Bullion Mine Operable Unit 06

of the Basin Mining Area Superfund Site,

Jefferson County, Montana

Interim Record of Decision

Final

U.S. Environmental Protection Agency Region 8

10 West 15th Street
Suite 3200
Helena, Montana 59626

April 2015

Bullion Mine Operable Unit 06

of the Basin Mining Area Superfund Site,

Jefferson County, Montana

Final Interim Record of Decision

Part 1, Declaration

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April 2015

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 8, MONTANA OFFICE

Part 1
Declaration

Contents

Site Name and Location

Site Name and Location

Basin Mining Area Superfund Site

Jefferson County, Montana

CERCLIS ID: MTD982572562

Site ID No: 0801057 Bullion Mine Site Operable Unit (OU) 6

Statement of Basis and Purpose

This decision document presents the selected interim remedial action for the Bullion Mine Operable Unit (OU) 6 Superfund Site (Site) in Jefferson County, Montana. The Bullion Mine OU6 lies within the Basin Watershed OU2. The record of decision (ROD) for the Basin Watershed OU2 will be completed in the future and will consider the interim actions taken at the Bullion Mine and Crystal Mine, and determine if any additional actions are needed. Therefore, the Basin Watershed ROD will address the final remedy for the Bullion Mine. The interim remedy for OU6 was selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), 42 USC § 9601 et seq., as amended, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300, as amended. This decision was based on the administrative record established in accordance with section 113(k) of CERCLA and is available for review at the Boulder Library in Boulder, Montana and at the EPA Region 8 Records center in Helena, Montana.

The Montana Department of Environmental Quality (MDEQ) and U.S. Forest Service (USFS), Region One, both supporting agencies, concur with the selected interim remedy.

Assessment of Site

Hazardous substances in the form of metal contaminants are being released into the environment by the Bullion Mine and pose a risk to human health and the environment. The response action described in the ROD is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances.

Description of Selected Interim Remedy

This ROD describes the selected interim remedy for the Bullion Mine OU6, located within the Basin Mining Area Superfund Site, Jefferson County, Montana. This remedy complements previous removal actions by remediating acid mine drainage (AMD) and soil contamination to finish OU cleanup. The Basin Watershed ROD will detail the final determination regarding the need and extent of any additional actions at OU6.

The acid mine drainage from the lower adit comprises a principal threat waste at the Site. Small areas of contaminated soil exposed by erosion are considered a non-principal threat waste. A brief description of the selected remedy (alternative 5 from the proposed plan) is as follows:

Source Control:

- Implement source water control by intercepting and diverting surface water utilizing runoff conveyance features and by sealing latent mine structures that allow water into underground workings (for example, exposed/caved shafts).

- A time critical removal action (TCRA) scheduled to begin in 2014 and be completed in 2015 will dewater the mine and re-open and stabilize the portal to allow mine water to flow freely into an existing discharge channel. Portal opening will be secured to prevent unauthorized human entry, if warranted, and accommodate appropriate wildlife access (for example, bats), if recommended by the Montana Department of Fish, Wildlife, & Parks (MDFWP) or U.S. Fish and Wildlife Service (USFWS). This activity will be implemented by the EPA prior to remedial design (RD).

Treatment (Water and Soil):

- Collect contaminated ground water below the mine via a ground water cut-off wall.
- Collect mine adit flow using a diversion structure within the existing discharge channel.
- Convey the collected water to the passive treatment system (PTS).

The three stages of the PTS are as follows (see *Bullion Mine Focused Feasibility Study* for more detail):

Stage 1 - pH Adjustment Cell. The pH adjustment cell will increase AMD pH to greater than 6.

Stage 2 - Sulfate Reducing Biochemical Reactor (SRBR). The SRBR will convert sulfate and trace metals in the water into metal sulfides that remain with the media.

Stage 3 - Clarification and Discharge to Jill Creek. The clarification pond follows the SRBR and will allow settling of sludges and organic materials formed in the prior two stages. At the shallow end of the pond, native aquatic vegetation will provide biological filtering.

Areas of contaminated soil exposed by erosion of the previous cover material will be regraded, amended with topsoil and revegetated.

Institutional Controls:

- Institutional controls (ICs) to prohibit residential use, prevent installation of drinking water wells, and to protect the remedy will be required throughout the Site. ICs include administrative land management methods necessary to maintain the effectiveness of the remedy and protect human health by preventing exposure to contaminated soil and ground water that creates an unacceptable risk to human health. ICs will be tailored to the size, location and complexity of the area.
- The EPA and MDEQ will work with adjacent landowner agencies (primarily USFS) on the specific application of this remedy including protective ICs.

Long-term Monitoring and Maintenance:

- An operation, monitoring and maintenance (OMM) plan will be developed as part of the remedy. Periodic replacement of the pH adjustment cell and SRBR media will be required. Sludge that settles in the deep end of the clarification pond will require periodic removal, drying and disposal at the Luttrell Repository.
- Construction and post construction monitoring of adit discharge, shallow downgradient ground water, and Jill Creek water quality.
- Periodic inspection and maintenance of soil and vegetative cover and erosion controls will be needed.
- Monitoring and maintenance of ICs to assure long-term protectiveness will be required.

Statutory Determinations

The selected interim remedy is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action unless justified by a waiver, is cost effective, and utilizes permanent solutions and alternative technologies to the maximum extent practicable. The selected interim remedy is also consistent with, and contributes to, the anticipated final remedy for the Basin Watershed OU2.

This remedy also satisfies the statutory preference for treatment as a principal element of the remedy (for example, reduces the toxicity, mobility or volume of hazardous substances, pollutants or contaminants through treatment).

Because this remedy will result in hazardous substances remaining onsite above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after initiation of the remedial action, and at a minimum every 5 years thereafter, to ensure that the remedy is, or will be, protective of human health and the environment.

ROD Data Certification Checklist

The following information is included in the decision summary section of this interim ROD. Additional information can be found in the administrative record file for this Site.

1) Contaminants of concern and their respective concentrations (Section 5)
2) Baseline risks represented by the contaminants of concern (Section 7)
3) Cleanup levels established for contaminants of concern and the basis for these levels (Section 7)
4) Discussion of principal threat wastes (Section 11)
5) Current and reasonably anticipated future land use assumptions used in the baseline risk assessment (Section 6)
6) Potential land use and ground water use that will be available as a result of the selected remedy (Section 12)
7) Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (Section 12)
8) Key factors that led to selecting the remedy (Sections 10, 11 and 12)

Authorizing Signatures

This ROD documents the selected interim remedy for the Basin Mining Area Superfund Site, Bullion Mine Operable Unit 6, Jefferson County, Montana. The following authorized officials from their respective Agencies approve the selected remedy as described in this ROD.

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Martin Hestmark
Assistant Regional Administrator
Office of Ecosystems Protection and Remediation

Date: ______________________________

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Tom Livers
Director
Montana Department of Environmental Quality

Date: ______________________________

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David E. Schmid
Regional Forester (Acting)
United States Forest Service, Region One

Date: ______________________________

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Martin Hestmark
Assistant Regional Administrator
Office of Ecosystems Protection and Remediation

Date: 4/24/15

Tom Livers
Director
Montana Department of Environmental Quality

Date: ______________________________

David E. Schmid
Regional Forester (Acting)
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Date: __________________________

Tom Livers

Tom Livers
Director
Montana Department of Environmental Quality

Date: 4/20/15

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Tom Livers
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Montana Department of Environmental Quality

Date: ____________________________

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David E. Schmid
Regional Forester (Acting)
United States Forest Service, Region One

Date: 4/17/15

Part 2
Decision Summary

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Section 1. Site Name, Location, and Description

Basin Mining Area Superfund Site
Bullion Mine Site OU6
Jefferson County, Montana

Site ID Number:	0801057
CERCLIS ID:	MTD982572562
Lead Agency:	U.S. Environmental Protection Agency (EPA)
Support Agency:	Montana Department of Environmental Quality (MDEQ)
Cleanup Funding:	The EPA Superfund Trust Fund
Site Type:	Abandoned Mine (historic hard rock mine)

Mining-waste related contamination in the Basin Watershed and in the Town of Basin resulted in the listing of the Basin Mining Area on Superfund's National Priorities List (NPL) on October 22, 1999. The west-central Montana mining area includes the watersheds of Basin and Cataract Creek and portions of the Boulder River below the confluence with these heavily impacted streams (see Exhibits 1-1 and 1-2).

EXHIBIT 1-1
Location of Basin Mining District in West Central Montana

LEGEND:

- Local Mountain Peak over 8,000 feet above Mean Sea Level
- River or Creek
- Basin Creek Mine Area
- Interstate
- Luttrell Repository
- Bullion Mine Study Area
- Watersheds
- Subbasins
- Township and Range Block

Note: Study area is within the Beaverhead-Deerlodge National Forest

Source: Draft RI for Basin Watershed OU2 (CDM 2005b)

EXHIBIT 1-2
BULLION MINE SITE
Basin Watershed with Basin Creek and Cataract Creek Drainages
Bullion Mine OU6 ROD

CH2MHILL

The Basin Mining Area NPL Site is divided into the following relevant operable units (OUs): the Town of Basin OU1, Basin Watershed OU2, Luttrell Repository OU3, Buckeye/Enterprise Mine OU4, Crystal Mine OU5, and Bullion Mine OU6.

Approximately 300 abandoned hard rock mines exist within the Basin Watershed OU2, according to a remedial investigation (RI) conducted by CDM Federal Programs Corporation (CDM) for the EPA (CDM, 2005). Findings from the Basin Watershed OU2 RI identified the Bullion OU6 and Crystal OU5 Mines, with their associated acid mine drainage (AMD), as the largest contributors of mine-related contamination into the surface water system.

The Bullion Mine is located in the upper part of the Jill Creek subbasin (T7N, R6W, Sections 13 and 14) within the Jack Creek drainage, approximately 6 miles north of the Town of Basin (9 miles by road). The Bullion mining claims encompass approximately 40 acres, at an elevation of between 7100 feet (ft) above mean sea level (amsl) and 7800 ft amsl, and is surrounded by the Beaverhead-Deerlodge National Forest.

The Bullion vein consists of quartz, pyrite, tetrahedrite, galena, sphalerite, chalcopyrite, arsenopyrite and siderite. The mine produced gold, silver, copper, lead and zinc ore. The Site is now a significant source of AMD that is impacting water quality in Jill Creek, Jack Creek and Basin Creek. Elevated concentrations of arsenic and heavy metals (particularly aluminum, cadmium, copper, lead, manganese and zinc) are present in Site soils (under a soil cover), mine discharge and downstream surface water and sediment. The principal source of AMD is discharge from the lower Bullion adit, plus springs and diffuse seepage from the surrounding slope in the vicinity of the lower adit. Springs, seeps and adit drainage contribute to the total metal load in Jill Creek downstream of the Bullion Mine. Jill Creek flows into Jack Creek approximately 1 mile downstream of its confluence with the Bullion Mine adit drainage.

Section 2. Site History and Enforcement Activities

2.1 Site Background and History

Mining in the Basin district began in the mid to late 1800s and continued sporadically into the 1960s. The Bullion Mine was the largest and most productive mine in the Basin Mining District. The Bullion Mine was worked periodically from 1897 to 1974. The ore was extracted from adits constructed at three different elevations. Internal workings are connected by stopes and inclines. The underground workings extend for approximately 4,500 feet. A smelter (located approximately 1 mile downstream) and gravity concentrator were constructed in 1905. In 1929, a flotation mill was constructed in the main development area. The mine produced approximately 30,000 tons of gold, silver, copper, lead and zinc ore between 1905 and 1955. Today seven foundations remain from the original mining structures; all are scattered through the lower portion of the Site. All three adit portals are collapsed. Ground water accumulates in the mine workings and drains from the lowest adit portal.

The following is a list of relevant historic activities and Site investigations. The Site investigations are explained in more detail in Section 1.5 of the Bullion Mine OU6 RI report.

(1897) Claim Surveyed. The claim was surveyed in 1897 and the Bullion lode was discovered in 1888.

(1897 to 1974) Mining Begin/Finish. Mining of gold, silver, copper, lead and zinc occurred between 1897 and 1974.

(1994 to 2008) Site Investigations

March 1994. Abandoned Hardrock Mine Priority Sites – Summary Report (Red Book). The Montana Department of State Lands (Abandoned Mines and Reclamation Bureau) identified and inventoried abandoned and inactive hard rock mine sites in Montana that exhibited severe environmental degradation of surface water and ground water. The Site ranked 32 out of 263 state-wide, or in the top 12 percent.

April 1994. Abandoned-Inactive Mines Program Deerlodge National Forest, Basin Creek Drainage. Volume I, Basin Creek Drainage and Volume II, Cataract Creek Drainage. Prepared by Montana Bureau of Mines and Geology (MBMG). In 1992, the USFS and MBMG entered into an agreement to inventory and characterize abandoned and inactive mines on Deerlodge National Forest Lands.

2001. Sampling Activities Report: Basin Mining Area – Bullion Mine, Jefferson County, Montana. Prepared for the EPA by URS Operating Services and TetraTech, Inc. This investigation characterized soils and mine waste at and below the former mill area and in the adjacent adit discharge channel.

2001. Bullion Mine and Mill Site Investigation. Prepared for Beaverhead-Deerlodge National Forest U.S. Department of Agriculture (USDA) Forest Service, Region 1, by Maxim Technologies Inc. In 1999, Maxim Technologies Inc. performed an investigation of the Bullion Flotation Mill tailing site. The data aided evaluation and planning of a potential removal action at the Site.

2003 - 2004. Montana State University Investigations. Montana State University performed several detailed investigations of the vegetation, soil and water at the Site in 2003 and 2004 (Montana State University, 2003; Montana State University, 2004).

2004. Integrated Investigation of Environmental Effects of Historical Mining in the Basin and Boulder Mining Districts, Boulder River Watershed, Jefferson County, Montana. U.S. Geological Survey Professional Paper 1652. In 1998, the U.S. Geological Survey (USGS) initiated a 5-year study in the Boulder River Basin to evaluate abandoned mines and issues related to AMD and its effects on the environment (see Exhibit 2-1).

2005. Basin Watershed OU2 RI/FS Study. Prepared by CDM for the EPA. In 1991, a remedial investigation and feasibility study was initiated on the Basin Watershed OU2 that included the Site.

2008. Draft Final Reclaimed Mine Inspection Report for the Bullion Mine Site. Prepared by Pioneer Technical Services, Inc. In 2008, Pioneer Technical Services completed a comprehensive post-reclamation inspection to evaluate the performance of reclamation activities at the Site implemented in 2001 and 2002.

2.2 Regulatory Activities

Regulatory and government interest in the Site began in the 1990s. The following is a list of relevant regulatory activities that have occurred at the Site.

1998-1999. Preliminary Assessment/Site Investigation. The EPA conducted a preliminary assessment (PA) and site investigation (SI) of the Basin Mining Area in 1998 and 1999. The Crystal Mine OU5 and Bullion Mine OU6 were included in the PA/SI. Elevated concentrations of arsenic, copper, lead and zinc were detected in soils, mine wastes and surface water.

1999. National Priority Listing. The Bullion Mine was proposed for the Superfund NPL as part of the Basin Mining Area in October 1999.

2000. Action Memorandum. Formal designation of the Site as OU6 occurred on April 12, 2000.

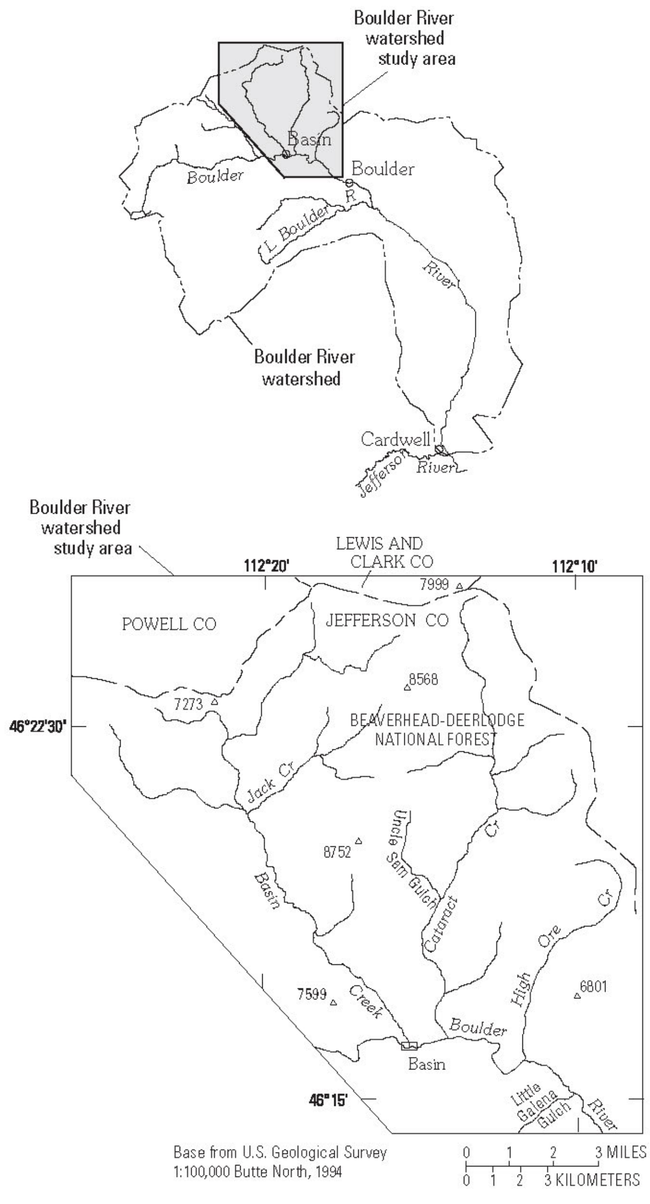
2001-2002. Time Critical Removal Action. In 2001 and 2002, a time critical removal action (TCRA) at the Bullion Mine was completed through a joint initiative by USFS and the EPA. Waste was removed from approximately 8 acres (approximately 27,238 cubic yards) from the upper, middle and lower waste rock piles (below the three adits), and tailings from impoundments adjacent to Jill Creek. Waste materials were transported to the Luttrell Repository on the northern boundary of the watershed near the headwaters of Basin Creek. Removal areas were covered with clean soil and vegetated.

2010-2013. Remedial Investigation, Feasibility Study, Human Health and Ecological Risk Assessment. A focused remedial investigation/feasibility study (RI/FS) and risk assessment of the Site was initiated by the EPA in 2010 and was completed in November 2013.

2014. Proposed Plan. The proposed plan for the Bullion Mine OU6 was distributed for public review in March 2014. A public meeting to explain the proposed remedial action, answer questions and accept comments was held on March 19, 2014. The public comment period ended April 21, 2014, and no written comments were received.

EXHIBIT 2-1

Location of Boulder River Watershed and Study Area, Montana



Adapted from USGS Professional Paper 1652 (2004)

2.3 Enforcement History

Between 1999 and 2000, a potentially responsible party (PRP) search was conducted for the Basin Watershed OU2 NPL site that identified former operators, all now defunct mining companies, and past and current land owners. The EPA sent out information request letters to all owners and operators of mining claims contributing to contamination of the Basin site in 2000 and again in 2008. Based on this investigation, the EPA was unable to identify any viable PRPs.

Section 3

3.1 Community Participation

Community involvement in the cleanup of the Basin Mining Area began prior to the NPL listing of the site and continued through the remedial investigation, remedy selection process, and proposed plan for the Basin Watershed OU2. Several superfund activities have contributed to public involvement, including the development of a community relations plan in 2000 (and updated in 2013), the cleanup of the Town of Basin OU1 (2002–2004) with two subsequent 5-year reviews (2007, 2012), a TCRA by the EPA and the USFS at the Bullion Mine (2001-2002), the RI/FS of the Basin Watershed OU2 (2001–2005), and the current RI/FS and interim ROD development process for the Bullion Mine.

1) **Cleanup of the Town of Basin –** Contaminated surface water from the Site flows into a tributary to Basin Creek. Basin Creek flows through the Town of Basin and into the Boulder River. The EPA prepared a detailed community relations plan for the Town of Basin in March 2000 describing activities for which public participation would be solicited. Activities were posted in local newspapers (Butte Standard, Boulder Monitor and Helena Independent Record) prior to their occurrence and public opinion and comments were captured in a responsiveness summary to a ROD for the town in 2001 (CDM). From 2002 to 2004, cleanup of mining waste within the town commenced. This activity triggered heightened community interaction as remedial activities progressed from property to property. Public involvement continued as interviews of public officials and residents of Basin were conducted to evaluate the success of the Town of Basin cleanup during subsequent 5-year reviews (2007, 2012). A fact sheet discussing prudent use and contact with the surface water and soils from the watershed was prepared and distributed to town residents by the EPA and MDEQ in December 2012.

2) **TCRA at the Bullion Mine –** As described in Section 2.2, a joint initiative by the USFS and the EPA to remove exposed mine waste from the Bullion Mine was implemented in 2001 and 2002. Approximately 27,000 cubic yards of mine waste was removed and transported to a local repository (Luttrell), and excavated areas were covered with clean soil and vegetated. Prior to this action, a notice was posted in local newspapers (Butte Standard, Boulder Monitor and Helena Independent Record) to inform the local community of increased traffic on Basin Creek Road and to solicit comments.

3) **RI/FS of the Basin Watershed OU2 –** Concurrent with cleanup of the town, the EPA conducted the RI/FS of the Basin Watershed OU2 (which included the Bullion Mine). Public participation was solicited through a public notice describing where the final documents could be found for review. In June 2003, a final draft proposed plan was prepared by the EPA describing the preferred remedy for the Basin Watershed OU2. Before this document was provided to the public, the EPA shifted focus to concentrate on interim cleanups of the Bullion and Crystal Mine sites due to their significant contributions to water quality degradation in the Basin Watershed.

4) **Current RI/FS, Proposed Plan and ROD Process for the Bullion Mine –** RI/FS reports for the Bullion Mine were completed in December 2013 and distributed to the local information repository in the Town of Boulder. A proposed plan describing the preferred cleanup for the Bullion Mine was prepared and distributed to the local community on March 7, 2014. The official public comment period ran from March 7 to April 21, 2014. Copies of the proposed plan were distributed to the current owners of the Bullion Mine (Chris Bullock, Allan Bullock and Carol Johnson), and the Basin post office. The proposed plan was also posted on the EPA website for the Basin Mining Area Superfund Site. A notice of availability of the proposed plan and announcement of a public meeting was published in the local newspapers (Butte Standard, Boulder Monitor and Helena Independent Record) at the beginning of the public comment period in an effort to further publicize the availability of the proposed plan. The EPA held a public meeting at the Basin School on March 19, 2014, to explain the preferred remedy and the ROD process to the community and to solicit their comments. Comments verbalized at this meeting were generally supportive of the proposed clean-up plan. A transcript of the meeting was placed in the administrative record for the Site. No written comments were received during the public comment period.

Section 4

4.1 Scope and Role of Operable Unit or Response Actions

As with many Superfund sites, the problems at the Basin Mining Area NPL Site (77 square miles) are complex. As a result, the EPA has organized the work into the following six operable units, of which the Bullion Mine is OU6:

- **Operable Unit 1 – The Town of Basin**. The Town of Basin is located at the mouth of the Basin Watershed OU2. Mine wastes within town represented the most immediate threat to human health. The ROD was completed on March 30, 2001, and remedial action was completed December 16, 2004.
- **Operable Unit 2 – Basin Watershed**. The Basin Watershed is the largest operable unit (77 square miles) and encompasses OUs 3, 4, 5 and 6. The RI/FS and a draft proposed plan were completed between 2002 and 2005. A final proposed plan and cleanup of the watershed will follow interim actions at OU5 and OU6. The EPA has decided to conduct interim actions at OU5 and OU6 first because the acidic adit discharges from these OUs significantly degrade water quality within the Basin Watershed. Upon completion of the interim remedies at these two mine sites, a final ROD for the remainder of the watershed will be written.
- **Operable Unit 3 – Luttrell Repository**. Luttrell is the regional repository located on the divide between Ten Mile Creek and the Basin Watershed. Construction of this repository was initiated in 2000. The site currently accepts mining wastes associated with response actions performed by the USFS, the State of Montana and the EPA (Region 8).
- **Operable Unit 4 – Buckeye/Enterprise Mines**. Contaminated soils and mining waste were removed under a time critical removal action completed at these sites in 2006.
- **Operable Unit 5 – Crystal Mine**. A removal action to line and cover a surface mine trench was performed between 2001 and 2002. The purpose of the action was to prevent snow melt and precipitation from infiltrating and migrating into underground mine workings. Contaminated mine wastes and AMD from the lower adit remain unremediated. Another removal action in 2014 will remove the pond sludges and liner material and transport them to the Luttrell Repository.
- **Operable Unit 6 – Bullion Mine.** In a joint removal action conducted in 2001 and 2002 by the USFS and the EPA, contaminated mine and mill wastes were removed to the local repository at Luttrell. Another removal action will be performed in 2014 and 2015 to treat pooled mine water, discharge the treated water to Jill Creek and remove the contaminated adit debris plug materials to the Luttrell Repository.

As noted above, the EPA decided to prioritize remedial action at the two mine sites (Crystal OU5 and Bullion OU6) in the Basin Watershed OU2 that contribute the most to water quality degradation. Upon completion of the interim remedies at these two mine sites, a ROD for the Basin Watershed OU2 will be written. The interim action at the Bullion Mine will focus on minimizing surface water infiltration and treating the mine-contaminated water discharging from the lower adit. Amended soil cover and vegetation will be applied to former, select removal areas that exhibit excessive erosion.

The anticipated sequence of cleanup activities for the Bullion Mine starts with a 2014 and 2015 TCRA which will dewater the mine and stabilize the lower adit portal area. Pooled mine water in the underground workings represents a serious risk because of the potential for catastrophic failure of the existing soil/debris plug and potential for release of up to several million gallons of contaminated mine water into Jill Creek.

Once the TCRA is complete and the portal is open and stabilized, the interim remedy will capture the free flowing AMD from the mine and treat it through a semi-passive biological treatment process to mitigate the existing impact of AMD on Jill Creek. Amended soil cover will then be placed over select areas of excessive erosion, and these areas will be revegetated and protected from off-road use. Finally, land- and water-use controls will be established. Prescribed monitoring of the reclamation and maintenance of the treatment system will conclude the sequence of remedial actions.

Remediation of the mine discharge will improve water quality, reduce risks to human and ecological receptors, and contribute to meeting downstream total maximum daily load (TMDL) goals for Jack and Basin Creeks.

This interim ROD will be consistent with the final action selected for the Basin Watershed OU2.

Section 5. Summary of Site Characteristics

5.1 Conceptual Site Model

A conceptual site model (CSM) for the Site was prepared to help with identification of (1) potential sources of metals and arsenic; (2) probable pathways of movement of these contaminants from source material into soils, ground water and surface water; and (3) the potential assimilation into aquatic and terrestrial receptors. An accurate conceptual site model facilitates evaluation of potential risks to human health and the environment (EPA, 1989).

The CSM for the Site was developed from existing data (previous sampling and Basin Watershed OU2 RI) and information obtained from RI field activities performed in 2010 and 2012. Prominent Site features are presented in Exhibit 5-1.

The Basin Watershed is largely underlain by the Boulder batholith, a relatively small batholith, exposed at the surface as granite (more specifically quartz monzonite) and serving as the host rock for rich mineralized deposits. Regional uplift brought the deep-seated granite to the surface, where erosion exposed the granite and the extremely rich mineral veins. Hundreds of millions of dollars' worth of copper, silver, gold, zinc, lead and other metals have been mined from the batholith, using both underground mining and pit mining.

Snowmelt and precipitation infiltrates the shallow, unconsolidated glacial till and alluvial surface soils at the Bullion Site. Ground water flow generally follows surface topography and infiltrates downward through the shallow soils to the uppermost fractured and weathered zone of the Boulder batholith bedrock. This ground water then migrates primarily through fractures or faults in the bedrock, some of which are mineralized and host the ore deposits exploited by mining. The ground water at the Bullion Site eventually intercepts the underground mine workings. This water moves through the workings and discharges from the lower adit at an average rate of approximately 5 gallons per minute (gpm), flows down a rock-lined channel constructed during the 2002 TCRA, and discharges into Jill Creek approximately 235 yards downstream from the adit portal. Discharge from the adit is highest in the late summer, reflecting snowmelt and runoff travel time through the rock and mine workings. In addition, numerous springs discharge on the slope above and below the adit portal and contribute to the flow of Jill Creek. Exhibits 5-2 and 5-3 present plan and profile illustrations of the conceptual site model.

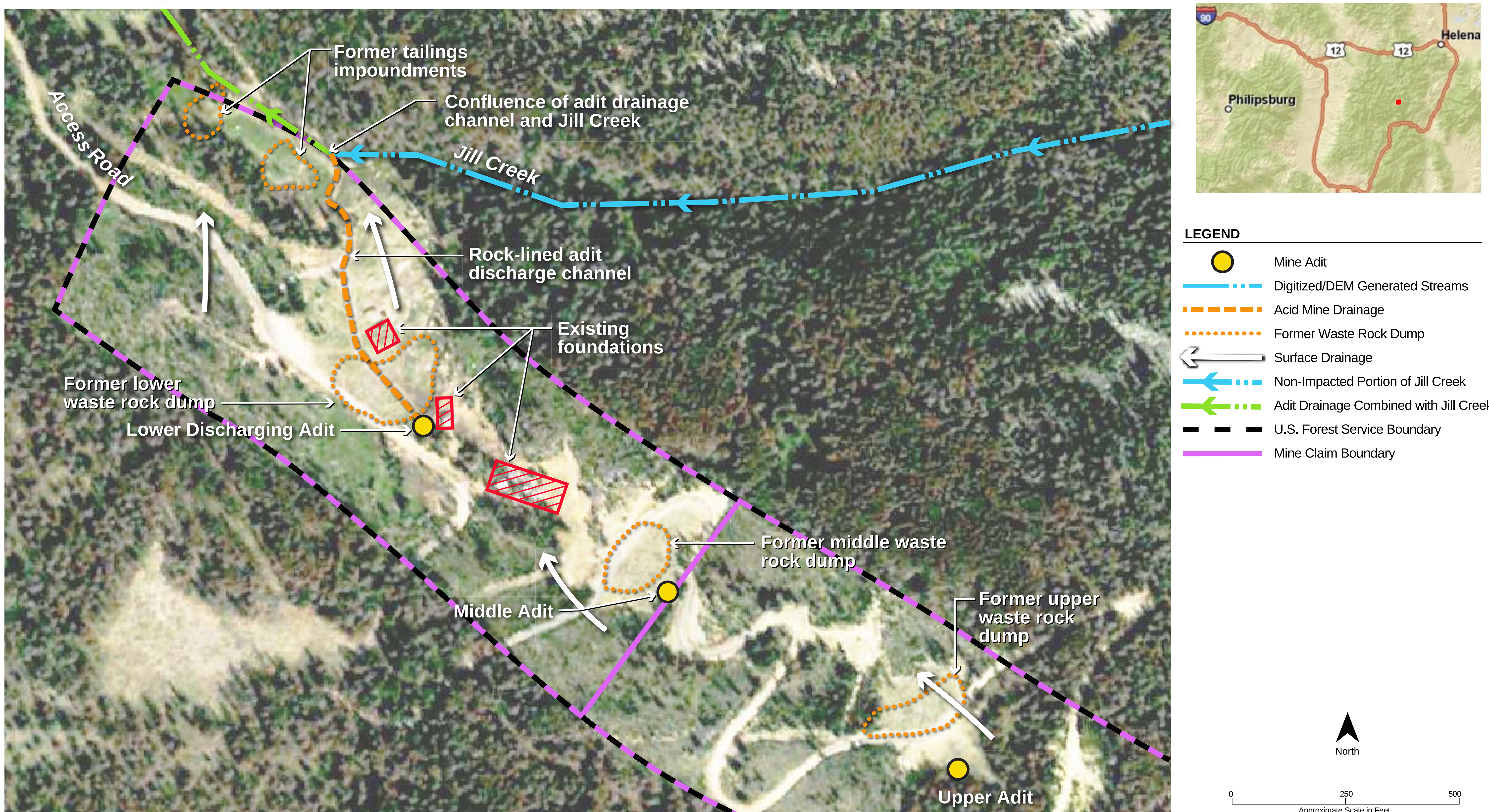
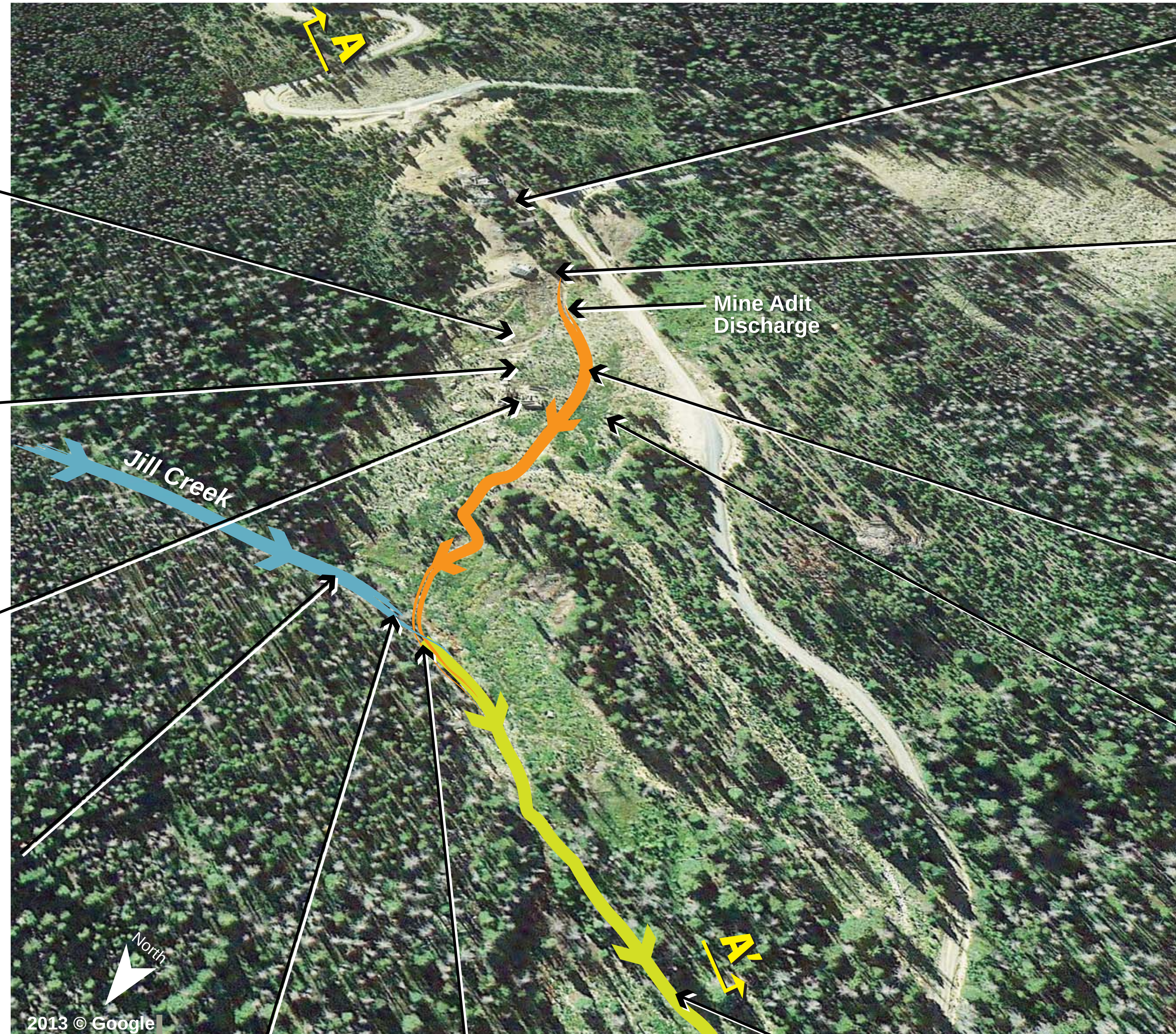


EXHIBIT 5-1

BULLION MINE CONCEPTUAL SITE PLAN

Prominent Site Features

Bullion Mine OU6 ROD



Reclaimed area and acidic springs

Pool formed in saturated slope

Historic flotation structures

Jill Creek above Bullion Mine. Note pristine conditions.

Collapsed adit cover

Acid mine discharge

Rock-lined adit discharge channel. Note oxidation.

Panorama of rock-lined channel and reclaimed area.

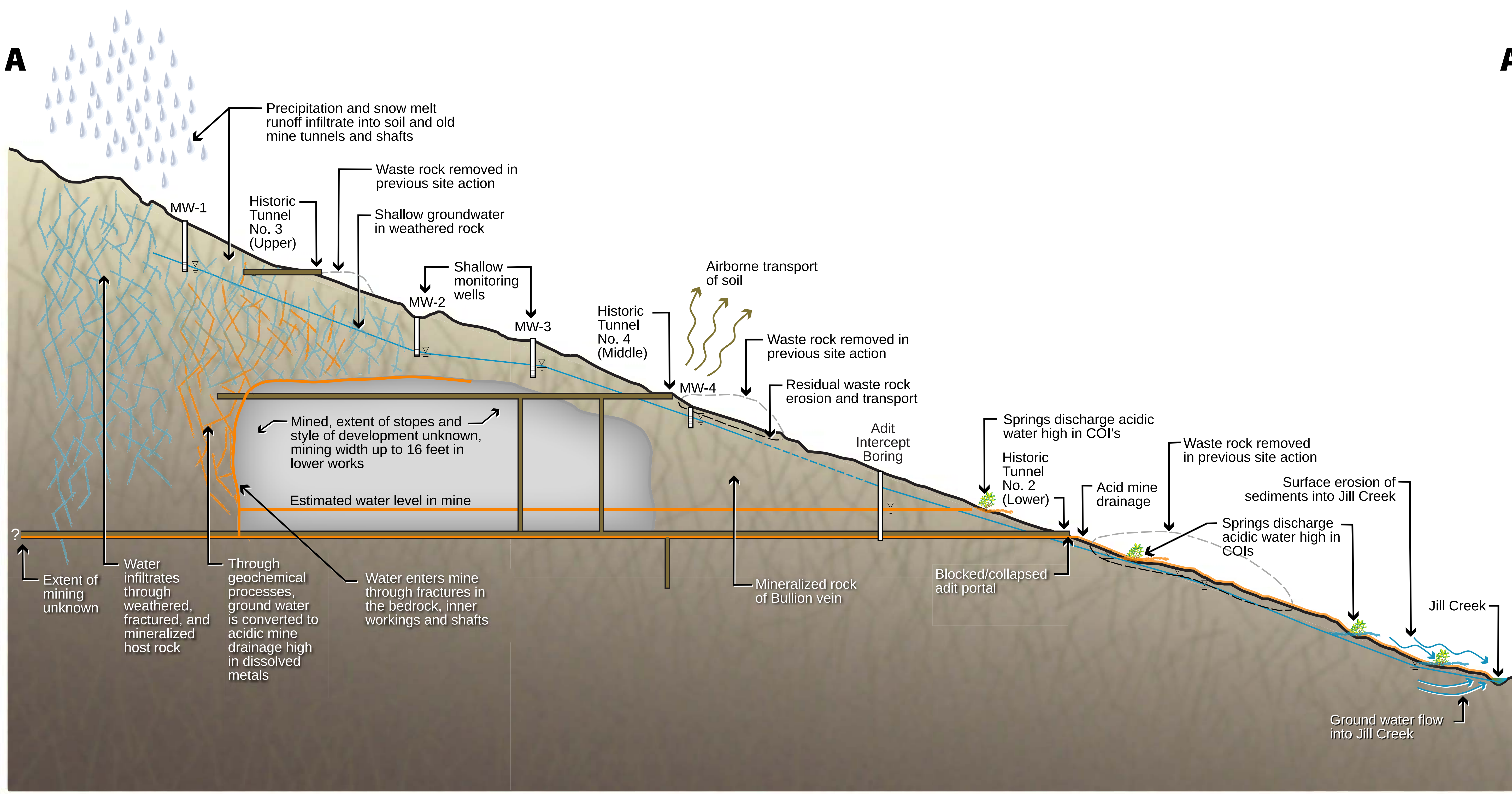
LEGEND:
See Figure 5-X for Cross Section A-A'

Sampling Jill Creek above confluence with adit drainage channel. Note clear water.

Confluence of adit drainage channel and Jill Creek. Note deteriorated condition of creek below confluence.

Jill Creek below Bullion Mine. Note poor condition of creek and dead trees.

EXHIBIT 5-2
BULLION MINE CONCEPTUAL SITE PLAN
Plan View
Bullion Mine OU6 ROD



LEGEND

Groundwater Level

Unimpacted groundwater

Acidic groundwater high in COIs

EXHIBIT 5-3
BULLION MINE SITE PLAN - **PROFILE**
Bullion Mine OU6 ROD

5.1.1 Potential Contamination Sources

Residual mine waste rock and contaminated soils, along with contaminated waters pooled within the Bullion Mine workings and seeping out through fractures to the surface, are the potential sources of contamination at this Site.

Waste Rock and Soils

Surface accumulations of waste rock, host rock and mineralized overburden extracted during mining of the Bullion claims were removed and transported to the Luttrell Repository during a removal action performed in 2001 and 2002. However, under the 12 to 18 inches of imported cover and topsoil, residual mine wastes are present in some areas of the Site, and have become exposed due to erosion in lightly vegetated areas. The depth of cover soil varies across the Site from a few inches on steep hillsides to several feet in former waste rock dump and tailings areas (Maxim Technologies, Inc., 2003). Natural lenses of sulfide minerals occur within portions of the vein and contribute to the acid-generating potential of the waste material. Contaminants continue to migrate from the discharging acidic mine waters into Site soils, as well as to the surface water and sediment of Jill Creek.

Adit Discharge

The portal to the lower workings adit is presently collapsed with its only surface expression being dilapidated head set timbers and a discharge of acidic mine water. While the mine was being worked, waste rock and ore were transported out of the lower workings of the mine through this adit. Over time, through disuse and lack of general maintenance, several sections of the adit collapsed, making direct entry into the adit impossible. Ground water has pooled behind this natural plug. The pressure from the pooled ground water has eroded a small outlet through the collapsed debris, resulting in a sustained perennial discharge from the mine. Contaminants continue to migrate from the discharging mine waters into Site soils, as well as to the surface water and sediment of Jill Creek.

During the USFS and the EPA removal action in 2001 and 2002, a sump was installed to capture a diffuse discharge source from the adit and direct it into a more controllable point source. Exposure of the mineralized rock within the mine's underground workings to ground water and bacteria have resulted in a constant discharge of acidic water from the mouth of the adit and ultimately into Jill Creek (Exhibit 5-1). This discharge represents the primary and most significant source of arsenic and metals at the Site.

5.1.2 Movement and Behavior of Contaminants of Concern

Oxidation of metal sulfides produces acidity (hydrogen ions), free metal ions and sulfate. Acidic conditions increase the mobility of most metals, whereas alkaline environments inhibit metal mobility. Arsenic may become more mobile in high pH environments because it is a metalloid. As free metal ions move into the ground water or surface water, geochemical reactions can occur to enhance or inhibit mobility. Oxidation-reduction potential (ORP) and pH strongly influence metal mobility in water. Because the reactions influencing form and mobility of metals and arsenic in ground water and surface water are primarily dissolution/precipitation and adsorption, the chemical and physical factors that dominate these reactions will have a strong influence on the form and mobility of metals and arsenic as well. Therefore, the acidity, alkalinity, ORP conditions, hardness and the presence of organic material in ground water and surface water are important factors influencing the movement and behavior of contaminants.

Contaminants of Concern

The contaminants of concern (COCs) at the Site are aluminum, antimony, arsenic, cadmium, copper, iron, lead, silver, and zinc. In soils, antimony, arsenic, cadmium, copper, lead, silver and zinc are the focus for terrestrial life because significant concentrations of these contaminants still remain in small exposed areas. In surface water and ground water discharging to surface water, elevated concentrations of aluminum, antimony, arsenic, cadmium, copper, iron, lead, and zinc are of particular concern because of their toxicity to aquatic life and potential toxicity to plants in the floodplain. Stream sediment data show that antimony, arsenic, cadmium, iron and silver exist at concentrations high enough to cause adverse effects on stream macroinvertebrates (aquatic life).

Contamination Mobilization, Transport and Pathways, and the Exposure Model

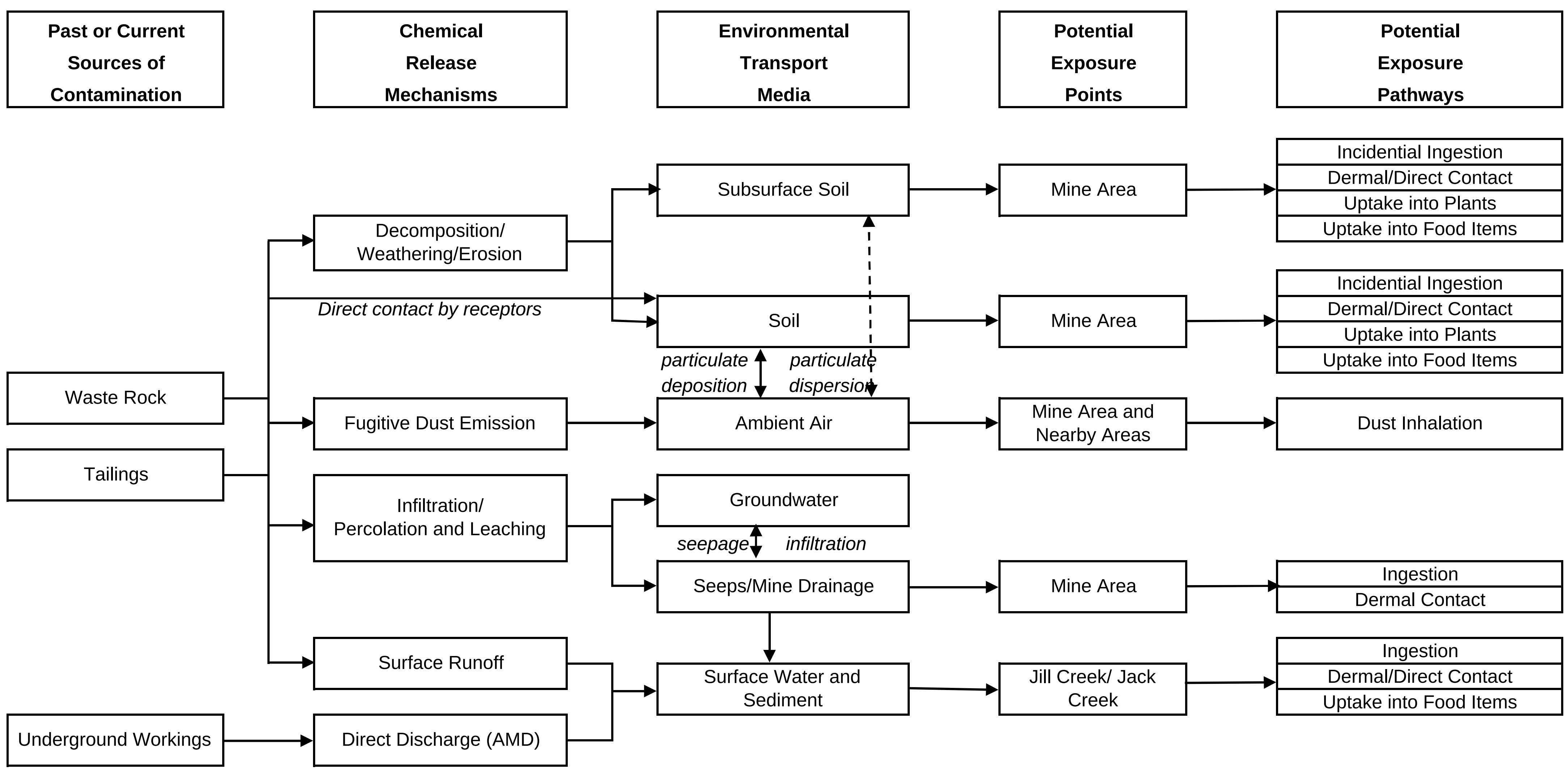
Metals-laden materials can be mobilized from Site sources in a number of ways. For the CSM, these processes include erosion, runoff, infiltration and wind-borne transport. The most likely transport pathways for contaminants are through surface water, ground water, air, vegetation and soil pore water (vadose zone). Along these pathways, exchange of COCs may occur between:

- Soil and ground water
- Stream sediment and surface water
- Soil and vegetation
- Surface water and ground water
- Vegetation and surface water

Specific pathways between abiotic and biological elements of the Site will be discussed in more detail by the screening risk assessment. A source, pathway, receptor exposure diagram (conceptual exposure model [CEM]) specific to the Bullion Mine Site is presented in Exhibit 5-4.

The major mobilization mechanisms for the contaminants at the Bullion Mine Site are summarized below. Detailed descriptions of these mechanisms and contaminant transport phenomena are presented in Section 2.3 of the RI/FS report.

- **Erosion and runoff.** Stream bank erosion, especially during high flows, may cause stream bank materials containing arsenic and metals to erode directly into the stream. The degree to which materials may be transported is influenced by climatic conditions, infiltration, slope, soil conditions, animal-human activity, the proximity of waste rock and metals-impacted soil, and the presence of vegetation.
- **Infiltration and vadose zone transport.** Soluble metals of concern in source material may be leached by infiltrating water and carried into underlying soil and shallow ground water.
- **Ground water inflow into the fluvial system.** Ground water discharging to the surface through a mine adit is a particularly important transport mechanism at the Site. Adit discharge water originates from the infiltration of precipitation and snowmelt into the soil profile and its migration into underlying bedrock fractures. Movement of water down through fractures intercepts the mineralized zone and underground workings created by mining. Once the ground water discharges from the portal, exposure to the atmosphere may result in precipitation, co-precipitation and absorptive processes that change free metal ions to less mobile forms. Arsenic and metals that remain in solution are transported as a point discharge until they infiltrate into the soil or intercept runoff or other surface water such as Jill Creek.
- **Physical transport of sediments.** Transient sediment deposits may form along the creek as point bar deposits or within the streambed itself, where metals may reside for a long time until they are remobilized by a change in flow regime.
- **Surface water flow to ground water.** Surface water may transport contaminants into ground water along stream reaches that lose water into shallow alluvial aquifers.
- **Airborne transport.** Contaminants could potentially be carried on dust particles entrained by the wind. Variables influencing the degree to which this transport mechanism might occur include climatic conditions, surface area or exposed and sparsely vegetated source materials.



Transport Media / Exposure Point	Potential Exposure Pathways	Current and Future Recreational Users (Adolescent and Adult)	Future Intermittent Worker	Future Excavation Worker	Hypothetical Industrial Worker	Hypothetical Residents	Terrestrial Wildlife (birds and mammals)	Vegetation (upland plants)	Aquatic Biota (fish and invertebrates)
Subsurface Soil / Mine Area	Incidential Ingestion	--	--	C	--	--	--	--	--
	Dermal/Direct Contact	--	--	C	--	--	--	--	--
	Uptake into Plants	--	--	--	--	--	--	C	--
	Uptake into Food Items	I	--	--	--	--	--	--	--
Soil / Mine Area	Incidential Ingestion	C	C	--	C	C	C	--	--
	Dermal/Direct Contact	C	C	--	C	C	I	--	--
	Uptake into Plants	--	--	--	--	--	--	C	--
	Uptake into Food Items	I	--	--	--	--	C	--	--
Ambient Air / Mine Area and Nearby Areas	Dust Inhalation	C	C	C	C	C	I	--	--
Seeps/Mine Drainage / Mine Area	Ingestion	--	--	--	--	--	I	--	--
	Dermal Contact	--	--	--	--	--	I	--	--
Surface Water and Sediment / Jill Creek/ Jack Creek	Ingestion	C	--	--	--	--	C	--	--
	Dermal/Direct Contact	I	--	--	--	--	I	--	C
	Uptake into Food Items	I	--	--	--	--	C	--	C

Notes:

C = Potentially complete pathway; quantitatively evaluated in the risk assessment

-- = Incomplete pathway

I = Potentially complete pathway; considered insignificat and not quatitatively evaluated in the risk assessment

EXHIBIT 5-4
CONCEPTUAL EXPOSURE MODEL (CEM)
FOR POTENTIAL HUMAN HEALTH AND
ECOLOGICAL RECEPTORS AT THE BULLION MINE
Bullion Mine OU6 ROD

CH2MHILL

5.2 Previous Site Removal Actions

In 2001 and 2002, the EPA and USFS jointly conducted a TCRA at the Bullion Mine. The goal of the agencies was to reduce human and environmental risks from metal-contaminated soils and sediment (Maxim, 2003). The TCRA resulted in the removal of 27,000 cubic yards of waste rock and tailings, placement of a clean soil cover and revegetation of disturbed areas, consolidation of adit discharge into a rock-lined channel to Jill Creek, and reconstruction of the Jill Creek channel. The TCRA greatly reduced risks associated with wind- and runoff-generated erosion and direct exposure to contaminated waste rock and soils. The findings from the TCRA are summarized in Appendix A of the Bullion Mine RI/FS.

5.3 Site Description

The Bullion Mine resides on a steep, north- to northwest-facing slope. Slopes across the Site range from less than 3 percent to as steep as 40 percent in localized areas. The overall Site gradient between the three adit portals is approximately 30 percent. The Jill Creek floodplain slopes approximately 3 percent to the northwest. Elevations at the Site range from approximately 7100 feet amsl along Jill Creek to 7800 feet amsl above the upper mine portal. One semi-improved gravel road provides access to the Site.

Climate

The Site receives an average annual precipitation of approximately 29 inches. The highest precipitation for the area generally occurs in May, June and July. Temperature extremes for the Site range from highs near 85 degrees Fahrenheit (°F) in late summer to lows near -40°F in December and January. Snowfall accumulation typically occurs between October and March.

Drainage and Hydrology

Surface runoff from the Site flows northward into Jill Creek. Jill Creek flows east to west for approximately 1 mile to its confluence with Jack Creek. From there, Jack Creek flows southwest approximately 2 miles to its confluence with Basin Creek. The local creeks experience a seasonal flow pattern with high flows occurring in the spring because of snowmelt and low flows in the late summer through the winter months. The lower third of the Site, in the Jill Creek floodplain, is wet, and supports a boggy wet meadow with numerous springs and seeps that drain towards Jill Creek.

The beneficial use classification for the entire Missouri River drainage, unless otherwise identified, is B-1. The Basin Creek drainage to the Town of Basin water supply intake is classified A-1. The B-1 classification states that the water quality of the stream must be sufficient to support recreational activities such as bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life and other wildlife; agricultural and industrial water supply; and drinking, culinary, and food processing purposes after conventional treatment. The A-1 classification states that waters are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment *for removal of naturally present impurities*. Water quality must be maintained suitable for bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

Soils and Geologic Setting

The majority of the Site is underlain by very thin sandy loam, gravelly loam, and sandy soil typically less than 20 inches thick, and underlain by granitic bedrock. The floodplain along Jill Creek is underlain by sandy loam and gravelly clay loam to a depth of greater than 60 inches. However, because of previous mining and reclamation activities, most the onsite soils within the mine claim have been highly disturbed over the years.

Bedrock geologic units in the Bullion Mine vicinity include volcanic rocks of the Elkhorn Mountains Volcanics and intrusive granitic rocks of the Butte Pluton. The Butte Pluton rocks underlie as much as 90 percent of the Basin Creek area, including the Bullion Mine area. Surficial geologic units in the Bullion Mine vicinity include sandy to gravelly glacial till, sandy gravel alluvial deposits, and silty and sandy colluvial deposits.

The geologic structure in the vicinity influences the orientation and location of the ore bodies and quartz veins. Geologic structures in the area consist of faults, shear zones and fractures. The Bullion vein is formed in a prominent east-trending structural shear zone that extends more than 3.5 miles in length. The orientation and density of geologic structure and fractures also influences ground water flow in the vicinity of the Bullion Mine, where ground water flows through high-permeability fractures in the bedrock.

Disturbed Areas, Surface Features, Historical Features

The majority of the land within the Basin Creek Watershed is managed by the USFS or U.S. Bureau of Land Management (BLM). The historic land use for claim properties in the watershed includes mining, logging, grazing, recreation and residential. A few residences are located along Basin and Jack Creeks, with the Town of Basin at the mouth of the watershed. No known potable water supply wells are located within a 1-mile radius of the Site, but water from Basin Creek is used for irrigation, supports impaired fisheries and discharges to the Boulder River, which is a drinking water source for the towns of Basin and Boulder.

Disturbed, barren, erosion-prone surfaces at the Site are limited to several former waste rock dump locations and the main access road. Most of the Site is revegetated as part of the waste rock pile removal action performed by the EPA and USFS in 2002. Seven foundations from mining structures are scattered throughout the lower half of the Site. Several buildings and ore bins, a flotation mill with tailings and two breached tailings impoundments were also present prior to the removal action. A smelter and a gravity concentrator were constructed approximately 1 mile away, on another tributary to Jack Creek.

Renewable Technologies, Inc. (RTI) performed an updated cultural resources inventory of the Site (RTI, 2011), noted any changes that might have occurred since 1998 (RTI, 1999), and reconsidered Site eligibility for listing in the National Registry of Historic Places in light of the 2003 guidance. RTI found in 2011 that the Site had not only changed because of the 2001–2002 reclamation work, but also had been damaged by natural deterioration since last inventoried 13 years ago. The majority of remaining buildings and structures at the Bullion Mine are concentrated in what was once a residential area. Relatively few mining and milling features are left. Therefore, RTI now believes the Bullion Mine is not eligible for the National Register for Historic Places.

5.4 2010-2012 Field Investigations

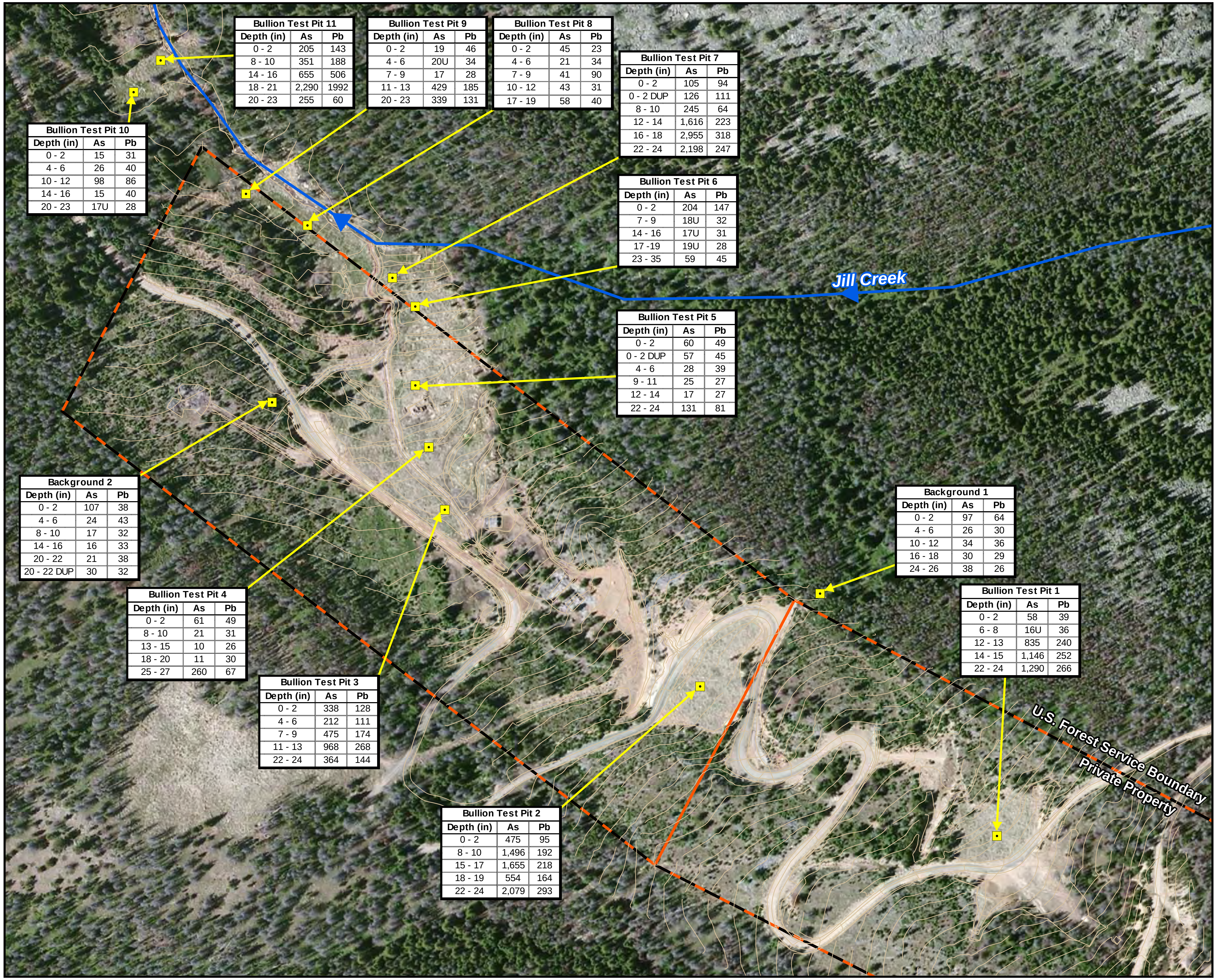
Site characterization undertaken between 2010 and 2012 focused on the following objectives:

- Assess the condition of underground mine workings and the competence of host rock by drilling into the lower mine adit.
- Observe the occurrence and volume of water within the plugged adit, measure discharge from the adit and obtain water samples.
- Evaluate shallow hydrogeologic conditions and obtain ground water samples.
- Identify and inventory springs in the immediate vicinity of the mine, and collect and analyze water samples.
- Assess and quantify potential mine-related impacts to Jill Creek by water and sediment sampling.
- Define the vertical thickness of cover soil and sample surface soils to evaluate the bioavailability of arsenic and lead.
- Inventory and delineate wetlands.
- Assess the status of revegetation establishment that has occurred since the 2001-2002 TCRA by the USFS and the EPA.
- Identify endangered and threatened species.
- Perform a survey of the benthic community in Jill Creek.

5.4.1 Soil Investigations

During the 2010 field season, soil samples were collected at representative locations along the banks of Jill Creek and in areas where waste rock was removed and the soils reclaimed. Eleven test pits were excavated that ranged in depth from 19 to 24 inches, deep enough to penetrate through non-native fill and sample native materials. A field x-ray fluorescence (XRF) instrument was used to quantify concentrations of metals in the soil to estimate the areal and vertical extent of contamination. A total of 73 samples was collected for elemental analysis, including two background samples from offsite locations. A subset of the soil samples was sent to an analytical laboratory to confirm the concentrations of the elements identified by the XRF.

Exhibit 5-5 shows the locations of the test pits and soil XRF results for arsenic and lead versus depth.



Bullion Test Pit 11

Depth (in)	As	Pb
0 - 2	205	143
8 - 10	351	188
14 - 16	655	506
18 - 21	2,290	1992
20 - 23	255	60

Bullion Test Pit 9

Depth (in)	As	Pb
0 - 2	19	46
4 - 6	20U	34
7 - 9	17	28
11 - 13	429	185
20 - 23	339	131

Bullion Test Pit 8

Depth (in)	As	Pb
0 - 2	45	23
4 - 6	21	34
7 - 9	41	90
10 - 12	43	31
17 - 19	58	40

Bullion Test Pit 7

Depth (in)	As	Pb
0 - 2	105	94
0 - 2 DUP	126	111
8 - 10	245	64
12 - 14	1,616	223
16 - 18	2,955	318
22 - 24	2,198	247

Bullion Test Pit 10

Depth (in)	As	Pb
0 - 2	15	31
4 - 6	26	40
10 - 12	98	86
14 - 16	15	40
20 - 23	17U	28

Bullion Test Pit 6

Depth (in)	As	Pb
0 - 2	204	147
7 - 9	18U	32
14 - 16	17U	31
17 -19	19U	28
23 - 35	59	45

Bullion Test Pit 5

Depth (in)	As	Pb
0 - 2	60	49
0 - 2 DUP	57	45
4 - 6	28	39
9 - 11	25	27
12 - 14	17	27
22 - 24	131	81

Background 2

Depth (in)	As	Pb
0 - 2	107	38
4 - 6	24	43
8 - 10	17	32
14 - 16	16	33
20 - 22	21	38
20 - 22 DUP	30	32

Background 1

Depth (in)	As	Pb
0 - 2	97	64
4 - 6	26	30
10 - 12	34	36
16 - 18	30	29
24 - 26	38	26

Bullion Test Pit 1

Depth (in)	As	Pb
0 - 2	58	39
6 - 8	16U	36
12 - 13	835	240
14 - 15	1,146	252
22 - 24	1,290	266

Bullion Test Pit 4

Depth (in)	As	Pb
0 - 2	61	49
8 - 10	21	31
13 - 15	10	26
18 - 20	11	30
25 - 27	260	67

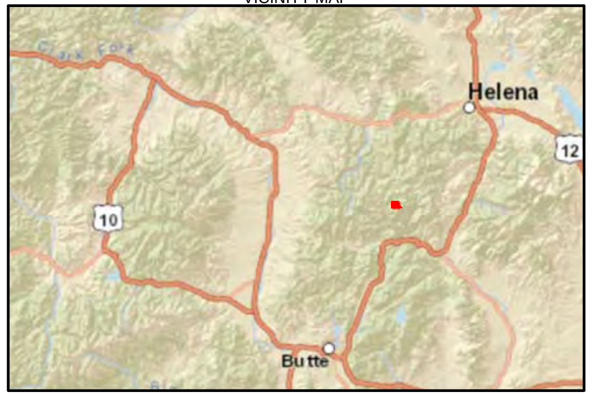
Bullion Test Pit 3

Depth (in)	As	Pb
0 - 2	338	128
4 - 6	212	111
7 - 9	475	174
11 - 13	968	268
22 - 24	364	144

Bullion Test Pit 2

Depth (in)	As	Pb
0 - 2	475	95
8 - 10	1,496	192
15 - 17	1,655	218
18 - 19	554	164
22 - 24	2,079	293

VICINITY MAP



LEGEND

- Test Pit
- NHD Stream
- Topographic Survey
- U.S. Forest Service Boundary
- Mine Claim Boundary

Notes:
1. Analytical values are based on XRF samples, concentations are in mg/kg
2. 2011 Imagery - ArcGIS Streaming Map Service.
3. U = Below Detection Limit

N

0 100 200
Feet

EXHIBIT 5-5
SOIL TEST PITS AND XRF SAMPLING RESULTS
Bullion Mine OU6 ROD

CH2MHILL

A summary of metal and arsenic concentrations (measured by field XRF) in the soil samples is presented in Table 5-1. The data are arranged by soil depth increment, number of samples collected from each increment, and the mean, maximum, and minimum concentrations of the elements. Almost all of the antimony, cadmium, nickel, selenium and silver data were reported as less than their respective XRF detection limits and are not shown in the table.

TABLE 5-1

Mean concentrations (mg/kg) of arsenic, copper, iron, lead, manganese, and zinc in Bullion Mine wastes and soils

Soil Depth (inches)	No. Samples	Concentration mg/kg	Arsenic	Copper	Iron	Lead	Manganese	Zinc
0-2	13	Mean	136	65	32,549	77	607	243
		Max	475	110	78,652	147	1,575	1,442
		Min	15	30	21,957	23	254	55
4-6	5	Mean	61	34	24,955	52	606	229
		Max	212	38	30,093	111	1,032	992
		Min	20U*	26	15,433	34	372	56
6-9	5	Mean	113	38	28,589	72	597	107
		Max	475	47	31,103	174	1,153	260
		Min	16U	32	22,923	28	396	53
8-11	5	Mean	428	125	30,606	100	670	214
		Max	1,496	259	46,336	192	1,213	469
		Min	21	29	22,146	27	482	52
10-14	6	Mean	661	92	29,546	172	522	187
		Max	1,616	178	36,522	268	718	380
		Min	17	32	18,022	27	450	67
13-17	6	Mean	583	85	32,417	179	616	213
		Max	1,655	185	48,019	506	1,243	549
		Min	10	27	23,347	26	322	43
17-24	11	Mean	860	218	32,869	309	757	412
		Max	2,290	1,167	46,364	1,992	1,809	1,127
		Min	11	32	14,138	28	239	46
25-27	2	Mean	160	39	27,563	26	569	114
		Max	260	43	28,693	67	664	126
		Min	59	34	26,432	45	474	101

Notes:

* U =concentration less than or equal to XRF detection limit.

5.4.2 Subsurface Soil Elemental Levels

The interpretation of metal and arsenic concentrations in the soils was complicated by the cover soil that was imported after excavation activities were completed in 2001. Mean levels of arsenic increase with sample depth, with a mean value of 860 mg/kg (milligrams per kilogram) for samples collected from a depth of 17 to 24 inches. This sample increment is interpreted to be below the imported cover soil, and thereby represents residual soil contamination remaining after the excavation of wastes and contaminated soils. Maximum concentrations of arsenic (2,290 mg/kg), copper (1,167 mg/kg), lead (1,992 mg/kg) are also found in soils from this depth increment.

These trends of increasing soil concentrations by depth are displayed in Exhibits 5-6 (arsenic) and 5-7 (lead). Mean elemental concentrations in background samples were found for arsenic (approximately [≈] 40 mg/kg), copper (≈38 mg/kg), iron (≈19,750 mg/kg), lead (≈36 mg/kg) and zinc (≈80 mg/kg).

EXHIBIT 5-6
Soil Arsenic Level versus Depth

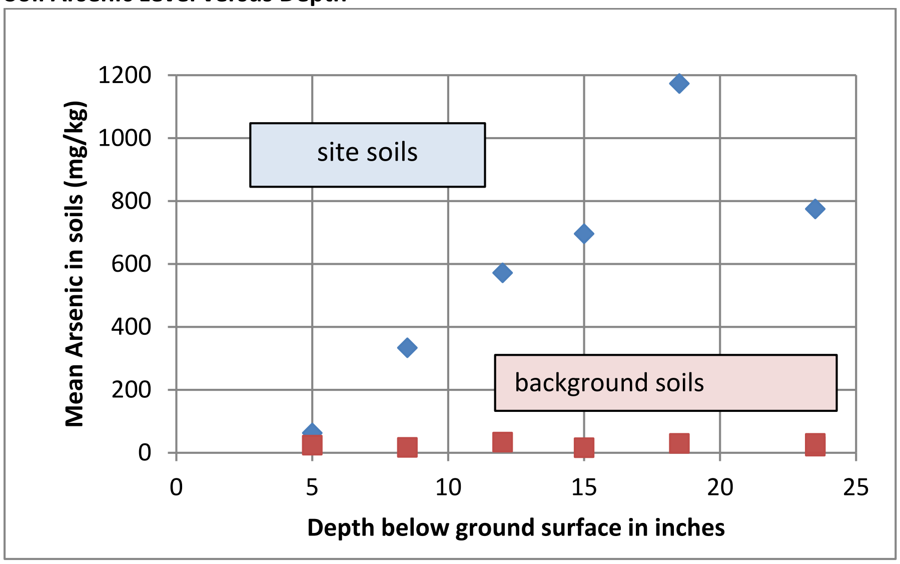
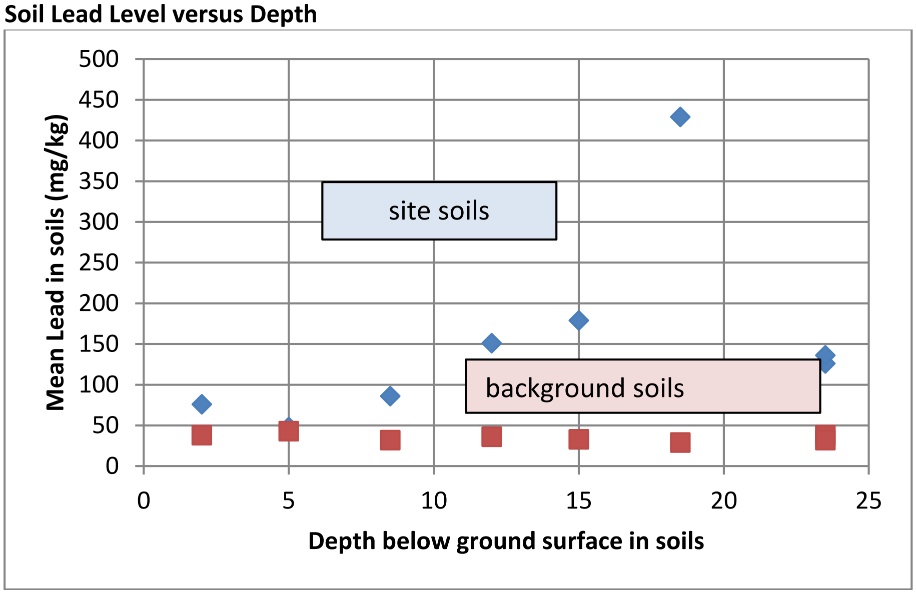


EXHIBIT 5-7
Soil Lead Level versus Depth



5.4.3 Soil Concentrations and Ecological and Human Benchmark Values

Mean and maximum concentrations of the arsenic, cadmium, copper, lead, iron, manganese, aluminum, nickel and zinc exceed their respective ecological benchmark values (see Table 5-1). For example, the mean and maximum concentrations of arsenic in Site soils (452 mg/kg and 2,955 mg/kg, respectively) are three to four orders of magnitude greater than the ecological benchmark of 0.36 mg/kg. Maximum and mean arsenic concentrations throughout the soil profile exceed this ecological benchmark. The ecological benchmarks for lead (11 mg/kg), cadmium (0.36 mg/kg) and zinc (160 mg/kg) are also exceeded in many samples, with mean and maximum concentrations up to two orders of magnitude greater than the benchmark value. Table 5-2 summarizes soil and sediment screening benchmarks, and Table 5-3 summarizes conservative screening benchmarks by media.

Comparisons of soil and waste rock concentrations in samples collected in 2010 to human health residential benchmark values (see Table 5-2) indicate that the cover soil and waste values of arsenic, cadmium, copper, lead, manganese and zinc exceed those considered to be protective of human health.

The Bullion Mine is located in a naturally mineralized zone and greater concentrations of these elements are expected. Arsenic levels in soils collected from the background sites range from 16 to 107 mg/kg with a mean level of 40 mg/kg. The mean and maximum concentrations in both the cover soil and underlying wastes exceed the background concentrations for arsenic and other elements. This same pattern is repeated for copper, lead, manganese, nickel and zinc.

TABLE 5-2
Soil and Sediment Screening Benchmarks

	Soil					Sediment			
	Human Health Soil Screening Levels (mg/kg)[a]		Ecological Soil Screening Levels (mg/kg)[b]			EPA Region 3 (mg/kg)[c]	NOAA SQuiRTs (mg/kg)[d]	Ecological Soil Screening Levels (mg/kg)[b]	
Analyte	Occupational	Residential	Plants	Avian	Mammalian		ARCS	Avian	Mammalian
Aluminum	110,000	7,700	—	—	—	—	25,500	—	—
Antimony	47	3.1	—	—	0.27	2	—	NA	0.27
Arsenic	3.0	0.67	18	43	46	9.8	—	43	46
Cadmium	98	7	32	0.77	0.36	0.99	—	0.77	0.36
Copper	4,700	310	70	28	49	31.6	—	28	49
Iron	82,000	5,500	—	—	—	20,000	—	—	—
Lead	800	400	120	11	56	35.8	—	11	56
Manganese	2,600	180	220	4,300	4,000	460	—	4,300	4,000
Nickel	—	—	38	210	130	22.7	—	210	130
Selenium	580	39	0.52	1.2	0.63	2	—	1.2	0.63
Silver	580	39	560	4.2	14	1	—	4.2	14
Thallium	1.2	0.078	—	—	—	—	—	—	—
Zinc	35,000	2,300	160	46	79	121	—	46	79

Notes:
mg/kg = milligrams per kilogram
[a] Residential soil screening levels from the EPA (2012a). *Regional Screening Levels for Chemical Contaminants at Superfund Sites*. (Carcinogenic effect TR = 10^{-6}, Noncarcinogenic effect HQ = 0.1). Although residential scenarios are not expected onsite, these levels serve as conservative screening values.
[b] Eco soil screening levels from the EPA EcoSSL guidance serve as conservative estimates of minimum detection limits. *Guidance for Developing Ecological Soil Screening Levels (EcoSSLs)* (EPA, 2005).
[c] Sediment screening levels are from the EPA Region 3 Freshwater Sediment Screening Benchmarks. Available at: http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fwsed/screenbench.htm.
[d] National Oceanic and Atmospheric Association (NOAA). 2008. Screening Quick Reference Tables (SQuiRTs).
ARCS = assessment and remediation of contaminated sediments. PNEC = predicted no-effect concentration

TABLE 5-3
Summary of Conservative Screening/Cleanup Benchmarks by Media*

Analyte	Soil Screening Value (mg/kg)	Surface Water Screening Value (mg/L)	Sediment Screening Value (mg/kg)	Ground water Screening Value (mg/L)
Aluminum	7,700 (14,350)	0.087	25,500	—
Antimony	0.27 (0.39)	0.0056	0.27	0.006
Arsenic	0.67 (23)	0.01	9.8	0.01
Cadmium	0.36 (0.45)	0.000097	0.36	0.005
Copper	28 (12)	0.00285	28	1.3
Iron	5,500 (6,600)	1,000	20,000	—
Lead	11 (23)	0.000545	11	0.015
Manganese	180 (23)	—	460	NA
Nickel	38 (7)	0.0161	23	0.1
Selenium	0.5 (—)	0.001	0.6	0.05
Silver	4.2 (—)	0.000374	1.0	0.1
Thallium	0.08 (—)	0.00024	NA	0.002
Zinc	46 (56)	0.037	46	2.0

Notes:
Derived from Tables 1-6 and 1-7 in the Remedial Investigation (CH2M HILL, 2013);
Value in parenthesis in Soil Screening column indicates Site mean (analytical) background value for that constituent; — = Non detect
*Screening benchmarks are intentionally conservative—not intended for assessment of risk; values consistent with Circular DEQ-7 numeric water quality standards represent binding cleanup levels.

5.5 Bioavailability of Arsenic and Lead in Soils

A Bullion Mine Site-specific bioavailability study was conducted to provide a better understanding of the bioavailability of arsenic and lead in selected Site soils. This information will be used to more accurately assess the potential risk to human and ecological receptors. The InVitro Bioaccessibility Procedure (IVBA) procedure used an *in vitro* test to measure the fraction of a chemical solubilized from a soil sample under simulated mammalian gastrointestinal conditions. A detailed description of the analytical methods and test procedures is provided in sections 3.6.3 and 3.6.4 of the RI. The Mine-specific mean bioavailability factors of 22 percent for arsenic and 19 percent for lead provide a realistic assessment of risk to receptors at the Site.

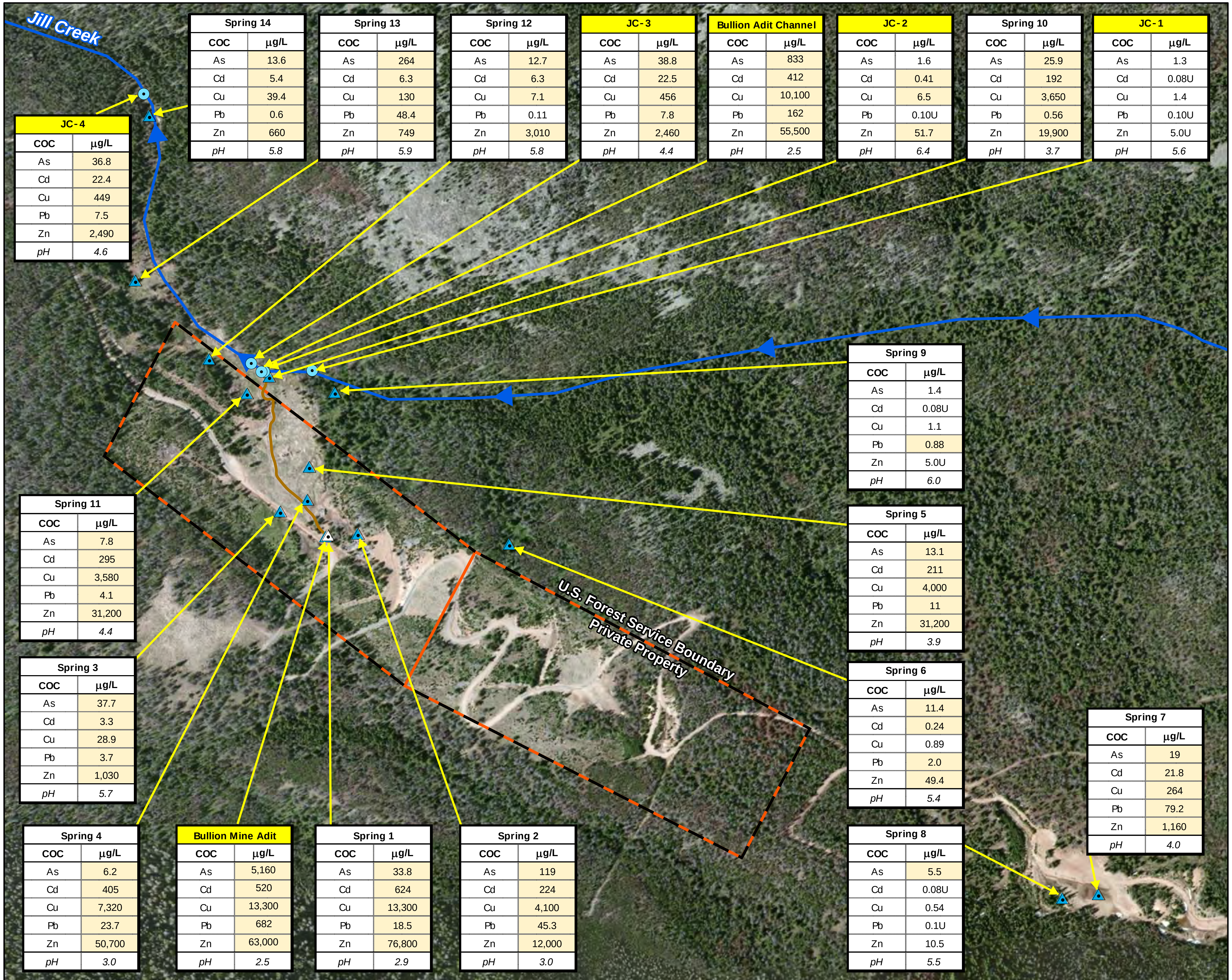
5.6 Surface Water Investigations

Synoptic sampling of waters from Jill Creek and samples from seeps and springs were collected in the spring and fall of 2010. Physical and chemical characterization of the waters were compared to standards for human health and aquatic health.

5.6.1 Synoptic Sampling of Jill Creek

The purpose of a synoptic sampling of Jill Creek was to identify and document seasonal changes in flow and water quality in the target reach of Jill Creek. Synoptic sampling was performed twice during the 2010 field season, in the early summer during high spring runoff, and in the fall during low flow. Sampling was performed at four locations, including above and below the confluence of the adit drainage channel. Discharge from the lower Bullion adit, above the channel confluence with Jill Creek, was also sampled as part of this investigation. At each location, stream discharge was measured and water samples were collected and analyzed for major ions and total and dissolved contaminants of interest. Field parameters were also measured (pH, dissolve oxygen, specific conductivity, temperature and turbidity) at each designated station. Details of sampling, field measurements, analytical procedures and assessment of data quality are described in the RI document (CH2M HILL, 2013).

Exhibit 5-8 shows the locations of the surface water samples, and contaminant of concern (COC) concentrations during spring runoff conditions.



Spring 14

COC	µg/L
As	13.6
Cd	5.4
Cu	39.4
Pb	0.6
Zn	660
pH	*5.8*

Spring 13

COC	µg/L
As	264
Cd	6.3
Cu	130
Pb	48.4
Zn	749
pH	*5.9*

Spring 12

COC	µg/L
As	12.7
Cd	6.3
Cu	7.1
Pb	0.11
Zn	3,010
pH	*5.8*

JC - 3

COC	µg/L
As	38.8
Cd	22.5
Cu	456
Pb	7.8
Zn	2,460
pH	*4.4*

Bullion Adit Channel

COC	µg/L
As	833
Cd	412
Cu	10,100
Pb	162
Zn	55,500
pH	*2.5*

JC - 2

COC	µg/L
As	1.6
Cd	0.41
Cu	6.5
Pb	0.10U
Zn	51.7
pH	*6.4*

Spring 10

COC	µg/L
As	25.9
Cd	192
Cu	3,650
Pb	0.56
Zn	19,900
pH	*3.7*

JC - 1

COC	µg/L
As	1.3
Cd	0.08U
Cu	1.4
Pb	0.10U
Zn	5.0U
pH	*5.6*

JC - 4

COC	µg/L
As	36.8
Cd	22.4
Cu	449
Pb	7.5
Zn	2,490
pH	*4.6*

Spring 9

COC	µg/L
As	1.4
Cd	0.08U
Cu	1.1
Pb	0.88
Zn	5.0U
pH	*6.0*

Spring 5

COC	µg/L
As	13.1
Cd	211
Cu	4,000
Pb	11
Zn	31,200
pH	*3.9*

Spring 11

COC	µg/L
As	7.8
Cd	295
Cu	3,580
Pb	4.1
Zn	31,200
pH	*4.4*

Spring 3

COC	µg/L
As	37.7
Cd	3.3
Cu	28.9
Pb	3.7
Zn	1,030
pH	*5.7*

Spring 6

COC	µg/L
As	11.4
Cd	0.24
Cu	0.89
Pb	2.0
Zn	49.4
pH	*5.4*

Spring 7

COC	µg/L
As	19
Cd	21.8
Cu	264
Pb	79.2
Zn	1,160
pH	*4.0*

Spring 4

COC	µg/L
As	6.2
Cd	405
Cu	7,320
Pb	23.7
Zn	50,700
pH	*3.0*

Bullion Mine Adit

COC	µg/L
As	5,160
Cd	520
Cu	13,300
Pb	682
Zn	63,000
pH	*2.5*

Spring 1

COC	µg/L
As	33.8
Cd	624
Cu	13,300
Pb	18.5
Zn	76,800
pH	*2.9*

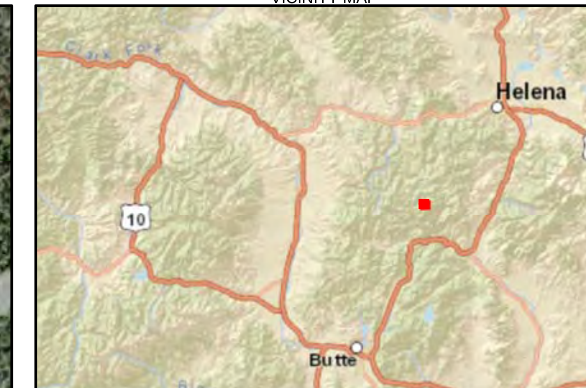
Spring 2

COC	µg/L
As	119
Cd	224
Cu	4,100
Pb	45.3
Zn	12,000
pH	*3.0*

Spring 8

COC	µg/L
As	5.5
Cd	0.08U
Cu	0.54
Pb	0.1U
Zn	10.5
pH	*5.5*

VICINITY MAP



LEGEND

- Bullion Lower Adit
- Stream Sample Location
- Spring Sample Location
- Adit Discharge Channel
- U.S. Forest Service Boundary
- Mine Claim Boundary

Notes:
1. Shaded Cells Exceed Screening Benchmarks.
2. 2011 Imagery - ArcGIS Streaming Map Service.
3. Sample results shown are Total Metals, June 2010.
4. U = Below Detection Limits.

EXHIBIT 5-8
SPRING AND SURFACE WATER SAMPLING LOCATIONS AND ANALYTICAL RESULTS (TOTAL)
Bullion Mine OU6 ROD

Table 5-4 shows the total concentrations of several metals and metalloids, major anions and sulfate.

TABLE 5-4
Total Elemental Levels (µg/L) in Surface Waters

Parameter	Screening/ Cleanup Level	Collection Period	Bullion Adit Channel	Bullion Adit	JC-1	JC-2	JC-3	JC-4
Al	87 µg/L[1]	Spring	19,900	19,500	41.1	51.3	966	915
		Fall	15,800	13,300	56.4	50.9	390	840
Sb	5.6 µg/L	Spring	4.6	21.8	0.5U	0.5U	0.5U	0.5U
		Fall	3.2	17.8	0.5U	0.5U	0.5U	0.5U
As	10 µg/L	Spring	833	5,160	1.3	1.6	38.3	36.8
		Fall	297	1,740	1.1	1.6	1.3	19.5
Cd	0.097 µg/L[a]	Spring	412	520	0.08U	0.41	22.5	22.4
		Fall	318	314	0.08U	0.79	20.7	20.5
Ca	—	Spring	75,600	74,400	5,190	5,500	8,640	10,400
		Fall	81,100	73,800	5,920	6,580	10,700	12,400
Cu	2.85 µg/L[a]	Spring	10,100	13,300	1.4	6.5	456	449
		Fall	8,210	7,170	0.79	11.1	325	338
Fe	300 µg/L[1]	Spring	136,000	243,000	50.0U	50.0U	6,110	5,580
		Fall	110,000	169,000	50.0U	50.0U	1,490	5,130
Pb	0.55 µg/L[a]	Spring	162	682	0.10U	0.10U	7.8	7.5
		Fall	122	395	0.10U	0.10U	1.0	6.9
Mg	—	Spring	28,200	30,800	1,080	1,140	2,330	2,760
		Fall	29,600	28,900	1,230	1,360	2,930	3,300
Mn	120 µg/L[1]	Spring	26,200	29,900	1.3	18.5	1,240	1,130
		Fall	23,000	21,200	1.2	40.0	1,300	1,230
Ni	16.1 µg/L[a]	Spring	106	114	0.5U	0.5U	5.3	5.6
		Fall	92.4	80.1	0.64	0.63	6.0	6.0
K	—	Spring	2,100	3,030	746	762	761	921
		Fall	2,350	2,880	785	791	884	928
Se	5 µg/L	Spring	3.6	3.4	0.5U	0.5U	0.5U	0.5U
		Fall	3.9	3.1	0.5U	0.5U	0.5U	0.5U
Ag	0.37 µg/L[a]	Spring	0.5U	0.97	0.5U	0.5U	0.5U	0.5U
		Fall	-	-	-	-	-	-
Na	—	Spring	4,200	5,030	2,110	2,080	2,010	2,340
		Fall	5,410	5,010	2,180*	2,106*	2,410*	2,450*
Tl	0.24 µg/L	Spring	0.1U	0.42	0.1U	0.1U	0.1U	0.1U
		Fall	0.2	0.19	0.1U	0.1U	0.1U	0.1U
Zn	37 µg/L[a]	Spring	55,500	63,000	5.0U	51.7	2,460	2,490
		Fall	40,900	36,900	5.0U	102	2,210	1,300

TABLE 5-4
Total Elemental Levels (µg/L) in Surface Waters

Parameter	Screening/ Cleanup Level	Collection Period	Bullion Adit Channel	Bullion Adit	JC-1	JC-2	JC-3	JC-4
Cl	—	Spring	7.2	1.0U	1.0U	1.0U	1.0U	1.0U
		Fall	1.0U	1.0	1.0U	1.0U	1.0U	1.0U
SO_4	—	Spring	1,030	1,390	5.4	6.4	52.0	58.1
		Fall	956	1,120	5.8	5.0U	58.4	58.2

Notes:
Shaded cells indicate value is greater than the Screening Level (Table 5-2).
*Estimated value due to elevated Na in field blank.
[1]EPA Freshwater Screen Benchmarks (milligrams per liter [mg/L]). Available at http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fw/screenbench.htm.
[a]The freshwater criterion for this metal is expressed as a function of hardness (mg/L) in the water column. The value given here corresponds to a hardness of 25 mg/L. Criteria values for other hardness may be calculated from the following:
CMC (dissolved) = exp(mA[ln(hardness)]+bA) (CF), or CCC (dissolved) exp (mC[ln(hardness)] + bC) (CF)
U indicates reported value $\leq$ method detection limit.

Concentrations of many elements exceeded conservative screening benchmarks shown in Table 5-3. These same patterns were demonstrated in the dissolved elemental concentrations. These data may be found in the RI report.

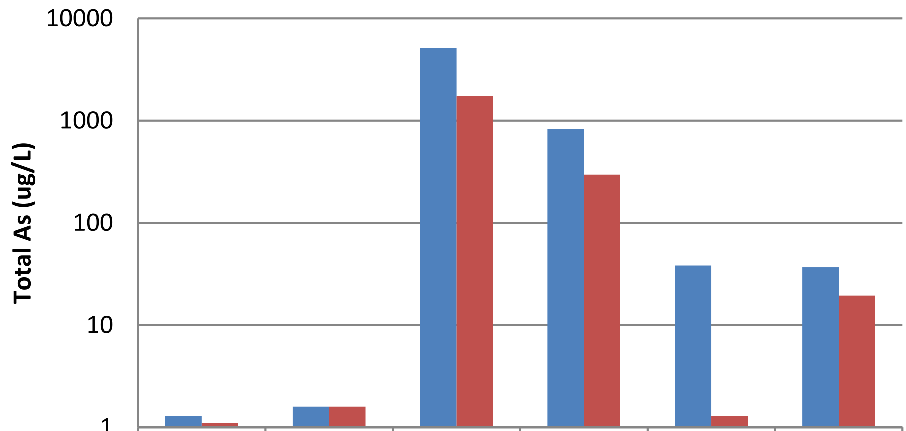
Water quality in Jill Creek above the confluence with the mine adit discharge is superior to that recorded at downstream stations. The water quality degrades up to several orders of magnitude downstream of the confluence of the lower adit discharge channel. COC concentrations at surface water stations above the confluence with the mine discharge (JC-1 and JC-2) remained relatively stable for both the July and September sampling episodes. At stations JC-3 and JC-4, analyses for several metals were lower in the September sampling. This was true for dissolved values of aluminum, arsenic, cadmium, copper, iron, lead and zinc concentrations at station JC-4 as well.

Total concentrations of arsenic, copper and zinc are presented in Exhibits 5-9, 5-10 and 5-11, respectively, as examples of seasonal variations in contaminants. In general, concentrations at most sampling locations were greater in the spring compared to levels found during the fall sampling. The lower adit at the Bullion Mine has a perennial discharge that varies seasonally, with the highest flows occurring in the May to July time frame. This seasonal recharge activity appears to drive seasonal variations in contaminant concentrations in AMD as the ground water moves across the exposed rock surfaces, collects along the floor of the adit, and seeps out of the partially plugged portal opening into a rock-lined channel that discharges to Jill Creek.

Contaminant loading into Jill Creek from adit discharge was calculated for several representative COCs based on observed discharge in the adit channel, which was higher in July 2012 (17 gpm) than in September 2012 (2.2 gpm). The loading rate for July and September sampling, respectively (pounds per day) was as follows: arsenic (0.17, 0.01); cadmium (0.08, 0.01); copper (2.06, 0.19); lead (0.03, 0.003); and zinc (11.3, 1.1).

EXHIBIT 5-9

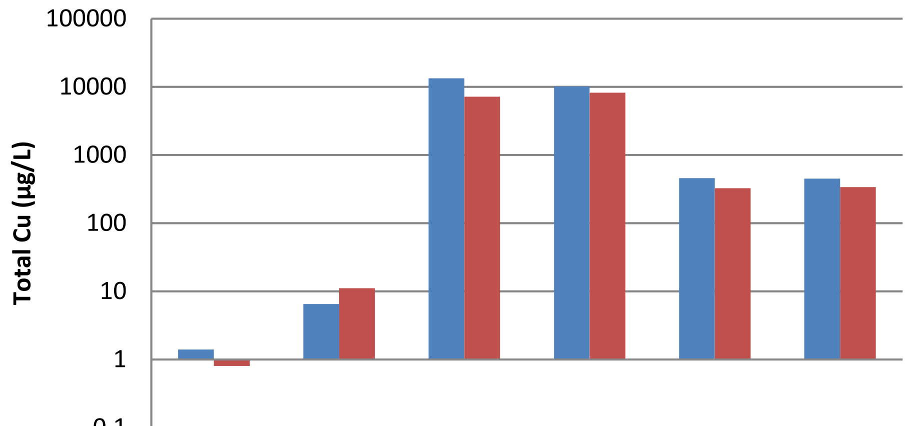
Total Arsenic Concentrations in Jill Creek and Adit Discharge



	Jill 1	Jill 2	Adit	Channel	Jill 3	Jill 4
Spring	1.3	1.6	5130	833	38.3	36.8
Fall	1.1	1.6	1740	297	1.3	19.5

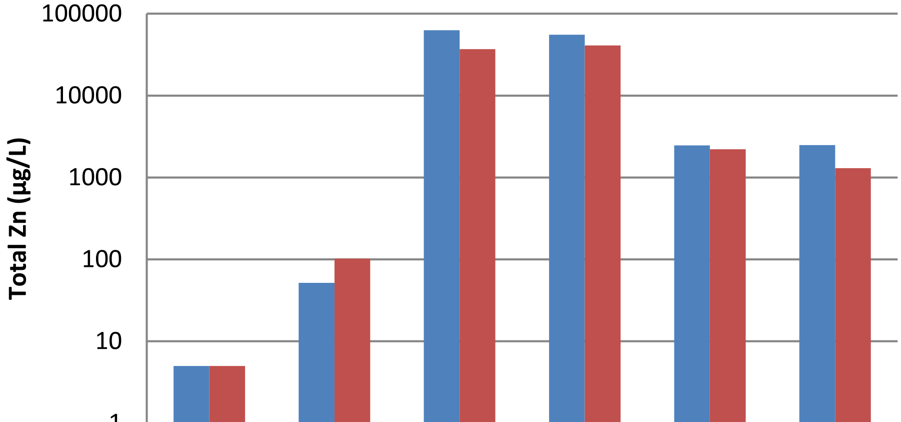
EXHIBIT 5-10

Total Copper Concentrations in Jill Creek and Adit Discharge



	Jill 1	Jill 2	Adit	Channel	Jill 3	Jill 4
Spring	1.4	6.5	13300	10100	456	449
Fall	0.8	11.1	7170	8210	325	338

EXHIBIT 5-11
Total Zinc Concentrations in Jill Creek and Adit Discharge



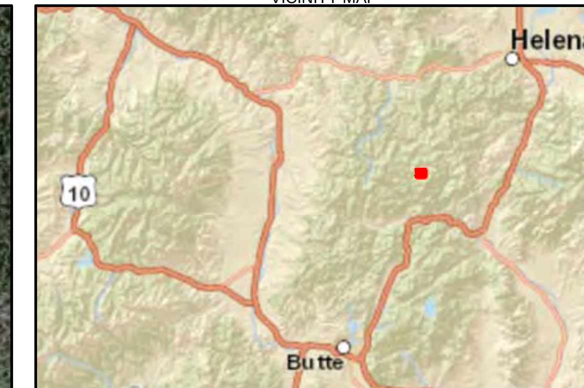
	Jill 1	Jill 2	Adit	Channel	Jill 3	Jill 4
Spring	5	51.7	63000	55500	2460	2490
Fall	5	102	36900	40900	2210	1300

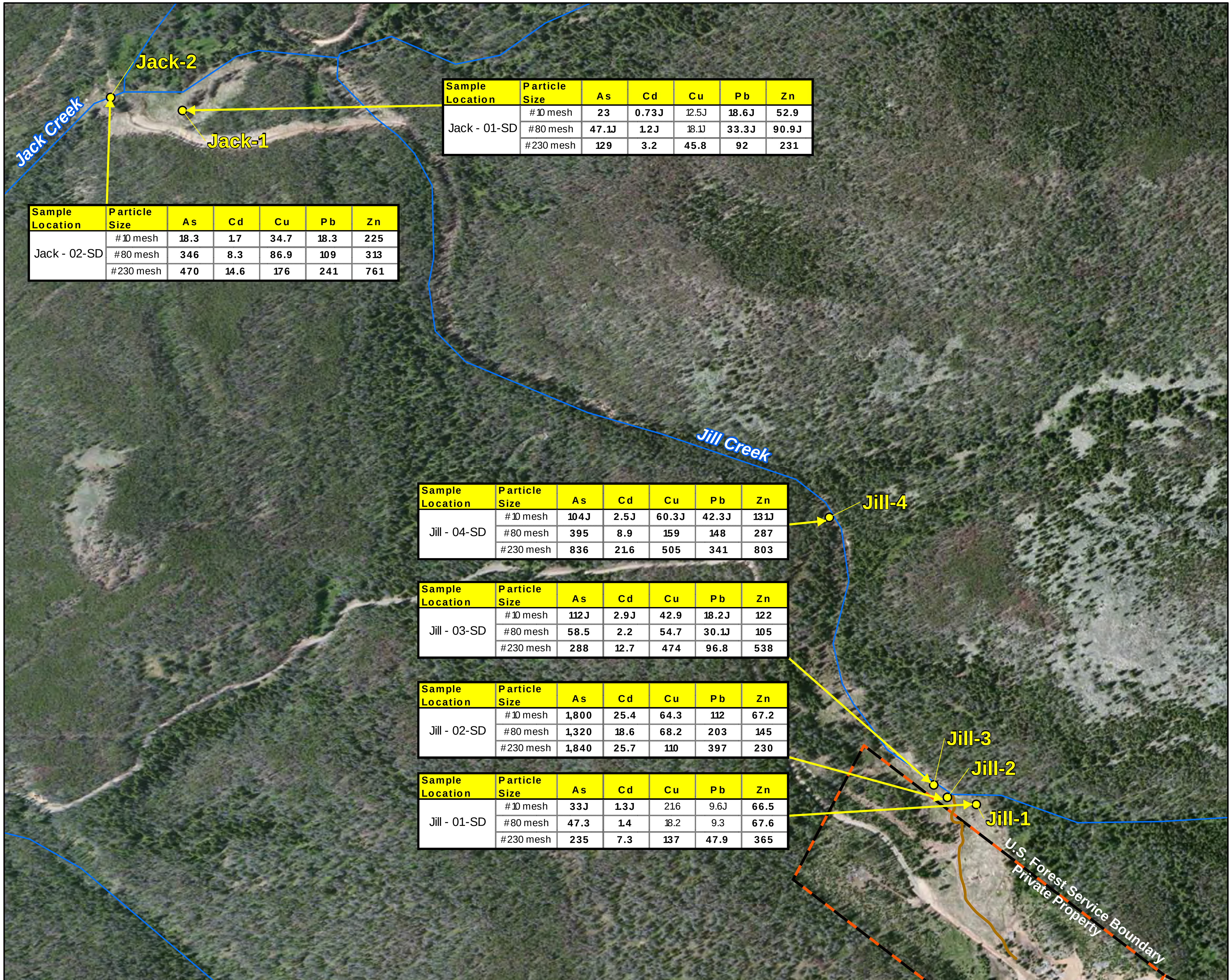
5.6.2 2010 Spring Inventory and Sampling Results

A spring/seep inventory was conducted in the vicinity of the Site to document spring/seep locations, flow rates, water quality and to document any seasonal changes in flow and chemistry. This information also provided insight about the linkage between ground water inflow at the Bullion Mine and discharge at the springs.

Fourteen springs were located and initially sampled in July 2010. Three of the springs are located upgradient of the Bullion Mine discharging adit and the remaining 11 are downgradient. A second field sampling event was conducted in the early fall (September 2010) to document changes in spring discharge and collect additional water quality samples.

Field measurements included pH, specific conductance, dissolved oxygen temperature, oxidation/reduction potential, turbidity and flow rate. Most of the waters from these seeps were acidic with pH values as low as 2.9. The samples were analyzed for total and dissolved metals, and major cations and anions. Exhibit 5-8 shows the locations of identified springs and the analytical results.





Sample Location	Particle Size	As	Cd	Cu	Pb	Zn
Jack - 01-SD	#10 mesh	**23**	**0.73J**	12.5J	**18.6J**	**52.9**
	#80 mesh	**47.1J**	**1.2J**	18.1J	**33.3J**	**90.9J**
	#230 mesh	**129**	**3.2**	**45.8**	**92**	**231**

Sample Location	Particle Size	As	Cd	Cu	Pb	Zn
Jack - 02-SD	#10 mesh	**18.3**	**1.7**	**34.7**	**18.3**	**225**
	#80 mesh	**346**	**8.3**	**86.9**	**109**	**313**
	#230 mesh	**470**	**14.6**	**176**	**241**	**761**

Sample Location	Particle Size	As	Cd	Cu	Pb	Zn
Jill - 04-SD	#10 mesh	**104J**	**2.5J**	**60.3J**	**42.3J**	**131J**
	#80 mesh	**395**	**8.9**	**159**	**148**	**287**
	#230 mesh	**836**	**21.6**	**505**	**341**	**803**

Sample Location	Particle Size	As	Cd	Cu	Pb	Zn
Jill - 03-SD	#10 mesh	**112J**	**2.9J**	**42.9**	**18.2J**	**122**
	#80 mesh	**58.5**	**2.2**	**54.7**	**30.1J**	**105**
	#230 mesh	**288**	**12.7**	**474**	**96.8**	**538**

Sample Location	Particle Size	As	Cd	Cu	Pb	Zn
Jill - 02-SD	#10 mesh	**1,800**	**25.4**	**64.3**	**112**	**67.2**
	#80 mesh	**1,320**	**18.6**	**68.2**	**203**	**145**
	#230 mesh	**1,840**	**25.7**	**110**	**397**	**230**

Sample Location	Particle Size	As	Cd	Cu	Pb	Zn
Jill - 01-SD	#10 mesh	**33J**	**1.3J**	216	9.6J	**66.5**
	#80 mesh	**47.3**	**1.4**	18.2	9.3	**67.6**
	#230 mesh	**235**	**7.3**	**137**	**47.9**	**365**

LEGEND
- 2012 Sediment Sampling Location
- NHD Stream
- Adit Discharge Channel
- U.S. Forest Service Boundary
- Mine Claim Boundary

Note:
1. 2011 Imagery - ArcGIS Streaming Map Service.
2. All results in mg/kg.
3. **Bold** values = Exceed Screening Benchmarks
4. J = Results Estimated

N

0 250 500
Feet

EXHIBIT 5-12
SEDIMENT SAMPLING LOCATIONS AND ANALYTICAL RESULTS, JULY 2012
Bullion Mine OU6 ROD

CH2MHILL

Table 5-5 shows total mean, maximum and minimum concentrations of arsenic (As), cadmium (Cd), copper (Cu), lead (Pb), and zinc (Zn), (representative contaminants) differentiated by spring/seeps located outside the Site (natural conditions) and those within the mine area. Springs 6, 9 and 8 (located north, northwest and east of the Site, respectively) represent natural conditions. Elevated levels of certain COCs are present in "natural" waters, because these are all within the general area of the Bullion Vein (ore body) that contains the mineralized rock. Springs 1 through 5 and 10 through 14 are topographically downgradient of the lower adit portal area or are within the disturbed mine land footprint. These show more of a mineralized signature, with higher COC concentrations than background springs. Comparison of these COC concentrations with screening benchmarks is presented in the next section.

TABLE 5-5
Mean, Maximum, and Minimum Total Concentrations (µg/L) of Selected Contaminants in Springs and Seeps

Parameter	Screening Level (µg/L)	Collection Period	Background Seeps/Springs No. 6, 8, and 9			Seeps/Springs within the Bullion Mine Footprint No. 1-5 and 10-14		
			Mean	Max	Min	Mean	Max	Min
Al	87 µg/L	Spring	62.5	124	9.8	10,157	31,400	11.4
		Fall	134.8	239	5.6	9,218	35,600	20.1
Sb	5.6 µg/L	Spring	0.37	0.61	0.5u	2.1	7.7	0.5u
		Fall	0.19	0.8	0.5u	1.48	3.9	0.5u
As	5 µg/L	Spring	10.0	11.4	1.4	50.2	264	6.2
		Fall	6.1	22.4	1.6	16.0	25.6	5.4
Cd	0.097 µg/L[2]	Spring	0.14	0.24	0.08U	197	624	3.3
		Fall	0.20	0.43	0.08U	152	407	5.4
Cu	2.85 µg/L[2]	Spring	0.84	1.1	0.54	3,600	13,300	5.4
		Fall	1.53	2.5	0.50U	2,874	8,790	5.4
Fe	300 µg/L[1]	Spring	89.2	160	50U	27,313	248,000	50U
		Fall	219	391	50U	20,503	167,000	50U
Pb	0.55 µg/L[2]	Spring	1.0	2.0	0.1U		48.4	0.11
		Fall	2.4	5.7	0.1U		12.6	0.54
Mn	120 µg/L[1]	Spring	8.0	17.4	1.9	11,800	34,900	1.2
		Fall	920	2730	1.1	11,470	28,800	2.1
Zn	37 µg/L[2]	Spring	20.1	49.4	5.0U	25,250	76,800	660
		Fall	27.2	65.8	5.0U	20,300	50,300	670

Notes:
Shaded cell indicate value is greater than the Screening Level.
[1]EPA Freshwater Screen Benchmarks. Available at http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fw/screenbench.htm.
[2]The freshwater criterion for this metal is expressed as a function of hardness (mg/L) in the water column. The value given here corresponds to a hardness of 25 mg/L. Criteria values for other hardness may be calculated from the following:
CMC (dissolved) = exp(mA[ln(hardness)]+bA) (CF), or CCC (dissolved) exp (mC[ln(hardness)] + bC) (CF)
U indicates reported value ≤ method detection limit.

The total cumulative spring discharge was estimated to be 13.2 gpm in the early summer, and approximately 10 gpm in the early fall (25 percent reduction). Seven of the springs exhibited flow decreases from July to September, five of the springs increased in flow, and two of the springs remained approximately the same.

In general, the springs in the vicinity of the adit decreased in discharge over the summer, whereas springs lower down on the slope in the vicinity of Jill Creek increased in discharge over the summer.

Comparison to Water Quality Standards

Surface water standards have been established by the EPA in accordance with the Clean Water Act (CWA). Numerical values for some elements vary with water hardness and are often referred to as aquatic life standards. The Montana surface water quality standards are equal to or more restrictive than federal standards. The primary maximum contaminant levels (MCLs) and acute and chronic aquatic life standards for the COCs, as listed in State of Montana Circular DEQ-7 numeric water quality standards (2012), are presented in Table 5-6.

TABLE 5-6
Surface Water and Ground Water Screening Benchmarks in mg/L.

Analyte	State of Montana Standards [2]				National Recommended Water Quality Criteria – Aquatic Life[3,c]		EPA Surface Water[1]
	Human Health Standards		Aquatic Life				
	Surface Water	Ground Water	Acute	Chronic	Acute	Chronic	
Aluminum	—	—	0.75	0.087	—	—	0.087
Antimony	0.0056	0.006	—	—	—	—	0.03
Arsenic	0.01	0.01	0.34	0.15	0.34	0.15	0.005
Cadmium	0.005	0.005	0.00052	0.000097	0.0020[a]	0.00025[a]	0.00025
Copper	1.3	1.3	0.00379	0.00285	0.013[a]	0.0090[a]	0.009
Iron	—	—	—	1	—	—	0.3
Lead	0.015	0.015	0.01398	0.000545	0.065[a]	0.0025[a]	0.0025
Manganese	—	—	—	—	—	—	0.12
Nickel	0.1	0.1	0.145	0.0161	0.47[a]	0.052[a]	0.052
Selenium	0.05	0.05	0.02	0.005	—	0.0050[b]	0.001
Silver	0.1	0.1	0.000374	—	0.0032[a]	—	0.0032
Thallium	0.00024	0.002	—	—	—	—	0.0008
Zinc	2	2	0.037	0.037	0.12[a]	0.12[a]	0.12

Notes:
[1] EPA Freshwater Screen Benchmarks (mg/L). Available at http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fw/screenbench.htm
[2] DEQ-7 Montana numeric water quality standards
[3] Freshwater standards from the EPA. 2009a. *National Recommended Water Quality Criteria for Priority Pollutants*. EPA Office of Water. Office of Science and Technology (4304T). Available at https://www.epa.gov/waterscience/criteria/wqcriteria.html. Updated December 2, 2009; Acute Criteria and Chronic Criteria.
[a] The freshwater criterion for this metal is expressed as a function of hardness (mg/L) in the water column. The value given here corresponds to a hardness of 25 mg/L. Criteria values for other hardness may be calculated from the following: CMC (dissolved) = exp(mA[ln(hardness)]+bA) (CF), or CCC (dissolved) exp (mC[ln(hardness)] + bC) (CF]
[b] This recommended water quality criterion for selenium is expressed in terms of total recoverable metal in the water column. It is scientifically acceptable to use the conversion factor (0.996 – CMC or 0.922 – CCC) that was used in the GLI (60 FR 15393-15399, March 23, 1995; 40 CFR 132 Appendix A) to convert this to a value that is expressed in terms of dissolved metal
[c] Metals are stated as dissolved unless otherwise specified
Units are all reported in mg/L = milligram per liter (to covert to microgram per liter [µg/L] divide by 1000)

Table 5-7 illustrates where sample results indicate that MCLs and chronic aquatic life standards are exceeded by a representative suite of COCs in surface waters. For the purpose of this interim ROD, the chronic aquatic life standards and the MCLs are being used for relative risk comparison. The surface water and ground water standards are waived until the final ROD for the Basin Watershed OU2 is completed. The goal of the final remedy for OU2 will be to meet both surface and ground water standards.

TABLE 5-7
Exceedances of human health MCLs (total) and acute/chronic aquatic life standards (dissolved) at surface water collection sites

Sample Location	As	Cd	Cu	Pb	Zn
ADIT					
Adit Discharge	Human Acute Chronic	Human Acute Chronic	Human Acute Chronic	Human Acute Chronic	Human Acute Chronic
Adit Channel	Human Acute Chronic	Human Acute Chronic	Human Acute Chronic	Human Acute Chronic	Human Acute Chronic
JILL CREEK SURFACE WATER					
Jill-1*	None	None	None	None	None
Jill-2*	None	Acute Chronic	None	None	Acute Chronic
Jill-3	Human	Human Acute Chronic	Acute Chronic	Acute Chronic	Human Acute Chronic
Jill-4	Human	Human Acute Chronic	Acute Chronic	Acute Chronic	Human Acute Chronic
SPRINGS and SEEPS					
Spring 1	Human	Human Acute Chronic	Human Acute Chronic	Human Acute Chronic	Human Acute Chronic
Spring 2	Human	Human Acute Chronic	Human Acute Chronic	Human Acute Chronic	Human Acute Chronic
Spring 3	Human	Acute Chronic	Acute Chronic	None	Acute Chronic
Spring 4	None	Human Acute Chronic	Human Acute Chronic	Human Acute Chronic	Human Acute Chronic

TABLE 5-7

Exceedances of human health MCLs (total) and acute/chronic aquatic life standards (dissolved) at surface water collection sites

Sample Location	As	Cd	Cu	Pb	Zn
Spring 5	Human	Human Acute Chronic	Human Acute Chronic	Acute Chronic	Human Acute Chronic
Spring 6*	Human	Acute Chronic	None	None	Acute Chronic
Spring 7	Human	Human Acute Chronic	Acute Chronic	Human Acute Chronic	Acute Chronic
Spring 8*	None	None	None	None	None
Spring 9*	None	None	None	None	None
Spring 10	Human	Human Acute Chronic	Human Acute Chronic	Acute Chronic	Human Acute Chronic
Spring 11	None	Human Acute Chronic	Human Acute Chronic	Acute Chronic	Human Acute Chronic
Spring 12	Human	Human Acute Chronic	Acute Chronic	None	Human Acute Chronic
Spring 13	Human	Human Acute Chronic	Acute Chronic	Human	Acute Chronic
Spring 14	Human	Human Acute Chronic	Acute Chronic	Acute Chronic	Acute Chronic

Notes:
* = Background Water Quality

5.7 Sediment Investigations

Stream sediments were not characterized during the initial 2010 investigations. Agency review comments on the Bullion Mine draft RI document suggested that stream sediment be sampled to help provide a more current assessment of risk to aquatic and benthic receptors. Therefore, 2012 Jill Creek sediments were sampled adjacent to previous benthic macroinvertebrate (BMI) sampling sites from the 2010 investigation.

Surface sediment samples were collected from the top 10 centimeters of sediments deposited in slow-moving areas of Jill Creek at six locations. The analytical facility dried and then sieved the samples through 2.0 millimeter (mm) (coarse sand), 0.18 mm (fine sand) and 0.0625 mm (silt/clay). Target analytes included aluminum, antimony, arsenic, cadmium, copper, iron, lead, manganese, nickel, selenium, silver, thallium and zinc.

Exhibit 5-12 shows locations of sediment sample locations and analytical results.

Exhibits 5-13 through 5-16 display sediment data for arsenic, lead, copper and zinc versus location along Jill Creek. The greatest concentrations of COCs in sediments were generally observed in the smaller size fractions (silt/clay), which is consistent with sediment chemistry. However, for each sample, the smallest size fraction represents the smallest percentage by weight of the sample. COC concentrations in the sediments were generally progressively higher in a downstream direction, but were often greatest at Station Jill-2, located immediately downstream of the confluence of Jill Creek and the Bullion adit channel. Additional springs and base flow entering Jill Creek likely diluted the COC concentrations farther downstream. Concentrations of antimony, arsenic, cadmium, copper, iron lead, manganese, selenium, silver and zinc all exceeded the conservative freshwater sediment screening benchmarks.

EXHIBIT 5-13
Sediment Arsenic Concentrations by Particle Size – Jill Creek

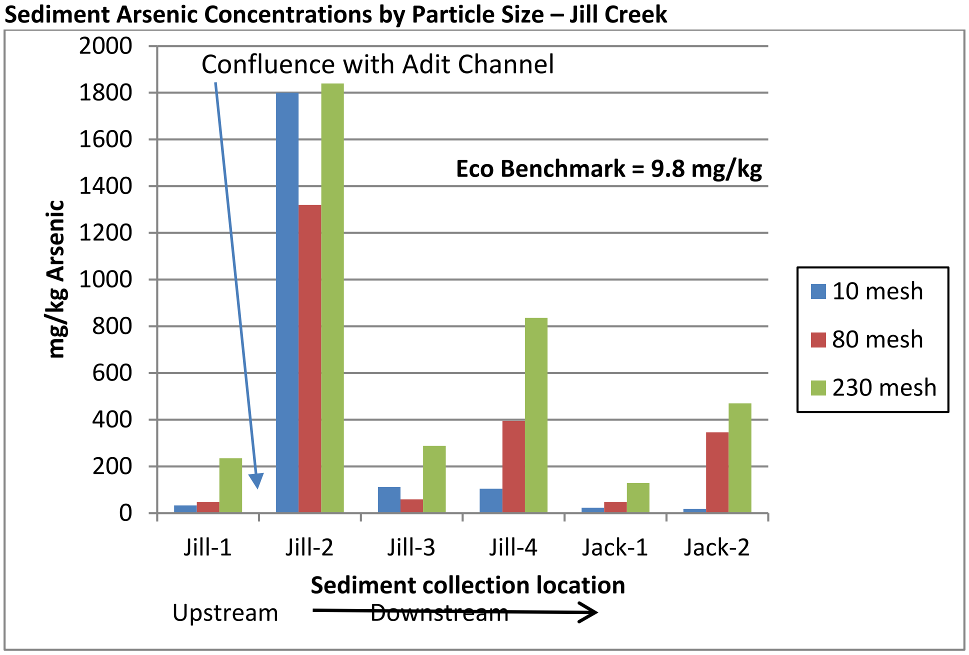


EXHIBIT 5-14
Sediment Lead Concentrations by Particle Size – Jill Creek

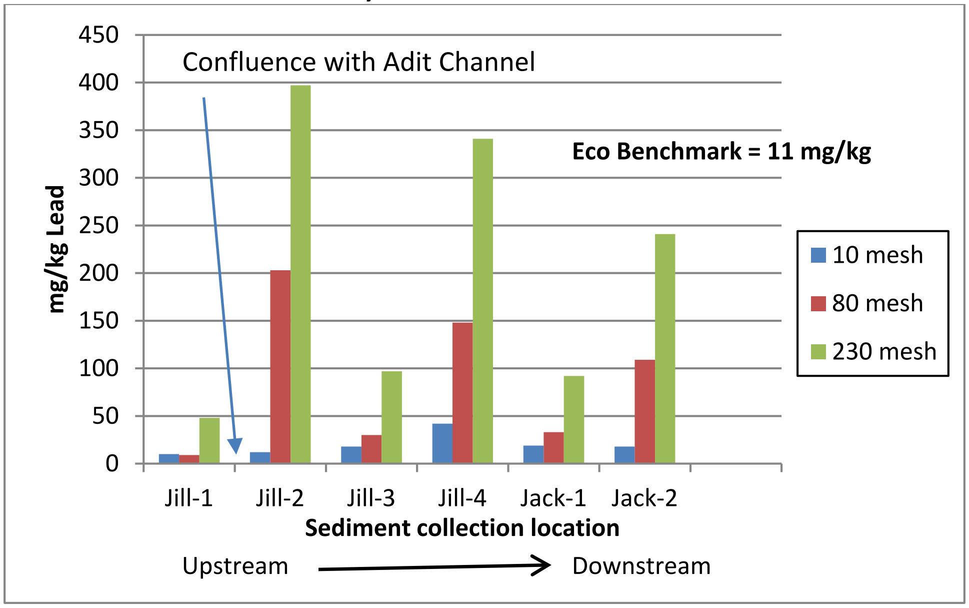


EXHIBIT 5-15
Sediment Copper Concentrations by Particle Size – Jill Creek

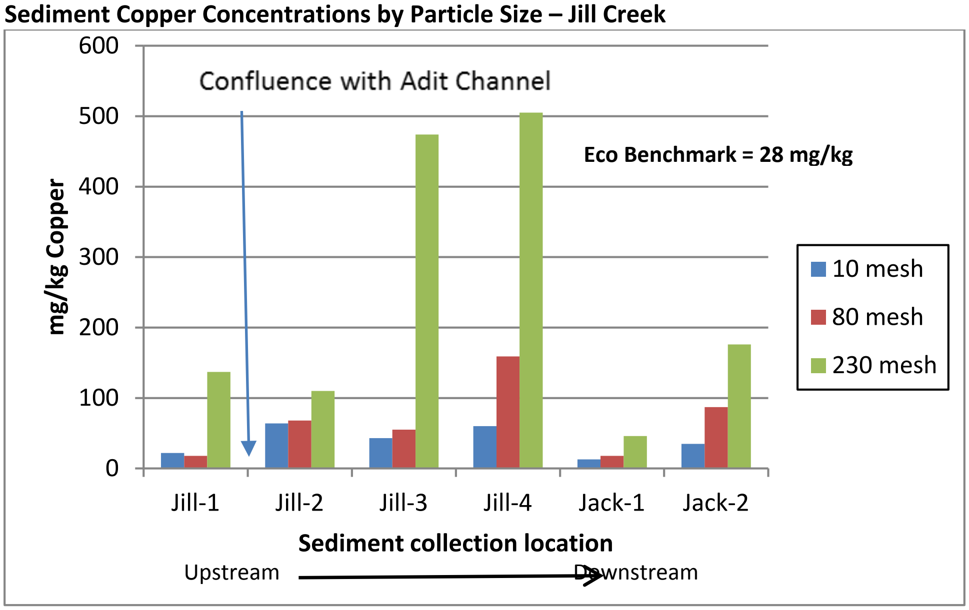
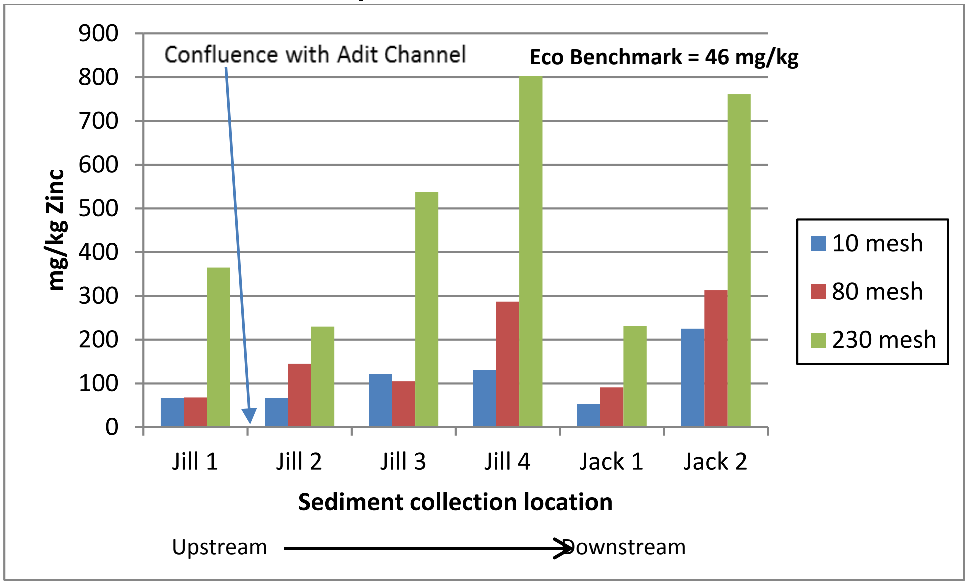


EXHIBIT 5-16

Sediment Zinc Concentrations by Particle Size – Jill Creek

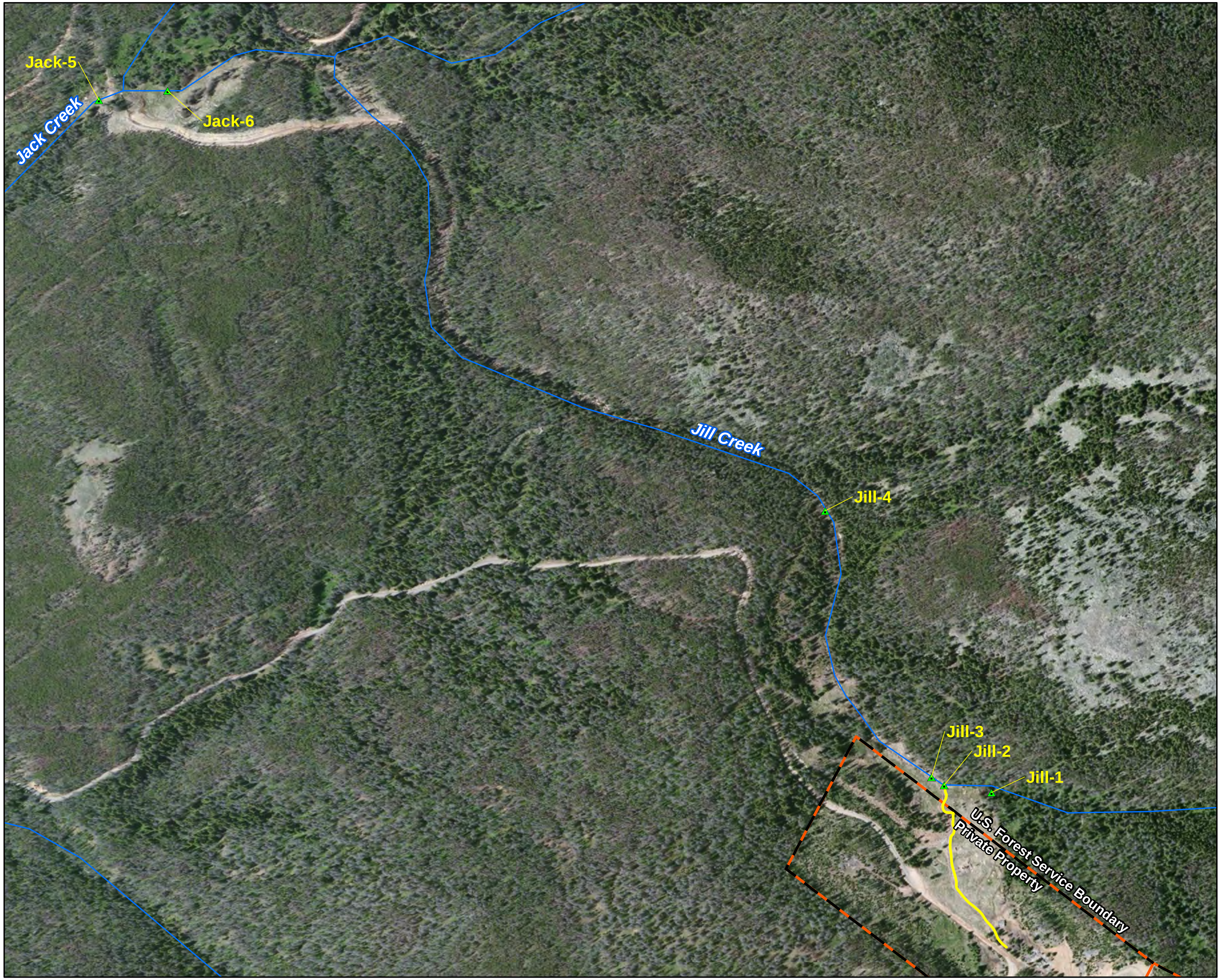


5.8 Aquatic Resource Investigation

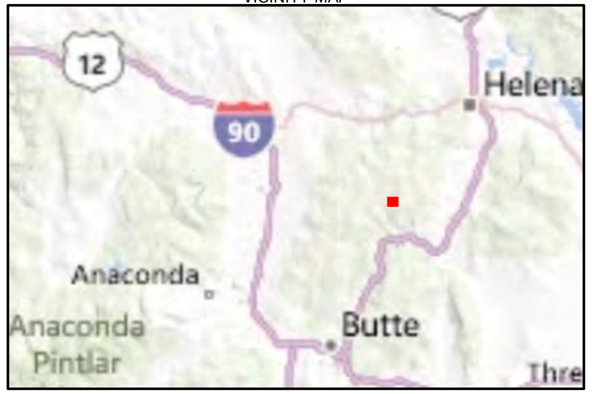
A BMI inventory was conducted on Jill Creek in 2010 to assess the relative health of aquatic biota along the Bullion Mine reach. Six collection stations were established – four along Jill Creek and two along Jack Creek. Monitoring stations were located upstream of the Bullion Mine (Jill-1), and immediately above (Jill-2) and below (Jill-3) the mine adit confluence. Jill-4 was located approximately 600 meters downstream from the adit. Monitoring sites were established on Jack Creek above (Jack-6) and below (Jack-5) the Jill Creek confluence (Exhibit 5-17).

Organisms were collected in a rectangular net, and preserved in 95 percent ethanol. In the laboratory, ethanol was rinsed and organisms were identified to the lowest level (genus or species) and enumerated. The following metrics were determined and they describe the status of the BMI community: taxa richness, density, composition and relative abundance. In addition, the percentages of stoneflies and mayflies were calculated. Comparisons of these metrics among the six collection stations were completed.

These data sets revealed a pattern; mean values for community density, taxa richness and richness counts for EPT species (mayfly, stonefly, and caddis fly) were greatest for BMI at Jack-6, which is above the confluence of Jill Creek and at locations on Jill Creek above the mine adit (Jill-1 and Jill-2). Community density values and taxa richness counts for locations below the adit, at Jill-3 and Jill-4, were very low. For Jack-5, below the confluence of the two creeks, metric values were intermediate. Mean community BMI density values are presented in Exhibit 5-18. Total taxa richness and richness of EPT are shown in Exhibit 5-19.



VICINITY MAP



LEGEND

- Macro-Invertebrate Sampling Location
- Adit Discharge Channel
- NHD Stream
- U.S. Forest Service Boundary
- Mine Claim Boundary

Notes:
1. Area of interest subject to change.
2. 2011 Imagery - ArcGIS Streaming Map Service.

N

0 250 500
Feet

EXHIBIT 5-17
JILL CREEK (BMI) SAMPLING LOCATIONS
Bullion Mine OU6 ROD

BOI \\OWL\PROJ\EPA\408158BULLIONMINE\GIS\MAPFILES\MACROINVERTEBRATES.MXD JCARR3 2/28/2013 10:40:05 AM

CH2MHILL

EXHIBIT 5-18

Mean BMI Community Density

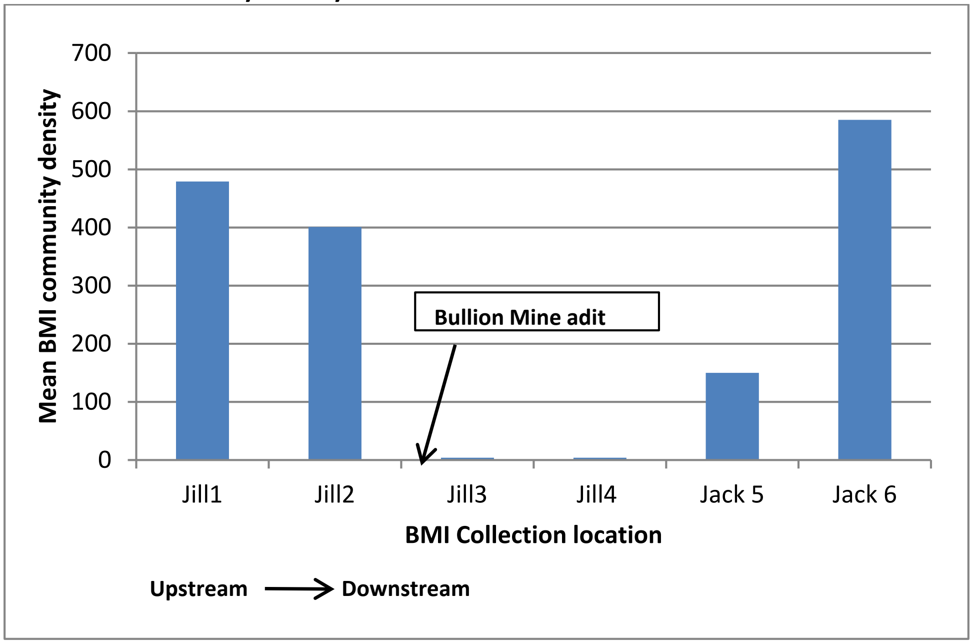
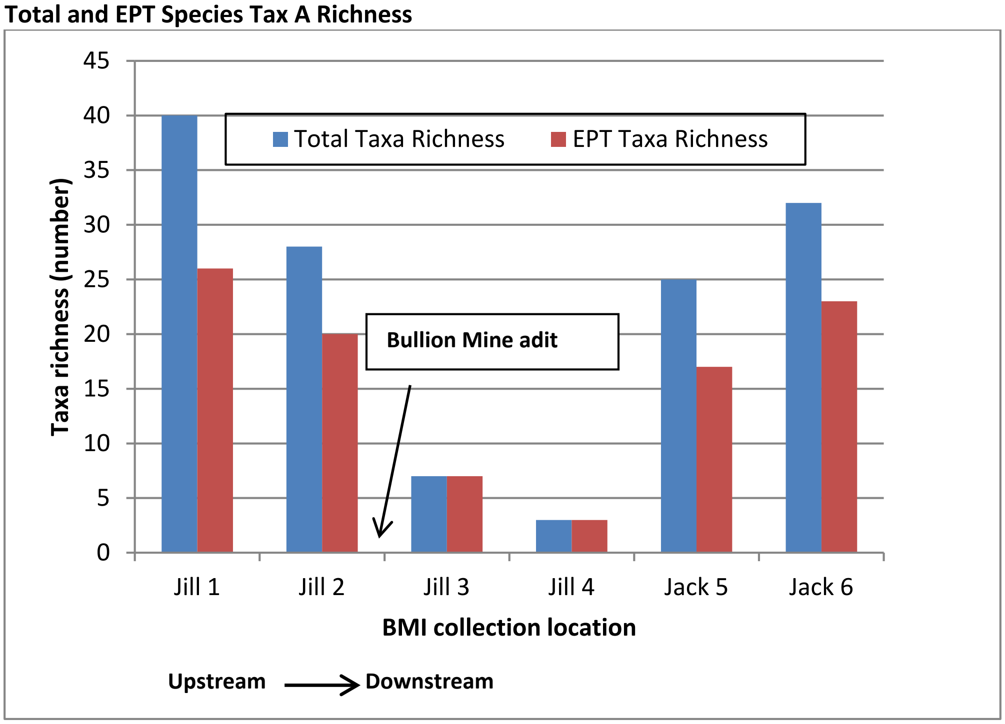


EXHIBIT 5-19

Total and EPT Species Tax A Richness



5.9 Geology and Ground Water Investigations

A geologic and drilling investigation was conducted to gather geologic and hydrogeologic data to develop the CSM and assist in evaluating remedial alternatives. The geologic investigation included drilling a boring to intercept and observe the lower adit tunnel, constructing monitoring wells and shallow piezometers to measure shallow ground water and collect ground water samples, and conducting a geophysical investigation to evaluate depth to bedrock and bedrock properties.

The drilling and geologic exploration was performed in August of 2010. The monitoring wells were screened in the first water-bearing zone in bedrock, and ranged between 25 and 60 feet in depth.

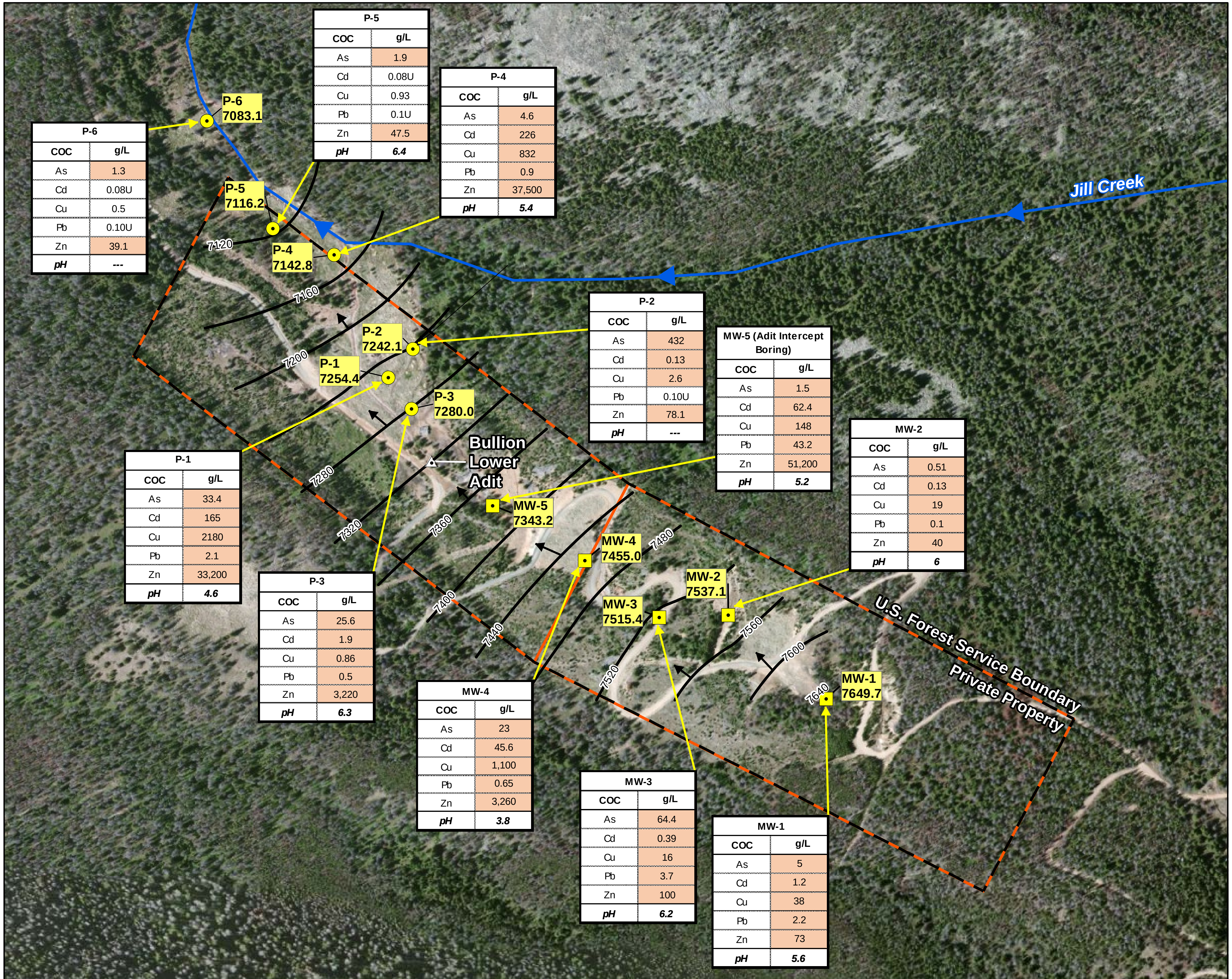
Downslope from the lower Bullion adit and along Jill Creek, drive-point piezometers were installed to measure ground water levels and collect samples. The piezometers were installed to depths between approximately 7 and 11 feet below ground surface.

Exhibit 5-20 shows the locations of monitoring wells, piezometers, shallow ground water contours and ground water analytical results.

5.9.1 Mine Workings and Mineral Deposits

Based on review of historical records and mine maps, the Bullion Mine consists of three near-horizontal adits, connected by stopes, raises and inclines. Vertical shafts and exploratory trenches were excavated at the surface. The main (lower) adit is the longest and extends at least 2,600 feet to the east-southeast. The middle and upper adits appear to extend approximately 800 and 200 feet, respectively. Ore has been mined by stoping between the lower, middle and upper adit, and the mined zone is up to 16 feet wide in the lower workings.

The Bullion vein trends N70W, dips between 50 and 70 degrees to the northeast, and ranges from a few inches to about 40 feet wide. The mine produced approximately 30,000 tons of ore containing 3,500 ounces of gold; 250,000 ounces of silver; 300 tons of copper; 1,000 tons of lead; and 1,000 tons of zinc. Exhibit 5-21 shows a plan view of the underground workings. Exhibit 5-3, the CSM profiles, shows a generalized cross-section of the mine workings and various levels.



P-6	
COC	g/L
As	1.3
Cd	0.08U
Cu	0.5
Pb	0.10U
Zn	39.1
pH	---

P-5	
COC	g/L
As	1.9
Cd	0.08U
Cu	0.93
Pb	0.1U
Zn	47.5
pH	*6.4*

P-4	
COC	g/L
As	4.6
Cd	226
Cu	832
Pb	0.9
Zn	37,500
pH	*5.4*

P-2	
COC	g/L
As	432
Cd	0.13
Cu	2.6
Pb	0.10U
Zn	78.1
pH	---

P-1	
COC	g/L
As	33.4
Cd	165
Cu	2180
Pb	2.1
Zn	33,200
pH	*4.6*

P-3	
COC	g/L
As	25.6
Cd	1.9
Cu	0.86
Pb	0.5
Zn	3,220
pH	*6.3*

MW-5 (Adit Intercept Boring)	
COC	g/L
As	1.5
Cd	62.4
Cu	148
Pb	43.2
Zn	51,200
pH	*5.2*

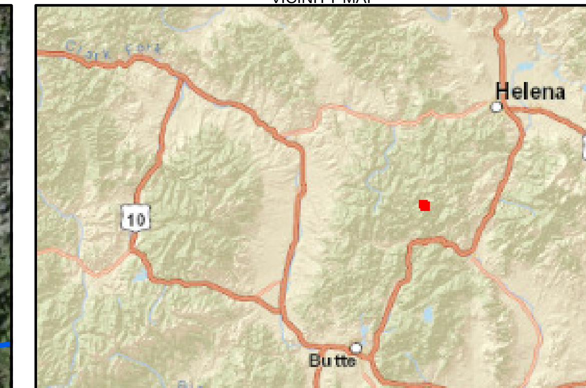
MW-2	
COC	g/L
As	0.51
Cd	0.13
Cu	19
Pb	0.1
Zn	40
pH	*6*

MW-4	
COC	g/L
As	23
Cd	45.6
Cu	1,100
Pb	0.65
Zn	3,260
pH	*3.8*

MW-3	
COC	g/L
As	64.4
Cd	0.39
Cu	16
Pb	3.7
Zn	100
pH	*6.2*

MW-1	
COC	g/L
As	5
Cd	1.2
Cu	38
Pb	2.2
Zn	73
pH	*5.6*

VICINITY MAP



LEGEND
- Piezometer
- Monitoring Well and Groundwater Elevation
- Bullion Lower Adit
- Groundwater Contour (elevation in feet)
- Groundwater Flow Direction
- NHD Stream
- U.S. Forest Service Boundary
- Mine Claim Boundary

Notes:
1. 2011 Imagery - ArcGIS Streaming Map Service.
2. All results in g/kg.
3. Shaded cells exceed screening benchmarks.
4. Sample results are dissolved metals.

N

0 250 500
Feet

EXHIBIT 5-20
GROUNDWATER MONITORING WELLS, CONTOUR MAP, AND GROUNDWATER ANALYTICAL RESULTS
Bullion Mine ROD

BOI \\OWL\PROJ\EPA\408158BULLIONMINE\GIS\MAPFILES\2014\CONTOUR_GROUNDWATER.MXD JCARR3 3/28/2014 1:45:24 PM

CH2MHILL

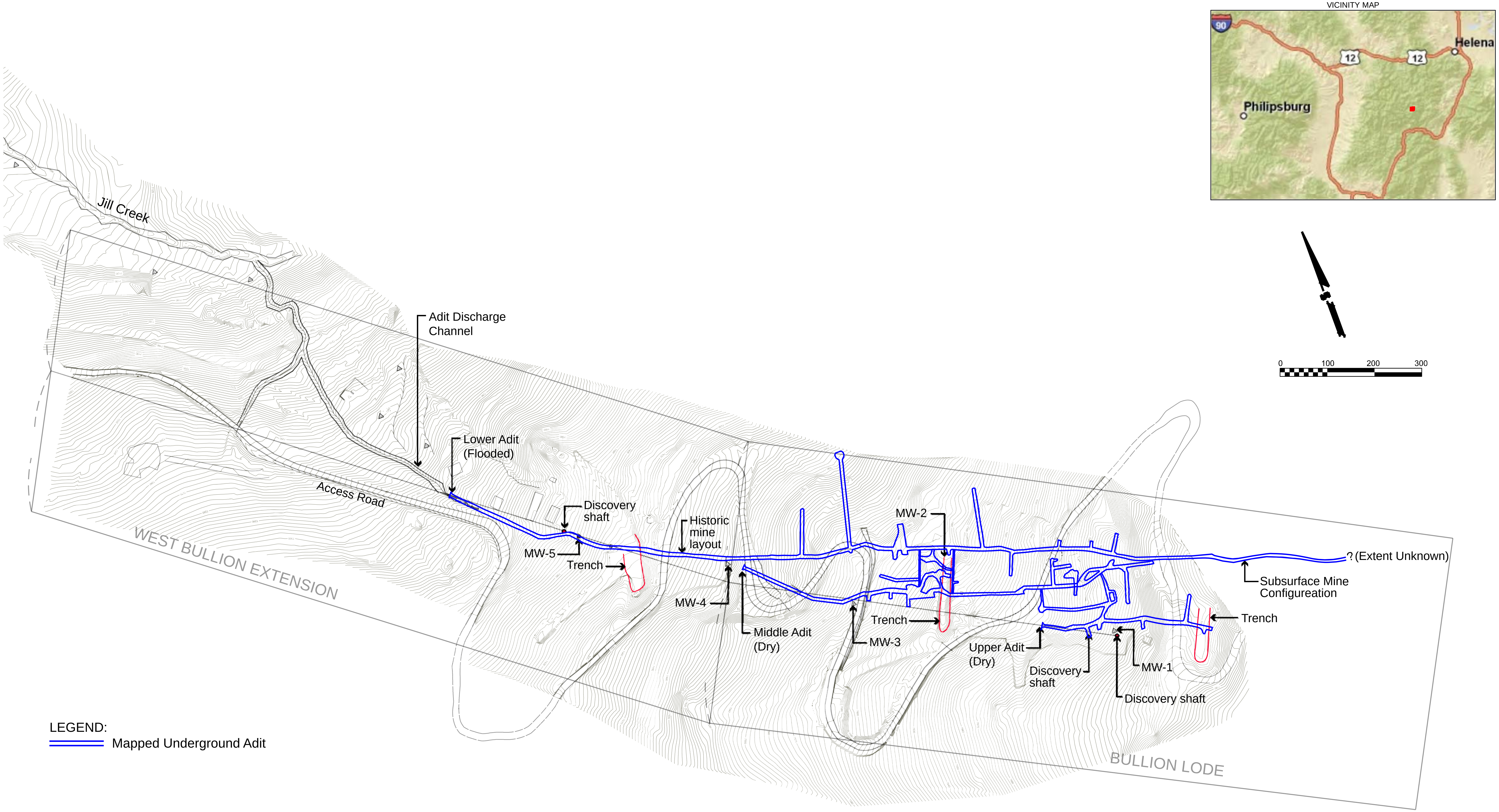


EXHIBIT 5-21
BULLION MINE **UNDERGROUND WORKINGS**
Plan View
Bullion Mine OU6 ROD

5.9.2 Subsurface Geological and Adit Conditions

Subsurface conditions consist primarily of a thin residual soil layer (typically less than 5 feet thick) overlying brownish to gray, iron-stained, slightly- to moderately-weathered and altered granitic rock.

Boring MW-5 was drilled vertically open-hole to intercept the lower Bullion adit. The subsurface profile at this location consists of moderate to highly weathered granite that was further weathered to sand, silt and clay in the upper 13 feet. The lower adit was intercepted at 74 feet below ground surface (bgs) and the bottom of the adit was measured to be 80.5 feet bgs. Depth to water was measured at 48.5 feet bgs at the time of drilling, which indicated that the mine was flooded to a depth of more than 30 feet. A downhole video showed that the adit is clearly open and flooded in this area. The mine continues to remain flooded, based on depth-to-water measurements conducted during 2011 and 2012.

5.9.3 Geophysics Investigations

The geophysical exploration was conducted in order to determine depth to bedrock, and the seismic velocities of the sediments and rock in the shallow subsurface. Two general areas were investigated, including a proposed ground water cutoff area near Jill Creek, and along a profile parallel to the trend of the Bullion vein and mine workings.

In the proposed cutoff wall area, the depth to bedrock ranged from approximately 5 to 10 feet bgs. The seismic velocities observed in this vicinity indicate that the granitic rock is likely to be moderately weathered and fractured.

The seismic data from Jill Creek to the Bullion adit portal indicated that the depth to bedrock ranged from approximately 10 to 15 feet downslope from the Bullion adit, to as shallow as 5 feet near the portal. Seismic velocities of the underlying granitic bedrock indicate that the rock under this area is moderately to highly weathered and fractured.

The remaining geophysical spread traversed from the lower Bullion adit to above the uppermost adit, and these data indicated that the depth to bedrock ranged from approximately 5 feet bgs to as much as 20 feet bgs under areas of fill material. The seismic velocities indicate moderately to highly weathered rock, with generally poor rock mass in this area. This is consistent with the seismic line overlying the weathered and altered ore vein and confirmed by the findings of the drilling investigation.

5.9.4 Hydrogeological Conditions

In the vicinity of the Bullion Mine, ground water inflow into the underground workings originates from infiltration of precipitation and snowmelt through fractured/weathered bedrock and collapsed shafts and open trenches above the mine workings. Shallow ground water discharges through springs, seeps, diffuse seepage into Jill Creek, and discharge from the lower Bullion Mine adit. The CSM (Exhibit 5-3) shows a general geologic and hydrologic cross-section.

Monitoring well and piezometer data show that the first ground water occurred within shallow weathered and fractured bedrock. Shallow ground water flow direction follows the Site topography towards Jill Creek (Exhibit 5-20). Ground water elevations are feet higher during earlier summer versus the fall, which supports the assertion that the shallow ground water system is recharged by local seasonal snowmelt and infiltration. In addition, the level of water in the mine (measured in MW-5) was 8 feet higher in July 2012 versus September 2010. This supports the conclusion that the flooding in the mine is meteorically influenced, and responds to seasonal changes in the ground water levels.

The extent of the topographic area contributing to the recharge has not been delineated, but existing information (MBMG, 2012) suggests that the travel time from surface to underground workings is relatively brief. The following findings support this understanding:

- An empirical analysis of ground water velocity and travel time using hydraulic conductivity estimates and travel distance indicates that water could infiltrate from the surface and reach the mine workings in as a little as a few days to several months.
- A graph of local daily precipitation superimposed on daily discharge from the Bullion Mine adit shows some similarities, where precipitation and snowmelt runoff in late May and June are followed by a spike in adit discharge in August followed by a slow sustained decline in discharge until October.
- Findings of isotopic data from adit water samples indicated that “the residence time of the water was not sufficient for oxygen isotopes to equilibrate between water and subsurface minerals and that the water is representative of recent precipitation/recharge events.” (MBMG, 2012)

5.9.5 Ground Water Analytical Results

Ground water samples exceeded screening benchmarks for antimony, arsenic, cadmium, copper, lead, nickel and zinc in most of the wells and piezometers.

Table 5-8 presents ground water quality sample results from monitoring well and piezometer sampling. The ground water analytical results indicate arsenic, cadmium, copper, lead, nickel and zinc concentrations are elevated in most of the ground water wells and exceed the screening benchmarks. MW-4, which was drilled near the second adit, and MW-5, which was drilled into the lower adit, are highest in COCs. Piezometers P-1, P-3 and P-4, located in the saturated slope below the discharging lower adit, are very high in COC concentrations.

TABLE 5-8

Summary of 2010 Ground Water Analytical Results

Site	Date Sample Collected	Dissolved Metals (µg/L)													Anions (mg/L)		Alkalinity (mg/L)[f]	
		Al	Sb	As	Cd	Cu	Fe	Pb	Mn	Ni	Se	Ag	Tl	Zn	Cl [f]	SO_4^{2} [f]	Total	$CaCO_3$
MONITORING WELLS																		
MW-1	9/23/2010	33.6	**35.1**	**5.0**	**1.2**	**38.2**	200	**2.2**	1,460	**13.2**	0.50U	—	0.10U	**73.3**	2.9	31.9	33.0	33.0
MW-2	9/23/2010	25.1	0.50U	**0.51**	**0.13**	**19.4**	50.0U	**0.1**	115	**1.7**	0.50U	—	0.10U	**40.2**	1.0U	80.2	28.4	28.4
MW-3	9/23/2010	28.4	**3.1**	**64.4**	**0.39**	**15.7**	50.0U	**3.7**	70.6	**2.4**	0.50U	—	0.10U	**100**	1.0U	24.6	16.1	16.1
MW-4	9/23/2010	280	0.50U	**23.3**	**45.6**	**1,100**	168	**0.65**	1,240	**10.8**	0.50U	—	0.10U	**3,260**	1.0U	54.7	5.0U	5.0U
ADIT INTERCEPT BORING																		
MW-5	9/23/2010	280	0.50U	**1.5**	**62.4**	**148**	13,300	**43.2**	25,000	**255**	**0.78**	—	**0.11**	**51,200**	2.1	2,080	7.7	7.7
PIEZOMETERS																		
P-1	9/24/2010	7,980	0.50U	**33.4**	**165**	**2,180**	14,00	**2.1**	23,200	**108**	**2.2**	—	0.10U	**33,200**				
P-2	10/1/2010	26.2	**0.74**	**432**	**0.13**	**2.6**	51,500	0.10U	14,200	**4.7**	0.50U	0.50U	0.10U	**78.1**				
P-3	10/1/2010	23.9	**1.3**	**25.6**	**1.9**	**0.86**	7,890	**0.46**	34,800	**50.0**	0.50U	0.50U	**0.16**	**3,220**				
P-4	9/23/2010	327	0.50U	**4.6**	**226**	**832**	492	**0.9**	8,140	**103**	0.50U	—	0.10U	**37,500**	1.4	878	5.0U	5.0U
P-5	10/1/2010	11.4	**3.2**	**1.9**	0.08U	0.93	11,500	0.1U	2,780	**17.4**	0.50U	0.50U	0.10U	**47.5**				
P-6	10/1/2010	18.8	**1.0**	**1.3**	0.08U	0.5	9,890	0.10U	1,210	**7.4**	0.50U	0.50U	0.10U	**39.1**				
Screening Levels		*—*	*6*	*10*	*5*	*1,300*	*—*	*15*	*—*	*100*	*50*	*100*	*2*	*2,000*				

Notes:

Piezometers water yield was limited for sampling – no field parameters recorded.

All results are dissolved concentrations

* See Tables 1-10 through 1-12 for Screen Level benchmarks (bold values indicate exceedance of screening benchmarks)

U = less than detection limits

5.10 Geochemistry of Ground and Surface Waters

The waters above, within and below the Bullion Mine can be characterized into two broad categories with clear geochemical distinctions; those affected by the mine and associated mineralization, and those that are not. This is because ore deposits within the mineralized zones of the mine are rich in sulfides and naturally contain small concentrations of COCs. When sulfide minerals are exposed to oxygen and water through mining activity, the sulfides are oxidized which generates sulfate (SO_4) and acid, and concurrently solubilizes and mobilizes metals.

Surface waters collected from springs and from Jill Creek upstream of the mine adit discharge are characterized by bicarbonate-type water and pH levels above 5.5. Surface waters and springs downstream express an acid-sulfate signature dominated by elevated calcium, sulfate and acidity (pH values <5.5).

Exhibit 5-22 shows that waters from the adit and channel and within the Site exhibit low pH and elevated concentrations of dissolved copper. Mixed waters (interception of clean by contaminated ground water) and waters above the Site exhibit much lower levels of dissolved copper and pH levels generally greater than 5.5. Similar relationships were observed for aluminum, cadmium, lead and zinc. This chemical pattern suggests that the acidic, high-sulfate water containing elevated trace metals is concentrated in and around the main adit channel of the mine workings.

Arsenic exists as an anion in solution and, therefore, exhibits a scattered relationship with pH compared to the metals (Exhibit 5-23). At higher pH, arsenic is associated with iron oxides that co-precipitate or become adsorbed onto the surfaces of these minerals.

Dissolved arsenic concentrations in low-pH (acidic) water discharging from the Bullion Mine adit and immediately downstream in the channel are elevated. The dissolved concentrations of arsenic show no discernable relationship within a pH range from about 3 to 6.5, although the highest concentrations of arsenic are found in the lowest-pH water. A detailed description and interpretation of the geochemistry of the Bullion Mine waters, including graphical geochemical diagrams, are provided in the RI.

EXHIBIT 5-22
Dissolved Copper versus pH in Mine Water

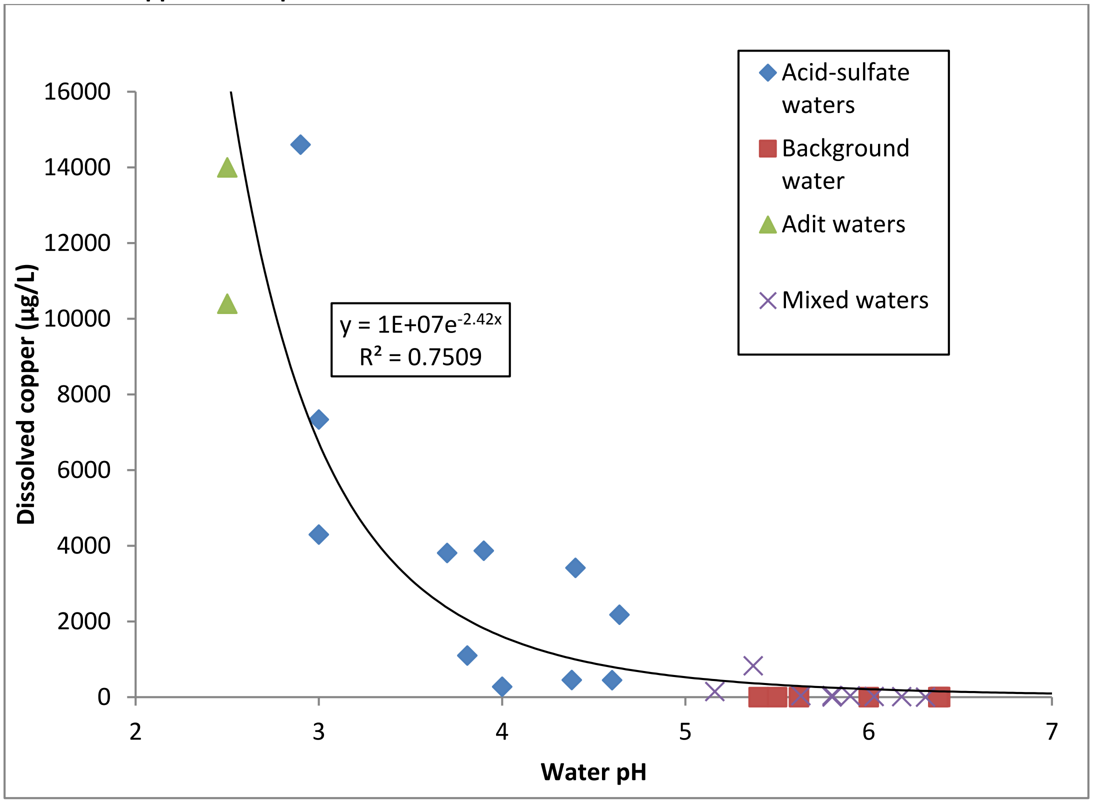
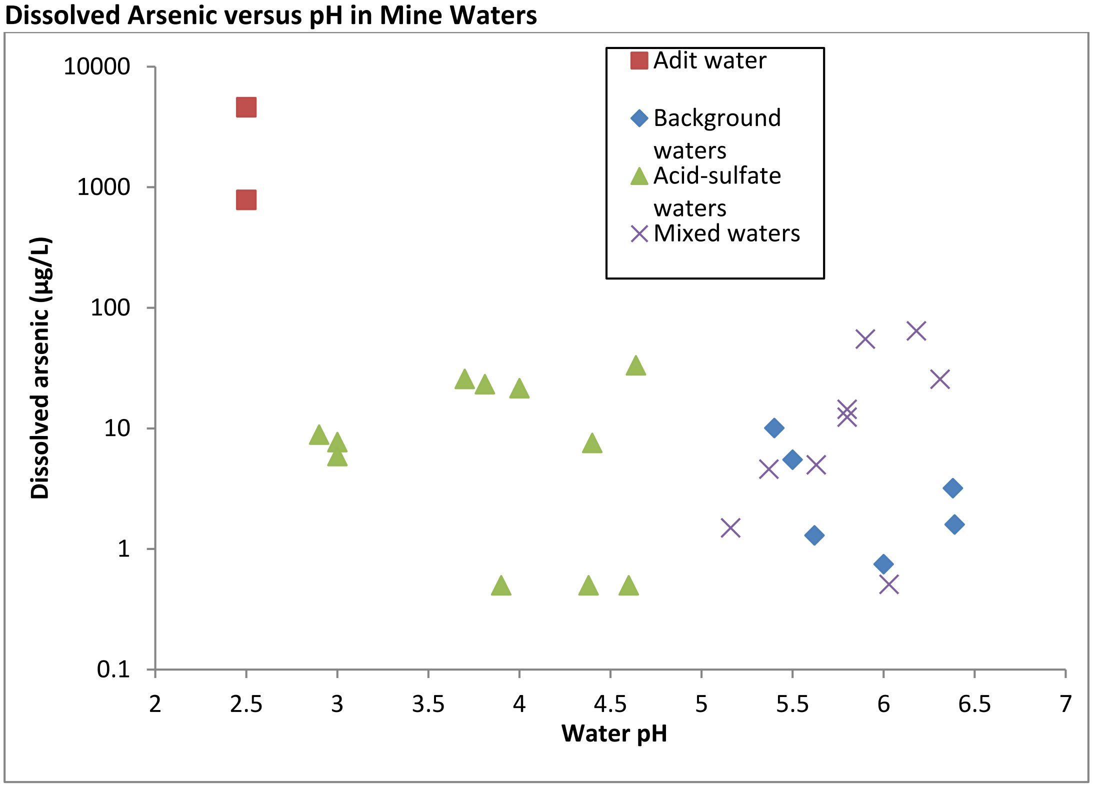


EXHIBIT 5-23
Dissolved Arsenic versus pH in Mine Waters



5.11 Water Volume within the Bullion Mine Workings

The volume of water stored in the mine was investigated using information from the spring inventory and sampling, historic mine mapping, and the water level measurements from 2010 to 2012 in MW-5.

Two general scenarios that reflect different assumptions with respect to gradient and dimensions of the adit were initially evaluated to estimate the volume of water in the flooded mine workings. The first scenario assumes no ore removal beyond the adit dimensions and a 3 percent slope. The second or “worst case” scenario assumes there is a mined-out area up to 16 feet wide and of infinite height (as shown on historic mine maps), with an average of 22 feet of water head. Under the worst-case scenario, the maximum estimated volume of acidic water stored in the mine was calculated to be as high as 2.5 million gallons.

Table 5-9 provides a rough estimate of the volume of water potentially stored within the mine workings under both scenarios. Exhibit 5-24 (CSM long profile) shows a cross-section of the estimated flooded portion of the mine.

The pooled water stored within the mine workings may be contributing to the numerous springs observed in the western portion of the Bullion Extension Claim in the vicinity of the discharging lower adit. In addition, the low pH and elevated concentrations of metals and arsenic in the mine water suggests that some pH adjustment of the potentially large volume of water stored within the mine workings would be beneficial prior to discharge.

TABLE 5-9
Potential Volume of Store Water in Mine Workings

	Scenario 1	Scenario 2*
Incline of mine workings	3 percent	3 percent
Flooded distance (feet)	1,175	2,000
Assumed dimensions of adit (feet)	6 by 8 8 by 8	8 by 8 16 by 22
Adit volume (cubic feet) 8 by 8 feet 16 by 22 feet	 56,640 73,387	 83,200 246,400
Adit volume (gallons) 8 by 8 feet 16 by 22 feet	 423,667 548,932	 624,000 1,848,000
Estimated Total (gallons)	**972,600**	**2,500,000**

Notes:
**Worst Case Scenario:*

- Mine adit is 8 feet by 8 feet and full in first 700 feet (8 feet of head)
- Based on maps, the mine has a width and height of 16 feet by 22 feet, from 700 to 1,300 feet in from portal, and water from 27 to 16 feet deep (22 feet average)
- Mine reverts to 8 feet by 8 feet from 1,300 to 2,000 feet. Based on static water level in boring MW-5 and grade of adit, water is estimated to extend into the mine 2,000 feet from lower adit portal.

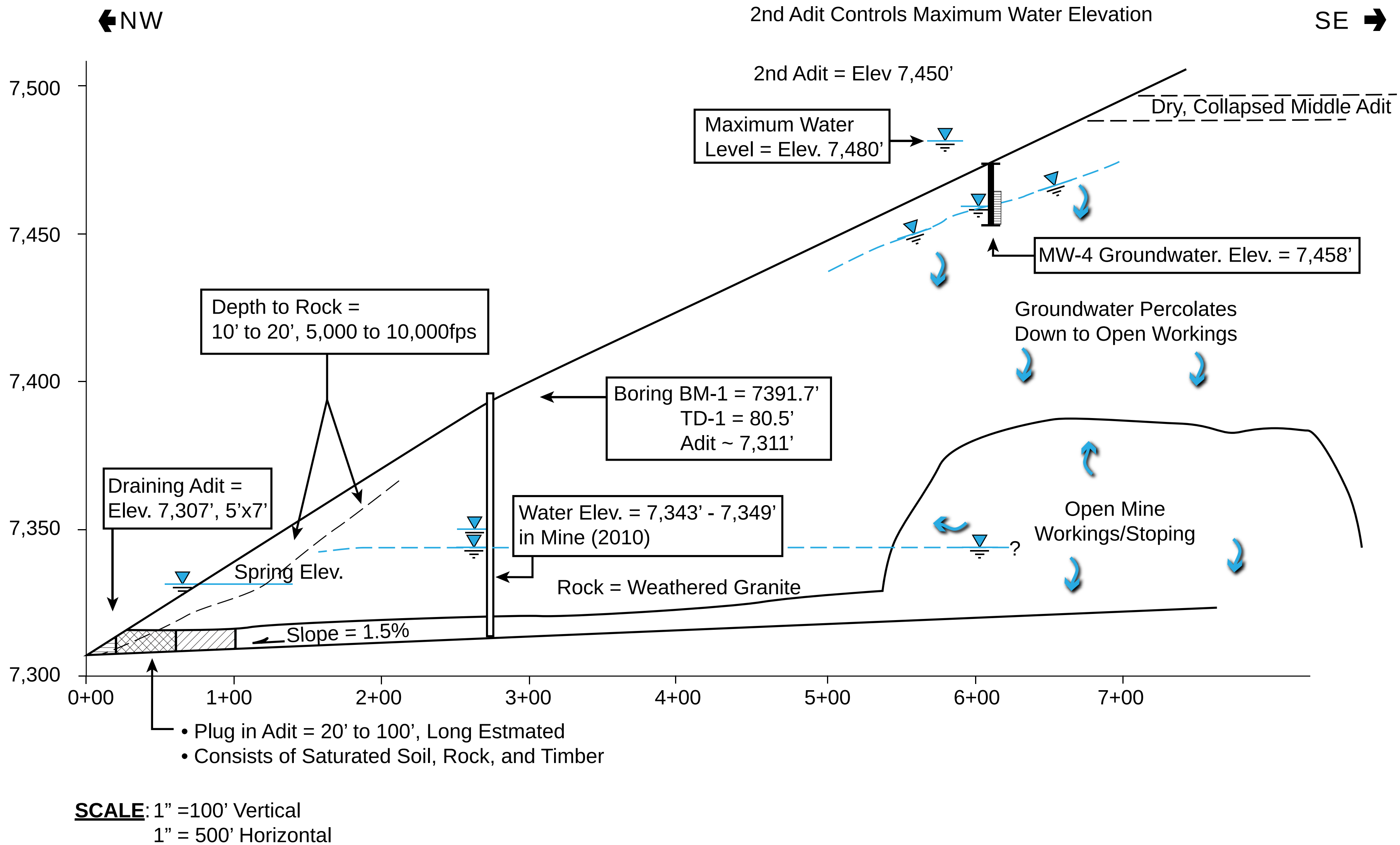


EXHIBIT 5-24
CSM LONG PROFILE SHOWING POOLED
GROUNDWATER CONDITIONS
Bullion Mine OU6 ROD

Section 6

6.1 Current and Reasonably Anticipated Future Land and Resource Uses

This section describes the current and reasonably anticipated future land uses and current and potential beneficial surface water and ground water uses at or near the Bullion Mine. Understanding these resource uses is important to the EPA's decision-making process because it helps ensure that the selected remedy is protective of human health and the environment now and in the future, and is accepted by the community. Community and stakeholder input was acquired and considered during the public comment period for the proposed plan (March 2 through April 21, 2014). The information presented in the following subsections forms the basis for the risk characterization conclusions presented in Section 7.

6.1.1 Land Use

The majority of the land within the Basin Watershed is managed by the USFS or BLM. The historic land use for claim properties in the watershed has been mining. The watershed is sparsely populated, with limited residences located along the mainstem of Basin and Cataract Creeks. The Town of Basin is located at the mouth of the watershed where Basin Creek feeds into the Boulder River. The Bullion Mine, located in the upper Basin Watershed (see Exhibit 1-2), is currently abandoned and unoccupied, and is typically covered with snow for about 6 months per year.

6.1.2 Human Land Uses

Human land uses within the vicinity of the Bullion Mine include historical mining and seasonal recreational use (for example, hiking, all-terrain vehicle [ATV] riding, camping, and big-game hunting). Motorized use (including ATV or motorcycle riding) at the Bullion Mine is largely limited to the roadway because of steep terrain, boulders and woody debris. Given the present understanding of baseline conditions at the Bullion Mine including its remote location, steep land slopes, high elevation, unreliable domestic water source, underground mine workings and unconsolidated material on which to build a structure, residential use at the Site is improbable.

6.1.3 Ecological Land Uses

Habitat in the watershed is primarily forest land dominated by lodgepole pine, and to a lesser extent, by subalpine fir, Douglas fir, Engleman spruce, quaking aspen and common juniper. At the Site, the dominant woody plants species present are lodgepole pine and white spruce. Among the dominant herbaceous species, tufted hairgrass have the greatest overall presence at the Site, particularly in wetland areas. Idaho fescue and birds-foot trefoil are dominant in upland areas. Given the degree of historic physical disturbance of the Site and the recent efforts at revegetation, the Bullion Mine is best characterized as a mixed matrix of wetlands and uplands.

Habitat at the Site and surrounding area is sufficient to support a variety of wildlife species, including piscivorous birds, omnivorous birds, raptors, small burrowing mammals and large game species. Raptors found in the area include eagles and goshawks. Among the mammals potentially using the watershed are snowshoe hare, deer, elk, moose, black bear and small mammals (for example, mice). Current lists of endangered, threatened, proposed and candidate species obtained from U.S. Fish and Wildlife Service (USFWS), the State of Montana Department of Fish, Wildlife and Parks (MDFWP), and the Montana Natural Heritage Program (MNHP) suggest that the Canada lynx and grizzly bear have the potential of using habitats consistent with those found at Bullion Mine. However, both of these mammals are large carnivores with foraging areas significantly greater than the area occupied by the Bullion Mine, so they would not be expected to frequent the Site.

6.2 Surface Water Use

Jill Creek is adjacent to and immediately downgradient of the Bullion Mine. The confluence of Jill Creek with Jack Creek is approximately 1 mile downstream from the mine adit discharge. MDEQ classifies Jack Creek (and Jill Creek as its tributary) as B-1. In fact, the beneficial use classification for the entire Missouri River drainage, unless otherwise identified, is B-1. The B-1 classification states that the water quality of the stream must be sufficient to support recreational activities such as bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life and other wildlife; and agricultural and industrial water supply; and drinking, culinary and food processing purposes after conventional treatment.

Water from Jack Creek eventually recharges Basin Creek and shallow alluvial aquifers that are a source of drinking water for the Town of Basin residents and was a primary human exposure pathway considered during the Basin Watershed OU2 RI. The Basin Creek drainage to the Basin water supply intake (well field) is classified A-1. In addition to meeting the B-1 uses listed in the paragraph above, the A-1 classification states that waters are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment *for removal of naturally present impurities*. Water quality must be maintained suitable for bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

6.3 Ground Water Use

There are no current or reasonably anticipated future uses of the limited ground water at the site. It is not likely that it will be necessary to develop ground water resources at this remote high alpine site (7100 to 8000 feet amsl) due to its limited access, severe climate and the fact it is surrounded by federally owned lands (Beaverhead – Deerlodge National Forest). Ground water development may not be feasible because of unpredictable recharge from low permeability fractured bedrock. No drinking water wells are located within or adjacent to the Site. The nearest drinking water well is approximately 2 miles from the Site. Therefore, ground water use is limited to the recharge of nearby surface water bodies (for example, Jill and Jack Creeks).

Section 7

7.1 Summary of Site Risks

This section of the ROD summarizes the Site risks associated with residual contamination at the Bullion Mine. Human health (HHRA) and ecological (ERA) risk assessments were conducted to evaluate whether, in the absence of any remedial action, mining-related metals contamination at the Bullion Mine poses an unacceptable risk to human or ecological receptors. Site risks provide the basis for taking action and identify the contaminants and exposure pathways that need to be addressed by remedial actions. A summary of the results of the HHRA and ERA is presented in the following subsections. More detailed information regarding the risk assessments is available in the RI.

7.1.1 Human Health Risk Assessment

The HHRA was conducted to estimate risk for potentially complete exposure pathways assuming no remedial action is taken. The purpose of the HHRA was to determine whether a potential for unacceptable risk to human health exists under current and reasonably anticipated future Site use. Data used in the HHRA were collected during the RI and were validated, evaluated, and determined to be representative of Site conditions and exposures and of high enough quality to use in the HHRA. The results were used to identify the COCs that were the focus of the feasibility study and that require remedial action.

Contaminants of Concern

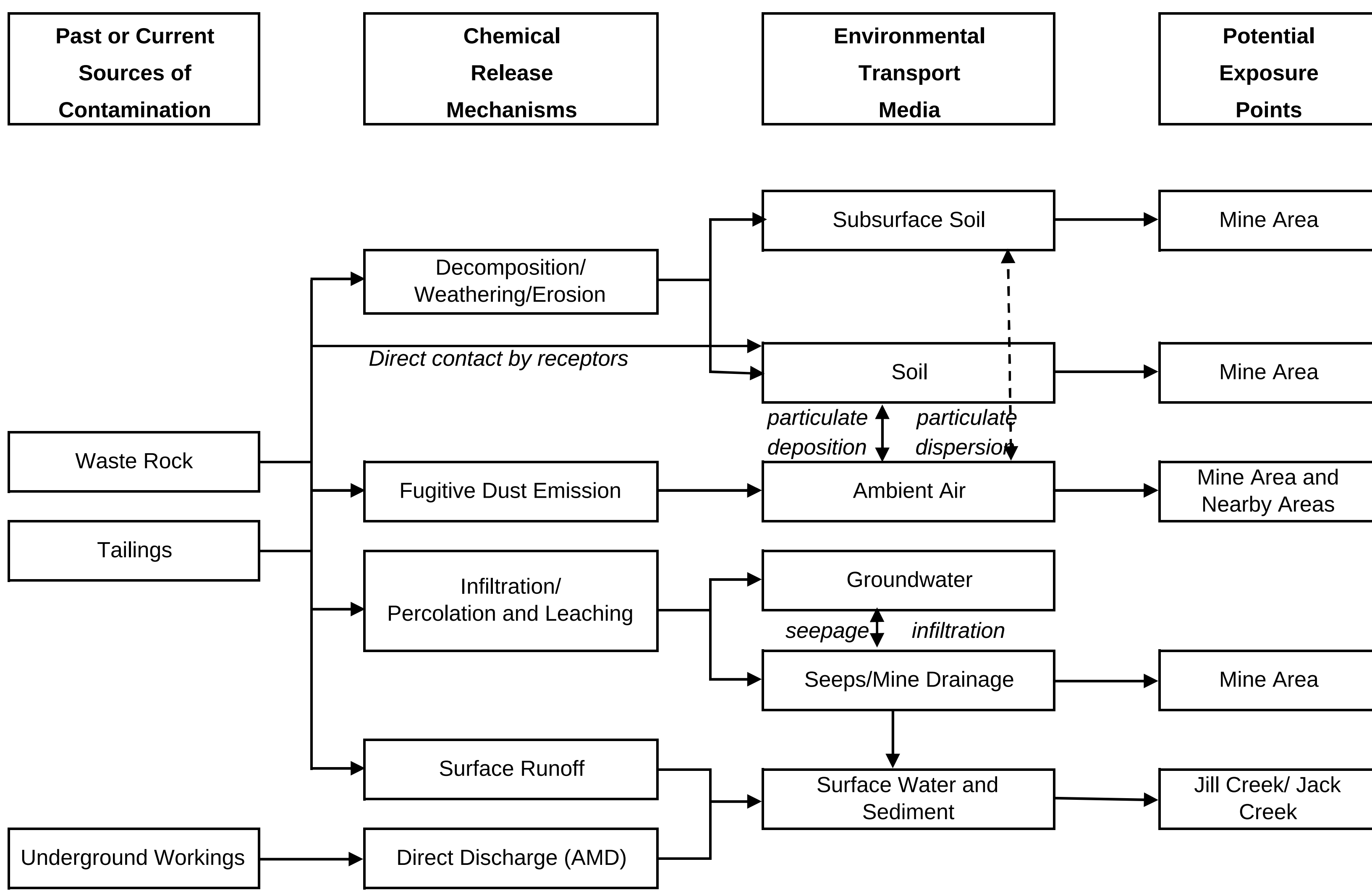
Based on historical investigations in the Basin Watershed and the conceptual site model, 12 metals were evaluated as contaminants that exist at levels of potential concern (COPCs) at the Bullion Mine. The COCs were then selected by comparing the Site-wide maximum detected concentration of each COPC to a conservative risk-based screening level. Of the 12 COPCs, arsenic in soil and seep/spring water, and cadmium in seep/spring water were identified as the only COCs associated with human health for current recreational users (adult and adolescent) of the Site. Arsenic in soil was also identified as a COC for the hypothetical future industrial worker exposure scenario. Ground water samples exceeded the screening benchmarks for antimony, arsenic, cadmium, copper, lead, nickel and zinc in most of the wells and piezometers. Potable use of ground water is currently not occurring at the Site.

Exposure Assessment

The exposure assessment component of the HHRA identified the populations that could be exposed, the routes by which these individuals could become exposed, and the magnitude, frequency and duration of potential exposures. Human health effects associated with exposure to the contaminants of potential concern were estimated through the development of several current and hypothetical future exposure pathways. The exposure pathways were developed using the CSM and reflect the potential for exposure to hazardous substances based on the present and reasonably anticipated future land and water uses (see Section 6) of the Bullion Mine. The potential pathways for human health exposure are depicted on the conceptual exposure model, presented in Exhibit 7-1 and described in Section 6 of the RI.

The Bullion Mine and nearby lands are currently used mainly for recreation. Reasonably anticipated future land use is also recreational. The Site is of potential human health concern to the EPA because historical mining activities have resulted in the release of metals to soil, surface water and sediment, and excessive human exposure to mining-related contaminants can lead to adverse health effects. The most plausible current or future human receptor populations were evaluated for the Bullion Mine and included the following:

- ✓ Future intermittent workers (for example, road maintenance, environmental sampling and forest service workers)
- ✓ Future adult and adolescent recreational users (for example, hikers, ATV riders or hunters)
- ✓ Future excavation workers (for example, excavation during remedial actions)



Potential Exposure Points	Potential Exposure Pathways	Current and Future Recreational Users (Adolescent and Adult)	Future Intermittent Worker	Future Excavation Worker	Hypothetical Industrial Worker	Hypothetical Residents	Terrestrial Wildlife (birds and mammals)	Vegetation (upland plants)	Aquatic Biota (fish and invertebrates)
Mine Area (Subsurface Soil)	Incidential Ingestion	--	--	C	--	--	--	--	--
	Dermal/Direct Contact	--	--	C	--	--	--	--	--
	Uptake into Plants	--	--	--	--	--	--	C	--
	Uptake into Food Items	I	--	--	--	--	--	--	--
Mine Area (Soil)	Incidential Ingestion	C	C	--	C	C	C	--	--
	Dermal/Direct Contact	C	C	--	C	C	I	--	--
	Uptake into Plants	--	--	--	--	--	--	C	--
	Uptake into Food Items	I	--	--	--	--	C	--	--
Mine Area and Nearby Areas (Ambient Air)	Dust Inhalation	C	C	C	C	C	I	--	--
Mine Area (Seeps/Mine Drainage)	Ingestion	--	--	--	--	--	I	--	--
	Dermal Contact	--	--	--	--	--	I	--	--
Jill Creek/ Jack Creek (Surface Water and Sediment)	Ingestion	C	--	--	--	--	C	--	--
	Dermal/Direct Contact	I	--	--	--	--	I	--	C
	Uptake into Food Items	I	--	--	--	--	C	--	C

Notes:
C = Potentially complete pathway; quantitatively evaluated in the risk assessment
-- = Incomplete pathway
I = Potentially complete pathway; considered insignificat and not quatitatively evaluated in the risk assessment

EXHIBIT 7-1
CONCEPTUAL EXPOSURE MODEL (CEM) FOR POTENTIAL HUMAN HEALTH AND ECOLOGICAL RECEPTORS AT THE BULLION MINE
Bullion Mine OU6 ROD

For these potentially exposed populations, the most plausible exposure routes considered for characterizing human health risks include the following:

- Incidental ingestion and dermal contact with surface soil, or inhalation of dust by future intermittent workers and recreational users
- Incidental ingestion and dermal contact with subsurface soil, or inhalation of dust by future excavation workers
- Ingestion of surface water (at springs/seeps and in Jill Creek) by recreational users

As described in Section 6, the Site conditions make residential use and occupational worker use scenarios highly unlikely. However, to provide a comparative perspective for decision-making, conservative risk estimates for a hypothetical occupational worker scenario were considered in the HHRA. Although the Basin Watershed may also be used for fishing, Jill Creek near the Site is characterized as a high-altitude, small (both narrow and shallow), first-order stream not capable of supporting fish sizable enough for human consumption. Therefore, angler exposure scenarios were not considered.

Toxicity Assessment

The toxicity assessment component of the HHRA evaluated the relationship between the magnitude of exposure to a chemical at the Site and the likelihood of adverse health effects to potentially exposed populations. This assessment provided a numerical estimate of the increased likelihood of adverse effects associated with chemical exposure. Arsenic was the only COC in soil identified in the HHRA. The toxicity assessment was comprised of two steps: hazard characterization and dose-response evaluation. MDEQ compares ground water and surface water directly to the Circular DEQ-7 numeric water quality standards, and considers any exceedance of the human health standards to be a risk.

Risk Characterization

In the risk characterization component of the HHRA process, quantification of risk is accomplished by combining the results of the exposure assessment (estimated chemical intakes) with the results of the dose-response assessment (toxicity values identified in the toxicity assessment) to provide numerical estimates of potential health effects. The quantification approach differs for potential noncancer and cancer effects. The evaluation of cancer risk and noncancer risk for all contaminants of potential concern are presented in the HHRA chapter of the RI. This section of the ROD focuses on the exposure scenarios and contaminants that were identified as posing unacceptable risk in the HHRA.

Although this HHRA produces numerical estimates of risk, it should be recognized that these numbers might not predict actual health outcomes because they are based largely on hypothetical assumptions. Their purpose is to provide a frame of reference for risk management decision-making. Any actual risks are likely to be lower than these estimates. Interpretation of the risk estimates provided should consider the nature and weight of evidence supporting these estimates, as well as the magnitude of uncertainty surrounding them. The potential for unacceptable human health risk at the Bullion Mine was identified using the following risk thresholds:

- In interpreting estimates of excess lifetime cancer risks, the EPA under the Superfund program generally considers action to be warranted when the multi-chemical aggregate cancer risk for all exposure routes within a specific exposure scenario exceeds the 1×10^{-4} risk range. The NCP directs that the “point of departure” for contaminants that do not have an ARAR should be 1×10^{-6}. Action generally is not necessarily required for risks falling within 1×10^{-6} and 1×10^{-4}; however, this is judged on a case-by-case basis. Under state guidance, MDEQ considers a cancer risk exceeding 1×10^{-5} as unacceptable risk.
- Under the EPA and MDEQ guidance, a hazard index (HI) (the ratio of chemical intake to the RfD for all constituents) greater than 1 indicates that some potential exists for adverse noncancer health effects associated with exposure to the COPCs (EPA, 1991).

Cancer Risk Estimation Method

The potential for cancer effects is evaluated by estimating excess life time cancer risk (ELCR). This risk is the incremental increase in the probability of developing cancer during one's lifetime in addition to the background probability of developing cancer (that is, if no exposure to Site constituents occurs). For example, a 2×10^{-6} ELCR means that, for every 1 million people exposed to the carcinogen throughout their lifetimes, the average incidence of cancer may increase by 2 cases of cancer. In the U.S., the background probability of developing cancer for men is a little less than one in two, and for women a little more than one in three (American Cancer Society, 2003). Although synergistic or antagonistic interactions might occur between cancer-causing constituents and other constituents, information is generally lacking in the toxicological literature to predict quantitatively the effects of these potential interactions. Therefore, cancer risks are treated as additive within an exposure route in this assessment. This is consistent with the EPA guidance regarding risk assessment of chemical mixtures (EPA, 1986).

Noncancer Risk Estimation

For noncancer effects exposures, the likelihood that a receptor will develop an adverse effect is estimated by comparing the predicted level of exposure for a particular constituent with the highest level of exposure that is considered protective. The ratio of the chronic daily intake divided by RfD (or RfC) is termed the hazard quotient (HQ). Oral, dermal and inhalation HQs are summed to provide the total HQ for an individual COPC. When the HQ for a COPC exceeds one (that is, exposure exceeds RfD or RfC), there is a concern for potential noncancer health effects. To assess the potential for noncancer effects posed by exposure to multiple constituents, a HI approach was used according to the EPA guidance (EPA, 1989). This approach assumes that the noncancer hazard associated with exposure to more than one constituent is additive; therefore, synergistic or antagonistic interactions between constituents are not accounted for. The HI may exceed 1 even if all the individual HQs are less than 1. In this case, the constituents may be segregated by similar mechanisms of toxicity and toxicological effects. Separate HIs may then be derived based on mechanism and effect.

Summary of Risk Estimates by Exposure Scenario

The evaluation of cancer risk and noncancer risk are described, but risk estimates are only summarized for the media, contaminant (for example, arsenic and cadmium) and the exposure scenarios for which unacceptable risk was identified. The risk estimates for these are provided in Table 7-1. More details regarding the risk estimates calculated for the other media, COPCs, and exposure scenarios are provided in Section 6 (for example, the HHRA) of the RI.

TABLE 7-1
Summary of Human Health Risks above Regulatory Threshold Levels

Receptor	Media	Pathway	Chemical of Concern	EPC Soil (mg/kg)/ Water (ug/L)	RME Cancer Risk	RME Noncancer Hazard (HQ)	CTE Cancer Risk	CTE Noncancer Hazard (HQ)
Future Intermittent Worker	Surface Soil (0-10 inches bgs)	Ingestion	Arsenic	442.8	4E-06	0.1	2E-07	0.02
		Inhalation	Arsenic	442.8	5E-09	0.001	7E-10	0.0004
Future Recreational User – Adult	Surface Soil (0-10 inches bgs)	Ingestion	Arsenic	442.8	2E-05	0.1	1E-06	0.01
		Inhalation	Arsenic	442.8	2E-05	1	1E-06	0.1
	Surface Water	Ingestion	Arsenic	38.8	6E-05	0.3	2E-05	0.1
	Springs/Seeps	Ingestion	Arsenic	264	**4E-04**	**2**	1E-04	0.7
			Cadmium	264	—	**2**	—	0.5
Future Recreational User – Adolescent	Surface Soil (0-10 inches bgs)	Ingestion	Arsenic	442.8	1E-05	0.4	1E-06	0.05
		Inhalation	Arsenic	442.8	6E-06	1	3E-07	0.1
	Surface Water	Ingestion	Arsenic	38.8	2E-05	0.09	5E-06	0.03
	Springs/Seeps	Ingestion	Arsenic	264	**1E-04**	0.6	3E-05	0.2
Excavation Worker	Subsurface Soil (0-10 feet bgs)	Ingestion	Arsenic	1,124	1E-05	0.3	1E-06	0.2
		Inhalation	Arsenic	1,124	6E-09	0.001	5E-10	0.0005
Hypothetical Industrial Worker	Surface Soil (0-10 inches bgs)	Ingestion	Arsenic	442.8	6E-05	0.3	7E-06	0.2
		Inhalation	Arsenic	442.8	6E-08	0.002	2E-08	0.002

Note:
Bold represents exceedance of a cancer risk of 10^{-5} or hazard quotient greater than 1
MDEQ considers surface soil to be 0-2 feet bgs, evaluating the top 10 inches may not be adequately protective

Uncertainties in the Human Health Risk Assessment

Full characterization of human health requires that the numerical estimates of risk presented in the risk assessments be accompanied by a discussion of the uncertainties inherent in the assumptions used to estimate those risks. Considering this, the risk results are themselves uncertain, and it is important for risk managers and the public to keep this in mind when interpreting the results of a risk assessment. Uncertainties in risk assessment methods may result either in understating or in overstating the risks, although the latter is likely the case because health-conservative assumptions are used to characterize risk. Several key uncertainties are described below:

- The degree to which sample collection and analyses reflecting real exposure concentrations will influence the reliability of the risk estimates. Because the Site investigations have generally focused on sampling close to suspected source areas at the mine, rather than at areas where exposures are most likely, exposure point concentrations used for the risk estimates may be biased high.
- The estimation of exposure in this risk assessment required many assumptions. There are uncertainties regarding the likelihood of exposure, the frequency of contact with contaminated media, the concentrations of chemicals at exposure points and the total duration of exposure. The human exposure assumptions used in the risk estimates are intended to be conservative and likely overestimate the actual risk or hazard.
- The risk estimates for the recreational users assume the use of ATVs and the exposures for this scenario are uncertain because the concentration of arsenic in air was not measured directly but was estimated using a screening-level soil-to-air transfer model. Additionally, dust levels during ATV use depends on a number of factors and is expected to be highly variable. However, the particulate emissions factor (PEF) used for the recreational user scenarios was derived from empirical data and is expected to provide a reasonable upper-end measure of exposure.
- Furthermore, current conditions at the Site (for example, large woody debris, steep slopes and boulders) reduce the likelihood that significant ATV use could occur. Thus, risk estimates for arsenic should be considered uncertain, and true risks are more likely to be smaller than the calculated risks.
- There is a relatively high level of uncertainty associated with the evaluation of exposure and risks for exposure to springs/seeps, since the results are based on a limited data set and the degree of attenuation of seep water is expected to be considerable upon discharging and mixing into Jill Creek. The risk assessment conservatively assumes these could be used intermittently as drinking water sources.
- Uncertainties in toxicological data can also influence the reliability of risk management decisions. The toxicity values used for quantifying risk in this risk assessment have varying levels of confidence that may affect the confidence in the resulting risk estimates. The general sources of toxicological uncertainty include the following:
  - Extrapolation of dose-response data derived from high-dose exposures to adverse health effects that may occur at the low levels seen in the environment.
  - Extrapolation of dose-response data derived from short-term tests to predict effects of chronic exposures.
  - Extrapolation of dose-response data derived from animal studies to predict effects on humans.
  - Extrapolation of dose-response data from homogeneous populations to predict effects on the general population.

7.2 Ecological Risk Assessment

An ERA was conducted to estimate risk for potentially complete exposure pathways assuming no remedial action is taken. The ERA provides an assessment of the potential for adverse impacts of past releases to soil, sediment and surface water on aquatic resources and wildlife users in the vicinity of the Bullion Mine (Note: MDEQ compares surface water directly to the Circular DEQ-7 numeric water quality standards, and does not conduct a separate risk assessment). The overall objective of the ERA was to quantitatively and qualitatively evaluate baseline or existing exposure and risks to ecological receptors, and to provide risk managers with information needed to achieve their ecological management goals and help determine remedial decisions, as necessary.

The ERA characterized the ecological communities at and in the vicinity of the Bullion Mine, identified complete ecological exposure routes, identified contaminants of potential ecological concern (COPECs) and determined whether ecological exposures are high enough to pose unacceptable risks. The ERA used multiple lines of evidence to determine whether any releases at the Site could pose an unacceptable risk to these ecological receptors.

The ERA followed the eight-step approach recommended by the EPA (1997). More information on the process can be found in the risk assessment section of the RI.

The Bullion Mine ERA and its findings are summarized in the following sections.

The following constituents were identified in the screening level ecological risk assessment (SLERA) as COPECs for their respective exposures:

- **Soil** (plants)—aluminum, antimony, arsenic, cadmium, copper, iron, lead, manganese, selenium, zinc.
- **Soil** (wildlife)—aluminum, antimony, arsenic, cadmium, copper, iron, lead, selenium, silver, zinc.
- **Surface Water** (aquatic organisms)—aluminum, arsenic, cadmium, copper, iron, lead, manganese, nickel, zinc.
- **Sediment** (benthic infauna)—antimony, arsenic, cadmium, copper, iron, lead, manganese, silver, thallium, zinc.

7.2.1 Baseline Ecological Risk Assessment (BERA) Problem Formulation

Upon completion of the SLERA, several metals/metalloids identified as COPECs were carried forward for additional evaluation in the baseline ecological risk assessment (BERA) problem formulation. The BERA begins with a refinement of the COPECs, in which the conservative assumptions used in the SLERA are refined and risk estimates are calculated with exposure models that allow use of more site-specific assumptions. This ROD focuses on the ecological risk estimates for the media, contaminants and exposure scenarios for which unacceptable risk was identified. More detailed information is available in the risk assessment (Section 6) of the RI.

A summary of the risk results for contaminants of ecological concern (COECs) is provided in the following sections separately for plants, aquatic resources, benthic infauna and wildlife (mammals and birds).

Risk Characterization for Plants. These terrestrial plant screening benchmarks for COECs are summarized in Table 7-7. The results indicate that concentrations for the following seven COECs exceeded benchmarks and levels measured at background locations: antimony, arsenic, copper, lead, manganese, selenium and zinc.

Exceedances occur in both surface and subsurface soils, with the greatest factors of exceedances being from antimony and arsenic. Antimony and arsenic exposure point concentrations (EPCs) were also greater than 10 times above background levels. These results indicate that soil concentrations at the Bullion Mine exceed levels known to pose a risk to vegetation and the levels of the COECs at the Site are above measured background levels. Considering higher concentrations occur below the previous soil cover, deeper-rooted vegetation forms are expected to have the greatest potential of being affected.

Risk Characterization for Aquatic Resources. To provide confidence in any decision making regarding aquatic resources in the Jill Creek and downgradient streams, potential effects on aquatic communities are assessed using an approach that considers multiple lines of evidence collectively.

A summary of COEC concentrations detected in surface water compared with surface water benchmarks is provided in Table 7-2. The results indicate that acute water quality criteria (WQC) were exceeded for dissolved aluminum, dissolved cadmium, dissolved copper and dissolved zinc. While chronic WQC were exceeded for dissolved aluminum, dissolved cadmium, dissolved copper, dissolved iron, dissolved lead and dissolved zinc. Additionally, the pH of surface water (in Jill Creek) adjacent to and immediately downgradient of the Bullion Mine ranged from 4.9 to 5.9, which is below the chronic WQC range of 6.5 to 9.0. Metals concentrations were significantly elevated immediately below the influence of the adit discharge when compared with the upstream reference location.

Overall, the results of the benchmark comparisons for surface water indicate that cadmium, copper and zinc significantly exceeded freshwater acute and chronic WQC. To a lesser extent, aluminum, iron and lead concentrations in Jill Creek were also measured at levels exceeding freshwater chronic WQC. These exceedances indicate that water quality within Jill Creek is not suitable to support aquatic life. Furthermore, historical fish toxicity testing conducted within Jack Creek provides empirical evidence in support of this conclusion.

TABLE 7-2

Summary of Ecological Risk Hazard Quotients for Plants, Aquatic Organisms, and Benthic Infauna

	Sediment – Benthic Infauna (mg/kg)							Soil – Plants (mg/kg)				Surface Water – Aquatic Organisms (ug/L)					
COC[a]	Upper Effects Concentrations	JACK-01	JACK-02	JILL-01	JILL-02	JILL-03	JILL-04	Plant Screening Levels	Range of Soil Background Levels	Surface Soil EPC	Subsurface Soil EPC	*Acute WQC	*Chronic WQC	JILL-01	JILL-02	JILL-03	JILL-04
Aluminum	—	—	—	—	—	—	—	—	—	—	—	750	87	56.4	51.3	1010	915
Antimony	3	0.76	4.9	0.94	7	0.09	6.4	5	0.38U to 0.4	141	141	—	—	—	—	—	—
Arsenic	120	129	470	235	1,840	288	836	18	7.6 to 162	1,159	1,124	340	150	—	—	—	—
Cadmium	5.4	3.2	14.6	7.3	25.7	12.7	21.6	32	0.22 to 0.38	44	44	0.52	0.097	<0.08	0.79	22.5	22.4
Copper	1,200	45.8	176	137	110	474	505	70	6.8 to 52	178	173	3.79	2.85	1.4	11.1	478	449
Iron	40,000	26,500	26,600	27,400	124,000	48,100	37,600	—	—	—	—	—	1,000	<50	<50	6,210	5,580
Lead	>1,300	92	241	48	397	96.8	341	120	9.9 to 189	412	399	13.98	0.545	<0.1	<0.1	8.0	7.5
Manganese	—	—	—	—	—	—	—	220	NA	672	668	—	—	—	—	—	—
Silver	1.7	0.058	1.4	0.053	1.5	0.045	1.7	—	—	—	—	0.374	—	—	—	—	—
Selenium	—	—	—	—	—	—	—	0.52	0.58U to 0.98	1.2	1.2	20	5	—	—	—	—
Zinc	>4,200	231	761	365	230	538	803	160	17.3 to 185	337	323	37	37	<5	102	2,650	2,490

Notes:
COC = contaminant of concern
WQC = water quality criteria equivalent to DEQ-7 standards
EPC = exposure point concentration
* Hardness value upon which these DEQ-7 standards are based is 25 mg/l
Soil and sediment screening levels and concentrations reported as mg/kg = milligram per kilogram
Surface water screening levels and concentrations reported as ug/L – micrograms per liter
Bold indicates concentration exceeded screening levels and background (or upstream) locations
[a] Results are only provided for COCs in each media as identified during the risk assessment

Risk Characterization for Benthic Infauna. Similar to the approach used to address risks to freshwater aquatic resources, potential effects on benthic communities are assessed using an approach that considers collective lines of evidence.

Comparisons of COEC concentrations detected in sediment with probable (upper) effects benchmarks are provided in Table 7-2. These represent levels above which significant benthic macroinvertebrate impairment would be likely. The following conclusions can be drawn from the benchmark comparisons:

- Probable effects benchmarks were exceeded for antimony, arsenic, cadmium, iron and silver at sample locations adjacent to or downgradient of the Site. Arsenic had the highest levels of exceedance with levels 15 times above the conceptual screening level (CSL) in the smallest size fractions.
- Because the COECs are naturally occurring constituents and potentially influenced by upstream sources, further understanding of the background contributions is also important. The results indicated that levels downstream of influence of the Site are significantly elevated.

An additional line of evidence supporting the ecological risk characterization for sediment consists of a Site-specific benthic macroinvertebrate investigation conducted in 2010. The methodology and results were provided in Appendix G of the RI. The study found that a sparse but diverse macroinvertebrate community occurs in Jill Creek above the Bullion Mine and that few organisms are living downstream of the mine. The study clearly showed significant impairment of benthic macroinvertebrate populations downstream of the Site. Measurable impacts extended beyond the confluence of Jill Creek and Jack Creek, which is approximately 1 mile downstream of the Site.

A supporting line of evidence is noting geographic trends between COEC concentrations in sediment and corresponding benthic macroinvertebrate survey results. The relationship between COEC concentrations in sediment and benthic macroinvertebrate health metrics (abundance and taxa richness) was explored. Limited data existed to provide a meaningful statistical evaluation between these measures. However, macroinvertebrate populations are significantly impaired at locations where COEC concentrations are highest. No habitat differences (for example, differing flow rates or substrate) were identified that would confound the interpretation of the macroinvertebrate survey results.

Considered collectively, these lines of evidence provided a strong indication that these COECs in sediment in Jill Creek and Jack Creek near its confluence with Jill Creek are at levels that pose significant risk to sediment infauna.

Risk Quantification for Wildlife. Risks posed to mammalian and avian species that may use the Site were determined for mammalian and avian receptors.

Exposure was assumed to occur to COECs in soil, sediment and surface water collectively. COECs resulting in LOAEL-based ecological HQs exceeding 1 are as follows:

- Deer mouse—aluminum, antimony, arsenic, cadmium, lead
- Mule deer—arsenic
- Raccoon—aluminum, antimony, arsenic
- Dusky flycatcher—arsenic, cadmium, copper, lead, zinc

A comparison of surface soil EPCs with the range of COEC concentrations measured at background locations was also provided in the ERA and, for those COECs identified with ecological HQs exceeding 1, surface soil EPCs for all are above background levels with the exception of aluminum. Additionally, as previously mentioned, early remedial actions at the Bullion Mine included the removal of contaminated soils and placement of a soil cover or cap to an approximate depth of 18 inches bgs. Direct soil exposure for the majority of wildlife species generally occurs in the upper few inches of the soil profile.

Overall, the risk evaluation of mammalian and avian wildlife indicated that the combined exposures to measured levels of COECs in surface soil, sediment and water are high enough to pose a significant risk to wildlife should they forage at the Site. The risks are greatest for individuals with smaller foraging areas (for example, deer mouse and dusky flycatcher) and for species that burrow and consume burrowing organisms or deeper-rooted plant forms.

Uncertainties in the Ecological Risk Assessment

Full characterization of ecological risks requires that the numerical estimates of risk presented in the risk assessments be accompanied by a discussion of the uncertainties inherent in the assumptions used to estimate those risks. Uncertainties in risk assessment methods may result either in understating or in overstating the risks. The latter is likely the case when health-conservative assumptions are used to characterize risk. Several key uncertainties are discussed below:

- The degree to which sample collection and analyses reflect real exposure concentrations will influence the reliability of the risk estimates. Because the Site investigations have generally focused on sampling close to suspected source areas at the mine, rather than at areas where exposure are most likely (for example, vegetated areas for wildlife), exposure point concentrations used for the risk estimates may be biased high for some receptors.
- Uncertainty in exposure estimation is introduced if a constituent occurring in soil is in a form that is more or less bioavailable than the form used to determine the COPECs toxicity in a laboratory study (as reported in literature) used to derive a toxicity reference value (TRV). For the ERA, bioavailability was assumed equal to the form used in the toxicity study reported in the literature. Because metals are primary contributors to the risk estimates for birds and mammals and because the available toxicity studies are generally conducted using very bioavailable constituent forms, the use of TRVs based on these more available forms may overestimate risk to wildlife.
- In the development of exposure estimates, exposure assumptions relating to wildlife diet are expected to overestimate risk. This is because the species' selected as endpoints are mobile and most are not likely to forage at the Bullion Mine 100 percent of the time when higher quality habitat is available in nearby locations. As previously stated, early remedial actions at the Site included the removal of contaminated soils and placement of a soil cover to an approximate depth of 18 inches bgs. Direct soil exposure for the majority of wildlife species occurs in the upper few inches of the soil profile. Therefore, the assumption made that wildlife exposure occurs in the soil profile from 0 to 2 feet bgs likely overestimates the exposure to most species.
- Maximum sediment concentrations were used for the food chain calculations, which likely results in an overestimation of actual risk to most wildlife. The ERA assumes that each endpoint species receives at least a portion of their drinking water from the Site. This assumption may overestimate exposure because, for some species, most or all water intake comes from food items.
- Uncertainties in toxicological data can also influence the reliability of risk management decisions. The toxicity values used for quantifying risk in this risk assessment have varying levels of confidence that may affect the confidence in the resulting risk estimates.
- Because the COECs in Site media occur naturally, it is important when interpreting risks to consider the relative level of potential risk posed by naturally occurring levels.

7.3 Basis for Action

Table 7-3 summarizes the basis for action at the Site and a brief description is provided below.

Contaminants in soil and seeps/springs represent a threat to human health. The primary risk to human health documented in the HHRA was for exposure of adolescent and adult recreational users (primarily to potential ATV users) to arsenic in soils at the Site. Additionally, arsenic and cadmium levels emanating from seeps/springs are high enough to pose an unacceptable risk to recreational users that could use these as source of drinking water.

The ERA indicates unacceptable risks to fish and benthic organisms exposed to Jill Creek and Jack Creek surface water and sediment. Levels of several COECs in Jill Creek surface water exceed Montana WQS and surface water toxicity tests show significant fish mortality. Levels of several COECs in Jill Creek sediments exceed benchmarks and population surveys indicate reduced abundance and diversity of benthic macroinvertebrates. The ERA also indicates levels of several COECs (primarily in soil and sediment) pose unacceptable risks to plants, birds and mammals. Due to the poor quality habitat (large area of physical disturbance, limited vegetation and limited food sources) and the abundance of quality habitat adjacent to the mined area, exposure to current bird or mammal populations is likely low.

The remedial actions selected in this interim ROD are necessary to protect human health and the environment from actual or threatened releases of hazardous contaminants.

TABLE 7-3
Basis for Action

Receptor	Media	Reasonably Anticipated Future Land Use	Contaminant of Concern Requiring Action	Basis for Action
Human Health	Surface soil	Future intermittent worker	No unacceptable risks	Not applicable
		Current and future recreational users (adolescents and adults)	Arsenic	Cancer risk > $1x10^{-5}$
		Current and future adult recreational user	Arsenic	Cancer risk > $1x10^{-5}$
		Hypothetical future industrial worker	Arsenic	Cancer risk > $1x10^{-5}$
	Subsurface soil	Future excavation worker	No unacceptable risks	Not applicable
	Surface water	Current and future recreational users (adolescents and adults)	Arsenic	Cancer risk > $1x10^{-5}$ and HQ > 1
	Seep/Springs*	Current and future recreational users (adolescents and adults)	Arsenic and cadmium	Cancer risk > $1x10^{-5}$ and HQ > 1
Ecological	Surface soil	Habitat supporting birds, and mammals	Antimony, arsenic, cadmium, copper, lead, silver, zinc	LOAEL-based HQ >1
	Subsurface soil	Supporting plants	Antimony, arsenic, copper, lead, manganese, selenium, zinc	LOAEL-based HQ >1
	Surface water**	Habitat supporting aquatic organisms, birds and mammals	Aluminum, cadmium, copper, iron, lead, zinc	Exceedances of WQS
	Sediment	Habitat supporting benthic infauna, birds and mammals	Antimony, arsenic, cadmium, copper, iron, lead, silver, zinc	LOAEL-based HQ >1

Notes:
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
WQS = water quality standards
*MDEQ compares surface water to the DEQ-7 human health standards in order to determine whether a risk to human health exists
** MDEQ compares surface water to chronic aquatic DEQ-7 standards to determine whether a contaminant poses an ecological risk

Section 8

8.1 Remedial Action Objectives and Remedial Goals

Remedial action objectives (RAOs) were developed by the EPA to address Site conditions. Remedial objectives are based on reasonably anticipated future land, water and ground water uses, and the findings of the risk assessment, presented in Sections 6 and 7, respectively.

8.1.1 Surface Water RAOs

Water quality in Basin Creek is classified by MDEQ as an A-1 stream. Jack and Jill Creeks are tributaries to Basin Creek and are classified as B-1 streams. Basin Creek appears on MDEQ's CWA section 303(d) list for the following water quality parameters that exceeded standards: aluminum, arsenic, cadmium, copper, lead and zinc. Jack Creek will be listed in 2014 on a MDEQ's CWA section 303(d) list for the same constituents. TMDLs for these waters were developed by MDEQ and approved by the EPA in December 2012. The EPA does not propose to meet these standards with this interim ROD, but believes the remedy will contribute to achieving the TMDLs within the Basin Watershed OU2. Because of these characteristics, the surface water RAOs proposed for Jack and Jill Creeks are as follows:

1. Reduce or prevent surface water infiltration and migration into the underground mine workings in an effort to reduce the volume of AMD discharging to Jill Creek.
2. Reduce or prevent the release of COCs to surface waters that result in unacceptable risks to terrestrial and aquatic species.
3. Reduce or prevent the release of COCs to surface waters that result in exceedances of the Circular DEQ-7 numeric water quality chronic aquatic standards.

8.1.2 Ground Water Remedial Action Objectives (RAOs)

Ground water infiltrates through the bedrock fractures into the underground workings and discharges from the lower adit as AMD. This discharge presently intercepts and degrades Jill Creek, which flows into Jack Creek and eventually the Boulder River. Formal ground water quality objectives will be determined by the Basin Watershed OU2 remedy. In the interim, proposed RAOs for ground water are as follows:

1. Reduce or prevent surface water infiltration and migration into the underground mine workings in an effort to reduce the volume of AMD.
2. Prevent or minimize ground water discharge containing COCs that contribute to TMDL exceedances in Jack Creek.
3. Prevent or minimize human exposure to ground water contaminated with COCs above the Circular DEQ-7 numeric water quality standards.

8.1.3 Soil RAOs

The nature and extent of mine waste and impacted soils are described in the RI and are mitigated by a previous removal action and a vegetated soil cover. Subsurface soils, below the soil cover or exposed by erosion of the cover material, remain contaminated with significant concentrations of COCs. The RAO for soils in areas where the cover material is compromised by erosion, are as follows:

1. Prevent or minimize human exposure to soils/waste rock contaminated with COCs where incidental ingestion, dust inhalation or direct contact would pose an unacceptable health risk.
2. Prevent or minimize unacceptable risk to ecological systems (including aquatic and terrestrial) from contaminated waste rock/soils containing elevated levels of metals (antimony, arsenic, cadmium, copper, lead, silver and zinc).

8.1.4 Stream Sediment RAOs

The nature and extent of contaminated sediments in Jill Creek is explained in the RI. Since implementation of the 2002 TCRA, which remediated the hillsides adjacent to the creek and reconstructed the creek channel, remediation of stream sediments have and will rely on annual spring runoff and local thunderstorms to mitigate minor residual-sediment contamination by natural burial and mixing after the direct mine discharge is eliminated. Annual monitoring of sediment deposits in Jill Creek, prior to its confluence with Jack Creek, will track the success of this natural recovery process. The RAO for sediments is as follows:

1. Prevent or minimize unacceptable risk to ecological systems (including aquatic and terrestrial) degraded by contaminated sediment containing elevated levels of metals (arsenic, cadmium, iron and silver).
2. Prevent or minimize further migration of Site-contaminated source materials or discharges in close proximity to the creek.

8.2 Remediation Goals

The remediation goals (RGs) represent the concentration below which a contaminant is not considered an unacceptable risk. RGs are developed for both the protection of human health and for the protection of ecological receptors.

The risk assessment section of the RI report identified aluminum, cadmium, copper, iron, lead and zinc in surface water and ground water as COCs. Because this is an interim action, this ROD waives the surface and ground water quality standards until a final action is taken for the Basin Watershed OU2. The final remedy for the Basin Watershed OU2 will meet all surface and ground water quality standards. However, this interim action will improve water quality and the numerical values set forth in the DEQ-7 standards for chronic aquatic and human health will be used for comparison purposes for the Site (see Table 8-1).

TABLE 8-1
DEQ-7 surface and ground water standards the EPA will address with the Basin Watershed OU2 ROD

Contaminant	Human Health	Chronic [a]
Aluminum	—	0.087
Antimony	0.0056	—
Arsenic	0.01	0.15
Cadmium	0.005	0.000097
Copper	1.3	0.00285
Iron	—	1
Lead	0.015	0.000545
Manganese	—	—
Nickel	0.1	0.0161
Selenium	0.05	0.005
Silver	0.1	0.000374 [b]
Thallium	0.0002	—
Zinc	2	0.037

Notes:
[a] Circular DEQ-7 (MDEQ, 2012), based on 25 mg/L hardness
[b] Circular DEQ-7 (MDEQ, 2012) acute standard

A human health remedial action level (RAL) for soil was derived for arsenic—the only contaminant that exceeded human health risk thresholds for recreational users (ATV riders and hikers). The RAL for arsenic is based on potential risks derived for the adolescent recreational user (296 mg/kg). Potential exposure is limited to small areas where erosion has compromised the original soil cover placed during the removal action in 2002. Antimony, arsenic, cadmium, copper, lead, silver and zinc were identified as ecological contaminants of concern in soils. Potential ecological exposure in soils is limited to small areas where erosion has compromised the existing soil cover, and to wildlife species that may burrow or consume food items below the soil cover. Exposure will be mitigated through the addition of clean cover material and vegetation.

The PRGs for contaminants in stream sediments in Jill Creek address potential risks to benthic infaunal communities, and are derived from the more restrictive of probable effects threshold concentrations (PEC) for protection of sediment infauna and wildlife (see Table 8-2). PEC represents the concentration above which adverse effects would be expected to frequently occur.

TABLE 8-2
Stream Sediment PRGs in mg/kg[a]

Contaminant	Probable Effects Concentration/ Cleanup Screening Level
Antimony	3.0 [b]
Arsenic	33.0
Cadmium	4.98
Copper	149
Iron	40,000 [b]
Lead	128
Nickel	48.6
Silver	4.5 [b]
Zinc	459

Notes:
[a] Dry Weight. Source: D.D McDonald; C.G. Ingersoll; T.A. Berger. *Development and Evaluation of Consensus Based Sediment Quality Guidelines for Freshwater Ecosystems.* Arch. Environ. Toxicol. 39, 20-31 (2000)
[b] Upper Effects Thresholds (UETs) from the NOAA SQuiRT tables (Buchman, 2008).

Monitored natural recovery is proposed as the remedial cleanup approach to achieve the stream sediment PRGs. As explained under the RAOs, the quantity of contaminated stream sediment is limited because of previous removal work, removal of sediments will harm the streambed and banks, and sediment quality is expected to improve through natural recovery after remedial actions for the contaminant source (treatment of mine adit discharge into Jill Creek). Progress of the natural recovery will be monitored on an appropriate sampling schedule to judge improvement. The monitoring point will be at the downstream edge of the Bullion Mine claim boundary.

Section 9

9.1 Description of Alternatives

The EPA considered a wide range of remedial alternatives to reduce Site risks and achieve RAOs. The EPA evaluated these alternatives for nine NCP criteria including: overall protection of human health and the environment; compliance with ARARs; long-term effectiveness and permanence; reduction of toxicity, mobility or volume through treatment; short-term effectiveness; technical feasibility; administrative feasibility; availability of services and materials; and cost. Five remedial alternatives were retained for remediating contaminated mine water (ground water). With the exception of the no action alternative, all included a minor common element to address erosion of the soil cover material constructed as part of the 2002 TCRA. Institutional controls in the form of land use restrictions to preserve and protect the remedy will also be an element of each alternative. Ongoing operation, maintenance and monitoring activities would include inspections and documentation to assure remedy protectiveness. The alternatives selected for remedial consideration included:

9.1.1 Limited Action:

- Alternative 1 – No Action

9.1.2 Ground Water Containment:

- Alternative 2 – Mine Plugging

9.1.3 Ground Water Treatment:

- Alternative 3 – Active Treatment (high-density sludge or comparable process)
- Alternative 4 – Semi- Active Treatment (lime precipitation process)
- Alternative 5 – Semi-Passive Treatment (sulfate reducing biochemical reactor)

Brief descriptions of remedial features and approach, estimated cost (net present worth), and common elements of the alternatives considered for the remedy are presented in the following section.

TABLE 9-1
Description of Primary Alternatives

Alternative	Summary of Remedial Alternatives
Alternative 1—No Further Action	This alternative is required by the NCP as the baseline conditions against which the other remedial action alternatives are compared. No additional active remediation work or institutional controls would be implemented at the Site. This applies to all media. Any ongoing long-term biological and surface water monitoring conducted by MBMG, USFS (District 1), the State of Montana, and the USGS is assumed to continue. Because contaminants would remain in place, 5-year Site reviews would need to be completed as required by CERCLA and the NCP. Costs: Capital: N/A 30-year Operations & Maintenance (O&M): $231,000 Total: $231,000
Alternative 2—Mine Plugging	This alternative would consist of a hydraulic plug constructed in competent bedrock within the adit and designed to minimize or prevent the flow of ground water from beyond that point in the mine. The plug would also prevent air from entering the mine through the adit, potentially reducing oxidation and generation of AMD. After sealing the mine adit, the surrounding area would be monitored for new ground water discharge points, significant changes to the ground water levels within the mine, or discharge from other collapsed portals. Costs: Capital: $4,279,000 30-year O&M: $1,241,000 Total: $5,520,000

TABLE 9-1
Description of Primary Alternatives

Alternative	Summary of Remedial Alternatives
Alternative 3—Active Treatment of AMD	Alternative 3 would consist of an onsite, active water treatment process to treat AMD. Alternative 3 would use a high-density sludge (HDS) treatment, which is a standard (and representative) technology for treating AMD. The HDS plant would use a treatment process similar to that described in Section 3 of the FS. Construction of the HDS plant would require a permanent source of electrical power at the Site, resulting in the installation of above-ground transmission lines running to the Site or possibly a solar and/or wind-powered generator. Periodically, the sludge generated by the plant operation would require disposal at the Luttrell Repository. Lime and other additives used during the operation of the HDS plant would need to be shipped to the Site periodically and stored onsite. The plant would require a full-time operator. <u>Costs:</u> Capital: $4,123,000 30-year O&M: $2,818,000 Total: $7,140,000
Alternative 4—Semi-Active Treatment of AMD	Alternative 4 would consist of a semi-active AMD treatment process. The mine would be dewatered, and the portal re-opened and stabilized to allow mine water to flow freely. Contaminated ground water and surface water would be collected downgradient of the mine via the ground water cut-off wall. Adit discharge would be collected by a diversion structure and conveyed into the treatment process. A semi-active treatment process using a quicklime injection system is the proposed treatment method for this alternative. <u>Costs:</u> Capital: $2,545,000 30-year O&M: $1,614,000 Total: $4,358,000
Alternative 5—Semi-Passive Treatment of AMD	Alternative 5 would consist of a three-stage semi-passive system utilizing a pH adjustment cell, a SRBR, and a clarification pond. The proposed treatment system concept uses enhanced biological processes to reduce metal concentrations in the mine water rather than chemicals as described in previous treatment options. The specific treatment process details will be refined through pilot testing with mine water during remedial design. Implementation of this alternative would consist of dewatering the mine and re-opening and stabilizing the portal to allow mine water to flow freely. (The EPA will conduct this activity as part of a removal action prior to remedy implementation.) Contaminated ground water and surface water downgradient of the mine would be collected via a cut-off wall; adit discharge would be collected by a diversion structure, and all contaminated water would be conveyed to the treatment cell. Two parallel treatment trains would be installed to allow for one to be out of service for maintenance or repairs while the other served treatment needs. <u>Costs:</u> Capital: $1,224,000 30-year O&M: $1,122,000 Total: $2,346,000

9.1.4 Common Elements

Several elements are common to all alternatives except the no-action alternative. They include actions to facilitate general Site access and equipment staging such as road improvement and Site preparation. Another element common to all alternatives is the addition of soil cover and vegetation to previously capped areas where erosion has compromised the soil and vegetation cap installed by the 2002 TCRA.

Surface water controls to convey potential source water (in the form of runoff) offsite and away from underground workings is common to all alternatives. Institutional controls that would protect the integrity of the remedy by preventing development, limit access to remedial features, or prevent use of contaminated surface or ground water for potable use is also common to all alternatives.

Containment of mine waters (utilizing mine plugs and piping) is a common element of alternatives 2 through 5. Although the means of treatment vary, common activities include Site construction, application of chemicals for Alternatives 2 and 3, and disposal of sludges and biological media at the local Luttrell Repository.

All alternatives employ some form of monitoring. For instance:

- Alternative 1 – Continued semi-annual monitoring of water quality by the USGS. Reviews every 5 years would also be required because of wastes left onsite that prohibits unlimited use and unrestricted exposure.
- Alternatives 2, 3, 4 and 5 – Monitoring of water levels in the mine, operational conditions (influent and effluent water quality) and functional conditions that represent sustainable treatment conditions. Reviews every 5 years would also be required for these alternatives because of wastes left onsite that prohibit unlimited use and unrestricted exposure. Visual inspections of soil cover areas to promote the integrity of the cover would continue on a 5-year basis.

Common remedial activities shared by the alternatives are presented in Table 9-2.

TABLE 9-2
Common Activities among Remedial Alternatives

Remedial Components	Alternatives				
	1	2	3	4	5
Pre-Remedial Activities:					
Improve access and site roads		O	O	O	O
Construct surface water controls		O	O	O	O
Construct erosion control		O	O	O	O
Offsite Disposal of Wastes:					
Waste disposal in Luttrell Repository		O	O	O	O
Remedial Cover:					
Cover contaminated soils exposed by erosion with amended top soil and revegetate		O	O	O	O
Remedial Containment:					
Construct adit bulkhead to regulate flow		O	O	O	O
Treatment:					
Construct treatment plant or chemical-dispensing facility			O	O	
Construct lined settling ponds			O	O	O
Construct treatment cells				O	O
Monitoring:					
Periodic monitoring of Site (operational, functional, 5-year reviews)	O	O	O	O	O
Institutional Controls:					
Prevent development; use of water; limit access to remedial features	O	O	O	O	O

Notes:
Alt.-1 No Action
Alt.-2 Mine Plugging through Re-opened Adit
Alt.-3 Active Treatment
Alt.-4 Semi-Active Treatment (Quicklime Injection System)
Alt.-5 Semi-Passive Treatment (Sulfate Reducing Biochemical Reactor)

Section 10

10.1 Comparative Analysis of Alternatives

The Superfund law and regulations require that the EPA, in consultation with MDEQ, evaluate and compare the remedial cleanup alternatives based on the nine NCP criteria. These nine criteria are contained in Superfund law, especially section 121 of CERCLA, 42 U.S.C. § 9621, and are promulgated in the NCP at 40 CFR § 300.430(e)(9)(iii).

Any selected remedy must meet the **threshold criteria** of "overall protectiveness of human health and the environment" and "compliance with ARARs or appropriate justification for use of the CERCLA ARAR waivers." Only those alternatives that meet these criteria are considered further by the EPA. The **balancing criteria** of long-term effectiveness and permanence; reduction of toxicity, mobility or volume through treatment; short-term effectiveness; implementability; and cost are used by the EPA to identify and consider major trade-offs among the alternatives. Two of these criteria—long-term effectiveness and permanence, and reduction in toxicity, mobility, or volume through treatment—are emphasized by the NCP and the EPA guidance. The **modifying criteria** represent State and community acceptance. Exhibit 10-1 describes the nine criteria.

EXHIBIT 10-1
The EPA's Remedial Alternative Evaluation Criteria

EPA'S Evaluation Criteria

Threshold Criteria—Must be Addressed

1. Overall protection of human health and the environment—*must be protective of human health and the environment.*
2. Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)—includes state and federal regulations; where ARARs cannot be met, a justification for a waiver is required

Balancing Criteria—Must be Considered

1. Long-term effectiveness and permanence
2. Reduction of toxicity, mobility and volume
3. Short-term effectiveness
4. Implementability
5. Cost

Modifying Criteria—Must be Considered

1. State acceptance
2. Community acceptance

The EPA evaluates these criteria in detail in both the “Detailed Analysis” and the “Comparative Analysis of Alternatives” sections of the feasibility study. The EPA, in consultation with MDEQ, formally evaluated these nine alternatives using the threshold and balancing criteria. Table 10-1 presents the relative ranking of alternatives by each criteria.

TABLE 10-1
Relative Ranking of Alternatives* after Comparison Analysis

Criterion	Alternative 1 – No Action	Alternative 2—Mine Plugging	Alternative 3—Active Treatment	Alternative 4—Semi-Active Treatment	Alternative 5— Semi-Passive Treatment
Threshold Criteria					
Human health and environment	1	2	5	4	4
Compliance with ARARs	-	+	+	+	+
Primary Balancing Criteria					
Long-term effectiveness	1	2	5	4	3
Reduction in toxicity, mobility, volume	1	2	5	4	3
Short-term effectiveness	5	2	3	4	4
Implementability:					
Technical	5	3	4	4	4
Administrative	5	4	3	3	3
Availability of service and materials	5	3	1	4	4
Present worth cost	5	2	1	3	4
Modifying Criteria					
Community Acceptance					Yes*
State Acceptance					Yes*

Notes:
Scale of Score = 1 is low; 5 is high (most favorable)
+ indicates the alternative promotes ARAR compliance in the Basin Watershed
- Indicates no promotion of ARAR compliance
* Only the preferred alternative was evaluated for state and community acceptance
Yellow Indicates preferred alternative

A summary of the comparative analysis of the individual ground water alternatives is provided in the following text.

10.1.1 Threshold Criteria

Overall Protection of Human Health and the Environment

Alternative 1 will leave existing conditions at the Bullion Mine unchanged. This alternative does not address or mitigate the identified baseline risks to human or ecological receptors and is not protective of human health and the environment.

Water treatment alternatives are the most protective of human health and the environment because they reliably reduce metal loading to Jill Creek.

- Alternative 2, which allows untreated ground water to build up behind the plug (potentially creating a large pressure head), will provide only moderate protection of human health and the environment because of the high uncertainty of total containment (the consequences of which may include potential plug failure, uncontrolled seeps forming under influence of the pressure building from water trapped in the mine, or uncontrolled discharge from another adit as the static water level rises within the mine workings).
- Alternative 3 uses a conventional, demonstrated treatment process, which offers the greatest protection to both human health and the environment. This alternative effectively captures and reliably treats the AMD, breaking the human health and ecological exposure pathways. However, constant operator attention and frequent maintenance is required.
- Alternatives 4 and 5 are less protective than Alternative 3 because the treatment processes are subject to more variability caused by limited pond capacities and potential treatment upsets or disruptions (chemical and biological) that would go undetected because of lack of regular operator attention. Although the degree of treatment of the effluent will be acceptable, it will be less efficient and reliable than that of Alternative 3.

Compliance with ARARs

Section 121(d) of CERCLA and the NCP at 40 CFR § 300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites attain legally applicable or relevant and appropriate federal and state requirements, standards, criteria and limitations which are collectively referred to as ARARs, unless ARARs are waived under CERCLA § 121(d)(4). A listing of Site ARARs is presented in Table 10-2. A more comprehensive presentation of ARARs is included as Appendix A to this interim ROD. That appendix contains appropriate definitions and descriptions of terms relevant to the ARAR identification and compliance analysis for this Site.

ARARs are chemical, location or action specific. The remedial compliance implication of each designation is described as follows:

- **Chemical-Specific ARARs –** Chemical-specific requirements address chemical or physical characteristics of compounds or substances on sites. These values establish acceptable amounts or concentrations of chemicals, which may be found in, or discharged to, the ambient environment. This category includes Montana surface water and ground water standards (MDEQ, 2012) and the ability of each alternative to achieve these water quality standards, and sustain compliance with water quality standards.
- **Location-Specific ARARs –** Location-specific requirements are restrictions placed upon the concentrations of hazardous substances or the conduct of cleanup activities because they are in specific locations. Location-specific ARARs relate to the geographical or physical positions of sites, rather than to the nature of contaminants at sites. This category includes Montana’s solid waste and floodplain management standards and ARARs for protected resources.

- **Action-Specific ARARs –** Action specific requirements are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous substances, pollutants or contaminants. A given cleanup activity will trigger an action-specific requirement. Mine reclamation standards that specify requirements for re-establishing remediated areas were examined, along with solid waste and floodplain requirements.
- **Waived ARARs –** Because the EPA is selecting an alternative at the Bullion Mine as an interim measure, the EPA waives compliance with surface and ground water ARARs until all five OUs comprising the Basin Mine Area NPL Site are complete. MDEQ has identified DEQ-7 standards for ground water and chronic aquatic life standards for surface water as ARARs. The EPA will monitor water quality at the Site boundaries and compare those values to the DEQ-7 standards. The final remedial action for the Basin Watershed OU2 will meet all ARARs, including the DEQ-7 standards for ground water and surface water.

All alternatives, with the exception of no action, had common ARARs associated with the treatment of the AMD discharge.

TABLE 10-2
Listing of Site ARARs (Federal and State of Montana)

The following is a list of the federal statutes, regulations, standards or requirements considered for the remedy at OU6 (as outlined in Appendix A):		
National Historic Preservation Act and regulations	Migratory Bird Treaty Act	Resource Conservation and Recovery Act, Subtitle C
Clean Water Act	Bald Eagle Protection Act	
The following is a list of the Montana state statutes, regulations, standards or requirements considered for the remedy at OU6 (as outlined in Appendix A):		
Ground water protection rules	Montana Metal Mining Act	Montana Floodplain and Floodway Management Act and regulations
Montana Water Quality Act and regulations (for example, Circular DEQ-7 numeric water quality standards)	Substantive MPDES permit requirements	Montana Natural Streambed and Land Preservation Act and regulations
Montana Fugitive Dust Emissions	Stormwater Runoff Control requirements	The Montana Hazardous Waste Act and implementing regulations
Montana Strip and Underground Mine Reclamation Act	Noxious Weeds	Montana Solid Waste Requirements
Montana Ambient Air Quality Regulations	Montana Human Skeletal Remains and Burial Site Protection Act	

10.1.2 Primary Balancing Criteria

Long-Term Effectiveness and Permanence

Alternative 1 will leave existing conditions at the Bullion Mine unchanged. This alternative will be least effective compared to the action alternatives in the long-term.

Alternative 3 will offer the greatest long-term effectiveness because of the process control that is available to the trained operator of the plant. Typical removal efficiencies at similar HDS treatment plants at other mine sites are often greater than 99 percent. Operational upsets within the treatment system (identified by system alarms) will reduce the removal efficiencies at times, but could be readily diagnosed and corrected by the operator. Alternative 3 will require the greatest level of operations and maintenance effort to ensure long-term effectiveness and permanence.

Alternative 4 offers the potential for 85 to 95 percent effectiveness of removal of contaminants. Upsets within the system can be diagnosed and corrected by trained operators. However, because of the lower level of O&M required, no telemetry or alarms will be included, and upsets within the treatment system would take longer to discover, diagnose and correct when compared to Alternative 3. Proper operations and maintenance for the treatment ponds and process will contribute significantly to the long-term effectiveness and permanence of this treatment alternative. Alternative 5 offers 75 to 95 percent long-term effectiveness. The greater range in effectiveness results from anaerobic biological processes being less predictable and consistent than chemical precipitation. Upsets within the treatment system may go undetected longer before being identified. Proper operations and timely, long-term maintenance for the treatment ponds/cells and process would contribute significantly to the effectiveness and permanence of this treatment alternative.

The long-term effectiveness of Alternative 2 will potentially range from as low as 25 percent to as high as 90 percent. The large range in effectiveness results from uncertainties associated with the competence of fractured bedrock, geologic conditions, effectiveness of grouting and potential recharge sources within the mine workings. Over time grout and plug material would degrade because of the corrosiveness of the ground water and likely require some form of maintenance approximately every 10 years.

Reduction of Toxicity, Mobility or Volume through Treatment

Water treatment alternatives are the only remedial options that offer a reduction in toxicity, mobility and volume through treatment. Alternatives 3, 4 and 5 will all offer treatment, while Alternatives 1 and 2 do not. However, Alternative 2 will reduce toxicity by inhibiting acid generation through mine flooding. Alternative 2 will also reduce mobility and volume by retaining AMD within the mine workings, assuming the host rock is competent. All treatment alternatives will also reduce the toxicity, mobility and volume of arsenic and other metal contaminants in the AMD. In the treatment process, sludges and wastes are created as a byproduct of all three treatment alternatives and must be properly disposed of in a repository. Alternative 3 will offer the greatest amount of control of sludges by drying the sludges as part of the treatment process. Alternatives 4 and 5 will require physical excavation of sludges prior to their drying for disposal. Alternative 5 has less process control, resulting in the potential for greater mobility of contaminants when compared to Alternative 4. Alternative 4 is rated higher than Alternative 5.

Short-Term Effectiveness

Alternative 1 will have the least short-term impact because no construction would occur.

Alternative 2 is considered to have the greatest short-term impacts of the alternatives because it will require considerable construction work within the mine, increasing potential risk to construction workers. Alternative 2 will also carry impacts from transport and operation of construction equipment, and the transport of debris and muck to the Luttrell Repository. Alternative 3 will require improving the access road to the Site to allow for year-round access. This alternative will carry similar short-term safety concerns as discussed for Alternative 2 because it will also require Site construction with some work within the mine. Construction will probably require two field seasons, but when complete, the treatment process should be fully effective. Alternatives 4 and 5, through construction disturbance, will impose short-term impacts (primarily traffic) on the mine sites and the local populations. However, implementation of these alternatives will carry similar safety concerns as previously described, including the need for two construction seasons. Unlike Alternative 3, when construction is complete, several months may be required before these systems meet their optimal treatment efficiencies.

Implementability

Implementability includes the evaluation of technical and administrative feasibility as well as the local availability of goods and services to successfully implement the chosen alternative.

Technical Feasibility

Alternative 1 will not involve construction, so no technical constraints exist with regard to its implementation.

Alternative 2, 3, 4 and 5 will require specialized services to dewater the mine, re-open the mine portal and construct a safe entry point into the mine. Alternative 2 requires assessment and inspection of the adit for competence, evaluation of seepage and recharge, and strategic placement of a mine plug, which will require special mining expertise and equipment. These activities are technically feasible to execute and the expertise to implement them is available in the local intermountain area.

Technical feasibility constraints associated with Alternative 3 will be the construction and operation of the treatment plant, and providing power to the Site. Technical feasibility challenges associated with Alternatives 4 and 5 are installing the treatment ponds/cells, installation of liners and collection of contaminated ground water. These alternatives are considered equivalent in technical implementability.

Administrative Feasibility

All ground water alternatives will require meeting the substantive requirements of a special use permit for using USFS-maintained access roads, developing topsoil borrow areas and constructing treatment facilities on USFS property. In addition, waste sludges generated by the treatment alternatives will have to be characterized and managed in compliance with State and federal solid waste regulations. Hazardous waste regulations may be relevant and appropriate requirements for any waste sludges generated. Impacts to wetlands will need to be considered and evaluated. Alternatives 3, 4 and 5 will be equivalent and slightly harder to implement than Alternative 1 or 2.

10.1.3 Availability of Services and Materials

Most of the services and materials associated with the implementation of Alternative 2 are available regionally.

Alternative 3 consists of the construction of a water treatment plant, which requires specialized supply and services available regionally. Alternative 3 is ranked lowest of the four action alternatives in availability of services and materials.

Alternatives 4 and 5 require typical construction capabilities available locally and regionally. These alternatives are equivalent and rank above Alternatives 2 and 3.

Cost

Proposed alternative costs for this interim ROD consist of direct and indirect capital costs and long-term (30-year) O&M costs. Direct capital costs pertain to construction, materials, land, transportation and analysis of samples for proposed alternatives. Indirect capital costs pertain to design, legal fees and permits. O&M costs pertain to maintenance and long-term monitoring and are presented as a present worth value. Ranked by cost, the action alternatives, from most to least costly, are Alternative 3 ($7.1 million), Alternative 2 ($5.5 million), Alternative 4 ($4.3 million), and Alternative 5 ($2.3 million). Long-term monitoring costs associated with the Alternative 1 are estimated to be $231,000 over the next 30 years.

10.1.4 Modifying Criteria

Community Acceptance

The Community of Jefferson County and towns of Basin and Boulder, Montana, support the selected remedy, as described in Section 12. No objections were verbally stated by the community during the public meeting, or received in writing during the public comment period.

State Acceptance

This is an Interim ROD to address a significant source of metal and arsenic loading to Jack Creek, a tributary to Basin Creek. The Basin Watershed ROD (OU2) will detail the final determination regarding the need for and extent of any additional remedial actions at OU6, following implementation of the selected interim action. MDEQ supports the objective of reducing the contaminant loading to Jack Creek. MDEQ supports the sequenced implementation of the Bullion Interim ROD as follows: (1) evaluate surface water controls and ground water controls, to the extent feasible, to reduce infiltration into the mine workings; (2) design and construct the AMD treatment system needed to reduce the metal and arsenic loading to Jack Creek to acceptable levels; and (3) the EPA’s commitment to operate and maintain the AMD treatment system in accordance with 40 CFR § 300.435. MDEQ’s determination that a waiver of the State of Montana Circular DEQ-7 numeric water quality standards for ground water and surface water is justified based upon the EPA’s commitment that the final remedy for OU2 will meet all State of Montana Circular DEQ-7 numeric water quality standards for ground water and chronic aquatic surface water standards.

Section 11

11.1 Principal Threat Waste

Principal threat wastes are source materials considered highly toxic or highly mobile that generally cannot be contained in a reliable manner or present a significant risk to human health or the environment should exposure occur. The NCP establishes an expectation that the EPA will use treatment to address principal threats posed by a site wherever practicable (NCP, 40 CFR § 300.430(a)(1)(iii)(A)), but recognizes that treatment is not always possible. A source material is one that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to ground water, surface water, or air, or acts as a source for direct exposure.

Perennial discharge from the lowest adit, characterized by low pH, high arsenic and metals concentrations, is the major principal threat waste at the Bullion Mine. The source of contamination is the interaction of ground water with mineralized ore within the geologic formation exposed by historic mining. The mine adit discharge contributes high concentrations of dissolved aluminum, arsenic, cadmium, copper, iron, lead and zinc to Jill Creek and downstream tributaries. These constituents are highly toxic to aquatic life and this source and pathway present acute and chronic risks to aquatic life in the creek.

Potential sources of soil contamination (former waste rock dumps and tailings impoundment locations) are currently covered with 12 to 18 inches of clean soil and vegetation, placed by the 2001-2002 TCRA. Arsenic in the residual waste material and mixed soils, where exposed by erosion, has been determined to be a non-principal threat to human health at the Site. As discussed in the RI, if this material was not covered and people were to live or recreate with dust-generating four wheelers in areas where they have repeated, daily contact with the mine waste, risks from arsenic could be in the range of concern for both noncancer and cancer (EPA, 2013).

Section 300.430(a)(1)(iii)(A) of the NCP states that principal threat wastes will be addressed with “reliable treatment.” For the contaminated adit discharge flowing into Jill Creek, treatment is required to remediate the quality of the water. The EPA has selected an aggressive remedial alternative to treat this principal threat waste. The selected alternative also addresses areas where the TCRA soil cover has been eroded, exposing residual mine waste and mixed soils. These areas will be mitigated by the application of new, revegetated cover material, and best management practices to sustain a healthy vegetated cover.

Section 12

12.1 Selected Remedy

The EPA's preferred alternative for remedial action at OU6, as presented in the proposed plan, is Alternative 5 (Semi-Passive Treatment of AMD). Based on consideration of the CERCLA requirements, the detailed analysis of viable remedial alternatives, and State and public comments, the EPA has determined that Alternative 5 is the appropriate remedy for OU6.

12.1.1 Short Description of the Selected Remedy

Note: Because the integrity of the debris plug blocking the lower adit portal is uncertain, the EPA will conduct a TCRA removal effort in the 2014 and 2015 field seasons. The removal effort will dewater the mine and re-open the portal to facilitate the free flow of mine water into the existing drainage channel.

- Alternative 5 is a three-stage semi-passive system. Implementation of this alternative will consist of: Contaminated ground water below the mine will be collected via a ground water cut-off wall.
- A secure portal entrance will be constructed to facilitate mine drainage while preventing access into the mine adit by recreationists. If appropriate, and recommended by MDFWP or USFWS experts, the gate structure will facilitate access by certain wildlife, such as bats. Mine adit flow will be collected by a diversion structure within the existing drainage channel.
- The collected water will be conveyed to the PTS.

The three stages of the treatment process are as follows (see *Bullion Mine Focused Feasibility Study* for more detail):

Stage 1 - pH Adjustment Cell. The pH adjustment cell will increase AMD pH to greater than 6.

Stage 2 - Sulfur Reducing Biochemical Reactor. The SRBR will convert sulfate and trace metals in the water into metal sulfides that remain with the media.

Stage 3 - Clarification and Discharge to Jill Creek. The clarification pond follows the SRBR and will allow settling of sludges and organic materials formed in the prior two stages. At the shallow end of the pond, native aquatic vegetation will provide biological filtering.

- Areas of contaminated soil exposed by erosion of the previous cap material will be regraded, amended with topsoil and revegetated.
- **Operation and Maintenance.** Periodic replacement of the pH adjustment cell and SRBR media will be required. Sludge that settles in the deep end of the clarification pond will also require removal and disposal at the Luttrell Repository. If appropriate, sludge removal may include injection into fabric tubes to facilitate dewatering and transport to the repository. Facilities to accommodate this activity will be incorporated into a remedial design (for example, using 20 yard dumpster bags to remove the sludge tubes).
- **ICs to prohibit residential use, prevent installation of drinking water wells and to protect the remedy will be developed**. ICs refer to administrative land management methods necessary to maintain the effectiveness of the remedy and protect human health by preventing exposure to contaminated soil and ground water that creates an unacceptable risk to human health. ICs will be tailored to the size, location and complexity of the area.

- The EPA and MDEQ will work with adjacent landowner agencies (primarily USFS) on the specific application of this remedy.
- Construction and post construction monitoring of water quality and other environmental parameters will be performed.

12.1.2 Rationale for the Selected Remedy

The selected remedy meets the mandatory threshold criteria requirements: protection of human health and the environment and compliance with ARARs, or justification for a waiver of the ARARs. The selected remedy successfully addresses the needs and tradeoffs of the five balancing criteria, reduces environmental risk from remaining contaminants, and promotes the long-term protectiveness of previous removal actions, as well as the current remedial action.

The selected remedy will protect human health by removing AMD contaminants discharging into Jill Creek, preventing consumption of ground water at the Site through an IC, and breaking the pathway to exposed soil contaminants by reconstructing the soil cover in eroded areas.

The selected remedy will protect the environment by reducing the transport and loading of contaminants from the mine into Jill Creek, Jack Creek and Basin Creek. Treatment of the mine water will reduce the contaminants that fish and other aquatic receptors downstream of the mine are exposed to, and will contribute to meeting State water-quality ARARs for the long-term protection of aquatic life. Passive treatment was selected over more conventional treatment because of the remote Site location and difficult, costly access during the winter. It also offered the best balance between cost effectiveness, implementability and protectiveness.

The selected remedy addresses contaminated sediment by reducing the primary source, the untreated mine discharge and ancillary sources of exposed soils. Contaminated sediments will decrease through natural mixing and transport processes of annual runoff and storm flow. The remedy does not include physical removal of sediment. The channel was cleaned and reconstructed as part of the previous TCRA action in 2002. Re-entering and reconstructing the present channel would cause detrimental environmental impacts to a system that will be flushed naturally on an annual basis.

The remedy does not address ground water beyond the discharge of mine water from the adit. The Site is located in an area of highly mineralized rock. Natural interaction between ground water and the mineralized veins in the bedrock occurs, resulting in isolated areas of contaminated ground water. Because this is an interim ROD, it is beyond the scope of this action to address all of the sources of ground water contamination in the watershed. However, the 2014-2015 TCRA and the selected remedy are expected to improve ground water quality at the Site by relieving the pressure head of water that is currently blocked in the mine by a debris plug. The hydrostatic pressure in the mine is forcing water into localized fractures in the bedrock and conveying the water away from the mine, showing up as shallow ground water and springs and seeps in the vicinity of the lower workings. The TCRA will alleviate this condition. The final remedy for the Basin Watershed OU2 will meet ground water and surface water quality standards.

Monitoring, long-term O&M and institutional controls will assure the long-term protectiveness of the selected remedy.

12.1.3 Detailed Description of the Selected Remedy

A detailed description of the selected remedy is presented in this section. Minor changes to the remedy may occur during remedial design and remedial action to adapt the system to its location and optimize its treatment output. Exhibits 12-1 to 12-3 provide a conceptual design of the selected remedial alternative.

Site Access and Mine Dewatering

From the intersection of Jack Creek Road with Basin Creek Road up through the Bullion Mine Site, approximately 3 miles of existing USFS road will be improved as an initial step to facilitate the safe movement of equipment and construction materials to and from the Site.

The EPA Removal Program will de-water the mine and open the lower portal to allow the free flow of water from the mine in 2014 and 2015 to prevent an uncontrolled release of the mine water should the existing debris plug fail. The Removal Program will treat the mine water through an adjustment in pH before its release into the existing mine discharge channel and Jill Creek. Completion of this activity before the remedy will allow an accurate assessment of the flow rate from the mine and contribute to the proper design and sizing of the treatment system.

Source Water Assessment and Control

The source water assessment and control effort will be comprised of a series of steps performed to determine if the flow of ground water into the mine workings (recharge) can be reduced. The specific steps to this process will be determined during RD, and will include the following:

Step 1

- Review existing information and look for additional information on the extent of the mine workings. Identify mine features not observed during the RI that may have a surface expression that would allow water to enter the workings.
- Perform a final Site reconnaissance to locate areas that could act as a conduit for surface water into the mine.
- Investigate and evaluate ground water inflow and contaminant release locations.
- Identify strategic locations for surface water control features to capture and convey snowmelt and rainfall away from areas above the underground workings.

Step 2

- Design seals for mine features identified in Step 1.
- Design water control features for conveyance away from areas above the underground workings and into adjacent drainages to limit ponding and infiltration.

Step 3

- Construct surface and ground water seals and water control and conveyance features.
- Continue to monitor lower adit discharge to gage impact on flow.

Step 4

- Design and construct an appropriate treatment system, using flow rates adjusted after source water control actions have been implemented.

Passive Water Treatment System

Alternative 5 is a three-stage semi-passive system utilizing a pH adjustment cell, a SRBR and a clarification pond. The specific details for this treatment process will be determined during RD. To incorporate desirable sustainability concepts into the design, the treatment process will function by gravity flow, utilize natural treatment chemistry, incorporate low operational and maintenance requirements, and sustain its effectiveness through seasonal changes at this remote Site.

Upon completion of the 2014-2015 TCRA, the mine portal will be stabilized to allow mine water to flow freely, possibly through a pipe or culvert. Contaminated ground water and surface water downgradient of the mine would be collected via the ground water cut-off wall discussed in Section 3.2.1. Adit discharge will be collected by a diversion structure and conveyed to the treatment alternative as discussed in

Section 3.2.1. The collected ground water and surface water from the ground water cut-off wall and the adit discharge diversion structure will also be conveyed to the passive treatment system. Two parallel treatment trains will be installed to allow for one to be out of service for maintenance or repairs while the other served treatment needs. The three stages of the treatment process are as follows (see Exhibits 12-1 through 12-3).

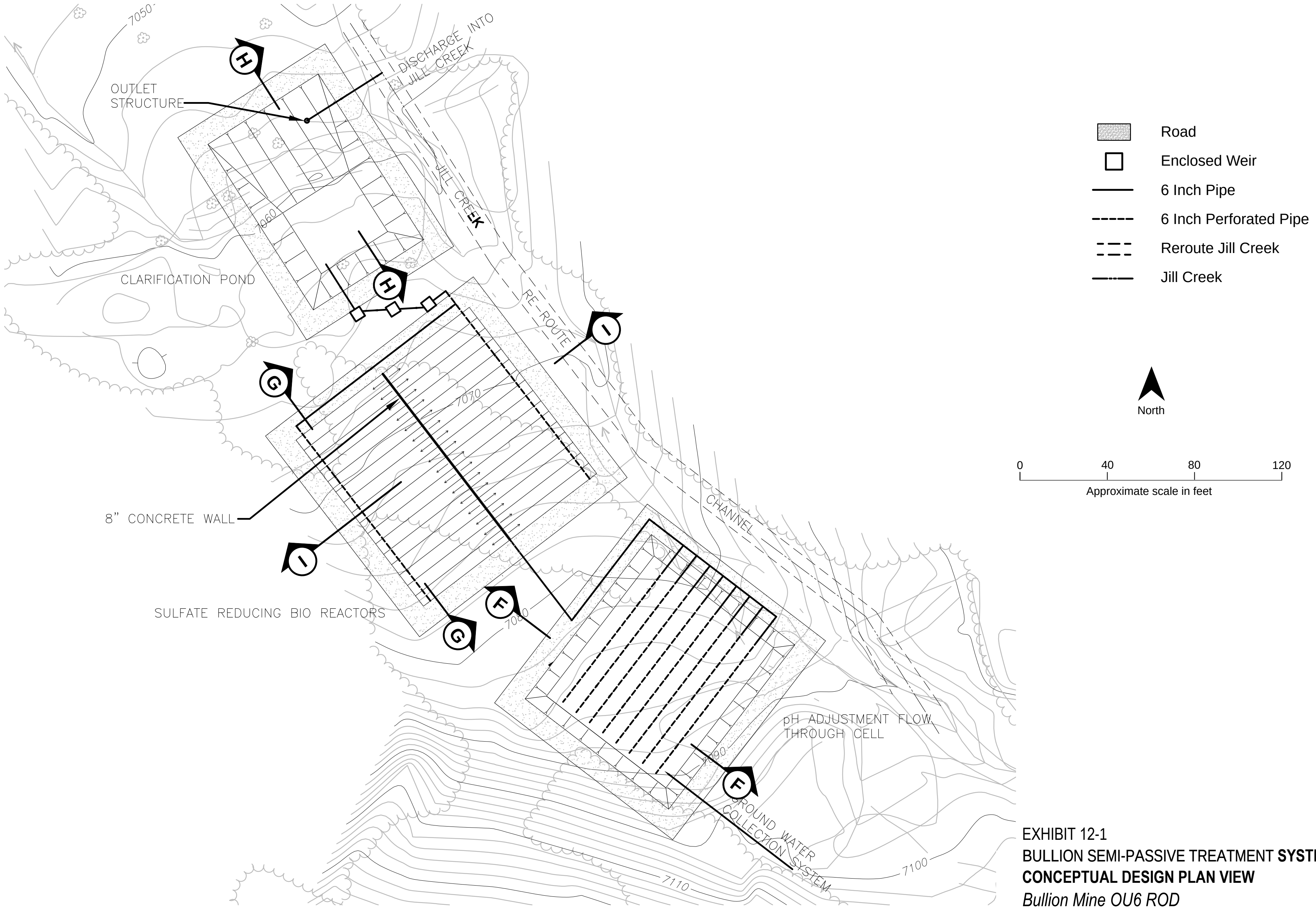
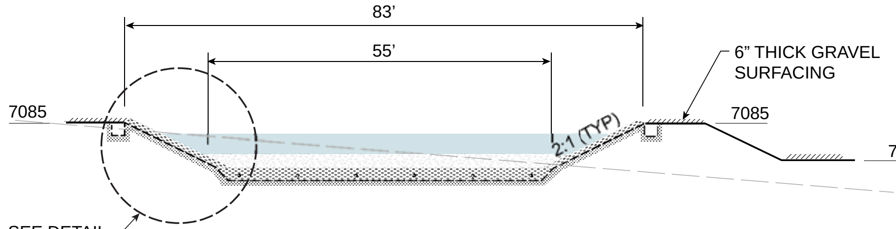
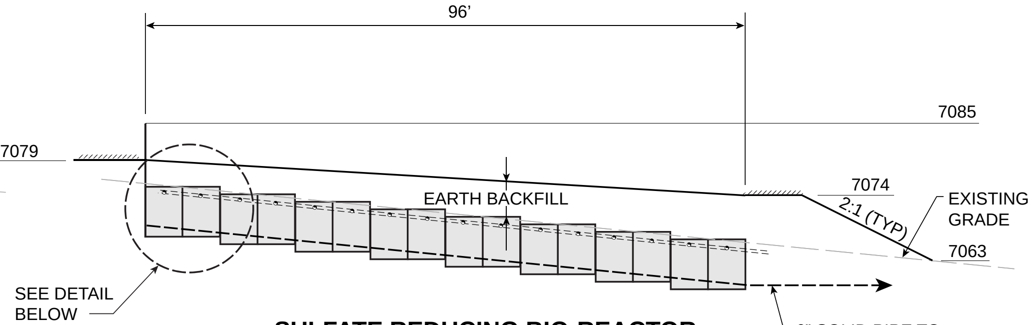


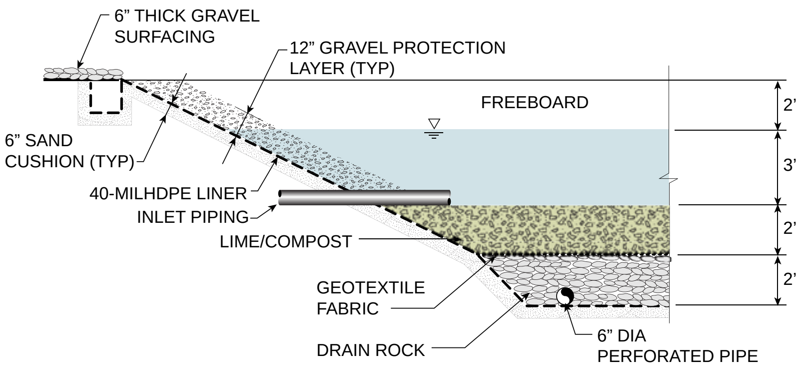
EXHIBIT 12-1
BULLION SEMI-PASSIVE TREATMENT **SYSTEM**
CONCEPTUAL DESIGN PLAN VIEW
Bullion Mine OU6 ROD



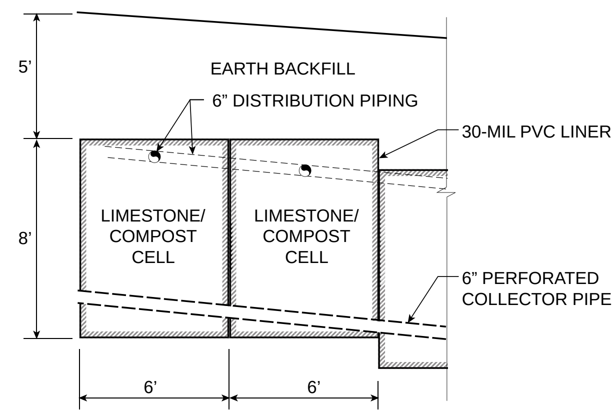
pH ADJUSTMENT POND
SECTION F-F



SULFATE REDUCING BIO-REACTOR
SECTION G-G

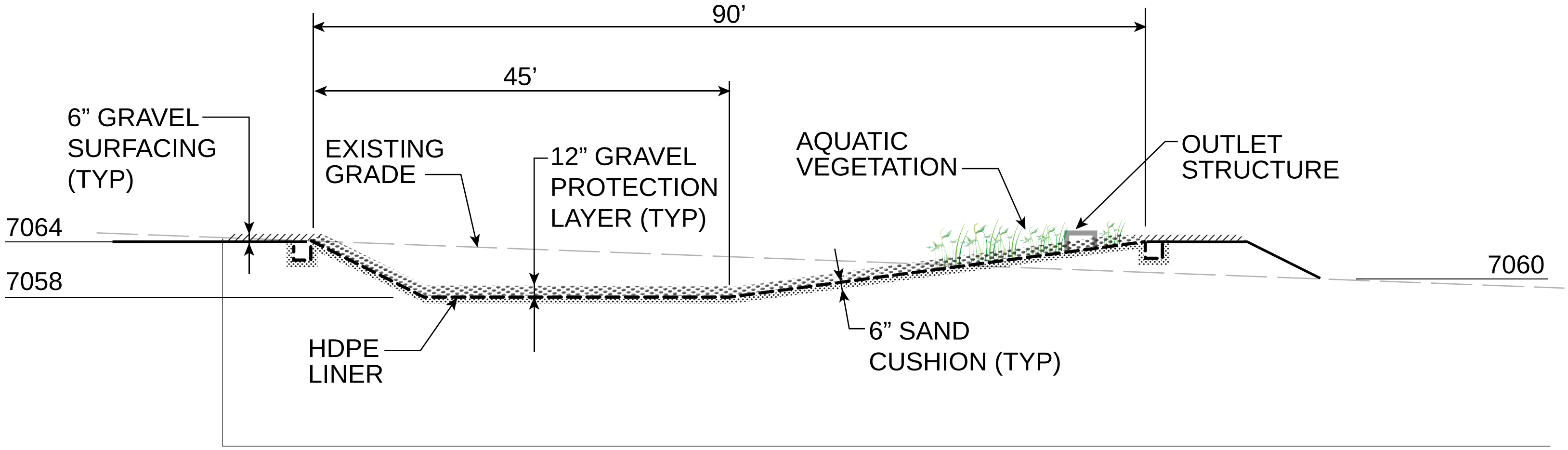


pH ADJUSTMENT POND DETAIL



TYPICAL SRB CELL

EXHIBIT 12-2
BULLION SEMI-PASSIVE TREATMENT **SYSTEM**
CROSS SECTION F-F **AND** SECTION G-G
Bullion Mine OU6 ROD



CLARIFICATION POND SECTION H-H

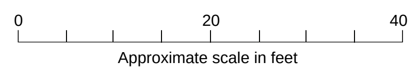


EXHIBIT 12-3
BULLION SEMI-PASSIVE TREATMENT **SYSTEM**
CROSS SECTION H-H
Bullion Mine OU6 ROD

Stage 1 - pH Cell

The pH adjustment cell will consist of three layers and is designed to adjust AMD to a pH greater than 5.

The top layer will be a 3-foot-deep layer of water (mine discharge water) to act as an insulator during the winter. Below the water layer will be a 2-foot-thick layer of a mixture of limestone sand and compost or stable waste, with a mix ratio of approximately 25 percent limestone to 75 percent compost by volume.

The limestone/compost layer will be sized to provide approximately 16 hours retention time. Below the limestone/compost layer will be a 2-foot-thick layer of drain-rock with 6-inch-diameter perforated collector pipes running through the layer. The two layers will be separated by a geotextile fabric that will act as a filter keeping the limestone/compost out of the drain-rock.

The perforated collector pipes will drain into a solid 6-inch-diameter collector pipe, which drains into the SRBR cells. The entire pH adjustment cell will be lined with a high-density polyethylene (HDPE) liner. To break up any scaling of the limestone that may occur, the limestone/compost layer will be rototilled approximately every 2 years and replaced approximately every 6 years. Water from the pH adjustment cell then flows by gravity into the SRBR cells.

Stage 2 - Sulfate Reducing Biochemical Reactor

The SRBR consists of a series of horizontal flow-through cells. Each cell will be comprised of limestone gravel and compost or stable waste. However, unlike the pH adjustment cell, the mix ratio will be approximately 10 percent limestone gravel and 90 percent compost by volume. Each cell will be about 6 feet wide by 8 feet tall and wrapped in an impervious polyvinyl chloride (PVC) liner. The total length of the SRBR cells will provide, at a minimum, 5 days retention time.

Effluent from the pH adjustment cell will be evenly distributed to the SRBR cells at one end of each cell. At the opposite end of each cell, treated effluent will be collected in 6-inch-diameter perforated PVC pipes that drain into a 6-inch solid PVC collector pipe that discharges into a clarification pond.

For insulation purposes, 5 feet of earth backfill will be placed on top of the SRBR cells. The SRBR cells will need to be replaced approximately every 15 years. Between the SRBR cells and the clarification pond, the treated effluent will pass over a series of enclosed weirs or manholes to allow for aeration prior to discharging into the clarification pond. The weirs or manholes will be enclosed to reduce icing during winter.

Stage 3 - Clarification

The clarification pond will allow settling of sludges and organic materials formed in the prior two stages. Effluent from the SRBR cells will be discharged into the 6-foot-deep end of the pond, which offers storage for settling sludges.

Halfway through, the bottom of the pond will gradually rise. At the shallow end of the pond, native aquatic vegetation will provide biological filtering.

Periodically, sludge that settles in the deep end of the clarification pond will be removed and dewatered, with effluent draining into the clarification pond.

The dried waste will be transported to the Luttrell Repository for disposal. If the Luttrell Repository is closed or cannot take sludges from the treatment systems, alternative disposal locations will need to be identified. For the purpose of this ROD, it is assumed that dewatered sludge would go to the Luttrell Repository for disposal.

Table 12-1 shows design parameters for the implementation of Alternative 5.

TABLE 12-1
Alternative 5 Design Parameters

Feature	Bullion Mine
Design flow rate[a]	30 gpm
Ground water collection	One 250-foot ground water cut-off wall and piping, One discharge channel diversion structure and piping
Two pH adjustment ponds[b]	226,000-gallon HDPE lined, 6 feet deep, with additional 2 feet of freeboard
Two SRBR cells	2,800 cubic yards PVC-wrapped cells with 5-foot-thick soil cover for insulation
Two clarification ponds	207,000-gallon HDPE-lined, 6-foot-deep pond

Notes:
[a] See Appendix B of the FS (2013) for determination of design flow rates. (see Sect. 3.3.3 for flow uncertainty)
[b] Size of settling ponds based on available space.

Soil Cover Remediation

Areas of contaminated soil exposed by erosion of the previous cover material will be identified, regraded, amended with imported topsoil and revegetated. Debris or large rock will be strategically placed over the reclaimed areas to discourage ATV use.

Institutional and Engineering Controls

ICs will consist of a combination of legal and administrative controls, access controls (physical controls), and community awareness activities to restrict access and use of contaminated areas and provide awareness of risks from exposure. The ICs will be tailored to the property to provide protection of human health and to maintain the integrity of the remedy to the extent possible.

As described in the preferred remedy, ICs are important, supplementary parts of the selected remedy. Presented here is a general description of the ICs that the EPA sees as necessary for the remedy.

- Educational efforts for recreational users concerning the need to prevent incidental intake or ingestion of surface water in the vicinity of the Site. The EPA plans to work with local and county officials for implementation of this program.
- Prevention of ground water use for domestic consumption or activities that may spread ground water contamination at the operable unit. Several mechanisms could be used to implement this IC including local and county ordinances, or specific deed restrictions or easements on contaminated land.
- Restrictions that protect the remedy and promote the appropriate management of revegetated areas so that recreational use of these areas can occur, while the important revegetation efforts are protected, comply with ARARs and are sustained over time.
- Restrictions that prevent residential or commercial use (for example, deed restrictions), because the soil cleanup level is based upon recreational exposure.
- Fencing (an engineering control) may be needed to discourage public access to the PTS. Access by large wildlife (deer, elk and moose) will also be discouraged by a fence of appropriate size. Vigilance through annual inspections of dikes and berms will be required to prevent damage by small burrowing rodents.
- The EPA and MDEQ will work with adjacent landowner agencies (primarily USFS) on the specific application of this remedy. The agencies will work to ensure that ICs are protective of human health and compatible with existing and reasonably anticipated future land use in the area.

Post Remedy Construction Operation, Monitoring and Maintenance

In order to track and measure progress toward achieving cleanup goals at the Site, a monitoring program that includes physical, chemical and biological components is essential. Therefore, the EPA and MDEQ will develop a Site-wide operation, monitoring and maintenance (OMM) plan (including ongoing operation, maintenance and monitoring requirements for all remedy components) when remedial actions are complete.

Anticipated activities include inspection of the Site remedy, maintenance of surface water channels and trenches, monitoring and maintenance of soil cover and re-vegetated areas to ensure the vegetative cover is adequate to maintain protectiveness and control erosion, and maintenance of engineered structures associated with the PTS.

Operation and maintenance of the PTS will include ongoing water quality monitoring at the discharge point and at the mine claim boundary, system inspection and review, periodic cell maintenance and sludge removal/disposal, and periodic excavation, disposal and replacement of biochemical reactor media. Frequency of maintenance will be refined during remedial design and initial operations. Emphasis will be placed on operation and maintenance considerations of the PTS during design because of the remote, high-elevation location of the system, the difficult access during the winter months, and need to sustain a high level of function throughout the year. Maintenance activities need to be easily executed and cost effective.

12.1.4 Estimated Cost of the Selected Remedy

The costs for the selected remedy (Alternative 5) presented in this section are estimates, with an accuracy expectation of +50 percent to -30 percent. The estimates will be refined as the remedy is designed and implemented. Even after the remedial action is constructed, the total project costs will be reported as an estimate due to the uncertainty associated with the OMM expenditures. Periodic costs are those costs that occur only once every few years or expenditures that occur only once during the entire OMM period or remedial time frame (for example, site closeout, remedy failure/replacement). These costs may be either capital or OMM costs. Because of the duration of the cost evaluation for this interim ROD (30 years), periodic costs were primarily associated with OMM and the 5-year reviews. As an interim ROD, it is believed that a 30-year cost evaluation is justified, since the ROD for the Basin Watershed OU2 will likely occur during this period and re-evaluate the operation and adequacy of the interim passive treatment remedy.
Table 12-2 presents a breakdown of the cost estimate for the selected remedy, including net present value (NPV) analysis on a year-by-year basis (discounted by 5 percent per year).

Those costs are summarized in the following points.

1) The NPV cost for Alternative 5 is approximately $2,346,000. The individual components of this cost are:
    a) Estimated total capital costs: $1,224,000
    b) Estimated total O&M costs (first 30 years): $1,122,000
    c) Estimated construction time: Two field seasons

TABLE 12-2
Breakdown of the Selected Remedy – Alternative 5

Capital Costs					
Description	**Quantity**	**Unit**	**Unit Cost**	**Cost**	**Assumptions**
Mobilization and Demobilization	1	LS	$50,000	$50,000	
Excavation	4,426	CY	$10	$44,260	
Road improvement (Bullion mine Road)	5,300	LF	$20	$106,000	Grade 15 feet wide road; add 6 inches aggregate, compact
Excavate/load clean fill/top soil	6,500	CY	$5	$32,500	Cover 2 acres of disturbance
Haul (fill material/top soil)	6,500	CY	$10	$65,000	From borrow source, estimate 25 miles
Grade fill material	6,500	CY	$11	$71,500	Dozer spread to repair cover
Revegetation of reclaimed areas	2	Acres	$7,000	$14,000	Revegetate/recontour cover
Backfill	4,426	CY	$10	$44,260	
Liner Protection Gravel	550	CY	$30	$16,500	12 inches on top of liner and 6 inches below liner
Drain Rock	380	CY	$40	$15,200	
Limestone Gravel	320	CY	$80	$25,600	Assume supply from limestone quarry near the Site
Limestone Sand	120	CY	$80	$9,600	Assume supply from limestone quarry near the Site
Compost	3,560	CY	$20	$71,200	
Erosion Control Seeding	2	Acres	$2,000	$4,000	
6-inch HDPE Pipe	110	LF	$20	$2,200	
Pipe Intake Grating and Valves	1	LS	$2,500	$2,500	
PVC 6-inch Solid Pipe	670	LF	$15	$10,050	
PVC 6-inch Perforated Pipe	690	LF	$15	$10,350	
HDPE Liner	14,781	SF	$0.5	$7,391	For polishing pond
PVC Liner	56,000	SF	$0.75	$42,000	Wrap individual SRBR cells in PVC liner
Geotextile Fabric	7,296	SF	$0.30	$2,189	
Outlet Structure	1	EA	$5,000	$5,000	
Weir Box	3	EA	$3,000	$9,000	
Adit Discharge Collection	1	LS	$97,000	$97,000	Collect Mine discharge in portal area
Ground Water Cutoff Trench	1	LS	$31,000	$31,000	Downgradient french drain to collect shallow ground water
Subtotal Capital Costs				$788,299	
Contingencies (35 percent)				$275,905	
Engineering and SDC (15 percent)				$159,631	
Subtotal Capital Costs				$1,224,000	
Operations and Maintenance					
Description	**Quantity**	**Unit**	**Unit Cost**	**Cost**	**Assumptions**
Labor (Operators)	100	HR/YR	$50	$5,000	Assume 6 hrs/mo plus 28 hrs/yr for misc O&M
Rototilling of pH Adjustment Cell	1	LS/YR	$250	$250	Assume $500 every 2 years
Periodic Replacement of pH Adjustment Cell	1	LS/YR	$5,500	$5,500	Assume $33,000 to replace media every 6 years
Periodic Replacement of SRBR Beds	1	LS/YR	$13,000	$13,000	Assume $200,000 to reconstruct SRBR cells every 15 years
Miscellaneous Equipment and Supplies	1	LS/YR	$4,500	$4,500	
Sludge disposal	350	CY/YR	$10	$3,500	Disposal of pH adjustment (1/6 per year) and SRBR (1/15 per year) media at Luttrell Repository
Soil Cap Maintenance - Labor	50	HR/YR	$50	$2,500	Assume 3 hrs/mo plus 14 hrs/yr for inspection and misc maintenance
Soil Cap Maintenance – Equip & Supplies	1	LS/YR	$1,500	$1,500	Assume $7,500 for cap improvements every 5 years
5-year Review Process	1	LS/YR	$3,300	$3,300	5-year review costs
Monitoring	1	LS/YR		$19,000	Monthly sampling of streams and processes
Subtotal O & M Costs				$58,050	
Contingencies (35 percent)				$20,318	
Net Present Value of O&M Costs				$1,204,701	Assumes 5 percent discount rate for 30 years
Alternative 5 Total Present Worth Costs				**$2,429,000**	

12.2 Expected Outcomes of the Selected Remedy

Dewatering the mine is expected to eliminate the risk of an uncontrolled release of a large volume of contaminated water into Basin Creek via the Jack and Jill Creek tributaries. Adjusting the pH before discharging this water will temporarily reduce metals loading to the creek. Removing the debris plug in the portal will allow the mine water to flow freely, enable an accurate gaging of the flow rate and contribute to accurate sizing of a PTS.

Completing a source water assessment and control effort is expected to reduce source water infiltrating into the mine workings, reducing the volume of AMD produced by the mine that will be treated in the PTS.

Successful operation of a PTS to control and treat the AMD is expected to reduce the loading of low pH water and metals to Jill Creek. Water quality is expected to improve in Jill Creek, reduce risks to aquatic life, and promote a healthier, more robust aquatic environment and riparian corridor. Water quality improvements will contribute to Jill Creek attaining the State beneficial use designation of B-1. Shallow ground water quality near the lower adit is expected to improve as the hydrostatic pressure in the mine is relieved and recharge in the soil-bedrock interface reverts to annual infiltration of uncontaminated precipitation and snowmelt.

As exposed areas of residual soil contamination are covered and re-vegetated, erosion is expected to decrease, and exposure of terrestrial receptors will be eliminated.

As the mine discharge to Jill Creek is remediated through treatment and the soil and vegetation cover is restored over impacted soils, sediment contamination in Jill Creek is expected to diminish. Spring runoff and summer storms will advance the migration, mixing, and dilution of contaminated sediment. This action will contribute to an improved aquatic environment. The progress of improvement will be tracked by periodic monitoring, the frequency of which will be identified in the OMM plan.

12.3 Performance Standards

This section describes and discusses key performance standards for surface water, soils and sediment applicable to the Bullion Mine interim remedial action only. Performance standards are also presented in Appendix A – the description of ARARs.

Performance standards for soil were derived for arsenic—the only human health risk for recreational users (ATV riders and hikers). The cleanup level for arsenic (296 mg/kg) is based on potential risks (including bioavailability testing) derived for the adolescent recreational user. Potential exposure is limited to small areas where erosion has compromised the original soil cover placed during the removal action in 2002. To limit future exposure to contaminated soil, remedial action will consist of maintenance of the existing clean soil cover by placement of debris or some other method to discourage ATV use, and selective amendment of soils where such cover is inadequate. The proposed recreational cleanup level is based upon the assumption that ICs will be placed on the Site, limiting residential and commercial use.

Performance standards were not developed for terrestrial receptors due to the presence of a vegetated soil cover constructed in 2002. As previously stated, areas of concern created by erosion of cover material will be remediated by reconstruction of the cover with vegetation to prevent exposure to any underlying residual soil contamination.

Table 12-3 presents contaminant concentrations that are expected to be protective of ecological receptors. Protective levels for aquatic receptors exposed to surface water are based on MDEQ water quality and aquatic life standards, Circular DEQ-7 (2012). These concentrations are provided for comparison purposes only. Because this is an interim action, the EPA has waived the surface and ground water quality standards until a final action is taken for the Basin Watershed OU2. The final action for OU2 will meet all ARARs, including DEQ-7 standards for surface water and ground water. However, the EPA expects that the interim action will improve water quality, and monitoring of Site waters will be compared to the concentrations in Table 12-3.

TABLE 12-3
Surface Water Targets in mg/L

Contaminant	Human Health	Acute[b]	Chronic [a]
Aluminum	—	0.75	0.087
Antimony	0.0056	—	—
Arsenic	0.01	0.34	0.15
Cadmium	0.005	0.00052	0.000097
Copper	1.3	0.00379	0.00285
Iron	—	—	1
Lead	0.015	0.013	0.000545
Manganese	—	—-	—
Nickel	0.1	0.145	0.0161
Selenium	0.05	0.02	0.005
Silver	0.1	0.000374 [b]	—
Thallium	0.0002	—	—
Zinc	2	0.037	0.037

Notes:
[a] Circular DEQ-7 (MDEQ, 2012), based on 25 mg/L hardness
[b] Circular DEQ-7 (MDEQ, 2012) acute standard

Cleanup levels were not established for aquatic receptors exposed to sediments because it was determined that sediment contamination would be addressed by reducing the source of sediments (through mine water treatment and soil cover repair) and natural recovery induced by runoff action rather than by a second removal action in the channel. The progression of natural recovery will be monitored at several strategic downstream points along Jill Creek within the Site boundaries. Specific monitoring locations and frequency of monitoring will be determined after remedial construction in the OMM plan.

12.3.1 Performance Evaluations for the Selected Remedy

Following implementation of the selected remedy, the EPA will operate the PTS and demonstrate that the remedy is operational and functional, and protects human health and the environment. As provided in 40 CFR § 300.435(f)(3), "[f]or Fund-financed remedial actions involving treatment or other measures to restore ground- or surface-water quality to a level that assures protection of human health and the environment, the operation of such treatment or other measures for a period of up to 10 years after the remedy becomes operational and functional will be considered part of the remedial action." EPA will develop an OMM plan that will include the following evaluations of the remedy:

- Improvements in surface water quality by comparing pre-treatment baseline values to values at a downstream point near the Site boundary (above confluence with Jack Creek). The EPA's goal for the interim remedy is to achieve a 90 percent or higher reduction in aluminum, antimony, arsenic, cadmium, copper, iron, lead and zinc.
- Reduction of acute and chronic risks to aquatics as measured by benthic macroinvertebrate taxa richness and species diversity counts over a reasonable period. The EPA's goal for the interim remedy is to promote a robust aquatic environment that supports benthic macroinvertebrate taxa richness and species diversity counts equivalent to an appropriate reference stream reach.

- A measure of vegetation attributes of cover, production, species richness and successional trend across the reconstructed soil cover equivalent to an appropriate reference area.
- Reduction in stream sediment metals concentrations for the following particle size classes: 10 mesh (medium to course sand), 80 mesh (very fine to fine sand), and 260 mesh (silt/clay size). Monitoring results will be compared to historic results for the same size classes. Evaluation frequency will be determined after remedial construction.

12.4 Safety Concerns

Conducting a cleanup in a safe manner is a primary concern. Safety will be stressed throughout all aspects of the project. Other sections of the ROD elaborate on why it is necessary to treat the contaminated mine water discharge. The EPA's experience with other sites where treatment of AMD has been performed indicates this project can be conducted safely with careful planning.

A primary consideration at the Site is managing truck traffic safely. This includes planning to safely optimize truck traffic flows on major highways, primary local county roads and secondary access USFS roads onto the Site. The EPA has consulted with construction specialists at the USFS and with the EPA's contractor, and believes that the project can be designed and implemented in a safe manner. Other construction projects, such as road construction and logging operations, commonly pose traffic safety risks and yet are effectively planned and implemented.

The EPA will emphasize project safety in implementation. This particular project will require road improvements and some possible widening. The EPA will strive to minimize public contact with the trucks and heavy equipment, and ensure wide and stable roads where that potential contact may occur. The remedy will retain responsibility for road upgrades and the EPA will work closely with local representatives. The EPA believes the remedy can be safely implemented through good planning and engineering practices.

Section 13

13.1 Statutory Determinations

Under CERCLA section 121 and the NCP, the EPA must select a remedy protective of human health and the environment that complies with or appropriately waives ARARs, is cost effective, and utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that include treatment that permanently and significantly reduces the volume, toxicity or mobility of hazardous substances, pollutants or contaminants as a principal element. The following sections discuss how the selected remedy meets these statutory requirements.

13.1.1 Protection of Human Health and the Environment

The selected remedy described in this ROD protects human health and the environment by reducing human and environmental receptor exposure pathways to Site contaminants through engineering controls, treatment, and institutional controls. The selected remedy will reduce metal concentrations in Jill Creek. A monitoring station on Jill Creek, near the boundary of the Site, will be the evaluation point for surface water quality. Surface water conveyance structures will effectively route runoff (potential recharge source water) away from mine features and underground workings to reduce formation of AMD. Downstream wetlands and associated ecological habitat will be protected.

Restoration and stabilization of the existing remedial soil cover in areas of excessive Site erosion will break exposure pathways to residual soil contaminants for plants, birds, mammals and other organisms. Implementation of the selected remedy will not pose any unacceptable short-term risks or cross-media impacts.

13.1.2 Compliance with ARARs

The ARARs that the selected remedy for this Site must comply with are identified in detail in Appendix A. Key ARAR requirements and other performance standards for the Site are described in section 12.6 of this ROD.

Other criteria, advisories or guidance to be considered during remedial design for this action are also identified in Appendix A.

The EPA has invoked the ARAR waiver of section 121(d)(4) of CERCLA for this Site, for surface water and ground water quality ARARs after treatment. The basis for the waiver of those standards is explained in Appendix A, and described in Section 10.1.2 of this ROD. Appendix A also describes the EPA's recognition that the final surface and ground water quality standards will be met by the Basin Watershed OU2 ROD*.*

13.1.3 Cost Effectiveness

In the EPA's judgment, the selected remedy is cost-effective. In making this determination, the following definition was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." (NCP, 40 CFR § 300.430(f)(1)(ii)(D)). This was accomplished by evaluating the overall effectiveness of the selected remedy and comparing that effectiveness to the overall costs. Overall effectiveness was evaluated by examining how the selected remedy meets three of the balancing criteria in combination—long-term effectiveness and permanence, reduction in toxicity, mobility and volume; and short-term effectiveness. The relationship of the overall effectiveness of the selected remedy was determined to be proportional to its costs.

The remedy provides significant long-term effectiveness and permanence by removing, through passive treatment, the principal threat from Jill Creek, its riparian corridor/floodplain and downstream tributaries. It also provides reductions in mobility and volume by removing the metals from the mine's discharge prior to its confluence with Jill Creek and the associated floodplain. The metals-laden sludge and spent media will be removed from the treatment system and disposed of at the Luttrell Repository on a routine schedule. The remedy provides for assurances that surface water RAOs will be consistently met after remedial construction because it removes, through treatment, the principal threat from the watershed. The remedy does contain some short-term risks (for example, truck and equipment traffic during construction), which lowers its overall protectiveness. However, the EPA will work closely with all stakeholders (USFS, MDEQ, local residents and recreationists) to ensure that these risks are addressed and minimized to the extent practicable.

13.1.4 Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable

This section looks at whether the remedy provides the best balance of trade-offs among the alternative with respect to the balancing criteria set forth in the NCP at 40 CFR § 300.430(f)(1)(i)(B), with an emphasis on long-term effectiveness and permanence and reduction in toxicity, mobility and volume (see NCP, 40 CFR § 300.430(f)(1)(ii)(E)). Modifying criteria were also examined in making this finding. In other words, the finding of practicability for use of permanent solutions and alternative treatment technologies to the maximum extent practicable is determined by looking at the remedy selection criteria and weighing trade-offs among those criteria.

The EPA has determined that the remedy represents the maximum extent to which permanent solutions and alternative treatment technologies can be utilized in a practicable manner at the Site. Of those alternatives that are protective of human health and the environment and comply with ARARs or justify a waiver, the EPA has determined that the remedy provides the best balance of trade-offs in terms of the balancing criteria, while also considering the statutory preference for treatment as a principal element and bias against offsite treatment and considering State and community acceptance. The EPA's balancing of the criteria and consideration of the criteria is explained in Sections 10.2 and 12.2 of this ROD.

A permanent solution is employed in the remedy through implementation of a passive water treatment system with a low maintenance demand compared to other alternatives and necessitated by the Site's remote location. Repair and revegetation of portions of an existing soil cover completes the permanent solution.

13.1.5 Preference for Treatment as a Principal Element

The principal threat waste at the Bullion Mine OU6 – the mine water discharged from the lower adit – is treated as part of the Site's remedy. Metals are removed from the discharge before it enters Jill Creek and disposed of at an existing mine waste repository upstream of the Site and out of the floodplain (Luttrell Repository). This is appropriate because more traditional treatment methods were not found during the FS to be feasible nor cost effective given the remote location of the Site, and the greater maintenance demands they carried.

13.1.6 5-Year Reviews

Because this remedy will result in contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after initiation of the remedial action, and at a minimum every 5 years thereafter, to ensure that the remedy is, or will be, protective of human health and the environment.

Section 14. Documentation of Significant Changes

The proposed plan for the site was released for public comment on March 2, 2014. It identified Alternative 5 as the preferred alternative. That alternative is described herein as the selected remedy. The public comment period ran until April 21, 2014 (30 days beyond the public meeting), and no extension was requested. The EPA received no written comments during that comment period. The EPA's response to comments is typically set forth in Part 3 (Responsiveness Summary). One significant change to the proposed plan was made; the Bullion Mine will be dewatered and the portal re-opened as part of a TCRA to be performed in 2014 and 2015. Mine water (estimated at up to 2.5 million gallons) is trapped behind a natural plug created by the collapse of the portal and associated debris. The pooled water represents a potential threat to receptors should a catastrophic release occur. The mine water was to be treated and removed as part of the remedy under the proposed plan. However, due to the risk of an uncontrolled release from deterioration of the debris forming the plug and contaminated water flowing into Jill Creek, Jack Creek, Basin Creek, and ultimately the Boulder River, the EPA decided early action was needed to treat and remove the water.

Part 3
Responsiveness Summary

The public comment period ended on April 21, 2014. The EPA's response to comments is typically set forth in Part 3 (Responsiveness Summary). However, no formal comments were received during the public comment period. Verbal comments during a public meeting held on March 19, 2014, were supportive of the selected remedy.

Part 4
Acronyms and Abbreviations, and References

Contents

Section **Page**

Part 4 Acronyms and Abbreviations, and References

Acronyms and Abbreviations

°F	degrees Fahrenheit
µg/L	micrograms per liter
Ag	silver
Al	aluminum
AMD	acid mine drainage
amsl	above mean sea level
ARARs	Applicable or Relevant and Appropriate Requirements
ARCS	assessment and remediation of contaminated sediments
ARM	Administrative Rules of Montana
As	arsenic
ATV	all-terrain vehicle
Basin Watershed OU2	Basin Mining Area Watershed Operable Unit 2
BERA	baseline ecological risk assessment
BF	bioavailability adjustment factor
Bgs	below ground surface
BLM	U.S. Bureau of Land Management
BMI	benthic macroinvertebrate
$CaCO_3$	calcium carbonate
CCC	Criterion Continuous Concentration
Cd	cadmium
CDM	CDM Federal Programs Corporation
CEM	conceptual exposure model
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Code of Federal Regulations
Cl	chlorine
CLP	Contract Laboratory Program
CMC	Criteria Maximum Concentration

COC	contaminant (chemical) of concern
COEC	contaminant (chemical) of ecological concern
COPC	contaminant (chemical) of potential concern
COPEC	contaminants (chemical) of potential ecological concern
CSL	conceptual screening level
CSM	conceptual site model
CTE	central tendency exposure
Cu	Copper
CWA	Clean Water Act
EcoSSL	Ecological Soil Screening Levels
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
EPT	mayflies, stoneflies and caddisflies (collectively)
ERA	ecological risk assessment
ESV	ecological screening value
FAA	Federal Aviation Administration
Fe	iron
FS	feasibility study
ft	feet
GI	gastrointestinal
gpm	gallons per minute
GPS	global positioning system
HDPE	high-density polyethylene
HDS	high-density sludge
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
IC	institutional control
IRIS	Integrated Risk Information System
IUR	Inhalation unit risk

IVBA	In Vitro Bioaccessibility
K	potassium
kg	kilograms
LOAEL	lowest observed adverse effect level
Maxim	Maxim Technologies Inc.
MBMG	Montana Bureau of Mines and Geology
MCLs	maximum contaminant levels
MDEQ	Montana Department of Environmental Quality
MDFWP	Montana Department of Fish, Wildlife & Parks
mg	magnesium
m^3/kg	cubic meters per kilogram
mg/m^3	milligrams per cubic meter
mg/kg	milligrams per kilogram
mg/kg-day	milligrams per kilograms-body weight per day
mg/L	milligrams per liter
mm	millimeter
Mn	manganese
MNHP	Montana Natural Heritage Program
Na	sodium
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
Ni	nickel
NOAA	National Oceanic and Atmospheric Administration
NOAEL	no observed adverse effect level
NPL	National Priority List
NPV	net present value
O&M	operation and maintenance
OMM	operation, monitoring, and maintenance
ORP	oxidation reduction potential
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit

PA	preliminary assessment
Pb	lead
PEC	probable effects threshold concentration
PEF	particulate emissions factor
PNEC	predicted no-effect concentration
PRP	potentially responsible party
PTS	passive treatment system
PVC	polyvinyl chloride
RAL	remedial action level
RAO	remedial action objective
RD	remedial design
RfC	reference concentration
RfD	reference dose
RG	remediation goal(s)
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RME	“reasonable maximum” exposure
ROD	Record of Decision
RTI	Renewable Technologies, Inc.
Sb	antimony
Se	selenium
SI	site investigation
SLERA	screening level ecological risk assessment
SMDP	Scientific Management Decision Point
SO_4	sulfate
SQuiRTs	Screening Quick Reference Tables
SRBR	Sulfate Reducing Biochemical Reactor
T&E	threatened and endangered
TCRA	time critical removal action
Tl	thallium
TMDL	total maximum daily load
TRV	toxicity reference value

UCL	upper confidence limit
UETS	upper effects thresholds
USFWS	U.S. Fish and Wildlife Service
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WQC	water quality criteria
XRF	x-ray fluorescence
Zn	zinc

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Appendix A
Applicable or Relevant and Appropriate Requirements (ARARs) – Federal and State Requirements

Summary of Federal and State Applicable or Relevant and Appropriate Requirements (ARARs) Bullion Mine OU6 – Basin Mining Area NPL Site

I. INTRODUCTION

Section 121(d) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. § 9621(d), the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Part 300 (1990), and guidance and policy issued by the U.S. Environmental Protection Agency (EPA) require that remedial actions under CERCLA comply with substantive provisions of applicable or relevant and appropriate standards, requirements, criteria or limitations (ARARs) from State of Montana and federal environmental laws and state facility siting laws during and at the completion of the remedial action. These requirements are threshold standards that any selected remedy must meet, unless an ARAR waiver is granted.

This document identifies ARARs for remedial action to be conducted at the Bullion Mine Operable Unit 6 (OU6), of the Basin Mining Area National Priorities List Site. The following ARARs or groups of related ARARs are each identified by a statutory or regulatory citation, followed by a brief explanation of the ARAR and how and to what extent the ARAR applies to the activities to be conducted under this remedial action. Remedial action is needed to treat acid mine drainage (AMD) and mitigate areas where a soil cap has eroded. Institutional controls will be adopted. These will restrict future access and exposure, and control any earth work or building modifications on the site. Removal and discharge of mine water; diversion, collection, treatment and discharge of ground water and surface water; and management of waste materials will need to be undertaken in compliance with certain ARARs. These ARARs are set forth below.

Substantive provisions of the requirements listed below are identified as ARARs pursuant to 40 CFR § 300.400. No federal, state or local permit shall be required for the portion of any removal or remedial action conducted entirely on site in accordance with section 121(e) of CERCLA.

II. TYPES OF ARARs

ARARs are either applicable or relevant and appropriate. Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria or limitations promulgated under federal environmental or state environmental and facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable.[1]

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not applicable to the hazardous substances, pollutants, contaminants, remedial actions, locations, or other

1 40 CFR § 300.5.

circumstances at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate.[2]

The determination that a requirement is relevant and appropriate is a two-step process: (1) determination if a requirement is relevant and (2) determination if a requirement is appropriate. In general, this involves a comparison of a number of site-specific factors, including an examination of the purpose of the requirement and the purpose of the proposed CERCLA action; the medium and substances regulated by the requirement and the proposed action; the actions or activities regulated by the requirement and the remedial action; and the potential use of resources addressed in the requirement and the remedial action. When the analysis results in a determination that a requirement is both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable.[3]

ARARs are chemical, location or action specific. Chemical specific requirements address chemical or physical characteristics of compounds or substances on sites. These values establish acceptable amounts or concentrations of chemicals that may be found in or discharged to the ambient environment.

Location specific requirements are restrictions placed upon the concentrations of hazardous substances or the conduct of cleanup activities because they are in specific locations. Location specific ARARs relate to the geographical or physical positions of sites, rather than to the nature of contaminants at sites. Action specific requirements are usually technology-based or activity-based requirements or limitations on actions taken with respect to hazardous substances, pollutants or contaminants. A given cleanup activity will trigger an action specific requirement. Such requirements do not themselves determine the cleanup alternative, but define how chosen cleanup methods should be performed.

Many requirements listed as ARARs are promulgated as identical or near identical requirements in both federal and state law, usually pursuant to delegated environmental programs administered by the EPA and the state. The preamble to the NCP provides that such a situation results in citation to the state provision and treatment of the provision as a federal requirement. These final ARARs will be set forth as performance standards for any and all remedial design or remedial action work plans.

Also contained in this list are policies, guidance or other sources of information that are to be considered (TBC) in the implementation of the record of decision (ROD). TBCs are generally used to set protective cleanup levels or otherwise used to make the remedy protective. The TBCs for this action are described in the Feasibility Study (EPA, 2013). These final ARARs will be set forth as performance standards for any and all remedial design or remedial action work plans.

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[2] 40 CFR § 300.5.

[3] CERCLA Compliance with Other Laws Manual, Vol. I, OSWER Directive 9234.1-01, August 8, 1988, p. 1-11.

III. ARARS WAIVER

40 CFR Section 300.430(f)(1)(ii)(C)(*1*) provides:

> (C) An alternative that does not meet an ARAR under federal environmental or state environmental or facility siting laws may be selected under the following circumstances:
>
> (1) The alternative is an interim measure and will become part of a total remedial action that will attain the applicable or relevant and appropriate federal or state requirement;
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The Bullion Mine OU6 cleanup will be an interim remedial action with respect to surface and ground water ARARs. It will not result in final compliance with these ARARs. The EPA is therefore invoking the interim action waiver as provided in 40 CFR § 300.430(f)(1)(ii)(C)(*1*) with respect to all surface water and ground water quality ARARs at OU6. The EPA does expect that surface and ground water ARARs will be attained at the time of the final remedial action for Basin Watershed OU2. The EPA also expects that implementation of the ROD will result in compliance with all other ARARs for the Bullion Mine OU6 remedy.

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Statutes, Regulations, Standards or Requirements	Citations or References[4]	ARAR Determination	Description	Comment	Chemical-Specific	Location-Specific	Action-Specific
Federal ARARs and TBCs							
National Historic Preservation Act (NHPA) National Register of Historic Places Determinations of eligibility for inclusion in the National Register of Historic Places Protection of historic properties Requirements for environmental information documents and third-party agreements for EPA actions subject to NEPA Historic Sites Act of 1935	16 United States Code (U.S.C.). § 470 36 Code of Federal Regulations (CFR) 60 36 CFR § 63 16 U.S.C. § 461, et seq.	**Applicable**	This statute and implementing regulations require federal agencies to take into account the effect of this response action upon any district, site, building, structure, or object that is included in or eligible for the National Register of Historic Places (generally, 50 years old or older	A cultural resource inventory of the site was prepared and submitted to the Montana SHPO. Findings indicated that structures on site had deteriorated and the site did not qualify for the National Register of Historic Places.		✓	
Migratory Bird Treaty Act List of Migratory Birds	16 U.S.C. § 703, et seq. 50 CFR § 10.13	**Relevant and Appropriate**	Makes it unlawful to "hunt, take, capture, kill," or take various other actions adversely affecting a broad range of migratory birds, without the prior approval of the Department of the Interior.	The selected remedial actions will be carried out in a manner to avoid adversely affecting migratory bird species, including individual birds or their nests.		✓	

4 All references are to statutes and regulations on the books in September 2014.

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Statutes, Regulations, Standards or Requirements	Citations or References[4]	ARAR Determination	Description	Comment	Chemical-Specific	Location-Specific	Action-Specific
Bald Eagle Protection Act	16 U.S.C. § 668, et seq.	**Applicable**	This requirement establishes a federal responsibility for protection of bald and golden eagles, and requires continued consultation with the U.S. Fish and Wildlife Service during remedial design and remedial construction to ensure that any cleanup of the site does not unnecessarily adversely affect the bald and golden eagles. Specific mitigative measures may be identified for compliance with this requirement.	If bald or golden eagles are identified within the areas identified for remediation, activities must be designed to conserve the species and their habitat.		✓	
Clean Water Act (dredge and fill requirements)	33 U.S.C. § 404	**Relevant and Appropriate**	Regulates discharge of dredged or fill materials into jurisdictional wetlands or waters of the United States. Substantive requirements of portions of Nationwide Permit No. 38 (General and Specific Conditions) are applicable to the Bullion Mine OU6 site remedial activities conducted within waters of the United States and will be addressed during the remedial design.	A portion of the Bullion Mine site to be remediated is within wetlands located adjacent to Jill Creek. The remedial design will address compliance with section 404 of the Clean Water Act.		✓	

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Statutes, Regulations, Standards or Requirements	Citations or References[4]	ARAR Determination	Description	Comment	Chemical-Specific	Location-Specific	Action-Specific
Federal RCRA Subtitle C Requirements	42 U.S.C. § 6921, et seq. 40 CFR § 261-263, 40 CFR-§ 268 ARM 17.53.6	**Relevant and Appropriate**	RCRA Subtitle C and implementing regulations are designated as applicable for any hazardous wastes that are actively "generated" or that were "placed" or "disposed" after 1980. Montana has an authorized hazardous waste program, please see below.	RCRA Subtitle C requirements will generally not be applicable for those wastes for which the EPA has specifically determined that Subtitle C regulation is not warranted (i.e., wastes covered by the Bevill exclusion). Thus mining contaminated soil is assumed to not be classified as hazardous waste. Subtitle C Generator Requirements would be applicable. Also these regulations may be potentially applicable to any unknown, potentially hazardous wastes encountered during excavation of contaminated soils (e.g., buried drums, etc.).			✓
STATE OF MONTANA ARARS and TBCs							
Ground Water Protection	Administrative Rules of Montana (ARM) 17.30.1005	**Applicable but Waived[3]**	Explains the applicability and basis for the ground water standards in ARM 17.30.1006, which establish the maximum allowable changes in ground water quality and may limit discharges to ground water.	The ROD does address contaminated ground water. The interim remedy will aid in reducing further contamination of ground water.	✓		

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Ground Water Protection (continued)	ARM 17.30.1006	**Applicable but Waived[3]**	Provides that ground water is classified I through IV based on its present and future most beneficial uses and also sets the standards for the different classes of ground water listed in department Circular DEQ-7.[1] Ground water is to be classified according to actual quality or use, whichever places the ground water in the higher class. Class I is the highest quality; class IV the lowest.		✓		
Montana Water Quality Act and Regulations	Montana Code Annotated (MCA) 75-5-101, et seq.	**Applicable but Waived[3]**	The Montana Water Quality Act, MCA Section 75-5-101, et seq., establishes requirements for restoring and maintaining the quality of surface and ground water. 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.	The OU addressed in the ROD does address contaminated ground water and surface water. Due to the proximity of remedial actions to surface waters, measures will be taken to prevent contamination of surface waters.	✓		

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Montana Water Quality Act and Regulations (continued)	ARM 17.30.610	**Applicable but Waived[3]**	Pursuant to this authority and the criteria established by Montana surface water quality regulations, ARM Section 17.30.601, et seq., Montana has established the Water-Use Classification system. Under ARM Section 17.30.610, tributaries to the Missouri River have been classified B-1. Cataract Creek and its tributaries are part of the Boulder River drainage. Pursuant to subsection (vii), “Basin Creek drainage to the Basin water supply intake” is classified A-1.		✓		

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Montana Water Quality Act and Regulations (continued)	ARM 17.30.622	**Applicable but Waived[3]**	Waters classified A-1 are, after conventional treatment for removal of naturally present impurities, suitable for drinking, culinary and food processing purposes. These waters are also suitable for bathing, swimming and recreation, growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers, and use for agricultural and industrial purposes. This section provides also that concentrations of carcinogenic, bioconcentrating, toxic, radioactive, nutrient or harmful parameters may not exceed the applicable standards set forth in department Circular DEQ-7. DEQ-7 provides that “whenever both Aquatic Life Standards and Health Standards exist for the same analyte, the more restrictive of these values will be used as the numeric Surface Water Quality Standard.” For the primary Contaminants of Concern the DEQ-7 standards are listed below. Surface Water in mg/L Aluminum 0.087* Antimony 0.0056 Arsenic 0.01 Cadmium 0.000097* Copper 0.00285*	The DEQ-7 standards are waived during this interim action. However, steps will be taken during remedial design to ensure that the remedy does not violate the other standards. In particular, the remedy must not result in an increase above naturally occurring turbidity or suspended sediment. There is the potential for waters at the site to include B-1 waters. However, the B-1 requirements are less stringent than the A-1 requirements. If A-1 requirements are met, by default, the B-1 requirements are also met.	✓		

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Montana Water Quality Act and Regulations (continued)	ARM 17.30.622	**Applicable but Waived[3]**	Iron 1* Lead 0.000545* Nickel 0.0161* Selenium 0.005* Silver .000374** Thallium .00024 Zinc 0.037* Notes: * Chronic aquatic standard in Circular DEQ-7 (2012), based on 25 mg/L hardness **Circular DEQ-7 (2012) acute standard The A-1 classification standards at ARM § 17.30.622 also include the criteria limiting reduction of dissolved oxygen, variation of hydrogen ion concentration (pH), temperature increases, and color increases. No increase above naturally occurring turbidity or suspended sediment is allowed except as permitted in 75-5-318, MCA, and no increases above naturally occurring concentrations of settleable solids, oils, floating solids, which will or are 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 are allowed.				

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Montana Water Quality Act and Regulations (continued)	ARM 17.30.637	**Applicable but Waived[3]**	Provides that surface waters must be free of substances attributable to industrial practices or other discharges that will: (a) settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines; (b) 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; (c) produce odors, colors or other conditions which create a nuisance or render undesirable tastes to fish flesh or make fish inedible; (d) create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life; (e) create conditions which produce undesirable aquatic life.		✓		
	MCA 75-5-303	**Applicable but Waived[3]**	This provision states that existing uses of state waters and the level of water quality necessary to protect the uses must be maintained and protected.		✓		

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Montana Water Quality Act and Regulations (continued)	MCA 75-5-605	**Applicable but Waived[3]**	This section of the Montana Water Quality Act prohibits the causing of pollution of any state waters. Pollution is defined as contamination or other alteration of physical, chemical or biological properties of state waters that exceeds that permitted by the water quality standards. Also, it is unlawful to place or cause to be placed any wastes where they will cause pollution of any state waters		✓		
	ARM 17.30.705 and 1011	**Applicable but Waived[3]**	Existing and anticipated uses of surface water and ground water quality necessary to support those uses must be maintained and protected unless degradation is allowed under the nondegradation rules at ARM 17.30.708.		✓		
Substantive MPDES Permit Requirements	ARM 17.30.1342-1344	**Applicable**	These set forth the substantive requirements applicable to all MPDES and National Pollutant Discharge Elimination System (NPDES) permits.	Treated discharge into waters of the State of Montana (Jill Creek) is planned as part of the final remedial action. This discharge will be made in consultation with the State of Montana. Measures must be taken to prevent any uncontrolled discharges.[2]			✓

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Substantive MPDES Permit Requirements (continued)	ARM 17.30.1203 and 1344	**Applicable**	Provisions of 40 CFR Part 125 for criteria and standards for the imposition of technology-based treatment requirements are adopted and incorporated in MPDES permits. Although the permit requirement would not apply to on-site discharges, the substantive requirements of Part 125 are applicable, i.e., for toxic and nonconventional pollutants treatment must apply the best available technology economically achievable (BAT); for conventional pollutants, application of the best conventional pollutant control technology (BCT) is required. Where effluent limitations are not specified for the particular industry or industrial category at issue, BCT/BAT technology-based treatment requirements are determined on a case by case basis using best professional judgment (BPJ). See CERCLA Compliance with Other Laws Manual, Vol. I, August 1988, p. 3-4 and 3-7 to 3-8.	The Site is an abandoned, not active mine. The pollutants are not conventional (BOD, fecal coliform, etc.). The EPA's BPJ is a passive treatment system as described in the ROD and in accordance with CERCLA.	✓		✓
Stormwater Runoff Control Requirements	ARM 17.24.633	**Relevant and Appropriate**	All surface drainage from a disturbed area must be treated by the best technology currently available.	These requirements would be applicable to disturbed remedial areas.			✓

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Stormwater Runoff Control Requirements (continued)	ARM 17.30.1341	**Relevant and Appropriate**	DEQ has issued general storm water permits for certain activities. The substantive requirements of the permits are applicable for the following activities: for construction activities General Permit for Storm Water Discharge Associated with Construction Activity, Permit No. MTR100000 (January 1, 2013).	Generally, the permits require best management practices (BMP) and all reasonable steps to minimize or prevent any discharge which has a reasonable likelihood of adversely affecting human health or the environment.			✓
Montana Ambient Air Quality Regulations	ARM 17.8.220	**Applicable**	Settled particulate matter shall not exceed a 30-day average of 10 grams per square meter.	The EPA expects that use of best management practices will result in compliance with these provisions. The EPA does not expect to monitor in connection with any of the substantive requirements listed here.			✓
	ARM 17.8.222		Lead emissions to ambient air shall not exceed a 90-day average of 1.5 micrograms per cubic liter of air.				✓
	ARM 17.8.223		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.				✓
	ARM 17.8.304(2)		Emissions into the outdoor atmosphere shall not exhibit an opacity of 20 percent or greater averaged over 6 consecutive minutes.				✓

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Montana Ambient Air Quality Regulations (continued)	ARM 17.8.308		There shall be no production, handling, transportation, or storage of any material; use of any street, road, or parking lot; or operation of a construction site or demolition project unless reasonable precautions are taken to control emissions of airborne particles. The 20 percent opacity limit described above is also specified for these activities.				✓
	ARM 17.8.604(2)	**Relevant and Appropriate**	Lists material that may not be disposed of by open burning except as approved by the department.				✓
	ARM 17.8.221		Concentrations of particulate matter in ambient air shall not exceed annual average scattering coefficient of particulate matter of 3 x 10-5 per meter.	Some measures identified in this regulation could be considered relevant and appropriate to control fugitive dust emissions in connection with excavation, earth moving and transportation activities conducted as part of the remedy at the site.			✓
Montana Fugitive Dust Emissions	ARM 17.24.761		Specifies measures for controlling fugitive dust emissions during reclamation activities, such as watering, chemically stabilizing, or frequently compacting and scraping roads, promptly removing rock, soil or other dust-forming debris from roads, restricting vehicle speeds, and promptly revegetating regraded lands.				✓

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Montana Strip and Underground Mine Reclamation Act, Section 82-4-201, et seq., MCA	Section 82-4-231, MCA	**Relevant and Appropriate**	Section 82-4-231, MCA Requires operators to reclaim and revegetate affected lands using most modern technology available. Operators must grade, backfill, topsoil, reduce high walls, stabilize subsidence, control water, minimize erosion, subsidence, land slides, and water pollution.				✓
	Section 82-4-233, MCA	**Relevant and Appropriate**	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.				✓
Montana Metal Mining Act, Section 82-4-301, et seq., MCA	Section 82-4-336, MCA.	**Relevant and Appropriate**	Section 82-4-336, MCA. Disturbed areas must be reclaimed to utility and stability comparable to adjacent areas.				✓
	General Backfilling and Grading Requirements, ARM 17.24.501	**Relevant and Appropriate**	General Backfilling and Grading Requirements, ARM 17.24.501. Requires backfill be placed so as to minimize sedimentation, erosion, and leaching of acid or toxic materials into waters, unless otherwise approved. Final grading must be to the approximate original contour of the land				✓
	Monitoring for Settlement, ARM 17.24.519	**Relevant and Appropriate**	Monitoring for Settlement, ARM 17.24.519. Requires monitoring of settling of regraded areas				✓

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Statutes, Regulations, Standards or Requirements	Citations or References[4]	ARAR Determination	Description	Comment	Chemical-Specific	Location-Specific	Action-Specific
Montana Metal Mining Act, Section 82-4-301, et seq., MCA (continued)	General Hydrology Requirements, ARM 17.24.631(1), (2), (3)(a) and (b)	**Relevant and Appropriate**	General Hydrology Requirements, ARM 17.24.631(1), (2), (3)(a) and (b). Requires minimization of disturbances to the prevailing hydrologic balance. Changes in water quality and quantity, in the depth to ground water and in the location of surface water drainage channels should be minimized. 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.				✓

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Montana Metal Mining Act, Section 82-4-301, et seq., MCA (continued)	Reclamation of Drainage Basins, ARM 17.24.63	**Relevant and Appropriate**	Reclamation of Drainage Basins, ARM 17.24.634. Requires disturbed drainages be restored to the approximate pre-disturbance configuration. Drainage design must emphasize channel and floodplain dimensions that approximate the premining configuration and that will blend with the undisturbed drainage above and below the area to be reclaimed. The average stream gradient must be maintained with a concave longitudinal profile. This regulation provides specific requirements for designing the reclaimed drainage to: (1) approximate an appropriate geomorphic habit or characteristic pattern; (2) remain in dynamic equilibrium with the system without the use of artificial structural controls; (3) improve unstable premining conditions; (4) provide for floods and for the long-term stability of the landscape; and (5) establish a premining diversity of aquatic habitats and riparian vegetation.				✓

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Montana Metal Mining Act, Section 82-4-301, et seq., MCA (continued)	Sedimentation Ponds and Other Treatment Facilities, ARM 17.24.639	**Relevant and Appropriate**	Sedimentation Ponds and Other Treatment Facilities, ARM 17.24.639. Sets forth requirements for construction and maintenance of sedimentation ponds, including that sedimentation ponds be located as near as possible to the disturbed area and out of any major stream courses.				✓
	Discharge Structures, ARM 17.24.640	**Relevant and Appropriate**	Discharge Structures, ARM 17.24.640. Requires discharges from sedimentation ponds, permanent and temporary impoundments, and diversions be controlled to reduce erosion, deepening or enlargement of stream channels and to minimize disturbance of the hydrologic balance.				✓
	Acid- and Toxic-Forming Spoils, ARM 17.24.641	**Relevant and Appropriate**	Acid- and Toxic-Forming Spoils, ARM 17.24.641. Requires drainage from acid- and toxic-forming spoil into ground and surface water be avoided and establishes practices to avoid such drainage.				✓
	Ground water, ARM 17.24.643 through 17.24.646	**Relevant and Appropriate**	Ground water, ARM 17.24.643 through 17.24.646. Sets forth provisions for ground water protection, ground water recharge protection, and ground water and surface water monitoring.				✓

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Montana Metal Mining Act, Section 82-4-301, et seq., MCA (continued)	Soil, ARM 17.24.701 and 17.24.702	**Relevant and Appropriate**	Soil, ARM 17.24.701 and 17.24.702. Sets forth requirements for redistributing and stockpiling of soil for reclamation. Also, outlines practices to prevent compaction, slippage, erosion, and deterioration of biological properties of soil.				✓
	Substitute Materials, ARM 17.24.703	**Relevant and Appropriate**	Substitute Materials, 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) is 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 17.24.702.				✓
	Establishment of Vegetation, ARM 17.24.711	**Relevant and Appropriate**	Establishment of Vegetation, ARM 17.24.711. Requires that a diverse, effective, and permanent vegetative cover of the same seasonal variety native to the area of land to be affected shall be established except on road surfaces and below the lowwater line of permanent impoundments.				✓

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Montana Metal Mining Act, Section 82-4-301, et seq., MCA (continued)	Section 82-4-233, MCA	**Relevant and Appropriate**	See also Section 82-4-233, MCA. Vegetative cover is considered of the same seasonal variety if it consists of a mixture of species of equal or superior utility when compared with the natural vegetation during each season of the year. This requirement may not be appropriate where other cover is more suitable for the particular land use or another cover is requested by the landowner.				✓
	Timing of Seeding and Planting, ARM 17.24.713	**Relevant and Appropriate**	Timing of Seeding and Planting, ARM 17.24.713. Requires seeding and planting of disturbed areas to be conducted during the first appropriate period favorable for planting after final seedbed preparation.				✓
	Soil Stabilizing Practices, ARM 17.24.714	**Relevant and Appropriate**	Soil Stabilizing Practices, ARM 17.24.714. Requires mulch or cover crop, or both, be used until adequate permanent cover can be established				✓

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Montana Metal Mining Act, Section 82-4-301, et seq., MCA (continued)	Method of Revegetation, ARM 17.24.716	**Relevant and Appropriate**	Method of Revegetation, ARM 17.24.716. Requires revegetation be carried out in a manner that encourages prompt vegetation establishment, such as by drill or broadcast seeding, by seedling transplants or by establishing sod plugs, and in a manner that avoids the establishment of noxious weeds. Seeding must be done on the contour, whenever possible. Seed mixes should be free of weedy or other undesirable species.				✓
	Planting of Trees and Shrubs, ARM 17.24.717	**Relevant and Appropriate**	Planting of Trees and Shrubs, ARM 17.24.717. Requires the planting of trees and other woody species if necessary, as provided in Section 82-4-233, MCA, to establish a diverse, effective, and permanent vegetative cover of the same seasonal variety native to the affected area and capable of self-regeneration and plant succession at least equal to the natural vegetation of the area. Introduced species may be used in the revegetation process where desirable and necessary to achieve the approved land use plan.				✓

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Montana Metal Mining Act, Section 82-4-301, et seq., MCA (continued)	Soil Amendments, ARM 17.24.718	**Relevant and Appropriate**	Soil Amendments, ARM 17.24.718. Requires soil amendments, irrigation, management, fencing, or other measures, as necessary to establish a diverse and permanent vegetative cover.				✓
	Eradication of Rills and Gullies, ARM 17.24.721	**Relevant and Appropriate**	Eradication of Rills and Gullies, ARM 17.24.721. Specifies that rills or gullies in reclaimed areas must be filled, graded or otherwise stabilized and the area reseeded or 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.				✓
	Monitoring, ARM 17.24.723	**Relevant and Appropriate**	Monitoring, ARM 17.24.723. Requires operators to conduct approved periodic measurements of vegetation, soils, and wildlife, and if data indicate that corrective measures are necessary, propose and implement such measures.				✓

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Montana Metal Mining Act, Section 82-4-301, et seq., MCA (continued)	Revegetation Success Criteria, ARM 17.24.724	**Relevant and Appropriate**	Revegetation Success Criteria, ARM 17.24.724. Specifies that revegetation success must be measured against approved technical standards or unmined reference areas. Reference areas and standards must be representative of vegetation and related site characteristics occurring on lands exhibiting good ecological integrity. Sets forth required management for reference areas.				✓
	Vegetation Measurements, ARM 17.24.726	**Relevant and Appropriate**	Vegetation Measurements, ARM 17.24.726. Requires standard and consistent field and laboratory methods to obtain and evaluate revegetated area data with reference area data and/or technical standards and sets forth the required methods for measuring productivity.				✓
	Analysis for Toxicity, ARM 17.24.731	**Relevant and Appropriate**	Analysis for Toxicity, ARM 17.24.731. If toxicity to plants or animals on the revegetated area or the reference area is suspected due to the effects of the disturbance, comparative chemical analyses may be required.				✓
	Protection and Enhancement of Fish and Wildlife, ARM 17.24.751.	**Relevant and Appropriate**	Protection and Enhancement of Fish and Wildlife, ARM 17.24.751(e) only. Sets forth requirements to protect and enhance fish and wildlife habitat.				✓

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Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered Information (TBCs)
Bullion Mine Site (OU6)

Statutes, Regulations, Standards or Requirements	Citations or References[4]	ARAR Determination	Description	Comment	Chemical-Specific	Location-Specific	Action-Specific
Montana Floodplain and Floodway Management Act and Regulations	MCA 76-5-101, et seq. ARM 36.15.601, et seq.	**Applicable**	Specifies types of uses and structures that are allowed or prohibited in the designated 100-year floodway and floodplain. These regulations prohibit, in both the floodway and the floodplain, solid and hazardous waste disposal and the storage of toxic or hazardous materials. ARM 36.15.602(5), 36.15.605, and 36.15.703 generally provide that obstructions cannot be placed within, nor can certain activities (e.g., solid and hazardous waste disposal and storage of toxic, flammable, hazardous, or explosive materials) take place within, floodplains or floodways. The permitting and variance provisions at ARM 36.15.218(1) allow actions within the floodplain or floodway under certain conditions: (a) the proposed use would not increase flood hazard either upstream or downstream in the area of insurable buildings; (b) refusal of a variance would because of exceptional circumstances cause a unique or undue hardship on the applicant or community involved; (c) the proposed use is adequately flood proofed; and	Mine areas to be remediated are located adjacent to Jill Creek. These standards are applicable to all actions within potential floodplain areas. The remedy may result in structures within a floodplain. The EPA, in consultation with DEQ, will evaluate the factors contained within the variance to determine whether a proposed use within the floodplain is eligible for the variance.		✓	

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Montana Floodplain and Floodway Management Act and Regulations (continued)	MCA 76-5-101, et seq. ARM 36.15.601, et seq.	**Applicable**	(d) reasonable alternative locations outside the designated floodplain are not available.				
Montana Human Skeletal Remains and Burial Site Protection Act	MCA 22-3-801	**Applicable**	The Human Skeletal Remains and Burial Site Protection Act is the result of years of work by Montana Tribes, State agencies and organizations interested in assuring that all graves within the State of Montana are adequately protected. Provides that all graves within the State of Montana are adequately protected. The Human Skeletal Remains and Burial Site Protection Act prohibits purposefully or knowingly disturbing or destroying human skeletal remains or burial sites.	If human skeletal remains or burial site are encountered during remedial activities at the site, then requirements will be applicable.		✓	
Montana Natural Streambed and Land Preservation Act and Regulations	MCA 75-7-101, et seq. ARM 36.2.401, et seq.	**Applicable**	Establishes minimum standards which would be applicable if a response 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.	A portion of the Bullion Mine site interim remedial action area is adjacent to Jill Creek. The remedial actions will not alter or affect a streambed or its banks.		✓	

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Montana Natural Streambed and Land Preservation Act and Regulations (continued)	MCA 87-5-502 and 504	**Applicable**	Provides that a state agency or subdivision shall not construct, modify, operate, maintain or fail to maintain any construction project or hydraulic project which may or will obstruct, damage, diminish, destroy, change, modify, or vary the natural existing shape and form of any stream or its banks or tributaries in a manner that will adversely affect any fish or game habitat.	One of the interim preliminary remedial goals is to prevent or minimize the release of contaminants to surface water. The interim remedial action will not adversely affect the fish or game habitat; it is intended to improve it.		✓	
Montana Solid Waste Requirements	MCA 75-10-212 ARM 17.50.523	**Relevant and Appropriate**	Specifies that solid waste must be transported in such a manner as to prevent its discharge, dumping, spilling or leaking from the transport vehicle.	Solid waste may be periodically transported offsite as part of operations and maintenance of the treatment system.			✓

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Montana Solid Waste Requirements (continued)	ARM 17.50.1403	**Relevant and Appropriate**	Sets forth closure requirements for solid waste facilities. Solid waste facilities must meet the following criteria: (1) install a final 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; and (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.	Minor erosion that occurred on the areas reclaimed during the 2001 TCRA will be repaired.			✓
	ARM 17.50.1404	**Relevant and Appropriate**	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 compliance with the ground water monitoring requirements found at ARM Title 17, chapter 50, subchapter 13.				✓

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Montana Solid Waste Requirements (continued)	MCA 75-10-206	**Relevant and Appropriate**	Allows variances to be granted from solid waste regulations if failure to comply with the rules does not result in a danger to public health or safety or compliance with specific rules would produce hardship without producing benefits to the health and safety of the public that outweigh the hardship				✓
Montana Solid Waste Management Act and regulations	ARM 17.50.1009(1)(c)	**Relevant and Appropriate**	Requires that solid waste facilities not discharge pollutants in excess of state standards. A solid waste facility must contain a leachate collection system unless there is no potential for migration of a constituent in Appendix I or II to 40 CFR 258. The department may, if necessary to protect human health or the environment, impose additional conditions on a facility in or near sensitive hydrogeological environments including, but not limited to, sole-source aquifers, wellhead protection areas, or gravel pits.	Mining wastes were removed from several areas in an earlier TCRA and the areas were reclaimed. As mentioned above, minor erosion of the reclaimed areas will be repaired. The EPA does not anticipate taking any other action to comply with this requirement.			✓
	ARM 17.50.1204	**Relevant and Appropriate**	Solid waste facilities must either be designed to ensure that MCLs are not exceeded or the solid waste facility must contain a composite liner and leachate collection system that complies with specified criteria.	The EPA is waiving compliance with all surface and ground water requirements until completion of the final ROD for OU2			

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Montana Solid Waste Management Act and regulations (continued)	ARM 17.50.1110	**Relevant and Appropriate**	Surface Water Requirements, ARM 17.50.1110. Prohibits any discharge of a pollutant from a solid waste facility to state waters, including wetlands, that violates any requirement of the Montana Water Quality Act. Prohibits any discharge from a solid waste facility of a nonpoint source of pollution to waters of the United States, including wetlands, that violates any requirement of an area-wide or statewide water quality management plan approved under the Federal Clean Water Act.	The EPA is waiving compliance with state surface and ground water requirements until completion of the final ROD for OU2.			
	Floodplains, ARM 17.50.1004; ARM 17.50.1009(1)(h).	**Relevant and Appropriate**	Floodplains, ARM 17.50.1004. A solid waste facility located within the 100-year floodplain may not restrict the flow of the 100-year flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste that poses a hazard to human health or the environment. See also ARM 17.50.1009(1)(h).	The reclaimed areas do not, and will not, restrict any such flow, reduce storage capacity, or result in washout.			
	Wetlands, ARM 17.50.1005.	**Relevant and Appropriate**	Wetlands, ARM 17.50.1005. A solid waste facility may not be located in a wetland, unless there is no demonstrable practicable alternative.				

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Montana Solid Waste Management Act and regulations (continued)	Fault Areas, ARM 17.50.1006.	**Relevant and Appropriate**	Fault Areas, ARM 17.50.1006. A solid waste facility cannot be located within 200 feet (60 meters) of a fault that has had displacement in Holocene time without demonstration that an alternative setback will prevent damage to the structural integrity of the solid waste facility and will be protective of human health and the environment.	EPA will repair areas from which solid waste was removed in the previous TCRA.			
	Seismic Areas, ARM 17.50.1007.	**Relevant and Appropriate**	Seismic Areas, ARM 17.50.1007. A solid waste facility may not be located in a seismic impact zone without demonstration, by a Montana licensed engineer, that the solid waste structure is designed to resist the maximum horizontal acceleration in lithified earth material for the site.				
	Unstable Areas, ARM 17.50.1008.	**Relevant and Appropriate**	Unstable Areas, ARM 17.50.1008. A solid waste facility may not be located in an unstable area (determined by consideration of local soil conditions, local geographic or geomorphologic features, and local artificial features or events, both surface and subsurface) without demonstration, by a Montana licensed engineer, that the solid waste facility is designed to ensure that the integrity of the structural components will not be disrupted.				

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Noxious Weeds	MCA 7-22-2101 (8)(a) ARM 4.5.201, et seq.	**Applicable**	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; or (ii) as a district noxious weed by a board, following public notice of intent and a public hearing.	Applicable requirements for the alternatives which include establishment of seed during restoration.			✓

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The Montana Hazardous Waste Act and implementing regulations.	§§ 75-10-401 et seq., MCA, ARM 17.53.501, et seq.	**Relevant and Appropriate**	This Act and regulations establishes a regulatory structure for the generation, transportation, treatment, storage and disposal of hazardous wastes. These requirements are applicable to substances and actions at the site that involve listed and characteristic hazardous wastes, as well as used oil.	These requirements will generally not be applicable for those wastes for which the EPA has specifically determined that Subtitle C regulation is not warranted (i.e., wastes covered by the Bevill exclusion). Thus mining contaminated soil is assumed not to be classified as hazardous waste. However, sludge from the water treatment system may be hazardous and covered under the Bevill exclusion; the generator, transportation, and disposal requirements would be relevant and required. Also these regulations may be potentially applicable to any unknown, potentially hazardous wastes encountered during excavation of contaminated soils (e.g., buried drums, etc.).	✓		

[1]Montana Department of Environmental Quality, Water Quality Division, Circular DEQ-7, Montana Numeric Water Quality Standards (October 2012).
[2]Montana's MPDES regulations are more stringent than the Federal NPDES regulations
[3]40 CFR § 300.430(f)(1)(ii)(C)(1)

Acronyms

ARAR	Applicable or Relevant and Appropriate Requirements
ARM	Administrative Rules of Montana
BTCA	best technology currently available
CFR	Code of Federal Regulations
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
FAA	Federal Aviation Administration
MCA	Montana Code Annotated
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
OU	operable unit
PRP	potentially responsible party
TBCs	to be considered information
U.S.C.	United States Code
USFWS	United States Fish and Wildlife Services

ARAR Determination Legend

Applicable requirements refer to those cleanup standards, standards of control and other substantive environmental protection requirements, criteria or limitations under Federal or State law that specifically address hazardous substance, pollutant, contaminant, remedial action, location or other circumstances found at a CERCLA site. Only those State standards more stringent than Federal Standards, identified in a timely manner, and applied consistently may be applicable.

Relevant and Appropriate requirements are those cleanup standards, standards of control and other substantive requirements under Federal or State environmental citing laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstances found at a CERCLA site address problems or situations sufficiently similar to those encountered at a CERCLA site that their use is well suited to the particular site. Only those State standards more stringent than Federal Standards, identified in a timely manner, and applied consistently may be applicable.

Regulations that are not considered environmental or facility location standards but are important regulations for remedial alternatives. These are "*To Be Considered*."