waste Area - Subsurface**	**No. 3 Tunnel Mine (EU 10) Waste Area**		**TOTAL**
Improve/Construct Access Roads	$ 36,000	$ 4,500	$ 90,000	$ 3,600	$ 5,400	$ 31,500	$ -	$ 9,000	$ 900	$ -	$ -		$ 180,900
Re-Grade Waste Piles, Prep for Lime Treatment	$ 48,520	$ 10,539	$ 5,457	$ 36,080	$ 14,019	$ 21,093	$ 2,124	$ 85,041	$ 3,879	$ 8,552	$ 9,828		$ 245,134
Load, Haul, Incorporate Lime	$ 26,416	$ 5,738	$ 2,971	$ 19,643	$ 7,632	$ 11,484	$ 1,156	$ 46,298	$ 2,112	$ 4,656	$ 5,350		$ 133,456
Seed, Fertilize, Mulch	$ 6,683	$ 1,452	$ 752	$ 4,970	$ 1,931	$ 2,905	$ 293	$ 11,714	$ 534	$ 1,178	$ 1,354		$ 33,765
Subtotal	$ 117,619	$ 22,228	$ 99,180	$ 64,293	$ 28,983	$ 66,982	$ 3,573	$ 152,054	$ 7,425	$ 14,386	$ 16,532		$ 593,254
Mob/Demob (10%)	$ 11,762	$ 2,223	$ 9,918	$ 6,429	$ 2,898	$ 6,698	$ 357	$ 15,205	$ 743	$ 1,439	$ 1,653		$ 59,325
Subtotal	$ 129,381	$ 24,451	$ 109,098	$ 70,722	$ 31,881	$ 73,680	$ 3,930	$ 167,259	$ 8,168	$ 15,825	$ 18,185		$ 652,580
Contingencies (15%)	$ 19,407	$ 3,668	$ 16,365	$ 10,608	$ 4,782	$ 11,052	$ 590	$ 25,089	$ 1,225	$ 2,374	$ 2,728		$ 97,887
Subtotal	$ 148,788	$ 28,119	$ 125,463	$ 81,330	$ 36,663	$ 84,733	$ 4,520	$ 192,348	$ 9,393	$ 18,199	$ 20,913		$ 750,467
Project Management (5%)	$ 7,439	$ 1,406	$ 6,273	$ 4,067	$ 1,833	$ 4,237	$ 226	$ 9,617	$ 470	$ 910	$ 1,046		$ 37,523
Engineering (6%)	$ 8,927	$ 1,687	$ 7,528	$ 4,880	$ 2,200	$ 5,084	$ 271	$ 11,541	$ 564	$ 1,092	$ 1,255		$ 45,028
Construction Administration (8%)	$ 11,903	$ 2,250	$ 10,037	$ 6,506	$ 2,933	$ 6,779	$ 362	$ 15,388	$ 751	$ 1,456	$ 1,673		$ 60,037
Total, Capital Cost	$ 177,058	$ 33,461	$ 149,301	$ 96,783	$ 43,629	$ 100,832	$ 5,378	$ 228,894	$ 11,177	$ 21,656	$ 24,886		$ 893,056
Operations and Maintenance (O & M)													
Site Inspections, Vegetation Maintenance and Repairs, Years 1-30	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250		$ 2,750
Periodic Repairs - Years 15 and 30 (1/3rd remedial cost lime, reveg)	$ 11,033	$ 2,396	$ 1,241	$ 8,204	$ 3,188	$ 4,796	$ 483	$ 19,337	$ 882	$ 1,945	$ 2,235		$ 55,740
Total, 30-yr Present Worth, O & M (3%)	$ 16,523	$ 7,425	$ 6,207	$ 13,543	$ 8,259	$ 9,953	$ 5,409	$ 25,272	$ 5,829	$ 6,949	$ 7,254		$ 112,624
TOTAL CAPITAL COST + O & M	$ 193,581	$ 40,886	$ 155,508	$ 110,326	$ 51,888	$ 110,785	$ 10,787	$ 254,166	$ 17,007	$ 28,605	$ 32,140		$ 1,005,680
TOTAL EA1 IN-SITU NEUTRALIZATION COSTS WITH 30-YR PRESENT WORTH O & M													**$ 1,005,680**

EA1 COST ESTIMATE DETAIL
IN-SITU NEUTRALIZATION

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Mobilization, Bonding, Insurance	LS	$ 59,325.45	1	$ 59,325	10% of construction cost
Improve/Construct Access Roads - Total	LF	$ 18.00	10,050	$ 180,900	Includes Clear/Grub/Log, Reclamation
Upper Anaconda Mine (EU 1A) Waste Area	LF	$ 18.00	2,000	$ 36,000	
Upper Anaconda Mine (EU 1B) Waste Piles	LF	$ 18.00	250	$ 4,500	
Capital Mine (EU 3) Waste Area	LF	$ 18.00	5,000	$ 90,000	
Carbonate Mine (EU 4) Waste Area	LF	$ 18.00	200	$ 3,600	
Edith Mine (EU 5) Mine Waste	LF	$ 18.00	300	$ 5,400	
Consolation Mine (EU 6) Waste Area	LF	$ 18.00	1,750	$ 31,500	
Mary P Mine (EU 7) Waste Pile	LF	$ 18.00	0	$ -	
Mike Horse Mine (EU 8) Waste Area	LF	$ 18.00	500	$ 9,000	
Paymaster Mine (EU 9A) Waste Area - Surface	LF	$ 18.00	50	$ 900	
Paymaster Mine (EU 9B) Waste Area - Subsurface	LF	$ 18.00	0	$ -	
No. 3 Tunnel Mine (EU 10) Waste Area	LF	$ 18.00	0	$ -	
Re-Grade Waste Piles, Prep for Lime Treatment - Total	SY	$ 3.00	78,435	$ 245,134	Engineer Estimate
Upper Anaconda Mine (EU 1A) Waste Area	SY	$ 3.00	16,173	$ 48,520	
Upper Anaconda Mine (EU 1B) Waste Piles	SY	$ 3.00	3,513	$ 10,539	
Capital Mine (EU 3) Waste Area	SY	$ 3.00	1,819	$ 5,457	
Carbonate Mine (EU 4) Waste Area	SY	$ 3.00	12,027	$ 36,080	
Edith Mine (EU 5) Mine Waste	SY	$ 3.00	4,673	$ 14,019	
Consolation Mine (EU 6) Waste Area	SY	$ 3.00	7,031	$ 21,093	
Mary P Mine (EU 7) Waste Pile	SY	$ 3.00	708	$ 2,124	
Mike Horse Mine (EU 8) Waste Area	SY	$ 3.00	28,347	$ 85,041	
Paymaster Mine (EU 9A) Waste Area - Surface	SY	$ 3.00	1,293	$ 3,879	
Paymaster Mine (EU 9B) Waste Area - Subsurface	SY	$ 3.00	2,851	$ 8,552	
No. 3 Tunnel Mine (EU 10) Waste Area	SY	$ 3.00	3,276	$ 9,828	
Load, Haul, Incorporate Lime - Total	AC	$ 7,905.00	16.9	$ 133,456	Based on Stucky Ridge - Costs Increased
Upper Anaconda Mine (EU 1A) Waste Area	AC	$ 7,905.00	3.3	$ 26,416	
Upper Anaconda Mine (EU 1B) Waste Piles	AC	$ 7,905.00	0.7	$ 5,738	
Capital Mine (EU 3) Waste Area	AC	$ 7,905.00	0.4	$ 2,971	
Carbonate Mine (EU 4) Waste Area	AC	$ 7,905.00	2.5	$ 19,643	
Edith Mine (EU 5) Mine Waste	AC	$ 7,905.00	1.0	$ 7,632	
Consolation Mine (EU 6) Waste Area	AC	$ 7,905.00	1.5	$ 11,484	
Mary P Mine (EU 7) Waste Pile	AC	$ 7,905.00	0.1	$ 1,156	
Mike Horse Mine (EU 8) Waste Area	AC	$ 7,905.00	5.9	$ 46,298	
Paymaster Mine (EU 9A) Waste Area - Surface	AC	$ 7,905.00	0.3	$ 2,112	
Paymaster Mine (EU 9B) Waste Area - Subsurface	AC	$ 7,905.00	0.6	$ 4,656	
No. 3 Tunnel Mine (EU 10) Waste Area	AC	$ 7,905.00	0.7	$ 5,350	

EA1 COST ESTIMATE DETAIL
IN-SITU NEUTRALIZATION

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Seed, Fertilize, Mulch - Total	AC	$ 2,000.00	16.9	$ 33,765	Engineer Estimate
Upper Anaconda Mine (EU 1A) Waste Area	AC	$ 2,000.00	3.3	$ 6,683	
Upper Anaconda Mine (EU 1B) Waste Piles	AC	$ 2,000.00	0.7	$ 1,452	
Capital Mine (EU 3) Waste Area	AC	$ 2,000.00	0.4	$ 752	
Carbonate Mine (EU 4) Waste Area	AC	$ 2,000.00	2.5	$ 4,970	
Edith Mine (EU 5) Mine Waste	AC	$ 2,000.00	1.0	$ 1,931	
Consolation Mine (EU 6) Waste Area	AC	$ 2,000.00	1.5	$ 2,905	
Mary P Mine (EU 7) Waste Pile	AC	$ 2,000.00	0.1	$ 293	
Mike Horse Mine (EU 8) Waste Area	AC	$ 2,000.00	5.9	$ 11,714	
Paymaster Mine (EU 9A) Waste Area - Surface	AC	$ 2,000.00	0.3	$ 534	
Paymaster Mine (EU 9B) Waste Area - Subsurface	AC	$ 2,000.00	0.6	$ 1,178	
No. 3 Tunnel Mine (EU 10) Waste Area	AC	$ 2,000.00	0.7	$ 1,354	
			Subtotal	$ 652,580	
Contingencies		15%		$ 97,886.99	
			Subtotal	$ 750,467	
Project Management		5%		$ 37,523	
Engineering		6%		$ 45,028	
Construction Management		8%		$ 60,037	
TOTAL				$ 893,056	
			TOTAL CAPITAL COSTS	**$ 893,056**	

OPERATIONS AND MAINTENANCE (O & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Site Inspections, Vegetation Maintenance and Repairs, Years 1-30	LS	$ 2,750.00	1	$ 2,750	Engineers Estimate
Periodic Repairs - Years 15 and 30 (1/3rd remedial cost, lime, reveg)	LS	$ 55,740.31	1	$ 55,740	Engineers Estimate
			Subtotal	$ 58,490	
			30-YEAR NET PRESENT VALUE ANNUAL O & M COSTS	**$ 112,643**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O & M COSTS) $ 1,005,699 — Value for the EA as a whole is slightly different than value calculated by summing individual sites within the EA due to compounding rounding error.

EA 1 COSTS													
EX-SITU NEUTRALIZATION WITH LIME	**Upper Anaconda Mine (EU 1A) Waste Area**	**Upper Anaconda Mine (EU 1B) Waste Piles**	**Capital Mine (EU 3) Waste Area**	**Carbonate Mine (EU 4) Waste Area**	**Edith Mine (EU 5) Waste Area**	**Consolation Mine (EU 6) Waste Area**	**Mary P Mine (EU 7) Waste Pile**	**Mike Horse Mine (EU 8) Waste Area**	**Paymaster Mine (EU 9A) Waste Area - Surface**	**Paymaster Mine (EU 9B) Waste Area - Subsurface**	**No. 3 Tunnel Mine (EU 10) Waste Area**		**TOTAL**
Improve/Construct Access Roads	$ 36,000	$ 4,500	$ 90,000	$ 3,600	$ 5,400	$ 31,500	$ -	$ 9,000	$ 900	$ -	$ -		$ 180,900
Excavate, Load, Haul and Place Waste in Mixing Area	$ 129,388	$ 42,156	$ 14,553	$ 96,214	$ 37,385	$ 56,249	$ 8,496	$ 226,777	$ 10,344	$ 45,612	$ 26,207		$ 693,379
Load, Haul, Incorporate Lime	$ 26,416	$ 5,738	$ 2,971	$ 19,643	$ 7,632	$ 11,484	$ 1,156	$ 46,298	$ 2,112	$ 4,656	$ 5,350		$ 133,456
Load, Haul and Replace Treated Waste	$ 71,163	$ 23,186	$ 8,004	$ 52,917	$ 20,562	$ 30,937	$ 4,673	$ 124,727	$ 5,689	$ 25,087	$ 14,414		$ 381,359
Seed, Fertilize, Mulch	$ 13,366	$ 2,903	$ 1,503	$ 9,939	$ 3,862	$ 5,811	$ 585	$ 23,427	$ 1,069	$ 2,356	$ 2,707		$ 67,530
Subtotal	$ 276,333	$ 78,483	$ 117,031	$ 182,313	$ 74,841	$ 135,980	$ 14,910	$ 430,230	$ 20,114	$ 77,711	$ 48,679		$ 1,456,624
Mob/Demob (10%)	$ 27,633	$ 7,848	$ 11,703	$ 18,231	$ 7,484	$ 13,598	$ 1,491	$ 43,023	$ 2,011	$ 7,771	$ 4,868		$ 145,662
Subtotal	$ 303,966	$ 86,331	$ 128,734	$ 200,545	$ 82,325	$ 149,578	$ 16,401	$ 473,253	$ 22,125	$ 85,482	$ 53,546		$ 1,602,286
Contingencies (15%)	$ 45,595	$ 12,950	$ 19,310	$ 30,082	$ 12,349	$ 22,437	$ 2,460	$ 70,988	$ 3,319	$ 12,822	$ 8,032		$ 240,343
Subtotal	$ 349,561	$ 99,281	$ 148,044	$ 230,626	$ 94,674	$ 172,014	$ 18,861	$ 544,241	$ 25,444	$ 98,304	$ 61,578		$ 1,842,629
Project Management (5%)	$ 17,478	$ 4,964	$ 7,402	$ 11,531	$ 4,734	$ 8,601	$ 943	$ 27,212	$ 1,272	$ 4,915	$ 3,079		$ 92,131
Engineering (6%)	$ 20,974	$ 5,957	$ 8,883	$ 13,838	$ 5,680	$ 10,321	$ 1,132	$ 32,654	$ 1,527	$ 5,898	$ 3,695		$ 110,558
Construction Administration (8%)	$ 27,965	$ 7,942	$ 11,844	$ 18,450	$ 7,574	$ 13,761	$ 1,509	$ 43,539	$ 2,035	$ 7,864	$ 4,926		$ 147,410
Total, Capital Cost	$ 415,977	$ 118,144	$ 176,173	$ 274,445	$ 112,662	$ 204,697	$ 22,445	$ 647,647	$ 30,278	$ 116,982	$ 73,278		$ 2,192,729
Operations and Maintenance (O & M)													
Site Inspections, Vegetation Maintenance and Repairs, Years 1-30	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250		$ 2,750
Periodic Repairs - Years 15 and 30 (1/3rd remedial cost lime, reveg)	$ 13,261	$ 2,880	$ 1,491	$ 9,861	$ 3,831	$ 5,765	$ 580	$ 23,242	$ 1,060	$ 2,337	$ 2,686		$ 66,995
Total, 30-yr Present Worth, O & M (3%)	$ 18,870	$ 7,935	$ 6,471	$ 15,288	$ 8,937	$ 10,973	$ 5,512	$ 29,386	$ 6,017	$ 7,363	$ 7,730		$ 124,481
TOTAL CAPITAL COST + O & M	$ 434,848	$ 126,079	$ 182,644	$ 289,734	$ 121,599	$ 215,670	$ 27,957	$ 677,033	$ 36,295	$ 124,344	$ 81,008		$ 2,317,210
TOTAL EA1 EX-SITU NEUTRALIZATION COSTS WITH 30-YR PRESENT WORTH O & M													**$ 2,317,210**

EA1 COST ESTIMATE DETAIL
EX-SITU NEUTRALIZATION

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Mobilization, Bonding, Insurance	LS	$ 145,662.40	1	$ 145,662	10% of construction cost
Improve/Construct Access Roads - Total	LF	$ 18.00	10,050	$ 180,900	Includes Clear/Grub/Log, Reclamation
Upper Anaconda Mine (EU 1A) Waste Area	LF	$ 18.00	2,000	$ 36,000	
Upper Anaconda Mine (EU 1B) Waste Piles	LF	$ 18.00	250	$ 4,500	
Capital Mine (EU 3) Waste Area	LF	$ 18.00	5,000	$ 90,000	
Carbonate Mine (EU 4) Waste Area	LF	$ 18.00	200	$ 3,600	
Edith Mine (EU 5) Mine Waste	LF	$ 18.00	300	$ 5,400	
Consolation Mine (EU 6) Waste Area	LF	$ 18.00	1,750	$ 31,500	
Mary P Mine (EU 7) Waste Pile	LF	$ 18.00	0	$ -	
Mike Horse Mine (EU 8) Waste Area	LF	$ 18.00	500	$ 9,000	
Paymaster Mine (EU 9A) Waste Area - Surface	LF	$ 18.00	50	$ 900	
Paymaster Mine (EU 9B) Waste Area - Subsurface	LF	$ 18.00	0	$ -	
No. 3 Tunnel Mine (EU 10) Waste Area	LF	$ 18.00	0	$ -	
Excavate, Load, Haul and Place Waste in Mixing Area - Total	CY	$ 12.00	57,782	$ 693,379	Engineer Estimate
Upper Anaconda Mine (EU 1A) Waste Area	CY	$ 12.00	10,782	$ 129,388	
Upper Anaconda Mine (EU 1B) Waste Piles	CY	$ 12.00	3,513	$ 42,156	
Capital Mine (EU 3) Waste Area	CY	$ 12.00	1,213	$ 14,553	
Carbonate Mine (EU 4) Waste Area	CY	$ 12.00	8,018	$ 96,214	
Edith Mine (EU 5) Mine Waste	CY	$ 12.00	3,115	$ 37,385	
Consolation Mine (EU 6) Waste Area	CY	$ 12.00	4,687	$ 56,249	
Mary P Mine (EU 7) Waste Pile	CY	$ 12.00	708	$ 8,496	
Mike Horse Mine (EU 8) Waste Area	CY	$ 12.00	18,898	$ 226,777	
Paymaster Mine (EU 9A) Waste Area - Surface	CY	$ 12.00	862	$ 10,344	
Paymaster Mine (EU 9B) Waste Area - Subsurface	CY	$ 12.00	3,801	$ 45,612	
No. 3 Tunnel Mine (EU 10) Waste Area	CY	$ 12.00	2,184	$ 26,207	
Load, Haul, Incorporate Lime - Total	AC	$ 7,905.00	16.9	$ 133,456	Based on Stucky Ridge - Costs Increased
Upper Anaconda Mine (EU 1A) Waste Area	AC	$ 7,905.00	3.3	$ 26,416	
Upper Anaconda Mine (EU 1B) Waste Piles	AC	$ 7,905.00	0.7	$ 5,738	
Capital Mine (EU 3) Waste Area	AC	$ 7,905.00	0.4	$ 2,971	
Carbonate Mine (EU 4) Waste Area	AC	$ 7,905.00	2.5	$ 19,643	
Edith Mine (EU 5) Mine Waste	AC	$ 7,905.00	1.0	$ 7,632	
Consolation Mine (EU 6) Waste Area	AC	$ 7,905.00	1.5	$ 11,484	
Mary P Mine (EU 7) Waste Pile	AC	$ 7,905.00	0.1	$ 1,156	
Mike Horse Mine (EU 8) Waste Area	AC	$ 7,905.00	5.9	$ 46,298	
Paymaster Mine (EU 9A) Waste Area - Surface	AC	$ 7,905.00	0.3	$ 2,112	
Paymaster Mine (EU 9B) Waste Area - Subsurface	AC	$ 7,905.00	0.6	$ 4,656	
No. 3 Tunnel Mine (EU 10) Waste Area	AC	$ 7,905.00	0.7	$ 5,350	
Load, Haul and Replace Treated Waste - Total	CY	$ 6.00	63,560	$ 381,359	Engineer Estimate
Upper Anaconda Mine (EU 1A) Waste Area	CY	$ 6.00	11,861	$ 71,163	
Upper Anaconda Mine (EU 1B) Waste Piles	CY	$ 6.00	3,864	$ 23,186	
Capital Mine (EU 3) Waste Area	CY	$ 6.00	1,334	$ 8,004	
Carbonate Mine (EU 4) Waste Area	CY	$ 6.00	8,820	$ 52,917	
Edith Mine (EU 5) Mine Waste	CY	$ 6.00	3,427	$ 20,562	
Consolation Mine (EU 6) Waste Area	CY	$ 6.00	5,156	$ 30,937	
Mary P Mine (EU 7) Waste Pile	CY	$ 6.00	779	$ 4,673	
Mike Horse Mine (EU 8) Waste Area	CY	$ 6.00	20,788	$ 124,727	
Paymaster Mine (EU 9A) Waste Area - Surface	CY	$ 6.00	948	$ 5,689	
Paymaster Mine (EU 9B) Waste Area - Subsurface	CY	$ 6.00	4,181	$ 25,087	
No. 3 Tunnel Mine (EU 10) Waste Area	CY	$ 6.00	2,402	$ 14,414	

EA1 COST ESTIMATE DETAIL
EX-SITU NEUTRALIZATION

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Seed, Fertilize, Mulch - Total	AC	$ 2,000.00	33.8	$ 67,530	Engineer Estimate - area doubled to account for mixing area
Upper Anaconda Mine (EU 1A) Waste Area	AC	$ 2,000.00	6.7	$ 13,366	
Upper Anaconda Mine (EU 1B) Waste Piles	AC	$ 2,000.00	1.5	$ 2,903	
Capital Mine (EU 3) Waste Area	AC	$ 2,000.00	0.8	$ 1,503	
Carbonate Mine (EU 4) Waste Area	AC	$ 2,000.00	5.0	$ 9,939	
Edith Mine (EU 5) Mine Waste	AC	$ 2,000.00	1.9	$ 3,862	
Consolation Mine (EU 6) Waste Area	AC	$ 2,000.00	2.9	$ 5,811	
Mary P Mine (EU 7) Waste Pile	AC	$ 2,000.00	0.3	$ 585	
Mike Horse Mine (EU 8) Waste Area	AC	$ 2,000.00	11.7	$ 23,427	
Paymaster Mine (EU 9A) Waste Area - Surface	AC	$ 2,000.00	0.5	$ 1,069	
Paymaster Mine (EU 9B) Waste Area - Subsurface	AC	$ 2,000.00	1.2	$ 2,356	
No. 3 Tunnel Mine (EU 10) Waste Area	AC	$ 2,000.00	1.4	$ 2,707	
			Subtotal	$ 1,602,286	
Contingencies		15%		$ 240,343	
			Subtotal	$ 1,842,629	
Project Management		5%		$ 92,131	
Engineering		6%		$ 110,558	
Construction Management		8%		$ 147,410	
TOTAL				$ 2,192,729	
			TOTAL CAPITAL COSTS	**$ 2,192,729**	

OPERATIONS AND MAINTENANCE (O & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Site Inspections, Vegetation Maintenance and Repairs, Years 1-30	LS	$ 2,750.00	1	$ 2,750	Engineers Estimate
Periodic Repairs - Years 15 and 30 (1/3rd remedial cost lime, reveg)	LS	$ 66,995.29	1	$ 66,995	Engineers Estimate
			Subtotal	$ 69,745	
30-YEAR NET PRESENT VALUE ANNUAL O & M COSTS				**$ 124,504**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O & M COSTS) $ 2,317,233 Value for the EA as a whole is slightly different than value calculated by summing individual sites within the EA due to compounding rounding error.

EA 1 QUANTITY ESTIMATES					
SITE	WASTE		ACCESS - DIST. TO ROADS		
	AREA	VOLUME	LENGTH	IMPROVE?	FENCING
	(sf)	(cy)	(ft)		(ft)
EU-1A Upper Anaconda	145,561	10,782	2,000	YES	1,670
EU 1B Upper Anaconda	31,617	3,513	250	YES	780
EU 3 Capital Mine	16,372	1,213	5,000	YES	560
EU 4 Carbonate	108,240	8,018	200	YES	1,440
EU-5 Edith Mine	42,058	3,115	300	YES	900
EU-6 Consolation	63,280	4,687	1,750	SLIGHT	1,100
EU 7 Mary P Mine	6,372	708	0	YES	350
EU 8 MH Waste Area	255,124	18,898	500	YES	2,210
EU-9A Paymaster	11,637	862	50	SLIGHT	470
EU-9B Paymaster Subsurface	25,657	3,801	0	NO	700
EU-10 No.3 Tunnel	29,483	2,184	0	NO	750
TOTALS	735,401	57,782	10,050		10,930

EVALUATION AREA	SITE-WIDE ELEMENTS			REMEDIAL ALTERNATIVE COSTS							
EA 2				No Action	GROUNDWATER						
Groundwater					Monitored Natural Attenuation	ENGINEERING CONTROLS			TREATMENT		
									Active		Passive
	ICs	Access Restrictions	Long-term Monitoring and Maintenance			Containment (Retention Pond)	Hydrologic and Hydraulic Control	Inundation	Chemical Reagent	Physical/ Mechanical	Chemical Reagent
Anaconda Mine (EU 1) Adit Discharge	$0	$0	$0	$0	$400,379	N/A	N/A	N/A	$337,119	$337,119	$1,446,928
Carbonate Mine (EU 4) Groundwater	$5,000	$0	$0	$0	$400,379	N/A	$464,514	N/A	$3,733,973	$3,733,973	$1,830,977
Mike Horse Mine (EU 8) Adit Discharge and Seeps	$0	$0	$0	$0	$400,379	N/A	N/A	N/A	$4,433,677	$4,433,677	$2,992,540
Paymaster Gulch Groundwater Aquifers	$5,000	$0	$0	$0	$400,379	N/A	N/A	N/A	$3,547,147	$3,547,147	$1,556,582
Upper Mike Horse Mine Bedrock Groundwater Aquifer	$5,000	$0	$0	$0	$400,379	N/A	N/A	N/A	$5,404,334	$5,404,334	N/A
Capital Mine Adit Plug	$0	$0	$0	$0	$0	N/A	N/A	$10,124	N/A	N/A	N/A
TOTAL COSTS	**$15,000**	**$0**	**$0**	**$0**	**$2,001,895**	**$0**	**$464,514**	**$10,124**	**$17,456,250**	**$17,456,250**	**$7,827,027**

EA 2 COSTS								
MONITORED NATURAL ATTENUATION	**Anaconda Mine (EU 1) Adit Discharge**	**Carbonate Mine (EU 4) Groundwater**	**Mike Horse Mine (EU 8) Adit Discharge and Seeps**	**Paymaster Gulch Groundwater Aquifers**	**Upper Mike Horse Mine Bedrock Groundwater Aquifer**	**Capital Mine Adit Plug**		**TOTAL**
Additional Monitoring Well Installation	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ -		$ 50,000
Subtotal	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ -		$ 50,000
Mob/Demob (10%)	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ -		$ 5,000
Subtotal	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ -		$ 55,000
Contingencies (15%)	$ 1,650	$ 1,650	$ 1,650	$ 1,650	$ 1,650	$ -		$ 8,250
Subtotal	$ 12,650	$ 12,650	$ 12,650	$ 12,650	$ 12,650	$ -		$ 63,250
Project Management (5%)	$ 633	$ 633	$ 633	$ 633	$ 633	$ -		$ 3,163
Engineering (6%)	$ 759	$ 759	$ 759	$ 759	$ 759	$ -		$ 3,795
Construction Administration (8%)	$ 1,012	$ 1,012	$ 1,012	$ 1,012	$ 1,012	$ -		$ 5,060
Total, Capital Cost	$ 15,054	$ 15,054	$ 15,054	$ 15,054	$ 15,054	$ -		$ 75,268
Operations and Maintenance (O & M)								
Semiannual Monitoring -Existing Wells, Sampling, Analysis, Report - Years 1-10	$ 27,000	$ 27,000	$ 27,000	$ 27,000	$ 27,000	$ -		$ 135,000
Annual Monitoring, Years 11-30	$ 13,500	$ 13,500	$ 13,500	$ 13,500	$ 13,500	$ -		
Total, 30-yr Present Worth, O & M (3%)	$ 385,326	$ 385,326	$ 385,326	$ 385,326	$ 385,326	$ -		$ 1,926,628
TOTAL CAPITAL COST + O & M	$ 400,379	$ 400,379	$ 400,379	$ 400,379	$ 400,379	$ -		$ 2,001,895
TOTAL EA2 MNA COSTS WITH 30-YR PRESENT WORTH O & M								**$ 2,001,895**

EA2 COST ESTIMATE DETAIL
MONITORED NATURAL ATTENUATION

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Mobilization/Demobilization	LS	$ 5,000.00	1	$ 5,000	10% of construction cost
Well Installation	EA	$ 10,000.00	5	$ 50,000	
			Subtotal	$ 55,000	
Contingencies		15%		$ 8,250	
			Subtotal	$ 63,250	
Project Management		5%		$ 3,163	
Engineering		6%		$ 3,795	
Construction Management		8%		$ 5,060	
TOTAL				$ 75,268	
			TOTAL CAPITAL COSTS	**$ 75,268**	

OPERATIONS AND MAINTENANCE (O & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Semiannual Monitoring -Existing Wells, Sampling, Analysis, Report - Years 1-10	LS	$ 135,000.00	1	$ 135,000	Based on current budget, increase for add'l wells and semiannual monitoring
Annual Monitoring, Years 11-30	LS	$ 67,500.00	1	$ 67,500	
			Subtotal	$ 202,500	
30-YEAR NET PRESENT VALUE ANNUAL O & M COSTS				**$ 1,926,628**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O & M COSTS) $ 2,001,895

Groundwater Monitoring	EA	$65,000.00	2	$130,000.00	Existing Annual Budget is ~$65K for GW - Double this for MNA
Analysis and Report	EA	$5,000	1	$5,000.00	
			Annual Cost	$135,000.00	

EA 2 COSTS									
HYDROLOGIC AND HYDRAULIC CONTROL		**Anaconda Mine (EU 1) Adit Discharge**	**Carbonate Mine (EU 4) Groundwater**	**Mike Horse Mine (EU 8) Adit Discharge and Seeps**	**Paymaster Gulch Groundwater Aquifers**	**Upper Mike Horse Mine Bedrock Groundwater Aquifer**	**Capital Mine Adit Plug**		**TOTAL**
Surface Water and Sediment Control		$ -	$ 9,000	$ -	$ -	$ -	$ -		$ 9,000
Install Temporary Stream Channel Diversion		$ -	$ 28,800	$ -	$ -	$ -	$ -		$ 28,800
Reconstruct Stream		$ -	$ 113,750	$ -	$ -	$ -	$ -		$ 113,750
Install Sheet Piling Cutoff Wall		$ -	$ 57,500	$ -	$ -	$ -	$ -		$ 57,500
Seed, Fertilize, Mulch		$ -	$ 4,000	$ -	$ -	$ -	$ -		$ 4,000
Subtotal		$ -	$ 213,050	$ -	$ -	$ -	$ -		$ 213,050
Mob/Demob (10%)	10%	$ -	$ 21,305	$ -	$ -	$ -	$ -		$ 21,305
Subtotal		$ -	$ 234,355	$ -	$ -	$ -	$ -		$ 234,355
Contingencies (15%)	15%	$ -	$ 35,153	$ -	$ -	$ -	$ -		$ 35,153
Subtotal		$ -	$ 269,508	$ -	$ -	$ -	$ -		$ 269,508
Project Management (5%)	5%	$ -	$ 13,475	$ -	$ -	$ -	$ -		$ 13,475
Engineering (6%)	6%	$ -	$ 16,170	$ -	$ -	$ -	$ -		$ 16,170
Construction Administration (8%)	8%	$ -	$ 21,561	$ -	$ -	$ -	$ -		$ 21,561
Total, Capital Cost		$ -	$ 320,715	$ -	$ -	$ -	$ -		$ 320,715
Operations and Maintenance (O & M)									
Channel and Reclamation Maintenance, Years 1-5		$ -	$ 15,000	$ -	$ -	$ -	$ -		$ 15,000
Channel and Reclamation Maintenance, Years 5-30		$ -	$ 5,000	$ -	$ -	$ -	$ -		$ 5,000
Total, 30-yr Present Worth, O & M (3%)	3%	$ -	$143,799	$ -	$ -	$ -	$ -		$ 143,799
TOTAL CAPITAL COST + O & M		$ -	$ 464,514	$ -	$ -	$ -	$ -		$ 464,514
TOTAL EA2 HYDROLOGIC AND HYDRAULIC CONTROL COSTS WITH 30-YR PRESENT WORTH O & M									**$ 464,514**

EA2 COST ESTIMATE DETAIL

HYDROLOGIC AND HYDRAULIC CONTROL

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Carbonate Mine (EU 4) Groundwater					
Mobilization, Bonding, Insurance	LS	$ 21,305.00	1	$ 21,305	10% of construction cost
Surface Water and Sediment Control	LS	$ 9,000.00	1	$ 9,000	General Site BMP's
Install Temporary Stream Channel Diversion	LF	$ 32.00	900	$ 28,800	Based on SSTOU Bid Tabs
Reconstruct Stream	LF	$ 125.00	910	$ 113,750	Based on SSTOU Bid Tabs
Install Sheet Piling Cutoff Wall	LF	$ 250.00	230	$ 57,500	Based on McLaren estimates in 2009
Seed, Fertilize, Mulch	AC	$ 2,000.00	2	$ 4,000	Native seed and fertilizer
			Subtotal	$ 234,355	
Contingencies		15%		$ 35,153	
			Subtotal	$ 269,508	
Project Management		5%		$ 13,475	
Engineering		6%		$ 16,170	
Construction Management		8%		$ 21,561	
TOTAL				$ 320,715	
			TOTAL CAPITAL COSTS	**$ 320,715**	

OPERATIONS AND MAINTENANCE (O & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Channel and Reclamation Maintenance, Years 1-5	LS	$ 15,000.00	1	$ 15,000	Engineers Estimate
Channel and Reclamation Maintenance, Years 5-30	LS	$ 5,000.00	1	$ 5,000	Engineers Estimate
			Subtotal	$ 20,000	
			30-YEAR NET PRESENT VALUE ANNUAL O & M COSTS	**$ 143,799**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O & M COSTS) $ 464,514

Value for the EA as a whole is slightly different than value calculated by summing individual sites within the EA due to compounding rounding error.

EA2 COSTS								
INUNDATION	Anaconda Mine (EU 1) Adit Discharge	Carbonate Mine (EU 4) Groundwater	Mike Horse Mine (EU 8) Adit Discharge and Seeps	Paymaster Gulch Groundwater Aquifers	Upper Mike Horse Mine Bedrock Groundwater Aquifer	Capital Mine Adit Plug		TOTAL
Capital Mine Adit Plug	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Subtotal	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Mob/Demob (10%)	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Subtotal	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Contingencies (15%)	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Subtotal	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Project Management (5%)	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Engineering (6%)	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Construction Administration (8%)	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Total, Capital Cost	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Operations and Maintenance (O & M)								
Site Inspection, Maintenance and Repairs, Year 1	$ -	$ -	$ -	$ -	$ -	$ 5,000		$ 5,000
Periodic Repairs - Years 15 and 30	$ -	$ -	$ -	$ -	$ -	$ 5,000		$ 5,000
Total, 30-yr Present Worth, O & M (3%)	$ -	$ -	$ -	$ -	$ -	$ 10,124		$ 10,124
TOTAL CAPITAL COST + O & M	$ -	$ -	$ -	$ -	$ -	$ 10,124		$ 10,124
TOTAL EA2 INUNDATION COSTS WITH 30-YR PRESENT WORTH O & M								**$ 10,124**

EA2 COST ESTIMATE DETAIL
INUNDATION

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Capital Mine Adit Plug					Already in place
			Subtotal	$ -	
Contingencies		15%		$ -	
			Subtotal	$ -	
Project Management		5%		$ -	
Engineering		6%		$ -	
Construction Management		8%		$ -	
TOTAL				$ -	
			TOTAL CAPITAL COSTS	**$ -**	

OPERATIONS AND MAINTENANCE (O & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Site Inspection, Maintenance and Repairs, Year 1	LS	$ 5,000.00	1	$ 5,000	Engineers Estimate
Periodic Repairs - Years 15 and 30	LS	$ 5,000.00	1	$ 5,000	Engineers Estimate
			Subtotal	$ 10,000	
			30-YEAR NET PRESENT VALUE ANNUAL O & M COSTS	**$ 10,124**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O & M COST) $ 10,124

EA 2 COSTS								
ACTIVE TREATMENT - CHEMICAL REAGENT (ALKALINE ADDITION)	**Anaconda Mine (EU 1) Adit Discharge**	**Carbonate Mine (EU 4) Groundwater**	**Mike Horse Mine (EU 8) Adit Discharge and Seeps**	**Paymaster Gulch Groundwater Aquifers**	**Upper Mike Horse Mine Bedrock Groundwater Aquifer**	**Capital Mine Adit Plug**		**TOTAL**
Preliminary Design and Detailed Site Investigations	$ -	$ 158,000	$ -	$ 171,500	$ 277,500	$ -		$ 607,000
Construct Capture and Conveyance System	$ -	$ 719,000	$ -	$ 477,500	$ 591,500	$ -		$ 1,788,000
Expansion of WTP	$ -	$ 420,470	$ -	$ 455,060	$ 727,160	$ -		$ 1,602,690
Subtotal	$ -	$ 1,297,470	$ -	$ 1,104,060	$ 1,596,160	$ -		$ 3,997,690
Mob/Demob (10%)	$ -	$ 129,747	$ -	$ 110,406	$ 159,616	$ -		$ 399,769
Subtotal	$ -	$ 1,427,217	$ -	$ 1,214,466	$ 1,755,776	$ -		$ 4,397,459
Contingencies (15%)	$ -	$ 214,083	$ -	$ 182,170	$ 263,366	$ -		$ 659,619
Subtotal	$ -	$ 1,641,300	$ -	$ 1,396,636	$ 2,019,142	$ -		$ 5,057,078
Project Management (5%)	$ -	$ 82,065	$ -	$ 69,832	$ 100,957	$ -		$ 252,854
Engineering (6%)	$ -	$ 98,478	$ -	$ 83,798	$ 121,149	$ -		$ 303,425
Construction Administration (8%)	$ -	$ 131,304	$ -	$ 111,731	$ 161,531	$ -		$ 404,566
Total, Capital Cost	$ -	$ 1,953,146	$ -	$ 1,661,997	$ 2,402,779	$ -		$ 6,017,923
Operations and Maintenance (O & M)								
Exist WTP Annual Operational Costs	$ 16,662	$ -	$ 223,515	$ -	$ -	$ -		$ 240,178
Incremental Increase in WTP Annual Costs - Carbonate	$ -	$ 62,009	$ -	$ -	$ -	$ -		$ 62,009
Incremental Increase in WTP Annual Costs - Paymaster	$ -	$ -	$ -	$ 67,109	$ -	$ -		$ 67,109
Incremental Increase in WTP Annual Costs - UMH	$ -	$ -	$ -	$ -	$ 107,238	$ -		$ 107,238
Annual Maintenance of Pipelines and Pump Stations	$ -	$ 23,455	$ -	$ 25,384	$ 40,562			$ 89,400
Periodic Replacement of Parts and Equipment - New Collection Systems, Years 15 and 30	$ 10,000	$ 100,326	$ 50,000	$ 68,579	$ 99,295	$ -		$ 328,200
Total, 30-yr Present Worth, O & M (3%)	$ 337,119	$ 1,780,826	$ 4,433,677	$ 1,885,151	$ 3,001,555	$ -		$ 11,438,327
TOTAL CAPITAL COST + O & M	$ 337,119	$ 3,733,973	$ 4,433,677	$ 3,547,147	$ 5,404,334	$ -		$ 17,456,250
TOTAL EA2 ACTIVE TREATMENT CHEMICAL REAGENT COST WITH 30-YR PRESENT WORTH O & M								**$ 17,456,250**

EA2 COST ESTIMATE DETAIL
ACTIVE TREATMENT - CHEMICAL REAGENT (ALKALINE ADDITION)

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Mobilization, Bonding, Insurance	LS	$ 399,769.00	1	$ 399,769	10% of construction cost
Preliminary Design and Detailed Site Investigations					
Anaconda Mine (EU 1) Adit Discharge	LS	$ 1.00	0	$ -	Already in Place
Carbonate Mine (EU 4) Groundwater - Total				$ 158,000	
Detailed Site Characterization at Removal site	LS	$ 23,000.00	1	$ 23,000	Ground based EM (Resistivity) Survey; Subsurface Mapping; Environmental Sampling (Solids and Water - Analysis, Interpreting, and Reporting)
Lab Based Treatability Studies	LS	$ 23,000.00	1	$ 23,000	Batch & Column; Implementation and Reporting
Computer Modeling (CSM)	LS	$ 10,000.00	1	$ 10,000	Hydrological / Hydrogeological; Biogeochemical
Preliminary Engineering Design	LS	$ 17,000.00	1	$ 17,000	Prepare, Review, and Approve; Preliminary Regulatory Compliance / Permitting
Pilot-Scale Testing	LS	$ 85,000.00	1	$ 85,000	Study Design and Documentation; Implementation (Procure, Install and Monitor); Integrated Data Access
Mike Horse Mine (EU 8) Adit Discharge and Seeps	LS	$ 1.00	0	$ -	Already in Place
Paymaster Gulch Groundwater Aquifers - Total				$ 171,500	
Detailed Site Characterization	LS	$ 25,000.00	1	$ 25,000	Ground based EM (Resistivity) Survey; Subsurface Mapping; Environmental Sampling (Solids and Water - Analysis, Interpreting, and Reporting)
Lab Based Treatability Studies	LS	$ 25,000.00	1	$ 25,000	Batch & Column; Implementation and Reporting
Computer Modeling (CSM)	LS	$ 11,000.00	1	$ 11,000	Hydrological / Hydrogeological; Biogeochemical
Preliminary Engineering Design	LS	$ 18,500.00	1	$ 18,500	Prepare, Review, and Approve; Preliminary Regulatory Compliance / Permitting
Pilot-Scale Testing	LS	$ 92,000.00	1	$ 92,000	Study Design and Documentation; Implementation (Procure, Install and Monitor); Integrated Data Access
Upper Mike Horse Mine Bedrock Groundwater Aquifer - Total				$ 277,500	
Detailed Site Characterization	LS	$ 40,000.00	1	$ 40,000	Ground based EM (Resistivity) Survey; Subsurface Mapping; Environmental Sampling (Solids and Water - Analysis, Interpreting, and Reporting)
Lab Based Treatability Studies	LS	$ 40,000.00	1	$ 40,000	Batch & Column; Implementation and reporting
Computer Modeling (CSM)	LS	$ 17,500.00	1	$ 17,500	Hydrological / Hydrogeological; Biogeochemical
Preliminary Engineering Design	LS	$ 30,000.00	1	$ 30,000	Prepare, Review, and Approve; Preliminary Regulatory Compliance / Permitting
Pilot-Scale Testing	LS	$ 150,000.00	1	$ 150,000	Study Design and Documentation; Implementation (Procure, Install and Monitor); Integrated Data Access
Construct Capture and Conveyance System					
Carbonate Mine (EU 4) Groundwater - Total				$ 719,000	
Install Sheet Pile Cutoff	LF	$ 250.00	600	$ 150,000	
Construct Interception Trench	LF	$ 200.00	600	$ 120,000	600 feet x 6 feet x 120 feet
Install Extraction Wells	EA	$ 12,000.00	2	$ 24,000	$100/feet, 120 feet deep
Construct Pumping Station	LS	$ 60,000.00	1	$ 60,000	
Construct Conveyance Pipeline	LF	$ 50.00	7,300	$ 365,000	
Paymaster Gulch Groundwater Aquifers - Total				$ 477,500	
Install Sheet Pile Cutoff	LF	$ 250.00	320	$ 80,000	
Construct Interception Trench	LF	$ 200.00	320	$ 64,000	600 feet x 6 feet x 120 feet
Install Extraction Wells	EA	$ 12,000.00	2	$ 24,000	$100/feet, 120 feet deep
Construct Pumping Station	LS	$ 60,000.00	1	$ 60,000	
Construct Conveyance Pipeline	LF	$ 50.00	4,990	$ 249,500	
Upper Mike Horse Mine Bedrock Groundwater Aquifer - Total				$ 591,500	
Install Sheet Pile Cutoff	LF	$ 250.00	325	$ 81,250	
Construct Interception Trench	LF	$ 200.00	325	$ 65,000	600 feet x 6 feet x 120 feet
Install Extraction Wells	EA	$ 12,000.00	2	$ 24,000	$100/feet, 120 feet deep
Construct Pumping Station	LS	$ 60,000.00	1	$ 60,000	
Construct Conveyance Pipeline	LF	$ 50.00	7,225	$ 361,250	

EA2 COST ESTIMATE DETAIL
ACTIVE TREATMENT - CHEMICAL REAGENT (ALKALINE ADDITION)

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Expansion of WTP - Total				$ 1,602,690	
Carbonate Mine (EU 4) Groundwater	LS	$ 420,470.00	1	$ 420,470	Proportion of 1/2 existing WTP, based on flow
Paymaster Gulch Groundwater Aquifers	LS	$ 455,060.00	1	$ 455,060	Proportion of 1/2 existing WTP, based on flow
Upper Mike Horse Mine Bedrock Groundwater Aquifer	LS	$ 727,160.00	1	$ 727,160	Proportion of 1/2 existing WTP, based on flow
			Subtotal	$ 4,397,459	
Contingencies		15%		$ 659,619	
			Subtotal	$ 5,057,078	
Project Management		5%		$ 252,854	
Engineering		6%		$ 303,425	
Construction Management		8%		$ 404,566	
TOTAL				$ 6,017,923	
			TOTAL CAPITAL COSTS	**$ 6,017,923**	

OPERATIONS AND MAINTENANCE (O & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Exist WTP Annual Operational Costs	LS	$ 240,177.50	1	$ 240,178	2013 WTP Budget - DEQ - Divided in half for using only half of the process
Incremental Increase in WTP Annual Costs - Carbonate	LS	$ 62,009.46	1	$ 62,009	Proportion based on flow rate
Incremental Increase in WTP Annual Costs - Paymaster	LS	$ 67,109.39	1	$ 67,109	Proportion based on flow rate
Incremental Increase in WTP Annual Costs - UMH	LS	$ 107,238.17	1	$ 107,238	Proportion based on flow rate
Annual Maintenance of Pipelines and Pump Stations	LS	$ 89,400.00	1	$ 89,400	5% initial construction
Periodic Replacement of Parts and Equipment - New Collection Systems, Years 15 and 30	LS	$ 268,200.00	1	$ 268,200	15% initial construction
Periodic Replacement of Parts and Equipment - Existing Collection Systems, Years 15 and 30	LS	$ 60,000.00	1	$ 60,000	Engineer Estimate
			Subtotal	$ 894,135	
			30-YEAR NET PRESENT VALUE ANNUAL O & M COSTS	**$ 11,438,439**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O & M COST) $ 17,456,362 Value for the EA as a whole is slightly different than value calculated by summing individual sites within the EA due to compounding rounding error.

EA 2 COSTS								
ACTIVE TREATMENT - PHYSICAL/MECHANICAL (CERAMIC MICROFILTRATION)	**Anaconda Mine (EU 1) Adit Discharge**	**Carbonate Mine (EU 4) Groundwater**	**Mike Horse Mine (EU 8) Adit Discharge and Seeps**	**Paymaster Gulch Groundwater Aquifers**	**Upper Mike Horse Mine Bedrock Groundwater Aquifer**	**Capital Mine Adit Plug**		**TOTAL**
Preliminary Design and Detailed Site Investigations	$ -	$ 158,000	$ -	$ 171,500	$ 277,500	$ -		$ 607,000
Construct Capture and Conveyance System	$ -	$ 719,000	$ -	$ 477,500	$ 591,500	$ -		$ 1,788,000
Expansion of WTP	$ -	$ 420,470	$ -	$ 455,060	$ 727,160	$ -		$ 1,602,690
Subtotal	$ -	$ 1,297,470	$ -	$ 1,104,060	$ 1,596,160	$ -		$ 3,997,690
Mob/Demob (10%)	$ -	$ 129,747	$ -	$ 110,406	$ 159,616	$ -		$ 399,769
Subtotal	$ -	$ 1,427,217	$ -	$ 1,214,466	$ 1,755,776	$ -		$ 4,397,459
Contingencies (15%)	$ -	$ 214,083	$ -	$ 182,170	$ 263,366	$ -		$ 659,619
Subtotal	$ -	$ 1,641,300	$ -	$ 1,396,636	$ 2,019,142	$ -		$ 5,057,078
Project Management (5%)	$ -	$ 82,065	$ -	$ 69,832	$ 100,957	$ -		$ 252,854
Engineering (6%)	$ -	$ 98,478	$ -	$ 83,798	$ 121,149	$ -		$ 303,425
Construction Administration (8%)	$ -	$ 131,304	$ -	$ 111,731	$ 161,531	$ -		$ 404,566
Total, Capital Cost	$ -	$ 1,953,146	$ -	$ 1,661,997	$ 2,402,779	$ -		$ 6,017,923
Operations and Maintenance (O & M)								
Exist WTP Annual Operational Costs	$ 16,662	$ -	$ 223,515	$ -	$ -	$ -		$ 240,178
Incremental Increase in WTP Annual Costs - Carbonate	$ -	$ 62,009	$ -	$ -	$ -	$ -		$ 62,009
Incremental Increase in WTP Annual Costs - Paymaster	$ -	$ -	$ -	$ 67,109	$ -	$ -		$ 67,109
Incremental Increase in WTP Annual Costs - UMH	$ -	$ -	$ -	$ -	$ 107,238	$ -		$ 107,238
Annual Maintenance of pipelines and pump stations	$ -	$ 23,455	$ -	$ 25,384	$ 40,562			$ 89,400
Periodic Replacement of Parts and Equipment - New Collection Systems, Years 15 and 30	$ 10,000	$ 100,326	$ 50,000	$ 68,579	$ 99,295	$ -		$ 328,200
Total, 30-yr Present Worth, O & M (3%)	$ 337,119	$ 1,780,826	$ 4,433,677	$ 1,885,151	$ 3,001,555	$ -		$ 11,438,327
TOTAL CAPITAL COST + O & M	$ 337,119	$ 3,733,973	$ 4,433,677	$ 3,547,147	$ 5,404,334	$ -		$ 17,456,250
TOTAL EA2 ACTIVE TREATMENT PHYSICAL/MECHANICAL COST WITH 30-YR PRESENT WORTH O & M								**$ 17,456,250**

EA2 COST ESTIMATE DETAIL
ACTIVE TREATMENT - PHYSICAL/MECHANICAL (CERAMIC MICROFILTRATION)

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Mobilization, Bonding, Insurance	LS	$ 399,769.00	1	$ 399,769	10% of construction cost
Preliminary Design and Detailed Site Investigations					
Anaconda Mine (EU 1) Adit Discharge	LS	$ 1.00	0	$ -	Already in Place
Carbonate Mine (EU 4) Groundwater - Total				$ 158,000	
Detailed Site Characterization at Removal site	LS	$ 23,000.00	1	$ 23,000	Ground based EM (Resistivity) Survey; Subsurface Mapping; Environmental Sampling (Solids and Water - Analysis, Interpreting, and Reporting)
Lab Based Treatability Studies	LS	$ 23,000.00	1	$ 23,000	Batch & Column; Implementation and reporting
Computer Modeling (CSM)	LS	$ 10,000.00	1	$ 10,000	Hydrological / Hydrogeological; Biogeochemical
Preliminary Engineering Design	LS	$ 17,000.00	1	$ 17,000	Prepare, Review, and Approve; Preliminary Regulatory Compliance / Permitting
Pilot-Scale Testing	LS	$ 85,000.00	1	$ 85,000	Study Design and Documentation; Implementation (Procure, Install and Monitor); Integrated Data Access
Mike Horse Mine (EU 8) Adit Discharge and Seeps	LS	$ 1.00	0	$ -	Already in Place
Paymaster Gulch Groundwater Aquifers - Total				$ 171,500	
Detailed Site Characterization	LS	$ 25,000.00	1	$ 25,000	Ground based EM (Resistivity) Survey; Subsurface Mapping; Environmental Sampling (Solids and Water - Analysis, Interpreting, and Reporting)
Lab Based Treatability Studies	LS	$ 25,000.00	1	$ 25,000	Batch & Column; Implementation and Reporting
Computer Modeling (CSM)	LS	$ 11,000.00	1	$ 11,000	Hydrological / Hydrogeological; Biogeochemical
Preliminary Engineering Design	LS	$ 18,500.00	1	$ 18,500	Prepare, Review, and Approve; Preliminary Regulatory Compliance / Permitting
Pilot-Scale Testing	LS	$ 92,000.00	1	$ 92,000	Study Design and Documentation; Implementation (Procure, Install and Monitor); Integrated Data Access
Upper Mike Horse Mine Bedrock Groundwater Aquifer - Total				$ 277,500	
Detailed Site Characterization	LS	$ 40,000.00	1	$ 40,000	Ground based EM (Resistivity) Survey; Subsurface Mapping; Environmental Sampling (Solids and Water - Analysis, Interpreting, and Reporting)
Lab Based Treatability Studies	LS	$ 40,000.00	1	$ 40,000	Batch & Column; Implementation and Reporting
Computer Modeling (CSM)	LS	$ 17,500.00	1	$ 17,500	Hydrological / Hydrogeological; Biogeochemical
Preliminary Engineering Design	LS	$ 30,000.00	1	$ 30,000	Prepare, Review, and Approve; Preliminary Regulatory Compliance / Permitting
Pilot-Scale Testing	LS	$ 150,000.00	1	$ 150,000	Study Design and Documentation; Implementation (Procure, Install and Monitor); Integrated Data Access
Construct Capture and Conveyance System					
Carbonate Mine (EU 4) Groundwater - Total				$ 719,000	
Install Sheet Pile Cutoff	LF	$ 250.00	600	$ 150,000	
Construct Interception Trench	LF	$ 200.00	600	$ 120,000	600 feet x 6 feet x 120 feet
Install Extraction Wells	EA	$ 12,000.00	2	$ 24,000	$100/feet, 120 feet deep
Construct Pumping Station	LS	$ 60,000.00	1	$ 60,000	
Construct Conveyance Pipeline	LF	$ 50.00	7,300	$ 365,000	
Paymaster Gulch Groundwater Aquifers - Total				$ 477,500	
Install Sheet Pile Cutoff	LF	$ 250.00	320	$ 80,000	
Construct Interception Trench	LF	$ 200.00	320	$ 64,000	600 feet x 6 feet x 120 feet
Install Extraction Wells	EA	$ 12,000.00	2	$ 24,000	$100/feet, 120 feet deep
Construct Pumping Station	LS	$ 60,000.00	1	$ 60,000	
Construct Conveyance Pipeline	LF	$ 50.00	4,990	$ 249,500	
Upper Mike Horse Mine Bedrock Groundwater Aquifer - Total				$ 591,500	
Install Sheet Pile Cutoff	LF	$ 250.00	325	$ 81,250	
Construct Interception Trench	LF	$ 200.00	325	$ 65,000	600 feet x 6 feet x 120 feet
Install Extraction Wells	EA	$ 12,000.00	2	$ 24,000	$100/feet, 120 feet deep
Construct Pumping Station	LS	$ 60,000.00	1	$ 60,000	
Construct Conveyance Pipeline	LF	$ 50.00	7,225	$ 361,250	

EA2 COST ESTIMATE DETAIL
ACTIVE TREATMENT - PHYSICAL/MECHANICAL (CERAMIC MICROFILTRATION)

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Expansion of WTP		$ 1,602,690.00		$ 1,602,690	
Carbonate Mine (EU 4) Groundwater	LS	$ 420,470.00	1	$ 420,470	Proportion of 1/2 existing WTP, based on flow
Paymaster Gulch Groundwater Aquifers	LS	$ 455,060.00	1	$ 455,060	Proportion of 1/2 existing WTP, based on flow
Upper Mike Horse Mine Bedrock Groundwater Aquifer	LS	$ 727,160.00	1	$ 727,160	Proportion of 1/2 existing WTP, based on flow
			Subtotal	$ 4,397,459	
Contingencies		15%		$ 659,619	
			Subtotal	$ 5,057,078	
Project Management		5%		$ 252,854	
Engineering		6%		$ 303,425	
Construction Management		8%		$ 404,566	
TOTAL				$ 6,017,923	
			TOTAL CAPITAL COSTS	**$ 6,017,923**	

OPERATIONS AND MAINTENANCE (O & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Exist WTP Annual Operational Costs	LS	$ 240,177.50	1	$ 240,178	2013 WTP Budget - DEQ - Divided in half for using only half of the process
Incremental Increase in WTP Annual Costs - Carbonate	LS	$ 62,009.46	1	$ 62,009	Proportion based on flow rate
Incremental Increase in WTP Annual Costs - Paymaster	LS	$ 67,109.39	1	$ 67,109	Proportion based on flow rate
Incremental Increase in WTP Annual Costs - UMH	LS	$ 107,238.17	1	$ 107,238	Proportion based on flow rate
Annual Maintenance of pipelines and pump stations	LS	$ 89,400.00	1	$ 89,400	5% initial construction
Periodic Replacement of Parts and Equipment - New Collection Systems, Years 15 and 30	LS	$ 268,200.00	1	$ 268,200	15% initial construction
Periodic Replacement of Parts and Equipment - Existing Collection Systems, Years 15 and 30	LS	$ 60,000.00	1	$ 60,000	Engineer Estimate
			Subtotal	$ 894,135	
			30-YEAR NET PRESENT VALUE ANNUAL O & M COSTS	**$ 11,438,439**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O & M COST) $ 17,456,362 Value for the EA as a whole is slightly different than value calculated by summing individual sites within the EA due to compounding rounding error.

EA 2 COSTS								
PASSIVE TREATMENT (PRB)	**Anaconda Mine (EU 1) Adit Discharge**	**Carbonate Mine (EU 4) Groundwater**	**Mike Horse Mine (EU 8) Adit Discharge and Seeps**	**Paymaster Gulch Groundwater Aquifers**	**Upper Mike Horse Mine Bedrock Groundwater Aquifer**	**Capital Mine Adit Plug**		**TOTAL**
Preliminary Design and Detailed Site Investigations	$ 128,000	$ 158,000	$ 205,000	$ 158,000	$ -	$ -		$ 649,000
Construct PRB Reactor	$ 78,000	$ 225,000	$ 871,500	$ 42,720	$ -	$ -		$ 1,217,220
Subtotal	$ 206,000	$ 383,000	$ 1,076,500	$ 200,720	$ -	$ -		$ 1,866,220
Mob/Demob (10%)	$ 20,600	$ 38,300	$ 107,650	$ 20,072	$ -	$ -		$ 186,622
Subtotal	$ 226,600	$ 421,300	$ 1,184,150	$ 220,792	$ -	$ -		$ 2,052,842
Contingencies (15%)	$ 33,990	$ 63,195	$ 177,623	$ 33,119	$ -	$ -		$ 307,926
Subtotal	$ 260,590	$ 484,495	$ 1,361,773	$ 253,911	$ -	$ -		$ 2,360,768
Project Management (5%)	$ 13,030	$ 24,225	$ 68,089	$ 12,696	$ -	$ -		$ 118,038
Engineering (6%)	$ 15,635	$ 29,070	$ 81,706	$ 15,235	$ -	$ -		$ 141,646
Construction Administration (8%)	$ 20,847	$ 38,760	$ 108,942	$ 20,313	$ -	$ -		$ 188,861
Total, Capital Cost	$ 310,102	$ 576,549	$ 1,620,509	$ 302,154	$ -	$ -		$ 2,809,314
Operations and Maintenance (O & M)								
Environmental and System Performance Monitoring	$ 13,000	$ 13,000	$ 13,000	$ 13,000	$ -	$ -		$ 52,000
Barrier Replacement	$ 28,000	$ 34,000	$ 40,000	$ 34,000	$ -	$ -		$ 136,000
Water Disposal/Onsite	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ -	$ -		$ 8,000
Misc. Support and Administrative	$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ -	$ -		$ 60,000
Total, 30-yr Present Worth, O & M (3%)	$ 1,136,826	$ 1,254,428	$ 1,372,031	$ 1,254,428	$ -	$ -		$ 5,017,713
TOTAL CAPITAL COST + O & M	$ 1,446,928	$ 1,830,977	$ 2,992,540	$ 1,556,582	$ -	$ -		$ 7,827,027
TOTAL EA2 COST WITH 30-YR PRESENT WORTH O & M								**$ 7,827,027**

EA2 COST ESTIMATE DETAIL
PASSIVE TREATMENT - CHEMICAL REAGENT (PRB)

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Mobilization, Bonding, Insurance	LS	$ 186,622.00	1	$ 186,622	10% of construction cost
Preliminary Design and Detailed Site Investigations					
Anaconda Mine (EU 1) Adit Discharge - Total				$ 128,000	
Detailed Site Characterization	LS	$ 20,000.00	1	$ 20,000	Ground based EM (Resistivity) Survey; Subsurface Mapping; Environmental Sampling (Solids and Water - Analysis, Interpreting, and Reporting)
Lab Based Treatability Studies	LS	$ 20,000.00	1	$ 20,000	Batch & Column; Implementation andReporting
Computer Modeling (CSM)	LS	$ 8,000.00	1	$ 8,000	Hydrological / Hydrogeological; Biogeochemical
Preliminary Engineering Design	LS	$ 15,000.00	1	$ 15,000	Prepare, Review, and Approve; Preliminary Regulatory Compliance / Permitting
Pilot-Scale Testing	LS	$ 65,000.00	1	$ 65,000	Study Design and Documentation; Implementation (Procure, Install and Monitor); Integrated Data Access
Carbonate Mine (EU 4) Groundwater - Total				$ 158,000	
Detailed Site Characterization at Removal site	LS	$ 23,000.00	1	$ 23,000	Ground based EM (Resistivity) Survey; Subsurface Mapping; Environmental Sampling (Solids and Water - Analysis, Interpreting, and Reporting)
Lab Based Treatability Studies	LS	$ 23,000.00	1	$ 23,000	Batch & Column; Implementation and Reporting
Computer Modeling (CSM)	LS	$ 10,000.00	1	$ 10,000	Hydrological / Hydrogeological; Biogeochemical
Preliminary Engineering Design	LS	$ 17,000.00	1	$ 17,000	Prepare, Review, and Approve; Preliminary Regulatory Compliance / Permitting
Pilot-Scale Testing	LS	$ 85,000.00	1	$ 85,000	Study Design and Documentation; Implementation (Procure, Install and Monitor); Integrated Data Access
Mike Horse Mine (EU 8) Adit Discharge and Seeps - Total				$ 205,000	
Detailed Site Characterization	LS	$ 35,000.00	1	$ 35,000	Ground based EM (Resistivity) Survey; Subsurface Mapping; Environmental Sampling (Solids and Water - Analysis, Interpreting, and Reporting)
Lab Based Treatability Studies	LS	$ 35,000.00	1	$ 35,000	Batch & Column; Implementation and reporting
Computer Modeling (CSM)	LS	$ 15,000.00	1	$ 15,000	Hydrological / Hydrogeological; Biogeochemical
Preliminary Engineering Design	LS	$ 25,000.00	1	$ 25,000	Prepare, Review, and Approve; Preliminary Regulatory Compliance / Permitting
Pilot-Scale Testing	LS	$ 95,000.00	1	$ 95,000	Study Design and Documentation; Implementation (Procure, Install and Monitor); Integrated Data Access
Paymaster Gulch Alluvial Aquifer - Total				$ 158,000	
Detailed Site Characterization	LS	$ 23,000.00	1	$ 23,000	Ground based EM (Resistivity) Survey; Subsurface Mapping; Environmental Sampling (Solids and Water - Analysis, Interpreting, and Reporting)
Lab Based Treatability Studies	LS	$ 23,000.00	1	$ 23,000	Batch & Column; Implementation and reporting
Computer Modeling (CSM)	LS	$ 10,000.00	1	$ 10,000	Hydrological / Hydrogeological; Biogeochemical
Preliminary Engineering Design	LS	$ 17,000.00	1	$ 17,000	Prepare, Review, and Approve; Preliminary Regulatory Compliance / Permitting
Pilot-Scale Testing	LS	$ 85,000.00	1	$ 85,000	Study Design and Documentation; Implementation (Procure, Install and Monitor); Integrated Data Access

EA2 COST ESTIMATE DETAIL
PASSIVE TREATMENT - CHEMICAL REAGENT (PRB)

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Construct PRB Reactor					
Anaconda Mine (EU 1) Adit Discharge					
Installation	LS	$ 78,000.00	1	$ 78,000	Using Biopolymer Trenching; Continuous Wall Option or Funnel and Gate Option
Carbonate Mine (EU 4) Groundwater					
Installation	LS	$ 225,000.00	1	$ 225,000	Using Biopolymer Trenching; Continuous Wall Option or Funnel and Gate Option
Mike Horse Mine (EU 8) Adit Discharge and Seeps					
Installation	LS	$ 871,500.00	1	$ 871,500	Using Biopolymer Trenching; Continuous Wall Option or Funnel and Gate Option
Paymaster Gulch Alluvial Aquifer					
Installation	LS	$ 42,720.00	1	$ 42,720	Using Biopolymer Trenching; Continuous Wall Option or Funnel and Gate Option
			Subtotal	$ 2,052,842	
Contingencies		15%		$ 307,926	
			Subtotal	$ 2,360,768	
Project Management		5%		$ 118,038	
Engineering		6%		$ 141,646	
Construction Management		8%		$ 188,861	
TOTAL				$ 2,809,314	
			TOTAL CAPITAL COSTS	**$ 2,809,314**	

OPERATIONS AND MAINTENANCE (O & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Environmental and System Performance Monitoring	LS	$ 52,000.00	1	$ 52,000	$13,000 each
Barrier Replacement	LS	$ 136,000.00	1	$ 136,000	$34,000 each
Water Disposal/Onsite	LS	$ 8,000.00	1	$ 8,000	$2,000 each
Misc. Support and Administrative	LS	$ 60,000.00	1	$ 60,000	$15,000 each
			Subtotal	$ 256,000	
			30-YEAR NET PRESENT VALUE ANNUAL O & M COSTS	**$ 5,017,713**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O & M COST) $ 7,827,027

EA 2 QUANTITY ESTIMATES								
	Distance to WTP	Length Cutoff Wall	Depth Cutoff Wall	Flow Rate to Treat				
		(FT)		(GPM)				
Anaconda Mine (EU 1) Adit Discharge	0	0	0	4.1				
Carbonate Mine (EU 4) Groundwater	7,300	600	120	14.2				
Mike Horse Mine (EU 8) Adit Discharge and Seeps	0	0	0	55.0				
Paymaster Gulch Groundwater Aquifers	4,990	320	120	15.4				
Upper Mike Horse Mine Bedrock Groundwater Aquifer	7,225	325	120	24.6				
Capital Mine Adit Plug	0	0	0	0.0				
	19,515	1,245	360	113				
Assumed flows	**K**	**i***	**Depth**	**Width**	**A**	**Flow**		Notes
	(ft/day)	(ft/ft)	(ft)	(ft)	(sf)	FT^3/day	gpm	
Mike Horse Bedrock	10	0.015	100	325	32500	4727.273	24.56	Textbook Value for K for fractured bedrock; gradient taken as 1/10th the ground slope; depth = upper 100'; Width = width of valley
Paymaster Alluvial Aquifer	3.8	0.0079	45	320	14400	432	2.24	K= that for LCMW-1 in RI; gradient taken as 1/10th the ground slope; Depth based on Well Log PMGW-120; Width = width of valley
Paymaster Bedrock Aquifer	10	0.0079	100	320	32000	2526.316	13.12	Textbook Value for K for fractured bedrock; gradient taken as 1/10th the ground slope; depth = upper 100'; Width = width of valley
Current Treatment Plant Flow	59	gpm						
Current Treatment Plant Construction Cost	$ 3,500,000	estimate from DEQ						
For Partial Treatment (Chemical Reagent or Microfiltration), assume the cost to expand the treatment plant would be approximately 1/2 this cost because of potential building addition.	$ 1,750,000							Use this cost for individual sites, proportioned by flow rate.

EVALUATION AREA	SITE-WIDE ELEMENTS			REMEDIAL ALTERNATIVE COSTS													
EA 3				No Action	PHYSICAL HAZARDS/SOLID MEDIA							SURFACE WATER					
Surface Water and Sediment					Monitored Natural Recovery	ENGINEERING CONTROLS/LAND DISPOSAL				TREATMENT		ENGINEERING CONTROLS			TREATMENT		
										In-situ	Ex-situ				Active		Passive
	ICs	Access Restrictions	Long-term Monitoring and Maintenance			Physical Barriers	Containment	Removal and On-site Disposal	Removal and Off-site Disposal	Neutralization W/Alkaline Amendment	Neutralization W/Alkaline Amendment	Containment (Retention Pond)	Hydrologic and Hydraulic Control	Inundation	Chemical Reagent	Physical/ Mechanical	Chemical Reagent
Blackfoot River (EU13)	$0.00	$0.00	$0.00	$0.00	$545,031	N/A	N/A	$5,405,401	$5,676,601	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stevens Creek	$0.00	$0.00	$0.00	$0.00	$436,025	N/A	N/A	$592,804	$601,184	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Porcupine Creek	$0.00	$0.00	$0.00	$0.00	$272,516	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Paymaster Creek	$0.00	$0.00	$0.00	$0.00	$436,025	N/A	N/A	$99,483	$99,940	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Shave Creek	$0.00	$0.00	$0.00	$0.00	$311,446	N/A	N/A	$104,903	$105,360	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Unnamed Tributary above WTP	$0.00	$0.00	$0.00	$0.00	$179,082	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mine Feature BR-01 Discharge Seep, or Spring	$0.00	$5,796	$6,928	$0.00	$0.00	N/A	N/A	N/A	N/A	N/A	N/A	$66,264	N/A	N/A	N/A	N/A	N/A
Mine Feature BR-14 Discharge Seep, or Spring	$0.00	$5,796	$6,928	$0.00	$0.00	N/A	N/A	N/A	N/A	N/A	N/A	$123,166	N/A	N/A	N/A	N/A	N/A
Mine Feature PBBS Discharge Seep, or Spring	$0.00	$5,796	$6,928	$0.00	$0.00	N/A	N/A	$94,981	$95,743	N/A	N/A	$98,779	N/A	N/A	N/A	N/A	N/A
Mine Feature PC-11 Discharge Seep, or Spring	$0.00	$5,796	$6,928	$0.00	$0.00	N/A	N/A	N/A	N/A	N/A	N/A	$55,425	N/A	N/A	N/A	N/A	N/A
Mine Feature PC-22 Discharge Seep, or Spring	$0.00	$5,796	$6,928	$0.00	$0.00	N/A	N/A	N/A	N/A	N/A	N/A	$47,297	N/A	N/A	N/A	N/A	N/A
Mine Feature SH-43 Discharge Seep, or Spring	$0.00	$5,796	$6,928	$0.00	$0.00	N/A	N/A	$29,046	$29,504	N/A	N/A	$52,716	N/A	N/A	N/A	N/A	N/A
Mine Feature SG-55 Discharge Seep, or Spring	$0.00	$5,796	$6,928	$0.00	$0.00	N/A	N/A	N/A	N/A	N/A	N/A	$220,713	N/A	N/A	N/A	N/A	N/A
Mine Feature SG-71 Discharge Seep, or Spring	$0.00	$5,796	$6,928	$0.00	$0.00	N/A	N/A	N/A	N/A	N/A	N/A	$98,779	N/A	N/A	N/A	N/A	N/A
Mine Feature SG-94 Discharge Seep, or Spring	$0.00	$5,796	$6,928	$0.00	$0.00	N/A	N/A	$34,466	$34,923	N/A	N/A	$58,135	N/A	N/A	N/A	N/A	N/A
Mine Feature SG-98 Discharge Seep, or Spring	$0.00	$5,796	$6,928	$0.00	$0.00	N/A	N/A	N/A	N/A	N/A	N/A	$253,228	N/A	N/A	N/A	N/A	N/A
Historic Paymaster Adit Discharge	$0.00	$5,796	$6,928	$0.00	$0.00	N/A	N/A	N/A	N/A	N/A	N/A	$41,877	N/A	N/A	N/A	N/A	N/A
TOTAL COSTS	**$0**	**$63,752**	**$76,209**	**$0**	**$2,180,125**	**$0**	**$0**	**$6,361,084**	**$6,643,253**	**$0**	**$0**	**$1,116,380**	**$0**	**$0**	**$0**	**$0**	**$0**

EA 3 COSTS													
SITE-WIDE ELEMENTS	**Mine Feature BR-01 Discharge Seep, or Spring**	**Mine Feature BR-14 Discharge Seep, or Spring**	**Mine Feature PBBS Discharge Seep, or Spring**	**Mine Feature PC-11 Discharge Seep, or Spring**	**Mine Feature PC-22 Discharge Seep, or Spring**	**Mine Feature SH-43 Discharge Seep, or Spring**	**Mine Feature SG-55 Discharge Seep, or Spring**	**Mine Feature SG-71 Discharge Seep, or Spring**	**Mine Feature SG-94 Discharge Seep, or Spring**	**Mine Feature SG-98 Discharge Seep, or Spring**	**Historic Paymaster Adit Discharge**		**TOTAL**
Institutional Controls	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
Access Restrictions													
Construct Fence	$ 2,200	$ 2,200	$ 2,200	$ 2,200	$ 2,200	$ 2,200	$ 2,200	$ 2,200	$ 2,200	$ 2,200	$ 2,200		**$ 24,200**
Install Gates	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500		**$ 16,500**
Install Warning Signs	$ 150	$ 150	$ 150	$ 150	$ 150	$ 150	$ 150	$ 150	$ 150	$ 150	$ 150		**$ 1,650**
Subtotal	$ 3,850	$ 3,850	$ 3,850	$ 3,850	$ 3,850	$ 3,850	$ 3,850	$ 3,850	$ 3,850	$ 3,850	$ 3,850		**$ 42,350**
Mob/Demob (10%)	$ 385	$ 385	$ 385	$ 385	$ 385	$ 385	$ 385	$ 385	$ 385	$ 385	$ 385		**$ 4,235**
Subtotal	$ 4,235	$ 4,235	$ 4,235	$ 4,235	$ 4,235	$ 4,235	$ 4,235	$ 4,235	$ 4,235	$ 4,235	$ 4,235		**$ 46,585**
Contingencies (15%)	$ 635	$ 635	$ 635	$ 635	$ 635	$ 635	$ 635	$ 635	$ 635	$ 635	$ 635		**$ 6,988**
Subtotal	$ 4,870	$ 4,870	$ 4,870	$ 4,870	$ 4,870	$ 4,870	$ 4,870	$ 4,870	$ 4,870	$ 4,870	$ 4,870		**$ 53,573**
Project Management (5%)	$ 244	$ 244	$ 244	$ 244	$ 244	$ 244	$ 244	$ 244	$ 244	$ 244	$ 244		**$ 2,679**
Engineering (6%)	$ 292	$ 292	$ 292	$ 292	$ 292	$ 292	$ 292	$ 292	$ 292	$ 292	$ 292		**$ 3,214**
Construction Administration (8%)	$ 390	$ 390	$ 390	$ 390	$ 390	$ 390	$ 390	$ 390	$ 390	$ 390	$ 390		**$ 4,286**
Total, Access Restrictions	$ 5,796	$ 5,796	$ 5,796	$ 5,796	$ 5,796	$ 5,796	$ 5,796	$ 5,796	$ 5,796	$ 5,796	$ 5,796		**$ 63,752**
Long-term Monitoring and Maintenance													
Site Security, Fence and Sign Maintenance, Years 1-30 (Annual)	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250	$ 250		**$ 2,750**
Periodic Replacement - Years 15 and 30	$ 1,925	$ 1,925	$ 1,925	$ 1,925	$ 1,925	$ 1,925	$ 1,925	$ 1,925	$ 1,925	$ 1,925	$ 1,925		**$ 21,175**
Total, 30-yr Present Worth, Long-term M&M (3%)	$ 6,928	$ 6,928	$ 6,928	$ 6,928	$ 6,928	$ 6,928	$ 6,928	$ 6,928	$ 6,928	$ 6,928	$ 6,928		**$ 76,209**
TOTAL ACCESS RESTRICTIONS + LONG-TERM M&M	$ 12,724	$ 12,724	$ 12,724	$ 12,724	$ 12,724	$ 12,724	$ 12,724	$ 12,724	$ 12,724	$ 12,724	$ 12,724		**$ 139,961**
TOTAL SITE-WIDE ELEMENTS COSTS WITH 30-YR PRESENT WORTH LONG-TERM M&M													**$ 139,961**

EA3 COST ESTIMATE DETAIL
SITE-WIDE ELEMENTS

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Mobilization, Bonding, Insurance	LS	$ 4,235.00	1	$ 4,235	10% of construction cost
Install Farm Fence - Total	LF	$ 5.50	4,400	$ 24,200	Based on Bald Butte/Great Divide
Mine Feature BR-01 Discharge Seep, or Spring	LF	$ 5.50	400	$ 2,200	
Mine Feature BR-14 Discharge Seep, or Spring	LF	$ 5.50	400	$ 2,200	
Mine Feature PBBS Discharge Seep, or Spring	LF	$ 5.50	400	$ 2,200	
Mine Feature PC-11 Discharge Seep, or Spring	LF	$ 5.50	400	$ 2,200	
Mine Feature PC-22 Discharge Seep, or Spring	LF	$ 5.50	400	$ 2,200	
Mine Feature SH-43 Discharge Seep, or Spring	LF	$ 5.50	400	$ 2,200	
Mine Feature SG-55 Discharge Seep, or Spring	LF	$ 5.50	400	$ 2,200	
Mine Feature SG-71 Discharge Seep, or Spring	LF	$ 5.50	400	$ 2,200	
Mine Feature SG-94 Discharge Seep, or Spring	LF	$ 5.50	400	$ 2,200	
Mine Feature SG-98 Discharge Seep, or Spring	LF	$ 5.50	400	$ 2,200	
Historic Paymaster Adit Discharge	LF	$ 5.50	400	$ 2,200	
Metal Security Gate - Total	EA	$ 1,500.00	11	$ 16,500	Based on Section 35 Bid Tabs
Mine Feature BR-01 Discharge Seep, or Spring	EA	$ 1,500.00	1	$ 1,500	
Mine Feature BR-14 Discharge Seep, or Spring	EA	$ 1,500.00	1	$ 1,500	
Mine Feature PBBS Discharge Seep, or Spring	EA	$ 1,500.00	1	$ 1,500	
Mine Feature PC-11 Discharge Seep, or Spring	EA	$ 1,500.00	1	$ 1,500	
Mine Feature PC-22 Discharge Seep, or Spring	EA	$ 1,500.00	1	$ 1,500	
Mine Feature SH-43 Discharge Seep, or Spring	EA	$ 1,500.00	1	$ 1,500	
Mine Feature SG-55 Discharge Seep, or Spring	EA	$ 1,500.00	1	$ 1,500	
Mine Feature SG-71 Discharge Seep, or Spring	EA	$ 1,500.00	1	$ 1,500	
Mine Feature SG-94 Discharge Seep, or Spring	EA	$ 1,500.00	1	$ 1,500	
Mine Feature SG-98 Discharge Seep, or Spring	EA	$ 1,500.00	1	$ 1,500	
Historic Paymaster Adit Discharge	EA	$ 1,500.00	1	$ 1,500	
Metal Warning Signs - Total	EA	$ 150.00	11	$ 1,650	Engineer Estimate
Mine Feature BR-01 Discharge Seep, or Spring	EA	$ 150.00	1	$ 150	
Mine Feature BR-14 Discharge Seep, or Spring	EA	$ 150.00	1	$ 150	
Mine Feature PBBS Discharge Seep, or Spring	EA	$ 150.00	1	$ 150	
Mine Feature PC-11 Discharge Seep, or Spring	EA	$ 150.00	1	$ 150	
Mine Feature PC-22 Discharge Seep, or Spring	EA	$ 150.00	1	$ 150	
Mine Feature SH-43 Discharge Seep, or Spring	EA	$ 150.00	1	$ 150	
Mine Feature SG-55 Discharge Seep, or Spring	EA	$ 150.00	1	$ 150	
Mine Feature SG-71 Discharge Seep, or Spring	EA	$ 150.00	1	$ 150	
Mine Feature SG-94 Discharge Seep, or Spring	EA	$ 150.00	1	$ 150	
Mine Feature SG-98 Discharge Seep, or Spring	EA	$ 150.00	1	$ 150	
Historic Paymaster Adit Discharge	EA	$ 150.00	1	$ 150	
			Subtotal	$ 46,585	
Contingencies		15%		$ 6,988	
			Subtotal	$ 53,573	
Project Management		5%		$ 2,679	
Engineering		6%		$ 3,214	
Construction Management		8%		$ 4,286	
TOTAL				$ 63,752	
			TOTAL CAPITAL COSTS	**$ 63,752**	

LONG-TERM MONITORING AND MAINTENANCE (M & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Site Security, Fence and Sign Maintenance, Years 1-30	LS	$ 2,750.00	1	$ 2,750	Engineers Estimate
Periodic Replacement - Years 15 and 30	LS	$ 21,175.00	1	$ 21,175	1/2 of fence replaced
			Subtotal	**$ 23,925**	
	30-YEAR NET PRESENT VALUE ANNUAL M&M COSTS			**$ 76,216**	**Discounted using the rate below**

3% Assumed Discount Rate

Value for the EA as a whole is slightly different than value calculated by summing individual sites within the EA due to compounding rounding error.

30-YEAR PRESENT VALUE (CAPITAL + M&M COST) $ 139,968

EA 3 COSTS								
MONITORED NATURAL RECOVERY	**Blackfoot River (EU13)**	**Stevens Creek**	**Porcupine Creek**	**Paymaster Creek**	**Shave Creek**	**Unnamed Tributary above WTP**		**TOTAL**
Subtotal	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Mob/Demob (10%)	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Subtotal	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Contingencies (15%)	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Subtotal	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Project Management (5%)	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Engineering (6%)	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Construction Administration (8%)	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Total, Capital Cost	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Operations and Maintenance (O& M)								
Semiannual Surface Water, Sediment Sampling, Analysis and Reporting, Years 1-10	$ 38,750	$ 31,000	$ 19,375	$ 31,000	$ 22,143	$ 12,732		$ 155,000
Annual Monitoring Years 11-30	$ 19,375	$ 15,500	$ 9,688	$ 15,500	$ 11,071	$ 6,366		$ 77,500
Total, 30-yr Present Worth, O & M (3%)	$ 545,031	$ 436,025	$ 272,516	$ 436,025	$ 311,446	$ 179,082		$ 2,180,125
TOTAL CAPITAL COST + O & M	$ 545,031	$ 436,025	$ 272,516	$ 436,025	$ 311,446	$ 179,082		$ 2,180,125
TOTAL EA3 MNR COSTS WITH 30-YR PRESENT WORTH O & M								**$ 2,180,125**

EA3 COST ESTIMATE DETAIL
MONITORED NATURAL RECOVERY

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
			Subtotal	$ -	
Contingencies		15%		$ -	
			Subtotal	$ -	
Project Management		5%		$ -	
Engineering		6%		$ -	
Construction Management		8%		$ -	
TOTAL				$ -	
			TOTAL CAPITAL COSTS	**$ -**	

MONITORING AND MAINTENANCE (M & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Semiannual Surface Water, Sediment Sampling, Analysis and Reporting, Years 1-10	LS	$155,000.00	1	$ 155,000	Based on current costs and increased to account for add'l stations and semiannual monitoring
Annual Monitoring Years 11-30	LS	$77,500.00	1	$ 77,500	
			Subtotal	$ 232,500	
			30-YEAR NET PRESENT VALUE ANNUAL O & M COSTS	**$ 2,180,125**	**Discounted using the rate below**

				3%	Assumed Discount Rate
			30-YEAR PRESENT VALUE (ICS + ACCESS RESTRICTIONS + O & M COSTS)	**$ 2,180,125**	
Surface Water and Sediment Monitoring	EA	$75,000.00	2	$150,000.00	Existing Annual Budget is ~$65K for SW/Sed. Add locations at Stevens, Shave.Porcupine, Unnamed Trib and make this semiannual (high + low flow)
Analysis and Report	EA	$5,000	1	$5,000.00	
			Annual Cost	$155,000.00	

EA 3 COSTS																			
REMOVAL AND ON-SITE DISPOSAL	**Blackfoot River (EU13)**	**Stevens Creek**	**Porcupine Creek**	**Paymaster Creek**	**Shave Creek**	**Unnamed Tributary above WTP**	**Mine Feature BR-01 Discharge Seep, or Spring**	**Mine Feature BR-14 Discharge Seep, or Spring**	**Mine Feature PBBS Discharge Seep, or Spring**	**Mine Feature PC-11 Discharge Seep, or Spring**	**Mine Feature PC-22 Discharge Seep, or Spring**	**Mine Feature SH-43 Discharge Seep, or Spring**	**Mine Feature SG-55 Discharge Seep, or Spring**	**Mine Feature SG-71 Discharge Seep, or Spring**	**Mine Feature SG-94 Discharge Seep, or Spring**	**Mine Feature SG-98 Discharge Seep, or Spring**	**Historic Paymaster Adit Discharge**		**TOTAL**
Floodplain Survey	$ 15,000	$ 5,000	$ -	$ 2,500	$ 2,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ 25,000
Sampling and Analysis Plan	$ 40,000	$ 10,000	$ -	$ 5,000	$ 5,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ 60,000
Surface Water and Sediment Control	$ 200,000	$ 10,000	$ -	$ 5,000	$ 5,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ 220,000
Dewatering	$ 44,500	$ 1,375	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ 45,875
Improve/Construct Access Roads	$ 370,620	$ 32,400	$ -	$ -	$ 3,600	$ -	$ -	$ -	$ 37,800	$ -	$ -	$ 7,200	$ -	$ -	$ 10,800	$ -	$ -		$ 462,420
Excavate, Load, Haul and Place Waste in Repository	$ 267,000	$ 11,000	$ -	$ 450	$ 450	$ -	$ -	$ -	$ 1,250	$ -	$ -	$ 750	$ -	$ -	$ 750	$ -	$ -		$ 281,650
Load, Haul, Place Stream Substrate	$ 445,000	$ 16,500	$ -	$ 750	$ 750	$ -	$ -	$ -	$ 1,750	$ -	$ -	$ 1,050	$ -	$ -	$ 1,050	$ -	$ -		$ 466,850
Reconstruct Stream	$ 2,059,200	$ 252,000	$ -	$ 24,000	$ 24,000	$ -	$ -	$ -	$ 12,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ 2,371,200
Seed, Fertilize, Mulch	$ 13,791	$ 1,250	$ -	$ 1,250	$ 1,250	$ -	$ -	$ -	$ 1,250	$ -	$ -	$ 1,250	$ -	$ -	$ 1,250	$ -	$ -		$ 21,291
Subtotal	$ 3,455,111	$ 339,525	$ -	$ 38,950	$ 42,550	$ -	$ -	$ -	$ 54,050	$ -	$ -	$ 10,250	$ -	$ -	$ 13,850	$ -	$ -		$ 3,954,286
Mob/Demob (10%)	$ 345,511	$ 33,953	$ -	$ 3,895	$ 4,255	$ -	$ -	$ -	$ 5,405	$ -	$ -	$ 1,025	$ -	$ -	$ 1,385	$ -	$ -		$ 395,429
Subtotal	$ 3,800,622	$ 373,478	$ -	$ 42,845	$ 46,805	$ -	$ -	$ -	$ 59,455	$ -	$ -	$ 11,275	$ -	$ -	$ 15,235	$ -	$ -		$ 4,349,715
Contingencies (15%)	$ 570,093	$ 56,022	$ -	$ 6,427	$ 7,021	$ -	$ -	$ -	$ 8,918	$ -	$ -	$ 1,691	$ -	$ -	$ 2,285	$ -	$ -		$ 652,457
Subtotal	$ 4,370,716	$ 429,499	$ -	$ 49,272	$ 53,826	$ -	$ -	$ -	$ 68,373	$ -	$ -	$ 12,966	$ -	$ -	$ 17,520	$ -	$ -		$ 5,002,172
Project Management (5%)	$ 218,536	$ 21,475	$ -	$ 2,464	$ 2,691	$ -	$ -	$ -	$ 3,419	$ -	$ -	$ 648	$ -	$ -	$ 876	$ -	$ -		$ 250,109
Engineering (6%)	$ 262,243	$ 25,770	$ -	$ 2,956	$ 3,230	$ -	$ -	$ -	$ 4,102	$ -	$ -	$ 778	$ -	$ -	$ 1,051	$ -	$ -		$ 300,130
Construction Administration (8%)	$ 349,657	$ 34,360	$ -	$ 3,942	$ 4,306	$ -	$ -	$ -	$ 5,470	$ -	$ -	$ 1,037	$ -	$ -	$ 1,402	$ -	$ -		$ 400,174
Total, Capital Cost	$ 5,201,152	$ 511,104	$ -	$ 58,633	$ 64,053	$ -	$ -	$ -	$ 81,364	$ -	$ -	$ 15,430	$ -	$ -	$ 20,849	$ -	$ -		$ 5,952,585
Operations and Maintenance (O & M)																			
Site Inspections, Vegetation Maintenance and Repairs, Years 1-5	$ 20,000	$ 8,000	$ -	$ 4,000	$ 4,000	$ -	$ -	$ -	$ 1,333	$ -	$ -	$ 1,333	$ -	$ -	$ 1,333	$ -	$ -		$ 40,000
Site Inspections, Vegetation Maintenance and Repairs, Years 6-30	$ 7,500	$ 3,000	$ -	$ 1,500	$ 1,500	$ -	$ -	$ -	$ 500	$ -	$ -	$ 500	$ -	$ -	$ 500	$ -	$ -		$ 15,000
Total, 30-yr Present Worth, O & M (3%)	$ 204,250	$ 81,700	$ -	$ 40,850	$ 40,850	$ -	$ -	$ -	$ 13,617	$ -	$ -	$ 13,617	$ -	$ -	$ 13,617	$ -	$ -		$ 408,499
TOTAL CAPITAL COST + O & M	$ 5,405,401	$ 592,804	$ -	$ 99,483	$ 104,903	$ -	$ -	$ -	$ 94,981	$ -	$ -	$ 29,046	$ -	$ -	$ 34,466	$ -	$ -		$ 6,361,084
TOTAL EA3 REMOVAL AND ON-SITE DISPOSAL COSTS WITH 30-YR PRESENT WORTH O & M																			**$ 6,361,084**

EA3 COST ESTIMATE DETAIL

REMOVAL AND ON-SITE DISPOSAL

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Mobilization, Bonding, Insurance	LS	$ 395,428.63	1	$ 395,429	10% of construction cost
Floodplain Survey - Total				$ 25,000	
Blackfoot River (EU13)	LS	$ 15,000.00	1	$ 15,000	Engineer Estimate
Stevens Creek	LS	$ 5,000.00	1	$ 5,000	
Shave Creek	LS	$ 2,500.00	1	$ 2,500	
Paymaster Creek	LS	$ 2,500.00	1	$ 2,500	
Sampling and Analysis Plan - Total				$ 60,000	
Blackfoot River (EU13)	LS	$ 40,000.00	1	$ 40,000	Engineer Estimate
Stevens Creek	LS	$ 10,000.00	1	$ 10,000	
Shave Creek	LS	$ 5,000.00	1	$ 5,000	
Paymaster Creek	LS	$ 5,000.00	1	$ 5,000	
Surface Water and Sediment Control - Total				$ 220,000	
Blackfoot River (EU13)	LS	$ 200,000.00	1	$ 200,000	Engineer Estimate - General Site BMPs
Stevens Creek	LS	$ 10,000.00	1	$ 10,000	
Shave Creek	LS	$ 5,000.00	1	$ 5,000	
Paymaster Creek	LS	$ 5,000.00	1	$ 5,000	
Dewatering - Total			18,350	$ 45,875	Engineer Estimate
Blackfoot River (EU13)	CY	$ 2.50	17,800	$ 44,500	
Stevens Creek	CY	$ 2.50	550	$ 1,375	
Improve/Construct Access Roads - Total	LF	$ 18.00	25,690	$ 462,420	Includes Clear/Grub/Log, Reclamation
Blackfoot River (EU13)	LF	$ 18.00	20,590	$ 370,620	
Stevens Creek	LF	$ 18.00	1,800	$ 32,400	
Porcupine Creek	LF	$ 18.00	0	$ -	
Paymaster Creek	LF	$ 18.00	0	$ -	
Shave Creek	LF	$ 18.00	200	$ 3,600	
Unnamed Tributary above WTP	LF	$ 18.00	0	$ -	
Mine Feature BR-01 Discharge Seep, or Spring	LF	$ 18.00	0	$ -	
Mine Feature BR-14 Discharge Seep, or Spring	LF	$ 18.00	0	$ -	
Mine Feature PBBS Discharge Seep, or Spring	LF	$ 18.00	2,100	$ 37,800	
Mine Feature PC-11 Discharge Seep, or Spring	LF	$ 18.00	0	$ -	
Mine Feature PC-22 Discharge Seep, or Spring	LF	$ 18.00	0	$ -	
Mine Feature SH-43 Discharge Seep, or Spring	LF	$ 18.00	400	$ 7,200	
Mine Feature SG-55 Discharge Seep, or Spring	LF	$ 18.00	0	$ -	
Mine Feature SG-71 Discharge Seep, or Spring	LF	$ 18.00	0	$ -	
Mine Feature SG-94 Discharge Seep, or Spring	LF	$ 18.00	600	$ 10,800	
Mine Feature SG-98 Discharge Seep, or Spring	LF	$ 18.00	0	$ -	
Historic Paymaster Adit Discharge	LF	$ 18.00	0	$ -	

EA3 COST ESTIMATE DETAIL

REMOVAL AND ON-SITE DISPOSAL

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Excavate, Load, Haul and Place Waste in Repository - Total	CY	$ 15.00	18,490	$ 281,650	Engineer Estimate
Blackfoot River (EU13)	CY	$ 15.00	17,800	$ 267,000	Volume estimated from 2012 Floodplain Study Report; includes 0.5 feet over-excavation
Stevens Creek	CY	$ 20.00	550	$ 11,000	
Porcupine Creek	CY	$ 15.00	0	$ -	
Paymaster Creek	CY	$ 15.00	30	$ 450	
Shave Creek	CY	$ 15.00	30	$ 450	
Unnamed Tributary above WTP	CY	$ 15.00	0	$ -	
Mine Feature BR-01 Discharge Seep, or Spring	CY	$ 25.00	0	$ -	
Mine Feature BR-14 Discharge Seep, or Spring	CY	$ 25.00	0	$ -	
Mine Feature PBBS Discharge Seep, or Spring	CY	$ 25.00	50	$ 1,250	
Mine Feature PC-11 Discharge Seep, or Spring	CY	$ 25.00	0	$ -	
Mine Feature PC-22 Discharge Seep, or Spring	CY	$ 25.00	0	$ -	
Mine Feature SH-43 Discharge Seep, or Spring	CY	$ 25.00	30	$ 750	
Mine Feature SG-55 Discharge Seep, or Spring	CY	$ 25.00	0	$ -	
Mine Feature SG-71 Discharge Seep, or Spring	CY	$ 25.00	0	$ -	
Mine Feature SG-94 Discharge Seep, or Spring	CY	$ 25.00	30	$ 750	
Mine Feature SG-98 Discharge Seep, or Spring	CY	$ 25.00	0	$ -	
Historic Paymaster Adit Discharge	CY	$ 25.00	0	$ -	
Load, Haul, Place Stream Substrate - Total	CY	$ 15.00	18,520	$ 466,850	Gravel and cobble substrate to rebuild disturbed areas
Blackfoot River (EU13)	CY	$ 25.00	17,800	$ 445,000	
Stevens Creek	CY	$ 30.00	550	$ 16,500	
Porcupine Creek	CY	$ 25.00	0	$ -	
Paymaster Creek	CY	$ 25.00	30	$ 750	
Shave Creek	CY	$ 25.00	30	$ 750	
Unnamed Tributary above WTP	CY	$ 25.00	0	$ -	
Mine Feature BR-01 Discharge Seep, or Spring	CY	$ 35.00	0	$ -	
Mine Feature BR-14 Discharge Seep, or Spring	CY	$ 35.00	0	$ -	
Mine Feature PBBS Discharge Seep, or Spring	CY	$ 35.00	50	$ 1,750	
Mine Feature PC-11 Discharge Seep, or Spring	CY	$ 35.00	0	$ -	
Mine Feature PC-22 Discharge Seep, or Spring	CY	$ 35.00	0	$ -	
Mine Feature SH-43 Discharge Seep, or Spring	CY	$ 35.00	30	$ 1,050	
Mine Feature SG-55 Discharge Seep, or Spring	CY	$ 35.00	0	$ -	
Mine Feature SG-71 Discharge Seep, or Spring	CY	$ 35.00	0	$ -	
Mine Feature SG-94 Discharge Seep, or Spring	CY	$ 35.00	30	$ 1,050	
Mine Feature SG-98 Discharge Seep, or Spring	CY	$ 35.00	0	$ -	
Historic Paymaster Adit Discharge	CY	$ 35.00	0	$ -	
Reconstruct Stream - Total			19,760	$ 2,371,200	
Blackfoot River (EU13)	LF	$ 120.00	17,160	$ 2,059,200	Engineers Estimate, Bid Tabs for similar jobs, Partial Reconstruction only 10% of length.
Stevens Creek	LF	$ 120.00	2,100	$ 252,000	
Porcupine Creek	LF	$ 120.00	0	$ -	
Paymaster Creek	LF	$ 120.00	200	$ 24,000	
Shave Creek	LF	$ 120.00	200	$ 24,000	
Unnamed Tributary above WTP	LF	$ 120.00	0	$ -	
Mine Feature BR-01 Discharge Seep, or Spring	LF	$ 120.00	0	$ -	
Mine Feature BR-14 Discharge Seep, or Spring	LF	$ 120.00	0	$ -	
Mine Feature PBBS Discharge Seep, or Spring	LF	$ 120.00	100	$ 12,000	
Mine Feature PC-11 Discharge Seep, or Spring	LF	$ 120.00	0	$ -	
Mine Feature PC-22 Discharge Seep, or Spring	LF	$ 120.00	0	$ -	
Mine Feature SH-43 Discharge Seep, or Spring	LF	$ 120.00	0	$ -	
Mine Feature SG-55 Discharge Seep, or Spring	LF	$ 120.00	0	$ -	
Mine Feature SG-71 Discharge Seep, or Spring	LF	$ 120.00	0	$ -	
Mine Feature SG-94 Discharge Seep, or Spring	LF	$ 120.00	0	$ -	
Mine Feature SG-98 Discharge Seep, or Spring	LF	$ 120.00	0	$ -	
Historic Paymaster Adit Discharge	LF	$ 120.00	0	$ -	

EA3 COST ESTIMATE DETAIL

REMOVAL AND ON-SITE DISPOSAL

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Seed, Fertilize, Mulch - Total	AC	$ 2,500.00	8.5	$ 21,291	Based on Bald Butte
Blackfoot River (EU13)	AC	$ 2,500.00	5.5	$ 13,791	
Stevens Creek	AC	$ 2,500.00	0.5	$ 1,250	
Porcupine Creek	AC	$ 2,500.00	0.0	$ -	
Paymaster Creek	AC	$ 2,500.00	0.5	$ 1,250	
Shave Creek	AC	$ 2,500.00	0.5	$ 1,250	
Unnamed Tributary above WTP	AC	$ 2,500.00	0.0	$ -	
Mine Feature BR-01 Discharge Seep, or Spring	AC	$ 2,500.00	0.0	$ -	
Mine Feature BR-14 Discharge Seep, or Spring	AC	$ 2,500.00	0.0	$ -	
Mine Feature PBBS Discharge Seep, or Spring	AC	$ 2,500.00	0.5	$ 1,250	
Mine Feature PC-11 Discharge Seep, or Spring	AC	$ 2,500.00	0.0	$ -	
Mine Feature PC-22 Discharge Seep, or Spring	AC	$ 2,500.00	0.0	$ -	
Mine Feature SH-43 Discharge Seep, or Spring	AC	$ 2,500.00	0.5	$ 1,250	
Mine Feature SG-55 Discharge Seep, or Spring	AC	$ 2,500.00	0.0	$ -	
Mine Feature SG-71 Discharge Seep, or Spring	AC	$ 2,500.00	0.0	$ -	
Mine Feature SG-94 Discharge Seep, or Spring	AC	$ 2,500.00	0.5	$ 1,250	
Mine Feature SG-98 Discharge Seep, or Spring	AC	$ 2,500.00	0.0	$ -	
Historic Paymaster Adit Discharge	AC	$ 2,500.00	0.0	$ -	
			Subtotal	$ 4,349,715	
Contingencies		15%		$ 652,457	
			Subtotal	$ 5,002,172	
Project Management		5%		$ 250,109	
Engineering		6%		$ 300,130	
Construction Management		8%		$ 400,174	
TOTAL				$ 5,952,585	
			TOTAL CAPITAL COSTS	**$ 5,952,585**	

MONITORING AND MAINTENANCE (M & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Site Inspections, Vegetation Maintenance and Repairs, Years 1-5	LS	$ 40,000.00	1	$ 40,000	Engineers Estimate
Site Inspections, Vegetation Maintenance and Repairs, Years 6-30	LS	$ 15,000.00	1	$ 15,000	Engineers Estimate
			Subtotal	$ 55,000	
			30-YEAR NET PRESENT VALUE ANNUAL O & M COSTS	**$ 408,499**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O & M COST) $ 6,361,084

EA 3 COSTS																			
REMOVAL AND OFF-SITE DISPOSAL	**Blackfoot River (EU13)**	**Stevens Creek**	**Porcupine Creek**	**Paymaster Creek**	**Shave Creek**	**Unnamed Tributary above WTP**	**Mine Feature BR-01 Discharge Seep, or Spring**	**Mine Feature BR-14 Discharge Seep, or Spring**	**Mine Feature PBBS Discharge Seep, or Spring**	**Mine Feature PC-11 Discharge Seep, or Spring**	**Mine Feature PC-22 Discharge Seep, or Spring**	**Mine Feature SH-43 Discharge Seep, or Spring**	**Mine Feature SG-55 Discharge Seep, or Spring**	**Mine Feature SG-71 Discharge Seep, or Spring**	**Mine Feature SG-94 Discharge Seep, or Spring**	**Mine Feature SG-98 Discharge Seep, or Spring**	**Historic Paymaster Adit Discharge**		**TOTAL**
Floodplain Survey	$ 15,000	$ 5,000	$ -	$ 2,500	$ 2,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ 25,000
Sampling and Analysis Plan	$ 40,000	$ 10,000	$ -	$ 5,000	$ 5,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ 60,000
Surface Water and Sediment Control	$ 200,000	$ 10,000	$ -	$ 5,000	$ 5,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ 220,000
Dewatering	$ 44,500	$ 1,375	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ 45,875
Construct Off-site Repository	$ 180,157	$ 5,567	$ -	$ 304	$ 304	$ -	$ -	$ -	$ 506	$ -	$ -	$ 304	$ -	$ -	$ 304	$ -	$ -		$ 187,444
Improve/Construct Access Roads	$ 370,620	$ 32,400	$ -	$ -	$ 3,600	$ -	$ -	$ -	$ 37,800	$ -	$ -	$ 7,200	$ -	$ -	$ 10,800	$ -	$ -		$ 462,420
Excavate, Load, Haul and Place Waste in Repository	$ 267,000	$ 11,000	$ -	$ 450	$ 450	$ -	$ -	$ -	$ 1,250	$ -	$ -	$ 750	$ -	$ -	$ 750	$ -	$ -		$ 281,650
Load, Haul, Place Stream Substrate	$ 445,000	$ 16,500	$ -	$ 750	$ 750	$ -	$ -	$ -	$ 1,750	$ -	$ -	$ 1,050	$ -	$ -	$ 1,050	$ -	$ -		$ 466,850
Reconstruct Stream	$ 2,059,200	$ 252,000	$ -	$ 24,000	$ 24,000	$ -	$ -	$ -	$ 12,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ 2,371,200
Seed, Fertilize, Mulch	$ 13,791	$ 1,250	$ -	$ 1,250	$ 1,250	$ -	$ -	$ -	$ 1,250	$ -	$ -	$ 1,250	$ -	$ -	$ 1,250	$ -	$ -		$ 21,291
Subtotal	$ 3,635,268	$ 345,092	$ -	$ 39,254	$ 42,854	$ -	$ -	$ -	$ 54,556	$ -	$ -	$ 10,554	$ -	$ -	$ 14,154	$ -	$ -		$ 4,141,731
Mob/Demob (10%)	$ 363,527	$ 34,509	$ -	$ 3,925	$ 4,285	$ -	$ -	$ -	$ 5,456	$ -	$ -	$ 1,055	$ -	$ -	$ 1,415	$ -	$ -		$ 414,173
Subtotal	$ 3,998,795	$ 379,601	$ -	$ 43,179	$ 47,139	$ -	$ -	$ -	$ 60,012	$ -	$ -	$ 11,609	$ -	$ -	$ 15,569	$ -	$ -		$ 4,555,904
Contingencies (15%)	$ 599,819	$ 56,940	$ -	$ 6,477	$ 7,071	$ -	$ -	$ -	$ 9,002	$ -	$ -	$ 1,741	$ -	$ -	$ 2,335	$ -	$ -		$ 683,386
Subtotal	$ 4,598,614	$ 436,541	$ -	$ 49,656	$ 54,210	$ -	$ -	$ -	$ 69,013	$ -	$ -	$ 13,350	$ -	$ -	$ 17,904	$ -	$ -		$ 5,239,289
Project Management (5%)	$ 229,931	$ 21,827	$ -	$ 2,483	$ 2,710	$ -	$ -	$ -	$ 3,451	$ -	$ -	$ 668	$ -	$ -	$ 895	$ -	$ -		$ 261,964
Engineering (6%)	$ 275,917	$ 26,192	$ -	$ 2,979	$ 3,253	$ -	$ -	$ -	$ 4,141	$ -	$ -	$ 801	$ -	$ -	$ 1,074	$ -	$ -		$ 314,357
Construction Administration (8%)	$ 367,889	$ 34,923	$ -	$ 3,972	$ 4,337	$ -	$ -	$ -	$ 5,521	$ -	$ -	$ 1,068	$ -	$ -	$ 1,432	$ -	$ -		$ 419,143
Total, Capital Cost	$ 5,472,351	$ 519,484	$ -	$ 59,090	$ 64,510	$ -	$ -	$ -	$ 82,126	$ -	$ -	$ 15,887	$ -	$ -	$ 21,306	$ -	$ -		$ 6,234,754
Operations and Maintenance (O & M)																			
Site Inspections, Vegetation Maintenance and Repairs, Years 1-5	$ 20,000	$ 8,000	$ -	$ 4,000	$ 4,000	$ -	$ -	$ -	$ 1,333			$ 1,333	$ -	$ -	$ 1,333	$ -	$ -		$ 40,000
Site Inspections, Vegetation Maintenance and Repairs, Years 6-30	$ 7,500	$ 3,000	$ -	$ 1,500	$ 1,500	$ -	$ -	$ -	$ 500	$ -	$ -	$ 500	$ -	$ -	$ 500	$ -	$ -		$ 15,000
Total, 30-yr Present Worth, O & M (3%)	$ 204,250	$ 81,700	$ -	$ 40,850	$ 40,850	$ -	$ -	$ -	$ 13,617	$ -	$ -	$ 13,617	$ -	$ -	$ 13,617	$ -	$ -		$ 408,499
TOTAL CAPITAL COST + O & M	$ 5,676,601	$ 601,184	$ -	$ 99,940	$ 105,360	$ -	$ -	$ -	$ 95,743	$ -	$ -	$ 29,504	$ -	$ -	$ 34,923	$ -	$ -		$ 6,643,253
TOTAL EA3 REMOVAL AND OFF-SITE DISPOSAL COSTS WITH 30-YR PRESENT WORTH O & M																			**$ 6,643,253**

EA3 COST ESTIMATE DETAIL

REMOVAL AND OFF-SITE DISPOSAL

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Mobilization, Bonding, Insurance	LS	$ 414,173.06	1	$ 414,173	10% of construction cost
Floodplain Survey - Total				$ 25,000	
Blackfoot River (EU13)	LS	$ 15,000.00	1	$ 15,000	Engineer Estimate
Stevens Creek	LS	$ 5,000.00	1	$ 5,000	
Paymaster Creek	LS	$ 2,500.00	1	$ 2,500	
Shave Creek	LS	$ 2,500.00	1	$ 2,500	
Sampling and Analysis Plan - Total				$ 60,000	
Blackfoot River (EU13)	LS	$ 40,000.00	1	$ 40,000	Engineer Estimate
Stevens Creek	LS	$ 10,000.00	1	$ 10,000	
Paymaster Creek	LS	$ 5,000.00	1	$ 5,000	
Shave Creek	LS	$ 5,000.00	1	$ 5,000	
Surface Water and Sediment Control - Total				$ 220,000	
Blackfoot River (EU13)	LS	$ 200,000.00	1	$ 200,000	Engineer Estimate - General Site BMPs
Stevens Creek	LS	$ 10,000.00	1	$ 10,000	
Paymaster Creek	LS	$ 5,000.00	1	$ 5,000	
Shave Creek	LS	$ 5,000.00	1	$ 5,000	
Dewatering - Total			18,350	$ 45,875	Engineer Estimate
Blackfoot River (EU13)	CY	$ 2.50	17,800	$ 44,500	
Stevens Creek	CY	$ 2.50	550	$ 1,375	
Construct Off-site Repository - Total	CY	$ 10.12	18,520.0	$ 187,444	State Section 18*
Blackfoot River (EU13)	CY	$ 10.12	17,800	$ 180,157	
Stevens Creek	CY	$ 10.12	550	$ 5,567	
Porcupine Creek	CY	$ 10.12	0	$ -	
Paymaster Creek	CY	$ 10.12	30	$ 304	
Shave Creek	CY	$ 10.12	30	$ 304	
Unnamed Tributary above WTP	CY	$ 10.12	0	$ -	
Mine Feature BR-01 Discharge Seep, or Spring	CY	$ 10.12	0	$ -	
Mine Feature BR-14 Discharge Seep, or Spring	CY	$ 10.12	0	$ -	
Mine Feature PBBS Discharge Seep, or Spring	CY	$ 10.12	50	$ 506	
Mine Feature PC-22 Discharge Seep, or Spring	CY	$ 10.12	0	$ -	
Mine Feature SH-43 Discharge Seep, or Spring	CY	$ 10.12	30	$ 304	
Mine Feature SG-55 Discharge Seep, or Spring	CY	$ 10.12	0	$ -	
Mine Feature SG-71 Discharge Seep, or Spring	CY	$ 10.12	0	$ -	
Mine Feature SG-94 Discharge Seep, or Spring	CY	$ 10.12	30	$ 304	
Mine Feature SG-98 Discharge Seep, or Spring	CY	$ 10.12	0	$ -	
Historic Paymaster Adit Discharge	CY	$ 10.12	0	$ -	
Improve/Construct Access Roads - Total	LF	$ 18.00	25,690	$ 462,420	Includes Clear/Grub/Log, Reclamation
Blackfoot River (EU13)	LF	$ 18.00	20,590	$ 370,620	
Stevens Creek	LF	$ 18.00	1,800	$ 32,400	
Porcupine Creek	LF	$ 18.00	0	$ -	
Paymaster Creek	LF	$ 18.00	0	$ -	
Shave Creek	LF	$ 18.00	200	$ 3,600	
Unnamed Tributary above WTP	LF	$ 18.00	0	$ -	
Mine Feature BR-01 Discharge Seep, or Spring	LF	$ 18.00	0	$ -	
Mine Feature BR-14 Discharge Seep, or Spring	LF	$ 18.00	0	$ -	
Mine Feature PBBS Discharge Seep, or Spring	LF	$ 18.00	2,100	$ 37,800	
Mine Feature PC-22 Discharge Seep, or Spring	LF	$ 18.00	0	$ -	
Mine Feature SH-43 Discharge Seep, or Spring	LF	$ 18.00	400	$ 7,200	
Mine Feature SG-55 Discharge Seep, or Spring	LF	$ 18.00	0	$ -	
Mine Feature SG-71 Discharge Seep, or Spring	LF	$ 18.00	0	$ -	
Mine Feature SG-94 Discharge Seep, or Spring	LF	$ 18.00	600	$ 10,800	
Mine Feature SG-98 Discharge Seep, or Spring	LF	$ 18.00	0	$ -	
Historic Paymaster Adit Discharge	LF	$ 18.00	0	$ -	

EA3 COST ESTIMATE DETAIL

REMOVAL AND OFF-SITE DISPOSAL

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Excavate, Load, Haul and Place Waste in Repository - Total	CY	$ 15.00	18,490	$ 281,650	Engineer Estimate
Blackfoot River (EU13)	CY	$ 15.00	17,800	$ 267,000	Vol Est. = 4 ft width for 3.25 mi. Upper Marsh to Alice Ck
Stevens Creek	CY	$ 20.00	550	$ 11,000	
Porcupine Creek	CY	$ 15.00	0	$ -	
Paymaster Creek	CY	$ 15.00	30	$ 450	
Shave Creek	CY	$ 15.00	30	$ 450	
Unnamed Tributary above WTP	CY	$ 15.00	0	$ -	
Mine Feature BR-01 Discharge Seep, or Spring	CY	$ 25.00	0	$ -	
Mine Feature BR-14 Discharge Seep, or Spring	CY	$ 25.00	0	$ -	
Mine Feature PBBS Discharge Seep, or Spring	CY	$ 25.00	50	$ 1,250	
Mine Feature PC-22 Discharge Seep, or Spring	CY	$ 25.00	0	$ -	
Mine Feature SH-43 Discharge Seep, or Spring	CY	$ 25.00	30	$ 750	
Mine Feature SG-55 Discharge Seep, or Spring	CY	$ 25.00	0	$ -	
Mine Feature SG-71 Discharge Seep, or Spring	CY	$ 25.00	0	$ -	
Mine Feature SG-94 Discharge Seep, or Spring	CY	$ 25.00	30	$ 750	
Mine Feature SG-98 Discharge Seep, or Spring	CY	$ 25.00	0	$ -	
Historic Paymaster Adit Discharge	CY	$ 25.00	0	$ -	
Load, Haul, Place Stream Substrate - Total	CY	$ 15.00	18,520	$ 466,850	Gravel and cobble substrate to rebuild disturbed areas
Blackfoot River (EU13)	CY	$ 25.00	17,800	$ 445,000	
Stevens Creek	CY	$ 30.00	550	$ 16,500	
Porcupine Creek	CY	$ 25.00	0	$ -	
Paymaster Creek	CY	$ 25.00	30	$ 750	
Shave Creek	CY	$ 25.00	30	$ 750	
Unnamed Tributary above WTP	CY	$ 25.00	0	$ -	
Mine Feature BR-01 Discharge Seep, or Spring	CY	$ 35.00	0	$ -	
Mine Feature BR-14 Discharge Seep, or Spring	CY	$ 35.00	0	$ -	
Mine Feature PBBS Discharge Seep, or Spring	CY	$ 35.00	50	$ 1,750	
Mine Feature PC-22 Discharge Seep, or Spring	CY	$ 35.00	0	$ -	
Mine Feature SH-43 Discharge Seep, or Spring	CY	$ 35.00	30	$ 1,050	
Mine Feature SG-55 Discharge Seep, or Spring	CY	$ 35.00	0	$ -	
Mine Feature SG-71 Discharge Seep, or Spring	CY	$ 35.00	0	$ -	
Mine Feature SG-94 Discharge Seep, or Spring	CY	$ 35.00	30	$ 1,050	
Mine Feature SG-98 Discharge Seep, or Spring	CY	$ 35.00	0	$ -	
Historic Paymaster Adit Discharge	CY	$ 35.00	0	$ -	
Reconstruct Stream - Total				$ 2,371,200	
Blackfoot River (EU13)	LF	$ 120.00	17,160	$ 2,059,200	Engineers Estimate, Bid Tabs for similar jobs, Partial Reconstruction only 10% of length.
Stevens Creek	LF	$ 120.00	2,100	$ 252,000	
Porcupine Creek	LF	$ 120.00	0	$ -	
Paymaster Creek	LF	$ 120.00	200	$ 24,000	
Shave Creek	LF	$ 120.00	200	$ 24,000	
Unnamed Tributary above WTP	LF	$ 120.00	0	$ -	
Mine Feature BR-01 Discharge Seep, or Spring	LF	$ 120.00	0	$ -	
Mine Feature BR-14 Discharge Seep, or Spring	LF	$ 120.00	0	$ -	
Mine Feature PBBS Discharge Seep, or Spring	LF	$ 120.00	100	$ 12,000	
Mine Feature PC-22 Discharge Seep, or Spring	LF	$ 120.00	0	$ -	
Mine Feature SH-43 Discharge Seep, or Spring	LF	$ 120.00	0	$ -	
Mine Feature SG-55 Discharge Seep, or Spring	LF	$ 120.00	0	$ -	
Mine Feature SG-71 Discharge Seep, or Spring	LF	$ 120.00	0	$ -	
Mine Feature SG-94 Discharge Seep, or Spring	LF	$ 120.00	0	$ -	
Mine Feature SG-98 Discharge Seep, or Spring	LF	$ 120.00	0	$ -	
Historic Paymaster Adit Discharge	LF	$ 120.00	0	$ -	

EA3 COST ESTIMATE DETAIL

REMOVAL AND OFF-SITE DISPOSAL

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Seed, Fertilize, Mulch - Total	AC	$ 2,500.00	8.5	$ 21,291	Based on Bald Butte
Blackfoot River (EU13)	AC	$ 2,500.00	5.5	$ 13,791	
Stevens Creek	AC	$ 2,500.00	0.5	$ 1,250	
Porcupine Creek	AC	$ 2,500.00	0.0	$ -	
Paymaster Creek	AC	$ 2,500.00	0.5	$ 1,250	
Shave Creek	AC	$ 2,500.00	0.5	$ 1,250	
Unnamed Tributary above WTP	AC	$ 2,500.00	0.0	$ -	
Mine Feature BR-01 Discharge Seep, or Spring	AC	$ 2,500.00	0.0	$ -	
Mine Feature BR-14 Discharge Seep, or Spring	AC	$ 2,500.00	0.0	$ -	
Mine Feature PBBS Discharge Seep, or Spring	AC	$ 2,500.00	0.5	$ 1,250	
Mine Feature PC-22 Discharge Seep, or Spring	AC	$ 2,500.00	0.0	$ -	
Mine Feature SH-43 Discharge Seep, or Spring	AC	$ 2,500.00	0.5	$ 1,250	
Mine Feature SG-55 Discharge Seep, or Spring	AC	$ 2,500.00	0.0	$ -	
Mine Feature SG-71 Discharge Seep, or Spring	AC	$ 2,500.00	0.0	$ -	
Mine Feature SG-94 Discharge Seep, or Spring	AC	$ 2,500.00	0.5	$ 1,250	
Mine Feature SG-98 Discharge Seep, or Spring	AC	$ 2,500.00	0.0	$ -	
Historic Paymaster Adit Discharge	AC	$ 2,500.00	0.0	$ -	
			Subtotal	$ 4,555,904	
Contingencies		15%		$ 683,386	
			Subtotal	$ 5,239,289	
Project Management		5%		$ 261,964	
Engineering		6%		$ 314,357	
Construction Management		8%		$ 419,143	
TOTAL				$ 6,234,754	
			TOTAL CAPITAL COSTS	**$ 6,234,754**	

MONITORING AND MAINTENANCE (M & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Site Inspections, Vegetation Maintenance and Repairs, Years 1-5	LS	$ 40,000.00	1	$ 40,000	Engineers Estimate
Site Inspections, Vegetation Maintenance and Repairs, Years 6-30	LS	$ 15,000.00	1	$ 15,000	Engineers Estimate
			Subtotal	$ 55,000	
			30-YEAR NET PRESENT VALUE ANNUAL O & M COSTS	**$ 408,499**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O & M COST) $ 6,643,253

* From the Repository Siting Study for UBMC - State Section 18 Site estimate was $15,034,436 for a 1,000,000 cy repository and includes wastes removed under the EE/CA actions. The total estimated cost included hauling and placement of waste. Construction costs for the repository were $4,048,472. For purposes of this feasibility study, estimated costs from the siting study are scaled to a 400,000 cy repository for a repository construction cost of $10.12/cy.

EA 3 COSTS													
CONTAINMENT (RETENTION POND)	**Mine Feature BR-01 Discharge Seep, or Spring**	**Mine Feature BR-14 Discharge Seep, or Spring**	**Mine Feature PBBS Discharge Seep, or Spring**	**Mine Feature PC-22 Discharge Seep, or Spring**	**Mine Feature PC-22 Discharge Seep, or Spring**	**Mine Feature SH-43 Discharge Seep, or Spring**	**Mine Feature SG-55 Discharge Seep, or Spring**	**Mine Feature SG-71 Discharge Seep, or Spring**	**Mine Feature SG-94 Discharge Seep, or Spring**	**Mine Feature SG-98 Discharge Seep, or Spring**	**Historic Paymaster Adit Discharge**		**TOTAL**
Improve/Construct Access Roads	$ 16,200	$ 54,000	$ 37,800	$ 9,000	$ 3,600	$ 7,200	$ 118,800	$ 37,800	$ 10,800	$ 140,400	$ -		$ 435,600
Construct Retention Pond	$ 17,130	$ 17,130	$ 17,130	$ 17,130	$ 17,130	$ 17,130	$ 17,130	$ 17,130	$ 17,130	$ 17,130	$ 17,130		$ 188,430
Seed, Fertilize, Mulch	$ 1,106	$ 1,106	$ 1,106	$ 1,106	$ 1,106	$ 1,106	$ 1,106	$ 1,106	$ 1,106	$ 1,106	$ 1,106		$ 12,167
Subtotal	$ 34,436	$ 72,236	$ 56,036	$ 27,236	$ 21,836	$ 25,436	$ 137,036	$ 56,036	$ 29,036	$ 158,636	$ 18,236		$ 636,197
Mob/Demob (10%)	$ 3,444	$ 7,224	$ 5,604	$ 2,724	$ 2,184	$ 2,544	$ 13,704	$ 5,604	$ 2,904	$ 15,864	$ 1,824		$ 63,620
Subtotal	$ 37,880	$ 79,460	$ 61,640	$ 29,960	$ 24,020	$ 27,980	$ 150,740	$ 61,640	$ 31,940	$ 174,500	$ 20,060		$ 699,816
Contingencies (15%)	$ 5,682	$ 11,919	$ 9,246	$ 4,494	$ 3,603	$ 4,197	$ 22,611	$ 9,246	$ 4,791	$ 26,175	$ 3,009		$ 104,972
Subtotal	$ 43,562	$ 91,379	$ 70,886	$ 34,454	$ 27,623	$ 32,177	$ 173,351	$ 70,886	$ 36,731	$ 200,675	$ 23,069		$ 804,789
Project Management (5%)	$ 2,178	$ 4,569	$ 3,544	$ 1,723	$ 1,381	$ 1,609	$ 8,668	$ 3,544	$ 1,837	$ 10,034	$ 1,153		$ 40,239
Engineering (6%)	$ 2,614	$ 5,483	$ 4,253	$ 2,067	$ 1,657	$ 1,931	$ 10,401	$ 4,253	$ 2,204	$ 12,040	$ 1,384		$ 48,287
Construction Administration (8%)	$ 3,485	$ 7,310	$ 5,671	$ 2,756	$ 2,210	$ 2,574	$ 13,868	$ 5,671	$ 2,938	$ 16,054	$ 1,845		$ 64,383
Total, Capital Cost	$ 51,838	$ 108,741	$ 84,354	$ 41,000	$ 32,871	$ 38,290	$ 206,287	$ 84,354	$ 43,709	$ 238,803	$ 27,452		$ 957,699
Operations and Maintenance (O & M)													
Site Inspections, Vegetation Maintenance and Repairs, Years 1-30	$ 409	$ 409	$ 409	$ 409	$ 409	$ 409	$ 409	$ 409	$ 409	$ 409	$ 409		$ 4,500
Periodic Repairs - Years 15 and 30 (1/3rd remedial cost pond construct and reveg)	$ 6,082	$ 6,082	$ 6,082	$ 6,082	$ 6,082	$ 6,082	$ 6,082	$ 6,082	$ 6,082	$ 6,082	$ 6,082		$ 66,900
Total, 30-yr Present Worth, O & M (3%)	$ 14,426	$ 14,426	$ 14,426	$ 14,426	$ 14,426	$ 14,426	$ 14,426	$ 14,426	$ 14,426	$ 14,426	$ 14,426		$ 158,682
TOTAL CAPITAL COST + O & M	$ 66,264	$ 123,166	$ 98,779	$ 55,425	$ 47,297	$ 52,716	$ 220,713	$ 98,779	$ 58,135	$ 253,228	$ 41,877		$ 1,116,380
TOTAL EA3 CONTAINMENT (RETENTION) COSTS WITH 30-YR PRESENT WORTH O & M													**$ 1,116,380**

EA3 COST ESTIMATE DETAIL
CONTAINMENT (RETENTION POND)

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Mobilization, Bonding, Insurance	LS	$ 63,619.67	1	$ 63,620	10% of construction cost
Improve/Construct Access Roads - Total	LF	$ 18.00	23,300	$ 435,600	Includes Clear/Grub/Log, Reclamation
Mine Feature BR-01 Discharge Seep, or Spring	LF	$ 18.00	900	$ 16,200	
Mine Feature BR-14 Discharge Seep, or Spring	LF	$ 18.00	3,000	$ 54,000	
Mine Feature PBBS Discharge Seep, or Spring	LF	$ 18.00	2,100	$ 37,800	
Mine Feature PC-11 Discharge Seep, or Spring	LF	$ 18.00	500	$ 9,000	
Mine Feature PC-22 Discharge Seep, or Spring	LF	$ 18.00	200	$ 3,600	
Mine Feature SH-43 Discharge Seep, or Spring	LF	$ 18.00	400	$ 7,200	
Mine Feature SG-55 Discharge Seep, or Spring	LF	$ 18.00	6,600	$ 118,800	
Mine Feature SG-71 Discharge Seep, or Spring	LF	$ 18.00	2,100	$ 37,800	
Mine Feature SG-94 Discharge Seep, or Spring	LF	$ 18.00	600	$ 10,800	
Mine Feature SG-98 Discharge Seep, or Spring	LF	$ 18.00	7,800	$ 140,400	
Historic Paymaster Adit Discharge	LF	$ 18.00	0	$ -	
Construct Retention Pond - Total	EA	$ 17,130.00	11	$ 188,430	Engineer Estimate
Mine Feature BR-01 Discharge Seep, or Spring	EA	$ 17,130.00	1	$ 17,130	
Mine Feature BR-14 Discharge Seep, or Spring	EA	$ 17,130.00	1	$ 17,130	
Mine Feature PBBS Discharge Seep, or Spring	EA	$ 17,130.00	1	$ 17,130	
Mine Feature PC-11 Discharge Seep, or Spring	EA	$ 17,130.00	1	$ 17,130	
Mine Feature PC-22 Discharge Seep, or Spring	EA	$ 17,130.00	1	$ 17,130	
Mine Feature SH-43 Discharge Seep, or Spring	EA	$ 17,130.00	1	$ 17,130	
Mine Feature SG-55 Discharge Seep, or Spring	EA	$ 17,130.00	1	$ 17,130	
Mine Feature SG-71 Discharge Seep, or Spring	EA	$ 17,130.00	1	$ 17,130	
Mine Feature SG-94 Discharge Seep, or Spring	EA	$ 17,130.00	1	$ 17,130	
Mine Feature SG-98 Discharge Seep, or Spring	EA	$ 17,130.00	1	$ 17,130	
Historic Paymaster Adit Discharge	EA	$ 17,130.00	1	$ 17,130	
Seed, Fertilize, Mulch - Total	AC	$ 2,500.00	4.4	$ 12,167	Engineer Estimate
Mine Feature BR-01 Discharge Seep, or Spring	AC	$ 2,500.00	0.4	$ 1,106	
Mine Feature BR-14 Discharge Seep, or Spring	AC	$ 2,500.00	0.4	$ 1,106	
Mine Feature PBBS Discharge Seep, or Spring	AC	$ 2,500.00	0.4	$ 1,106	
Mine Feature PC-11 Discharge Seep, or Spring	AC	$ 2,500.00	0.4	$ 1,106	
Mine Feature PC-22 Discharge Seep, or Spring	AC	$ 2,500.00	0.4	$ 1,106	
Mine Feature SH-43 Discharge Seep, or Spring	AC	$ 2,500.00	0.4	$ 1,106	
Mine Feature SG-55 Discharge Seep, or Spring	AC	$ 2,500.00	0.4	$ 1,106	
Mine Feature SG-71 Discharge Seep, or Spring	AC	$ 2,500.00	0.4	$ 1,106	
Mine Feature SG-94 Discharge Seep, or Spring	AC	$ 2,500.00	0.4	$ 1,106	
Mine Feature SG-98 Discharge Seep, or Spring	AC	$ 2,500.00	0.4	$ 1,106	
Historic Paymaster Adit Discharge	AC	$ 2,500.00	0.4	$ 1,106	
			Subtotal	$ 699,816	
Contingencies		15%		$ 104,972	
			Subtotal	$ 804,789	
Project Management		5%		$ 40,239	
Engineering		6%		$ 48,287	
Construction Management		8%		$ 64,383	
TOTAL				$ 957,699	
			TOTAL CAPITAL COSTS	**$ 957,699**	

EA3 COST ESTIMATE DETAIL
CONTAINMENT (RETENTION POND)

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES

MONITORING AND MAINTENANCE (M & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Site Inspections, Vegetation Maintenance and Repairs, Years 1-30	LS	$ 4,500.00	1	$ 4,500	Engineers Estimate
Periodic Repairs - Years 15 and 30 (1/3rd remedial cost pond construct and reveg)	LS	$ 66,900.00	1	$ 66,900	Engineers Estimate
			Subtotal	$ 71,400	
30-YEAR NET PRESENT VALUE ANNUAL O & M COSTS				**$ 158,704**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O & M COST) $ 1,116,403 Value for the EA as a whole is slightly different than value calculated by summing individual sites within the EA due to compounding rounding error.

EA 3 QUANTITY ESTIMATES					
SITE	SEDIMENT		ACCESS - DIST. TO ROADS		
	AREA	VOLUME	LENGTH	IMPROVE?	FENCING
	(sf)	(cy)	(ft)		(ft)
Blackfoot River (EU13)	240,300	17,800	20,590	YES	0
Stevens Creek	7,425	550	1,800	YES	0
Porcupine Creek	0	0	0	NO	0
Paymaster Creek	405	30	0	NO	0
Shave Creek	405	30	200	YES	0
Unnamed Tributary above WTP	0	0	300	YES	0
Mine Feature BR-01 Discharge Seep, or Spring	0	0	900	YES	400
Mine Feature BR-14 Discharge Seep, or Spring	0	0	3,000	YES	400
Mine Feature PBBS Discharge Seep, or Spring	675	50	2,100	YES	400
Mine Feature PC-11 Discharge Seep, or Spring	0	0	500	YES	400
Mine Feature PC-22 Discharge Seep, or Spring	0	0	200	YES	400
Mine Feature SH-43 Discharge Seep, or Spring	405	30	400	YES	400
Mine Feature SG-55 Discharge Seep, or Spring	0	0	6,600	YES	400
Mine Feature SG-71 Discharge Seep, or Spring	0	0	2,100	YES	400
Mine Feature SG-94 Discharge Seep, or Spring	405	30	600	YES	400
Mine Feature SG-98 Discharge Seep, or Spring	0	0	7,800	YES	400
Historic Paymaster Adit Discharge	0	0	0	NO	400
TOTALS	250,020	18,520	47,090		4,400

EVALUATION AREA EA 4 Upper Marsh	SITE-WIDE ELEMENTS: ICs	SITE-WIDE ELEMENTS: Access Restrictions	SITE-WIDE ELEMENTS: Long-term Monitoring and Maintenance	No Action	PHYSICAL HAZARDS/SOLID MEDIA: Monitored Natural Recovery	PHYSICAL HAZARDS/SOLID MEDIA: ENGINEERING CONTROLS/LAND DISPOSAL: Physical Barriers	PHYSICAL HAZARDS/SOLID MEDIA: ENGINEERING CONTROLS/LAND DISPOSAL: Containment	PHYSICAL HAZARDS/SOLID MEDIA: ENGINEERING CONTROLS/LAND DISPOSAL: Removal and On-site Disposal	PHYSICAL HAZARDS/SOLID MEDIA: ENGINEERING CONTROLS/LAND DISPOSAL: Removal and Off-site Disposal	PHYSICAL HAZARDS/SOLID MEDIA: TREATMENT: In-situ Neutralization W/Alkaline Amendment	PHYSICAL HAZARDS/SOLID MEDIA: TREATMENT: Ex-situ Neutralization W/Alkaline Amendment	SURFACE WATER/GROUNDWATER: Monitored Natural Attenuation	SURFACE WATER/GROUNDWATER: ENGINEERING CONTROLS: Containment (Retention Pond)	SURFACE WATER/GROUNDWATER: ENGINEERING CONTROLS: Hydrologic and Hydraulic Control	SURFACE WATER/GROUNDWATER: ENGINEERING CONTROLS: Inundation	SURFACE WATER/GROUNDWATER: TREATMENT: Active: Chemical Reagent	SURFACE WATER/GROUNDWATER: TREATMENT: Active: Physical/ Mechanical	SURFACE WATER/GROUNDWATER: TREATMENT: Passive: Chemical Reagent
Eastern Area	$5,000	$0	$0	$0	$182,849	N/A	$3,314,803	$4,465,125	$5,996,496	N/A	N/A	$154,719	N/A	N/A	N/A	N/A	N/A	N/A
Western Area	$5,000	$0	$0	$0	$182,849	N/A	$3,922,524	$5,380,951	$6,912,322	N/A	N/A	$154,719	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL COSTS	**$10,000**	**$0**	**$0**	**$0**	**$365,698**	**$0**	**$7,237,328**	**$9,846,075**	**$12,908,817**	**$0**	**$0**	**$309,437**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

(REMEDIAL ALTERNATIVE COSTS)

EA 4 COSTS				
MONITORED NATURAL RECOVERY	**Eastern Area**	**Western Area**		**TOTAL**
Subtotal	$ -	$ -		$ -
Mob/Demob (10%)	$ -	$ -		$ -
Subtotal	$ -	$ -		$ -
Contingencies (15%)	$ -	$ -		$ -
Subtotal	$ -	$ -		$ -
Project Management (5%)	$ -	$ -		$ -
Engineering (6%)	$ -	$ -		$ -
Construction Administration (8%)	$ -	$ -		$ -
Total, Capital Cost	$ -	$ -		$ -
Operations and Maintenance (O & M)				
Semiannual Surface Water, Sediment Sampling, Analysis and Reporting, Years 1-10	$ 13,000	$ 13,000		$ 26,000
Annual Monitoring Years 11-30	$ 6,500	$ 6,500		$ 13,000
Total, 30-yr Present Worth, O & M (3%)	$ 182,849	$ 182,849		$ 365,698
TOTAL CAPITAL COST + O & M	$ 182,849	$ 182,849		$ 365,698
TOTAL EA4 MNR COSTS WITH 30-YR PRESENT WORTH O & M				**$ 365,698**

EA4 COST ESTIMATE DETAIL
MONITORED NATURAL RECOVERY*

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Contingencies		15%		$ -	
			Subtotal	$ -	
Project Management		5%		$ -	
Engineering		6%		$ -	
Construction Management		8%		$ -	
TOTAL				$ -	
			TOTAL CAPITAL COSTS	**$ -**	

OPERATIONS AND MAINTENANCE (O & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Semiannual Surface Water, Sediment Sampling, Analysis and Reporting, Years 1-10	LS	$26,000.00	1	$ 26,000	Based on current costs and increased to account for add'l stations and semiannual monitoring
Annual Monitoring Years 11-30	LS	$13,000.00	1	$ 13,000	
			Subtotal	$ 39,000	
			30-YEAR NET PRESENT VALUE ANNUAL O & M COSTS	**$ 365,698**	**Discounted using the rate below**

* Surface water in the marsh is considered part of EA4 and is evaluated independent of the surface water for EA3.

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O & M COST) $ 365,698

Surface Water and Sediment Monitoring	EA	$12,000.00	2	$24,000.00	Existing Annual Budget is ~$65K for SW/Sed. Add locations above, below, and in the middle of upper marsh and make this semiannual (high + low flow)
Analysis and Report	EA	$2,000	1	$2,000.00	
			Annual Cost	$26,000.00	

EA 4 COSTS				
CONTAINMENT	**Eastern Area**	**Western Area**		**TOTAL**
Permitting	$ 20,000	$ 20,000		$ 40,000
Surface Water and Sediment Control	$ 30,000	$ 30,000		$ 60,000
Dewatering	$ 135,518	$ 166,014		$ 301,532
Improve/Construct Access Roads	$ 27,000	$ 18,000		$ 45,000
Re-Grade Marsh Sediment Areas, Strip Veg, Clear and Grub, Prep for Cover Soil Placement	$ 203,277	$ 249,021		$ 452,298
Load, Haul, Place Vegetative Cover	$ 1,355,178	$ 1,660,140		$ 3,015,318
Seed, Fertilize	$ 55,999	$ 68,601		$ 124,600
Reclaim Cover Soil Borrow Area	$ 83,999	$ 102,901		$ 186,900
Subtotal	$ 1,910,970	$ 2,314,677		$ 4,225,647
Mob/Demob (10%)	$ 191,097	$ 231,468		$ 422,565
Subtotal	$ 2,102,067	$ 2,546,145		$ 4,648,211
Contingencies (15%)	$ 315,310	$ 381,922		$ 697,232
Subtotal	$ 2,417,377	$ 2,928,066		$ 5,345,443
Project Management (5%)	$ 120,869	$ 146,403		$ 267,272
Engineering (6%)	$ 145,043	$ 175,684		$ 320,727
Construction Administration (8%)	$ 193,390	$ 234,245		$ 427,635
Total, Capital Cost	$ 2,876,678	$ 3,484,399		$ 6,361,077
Operations and Maintenance (O & M)				
Site Inspections, Vegetation Maintenance and Repairs, Years 1-30	$ 1,250	$ 1,250		$ 2,500
Periodic Repairs - Years 15 and 30 (1/4th remedial cost- re-coversoil, reveg)	$ 392,490	$ 392,490		$ 784,979
Total, 30-yr Present Worth, O & M (3%)	$ 438,125	$ 438,125		$ 876,251
TOTAL CAPITAL COST + O & M	$ 3,314,803	$ 3,922,524		$ 7,237,328
TOTAL EA4 CONTAINMENT COSTS WITH 30-YR PRESENT WORTH O & M				**$ 7,237,328**

EA 4 COST ESTIMATE DETAIL
CONTAINMENT

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Mobilization, Bonding, Insurance	LS	$ 422,564.67	1	$ 422,565	10% of construction cost
Permitting	LS	$ 40,000.00	1	$ 40,000	Engineer Estimate
Surface Water and Sediment Control	LS	$ 60,000.00	1	$ 60,000	Engineer Estimate
Dewatering - Total	CY	$ 1.50	201,021	$ 301,532	Engineer Estimate
Eastern Area	CY	$ 1.50	90,345	$ 135,518	
Western Area	CY	$ 1.50	110,676	$ 166,014	
Improve/Construct Access Roads - Total	LF	$ 18.00	2,500	$ 45,000	Includes Clear/Grub/Log, Reclamation
Eastern Area	LF	$ 18.00	1,500	$ 27,000	
Western Area	LF	$ 18.00	1,000	$ 18,000	
Re-Grade Marsh Sediment Areas, Strip Veg, Clear and Grub, Prep for Cover Soil Placement - Total	SY	$ 1.50	301,532	$ 452,298	Engineer Estimate
Eastern Area	SY	$ 1.50	135,518	$ 203,277	
Western Area	SY	$ 1.50	166,014	$ 249,021	
Load, Haul, Place Vegetative Cover - Total	CY	$ 15.00	201,021	$ 3,015,318	Engineer Estimate
Eastern Area	CY	$ 15.00	90,345	$ 1,355,178	
Western Area	CY	$ 15.00	110,676	$ 1,660,140	
Seed, Fertilize - Total	AC	$ 2,000.00	62.3	$ 124,600	Engineer Estimate
Eastern Area	AC	$ 2,000.00	28.0	$ 55,999	
Western Area	AC	$ 2,000.00	34.3	$ 68,601	
Reclaim Cover Soil Borrow Area - Total	AC	$ 4,500.00	41.5	$ 186,900	Engineer Estimate
Eastern Area	AC	$ 4,500.00	18.7	$ 83,999	
Western Area	AC	$ 4,500.00	22.9	$ 102,901	
			Subtotal	$ 4,648,211	
Contingencies		15%		$ 697,231.70	
			Subtotal	$ 5,345,443	
Project Management		5%		$ 267,272	
Engineering		6%		$ 320,727	
Construction Management		8%		$ 427,635	
TOTAL				$ 6,361,077	
			TOTAL CAPITAL COSTS	**$ 6,361,077**	

OPERATIONS AND MAINTENANCE (O & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Site Inspections, Vegetation Maintenance and Repairs, Years 1-30	LS	$ 2,500.00	1	$ 2,500	Engineers Estimate
Periodic Repairs - Years 15 and 30 (1/4th remedial cost- re-coversoil, reveg)	LS	$ 784,979.36	1	$ 784,979	Engineers Estimate
			Subtotal	$ 787,479	
			30-YEAR NET PRESENT VALUE ANNUAL O & M COSTS	**$ 876,251**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O & M COST) $ 7,237,328

EA 4 COSTS							
REMOVAL AND ON-SITE DISPOSAL	**Eastern Area**		**Western Area**			**TOTAL**	
Permitting	$	20,000	$	20,000		$	40,000
Surface Water and Sediment Control	$	40,000	$	40,000		$	80,000
Dewatering	$	451,726	$	553,380		$	1,005,106
Improve/Construct Access Roads	$	27,000	$	18,000		$	45,000
Excavate, Load, Haul and Place Sediment in Repository	$	1,355,178	$	1,660,140		$	3,015,318
Load, Haul, Place Clean Backfill/Vegetative Cover	$	677,589	$	830,070		$	1,507,659
Revegetate Floodplain Areas	$	223,996	$	274,403		$	498,400
Revegetate Cover Soil Borrow Area	$	34,999	$	42,876		$	77,875
Subtotal	$	2,830,488	$	3,438,869		$	6,269,357
Mob/Demob (10%)	$	283,049	$	343,887		$	626,936
Subtotal	$	3,113,537	$	3,782,756		$	6,896,292
Contingencies (15%)	$	467,030	$	567,413		$	1,034,444
Subtotal	$	3,580,567	$	4,350,169		$	7,930,736
Project Management (5%)	$	179,028	$	217,508		$	396,537
Engineering (6%)	$	214,834	$	261,010		$	475,844
Construction Administration (8%)	$	286,445	$	348,014		$	634,459
Total, Capital Cost	$	4,260,875	$	5,176,701		$	9,437,576
Operations and Maintenance (O & M)							
Site Inspections, Vegetation Maintenance and Repairs, Years 1-5	$	20,000	$	20,000		$	40,000
Site Inspections, Vegetation Maintenance and Repairs, Years 6-30	$	7,500	$	7,500		$	15,000
Total, 30-yr Present Worth, O & M (3%)	$	204,250	$	204,250		$	408,499
TOTAL CAPITAL COST + O & M	$	4,465,125	$	5,380,951		$	9,846,075
TOTAL EA4 REMOVAL AND ON-SITE DISPOSAL COSTS WITH 30-YR PRESENT WORTH O & M						**$**	**9,846,075**

EA4 COST ESTIMATE DETAIL

REMOVAL AND ON-SITE DISPOSAL

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Mobilization, Bonding, Insurance	LS	$ 626,935.67	1	$ 626,936	10% of construction cost
Permitting	LS	$ 40,000.00	1	$ 40,000	Engineer Estimate
Surface Water and Sediment Control	LS	$ 80,000.00	1	$ 80,000	Engineer Estimate
Dewatering - Total	CY	$ 5.00	201,021	$ 1,005,106	Engineer Estimate
Eastern Area	CY	$ 5.00	90,345	$ 451,726	
Western Area	CY	$ 5.00	110,676	$ 553,380	
Improve/Construct Access Roads - Total	LF	$ 18.00	2,500	$ 45,000	Includes Clear/Grub/Log, Reclamation
Eastern Area	LF	$ 18.00	1,500	$ 27,000	
Western Area	LF	$ 18.00	1,000	$ 18,000	
Excavate, Load, Haul and Place Sediment in Repository - Total	CY	$ 15.00	201,021	$ 3,015,318	Engineer Estimate
Eastern Area	CY	$ 15.00	90,345	$ 1,355,178	
Western Area	CY	$ 15.00	110,676	$ 1,660,140	
Load, Haul, Place Clean Backfill/Vegetative Cover - Total	CY	$ 15.00	100,511	$ 1,507,659	Not all areas returned to grade
Eastern Area	CY	$ 15.00	45,173	$ 677,589	
Western Area	CY	$ 15.00	55,338	$ 830,070	
Revegetate Floodplain Areas - Total	AC	$ 8,000.00	62	$ 498,400	
Eastern Area	AC	$ 8,000.00	28	$ 223,996	
Western Area	AC	$ 8,000.00	34	$ 274,403	
Revegetate Cover Soil Borrow Area - Total	AC	$ 2,500.00	31.1	$ 77,875	Based on Bald Butte
Eastern Area	AC	$ 2,500.00	14.0	$ 34,999	
Western Area	AC	$ 2,500.00	17.2	$ 42,876	
			Subtotal	$ 6,896,292	
Contingencies		15%		$ 1,034,444	
			Subtotal	$ 7,930,736	
Project Management		5%		$ 396,537	
Engineering		6%		$ 475,844	
Construction Management		8%		$ 634,459	
TOTAL				$ 9,437,576	
			TOTAL CAPITAL COSTS	**$ 9,437,576**	

OPERATIONS AND MAINTENANCE (O & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Site Inspections, Vegetation Maintenance and Repairs, Years 1-5	LS	$ 40,000.00	1	$ 40,000	Engineers Estimate; O & M costs for the Section 35 repository are not included.
Site Inspections, Vegetation Maintenance and Repairs, Years 6-30	LS	$ 15,000.00	1	$ 15,000	Engineers Estimate; O & M costs for the Section 35 repository are not included.
			Subtotal	$ 55,000	
			30-YEAR NET PRESENT VALUE ANNUAL O & M COSTS	**$ 408,499**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O & M COST) $ 9,846,075

EA 4 COSTS				
REMOVAL AND OFF-SITE DISPOSAL	**Eastern Area**	**Western Area**		**TOTAL**
Permitting	$ 20,000	$ 20,000		$ 40,000
Surface Water and Sediment Control	$ 40,000	$ 40,000		$ 80,000
Dewatering	$ 451,726	$ 553,380		$ 1,005,106
Improve/Construct Access Roads	$ 27,000	$ 18,000		$ 45,000
Construct Off-site Repository	$ 1,017,286	$ 1,017,286		$ 2,034,571
Excavate, Load, Haul and Place Sediment in Repository	$ 1,355,178	$ 1,660,140		$ 3,015,318
Load, Haul, Place Clean Backfill/Vegetative Cover	$ 677,589	$ 830,070		$ 1,507,659
Revegetate Floodplain Areas	$ 223,996	$ 274,403		$ 498,400
Revegetate Cover Soil Borrow Area	$ 34,999	$ 42,876		$ 77,875
Subtotal	$ 3,847,774	$ 4,456,154		$ 8,303,928
Mob/Demob (10%)	$ 384,777	$ 445,615		$ 830,393
Subtotal	$ 4,232,551	$ 4,901,770		$ 9,134,321
Contingencies (15%)	$ 634,883	$ 735,265		$ 1,370,148
Subtotal	$ 4,867,433	$ 5,637,035		$ 10,504,469
Project Management (5%)	$ 243,372	$ 281,852		$ 525,223
Engineering (6%)	$ 292,046	$ 338,222		$ 630,268
Construction Administration (8%)	$ 389,395	$ 450,963		$ 840,358
Total, Capital Cost	$ 5,792,246	$ 6,708,072		$ 12,500,318
Operations and Maintenance (O & M)				
Site Inspections, Vegetation Maintenance and Repairs, Years 1-5	$ 20,000	$ 20,000		$ 40,000
Site Inspections, Vegetation Maintenance and Repairs, Years 6-30	$ 7,500	$ 7,500		$ 15,000
Total, 30-yr Present Worth, O & M (3%)	$ 204,250	$ 204,250		$ 408,499
TOTAL CAPITAL COST + O & M	$ 5,996,496	$ 6,912,322		$ 12,908,817
TOTAL EA4 REMOVAL AND OFF-SITE DISPOSAL COSTS WITH 30-YR PRESENT WORTH O & M				**$ 12,908,817**

EA4 COST ESTIMATE DETAIL
REMOVAL AND OFF-SITE DISPOSAL

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Mobilization, Bonding, Insurance	LS	$ 830,392.80	1	$ 830,393	10% of construction cost
Permitting	LS	$ 40,000.00	1	$ 40,000	Engineer Estimate
Surface Water and Sediment Control	LS	$ 80,000.00	1	$ 80,000	Engineer Estimate
Dewatering - Total	CY	$ 5.00	201,021	$ 1,005,106	Engineer Estimate
Eastern Area	CY	$ 5.00	90,345	$ 451,726	
Western Area	CY	$ 5.00	110,676	$ 553,380	
Improve/Construct Access Roads - Total	LF	$ 18.00	2,500	$ 45,000	Includes Clear/Grub/Log, Reclamation
Eastern Area	LF	$ 18.00	1,500	$ 27,000	
Western Area	LF	$ 18.00	1,000	$ 18,000	
Construct Off-site Repository	CY	$ 10.12	201,021	$ 2,034,571	State Section 18 *
Excavate, Load, Haul and Place Sediment in Repository - Total	CY	$ 15.00	201,021	$ 3,015,318	Engineer Estimate
Eastern Area	CY	$ 15.00	90,345	$ 1,355,178	
Western Area	CY	$ 15.00	110,676	$ 1,660,140	
Load, Haul, Place Clean Backfill/Vegetative Cover - Total	CY	$ 15.00	100,511	$ 1,507,659	Not all areas returned to grade
Eastern Area	CY	$ 15.00	45,173	$ 677,589	
Western Area	CY	$ 15.00	55,338	$ 830,070	
Revegetate Floodplain Areas - Total	AC	$ 8,000.00	62	$ 498,400	
Eastern Area	AC	$ 8,000.00	28	$ 223,996	
Western Area	AC	$ 8,000.00	34	$ 274,403	
Revegetate Cover Soil Borrow Area - Total	AC	$ 2,500.00	31.1	$ 77,875	Based on Bald Butte
Eastern Area	AC	$ 2,500.00	14.0	$ 34,999	
Western Area	AC	$ 2,500.00	17.2	$ 42,876	
			Subtotal	$ 9,134,321	
Contingencies		15%		$ 1,370,148	
			Subtotal	$ 10,504,469	
Project Management		5%		$ 525,223	
Engineering		6%		$ 630,268	
Construction Management		8%		$ 840,358	
TOTAL				$ 12,500,318	
			TOTAL CAPITAL COSTS	**$ 12,500,318**	

OPERATIONS AND MAINTENANCE (O & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Site Inspections, Vegetation Maintenance and Repairs, Years 1-5	LS	$ 40,000.00	1	$ 40,000	Engineers Estimate
Site Inspections, Vegetation Maintenance and Repairs, Years 6-30	LS	$ 15,000.00	1	$ 15,000	Engineers Estimate
			Subtotal	$ 55,000	
30-YEAR NET PRESENT VALUE ANNUAL O & M COSTS				**$ 408,499**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O & M COST) $ 12,908,817

* From the Repository Siting Study for UBMC - State Section 18 Site estimate was $15,034,436 for a 1,000,000 cy repository and includes wastes removed under the EE/CA actions. The total estimated cost included hauling and placement of waste. Construction costs for the repository were $4,048,472. For purposes of this feasibility study, estimated costs from the siting study are scaled to a 400,000 cy repository for a repository construction cost of $10.12/cy.

EA 4 COSTS				
MONITORED NATURAL ATTENUATION	**Eastern Area**	**Western Area**		**TOTAL**
Subtotal	$ -	$ -		$ -
Mob/Demob (10%)	$ -	$ -		$ -
Subtotal	$ -	$ -		$ -
Contingencies (15%)	$ -	$ -		$ -
Subtotal	$ -	$ -		$ -
Project Management (5%)	$ -	$ -		$ -
Engineering (6%)	$ -	$ -		$ -
Construction Administration (8%)	$ -	$ -		$ -
Total Capital Cost	$ -	$ -		$ -
Operations and Maintenance (O & M)				
Semiannual Groundwater Sampling, Analysis and Reporting, Years 1-10	$ 11,000	$ 11,000		$ 22,000
Annual Monitoring Years 11-30	$ 5,500	$ 5,500		$ 11,000
Total, 30-yr Present Worth, O & M (3%)	$ 154,719	$ 154,719		$ 309,437
TOTAL CAPITAL COST + O & M	$ 154,719	$ 154,719		$ 309,437
TOTAL EA4 MNA COSTS WITH 30-YR PRESENT WORTH O & M				**$ 309,437**

EA4 COST ESTIMATE DETAIL
MONITORED NATURAL ATTENUATION - GROUNDWATER*

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Contingencies		15%		$ -	
			Subtotal	$ -	
Project Management		5%		$ -	
Engineering		6%		$ -	
Construction Management		8%		$ -	
TOTAL				$ -	
			TOTAL CAPITAL COSTS	**$ -**	

OPERATIONS AND MAINTENANCE (O & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Semiannual Groundwater Sampling, Analysis and Reporting, Years 1-10	LS	$ 22,000.00	1	$ 22,000	Based on current costs and adjusted for 4 wells and semiannual monitoring
Annual Monitoring Years 11-30	LS	$ 11,000.00	1	$ 11,000	Reduce to annual monitoring
			Subtotal	$ 33,000	
			30-YEAR NET PRESENT VALUE ANNUAL O & M COSTS	**$ 309,437**	**Discounted using the rate below**

* Groundwater in the marsh is considered part of EA4 and is evaluated independent of the groundwater for EA2.

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O & M COST) $ 309,437

Groundwater Monitoring	EA	$10,000.00	2	$20,000.00	Existing Annual Budget is ~$65K for GW sitewide. Estimate includes 4 existing wells - EDMW-2, PDGW-101, PMGW-117, LCMW-1. Monitor semiannually.
Analysis and Report	EA	$2,000	1	$2,000.00	
			Annual Cost	$22,000.00	

EA4 - UPPER MARSH - QUANTITY ESTIMATES					
SITE	SEDIMENT		HAUL ROADS		
	AREA	VOLUME	LENGTH	IMPROVE?	FENCING
	(sf)	(cy)	(ft)		(ft)
Eastern Area	1,219,660	90,345	1,500	NEW	0
Western Area	1,494,126	110,676	1,000	NEW	0
	2,713,786	201,021	2,500		
Groundwater Quantity					
Darcy's Law Q= KiA					
K	3.8	ft/day	Well LCMW-1/MPP-4 Pump test from 20		
i	0.0198	ft/ft	Average Hydraulic Gradient from Potenti Map - Figure 21 of the FS		
A	68,900	ft^2	Width = 1300 (avg at middle of Upper Ma		
			Depth = 53' (Well Log BRGW-101 - RI)		
Q	5,184	ft^3/day			
	0.060	cfs			
	26.9	gpm			

EVALUATION AREA	SITE-WIDE ELEMENTS			REMEDIAL ALTERNATIVE COSTS						
EA 5				No Action	PHYSICAL HAZARDS/SOLID MEDIA					
					ENGINEERING CONTROLS/LAND DISPOSAL				TREATMENT	
									In-situ	Ex-situ
Mining-related Features	ICs	Access Restrictions	Long-term Monitoring and Maintenance		Physical Barriers	Containment	Removal and On-site Disposal	Removal and Off-site Disposal	Neutralization W/Alkaline Amendment	Neutralization W/Alkaline Amendment
AC-01	$0.00	$6,661	$8,211	$0.00	N/A	$67,727	$61,025	$70,069	$51,991	N/A
BR-01, BR-14, BR-16, BR-20 BR-32, BR-39	$0.00	$28,338	$19,716	$0.00	N/A	$464,885	$397,640	$488,383	$306,993	N/A
BR-29	$0.00	$5,645	$7,855	$0.00	N/A	$62,031	$58,278	$63,342	$53,219	N/A
PC-01, PC-21	$0.00	$4,968	$7,618	$0.00	$121,191	N/A	N/A	N/A	N/A	N/A
PC-06, PC-11, PC-22	$0.00	$16,371	$11,609	$0.00	N/A	$229,335	$199,847	$239,639	$160,098	N/A
PBBS	$0.00	N/A	N/A	$0.00	N/A	N/A	N/A	N/A	N/A	N/A
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	$0.00	$23,258	$17,939	$0.00	N/A	$262,891	$218,606	$278,366	$158,909	N/A
PM-26, PM-28	$0.00	$15,129	$11,174	$0.00	N/A	$245,409	$207,129	$258,786	$155,526	N/A
SH-17, SH-23, SH-29, SH-37, SH-43 SH-44	$0.00	$35,338	$22,166	$0.00	N/A	$757,822	$602,074	$812,248	$392,124	N/A
SH-06, SH-07, SH-13, SH-14	$0.00	$30,596	$20,506	$0.00	$65,496	$808,060	$607,411	$878,176	$336,933	N/A
SG-13/14, SG-16, SG-43	$0.00	$22,919	$17,820	$0.00	N/A	$435,417	$346,124	$466,621	$225,754	N/A
SG-24, SG-44, SG-53, SG-55, SG-56 SG-58, SG-67, SG-98	$0.00	$60,063	$35,718	$0.00	N/A	$2,460,763	$1,855,854	$2,672,149	$1,040,427	N/A
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78, SG-82 SG-94, SG-95, SG-96, SG-99	$0.00	$41,209	$43,821	$0.00	N/A	$453,847	$353,603	$488,878	$218,473	N/A
SG-01, SG-31, SG-33, SG-35 SG-86, SG-89	$0.00	$19,984	$21,693	$0.00	$7,158	$250,043	$211,843	$263,392	$160,349	N/A
SWG-02	$0.00	$17,951	$16,082	$0.00	N/A	$52,305	$49,035	$53,448	$44,626	N/A
TOTAL COSTS	**$0**	**$328,430**	**$261,928**	**$0**	**$193,845**	**$6,550,534**	**$5,168,469**	**$7,033,497**	**$3,305,422**	**$0**

EA 5 COSTS

SITE-WIDE ELEMENT	AC-01	BR-01, BR-14 BR-16, BR-20 BR-32, BR-39	BR-29	PC-01, PC-21	PC-06, PC-11 PC-22	PBBS	PM-04, PM-06 PM-12, PM-35 PM-37, JM-01	PM-26, PM-28	SH-17, SH-23 SH-29, SH-37 SH-43, SH-44	SH-06, SH-07 SH-13, SH-14	SG-13/14, SG-16 SG-43	SG-24, SG-44 SG-53, SG-55 SG-56, SG-58 SG-67, SG-98	SG-41, SG-47 SG-48, SG-49/50 SG-51, SG-71 SG-78, SG-82 SG-94, SG-95 SG-96, SG-99	SG-01, SG-31 SG-33, SG-35 SG-86, SG-89	SWG-01	TOTAL
	MINING-RELATED FEATURES															
	Anaconda Creek	*Blackfoot River*		*Pass Creek*		*Porcupine Gulch*	*Paymaster Gulch*		*Shave Gulch*		*Stevens Gulch*				*Swamp Gulch*	
Access Restrictions																
Construct Fence	$ 2,775	$ 8,925	$ 2,100	$ -	$ 5,925	$ -	$ 7,200	$ 6,750	$ 13,575	$ 15,375	$ 10,275	$ 26,700	$ 10,875	$ 6,675	$ 10,275	**$ 127,425**
Install Gates	$ 1,500	$ 9,000	$ 1,500	$ 3,000	$ 4,500	$ -	$ 7,500	$ 3,000	$ 9,000	$ 4,500	$ 4,500	$ 12,000	$ 15,000	$ 6,000	$ 1,500	**$ 82,500**
Install Warning Signs	$ 150	$ 900	$ 150	$ 300	$ 450	$ -	$ 750	$ 300	$ 900	$ 450	$ 450	$ 1,200	$ 1,500	$ 600	$ 150	**$ 8,250**
Subtotal	$ 4,425	$ 18,825	$ 3,750	$ 3,300	$ 10,875	$ -	$ 15,450	$ 10,050	$ 23,475	$ 20,325	$ 15,225	$ 39,900	$ 27,375	$ 13,275	$ 11,925	**$ 218,175**
Mob/Demob (10%)	$ 443	$ 1,883	$ 375	$ 330	$ 1,088	$ -	$ 1,545	$ 1,005	$ 2,348	$ 2,033	$ 1,523	$ 3,990	$ 2,738	$ 1,328	$ 1,193	**$ 21,818**
Subtotal	$ 4,868	$ 20,708	$ 4,125	$ 3,630	$ 11,963	$ -	$ 16,995	$ 11,055	$ 25,823	$ 22,358	$ 16,748	$ 43,890	$ 30,113	$ 14,603	$ 13,118	**$ 239,993**
Contingencies (15%)	$ 730	$ 3,106	$ 619	$ 545	$ 1,794	$ -	$ 2,549	$ 1,658	$ 3,873	$ 3,354	$ 2,512	$ 6,584	$ 4,517	$ 2,190	$ 1,968	**$ 35,999**
Subtotal	$ 5,598	$ 23,814	$ 4,744	$ 4,175	$ 13,757	$ -	$ 19,544	$ 12,713	$ 29,696	$ 25,711	$ 19,260	$ 50,474	$ 34,629	$ 16,793	$ 15,085	**$ 275,991**
Project Management (5%)	$ 280	$ 1,191	$ 237	$ 209	$ 688	$ -	$ 977	$ 636	$ 1,485	$ 1,286	$ 963	$ 2,524	$ 1,731	$ 840	$ 754	**$ 13,800**
Engineering (6%)	$ 336	$ 1,429	$ 285	$ 250	$ 825	$ -	$ 1,173	$ 763	$ 1,782	$ 1,543	$ 1,156	$ 3,028	$ 2,078	$ 1,008	$ 905	**$ 16,559**
Construction Administration (8%)	$ 448	$ 1,905	$ 380	$ 334	$ 1,101	$ -	$ 1,564	$ 1,017	$ 2,376	$ 2,057	$ 1,541	$ 4,038	$ 2,770	$ 1,343	$ 1,207	**$ 22,079**
Total, Capital Cost	$ 6,661	$ 28,338	$ 5,645	$ 4,968	$ 16,371	$ -	$ 23,258	$ 15,129	$ 35,338	$ 30,596	$ 22,919	$ 60,063	$ 41,209	$ 19,984	$ 17,951	**$ 328,430**
Long-Term Monitoring and Maintenance (M & M)																
Site Security, Fence and Sign Maintenance, Years 1-30 (Annual)	$ 300	$ 500	$ 300	$ 300	$ 300	$ -	$ 500	$ 300	$ 500	$ 500	$ 500	$ 750	$ 1,500	$ 750	$ 500	**$ 7,500**
Periodic Replacement - Years 15 and 30	$ 2,213	$ 9,413	$ 1,875	$ 1,650	$ 5,438	$ -	$ 7,725	$ 5,025	$ 11,738	$ 10,163	$ 7,613	$ 19,950	$ 13,688	$ 6,638	$ 5,963	**$ 109,088**
Total, 30-yr Present Worth, Long-Term M&M (3%)	$ 8,211	$ 19,716	$ 7,855	$ 7,618	$ 11,609	$ -	$ 17,939	$ 11,174	$ 22,166	$ 20,506	$ 17,820	$ 35,718	$ 43,821	$ 21,693	$ 16,082	**$ 261,928**
TOTAL EA5 SITE-WIDE ELEMENTS WITH 30-YR PRESENT WORTH LONG-TERM M&M																**$ 590,358**

EA5 COST ESTIMATE DETAIL
SITE-WIDE ELEMENTS

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
ACCESS RESTRICTIONS					
Mobilization, Bonding, Insurance	LS	$ 21,817.50	1	$ 21,818	10% of construction cost
Install Farm Fence - Total	LF	$ 7.50	16,990	$ 127,425	Based on Bald Butte/Great Divide
AC-01	LF	$ 7.50	370	$ 2,775	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	LF	$ 7.50	1,190	$ 8,925	
BR-29	LF	$ 7.50	280	$ 2,100	
PC-01, PC-21	LF	$ 7.50	0	$ -	
PC-06, PC-11, PC-22	LF	$ 7.50	790	$ 5,925	
PBBS	LF	$ 7.50	0	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	LF	$ 7.50	960	$ 7,200	
PM-26, PM-28	LF	$ 7.50	900	$ 6,750	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	LF	$ 7.50	1,810	$ 13,575	
SH-06, SH-07, SH-13, SH-14	LF	$ 7.50	2,050	$ 15,375	
SG-13/14, SG-16, SG-43	LF	$ 7.50	1,370	$ 10,275	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	LF	$ 7.50	3,560	$ 26,700	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78 SG-82 SG-94, SG-95, SG-96, SG-99	LF	$ 7.50	1,450	$ 10,875	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	LF	$ 7.50	890	$ 6,675	
SWG-02	LF	$ 7.50	1,370	$ 10,275	
Metal Security Gate - Total	EA	$ 1,500.00	55	$ 82,500	Based on Section 35 Bid Tabs
AC-01	EA	$ 1,500.00	1	$ 1,500	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	EA	$ 1,500.00	6	$ 9,000	
BR-29	EA	$ 1,500.00	1	$ 1,500	
PC-01, PC-21	EA	$ 1,500.00	2	$ 3,000	
PC-06, PC-11, PC-22	EA	$ 1,500.00	3	$ 4,500	
PBBS	EA	$ 1,500.00	0	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	EA	$ 1,500.00	5	$ 7,500	
PM-26, PM-28	EA	$ 1,500.00	2	$ 3,000	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	EA	$ 1,500.00	6	$ 9,000	
SH-06, SH-07, SH-13, SH-14	EA	$ 1,500.00	3	$ 4,500	
SG-13/14, SG-16, SG-43	EA	$ 1,500.00	3	$ 4,500	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	EA	$ 1,500.00	8	$ 12,000	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78 SG-82 SG-94, SG-95, SG-96, SG-99	EA	$ 1,500.00	10	$ 15,000	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	EA	$ 1,500.00	4	$ 6,000	
SWG-02	EA	$ 1,500.00	1	$ 1,500	
Metal Warning Signs - Total	EA	$ 150.00	55	$ 8,250	Engineer Estimate
AC-01	EA	$ 150.00	1	$ 150	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	EA	$ 150.00	6	$ 900	
BR-29	EA	$ 150.00	1	$ 150	
PC-01, PC-21	EA	$ 150.00	2	$ 300	
PC-06, PC-11, PC-22	EA	$ 150.00	3	$ 450	
PBBS	EA	$ 150.00	0	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	EA	$ 150.00	5	$ 750	
PM-26, PM-28	EA	$ 150.00	2	$ 300	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	EA	$ 150.00	6	$ 900	
SH-06, SH-07, SH-13, SH-14	EA	$ 150.00	3	$ 450	
SG-13/14, SG-16, SG-43	EA	$ 150.00	3	$ 450	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	EA	$ 150.00	8	$ 1,200	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78 SG-82 SG-94, SG-95, SG-96, SG-99	EA	$ 150.00	10	$ 1,500	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	EA	$ 150.00	4	$ 600	
SWG-02	EA	$ 150.00	1	$ 150	
			Subtotal	$ 239,993	
Contingencies		15%		$ 35,998.88	
			Subtotal	$ 275,991	
Project Management		5%		$ 13,799.57	
Engineering		6%		$ 16,559.48	
Construction Management		8%		$ 22,079.31	
TOTAL				$ 328,430	
			TOTAL CAPITAL COSTS	**$ 328,430**	

MONITORING AND MAINTENANCE (M & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Site Security, Fence and Sign Maintenance, Years 1-30	LS	$ 7,500.00	1	$ 7,500	Engineers Estimate
Periodic Replacement - Years 15 and 30	LS	$ 109,087.50	1	$ 109,088	1/2 of fence replaced
			Subtotal	$ 116,588	
	30-YEAR NET PRESENT VALUE ANNUAL M&M COSTS			**261,965**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (ICS + ACCESS RESTRICTIONS + M&M COST) **$590,395** Value for the EA as a whole is slightly different than value calculated by summing individual sites within the EA due to compounding rounding error.

EA 5 COSTS						
						TOTAL
		Pass Creek	*Shave Gulch*	*Stevens Gulch*		
YSICAL BARRIER		PC-01, PC-21	SH-06	SG-01		
Install Adit Closure		$ 60,000	$ 30,000	$ -		$ 90,000
Plug Well		$ -	$ -	$ 1,500		$ 1,500
Subtotal		$ 60,000	$ 30,000	$ 1,500		$ 91,500
mob (10%)	10%	$ 6,000	$ 3,000	$ 150		$ 9,150
Subtotal		$ 66,000	$ 33,000	$ 1,650		$ 100,650
ncies (15%)	15%	$ 9,900	$ 4,950	$ 248		$ 15,098
Subtotal		$ 75,900	$ 37,950	$ 1,898		$ 115,748
ment (5%)	5%	$ 3,795	$ 1,898	$ 95		$ 5,787
ering (6%)	6%	$ 4,554	$ 2,277	$ 114		$ 6,945
ration (8%)	8%	$ 6,072	$ 3,036	$ 152		$ 9,260
l, Capital Cost		$ 90,321	$ 45,161	$ 2,258		$ 137,740
Operations and Maintenance (O & M)						
Site Inspection		$ 500	$ 500	$ 250		$ 1,250
Periodic		$ 20,000	$ 10,000	$ -		$ 30,000
	9/16/2014	$ -	$ -	$ -		
	9/16/2029	$ 20,000	$ 10,000	$ -		$ 30,000
	9/12/2044	$ 20,000	$ 10,000	$ -		$ 20,000
Total, 30-yr	3%	$ 30,870	$ 20,335	$ 4,900		$ 56,106
TOTAL CAPITAL COST + O&M		$ 121,191	$ 65,496	$ 7,158		$ 193,845
TOTAL EA5 PHYSICAL BARRIERS COSTS WITH 30-YR PRESENT WORTH O&M						**$ 193,845**

EA5 COST ESTIMATE DETAIL
PHYSICAL BARRIER

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Mobilization, Bonding, Insurance	LS	$ 9,150.00	1	$ 9,150	10% of construction cost
Install Adit Closure	EA	$ 30,000.00	3	$ 90,000	Based on Bald Butte/Great Divide
PC-01, PC-21	EA	$ 30,000.00	2	$ 60,000	Incl. transportation and handling of
SH-06	EA	$ 30,000.00	1	$ 30,000	equipment and materials
Plug Well	EA	$ 1,500.00	1	$ 1,500	Based on Section 35 Bid Tabs
SG-01	EA	$ 1,500.00	1	$ 1,500	
			Subtotal	$ 100,650	
Contingencies		15%		$ 15,098	
			Subtotal	$ 115,748	
Project Management		5%		$ 5,787	
Engineering		6%		$ 6,945	
Construction Management		8%		$ 9,260	
TOTAL				$ 137,740	
			TOTAL CAPITAL COSTS	**$ 137,740**	

OPERATIONS AND MAINTENANCE (O & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Site Inspection and Maintenance, Years 1-30	LS	$ 1,250.00	1	$ 1,250	Engineers Estimate
Periodic Replacement - Years 15 and 30	LS	$ 30,000.00	1	$ 30,000	Engineers Estimate
			Subtotal	$ 31,250	
	30-YEAR NET PRESENT VALUE ANNUAL O&M COSTS			**$ 56,116**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O&M COST) $ 193,856

Value for the EA as a whole is slightly different than value calculated by summing individual sites within the EA due to compounding rounding error.

EA 5 COSTS																	
	MINING-RELATED FEATURES																
	Anaconda Creek	*Blackfoot River*		*Pass Creek*		*Porcupine Gulch*	*Paymaster Gulch*		*Shave Gulch*		*Stevens Gulch*				*Swamp Gulch*		
CONTAINMENT	**AC-01**	**BR-01, BR-14 BR-16, BR-20 BR-32, BR-39**	**BR-29**	**PC-01, PC-21**	**PC-06, PC-11 PC-22**	**PBBS**	**PM-04, PM-06 PM-12, PM-35 PM-37, JM-01**	**PM-26, PM-28**	**SH-17, SH-23 SH-29, SH-37 SH-43, SH-44**	**SH-06, SH-07 SH-13, SH-14**	**SG-13/14, SG-16 SG-43**	**SG-24, SG-44 SG-53, SG-55 SG-56, SG-58 SG-67, SG-98**	**SG-41, SG-47 SG-48, SG-49/50 SG-51, SG-71 SG-78, SG-82 SG-94, SG-95 SG-96, SG-99**	**SG-01, SG-31 SG-33, SG-35 SG-86, SG-89**	**SWG-01**		**TOTAL**
Improve/Construct Access Roads	$ 27,000	$ 151,200	$ 29,700	$ -	$ 81,000	$ -	$ 67,500	$ 75,600	$ 151,200	$ 89,100	$ 86,400	$ 291,600	$ 64,800	$ 75,600	$ 24,300		$ 1,215,000
Re-Grade Waste Piles, Prep for Cover Soil Placement	$ 3,375	$ 33,865	$ 1,890	$ -	$ 14,850	$ -	$ 22,302	$ 19,278	$ 78,435	$ 101,048	$ 44,969	$ 304,634	$ 50,483	$ 19,238	$ 1,647		$ 696,013
Load, Haul, Place Vegetative Cover	$ 9,000	$ 90,306	$ 5,040	$ -	$ 39,600	$ -	$ 59,472	$ 51,408	$ 209,160	$ 269,460	$ 119,916	$ 812,358	$ 134,622	$ 51,300	$ 4,392		$ 1,856,034
Seed, Fertilize, Mulch	$ 558	$ 5,597	$ 312	$ -	$ 2,455	$ -	$ 3,686	$ 3,186	$ 12,964	$ 16,702	$ 7,433	$ 50,353	$ 8,344	$ 3,180	$ 272		$ 115,043
Reclaim Cover Soil Borrow Area	$ 465	$ 4,665	$ 260	$ -	$ 2,045	$ -	$ 3,072	$ 2,655	$ 10,804	$ 13,918	$ 6,194	$ 41,961	$ 6,954	$ 2,650	$ 227		$ 95,870
Subtotal	$ 40,398	$ 285,633	$ 37,203	$ -	$ 139,950	$ -	$ 156,032	$ 152,128	$ 462,563	$ 490,228	$ 264,911	$ 1,500,906	$ 265,203	$ 151,967	$ 30,838		$ 3,977,960
Mob/Demob (10%)	$ 4,040	$ 28,563	$ 3,720	$ -	$ 13,995	$ -	$ 15,603	$ 15,213	$ 46,256	$ 49,023	$ 26,491	$ 150,091	$ 26,520	$ 15,197	$ 3,084		$ 397,796
Subtotal	$ 44,438	$ 314,196	$ 40,923	$ -	$ 153,945	$ -	$ 171,635	$ 167,341	$ 508,820	$ 539,251	$ 291,402	$ 1,650,996	$ 291,724	$ 167,164	$ 33,922		$ 4,375,756
Contingencies (15%)	$ 6,666	$ 47,129	$ 6,138	$ -	$ 23,092	$ -	$ 25,745	$ 25,101	$ 76,323	$ 80,888	$ 43,710	$ 247,649	$ 43,759	$ 25,075	$ 5,088		$ 656,363
Subtotal	$ 51,103	$ 361,325	$ 47,061	$ -	$ 177,037	$ -	$ 197,381	$ 192,442	$ 585,142	$ 620,138	$ 335,113	$ 1,898,646	$ 335,482	$ 192,238	$ 39,010		$ 5,032,119
Project Management (5%)	$ 2,555	$ 18,066	$ 2,353	$ -	$ 8,852	$ -	$ 9,869	$ 9,622	$ 29,257	$ 31,007	$ 16,756	$ 94,932	$ 16,774	$ 9,612	$ 1,951		$ 251,606
Engineering (6%)	$ 3,066	$ 21,680	$ 2,824	$ -	$ 10,622	$ -	$ 11,843	$ 11,547	$ 35,109	$ 37,208	$ 20,107	$ 113,919	$ 20,129	$ 11,534	$ 2,341		$ 301,927
Construction Administration (8%)	$ 4,088	$ 28,906	$ 3,765	$ -	$ 14,163	$ -	$ 15,790	$ 15,395	$ 46,811	$ 49,611	$ 26,809	$ 151,892	$ 26,839	$ 15,379	$ 3,121		$ 402,570
Total, Capital Cost	$ 60,813	$ 429,977	$ 56,003	$ -	$ 210,674	$ -	$ 234,883	$ 229,006	$ 696,319	$ 737,965	$ 398,784	$ 2,259,388	$ 399,224	$ 228,764	$ 46,422		$ 5,988,222
Operations and Maintenance (O & M)																	
Site Inspections, Vegetation Maintenance and Repairs, Years 1-30	$ 250	$ 750	$ 250	$ -	$ 500	$ -	$ 750	$ 250	$ 750	$ 500	$ 500	$ 1,000	$ 1,250	$ 500	$ 250		$ 7,500
Periodic Repairs - Years 15 and 30 (1/5th remedial cost)	$ 1,912	$ 19,181	$ 1,070	$ -	$ 8,411	$ -	$ 12,632	$ 10,919	$ 44,425	$ 57,232	$ 25,470	$ 172,542	$ 28,593	$ 10,896	$ 933		$ 394,215
Total, 30-yr Present Worth, O&M (3%)	$ 6,914	$ 34,907	$ 6,028	$ -	$ 18,661	$ -	$ 28,008	$ 16,403	$ 61,502	$ 70,095	$ 36,633	$ 201,375	$ 54,624	$ 21,279	$ 5,883		$ 562,312
TOTAL CAPITAL COST + O&M	$ 67,727	$ 464,885	$ 62,031	$ -	$ 229,335	$ -	$ 262,891	$ 245,409	$ 757,822	$ 808,060	$ 435,417	$ 2,460,763	$ 453,847	$ 250,043	$ 52,305		$ 6,550,534
TOTAL EA5 CONTAINMENT COSTS WITH 30-YR PRESENT WORTH O&M																	**$ 6,550,534**

EA5 COST ESTIMATE DETAIL
CONTAINMENT

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Mobilization, Bonding, Insurance	LS	$ 397,795.97	1	$ 397,796	10% of construction cost
Improve/Construct Access Roads - Total	LF	$ 18.00	42,150	$ 1,215,000	Includes Clear/Grub/Log, Reclamation
AC-01	LF	$ 18.00	1,500	$ 27,000	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	LF	$ 18.00	8,400	$ 151,200	
BR-29	LF	$ 18.00	1,650	$ 29,700	
PC-01, PC-21	LF	$ 18.00	0	$ -	
PC-06, PC-11, PC-22	LF	$ 18.00	4,500	$ 81,000	
PBBS	LF	$ 18.00	0	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	LF	$ 18.00	3,750	$ 67,500	
PM-26, PM-28	LF	$ 18.00	4,200	$ 75,600	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	LF	$ 18.00	8,400	$ 151,200	
SH-06, SH-07, SH-13, SH-14	LF	$ 18.00	4,950	$ 89,100	
SG-13/14, SG-16, SG-43	LF	$ 18.00	4,800	$ 86,400	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	LF	$ 18.00	16,200	$ 291,600	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78 SG-82 SG-94, SG-95, SG-96, SG-99	LF	$ 18.00	3,600	$ 64,800	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	LF	$ 18.00	4,200	$ 75,600	
SWG-02	LF	$ 18.00	1,350	$ 24,300	
Re-Grade Waste Piles, Prep for Cover Soil Placement - Total	SY	$ 4.50	71,114	$ 696,013	Engineer Estimate
AC-01	SY	$ 4.50	750	$ 3,375	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	SY	$ 4.50	7,526	$ 33,865	
BR-29	SY	$ 4.50	420	$ 1,890	
PC-01, PC-21	SY	$ 4.50	0	$ -	
PC-06, PC-11, PC-22	SY	$ 4.50	3,300	$ 14,850	
PBBS	SY	$ 4.50	0	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	SY	$ 4.50	4,956	$ 22,302	
PM-26, PM-28	SY	$ 4.50	4,284	$ 19,278	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	SY	$ 4.50	17,430	$ 78,435	
SH-06, SH-07, SH-13, SH-14	SY	$ 4.50	22,455	$ 101,048	
SG-13/14, SG-16, SG-43	SY	$ 4.50	9,993	$ 44,969	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	SY	$ 4.50	67,697	$ 304,634	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78 SG-82 SG-94, SG-95, SG-96, SG-99	SY	$ 4.50	11,219	$ 50,483	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	SY	$ 4.50	4,275	$ 19,238	
SWG-02	SY	$ 4.50	366	$ 1,647	
Load, Haul, Place Vegetative Cover - Total	CY	$ 18.00	103,113	$ 1,856,034	Engineer Estimate
AC-01	CY	$ 18.00	500	$ 9,000	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	CY	$ 18.00	5,017	$ 90,306	
BR-29	CY	$ 18.00	280	$ 5,040	
PC-01, PC-21	CY	$ 18.00	0	$ -	
PC-06, PC-11, PC-22	CY	$ 18.00	2,200	$ 39,600	
PBBS	CY	$ 18.00	0	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	CY	$ 18.00	3,304	$ 59,472	
PM-26, PM-28	CY	$ 18.00	2,856	$ 51,408	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	CY	$ 18.00	11,620	$ 209,160	
SH-06, SH-07, SH-13, SH-14	CY	$ 18.00	14,970	$ 269,460	
SG-13/14, SG-16, SG-43	CY	$ 18.00	6,662	$ 119,916	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	CY	$ 18.00	45,131	$ 812,358	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78 SG-82 SG-94, SG-95, SG-96, SG-99	CY	$ 18.00	7,479	$ 134,622	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	CY	$ 18.00	2,850	$ 51,300	
SWG-02	CY	$ 18.00	244	$ 4,392	

EA5 COST ESTIMATE DETAIL
CONTAINMENT

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Seed, Fertilize, Mulch - Total	AC	$ 3,000	38.3	$ 115,043	Engineer Estimate
AC-01	AC	$ 3,000	0.2	$ 558	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	AC	$ 3,000	1.9	$ 5,597	
BR-29	AC	$ 3,000	0.1	$ 312	
PC-01, PC-11	AC	$ 3,000	0.0	$ -	
PC-21, PC-11, PC-22	AC	$ 3,000	0.8	$ 2,455	
PBBS	AC	$ 3,000	0.0	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	AC	$ 3,000	1.2	$ 3,686	
PM-26, PM-28	AC	$ 3,000	1.1	$ 3,186	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	AC	$ 3,000	4.3	$ 12,964	
SH-06, SH-07, SH-13, SH-14	AC	$ 3,000	5.6	$ 16,702	
SG-13/14, SG-16, SG-43	AC	$ 3,000	2.5	$ 7,433	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	AC	$ 3,000	16.8	$ 50,353	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78 SG-82 SG-94, SG-95, SG-96, SG-99	AC	$ 3,000	2.8	$ 8,344	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	AC	$ 3,000	1.1	$ 3,180	
SWG-02	AC	$ 3,000	0.1	$ 272	
Reclaim Cover Soil Borrow Area - Total	AC	$ 4,500	21.3	$ 95,870	Engineer Estimate
AC-01	AC	$ 4,500	0.1	$ 465	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	AC	$ 4,500	1.0	$ 4,665	
BR-29	AC	$ 4,500	0.1	$ 260	
PC-01, PC-21	AC	$ 4,500	0.0	$ -	
PC-06, PC-11, PC-22	AC	$ 4,500	0.5	$ 2,045	
PBBS	AC	$ 4,500	0.0	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	AC	$ 4,500	0.7	$ 3,072	
PM-26, PM-28	AC	$ 4,500	0.6	$ 2,655	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	AC	$ 4,500	2.4	$ 10,804	
SH-06, SH-07, SH-13, SH-14	AC	$ 4,500	3.1	$ 13,918	
SG-13/14, SG-16, SG-43	AC	$ 4,500	1.4	$ 6,194	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	AC	$ 4,500	9.3	$ 41,961	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78 SG-82 SG-94, SG-95, SG-96, SG-99	AC	$ 4,500	1.5	$ 6,954	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	AC	$ 4,500	0.6	$ 2,650	
SWG-02	AC	$ 4,500	0.1	$ 227	
			Subtotal	$ 4,375,756	
Contingencies		15%		$ 656,363	
			Subtotal	$ 5,032,119	
Project Management		5%		$ 251,606	
Engineering		6%		$ 301,927	
Construction Management		8%		$ 402,570	
TOTAL				$ 5,988,222	
			TOTAL CAPITAL COSTS	**$ 5,988,222**	

OPERATIONS AND MAINTENANCE (O & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Site Inspections, Vegetation Maintenance and Repairs, Years 1-30	LS	$ 7,500.00	1	$ 7,500	Engineers Estimate
Periodic Repairs - Years 15 and 30 (1/5th remedial cost- re-coversoil, reveg)	LS	$ 394,215.49	1	$ 394,215	Engineers Estimate
			Subtotal	$ 401,715	
	30-YEAR NET PRESENT VALUE ANNUAL O&M COSTS			**$ 562,447**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O&M COST) $ 6,550,668

Value for the EA as a whole is slightly different than value calculated by summing individual sites within the EA due to compounding rounding error.

EA 5 COSTS																	
	MINING-RELATED FEATURES																
	Anaconda Creek	*Blackfoot River*		*Pass Creek*		*Porcupine Gulch*	*Paymaster Gulch*		*Shave Gulch*		*Stevens Gulch*				*Swamp Gulch*		
REMOVAL AND ON-SITE DISPOSAL	**AC-01**	**BR-01, BR-14 BR-16, BR-20 BR-32, BR-39**	**BR-29**	**PC-01, PC-21**	**PC-06, PC-11 PC-22**	**PBBS**	**PM-04, PM-06 PM-12, PM-35 PM-37, JM-01**	**PM-26, PM-28**	**SH-17, SH-23 SH-29, SH-37 SH-43, SH-44**	**SH-06, SH-07 SH-13, SH-14**	**SG-13/14, SG-16 SG-43**	**SG-24, SG-44 SG-53, SG-55 SG-56, SG-58 SG-67, SG-98**	**SG-41, SG-47 SG-48, SG-49/50 SG-51, SG-71 SG-78, SG-82 SG-94, SG-95 SG-96, SG-99**	**SG-01, SG-31 SG-33, SG-35 SG-86, SG-89**	**SWG-01**		**TOTAL**
Improve/Construct Access Roads	$ 27,000	$ 151,200	$ 29,700	$ -	$ 81,000	$ -	$ 67,500	$ 75,600	$ 151,200	$ 89,100	$ 86,400	$ 291,600	$ 64,800	$ 75,600	$ 24,300		$ 1,215,000
Excavate, Load, Haul and Place Waste in Repository	$ 7,500	$ 75,255	$ 4,200	$ -	$ 33,000	$ -	$ 49,560	$ 42,840	$ 174,300	$ 224,550	$ 99,930	$ 676,965	$ 112,185	$ 42,750	$ 3,660		$ 1,546,695
Load, Haul, Place Vegetative Cover	$ 1,875	$ 18,814	$ 1,050	$ -	$ 8,250	$ -	$ 12,390	$ 10,710	$ 43,575	$ 56,138	$ 24,983	$ 169,241	$ 28,046	$ 10,688	$ 915		$ 386,674
Seed, Fertilize, Mulch	$ 465	$ 4,665	$ 260	$ -	$ 2,045	$ -	$ 3,072	$ 2,655	$ 10,804	$ 13,918	$ 6,194	$ 41,961	$ 6,954	$ 2,650	$ 227		$ 95,870
Reclaim Cover Soil Borrow Area	$ 116	$ 1,166	$ 65	$ -	$ 511	$ -	$ 768	$ 664	$ 2,701	$ 3,480	$ 1,549	$ 10,490	$ 1,738	$ 662	$ 57		$ 23,967
Subtotal	$ 36,956	$ 251,099	$ 35,275	$ -	$ 124,807	$ -	$ 133,290	$ 132,469	$ 382,580	$ 387,185	$ 219,055	$ 1,190,257	$ 213,723	$ 132,350	$ 29,159		$ 3,268,206
Mob/Demob (10%)	$ 3,696	$ 25,110	$ 3,528	$ -	$ 12,481	$ -	$ 13,329	$ 13,247	$ 38,258	$ 38,719	$ 21,906	$ 119,026	$ 21,372	$ 13,235	$ 2,916		$ 326,821
Subtotal	$ 40,652	$ 276,209	$ 38,803	$ -	$ 137,288	$ -	$ 146,619	$ 145,716	$ 420,838	$ 425,904	$ 240,961	$ 1,309,283	$ 235,096	$ 145,585	$ 32,074		$ 3,595,026
Contingencies (15%)	$ 6,098	$ 41,431	$ 5,820	$ -	$ 20,593	$ -	$ 21,993	$ 21,857	$ 63,126	$ 63,886	$ 36,144	$ 196,392	$ 35,264	$ 21,838	$ 4,811		$ 539,254
Subtotal	$ 46,749	$ 317,641	$ 44,623	$ -	$ 157,881	$ -	$ 168,612	$ 167,574	$ 483,963	$ 489,790	$ 277,105	$ 1,505,675	$ 270,360	$ 167,422	$ 36,886		$ 4,134,280
Project Management (5%)	$ 2,337	$ 15,882	$ 2,231	$ -	$ 7,894	$ -	$ 8,431	$ 8,379	$ 24,198	$ 24,489	$ 13,855	$ 75,284	$ 13,518	$ 8,371	$ 1,844		$ 206,714
Engineering (6%)	$ 2,805	$ 19,058	$ 2,677	$ -	$ 9,473	$ -	$ 10,117	$ 10,054	$ 29,038	$ 29,387	$ 16,626	$ 90,341	$ 16,222	$ 10,045	$ 2,213		$ 248,057
Construction Administration (8%)	$ 3,740	$ 25,411	$ 3,570	$ -	$ 12,630	$ -	$ 13,489	$ 13,406	$ 38,717	$ 39,183	$ 22,168	$ 120,454	$ 21,629	$ 13,394	$ 2,951		$ 330,742
Total, Capital Cost	$ 55,632	$ 377,993	$ 53,102	$ -	$ 187,878	$ -	$ 200,648	$ 199,413	$ 575,916	$ 582,850	$ 329,754	$ 1,791,753	$ 321,728	$ 199,233	$ 43,894		$ 4,919,793
Operations and Maintenance (O & M)																	
Site Inspections, Vegetation Maintenance and Repairs, Years 1-30	$ 250	$ 750	$ 250	$ -	$ 500	$ -	$ 750	$ 250	$ 750	$ 500	$ 500	$ 1,000	$ 1,250	$ 500	$ 250		$ 7,500
Periodic Repairs - Years 15 and 30 (1/5th remedial cost)	$ 468	$ 4,696	$ 262	$ -	$ 2,059	$ -	$ 3,092	$ 2,673	$ 10,876	$ 14,011	$ 6,235	$ 42,240	$ 7,000	$ 2,667	$ 228		$ 96,509
Total, 30-yr Present Worth, O&M (3%)	$ 5,393	$ 19,647	$ 5,176	$ -	$ 11,969	$ -	$ 17,958	$ 7,716	$ 26,158	$ 24,561	$ 16,369	$ 64,101	$ 31,875	$ 12,610	$ 5,141		$ 248,676
TOTAL CAPITAL COST + O&M	$ 61,025	$ 397,640	$ 58,278	$ -	$ 199,847	$ -	$ 218,606	$ 207,129	$ 602,074	$ 607,411	$ 346,124	$ 1,855,854	$ 353,603	$ 211,843	$ 49,035		$ 5,168,469
TOTAL EA5 REMOVAL AND ON-SITE DISPOSAL COSTS WITH 30-YR PRESENT WORTH O&M																	**$ 5,168,469**

EA5 COST ESTIMATE DETAIL

REMOVAL AND ON-SITE DISPOSAL

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Mobilization, Bonding, Insurance	LS	$ 326,820.57	1	$ 326,821	10% of construction cost
Improve/Construct Access Roads - Total	LF	$ 18.00	42,150	$ 1,215,000	Includes Clear/Grub/Log, Reclamation
AC-01	LF	$ 18.00	1,500	$ 27,000	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	LF	$ 18.00	8,400	$ 151,200	
BR-29	LF	$ 18.00	1,650	$ 29,700	
PC-01, PC-21	LF	$ 18.00	0	$ -	
PC-06, PC-11, PC-22	LF	$ 18.00	4,500	$ 81,000	
PBBS	LF	$ 18.00	0	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	LF	$ 18.00	3,750	$ 67,500	
PM-26, PM-28	LF	$ 18.00	4,200	$ 75,600	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	LF	$ 18.00	8,400	$ 151,200	
SH-06, SH-07, SH-13, SH-14	LF	$ 18.00	4,950	$ 89,100	
SG-13/14, SG-16, SG-43	LF	$ 18.00	4,800	$ 86,400	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	LF	$ 18.00	16,200	$ 291,600	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78 SG-82 SG-94, SG-95, SG-96, SG-99	LF	$ 18.00	3,600	$ 64,800	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	LF	$ 18.00	4,200	$ 75,600	
SWG-02	LF	$ 18.00	1,350	$ 24,300	
Excavate, Load, Haul and Place Waste in Repository - Total	CY	$ 15.00	47,409	$ 1,546,695	Engineer Estimate
AC-01	CY	$ 15.00	500	$ 7,500	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	CY	$ 15.00	5,017	$ 75,255	
BR-29	CY	$ 15.00	280	$ 4,200	
PC-01, PC-21	CY	$ 15.00	0	$ -	
PC-06, PC-11, PC-22	CY	$ 15.00	2,200	$ 33,000	
PBBS	CY	$ 15.00	0	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	CY	$ 15.00	3,304	$ 49,560	
PM-26, PM-28	CY	$ 15.00	2,856	$ 42,840	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	CY	$ 15.00	11,620	$ 174,300	
SH-06, SH-07, SH-13, SH-14	CY	$ 15.00	14,970	$ 224,550	
SG-13/14, SG-16, SG-43	CY	$ 15.00	6,662	$ 99,930	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	CY	$ 15.00	45,131	$ 676,965	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78 SG-82 SG-94, SG-95, SG-96, SG-99	CY	$ 15.00	7,479	$ 112,185	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	CY	$ 15.00	2,850	$ 42,750	
SWG-02	CY	$ 15.00	244	$ 3,660	
Load, Haul, Place Vegetative Cover - Total	CY	$ 15.00	11,852	$ 386,674	6 inch cover imported over removal areas
AC-01	CY	$ 15.00	125	$ 1,875	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	CY	$ 15.00	1,254	$ 18,814	
BR-29	CY	$ 15.00	70	$ 1,050	
PC-01, PC-21	CY	$ 15.00	0	$ -	
PC-06, PC-11, PC-22	CY	$ 15.00	550	$ 8,250	
PBBS	CY	$ 15.00	0	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	CY	$ 15.00	826	$ 12,390	
PM-26, PM-28	CY	$ 15.00	714	$ 10,710	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	CY	$ 15.00	2,905	$ 43,575	
SH-06, SH-07, SH-13, SH-14	CY	$ 15.00	3,743	$ 56,138	
SG-13/14, SG-16, SG-43	CY	$ 15.00	1,666	$ 24,983	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	CY	$ 15.00	11,283	$ 169,241	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78 SG-82 SG-94, SG-95, SG-96, SG-99	CY	$ 15.00	1,870	$ 28,046	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	CY	$ 15.00	713	$ 10,688	
SWG-02	CY	$ 15.00	61	$ 915	
Seed, Fertilize, Mulch - Total	AC	$ 3,000	14.7	$ 95,870	Based on Bald Butte
AC-01	AC	$ 3,000	0.2	$ 465	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	AC	$ 3,000	1.6	$ 4,665	
BR-29	AC	$ 3,000	0.1	$ 260	
PC-01, PC-21	AC	$ 3,000	0.0	$ -	
PC-06, PC-11, PC-22	AC	$ 3,000	0.7	$ 2,045	

EA5 COST ESTIMATE DETAIL

REMOVAL AND ON-SITE DISPOSAL

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
PBBS	AC	$ 3,000	0.0	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	AC	$ 3,000	1.0	$ 3,072	
PM-26, PM-28	AC	$ 3,000	0.9	$ 2,655	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	AC	$ 3,000	3.6	$ 10,804	
SH-06, SH-07, SH-13, SH-14	AC	$ 3,000	4.6	$ 13,918	
SG-13/14, SG-16, SG-43	AC	$ 3,000	2.1	$ 6,194	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	AC	$ 3,000	14.0	$ 41,961	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78 SG-82 SG-94, SG-95, SG-96, SG-99	AC	$ 3,000	2.3	$ 6,954	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	AC	$ 3,000	0.9	$ 2,650	
SWG-02	AC	$ 3,000	0.1	$ 227	
Reclaim Cover Soil Borrow Area - Total	AC	$ 4,500	2.4	$ 23,967	Based on Bald Butte
AC-01	AC	$ 4,500	0.0	$ 116	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	AC	$ 4,500	0.3	$ 1,166	
BR-29	AC	$ 4,500	0.0	$ 65	
PC-01, PC-21	AC	$ 4,500	0.0	$ -	
PC-06, PC-11, PC-22	AC	$ 4,500	0.1	$ 511	
PBBS	AC	$ 4,500	0.0	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	AC	$ 4,500	0.2	$ 768	
PM-26, PM-28	AC	$ 4,500	0.1	$ 664	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	AC	$ 4,500	0.6	$ 2,701	
SH-06, SH-07, SH-13, SH-14	AC	$ 4,500	0.8	$ 3,480	
SG-13/14, SG-16, SG-43	AC	$ 4,500	0.3	$ 1,549	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	AC	$ 4,500	2.3	$ 10,490	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78 SG-82 SG-94, SG-95, SG-96, SG-99	AC	$ 4,500	0.4	$ 1,738	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	AC	$ 4,500	0.1	$ 662	
SWG-02	AC	$ 4,500	0.0	$ 57	
			Subtotal	$ 3,595,026	
Contingencies		15%		$ 539,254	
			Subtotal	$ 4,134,280	
Project Management		5%		$ 206,714	
Engineering		6%		$ 248,057	
Construction Management		8%		$ 330,742	
TOTAL				$ 4,919,793	
			TOTAL CAPITAL COSTS	**$ 4,919,793**	

OPERATIONS AND MAINTENANCE (O & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Site Inspections, Vegetation Maintenance and Repairs, Years 1-30	LS	$ 7,500.00	1	$ 7,500	Engineers Estimate
Periodic Repairs - Years 15 and 30 (1/5th remedial cost)	LS	$ 96,508.65	1	$ 96,509	Engineers Estimate
			Subtotal	$ 104,009	
30-YEAR NET PRESENT VALUE ANNUAL O&M COSTS				**$ 248,709**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O&M COST) $ 5,168,502

Value for the EA as a whole is slightly different than value calculated by summing individual sites within the EA due to compounding rounding error.

EA 5 COSTS																	
	MINING-RELATED FEATURES																
	Anaconda Creek	*Blackfoot River*		*Pass Creek*		*Porcupine Gulch*	*Paymaster Gulch*		*Shave Gulch*		*Stevens Gulch*				*Swamp Gulch*		
REMOVAL AND OFF-SITE DISPOSAL	**AC-01**	**BR-01, BR-14 BR-16, BR-20 BR-32, BR-39**	**BR-29**	**PC-01, PC-21**	**PC-06, PC-11 PC-22**	**PBBS**	**PM-04, PM-06 PM-12, PM-35 PM-37, JM-01**	**PM-26, PM-28**	**SH-17, SH-23 SH-29, SH-37 SH-43, SH-44**	**SH-06, SH-07 SH-13, SH-14**	**SG-13/14, SG-16 SG-43**	**SG-24, SG-44 SG-53, SG-55 SG-56, SG-58 SG-67, SG-98**	**SG-41, SG-47 SG-48, SG-49/50 SG-51, SG-71 SG-78, SG-82 SG-94, SG-95 SG-96, SG-99**	**SG-01, SG-31 SG-33, SG-35 SG-86, SG-89**	**SWG-01**		**TOTAL**
Construct Off-site Repository	$ 5,061	$ 50,778	$ 2,834	$ -	$ 22,267	$ -	$ 33,440	$ 28,906	$ 117,608	$ 151,514	$ 67,427	$ 456,779	$ 75,696	$ 28,845	$ 2,470		$ 1,043,625
Improve/Construct Access Roads	$ 27,000	$ 151,200	$ 29,700	$ -	$ 81,000	$ -	$ 67,500	$ 75,600	$ 151,200	$ 89,100	$ 86,400	$ 291,600	$ 64,800	$ 75,600	$ 24,300		$ 1,215,000
Excavate, Load, Haul and Place Waste in Repository	$ 7,500	$ 75,255	$ 4,200	$ -	$ 33,000	$ -	$ 49,560	$ 42,840	$ 174,300	$ 224,550	$ 99,930	$ 676,965	$ 112,185	$ 42,750	$ 3,660		$ 1,546,695
Load, Haul, Place Vegetative Cover	$ 1,875	$ 18,814	$ 1,050	$ -	$ 8,250	$ -	$ 12,390	$ 10,710	$ 43,575	$ 56,138	$ 24,983	$ 169,241	$ 28,046	$ 10,688	$ 915		$ 386,674
Seed, Fertilize, Mulch	$ 465	$ 4,665	$ 260	$ -	$ 2,045	$ -	$ 3,072	$ 2,655	$ 10,804	$ 13,918	$ 6,194	$ 41,961	$ 6,954	$ 2,650	$ 227		$ 95,870
Reclaim Cover Soil Borrow Area	$ 116	$ 1,166	$ 65	$ -	$ 511	$ -	$ 768	$ 664	$ 2,701	$ 3,480	$ 1,549	$ 10,490	$ 1,738	$ 662	$ 57		$ 23,967
Subtotal	$ 42,017	$ 301,877	$ 38,109	$ -	$ 147,073	$ -	$ 166,730	$ 161,375	$ 500,188	$ 538,700	$ 286,482	$ 1,647,036	$ 289,420	$ 161,195	$ 31,628		$ 4,311,831
Mob/Demob (10%)	$ 4,202	$ 30,188	$ 3,811	$ -	$ 14,707	$ -	$ 16,673	$ 16,138	$ 50,019	$ 53,870	$ 28,648	$ 164,704	$ 28,942	$ 16,120	$ 3,163		$ 431,183
Subtotal	$ 46,218	$ 332,065	$ 41,920	$ -	$ 161,781	$ -	$ 183,403	$ 177,513	$ 550,207	$ 592,569	$ 315,131	$ 1,811,740	$ 318,362	$ 177,315	$ 34,791		$ 4,743,014
Contingencies (15%)	$ 6,933	$ 49,810	$ 6,288	$ -	$ 24,267	$ -	$ 27,510	$ 26,627	$ 82,531	$ 88,885	$ 47,270	$ 271,761	$ 47,754	$ 26,597	$ 5,219		$ 711,452
Subtotal	$ 53,151	$ 381,875	$ 48,208	$ -	$ 186,048	$ -	$ 210,914	$ 204,140	$ 632,738	$ 681,455	$ 362,400	$ 2,083,501	$ 366,116	$ 203,912	$ 40,010		$ 5,454,466
Project Management (5%)	$ 2,658	$ 19,094	$ 2,410	$ -	$ 9,302	$ -	$ 10,546	$ 10,207	$ 31,637	$ 34,073	$ 18,120	$ 104,175	$ 18,306	$ 10,196	$ 2,000		$ 272,723
Engineering (6%)	$ 3,189	$ 22,912	$ 2,892	$ -	$ 11,163	$ -	$ 12,655	$ 12,248	$ 37,964	$ 40,887	$ 21,744	$ 125,010	$ 21,967	$ 12,235	$ 2,401		$ 327,268
Construction Administration (8%)	$ 4,252	$ 30,550	$ 3,857	$ -	$ 14,884	$ -	$ 16,873	$ 16,331	$ 50,619	$ 54,516	$ 28,992	$ 166,680	$ 29,289	$ 16,313	$ 3,201		$ 436,357
Total, Capital Cost	$ 63,250	$ 454,431	$ 57,368	$ -	$ 221,397	$ -	$ 250,987	$ 242,926	$ 752,958	$ 810,931	$ 431,256	$ 2,479,366	$ 435,678	$ 242,655	$ 47,611		$ 6,490,815
Operations and Maintenance (O & M)																	
Site Inspections, Vegetation Maintenance and Repairs, Years 1-30	$ 250	$ 750	$ 250	$ -	$ 500	$ -	$ 750	$ 250	$ 750	$ 500	$ 500	$ 1,000	$ 1,250	$ 500	$ 250		$ 7,500
Periodic Repairs - Years 15 and 30 (1/5th remedial cost)	$ 468	$ 4,696	$ 262	$ -	$ 2,059	$ -	$ 3,092	$ 2,673	$ 10,876	$ 14,011	$ 6,235	$ 42,240	$ 7,000	$ 2,667	$ 228		$ 96,509
Off-site Repository O&M and Repairs, Years 1-30	$ 73	$ 730	$ 41	$ -	$ 320	$ -	$ 481	$ 415	$ 1,690	$ 2,178	$ 969	$ 6,565	$ 1,088	$ 415	$ 35		$ 15,000
Total, 30-yr Present Worth, O&M (3%)	$ 6,819	$ 33,952	$ 5,975	$ -	$ 18,242	$ -	$ 27,379	$ 15,860	$ 59,290	$ 67,245	$ 35,365	$ 192,783	$ 53,200	$ 20,737	$ 5,836		$ 542,683
TOTAL CAPITAL COST + O&M	$ 70,069	$ 488,383	$ 63,342	$ -	$ 239,639	$ -	$ 278,366	$ 258,786	$ 812,248	$ 878,176	$ 466,621	$ 2,672,149	$ 488,878	$ 263,392	$ 53,448		$ 7,033,497
TOTAL EA5 REMOVAL AND OFF-SITE DISPOSAL COSTS WITH 30-YR PRESENT WORTH O&M																	**$ 7,033,497**

EA5 COST ESTIMATE DETAIL

REMOVAL AND OFF-SITE DISPOSAL

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Mobilization, Bonding, Insurance	LS	$ 431,183.08	1	$ 431,183	10% of construction cost
Construct Off-site Repository - Total		$ 10.12	47,409	$ 1,043,625	State Section 18*
AC-01	CY	$ 10.12	500	$ 5,061	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	CY	$ 10.12	5,017	$ 50,778	
BR-29	CY	$ 10.12	280	$ 2,834	
PC-01, PC-21	CY	$ 10.12	0	$ -	
PC-06, PC-11, PC-22	CY	$ 10.12	2,200	$ 22,267	
PBBS	CY	$ 10.12	0	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	CY	$ 10.12	3,304	$ 33,440	
PM-26, PM-28	CY	$ 10.12	2,856	$ 28,906	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	CY	$ 10.12	11,620	$ 117,608	
SH-06, SH-07, SH-13, SH-14	CY	$ 10.12	14,970	$ 151,514	
SG-13/14, SG-16, SG-43	CY	$ 10.12	6,662	$ 67,427	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	CY	$ 10.12	45,131	$ 456,779	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78 SG-82 SG-94, SG-95, SG-96, SG-99	CY	$ 10.12	7,479	$ 75,696	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	CY	$ 10.12	2,850	$ 28,845	
SWG-02	CY	$ 10.12	244	$ 2,470	
Improve/Construct Access Roads - Total	LF	$ 18.00	42,150	$ 1,215,000	Includes Clear/Grub/Log, Reclamation
AC-01	LF	$ 18.00	1,500	$ 27,000	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	LF	$ 18.00	8,400	$ 151,200	
BR-29	LF	$ 18.00	1,650	$ 29,700	
PC-01, PC-11	LF	$ 18.00	0	$ -	
PC-21, PC-11, PC-22	LF	$ 18.00	4,500	$ 81,000	
PBBS	LF	$ 18.00	0	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	LF	$ 18.00	3,750	$ 67,500	
PM-26, PM-28	LF	$ 18.00	4,200	$ 75,600	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	LF	$ 18.00	8,400	$ 151,200	
SH-06, SH-07, SH-13, SH-14	LF	$ 18.00	4,950	$ 89,100	
SG-13/14, SG-16, SG-43	LF	$ 18.00	4,800	$ 86,400	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	LF	$ 18.00	16,200	$ 291,600	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78 SG-82 SG-94, SG-95, SG-96, SG-99	LF	$ 18.00	3,600	$ 64,800	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	LF	$ 18.00	4,200	$ 75,600	
SWG-02	LF	$ 18.00	1,350	$ 24,300	
Excavate, Load, Haul and Place Waste in Repository - Total	CY	$ 15.00	47,409	$ 1,546,695	Engineer Estimate
AC-01	CY	$ 15.00	500	$ 7,500	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	CY	$ 15.00	5,017	$ 75,255	
BR-29	CY	$ 15.00	280	$ 4,200	
PC-01, PC-21	CY	$ 15.00	0	$ -	
PC-06, PC-11, PC-22	CY	$ 15.00	2,200	$ 33,000	
PBBS	CY	$ 15.00	0	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	CY	$ 15.00	3,304	$ 49,560	
PM-26, PM-28	CY	$ 15.00	2,856	$ 42,840	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	CY	$ 15.00	11,620	$ 174,300	
SH-06, SH-07, SH-13, SH-14	CY	$ 15.00	14,970	$ 224,550	
SG-13/14, SG-16, SG-43	CY	$ 15.00	6,662	$ 99,930	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	CY	$ 15.00	45,131	$ 676,965	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78 SG-82 SG-94, SG-95, SG-96, SG-99	CY	$ 15.00	7,479	$ 112,185	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	CY	$ 15.00	2,850	$ 42,750	
SWG-02	CY	$ 15.00	244	$ 3,660	

EA5 COST ESTIMATE DETAIL
REMOVAL AND OFF-SITE DISPOSAL

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Load, Haul, Place Vegetative Cover - Total	CY	$ 15.00	11,852	$ 386,674	6 inch cover imported over removal areas
AC-01	CY	$ 15.00	125	$ 1,875	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	CY	$ 15.00	1,254	$ 18,814	
BR-29	CY	$ 15.00	70	$ 1,050	
PC-01, PC-21	CY	$ 15.00	0	$ -	
PC-06, PC-11, PC-22	CY	$ 15.00	550	$ 8,250	
PBBS	CY	$ 15.00	0	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	CY	$ 15.00	826	$ 12,390	
PM-26, PM-28	CY	$ 15.00	714	$ 10,710	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	CY	$ 15.00	2,905	$ 43,575	
SH-06, SH-07, SH-13, SH-14	CY	$ 15.00	3,743	$ 56,138	
SG-13/14, SG-16, SG-43	CY	$ 15.00	1,666	$ 24,983	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	CY	$ 15.00	11,283	$ 169,241	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78, SG-82 SG-94, SG-95, SG-96, SG-99	CY	$ 15.00	1,870	$ 28,046	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	CY	$ 15.00	713	$ 10,688	
SWG-02	CY	$ 15.00	61	$ 915	
Seed, Fertilize, Mulch - Total	AC	$ 3,000.00	14.7	$ 95,870	Based on Bald Butte
AC-01	AC	$ 3,000.00	0.2	$ 465	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	AC	$ 3,000.00	1.6	$ 4,665	
BR-29	AC	$ 3,000.00	0.1	$ 260	
PC-01, PC-21	AC	$ 3,000.00	0.0	$ -	
PC-06, PC-11, PC-22	AC	$ 3,000.00	0.7	$ 2,045	
PBBS	AC	$ 3,000.00	0.0	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	AC	$ 3,000.00	1.0	$ 3,072	
PM-26, PM-28	AC	$ 3,000.00	0.9	$ 2,655	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	AC	$ 3,000.00	3.6	$ 10,804	
SH-06, SH-07, SH-13, SH-14	AC	$ 3,000.00	4.6	$ 13,918	
SG-13/14, SG-16, SG-43	AC	$ 3,000.00	2.1	$ 6,194	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	AC	$ 3,000.00	14.0	$ 41,961	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78 SG-82 SG-94, SG-95, SG-96, SG-99	AC	$ 3,000.00	2.3	$ 6,954	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	AC	$ 3,000.00	0.9	$ 2,650	
SWG-02	AC	$ 3,000.00	0.1	$ 227	
Reclaim Cover Soil Borrow Area - Total	AC	$ 4,500.00	2.4	$ 23,967	Bald Butte
AC-01	AC	$ 4,500.00	0.0	$ 116	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	AC	$ 4,500.00	0.3	$ 1,166	
BR-29	AC	$ 4,500.00	0.0	$ 65	
PC-01, PC-21	AC	$ 4,500.00	0.0	$ -	
PC-06, PC-11, PC-22	AC	$ 4,500.00	0.1	$ 511	
PBBS	AC	$ 4,500.00	0.0	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	AC	$ 4,500.00	0.2	$ 768	
PM-26, PM-28	AC	$ 4,500.00	0.1	$ 664	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	AC	$ 4,500.00	0.6	$ 2,701	
SH-06, SH-07, SH-13, SH-14	AC	$ 4,500.00	0.8	$ 3,480	
SG-13/14, SG-16, SG-43	AC	$ 4,500.00	0.3	$ 1,549	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	AC	$ 4,500.00	2.3	$ 10,490	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78 SG-82 SG-94, SG-95, SG-96, SG-99	AC	$ 4,500.00	0.4	$ 1,738	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	AC	$ 4,500.00	0.1	$ 662	
SWG-02	AC	$ 4,500.00	0.0	$ 57	
			Subtotal	$ 4,743,014	

EA5 COST ESTIMATE DETAIL
REMOVAL AND OFF-SITE DISPOSAL

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Contingencies		15%		$ 711,452	
			Subtotal	$ 5,454,466	
Project Management		5%		$ 272,723	
Engineering		6%		$ 327,268	
Construction Management		8%		$ 436,357	
TOTAL				$ 6,490,815	
			TOTAL CAPITAL COSTS	**$ 6,490,815**	

OPERATIONS AND MAINTENANCE (O & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Site Inspections, Vegetation Maintenance and Repairs, Years 1-30	LS	$ 7,500.00	1	$ 7,500	Engineers Estimate
Periodic Repairs - Years 15 and 30 (1/5th remedial cost)	LS	$ 96,508.65	1	$ 96,509	Engineers Estimate
Off-site Repository O&M and Repairs, Years 1-30	LS	$ 15,000.00	1	$ 15,000	Engineers Estimate
			Subtotal	$ 104,009	
			30-YEAR NET PRESENT VALUE ANNUAL O&M COSTS	**$ 542,715**	**Discounted using the rate below**

	3%	Assumed Discount Rate
30-YEAR PRESENT VALUE (CAPITAL + O&M COST) $	**7,033,530**	Value for the EA as a whole is slightly different than value calculated by summing individual sites within the EA due to compounding rounding error.

* From the Repository Siting Study for UBMC - State Section 18 Site estimate was $15,034,436 for a 1,000,000 cy repository and includes wastes removed under the EE/CA actions. The total estimated cost included hauling and placement of waste. Construction costs for the repository were $4,048,472. For purposes of this feasibility study, estimated costs from the siting study are scaled to a 400,000 cy repository for a repository construction cost of $10.12/cy.

EA 5 COSTS																
	MINING-RELATED FEATURES															
	Anaconda Creek	*Blackfoot River*		*Pass Creek*		*Porcupine Gulch*	*Paymaster Gulch*		*Shave Gulch*		*Stevens Gulch*				*Swamp Gulch*	
IN-SITU NEUTRALIZATION WITH LIME	**AC-01**	**BR-01, BR-14 BR-16, BR-20 BR-32, BR-39**	**BR-29**	**PC-01, PC-21**	**PC-06, PC-11 PC-22**	**PBBS**	**PM-04, PM-06 PM-12, PM-35 PM-37, JM-01**	**PM-26, PM-28**	**SH-17, SH-23 SH-29, SH-37 SH-43, SH-44**	**SH-06, SH-07 SH-13, SH-14**	**SG-13/14, SG-16 SG-43**	**SG-24, SG-44 SG-53, SG-55 SG-56, SG-58 SG-67, SG-98**	**SG-41, SG-47 SG-48, SG-49/50 SG-51, SG-71 SG-78, SG-82 SG-94, SG-95 SG-96, SG-99**	**SG-01, SG-31 SG-33, SG-35 SG-86, SG-89**	**SWG-01**	**TOTAL**
Improve/Construct Access Roads	$ 27,000	$ 151,200	$ 29,700	$ -	$ 81,000	$ -	$ 67,500	$ 75,600	$ 151,200	$ 89,100	$ 86,400	$ 291,600	$ 64,800	$ 75,600	$ 24,300	$ 1,215,000
Re-Grade Waste Piles, Prep for Lime Treatment	$ 2,250	$ 22,577	$ 1,260	$ -	$ 9,900	$ -	$ 14,868	$ 12,852	$ 52,290	$ 67,365	$ 29,979	$ 203,090	$ 33,656	$ 12,825	$ 1,098	$ 464,009
Load, Haul, Incorporate Lime	$ 1,225	$ 12,291	$ 686	$ -	$ 5,390	$ -	$ 8,094	$ 6,997	$ 28,468	$ 36,675	$ 16,321	$ 110,566	$ 18,323	$ 6,982	$ 598	$ 252,616
Seed, Fertilize, Mulch	$ 558	$ 5,597	$ 312	$ -	$ 2,455	$ -	$ 3,686	$ 3,186	$ 12,964	$ 16,702	$ 7,433	$ 50,353	$ 8,344	$ 3,180	$ 272	$ 115,043
Subtotal	$ 31,033	$ 191,665	$ 31,958	$ -	$ 98,744	$ -	$ 94,149	$ 98,635	$ 244,922	$ 209,842	$ 140,133	$ 655,609	$ 125,123	$ 98,587	$ 26,268	$ 2,046,668
Mob/Demob (10%)	$ 3,103	$ 19,167	$ 3,196	$ -	$ 9,874	$ -	$ 9,415	$ 9,864	$ 24,492	$ 20,984	$ 14,013	$ 65,561	$ 12,512	$ 9,859	$ 2,627	$ 204,667
Subtotal	$ 34,136	$ 210,832	$ 35,154	$ -	$ 108,619	$ -	$ 103,564	$ 108,499	$ 269,414	$ 230,826	$ 154,146	$ 721,169	$ 137,635	$ 108,446	$ 28,895	$ 2,251,335
Contingencies (15%)	$ 5,120	$ 31,625	$ 5,273	$ -	$ 16,293	$ -	$ 15,535	$ 16,275	$ 40,412	$ 34,624	$ 23,122	$ 108,175	$ 20,645	$ 16,267	$ 4,334	$ 337,700
Subtotal	$ 39,256	$ 242,456	$ 40,427	$ -	$ 124,912	$ -	$ 119,098	$ 124,774	$ 309,827	$ 265,450	$ 177,268	$ 829,345	$ 158,280	$ 124,713	$ 33,229	$ 2,589,035
Project Management (5%)	$ 1,963	$ 12,123	$ 2,021	$ -	$ 6,246	$ -	$ 5,955	$ 6,239	$ 15,491	$ 13,273	$ 8,863	$ 41,467	$ 7,914	$ 6,236	$ 1,661	$ 129,452
Engineering (6%)	$ 2,355	$ 14,547	$ 2,426	$ -	$ 7,495	$ -	$ 7,146	$ 7,486	$ 18,590	$ 15,927	$ 10,636	$ 49,761	$ 9,497	$ 7,483	$ 1,994	$ 155,342
Construction Administration (8%)	$ 3,141	$ 19,397	$ 3,234	$ -	$ 9,993	$ -	$ 9,528	$ 9,982	$ 24,786	$ 21,236	$ 14,181	$ 66,348	$ 12,662	$ 9,977	$ 2,658	$ 207,123
Total, Capital Cost	$ 46,715	$ 288,523	$ 48,109	$ -	$ 148,645	$ -	$ 141,727	$ 148,481	$ 368,694	$ 315,886	$ 210,949	$ 986,920	$ 188,353	$ 148,408	$ 39,543	$ 3,080,952
Operations and Maintenance (O & M)																
Site Inspections, Vegetation Maintenance and Repairs, Years 1-30	$ 250	$ 750	$ 250	$ -	$ 500	$ -	$ 750	$ 250	$ 750	$ 500	$ 500	$ 1,000	$ 1,250	$ 500	$ 250	$ 7,500
Periodic Repairs - Years 15 and 30 (1/5th remedial cost)	$ 357	$ 3,578	$ 200	$ -	$ 1,569	$ -	$ 2,356	$ 2,037	$ 8,286	$ 10,675	$ 4,751	$ 32,184	$ 5,333	$ 2,032	$ 174	$ 73,532
Total, 30-yr Present Worth, O&M (3%)	$ 5,276	$ 18,469	$ 5,110	$ -	$ 11,453	$ -	$ 17,183	$ 7,046	$ 23,430	$ 21,047	$ 14,805	$ 53,506	$ 30,119	$ 11,941	$ 5,083	$ 224,470
TOTAL CAPITAL COST + O&M	$ 51,991	$ 306,993	$ 53,219	$ -	$ 160,098	$ -	$ 158,909	$ 155,526	$ 392,124	$ 336,933	$ 225,754	$ 1,040,427	$ 218,473	$ 160,349	$ 44,626	$ 3,305,422
TOTAL EA5 IN-SITU NEUTRALIZATION COSTS WITH 30-YR PRESENT WORTH O&M																**$ 3,305,422**

EA5 COST ESTIMATE DETAIL

IN-SITU TREATMENT

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Mobilization, Bonding, Insurance	LS	$ 204,666.81	1	$ 204,667	10% of construction cost
Improve/Construct Access Roads - Total	LF	$ 18.00	42,150	$ 1,215,000	Includes Clear/Grub/Log, Reclamation
AC-01	LF	$ 18.00	1,500	$ 27,000	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	LF	$ 18.00	8,400	$ 151,200	
BR-29	LF	$ 18.00	1,650	$ 29,700	
PC-01, PC-21	LF	$ 18.00	0	$ -	
PC-06, PC-11, PC-22	LF	$ 18.00	4,500	$ 81,000	
PBBS	LF	$ 18.00	0	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	LF	$ 18.00	3,750	$ 67,500	
PM-26, PM-28	LF	$ 18.00	4,200	$ 75,600	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	LF	$ 18.00	8,400	$ 151,200	
SH-06, SH-07, SH-13, SH-14	LF	$ 18.00	4,950	$ 89,100	
SG-13/14, SG-16, SG-43	LF	$ 18.00	4,800	$ 86,400	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	LF	$ 18.00	16,200	$ 291,600	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78 SG-82 SG-94, SG-95, SG-96, SG-99	LF	$ 18.00	3,600	$ 64,800	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	LF	$ 18.00	4,200	$ 75,600	
SWG-02	LF	$ 18.00	1,350	$ 24,300	
Re-Grade Waste Piles, Prep for Lime Treatment - Total	SY	$ 3.00	71,114	$ 464,009	Engineer Estimate
AC-01	SY	$ 3.00	750	$ 2,250	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	SY	$ 3.00	7,526	$ 22,577	
BR-29	SY	$ 3.00	420	$ 1,260	
PC-01, PC-21	SY	$ 3.00	0	$ -	
PC-06, PC-11, PC-22	SY	$ 3.00	3,300	$ 9,900	
PBBS	SY	$ 3.00	0	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	SY	$ 3.00	4,956	$ 14,868	
PM-26, PM-28	SY	$ 3.00	4,284	$ 12,852	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	SY	$ 3.00	17,430	$ 52,290	
SH-06, SH-07, SH-13, SH-14	SY	$ 3.00	22,455	$ 67,365	
SG-13/14, SG-16, SG-43	SY	$ 3.00	9,993	$ 29,979	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	SY	$ 3.00	67,697	$ 203,090	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78 SG-82 SG-94, SG-95, SG-96, SG-99	SY	$ 3.00	11,219	$ 33,656	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	SY	$ 3.00	4,275	$ 12,825	
SWG-02	SY	$ 3.00	366	$ 1,098	
Load, Haul, Incorporate Lime - Total	AC	$ 7,905.00	15	$ 252,616	Based on Stucky Ridge - Costs Increased
AC-01	AC	$ 7,905.00	0.15	$ 1,225	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	AC	$ 7,905.00	1.55	$ 12,291	
BR-29	AC	$ 7,905.00	0.09	$ 686	
PC-01, PC-21	AC	$ 7,905.00	0.00	$ -	
PC-06, PC-11, PC-22	AC	$ 7,905.00	0.68	$ 5,390	
PBBS	AC	$ 7,905.00	0.00	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	AC	$ 7,905.00	1.02	$ 8,094	
PM-26, PM-28	AC	$ 7,905.00	0.89	$ 6,997	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	AC	$ 7,905.00	3.60	$ 28,468	
SH-06, SH-07, SH-13, SH-14	AC	$ 7,905.00	4.64	$ 36,675	
SG-13/14, SG-16, SG-43	AC	$ 7,905.00	2.06	$ 16,321	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	AC	$ 7,905.00	13.99	$ 110,566	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78 SG-82 SG-94, SG-95, SG-96, SG-99	AC	$ 7,905.00	2.32	$ 18,323	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	AC	$ 7,905.00	0.88	$ 6,982	
SWG-02	AC	$ 7,905.00	0.08	$ 598	

EA5 COST ESTIMATE DETAIL

IN-SITU TREATMENT

CAPITAL COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Seed, Fertilize, Mulch - Total	AC	$ 3,000.00	17.6	$ 115,043	Based on Bald Butte
AC-01	AC	$ 3,000.00	0.19	$ 558	
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	AC	$ 3,000.00	1.87	$ 5,597	
BR-29	AC	$ 3,000.00	0.10	$ 312	
PC-01, PC-21	AC	$ 3,000.00	0.00	$ -	
PC-06, PC-11, PC-22	AC	$ 3,000.00	0.82	$ 2,455	
PBBS	AC	$ 3,000.00	0.00	$ -	
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	AC	$ 3,000.00	1.23	$ 3,686	
PM-26, PM-28	AC	$ 3,000.00	1.06	$ 3,186	
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	AC	$ 3,000.00	4.32	$ 12,964	
SH-06, SH-07, SH-13, SH-14	AC	$ 3,000.00	5.57	$ 16,702	
SG-13/14, SG-16, SG-43	AC	$ 3,000.00	2.48	$ 7,433	
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	AC	$ 3,000.00	16.78	$ 50,353	
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78 SG-82 SG-94, SG-95, SG-96, SG-99	AC	$ 3,000.00	2.78	$ 8,344	
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	AC	$ 3,000.00	1.06	$ 3,180	
SWG-02	AC	$ 3,000.00	0.09	$ 272	
			Subtotal	$ 2,251,335	
Contingencies		15%		$ 337,700	
			Subtotal	$ 2,589,035	
Project Management		5%		$ 129,452	
Engineering		6%		$ 155,342	
Construction Management		8%		$ 207,123	
TOTAL				$ 3,080,952	
			TOTAL CAPITAL COSTS	**$ 3,080,952**	

OPERATIONS AND MAINTENANCE (O & M) COSTS

DESCRIPTION	UNIT	UNIT COST	ESTIMATED QUANTITY	TOTAL PRICE	NOTES
Site Inspections, Vegetation Maintenance and Repairs, Years 1-30	LS	$ 7,500.00	1	$ 7,500	Engineers Estimate
Periodic Repairs - Years 15 and 30 (1/5th remedial cost)	LS	$ 73,531.93	1	$ 73,532	Engineers Estimate
			Subtotal	$ 81,032	
			30-YEAR NET PRESENT VALUE ANNUAL O&M COSTS	**$ 224,495**	**Discounted using the rate below**

3% Assumed Discount Rate

30-YEAR PRESENT VALUE (CAPITAL + O&M COST) **$3,305,447**

Value for the EA as a whole is slightly different than value calculated by summing individual sites within the EA due to compounding rounding error.

EA 5 QUANTITY ESTIMATES					
SITE	WASTE		ACCESS - DIST. TO ROADS		
	AREA	VOLUME	LENGTH	IMPROVE?	FENCING
	(sf)	(cy)	(ft)		(ft)
AC-01	6,750	500	1,500	YES	370
BR-01, BR-14, BR-16, BR-20, BR-32, BR-39	67,730	5,017	8,400	YES	1,190
BR-29	3,780	280	1,650	YES	280
PC-01, PC-21	0	0	1,200	YES	0
PC-06, PC-11, PC-22	29,700	2,200	4,500	YES	790
PBBS	0	0	2,100	YES	0
PM-04, PM-06, PM-12, PM-35 PM-37, JM-01	44,604	3,304	3,750	YES	960
PM-26, PM-28	38,556	2,856	4,200	YES	900
SH-17, SH-23, SH-29, SH-37, SH-43, SH-44	156,870	11,620	8,400	YES	1,810
SH-06, SH-07, SH-13, SH-14	202,095	14,970	4,950	YES	2,050
SG-13/14, SG-16, SG-43	89,937	6,662	4,800	YES	1,370
SG-24, SG-44, SG-53, SG-55, SG-56, SG-58, SG-67, SG-98	609,269	45,131	16200	YES	3,560
SG-41, SG-47, SG-48, SG-49/50 SG-51, SG-71, SG-78, SG-82 SG-94, SG-95, SG-96, SG-99	100,967	7,479	3,600	YES	1,450
SG-01, SG-31, SG-33, SG-35, SG-86, SG-89	38,475	2,850	4200	YES	890
SWG-02	3294	244	1350	YES	260
TOTALS	1,392,026	103,113	70,800		15,880