# *Engineering Evaluation/Cost Analysis*
# *Block P Mine Complex*
## *Monarch, Montana*

***Prepared for***
***The Doe Run Company***

***March 2010***

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### Table of Contents


1.0 Introduction ..... 1

2.0 Site Characterization ..... 3
- 2.1 Background ..... 3
  - 2.1.1 Site History ..... 3
  - 2.1.2 Physical Setting ..... 3
- 2.2 Previous Investigations ..... 4
  - 2.2.1 Surface and Groundwater ..... 4
  - 2.2.2 Mine Adit Discharges ..... 5
  - 2.2.3 Waste Rock Piles ..... 5

3.0 2008-2009 Field Investigation ..... 6
- 3.1 June 2008 Site Visit ..... 6
- 3.2 Fall 2008 Groundwater Monitoring ..... 7
  - 3.2.1 Rationale for Monitoring Wells ..... 8
  - 3.2.2 Groundwater Elevation Monitoring ..... 9
  - 3.2.3 Groundwater Quality Monitoring ..... 10
  - 3.2.4 Discussion of Groundwater Monitoring Results ..... 10
- 3.3 Fall 2008 Surface Water Monitoring ..... 14
  - 3.3.1 Adit Monitoring ..... 14
  - 3.3.2 Stream Monitoring ..... 14
  - 3.3.3 Discussion of Surface Water Monitoring Results ..... 14
- 3.4 Waste Rock Characterization ..... 15
  - 3.4.1 Chemical Characterization of Waste Rock Piles ..... 15
  - 3.4.2 Geotechnical Characterization of Waste Rock Piles ..... 16
  - 3.4.3 Waste Rock Volume Estimates ..... 16
  - 3.4.4 Discussion of Waste Rock Characterization Data ..... 16
- 3.5 Cultural Resources Inventory ..... 18
- 3.6 Mine Workings Evaluation ..... 18
  - 3.6.1 Grey Eagle Rehabilitation ..... 19
  - 3.6.2 Block P Rehabilitation ..... 19

3.7 Spring 2009 Monitoring Activities ..... 19
3.7.1 Analytical Parameter Selection ..... 19
3.7.2 Mine Workings Evaluation ..... 20
3.7.3 Groundwater Monitoring ..... 20
3.7.4 Stream Monitoring ..... 21
3.7.5 Discussion of Spring 2009 Monitoring Results ..... 21
3.8 Conceptual Mine Discharge Model ..... 22
3.9 Analytical Data Quality Control Review ..... 23
3.9.1 Quality Assurance/Quality Control ..... 23
3.9.2 Sampling Quality Control ..... 24
3.9.3 Laboratory Procedures ..... 24
3.9.4 Discussion ..... 26
3.9.5 Conclusion ..... 27
4.0 Evaluation of Potential Repository Locations ..... 28
4.1 Repository Area 1 ..... 28
4.1.1 Test Excavations and Geotechnical Analysis ..... 28
4.2 Repository Area 2 ..... 29
4.2.1 Test Excavations and Geotechnical Analysis ..... 29
4.2.2 Land Ownership at Area 2 ..... 30
4.3 Repository Efforts in Fall 2009 ..... 30
4.3.1 Repository Area 3 ..... 30
4.3.2 Repository Area 4 ..... 31
5.0 Streamlined Risk Evaluation ..... 32
5.1 Human Health Risk ..... 32
5.1.1 Potential Contaminants of Concern ..... 32
5.1.2 Exposure Assessment ..... 32
5.1.3 Risk Characterization ..... 33
5.2 Ecological Risk ..... 33
5.2.1 Contaminants of Concern ..... 33
5.2.2 Exposure Assessment ..... 33
5.2.3 Risk Characterization ..... 34
6.0 Identification of Removal Action Objectives ..... 35
6.1 Determination of Removal Action Scope ..... 35
6.2 Determination of Removal Schedule ..... 36
7.0 Description of Removal Action Alternatives ..... 37
7.1 Mine Wastes ..... 38
7.1.1 Alternative 1 – No Action ..... 38
7.1.2 Alternative 2 – Consolidate waste rock into Area 2 ..... 38
7.1.3 Alternative 3 – Consolidate waste rock into Area 3 ..... 39

7.1.4 Alternative 4 – Excavate for Offsite Repository ..... 40
7.2 Mine Drainage ..... 41
8.0 Analysis and Comparison of Removal Action Alternatives ..... 42
8.1 Alternative 1 – No Action ..... 42
8.2 Alternative 2 – Consolidate Waste Rock into Area 2 ..... 42
8.2.1 Overall Protection of Human Health and the Environment ..... 42
8.2.2 Compliance with ARARs ..... 43
8.2.3 Long-Term Effectiveness ..... 45
8.2.4 Reduction in Toxicity, Mobility, or Volume through Treatment ..... 45
8.2.5 Short-Term Effectiveness ..... 45
8.2.6 Implementability ..... 45
8.2.7 Cost Screening ..... 46
8.2.8 Summary ..... 46
8.3 Alternative 3 – Consolidate Waste Rock into Area 3 ..... 46
8.3.1 Overall Protection of Human Health and the Environment ..... 46
8.3.2 Compliance with ARARs ..... 46
8.3.3 Long-Term Effectiveness ..... 48
8.3.4 Reduction in Toxicity, Mobility, or Volume through Treatment ..... 49
8.3.5 Short-Term Effectiveness ..... 49
8.3.6 Implementability ..... 49
8.3.7 Cost Screening ..... 49
8.3.8 Summary ..... 50
8.4 Alternative 4 – Excavation for Offsite Repository ..... 50
References ..... 51

## List of Tables

Table 1 Adit Water Quality Data
Table 2 Groundwater Elevation Data
Table 3 Groundwater Water Quality Data
Table 4 Stream Water Quality Data
Table 5 Field Parameters
Table 6 Rock Quality Designation Table
Table 7 Waste Rock Sampling Results
Table 8 Waste Rock Volume Estimates
Table 9 Quality Assurance/Quality Control Table – Masked Duplicates
Table 10 Quality Assurance/Quality Control Table – Field and Lab Blanks
Table 11 Summary of Removal Action Cost Estimates

## List of Figures


Figure 1 Site Location Map

Figure 2 General Site Layout

Figure 3 Potential Mine Inflow Locations

Figure 4 Groundwater and Surface Water Monitoring Locations

Figure 5a Bedrock Groundwater Contour Map – September 21, 2008

Figure 5b Bedrock Groundwater Contour Map – November 13, 2008

Figure 5c Bedrock Groundwater Contour Map – June 2-5, 2009

Figure 6 Cross Section Locations – Block P Waste Rock Pile

Figure 7 Cross Section A – Block P Waste Rock Pile

Figure 8 Cross Section B – Block P Waste Rock Pile

Figure 9 Cross Section C – Block P Waste Rock Pile

Figure 10 Cross Section D – Block P Waste Rock Pile

Figure 11 Cross Section E – Block P Waste Rock Pile

Figure 12 Cross Section F – Block P Waste Rock Pile

Figure 13 Cross Section G – Block P Waste Rock Pile

Figure 14 Geotechnical Sampling Locations

Figure 15 Waste Rock Volume and Area Estimates

Figure 16 Block P Waste Rock Pile Volume Estimate

Figure 17 Potential Repository Locations

Figure 18 Conceptual Repository in Area 2 (Plan)

Figure 19 Conceptual Repository in Area 2 (Sections)

Figure 20 Conceptual Repository in Area 3 (Plan)

Figure 21 Conceptual Repository in Area 3 (Sections)

Figure 22 Conceptual Belt Creek Valley Repository (Plan)

Figure 23 Conceptual Belt Creek Valley Repository (Sections)

## List of Appendices


| | |
|---|---|
| Appendix A | June 2008 Site Visit Photographs |
| Appendix B | Monitoring Well Logs |
| Appendix C | Laboratory Reports (on CD only) |
| Appendix D | Ternary Diagrams (on CD only) |
| Appendix E | Land Ownership Information (on CD only) |
| Appendix F | Cultural Resources Inventory and Assessment (on CD only) |
| Appendix G | Atlas-Fausett Mine Rehabilitation Log |
| Appendix H | Applicable or Relevant and Appropriate Requirements |
| Appendix I | Block P Mine Complex Historical Cross Section |
| Appendix J | Removal Action Cost Analyses |

# 1.0 Introduction

This Engineering Evaluation/Cost Analysis (EE/CA) addresses the requirements of an Administrative Order on Consent (AOC) between The Doe Run Resources Company (Doe Run) and the United States Environmental Protection Agency (USEPA) issued for the Block P Mine Complex (the Site). Previous submittals required by the AOC included a Field Sampling and Analysis Plan (Barr, 2008b), a Work Plan (Barr, 2008c), a Project Health and Safety Plan (Barr, 2008d), and a Quality Assurance Project Plan (Barr, 2008e).

USEPA has determined that a non-time critical removal action is required for the Site because the waste rock and acid mine drainage discharged at the Site contain contaminants that present a threat of potential or actual exposure to nearby human population and ecological receptors.

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the National Contingency Plan (NCP) define removal actions to include "the cleanup or removal of released hazardous substances from the environment, such actions as may necessarily be taken in the event of the threat of release of hazardous substances into the environment, such actions as may be necessary to monitor, assess, and evaluate the release or threat of release of hazardous substances, the disposal of removed material, or the taking of such other actions as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare or to the environment, which may otherwise result from a release or threat of release." USEPA has categorized removal actions in three ways: emergency, time-critical, and non-time critical, based on the type of situation, the urgency and threat of the release or potential release, and the subsequent time frame in which the action must be initiated. Emergency and time-critical removal actions respond to releases requiring action within six months; non-time critical removal actions respond to releases requiring action that can start later than six months after the determination that a response is necessary (USEPA, 1993).

An EE/CA must be completed for all non-time critical removal actions under CERCLA as required by section 300.415(b)(4)(I) of the NCP. The goals of an EE/CA are to identify the objectives of the removal action, to analyze the effectiveness, implementability, and cost of various alternatives that may satisfy these objectives, and to recommend a removal action alternative (USEPA, 1993).

The purpose of this EE/CA is to present the results of the investigation activities conducted at the Site and evaluate non-time critical removal action alternatives developed from those presented in the AOC. This report is organized into eight sections:

- Section 1 – Introduction. This section provides the basis for the work and outlines the remaining sections of the EE/CA.

- Section 2 – Site Characterization. This section summarizes information regarding the site location and history as well as defining the nature and extent of contamination at the site.

- Section 3 – Summary of 2008-2009 Field Investigations. This section presents the data collected during the implementation of activities presented in the FSAP and Work Plan.

- Section 4 – Evaluation of Potential Repository Locations. This section describes the efforts made to identify and evaluate potential locations for a waste rock repository.

- Section 5 – Streamlined Risk Evaluation. This section summarizes the streamlined risk evaluation to human health and ecological receptors based on site-specific contaminants and existing conditions.

- Section 6 – Identification of Removal Action Objectives. This section outlines the removal action scope, schedule, and cleanup goals based on the Applicable or Relevant and Appropriate Requirements (ARARs).

- Section 7 – Description of Removal Action Alternatives. This section outlines the potential alternatives for the Block P Mine Complex and presents data limitations for evaluation of potential alternatives.

- Section 8 – Analysis and Comparison of Removal Action Alternatives. This section looks at the performance of potential removal action alternatives based on the identified criteria of effectiveness, implementability, and cost.

# 2.0 Site Characterization

## 2.1 Background

The Block P Mine Complex (the Site) is located on the border of Judith Basin County and Cascade County approximately 40 miles southeast of Great Falls, Montana (see Figure 1). The Site is located approximately 1.5 miles north of the Block P Mill Tailings Site within the Galena Creek watershed. It encompasses several discrete waste rock piles and their associated mine workings (see Figure 2).

### 2.1.1 Site History

Mining activities in the project area date back to 1879, when the first discovery of silver and lead ores was made. Near-surface ores were depleted by 1883 and mining activities in the area were minimal for the rest of the 19$^{th}$ century and for the first two decades of the 20$^{th}$ century (Chen-Northern, 1991). In 1927, the Block P properties were purchased by the St. Joseph Lead Company (whose successor is Doe Run). The onset of the Great Depression forced the mine to close operations in 1930. The mine was briefly operated from 1941 to 1943, but closed once again at the order of the War Production Board. The waste rock piles, abandoned mine workings, and historical buildings present at the Site are remnants of these historical mining operations.

### 2.1.2 Physical Setting

The Site is located within the Little Belt Mountains, and elevations range from approximately 5,500 ft. MSL to more than 6,000 ft. MSL. Galena Creek originates upstream of the project area and flows from north to south through the Site. In general, the mining features attributable to the Block P Mine Complex are located west of Galena Creek. In addition to the mining features that are included in this EE/CA (described below), there are numerous other historical mining properties and features present within the Galena Creek watershed. These other mining properties and features have been the focus of recent investigations by both state and federal agencies (Pioneer, 2007 and CDM, 2005).

The Barker/Block P (Block P) Mine is located along the western side of the upper end of Galena Creek. It consists of a large waste rock pile, mining-era buildings, and an uncontrolled mine adit that periodically discharges to Galena Creek. The waste rock pile has previously been estimated to contain between 185,000 – 250,000 cubic yards (Chen-Northern, 1991).

The Grey Eagle Mine is located on the east side of Galena Creek, across the valley from the Barker mine adit. Depending on factors such as the time of year and overall precipitation patterns in the

watershed, acid mine drainage from the Grey Eagle mine either discharges to Galena Creek via a shallow swale or infiltrates into the ground at the mouth of the adit before reaching the creek.

The Edwards Mine consists of two discrete waste rock piles located in the drainage of an intermittent stream that flows to Silver Creek (a western tributary to Galena Creek). The volume of the Edwards waste rock piles has previously been estimated to be 50,000 cubic yards. The Edwards Mine is located upslope to the west of the Block P Mine. An open adit has been observed at the Edwards Mine, but there has been no evidence that water discharges from this location.

The Wright Mine consists of four discrete waste rock piles located upslope of the Edwards Mine near the ridge that forms the western boundary of the Galena Creek valley. The total volume of these four waste rock piles has been previously estimated to be approximately 20,000 cubic yards. It is assumed that a collapsed adit is associated with each waste rock pile.

The Belt Patent Mine is located along the eastern bank of Galena Creek approximately 400 feet downstream of the Grey Eagle adit. Previous investigations have estimated that there are approximately 800 cubic yards of waste rock and tailings-like materials at this location. A collapsed adit is reportedly also associated with the Belt Patent Mine.

## 2.2 Previous Investigations

The following paragraphs provide a brief summary of previous environmental investigations conducted in the Galena Creek watershed.

### 2.2.1 Surface and Groundwater

The Montana Department of Natural Resources and Conservation (DNRC) conducted several streamflow and water quality studies in Galena Creek between 1973 and 1977. The 1977 DNRC report contained recommendations for isolating Galena Creek from the Block P (Barker) Mine dump at the upper end of the Galena Creek Valley (Montana DNRC, 1977).

Groundwater and surface water monitoring conducted in the Galena Creek watershed between 1998 and 2001 was summarized in the final EE/CA prepared for the Block P Mill Tailing Site (Barr, 1998; Barr, 2001). Implementation of June 2001 EE/CA occurred from 2004 to 2006. Annual monitoring has been conducted for the Block P Mill Tailings Site since that time. The results of the Block P Mill Tailings Site annual monitoring are summarized in annual monitoring reports prepared by Barr on behalf of Doe Run and submitted separately to the U.S. Department of Agriculture – Forest Service (USDA-FS) (Barr, 2007; Barr, 2008a; Barr, 2009).

### 2.2.2 Mine Adit Discharges

Samples of water discharging from both the Block P and Grey Eagle adits have been collected for laboratory analyses on multiple occasions since 1996. Adit samples have traditionally been analyzed for alkalinity, hardness, sulfate, total metals, and dissolved metals. Automated flow monitoring was conducted at the Block P and Grey Eagle adits during a portion of the year 2000. The mean flow rates recorded for the Grey Eagle and Block P adits that year were 20 gallons per minute (gpm) and 7.2 gpm, respectively, but significant seasonal variation and periods of no-flow have also been observed for both adits. The maximum flows recorded for the Grey Eagle and Block P adits in 2000 were 467 and 292 gpm, respectively (Barr, 2001).

### 2.2.3 Waste Rock Piles

Waste rock samples from the Wright Mine waste piles, Edwards Mine waste piles, Belt Patent mine waste pile, and several un-named waste piles were collected in 1999. The samples were analyzed for acid-base accounting (ABA) parameters, metals, and pH. At least one sample was collected from each discreet identified waste pile. The samples indicated waste rock with a low pH (varying between 2.4 to 4.6 standard units), elevated metals concentrations, and an elevated acid generating potential. The results of this sampling effort were previously submitted to MDEQ and USDA-FS.

# 3.0 2008-2009 Field Investigation

Initial field investigation activities in support of the Block P Mine Complex EE/CA were conducted between June and December 2008. Work conducted in 2008 included the following tasks:

- Installation of monitoring wells,
- Collection and analysis of groundwater, surface water, and mine discharge samples,
- Collection and analysis of waste rock samples,
- Evaluation of potential mine inflows,
- Evaluation of potential repository locations,
- Completion of test excavations of the Upper Repository area,
- Preparation of a cultural resource inventory and assessment for the project area,
- Topographical survey of the Block P waste rock pile and Upper Repository area, and
- Partial rehabilitation of the Block P and Grey Eagle mine workings.

Based upon the field and analytical data generated by this initial effort, it was determined that additional data were needed to more fully evaluate the proposed removal action alternatives. This supplemental work, conducted between March and August 2009, included additional adit flow gaging and sampling, additional waste rock characterization, and additional field reconnaissance of potential repository locations.

The following paragraphs summarize the field work completed at the Site and discuss the data collected in terms of their implications on evaluation of removal action alternatives.

## 3.1 June 2008 Site Visit

Doe Run, USEPA, MDEQ, and Barr staff met at the Block P Mine Complex the week of June 16, 2008. The primary objective of this site visit was to develop a common understanding of the current status of the Site via visual inspection of the waste rock piles, adits, and other features associated with the Block P, Wright, Edwards, Belt Patent, and Grey Eagle mines. Specific effort was also

made to “ground truth” locations of potential inflows to the Block P, Wright, and Edwards mine workings that had been identified from review of aerial photographs and information regarding the historical operation of the mines.

The Block P and Grey Eagle adits were flowing during the June 2008 site visit and were therefore sampled. An unnamed adit located within the Edwards Mine area that had not previously been sampled was also flowing and was therefore sampled. Adit sampling locations are shown on Figure 3. Mine discharge samples were analyzed for total and dissolved metals and sulfate. General chemistry parameters including pH, conductivity, dissolved oxygen, temperature, and redox potential were measured in the field. An estimate of flow rate was made at the time of sampling.

These adit samples are called Adit-BB-1, Adit-GE-1, and Adit-Unk-01, respectively. Analytical data for the adit water quality is presented in Table 1. Field data for adit water is I Table 5. Photographs taken as part of the June 2008 site visit are shown in Appendix A.

Several locations of potential inflow of surface water to mine workings have been identified (Figure 3). The topography near the top of the Block P shaft encourages surface drainage to flow towards the open shaft and enter the mine workings. The unknown location of the collapsed Wright/Edwards shaft is another potential inflow location and multiple smaller depressions that may represent collapse features have been identified on the mountainside above the mines. These locations are potential contributors to mine workings water; however, due to their location further up the mountain it is assumed that the area of drainage for these locations is much smaller than the potential drainage to the Block P shaft and potentially to the Wright/Edwards shaft.

During the June 2008 site visit, a series of seeps were observed at the toe of the Block P waste rock pile where it is in contact with Galena Creek. These seeps were generally observed at or slightly above the creek elevation. In all cases, there was an insufficient volume of water to quantify a flow rate for the seep or collect a water sample for laboratory analysis, but it is assumed that these seeps, when taken in aggregate, may be seasonally significant contributors to contaminant loading to Galena Creek.

## 3.2 Fall 2008 Groundwater Monitoring

A total of 11 new monitoring wells were installed in the vicinity of the Block P waste rock pile in September 2008 by Boland Drilling of Great Falls, Montana. These wells expanded the existing monitoring well network in the Block P Mine Complex, which had previously consisted of

monitoring wells HMW-05, HMW-06, and HMW-08. The locations of both the existing and new monitoring wells are shown on Figure 3.

### 3.2.1 Rationale for Monitoring Wells

Monitoring wells were installed at the locations shown on Figure 4 for one or more of the following purposes:

- To evaluate groundwater flow through the Block P waste rock pile via infiltration, advecting groundwater, or adit discharge;
- To evaluate groundwater quality within the unconsolidated alluvium both upgradient and downgradient of the Block P waste rock pile; or
- To evaluate groundwater quality within the bedrock near the Block P Mine Complex.

Wells were nested at selected locations to enable simultaneous evaluation of groundwater conditions within both the unconsolidated overburden and the underlying bedrock. The rationale for the installation of each new monitoring well is provided below:

- MW-14 was installed adjacent to existing monitoring well HMW-08 to evaluate groundwater conditions within the unconsolidated unit and to act as a nested pair with HMW-08 (HMW-08 is screened within bedrock).
- MW-15 was installed north of the Block P waste rock pile to evaluate groundwater conditions within the unconsolidated alluvium upgradient of the Block P Mine Complex.
- MW-16 was installed adjacent to the Block P adit discharge location to evaluate hydrologic conditions prior to the partial rehabilitation of the Block P mine workings.
- MW-17 was installed adjacent to existing monitoring well HMW-06 to evaluate groundwater conditions within the unconsolidated alluvium and to act as a nested pair with HMW-06 (HMW-06 is screened within bedrock).
- MW-18 was installed within the unconsolidated waste rock immediately above the bedrock interface on top of the Block P waste rock pile. MW-18 was constructed as a nested pair with MW-19 to evaluate groundwater conditions within the waste rock pile.

- MW-19 was installed within bedrock on top of the Block P waste rock pile and was constructed as a nested pair with MW-18 to evaluate groundwater quality and flow conditions within the waste rock pile and bedrock unit.

- MW-20 was installed upslope of the Block P waste rock pile and screened in bedrock to evaluate groundwater quality within the bedrock unit upslope of the Block P waste rock pile.

- MW-21 was installed on top of the Block P waste rock pile and screened within bedrock to evaluate groundwater conditions within the bedrock beneath the waste rock pile.

- MW-22 was installed within the unconsolidated waste rock immediately above the bedrock interface along the toe of the Block P waste rock pile. MW-22 was completed as a nested pair with MW-23 to evaluate groundwater quality and flow conditions within the waste rock pile.

- MW-23 was installed within the bedrock along the toe of the Block P waste rock pile. MW-23 was completed as a nested pair with MW-22 to evaluate groundwater quality and flow conditions within the waste rock pile and bedrock unit.

- MW-24 was installed along the toe of the Block P waste rock pile and screened within the waste rock to evaluate groundwater conditions within the waste rock pile.

Monitoring wells were constructed using two-inch diameter PVC risers and No. 10 slot PVC screens. Boring and construction logs for the new monitoring wells are provided in Appendix B.

### 3.2.2 Groundwater Elevation Monitoring

Groundwater elevations were recorded twice following installation of monitoring wells MW-14 through MW-24 (on 9/21/08 and 11/13/08). These data are summarized in Table 2.

Groundwater elevations in wells completed within the unconsolidated waste rock or alluvium were similar for each monitoring event. Groundwater elevations in monitoring wells completed in bedrock decreased at six of the seven locations between September and November 2008. The decreases in groundwater elevation in bedrock ranged from 0.8 to 11.1 feet. Monitoring well HMW-06, completed adjacent to Galena Creek downgradient of the Block P waste rock pile, was the only bedrock well to maintain approximately the same groundwater elevation between monitoring events.

Automatic data loggers were installed in monitoring wells MW-18, MW-19, MW-22, and MW-23 to record temperature, hydrostatic pressure, and barometric pressure. The data loggers were programmed to record data indefinitely to aid in the further evaluation of hydrologic and hydrogeologic conditions at the Block P Mine Complex.

### 3.2.3 Groundwater Quality Monitoring

Groundwater samples were collected from monitoring wells MW-14, MW-15, MW-16, MW-17, MW-18, MW-20, MW-21, MW-22, MW-23, MW-24, HMW-05, HMW-06, and HMW-08 in September 2008. Groundwater samples were analyzed for total and dissolved metals, sulfate, and total suspended solids. A sample was not collected from well MW-19 because the well was dry at the time of sampling. Analytical groundwater quality data are presented in Table 3. Field parameters measured as part of well sampling are summarized in Table 5. Analytical laboratory reports are included in Appendix C.

### 3.2.4 Discussion of Groundwater Monitoring Results

#### 3.2.4.1 Local Geologic Setting

Three primary geologic units were encountered within the Block P Mine Complex: unconsolidated alluvium, unconsolidated waste rock, and syenite bedrock. Unconsolidated alluvial deposits ranged from granular sandy gravels to poorly graded sand with gravel. Alluvial deposits were primarily encountered in shallow borings adjacent to Galena Creek, but a thin layer was also observed at the bedrock interface in some of the borings advanced within the Block P waste rock pile. Unconsolidated waste rock was encountered in all borings completed within the limits of the Block P waste rock pile. Particle grain size of the waste rock varied from clay to cobbles/boulders. Additional discussion of waste rock characterization is provided in Section 3.4. Syenite bedrock was the first bedrock unit encountered at all boring locations. The gray syenite (identified as “Syenite of Hughesville” in Witkind, 1971) was primarily composed of feldspar, quartz, and biotite minerals. This bedrock unit can alternatively be classified as a Quartz Monzonite. Core samples collected from the syenite bedrock fractured along pyrite veins. Rust discoloration, apparent microbial growth, and secondary deposition of a white accretion indicate water transport along the pyrite veins. Groundwater was encountered within both the unconsolidated units and within the syenite bedrock.

As shown on the USGS Geologic Map of the Barker Quadrangle, the Syenite of Hughesville is the first bedrock unit encountered for much of the Block P Mine Complex. A dike of the “Porphyry of Galena Creek” is located to the west of the Block P waste rock pile and is oriented on an arc between the Wright, Edwards, and Block P mines. The contact between the “Porphyry of Galena Creek” and

the “Syenite of Hughesville” is the zone of mineralization that was mined during historical mining operations that occurred within the Block P Mine Complex.

#### 3.2.4.2 Aquifer Interactions

Data collected since installation of monitoring wells in September 2008 suggest that the piezometric surface for groundwater in the unconsolidated units generally parallels local topography. The piezometric surface for bedrock groundwater also appears to parallels general topography (see Figures 5a, 5b, and 5c). Due to the steep slope of the top of the bedrock within Galena Creek valley, however, groundwater is only present within the unconsolidated units near the bottom of the Galena Creek valley. Monitoring well MW-19, which was completed in unconsolidated waste rock but further away from Galena Creek, did not produce water during the fall 2008 sampling events. The difference in ground surface elevation between MW-19 and Galena Creek suggests that any water observed in monitoring well MW-19 would likely be perched and not hydrogeologically connected to the unconsolidated unit in the valley of Galena Creek. Measured water observed at MW-19 would be indicative of infiltration and not groundwater migration. The bedrock aquifer piezometric surface appears to display greater seasonal fluctuation than the piezometric surface within the unconsolidated unit. The greater the distance a bedrock well is completed away from Galena Creek, the greater the apparent fluctuation in the piezometric head (as shown by the 11 foot drop in water elevation between September and November 2008 in MW-20, see Table 2).

Figure 6 shows the general site layout of the Block P waste rock pile and the orientation of geologic cross sections established to aid in better understanding subsurface conditions in the area (Figures 7 through 13). Nested monitoring wells completed near Galena Creek generally show an upward hydraulic gradient in the northern portion of the Block P Mine Complex. Nested wells HMW-08/MW-14 and MW-22/MW-23 both exhibited slight upward vertical gradients during the fall 2008 monitoring events, indicating discharge from the bedrock to the alluvium. The upward groundwater gradient measured in fall 2008 at nested pairs MW-14/HMW-08 and MW-22/MW-23 supports the idea that alluvial aquifer does not contribute contaminant loads to the bedrock aquifer. A slight downward vertical gradient was observed at the southern end of the Block P Mine Complex. Nested wells MW-17/HMW-06 had a downward vertical gradient of approximately 0.03 ft during the fall 2008 monitoring events.

The cause for the change from an upward hydraulic gradient at MW-14/HMW-09 to a downward hydraulic gradient at MW-17/HMW-06 has not yet been determined, but the groundwater elevation in bedrock monitoring well MW-24 was below the stage of nearby Galena Creek during this time

(see Figure 7). This may reflect a better hydraulic connection in the bedrock to a lower reach of Galena Creek, or simply be a result of the topographical changes along the creek.

The upward vertical gradient observed at nested wells MW-22/MW-23 suggests that groundwater discharging from the bedrock may contribute to saturated conditions in the unconsolidated waste rock present at the northern end of the Block P waste rock pile. The downward gradient observed at MW-17/HMW-06, however, suggests that the potential for waste rock located at the southern part of the Block P waste pile to become saturated is less likely (Figures 7, 8, and 10). The saturated thickness of waste rock (as measured at MW-22) is estimated to have varied seasonally between approximately 4 and 7 feet. Seeping conditions from saturated waste rock was observed during the Spring 2008 monitoring event. Seeping conditions were more prevalently observed for the northern end of the Block P waste rock pile, consistent with the piezometric data collected.

#### 3.2.4.3 Groundwater Quality in Unconsolidated Deposits

Water quality data for the unconsolidated unit alluvium upgradient of the Block P waste rock pile (as represented by MW-15) indicate that groundwater appears to be impacted even prior to entering the Block P Mine Complex. This is likely due to impacts from other mining-related sites within the upper Galena Creek watershed. At well MW-15, groundwater quality exceeds Montana DEQ-7 aquatic life standards for aluminum, cadmium, copper, iron, lead, and zinc (see Table 3). Metals concentrations in groundwater samples collected from MW-15 are, however, less than the concentrations measured at other monitoring wells finished in unconsolidated deposits within the Block P Mine Complex. Water quality data for monitoring well MW-17, which is also completed within the unconsolidated alluvium, but downgradient of the Block P Mine Complex, are significantly higher than concentrations measured at MW-15, suggesting that there is a significant contaminant load originating within the Block P Mine Complex.

#### 3.2.4.4 Groundwater Quality in Bedrock Aquifer

The data for groundwater samples collected from the bedrock aquifer were evaluated in a similar manner. The data for the three monitoring wells installed into bedrock through the Block P waste rock pile varied. The samples from upgradient monitoring well MW-20 had comparatively low metals concentrations, exceeding MT DEQ-7 standards only for cadmium, lead, and zinc. The sample collected from monitoring well MW-21 reportedly contained higher concentrations of similar metals measured at upgradient well MW-20, exceeding MT DEQ-7 standards for aluminum, cadmium, and zinc (see Table 3). The concentrations of metals observed in the groundwater samples collected from monitoring wells MW-18 and HMW-05, however, were significantly higher than

those observed for both MW-20 and MW-21, exceeding MT DEQ-7 standards for the majority of metals tested for.

The rate of recharge for well MW-21 following construction and subsequent sampling events was substantially slower than the recharge rate experienced at MW-18 and HMW-05. The rock quality designation value (RQD) was also greater at MW-21 than MW-18, indicating potentially fewer fractures were penetrated while drilling MW-21. The RQD value for both boring locations was above 75%, indicating highly competent rock (see Table 6). Monitoring wells MW-18 and HMW-05 are also located closer to the Block P shaft and known underground mine workings than MW-21. These facts, when combined with the presence of more highly mineralized water in MW-18 and HMW-05, could suggest that both wells have a greater hydrologic connection with the Block P mine workings.

#### 3.2.4.5 Groundwater Quality Data Analysis

The fall 2008 groundwater quality data were plotted on ternary diagrams in an effort to determine if there are any obvious chemical "signatures" for the various types of water samples (unconsolidated, bedrock, or mine discharge) and various sample locations. The ternary diagrams (see Appendix D) indicate that the chemical signature for the mineralized water is generally similar, and that several sampling locations plotted very closely. Specific trends in the water chemistry are described below:

- The groundwater samples collected from monitoring wells MW-14, MW-18, HMW-08, and MW-23 plotted very similarly to the sample collected from the Block P Adit (Adit-BB-1). MW-23 and HMW-08 are completed within the bedrock aquifer, whereas MW-14 is completed in the unconsolidated unit adjacent to HMW-08 north of the Block P waste rock pile.

- The chemical signature of the samples collected from bedrock well HMW-05 was not similar to the previously described group, but was very similar to the chemical signature derived for the sample collected from the unknown adit (Adit-UNK-1).

- The groundwater samples collected from bedrock monitoring wells MW-20 and MW-21 also displayed very similar chemical compositions. MW-20 is located upslope from the Block P waste rock pile, while MW-21 was installed through the southern end of the Block P waste rock pile.

The chemical signature analysis is based on the initial set of analytical data. Additional analyses incorporating the spring 2009 data is described in Sections 3.7 and 3.8 and aid in understanding potential groundwater relationships.

## 3.3 Fall 2008 Surface Water Monitoring

Surface water monitoring activities for this EE/CA consisted of sampling mine portals, Galena Creek, and Dry Fork Belt Creek. Two distinct surface water monitoring events were conducted in 2008. The adits and the intermittent creek that intersects the Wright/Edwards mine sites were sampled during the high-flow spring runoff period (June 2008) in an effort to account for discharges that are seasonal in nature. Monitoring of Galena Creek and Dry Fork Belt Creek was conducted in September 2008 as part of the long-term monitoring requirements for the Block P Mill Tailings Site.

### 3.3.1 Adit Monitoring

The Block P Adit (Adit-BB-1), the Grey Eagle Adit (Adit-GE-1), and the previously unnamed adit located between the Block P Mine and the Wright/Edwards Mines (Adit-UNK-1) were not flowing in fall 2008 and were therefore not resampled.

### 3.3.2 Stream Monitoring

Stream monitoring was conducted at ten locations along Galena Creek and Dry Fork Belt Creek as part of long-term monitoring program at the Block P Mill Tailings Site. Stream monitoring locations near the Block P Mine Complex are shown on Figure 4. Surface water samples were analyzed for total and dissolved metals and sulfate. General chemistry parameters were measured in the field. Estimates of streamflow rate were made at all surface water sampling locations in conjunction with sampling events by measuring flow velocity and estimating cross-sectional area.

### 3.3.3 Discussion of Surface Water Monitoring Results

General parameters measured in the field at the three mine adits in June 2008 indicated acidic pH values (4.2 to 5.0 standard units), high conductivity values (ranging from 0.3 to 1.1 mS/cm), and elevated redox potential. Metals concentrations at all three adits were reported to be above the MT DEQ-7 standards for aluminum, cadmium, copper, iron, lead, and zinc. Mine discharge water quality data are presented in Table 1. Field data associated with adit sampling are summarized in Table 5.

Mine water discharge rates for Adit-GE-1, Adit-BB-1, and Adit-UNK-1 were estimated in the field to be approximately 17 GPM, 60 GPM, and 0.7 GPM, respectively. The variability in flow conditions and difficulty in accurately measuring flow rates by timing the collection of a fixed volume of water

led to the decision to install temporary flow monitoring devices in both the Block P and Grey Eagle adits prior to the spring 2009 run-off to more accurately estimate mine discharge flow rates.

Two stream monitoring locations (GC-SS-1 and GC-SS-2) in the immediate vicinity of the Block P Mine Complex were sampled as part of the long-term monitoring program for the Block P Mill Tailings site. GC-SS-1 is located on Galena Creek immediately upstream of the Block P waste rock pile and GC-SS-2 is located on Galena Creek immediately downstream of the waste rock pile. The surface water sample collected at GC-SS-1 contained elevated concentrations of cadmium, copper, lead, and zinc using the standards derived for a total hardness of 100 mg/L. The sample collected at location GC-SS-2 exceeded the MT DEQ-7 standards for aluminum, cadmium, copper, iron, lead, and zinc for both the 100 mg/L and 400 mg/L hardness. The order-of-magnitude increase in both total and dissolved metals concentrations observed in Galena Creek as it passes through the Block P Mine Complex confirms that the creek is likely receiving contributions from both groundwater seepage and surficial erosion of the Block P waste rock pile. Analytical results of stream monitoring are provided in Table 4. Field parameters are presented in Table 5.

## 3.4 Waste Rock Characterization

The primary objectives for collecting and analyzing waste rock samples were to better understand the chemical and geotechnical characteristics of the waste rock and to refine the existing volume estimates of each waste rock pile.

### 3.4.1 Chemical Characterization of Waste Rock Piles

A total of seven composite samples were collected from the Wright, Edwards, and Belt Patent waste rock piles, as well as from one previously unnamed waste rock pile located upslope from the Block P waste rock pile. Each composite sample was prepared from four discrete grab samples that were in turn prepared from soils retrieved from varying locations/depth within the respective waste rock piles. Five grab samples were also collected from within the Block P waste pile at varying depths. All samples were analyzed for total metals and metals using the Synthetic Precipitation Leaching Procedure (SPLP). The samples collected from the Block P waste rock pile were also analyzed for acid-base-accounting parameters. Previous sampling on the Wright, Edwards, and Belt Patent for acid-base-accounting (ABA) parameters was conducted in 1999, so no additional ABA analyses of these waste rock piles were performed as part of the 2008 work.

### 3.4.2 Geotechnical Characterization of Waste Rock Piles

Five representative samples were collected from the Block P waste rock pile in the fall 2008 at locations designated BB-WP-01 through BB-WP-05 (see Figure 14). Two additional samples were collected in May 2009 at locations designated BB-WP-07 and BB-WP-08. Bulk samples were collected and analyzed for grain size distribution. Shelby tube samples were also collected at the Block P waste pile sample locations in September 2008, but the geotechnical laboratory indicated that the high percentage of coarse fraction of the samples prevented further analysis because the samples would not remain intact due to a lack of cohesion.

### 3.4.3 Waste Rock Volume Estimates

Several previous environmental investigations conducted in the Galena Creek watershed included estimates of the volumes of the Block P, Wright, Edwards, and Belt Patent waste rock piles. As part of the fall 2008 field work conducted in support of this EE/CA, the volume of these same piles were again estimated with the intent of comparing the 2008 values to the previous efforts.

Estimates of the Block P waste rock pile volume were prepared using data from obtained via traditional topographic surveys and boring logs. The volume for the Block P waste pile was estimated by computing the volume contained by the ground surface generated by traditional topographic survey data and the assumed elevation of the natural mountainside under the waste rock pile. This underlying surface was generated by interpolating between soil borings to model the shape of the mountainside beneath the waste.

The volume of the Wright, Edwards, and Belt Patent waste rock pile, along with an unnamed waste rock pile, were estimated from GPS survey measurements alone. First, the perimeter of each pile (as identified by unaltered topography and vegetation) was surveyed. Then, the coordinates and ground surface elevation of select locations of within the perimeter of each pile that best approximated the shape/volume of the pile were recorded. The volume contained between the interior points and the assumed bottom of the pile (assumed to be the ground surface that connects the perimeter points) was then automatically computed by the plotting software. The limitation to this technique is that no interior sampling (via hand augers or soil borings) was completed to confirm the assumption that the surface connecting the perimeter points is the true bottom of the waste rock pile.

### 3.4.4 Discussion of Waste Rock Characterization Data

Waste rock characterization data are presented in Table 7. The concentrations of total metals were generally typical for samples collected from a mineralized zone. Iron and lead were the most

prevalent metals observed, with lesser concentrations of arsenic, copper, and zinc. Except for lead, the metals concentrations returned by the SPLP analytical method were non-detectable. SPLP lead was detected in every waste rock sample submitted for analysis, with concentrations ranging from 0.4 to 14 mg/L. SPLP data are useful in evaluating the mobility of soil-based contaminants upon interaction with water having similar characteristics to precipitation. While the analytical data suggest that the potential for additional contaminant leaching from waste rock piles at the Site may be low, there are insufficient data regarding the volume and frequency of precipitation that infiltrates each waste rock pile sampled to be able to support the conclusion that contaminant leaching is not an ongoing risk.

In addition to metals and SPLP metals analyses, samples collected from the Block P waste rock pile were also analyzed for acid generating potential and sulfur content. The results of both of these analyses fell within historical ranges for observed for the waste rock samples collected in 1999.

Geotechnical samples that underwent grain size analysis confirmed the heterogeneous composition of the Block P waste rock pile. Particle grain size varied from greater than 3 inches down to clay fraction and each bulk waste rock sample had at least 10 percent of each of the gravel, sand, and fines gradation ranges. A direct shear test was also performed on sample BB-WP-8 from the Block P waste rock pile. Particles coarser than the #4 sieve were removed from the sample and then a standard Proctor was performed on the sample before direct shear testing. Once the sample was in the direct shear apparatus, it was compacted to 95% standard Proctor dry density and to optimum moisture content, after which the test was carried out. Three normal loads were applied before shearing (0.75, 1.5, and 3 tsf), with a resulting friction angle of 36.3 degrees.

Grain size sampling and analysis were not conducted for the other waste rock piles. It is assumed that the grain size distributions for these waste rock piles (Wright, Edwards, Belt Patent, and Unknown) are comparable to those reported for the Block P waste rock pile.

Waste rock volume estimates are shown in Table 8 and on Figures 15 and 16. The waste rock volume estimates are generally consistent with the volume estimates prepared by Pioneer (1995). Barr's estimated volume for Edwards-2, however, is an order of magnitude smaller than the estimate provided by Pioneer (approximately 3,000 and 50,000 cubic yards, respectively). Review of Pioneer's documentation indicated that the surface area assumed for Edwards-2 appears to be approximately an order of magnitude larger than the surface area surveyed by Barr. The estimate prepared by Barr during 2008 investigation activities is deemed to be the more accurate estimate

moving forward. The waste rock volume estimates calculated by Barr will be the estimates used for analysis of removal action alternatives.

## 3.5 Cultural Resources Inventory

Doe Run retained Frontier Historical Consultants of Grand View, Idaho to conduct a cultural resource inventory and assessment of the Block P Mine Complex. The purpose of the inventory and assessment was to locate, record, and evaluate the type and nature of cultural resources, if any, located within the project area and to provide an opinion of the significance of those resources in terms of the National Register of Historic Places. The inventory was conducted to meet state and federal requirements related to cultural and historic preservation. Field work for the cultural resource inventory was conducted in October 2008. A copy of the full report is included as Appendix F of this EE/CA (Frontier, 2009).

As detailed in the executive summary of Frontier's report, the Block P, Wright/Edwards, and Belt Patent mining sites were recorded and assessed in 1990 by GCM Services, Inc. At that time, the Block P mine was found to be eligible for listing on the National Register of Historic Places (NRHP), but the Edwards and the Belt properties were recommended to be not eligible. Based upon its 2008 reexamination, Frontier included the following conclusions in its report:

- All three sites were found to have diminished integrity.
- For the Block P mine, the eligibility for the NRHP under Criterion A was confirmed, but that eligibility should be reviewed or removed due to the continued physical deterioration of the site.
- For the Wright / Edwards mine, the 1990 recommendation of "not eligible" for the NRHP was upheld.
- For the Belt mine, the 1990 recommendation of "not eligible" for the NRHP was upheld.

Doe Run will work with USEPA and MDEQ to secure a Memorandum of Agreement with MT SHPO prior to implementation of removal action at the Site.

## 3.6 Mine Workings Evaluation

The workings of both the Block P and Grey Eagle mines were partially rehabilitated between October 27 and December 12, 2008 to allow further evaluation of mine discharge. Doe Run retained Atlas Fausett Contracting of Osburn, Idaho to rehabilitate the first several hundred feet of each of mine portals. The log of activities conducted by Atlas-Fausett is included as Appendix G. Following rehabilitation of the mine workings, the mine tunnels were visually inspected to look for locations of groundwater inflow that could contribute to adit discharge.

### 3.6.1 Grey Eagle Rehabilitation

The Grey Eagle mine workings were rehabilitated by reinforcing existing timbers or installing new timbers in both the ceiling and walls, and removing silt/debris that had accumulated on the tunnel floor. The general bearing of the Grey Eagle tunnel is eastward, gradually bearing southeastward. Seepage into the tunnel along the mine sidewalls was observed sporadically throughout the entire length of the rehabilitated tunnel. Seepage appeared to occur primarily along fractures; however, some apparent disperse seepage was observed. Several stopes were observed. Rehabilitation efforts within the Grey Eagle were stopped approximately 550 feet into the mine where a large collapse feature was encountered. Visual inspection suggested that there may be significant ponding of water behind the collapse.

### 3.6.2 Block P Rehabilitation

The 75-foot level of the Block P mine was rehabilitated by reinforcing existing timbers or installing new timbers in both the ceiling and walls, removing silt/debris that had accumulated on the tunnel floor, and removing waste rock and debris that caved-in from stoped areas above the tunnel. Rehabilitation of the 75-foot level was terminated 150 feet in from the Block P adit, at a feature that appeared to correspond with the location of the Block P/ Barker shaft. The feature encountered was filled with debris (see photos in Appendix G). Visual inspection suggested that the 75-foot level continued past the presumed shaft through an area of stoping. This is consistent with the description of the Block P/Barker Shaft in Vanderberg (1931, p. 3), which indicated that the first 350 feet of the shaft was sunk on the vein that was being mined. The rehabilitated segment of the 75-foot level bears west to southwest. Minimal water was encountered during rehabilitative efforts in the Block P and no sidewall seepage was observed during rehabilitation.

## 3.7 Spring 2009 Monitoring Activities

Review of the fall 2008 groundwater and surface water data indicated that additional data were needed to more fully assess current environmental conditions at the Site and better evaluate removal action alternatives. Another objective of the spring 2009 monitoring event was to further evaluate the potential for seasonal variation in surface water and groundwater conditions due to spring runoff. A summary of monitoring activities completed in spring 2009 was submitted to USEPA and MDEQ on May 29, 2009. Highlights from that submittal are presented below.

### 3.7.1 Analytical Parameter Selection

The QAPP for the Site summarizes the list of general and inorganic parameters originally included in sampling and analyses to be conducted as part of the Block P Mine Complex EE/CA. An extended

parameters listed was utilized for the Spring 2009 monitoring event so that a more thorough analysis of differing chemical signatures for surface water and groundwater could be performed. The extended parameter list was summarized in an addendum to the QAPP submitted on May 29, 2009.

### 3.7.2 Mine Workings Evaluation

V-notch weirs and data-loggers were installed at the Block P and Grey Eagle adits the week of May 4, 2009 to measure mine discharge flow rates during the spring runoff period. The flow data from the weir monitoring locations were downloaded in June as part of the spring 2009 monitoring event.

Also during the spring 2009 monitoring event, the rehabilitated length of both mine tunnels were visually inspected for surface water infiltration, potential groundwater inflows, and any other preferential flowpaths that allowed groundwater to enter the mine workings. The relative proportion of water inflows to the mine workings throughout the length of the mine workings was noted during the inspection. An attempt to discern whether water was entering the 75-foot level of the rehabilitated Block P workings via upwelling from the presumed shaft or cascading down the shaft was made.

A sample of the water discharging from both the Block P Adit (Adit-BB-1) and the Grey Eagle adit (Adit-GE-1) were collected in June. To facilitate comparison to the data generated from the monitoring installed in the vicinity of the Block P waste rock pile, the Block P mine discharge sample was analyzed for the extended parameter list as discussed below. The Grey Eagle mine discharge sample was analyzed for the standard parameter list.

Other previously identified adits located within the Block P Mine Complex (e.g. Adit-UNK-1) were inspected to see if flowing water was present. No other adits were flowing the first week of June 2009.

### 3.7.3 Groundwater Monitoring

Data loggers were installed in MW-18, MW-19, MW-22, and MW-23 in fall 2008 to monitor seasonal variation in water levels. In June 2009, data from the loggers were downloaded and water levels manually recorded for all monitoring wells located within the Block P Mine Complex. Groundwater samples were collected from monitoring wells MW-14, MW-15, MW-16, MW-17, MW-21, MW-24, HMW-05, HMW-06, and HMW-08 and analyzed for the standard parameter list. Groundwater samples collected from monitoring wells MW-18, MW-20, MW-22, and MW-23 were

analyzed for the extended parameter list. Monitoring well MW-19 did not contain enough water to sample.

### 3.7.4 Stream Monitoring

Surface water samples were collected from the stream monitoring locations on Galena Creek adjacent to the Block P Mine Complex (e.g. GC-SS-01 and GC-SS-02). Additionally, a surface water sample was collected from a new sampling location on upper Galena Creek (designated GC-SS-00) at a point just downstream of the confluence of Daisy Creek and Green Creek. This location provides a surface water sample upgradient of any interaction with groundwater impacted by the Block P Mine Complex. Samples GC-SS-00 and GC-SS-02 were analyzed for the extended parameter list, while GC-SS-01 was analyzed for the standard parameter list.

The intent was to also collect surface water samples on the intermittent creek located adjacent to the Wright/Edwards waste rock piles (e.g. SW-WR-01 and SW-WR-02) and analyze them for the standard parameter list. No flow was observed at either location in June 2009, so no samples were collected.

### 3.7.5 Discussion of Spring 2009 Monitoring Results

Significant water flow was not observed at the presumed shaft of the Block P Mine, either from upwelling or cascading. There were, however, locations of apparent inflow to the rehabilitated 75-foot level of the Block P mine, especially from backfilled stopes. Water inflow into the rehabilitated Grey Eagle mine was more disperse than that observed entering the Block P, but visually more apparent at areas of heavy fracturing.

Spring 2009 groundwater elevation data showed a significant increase as compared to the fall 2008 data (Table 2). This increase was noted in monitoring wells completed in both the unconsolidated deposits and bedrock. Measured water levels were recorded in MW-19 during the Spring 2009 monitoring. Water at MW-19 is indicative of infiltration through the waste rock pile during the spring snowmelt. The upward hydraulic gradient noted in fall 2008 at the nested monitoring wells located at the north end of the Block P waste rock pile and the downward hydraulic gradient noted in fall 2008 in nested wells at the south end of the Block P waste rock pile were maintained in the spring 2009 data set.

Regarding the analysis of chemical signatures derived from the spring 2009 groundwater and surface water quality data, several initial conclusions can be made:

- The chemical signatures of the mine drainage from both the Block P and the Grey Eagle mines did not change significantly as a result of the rehabilitation work completed on their respective tunnels.

- The surface water sample collected from station GC-SS-0 (Galena Creek upstream of the Block P Mine Complex) in spring 2009, while having lower concentrations of various constituents, displays a similar chemical signature as downstream monitoring stations GC-SS-1 and GC-SS-2 (see Table 2).

- The chemical signature of the groundwater sample collected from monitoring well MW-15 (located in the unconsolidated alluvium upgradient of the Block P waste rock pile) varies significantly from fall 2008 to spring 2009. Higher metals concentrations were observed in MW-15 during the spring 2009 sampling event (Table 3).

These initial conclusions will be reviewed and revised as additional data becomes available.

## 3.8 Conceptual Mine Discharge Model

Groundwater occurs within two aquifers in the Galena Creek watershed, the bedrock aquifer and the unconsolidated alluvial aquifer in the creek valley. Galena Creek is the primary discharge point for the bedrock aquifer in the watershed. In general, it is expected that the piezometric surface in bedrock wells near the creek would be higher than the normal creek stage and that groundwater elevations in the alluvium monitoring wells would be intermediate between the creek stage and the bedrock. In other words, the creek is generally expected to be gaining discharge from the bedrock and alluvium throughout its length at normal creek stage. Locally, this may not be the case.

Flow in the alluvial aquifer is expected to be more variable with respect to location and time of the year. The alluvial flow consists of discharge to Galena Creek in gaining reaches of the creek, recharge from the creek in losing reaches, and underflow more or less parallel to the creek in the downstream direction.

Impacts to groundwater and surface water occur primarily where water capable of oxidizing sulfide minerals comes in contact with sulfide-bearing materials. This is occurring within the portion of the watershed upstream of the Block P Mine Complex in both mined and unmined areas, in the Block P waste rock pile and shallow workings of the Grey Eagle and Block P mines, and, to some extent, downstream of the Block P mine complex where deeper groundwater discharges to Galena Creek.

It is possible that impacts to the groundwater also occur deeper in the Block P mine workings. This is suggested by the water quality in well MW-20, which monitors the bedrock upgradient of the waste rock pile. In these areas, oxidizing conditions are not likely to currently exist. In other mining regions, sulfate reduction is occurring in flooded underground workings, leading to relatively low concentrations of dissolved metals and more neutral pHs compared with areas in which sulfide oxidation is occurring (see Gammons, et al., 2006 and Roesler, et al., 2007). If the water chemistry of MW-20 is representative of the water quality in the bedrock aquifer between the flooded mine workings and Galena Creek, it may indicate the limit in improvement of water quality that can be achieved if the sulfide-oxidation issues elsewhere at the site are successfully addressed. Reported concentrations of cadmium and zinc from MW-20 exceed MT DEQ-7 standards.

## 3.9 Analytical Data Quality Control Review

As called for in the project QAPP (Barr, 2008e), Barr performed quality assurance and quality control checks on analytical data obtained from Columbia Analytical Services, Inc. (CAS), Isotech Laboratories, LLC (Isotech), Thomas, Dean and Hoskins, Inc. (TD&H), and ACZ Laboratories, Inc. (ACZ). Table 9 presents masked duplicate samples relative percent difference (RPD) data. Table 10 presents the field and laboratory blank sample data.

### 3.9.1 Quality Assurance/Quality Control

A quality assurance and quality control review was conducted to assess the integrity of the sampling and analytical procedures performed on the groundwater, adits, streams, surface water and waste rock samples at the Doe Run Resources Company Block P Mine Complex and Mill Tailings Sites during 2008 and 2009. Multiple surface water samples were collected in June 2008 at the Block P Mine Complex located near Great Falls, Montana, followed by groundwater, surface water, and waste rock sample sampling events conducted in September 2008 and June 2009.

This review was performed in accordance with the Barr Engineering Standard Operating Procedure for routine level metals and general chemistry data validation, which are based on The National Functional Guidelines for Inorganic Data Review (EPA, 2004). Samples were collected by employees of Barr Engineering Company. CAS located in Kelso, Washington performed the total and dissolved sulfate, alkalinity, total suspended solids (TSS), total dissolved solids (TDS), dissolved bromide, dissolved, chloride, dissolved fluoride, dissolved nitrate, dissolved nitrite, dissolved orthophosphorus, dissolved carbonate and bicarbonate, dissolved reactive silica, dissolved ammonia, dissolved organic carbon, analysis along with the total, dissolved, and SPLP metals analyses; Isotech located in Champaign, Illinois

performed the tritium analysis; TD&H located in Great Falls, Montana performed the grain size analysis; and ACZ located in Steamboat Springs, Colorado performed the acid neutralization potential analyses.

Both laboratory and field sampling procedures were examined in the review for the June 2008, September 2008, and June 2009 monitoring events at the Block P Mine Complex and Mill Tailings Sites. Field sampling procedures were examined utilizing field blank and masked (field) duplicate sample analysis. Laboratory procedures were evaluated by examining technical holding times, duplicate samples, precision and accuracy data, method blank samples and data package completeness.

### 3.9.2 Sampling Quality Control

#### 3.9.2.1 Blank Samples

Field blank samples are used to assess the existence and magnitude of contamination introduced in the field.

The field blank sample collected and analyzed during the June 2008 monitoring at the Block P Mill Tailings Site had a hardness as CaCO3 concentration of 15.5 mg/L but the associated sample data were not qualified because the sample concentrations were greater than five times the field blank sample concentration. One field blank sample was collected and analyzed during the September 2008 waste rock sampling event at the Block P Mine Complex Site. It had no detectable concentrations above the laboratory reporting limit for the target analytes. The field blank sample collected and analyzed during the June 2009 monitoring at the Block P Mill Tailings Site had multiple target analytes which were detected above the laboratory reporting limit. The field blank sample detections are as follows: chloride (0.2 mg/L), sulfate (0.4 mg/L), bicarbonate (4 mg/L), cadmium (0.03 µg/L), copper (0.9 µg/L), manganese (7.5 µg/L), and dissolved copper (0.3 µg/L). The associate sample concentrations that were less than five times the field blank sample concentration were “b” qualified indication potentially false positive concentrations and are presented in Table 10.

### 3.9.3 Laboratory Procedures

#### 3.9.3.1 Blank Samples

Laboratory method blank analyses are used to determine the existence and magnitude of contamination introduced at the laboratory.

The laboratories prepared and analyzed method blank samples at the appropriate frequency as required by the analytical methods during the analysis of the project samples. No method blank samples had detectable concentrations of target analytes above the laboratory reporting limit.

#### 3.9.3.2 Technical Holding Times

Technical holding times were evaluated for each sample and target parameter based on the EPA recommendations listed in 40 CFR SW-846 "Test Methods for Evaluating Hazardous Waste." All samples were analyzed within their recommended holding times.

#### 3.9.3.3 Precision and Accuracy

Precision and accuracy were evaluated at the laboratory utilizing laboratory control spikes, matrix spikes, laboratory batch duplicate and masked field duplicate samples.

For some methods the laboratory is required to prepare and analyze a sample of spiked reference matrix for measures of accuracy of the analytical process/system/method. CAS performed laboratory control sample (LCS) analyses as required by the methods at the appropriate frequency for each analytical batch. The LCS results met laboratory acceptance criteria for percent recovery of the spiked concentrations.

Matrix spikes provide information about the effect of each sample matrix on the sample preparation procedures and analytical results. CAS performed matrix spike (MS) analyses as required by the methods at the appropriate frequency for each analytical batch. During the June 2008, September 2008, and the June 2009 sampling events at the Block P Mine Complex and Mill Tailings Sites, there were several cases where MS recoveries for total and dissolved metals analyses were outside laboratory acceptance criteria. The spike concentrations were greater than 4x the associated native concentration, making spike recovery difficult and not applicable. In these cases, no qualifiers were applied to the associated native samples. The MS percent recoveries for sample BB-WP-03 were below the laboratory acceptance limits for arsenic and zinc for the September 2008 sampling event at the Block P Mine Complex Site. Therefore, the associated arsenic and zinc data were "*" qualified (estimated). The remaining MS recoveries met the laboratory acceptance criteria.

As required by the QAPP for this project, masked field duplicates were collected at a frequency of one (1) masked field duplicate for every twenty (20) sample collected and analyzed for the same parameters as the associated native sample for comparison of their relative percent differences (RPD). Generally, RPDs were within the acceptance criteria outlined in the QAPP (<30% for aqueous samples and <40% for solid samples). Sample ADIT-GE-1 collected June 17 2008, sample WR-WP-02 collected on September

14, 2008, sample MW-22 collected September 21, 2008, and sample ADIT-BB-1 collected on June 4, 2009, served as the masked duplicate samples for the Block P Mine Complex. The RPD for samples ADIT-GE-1, MW-22, and ADIT-BB-1 and their associated masked duplicate samples exceeded the applicable RPD criteria (<30%) for sulfate, total suspended solids (TSS), and ammonia, respectively; however, no sulfate and TSS data were qualified because the sample concentrations were near the laboratory reporting limit which can exaggerate the RPD. The associated ammonia data for sample ADIT-BB-1 was "j" qualified (estimated) based upon this deviation in precision. The RPDs for sample WR-WP-02 exceeded the RPD criteria (<40%) for arsenic, lead, magnesium and sodium. No data were qualified because the sample concentration was near the laboratory reporting limit for arsenic, but the associated lead, magnesium and sodium data were "*" qualified and should be considered estimated. The remaining masked duplicate samples met the applicable RPD acceptance criteria for precision.

Sample BB-WP-03 was used as the batch duplicate sample for one analytical batch. The RPD for sample BB-WP-03 exceeded the acceptance criteria (<30%) for arsenic, manganese and magnesium. The associated magnesium data were "*" qualified (estimated) based upon this deviation, however, no arsenic and manganese data were qualified because the RPD exceedance was minor (<5%).

All remaining precision and accuracy data met laboratory acceptance criteria, including percent recoveries and RPD.

### 3.9.4 Discussion

As specified in Section B2.3 of the Doe Run Mine Complex Quality Assurance Project Plan (Barr, 2008), the sample locations located within the Mill Tailings Site were revised to include the location designator in the sample name during the September 2008 and June 2009 monitoring events. Examples of location designators used during this monitoring event are DF (Dry Fork Creek) and GC (Galena Creek). The sample stations (location IDs) were renumbered as well.

| Old Sample ID | New Sample ID | Old Sample ID | New Sample ID |
|---|---|---|---|
| SS-1 | GC-SS-1 | SS-4 | DF-SS-2 |
| SS-2 | GC-SS-2 | SS-4A | DF-SS-3 |
| SS-3A | GC-SS-3 | SS-5 | DF-SS-4 |
| SS-3B | GC-SS-4 | SS-6 | DF-SS-1 |
| SS-3C | GC-SS-5 | SS-7 | DF-SS-5 |

#### 3.9.4.1 Data Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. The completeness goal of over 95% valid data was met for this project.

### 3.9.5 Conclusion

The data met the data project requirements and are deemed acceptable as qualified for the purposes of this project. The completeness of the overall data collection was satisfactory.

# 4.0 Evaluation of Potential Repository Locations

Recent reports prepared by state and federal agencies for the Barker-Hughesville Mining District attempted to identify potential locations for one or more waste rock repositories (CDM, 2005; Pioneer, 2007). As part of the work performed in support of this EE/CA, Doe Run undertook additional activities toward this goal.

An initial reconnaissance and evaluation of potential repository locations within the Galena Creek watershed was conducted in September 2008. This initial effort targeted two specific areas for evaluation (identified as Areas 1 and 2 on Figure 17). Area 1 is generally associated with the area in the vicinity of the Carter Mine. Area 2 was designated the "Upper Repository" area. Potential repository locations were evaluated on the physical setting and size of the area, potential for interaction with surface and groundwater, and suitability of the underlying unconsolidated soils and/or bedrock. The following paragraphs detail the work performed to evaluate the suitability of Areas 1 and 2.

## 4.1 Repository Area 1

Area 1 is located approximately 0.5 miles north of the Site, to the north and east of Green Creek. This area consists of a generally open meadow that increases in elevation and slope with increasing distance from the creek. There is a surface water channel that transects the likely repository footprint. Area 1 was visually inspected in June 2008 in preparation for further evaluation.

### 4.1.1 Test Excavations and Geotechnical Analysis

Two test excavations (TP-3 and TP-4) were completed at Area 1 to a depth of approximately 10 to 12 feet bgs (Figure 14). Bulk soil samples were collected for grain size distribution analyses. Groundwater was encountered at approximately 8 to 10 feet below ground surface, with evidence of seasonally higher fluctuations. Bedrock was not encountered during test excavations at Area 1.

At test pit TP-3, bulk soil samples collected from different depths indicate that the unconsolidated materials can be classified as ranging from a clayey gravel with sand to a poorly graded gravel with clay, with a maximum particle size of 6 inches. The percent passing the #200 sieve ranged from 9.2 to 11.5% for these samples, indicating that this material is somewhat coarser than the materials from Area 2. The sample from test pit TP-4 was classified as a silty, clayey sand with gravel. It had a maximum particle size of 3 inches and 30.3% passing the #200 sieve. Test pit logs are included in Appendix B. Sieve analysis reports are in Appendix C.

Area 1 is considered unsuitable as a potential repository location because there is insufficient space to construct a waste rock repository capable of containing the entire volume of waste rock attributable to Doe Run (260,000 cubic yards) without major alterations of existing surface water drainage patterns.

## 4.2 Repository Area 2

Area 2 is located upslope from the Wright and Edwards mines and is not located within an existing surface water drainage channel. The area was visually inspected during the June 2008 site reconnaissance and the horizontal extent of a potential repository footprint was surveyed using GPS methods during the September 2008 field activities. A topographic survey of Area 2 completed in December 2008 by subconsultant Thomas, Dean, & Hoskins (TD&H). These data were incorporated into engineering software to develop a conceptual design of a repository for Area 2.

As presented in the July 2009 draft EE/CA submitted to USEPA, the waste rock storage capacity of this conceptual design was originally estimated to be approximately 220,000 cubic yards. An expanded ground survey was conducted by TD&H in October 2009 in effort to determine whether the topography of Area 2 could support expanding the footprint of the conceptual design of the Upper Repository. With an expanded footprint, the data suggest that Area 2 is capable of storing the estimated 260,000 cubic yards of waste rock currently present at the Site.

### 4.2.1 Test Excavations and Geotechnical Analysis

Two test excavations (TP-1 and TP-2) were completed within Area 2 to a depth of approximately 10 to 12 feet bgs in September 2008 (Figure 14). Bulk soil samples were collected for grain size distribution analyses and an attempt was made to determine the depth to bedrock. Groundwater was not encountered in either test pit in Area 2.

The results of the grain size analyses indicate that unconsolidated soils found in Area 2 can be classified as silty sand with gravel, with a maximum particle size of 6 inches. The percent passing the #200 sieve ranged from 21.2 to 26.5% for these samples. Test pit logs are included in Appendix B. Sieve analysis reports are in Appendix C.

A direct shear test was performed on sample TP-1 collected from Area 2. Particles coarser than the #4 sieve were removed from the sample and then a standard Proctor was performed on the sample before direct shear testing. Once the sample was in the direct shear apparatus, it was compacted to 95% standard Proctor dry density and to optimum moisture content, after which the test was carried

out. Three normal loads were applied before shearing (0.5, 1, and 2 tsf), with a resulting friction angle of 47.0 degrees.

### 4.2.2 Land Ownership at Area 2

Area 2 encompasses several discrete parcels of property (see Figure E-1 in Appendix E). Land ownership information that is available on the Montana Cadastral mapping website (http://gis.mt.gov/) was reviewed in March 2008 in an effort to determine current property owner information. Based on this information, Doe Run believed that the footprint of a conceptual repository constructed within Area 2 could encroach on both private and public property (USDA-FS). USEPA and USDA-FS staff discussed this issue, and USEPA, USDA-FS, and Doe Run representatives met in Great Falls on October 13, 2009 to exchange information regarding property boundaries and repository construction details. USDA-FS survey data suggested that the footprint of the conceptual repository would fall entirely on private property. As part of the October 2009 expanded topographic survey work conducted in Area 2, an attempt was made to locate actual property corner pins or stakes. Field conditions (dense timber and early snow cover) prevented completion of this task.

Doe Run has a working relationship with the current owners of much of Area 2 through the Block P Mill Tailings site project and the same property owners previously granted Doe Run access to Area 2 to conduct the field reconnaissance and survey activities needed for this EE/CA. Doe Run expects that additional discussions regarding access for repository construction will be initiated if needed.

## 4.3 Repository Efforts in Fall 2009

Given the limitations of both Areas 1 and 2, USEPA requested that Doe Run expand its evaluation of potential repository locations to include two additional locations located with the Galena Creek watershed (Areas 3 and 4) and to refine its previous evaluation of the “offsite repository” alternative to include a more tangible location.

### 4.3.1 Repository Area 3

The location designated as Area 3 on Figure 17 is the general area identified in previous state and federal reports as a potential location for a site-wide waste rock repository (CDM, 2005; Pioneer, 2007).

Area 3 consists of a generally gentle slope of sufficient size to construct a repository more than large enough to contain the entire waste rock volume from the Block P Mine Complex. An intermittent drainage feature is present to the south of Area 3, but the area is large enough to provide an setback

to avoid surface water interaction from this drainage. The depth to groundwater under Area 3 has not been determined; however, given the general elevation of Area 3 relative to Galena Creek, it is anticipated that groundwater is present at a sufficient depth that allows for repository construction.

Based upon existing topographic contours taken from the USGS quad for the area, the estimated maximum storage volume of a conceptual repository in Area 3 is approximately 800,000 cubic yards (Figures 20 and 21). Given that the entire volume of waste rock within the Galena Creek watershed (including the volume associated with the Block P Mine Complex) has been estimated at approximately 450,000 cubic yards (CDM, 2005), this location has the potential to serve as a common repository for mine waste currently located throughout the Galena Creek watershed.

This location encompasses private property. Doe Run has a working relationship with the current owners of much of Area 3 through the Block P Mill Tailings site project. The owners of the most likely parcel for evaluation have been contacted, but permission to access the parcel(s) for field evaluation could not be obtained before the field season ended in late October. Doe Run expects that additional discussions will be initiated as this EE/CA moves toward completion.

### 4.3.2 Repository Area 4

During the October 2009 site visit, USEPA and Barr representatives agreed to conduct an initial reconnaissance of the properties immediately north of the existing Block P Mill Tailings site repository (Area 4). The area was walked to establish GPS coordinates of the potential extent of a repository footprint and the general topography of the area assessed. Area 4 is approximately 2.3 acres in size which is insufficient to store the entire volume of waste rock located within the Block P Mine Complex. Area 4 is therefore eliminated from further consideration as a location for a waste rock repository.

# 5.0 Streamlined Risk Evaluation

The purposes of the streamlined risk evaluation for the Block P Mine Complex site are to determine what current or potential exposures are created by existing environmental conditions at the Site and to provide support for selecting a removal action alternative. Risks are evaluated by comparing site-specific chemical concentration data to applicable human or ecological risk-based criteria. The evaluation assumes that no removal action is taken at the Site.

## 5.1 Human Health Risk

Evaluating the risks posed to human health by conditions within the Block P Mine Complex requires identification of potential contaminants of concern (COCs) and completion of an exposure pathway assessment.

### 5.1.1 Potential Contaminants of Concern

As shown in Table 3, one or more groundwater samples collected from Site monitoring wells finished in the unconsolidated aquifer that discharges to Galena Creek were above MT DEQ-7 human health standards for arsenic, cadmium, copper, lead, nickel, and zinc. As shown in Table 4, the sample collected from Galena Creek downgradient of the Block P waste pile (GC-SS-2) was above MT DEQ-7 human health standards for cadmium, copper, lead, and zinc.

The data presented in Table 7 indicate that waste rock materials located at the ground surface at the Site (and, therefore, potentially the adjacent or underlying soils) contain elevated concentrations of arsenic, copper, iron, lead, and zinc.

The parameters proposed as human-health based COCs for the Block P Mine Complex are therefore arsenic, cadmium, copper, lead, nickel, and zinc.

### 5.1.2 Exposure Assessment

The Block P Mine Complex is composed of multiple parcels of both public and private property. Current use of these parcels, however, appears limited to occasional, infrequent recreational activities of limited duration (hiking, hunting, OHV riding, etc). There are no known water supply wells located within the project area, and there is no known history of sport fishing or swimming in Galena Creek.

### 5.1.3 Risk Characterization

Despite the observed concentrations of COCs in waste rock, groundwater, and surface water at the Site, the expected use of the properties that comprise the Block P Mine Complex suggest that potential exposure pathways are limited, at most, and therefore there is limited human-health risk posed by existing conditions at the Site.

## 5.2 Ecological Risk

As with the human health risk evaluation, evaluation of the risk that existing site conditions pose to plants and animals requires identification of COCs, followed by completion of an exposure pathway assessment.

### 5.2.1 Contaminants of Concern

Concentrations of potential COCs in both groundwater and surface water were compared to the applicable MT DEQ-7 standards. As shown in Table 3, one or more groundwater samples collected from monitoring wells finished in the unconsolidated aquifer along Galena Creek (e.g. groundwater likely to discharge to the creek) were above MT DEQ-7 acute and/or chronic aquatic life standards for aluminum, arsenic, cadmium, copper, iron, lead, nickel, and zinc. As shown in Table 4, the surface water sample collected from Galena Creek downgradient of the Block P waste pile (GC-SS-2) reportedly contained concentrations of aluminum, cadmium, copper, iron, lead, and zinc above MT DEQ-7 acute and/or chronic aquatic life standards.

In addition, the presence of unvegetated waste rock piles at the Site provides evidence that phytotoxic conditions are present on the waste rock piles that are preventing vegetation from becoming re-established.

The parameters proposed as aquatic life based COCs for the Block P Mine Complex are therefore aluminum, arsenic, cadmium, copper, iron, lead, nickel, and zinc.

### 5.2.2 Exposure Assessment

The primary ecological receptor at the Site is aquatic life in Galena Creek. The elevated total and dissolved metals concentrations and low pH inhibit aquatic life in Galena Creek where it flows through the Site and for some additional unquantified distance downstream of the Site. Terrestrial plants are impacted by the elevated metals concentrations and unfavorable soil conditions present at the waste rock piles and from the uptake of soil moisture impacted by acid mine drainage with low pH and elevated metals concentrations.

### 5.2.3 Risk Characterization

Based on the observed concentrations of potential COCs and the current status and/or response ecological receptors identified within the project area, it is determined that there is an ecological risk posed by existing conditions at the Site.

# 6.0 Identification of Removal Action Objectives

The objective of the proposed removal action is to implement actions at the Block P Mine Complex that will prevent or minimize exposure to hazardous substances present in the mine waste at the surface and reduce or eliminate ongoing releases of hazardous substances from the mine waste that impact surface water and groundwater at the Site.

The goals of the combined objectives described above are to:

- Reduce contaminant loading from the Site such that water quality standards are not exceeded in surface water,
- Reduce groundwater contaminant loading, and
- Prevent exposure to hazardous substances on or near the surface that pose a threat to human health or the environment.

This action is being conducted on the broader National Priorities List (NPL) site and is considered an interim action that is expected to be followed by other actions in subsequent years leading to a final remedy. Therefore, this EE/CA is not intended to present alternatives that address contamination on the entire NPL site.

## 6.1 Determination of Removal Action Scope

The scope of the mine waste removal action is to consolidate and contain mine waste such that hazardous substance migration and exposure is minimized or eliminated. The objective of the mine drainage removal action is to reduce the discharge of hazardous substances from mine workings to surface water and groundwater through surface drainage/infiltration controls and/or passive treatment systems.

In accomplishing these objectives, the project must meet all applicable or relevant and appropriate requirements (ARARs), included as Appendix H. The waste rock piles associated with the Block P Mine, Wright Mine, Edwards Mine, Belt Patent Mine and the mine discharge from the Block P and Grey Eagle adits will be managed as part of this EE/CA or addenda to this EE/CA. The actions shall attain ARARs to the extent practicable as called for in Section 300.415 (j) of the NCP.

## 6.2 Determination of Removal Schedule

Implementation of the selected removal alternative will be accomplished in steps. First, the recommended removal alternative must be selected by the USEPA and published in an Action Memorandum. USEPA in consultation with MDEQ and Doe Run will then negotiate an AOC outlining specific time frames and schedules for project submittals. The AOC will likely require that a final design, construction plans and specifications, and an operations, monitoring, and maintenance plan be submitted to USEPA for review and approval. After the final design is approved, Doe Run will solicit construction bids from one or more qualified contractors, review the bids received, select a contractor for the removal action, and issue a notice to proceed. The initial activities for waste rock removal actions are planned for 2010.

# 7.0 Description of Removal Action Alternatives

The 2008 Work Plan for the Block P Mine Complex (Barr, 2008c) identified a series of conceptual removal action alternatives to be considered for inclusion in the EE/CA. The list of conceptual alternatives for mine wastes presented in the work plan included:

- No action
- In-situ fixation / stabilization
- In-situ capping with a soil cover
- Consolidation for synthetic capping
- Excavation for offsite disposal

The list of conceptual alternatives for mine drainage presented in the work plan included:

- No action
- Reduce inflow to mine workings
- Renovate mine workings to reduce drainage
- Construct passive mine drainage treatment system

Subsequent discussions between USEPA, MDEQ, and Doe Run refined these lists of conceptual alternatives to the alternatives presented in this section. Given the complexity of the interaction of the Block P waste rock pile and the Block P adit, the evaluation of alternatives designed to address mine drainage will be introduced in this EE/CA but is expected to require additional analysis before a remedy can be selected. The remainder of this section describes the removal action alternatives evaluated as part of the EE/CA.

## 7.1 Mine Wastes

The four removal action alternatives for mine wastes evaluated in this EE/CA include:

- No Action
- Consolidate waste rock into a repository located in Area 2
- Consolidate waste rock into a repository located in Area 3
- Excavate waste rock for disposal in a repository located outside the Galena Creek watershed

The following paragraphs describe each of the removal action alternatives selected for more detailed analysis. Table 8 summarizes the estimated volumes of waste rock associated with each of the identified mines.

### 7.1.1 Alternative 1 – No Action

Under the No Action alternative, no effort will be made to excavate, regrade, stabilize, revegetate, or otherwise actively reduce risks to human health or the environment currently posed by the Block P Mine Complex. No additional groundwater or surface water monitoring would be conducted in the project area.

### 7.1.2 Alternative 2 – Consolidate waste rock into Area 2

An area located upslope from the Wright-Edwards mines (Area 2) has been identified as a potentially suitable repository location capable of storing the entire volume of waste rock from the Block P Mine Complex (approximately 260,000 cubic yards). This area is believed to be comprised of both public (USDA-FS) and private property. Figures 18 and 19 depict the conceptual design for a repository in Area 2. Based on the geotechnical properties of the waste rock, it has been determined that a 2.5H:1V sideslope is sufficient for slope stability and can be constructed using standard earth-moving equipment. The cover material for the repository will be taken as a subcut from the unconsolidated soil present within the footprint of the repository. A 3-foot vegetative soil cover would be placed as a cover for the repository.

The conceptual design of an Area 2 repository has been revised since the July 2009 draft EE/CA to maximize the potential storage capacity. After expanding the topographic survey of Area 2 in October 2009, it was determined that additional suitable area for a repository was present to the west-southwest of the initially screened repository footprint. The initial conceptual footprint for a repository in Area 2 had an estimated storage capacity of approximately 220,000 cubic yards.

Expanding the footprint allows for the estimated 260,000 cubic yards required to store the entire Block P Mine Complex waste rock volume.

The existing access road to Area 2 would need to be improved to accommodate heavy equipment and haul trucks. The cover soil used to revegetate the former waste rock piles themselves would be excavated from the repository subcut. A total of approximately 35,000 cubic yards of material is required for revegetation at the waste rock piles. Test pit results have indicated that approximately 10-12 feet of unconsolidated material is potentially present in Area 2. The maximum amount of subcut would be taken from the upslope edge of the repository (see Figure 19) and the waste rock would be placed in the subcut void and construction progress would move downslope. This would allow for additional subcut to be made if additional soil is required for revegetation or stream channel reconstruction activities. Erosion control and temporary water management will be required for earthwork activities completed within surface water channels at the Block P waste rock pile and the Wright-Edwards waste rock piles located within the intermittent creek valley.

Alternative 2 will require the removal of the historical mining structures that remain on or near the Block P waste rock pile, as well as the abandonment of selected monitoring wells. The openings to the Block P and Grey Eagle adits would be secured, but not sealed. The vertical opening at the top of the Block P (Barker) shaft would be sealed from the ground surface down to the 75-foot level. A floodplain would be reestablished for Galena Creek and the stream channel would be stabilized as necessary to reduce the potential that the channel could meander into the former area of the Block P waste rock pile.

### 7.1.3 Alternative 3 – Consolidate waste rock into Area 3

Area 3, located between the Site and the Block P Mill Tailings Site, has been identified as another potentially suitable repository location capable of storing the entire volume of waste rock from the Block P Mine Complex (approximately 260,000 cubic yards). This area is comprised nearly entirely of property under the ownership of the same private landowner. Figures 20 and 21 depict the conceptual design for an Area 3 Repository. The footprint of a repository in Area 3 would be set back approximately 300 feet from the surface drainage channel located to the south. The offset distance is to prevent potential interaction with surface water and coincides with an increased topographic slope adjacent to the surface drainage channel. Based on the geotechnical properties of the waste rock, it has been determined that a 2.5H:1V sideslope is sufficient for slope stability and can be constructed using standard earth-moving equipment. The cover material for the repository

will be taken as a subcut from the unconsolidated soil present within the footprint of the repository. A 3-foot vegetative soil cover would be placed as a cover for the repository.

Part of Area 3 is densely forested all will require clearing as part of site preparation. It is assumed that a sufficient volume of suitable unconsolidated material will be present in the subcut or adjacent to the Area 3 repository to provide both cover soil for the repository itself and to provide cover soil at the former waste rock pile locations. Erosion control and temporary water management will be required for earthwork activities completed within surface water channels at the Block P waste rock pile and the Wright-Edwards waste rock piles located within the intermittent creek valley.

Alternative 3 will also require the removal of the historical mining structures that remain on or near the Block P waste rock pile, as well as the abandonment of selected monitoring wells. As with Alternative 2, the openings to the Block P and Grey Eagle adits would be secured, but not sealed, as part of Alternative 3, and the vertical opening at the top of the Block P (Barker) shaft would be sealed from the ground surface down to the 75-foot level. A floodplain would be reestablished for Galena Creek and the stream channel would be stabilized as necessary to reduce the potential that the channel could meander into the former area of the Block P waste rock pile.

### 7.1.4 Alternative 4 – Excavate for Offsite Repository

Under this alternative, all waste rock, contaminated soil, and mining-related debris identified for removal will be excavated using traditional excavation equipment and loaded directly into over-the-road vehicles for transportation to an engineered repository to be constructed outside of the Galena Creek watershed. Excavation for offsite disposal at an existing disposal facility was considered in the July 2009 draft EE/CA, but this potential alternative was deemed both unreasonably cost prohibitive and potentially technically infeasible.

As shown in Table 8, the total estimated volume of materials to be managed for offsite disposal is assumed to be approximately 260,000 cubic yards. For the purposes of this analysis, we have assumed that the off-site repository would be constructed within the Belt Creek watershed on a parcel of property (to be acquired) somewhere adjacent to Hwy 89. There are multiple locations with topography suitable for a repository in this area. The conceptual design for an off-site repository is shown on Figures 22 and 23. A synthetic liner and cap would be installed to reduce the potential that seasonally high surface or groundwater conditions would encroach on the waste rock in the repository. The repository would have sideslopes of 2.5H:1V. Cover material for the off-site

repository would be obtained from one of the aggregate sources currently in operation between Sluice Boxes State Park and the town of Belt.

As with both preceding removal action alternatives, Alternative 4 will require the removal of the historical mining structures that remain on or near the Block P waste rock pile, as well as the abandonment of selected monitoring wells. The openings to the Block P and Grey Eagle adits would be secured, but not sealed. The vertical opening at the top of the Block P (Barker) shaft would be sealed from the ground surface down to the 75-foot level. A floodplain would be reestablished for Galena Creek and the stream channel would be stabilized as necessary to reduce the potential that the channel could meander into the former area of the Block P waste rock pile.

## 7.2 Mine Drainage

As has been discussed with USEPA and MDEQ throughout this EE/CA process, potential solutions for the acid mine drainage conditions in the Block P and Grey Eagle mine adits are difficult to evaluate independent of the waste rock present at the Site. Mine drainage conditions will therefore be monitored and continually evaluated as the waste rock removal action is implemented. Removal of waste rock from the Site, particularly from the Block P mine and along Galena Creek is expected to lead to improvements in the water quality in the acid mine drainage flowing from the Block P adit and in Galena Creek itself. The need for additional removal actions specific to the acid mine drainage will be addressed separately.

# 8.0 Analysis and Comparison of Removal Action Alternatives

This section is intended to present a discussion of the four removal action alternatives presented in Section 7. In addition to providing additional information about the nature of each alternative, an analysis of each alternative with respect to its effectiveness, implementability, and cost is included. Effectiveness is defined as how well an alternative provides overall protection of human health and the environment, how well it complies with applicable or relevant and appropriate requirements (ARARs), how well it maintains effectiveness and permanence, what the short-term effectiveness of the option is, and the degree the option reduces the toxicity, mobility, or volume of the wastes. Implementability is a combination of the technical and administrative feasibility of the option with the availability of the required elements in the project area. Total costs represent the present worth of construction (capital), operating, monitoring, and maintenance costs.

This section does not analyze alternatives associated with mine drainage within the Block P Mine Complex. Further analysis of mine drainage alternatives will be conducted following waste rock removal implementation.

## 8.1 Alternative 1 – No Action

The no action alternative means that no removal action work would be performed at the Site, and that no additional investigation or site monitoring would be conducted. This alternative does not provide for a reduction in risk to either human health or the environment, is not compliant with ARARs, and is not effective in the short-term or long-term. This alternative is therefore eliminated from further consideration or evaluation.

## 8.2 Alternative 2 – Consolidate Waste Rock into Area 2

Alternative 2 entails consolidating the entire 260,000 cubic yards of waste rock from the Block P, Wright, Edwards, and Belt Patent mines into a repository located upslope from the Wright and Edwards mines in Area 2. The repository will be capped with a vegetative cover and the surface water will be diverted around the repository. The areas of the former waste rock piles will be regraded and revegetated.

### 8.2.1 Overall Protection of Human Health and the Environment

Consolidating and covering the waste rock will reduce contaminant mobility and eliminate the potential for direct contact or inhalation exposure. Waste rock will be removed from both the Galena

Creek floodplain and tributary drainages and separated from potential groundwater interaction. Capping of the consolidated waste rock repository will reduce the volume of precipitation available to leach contaminants from the waste rock to groundwater or surface water. Revegetation will stabilize the surface of the repository and reduce the potential for future wind and water erosion.

### 8.2.2 Compliance with ARARs

A list of proposed state and federal ARARs for the Block P Mine Complex were previously included in the 2008 Work Plan for the Engineering Evaluation / Cost Analysis (Barr, 2008c). Proposed ARARs are also included in Appendix H of this report. Surface water quality standards are applicable at the Site, and the releases of hazardous substances from the waste rock at the Block P Mine Complex do contribute to the heavy metals concentrations in Galena Creek exceeding Montana DEQ-7 standards. Fully attaining these standards is beyond the current scope of the removal action being considered. A final remedy decision under the USEPA's remedial program will address attainment of surface water quality standards. The following text describes how the actions proposed as part of Alternative 2 would meet the ARARs identified for the project.

Alternative 2 will eliminate direct contaminant loadings via surface water runoff to Galena Creek and eliminate contaminant leaching to groundwater due to infiltration of surface water through waste rock piles, thereby providing improvement in surface and groundwater water quality. Because this EE/CA action does not address other sources of mining-related wastes in the watershed, however, full compliance with contaminant-specific ARARs in Galena Creek is not expected to be achieved.

Groundwater quality in the vicinity of the Block P Mine Complex has been impaired by interaction of groundwater with abandoned mine workings and leaching of contaminants from waste rock piles. Removing waste rock piles and consolidating them within an engineered repository will significantly reduce or eliminate the interaction of waste rock with water, reducing the potential contaminant load to groundwater. Excavation of waste rock piles may also reduce contaminant loading resulting from interaction of abandoned mine workings with groundwater, but there is insufficient data at the present to quantify the potential reduction.

Ambient air monitoring to assess current inhalation exposure risks was not included in the scope of this EE/CA. Capping waste rock piles will, however, reduce the potential for future dust or particulate problems. Dust suppression activities will be conducted during construction activities as needed to reduce short-term exposure (detailed later in action specific ARARs).

Location specific requirements relating to working in floodplains, streambeds, and wetlands, would be followed to the extent practicable. Disturbed areas will be stabilized as needed with natural revetments and revegetated using species and techniques that maximize the potential for successful long-term revegetation. Because of the currently degraded nature of the Block P Mine Complex, this EE/CA action is not anticipated to impact any threatened or endangered species. Post-construction vegetative conditions in Area 2 would be similar to existing conditions with the construction of a vegetated soil cover. The work is expected to occur over a relatively short period of time and result in an overall improvement of habitat in the vicinity of the Block P Mine Complex. All work will be conducted in accordance with state and federal historic preservation requirements and documentation submitted to the Montana State Historical Preservation Office (SHPO) and federal agencies as required.

Mine wastes are not regulated under MDEQ mining and reclamation laws, and are also generally exempt from federal regulation as a RCRA hazardous waste by the Bevill Amendment. Certain requirements of the Montana Solid Waste Management Act may be applicable and/or relevant and appropriate for a removal action that involves construction of a mine waste repository.

Best management practices (BMPs) will be used to ensure compliance with action-specific ARARs for stormwater runoff, dust suppression, grading and revegetation. Grading, soil amendments, seeding, mulching, erosion control, and plant species selection will be conducted to establish a permanent vegetative cover. The final grading and revegetation plan will also minimize changes in the existing site water balance. Overland flow would be directed around the Upper Repository as much as possible.

Hydrology requirements set forth in the Montana Strip and Underground Mine Reclamation Act will be addressed by reducing infiltration through the waste rock piles and diverting surface flows around waste rock piles. Following construction activities to remove the waste rock from the creek valleys, the hydrologic balance will be returned as near as possible to pre-mining conditions. Implementation of Alternative 2 will substantially meet the hydrology requirements.

Site conditions require that Occupational Safety and Health Administration (OSHA) requirements covering employees working on contaminated sites be met. Initial 40-hour Hazardous Waste Operation and Emergency Response (HAZWOPER) training and 8-hour annual refresher training is required for all onsite workers. A site specific Health and Safety Plan which details activities to be

conducted at the Site and appropriate levels of employee protection for the conditions will be followed (Barr, 2008d).

### 8.2.3 Long-Term Effectiveness

Alternative 2 will reduce the volume of uncontrolled mining wastes within the Galena Creek watershed and consolidate the waste rock associated with the Block P Mine Complex into an engineered repository located out of the Galena Creek floodplain and its tributary drainages. These actions will significantly and permanently reduce the potential for future direct contact, ingestion, and inhalation for both human and ecological receptors, as well as reduce the potential for contaminant loading to groundwater or surface water.

### 8.2.4 Reduction in Toxicity, Mobility, or Volume through Treatment

Alternative 2 reduces the mobility of contaminants by placing waste rock into an engineered repository that is capped with a soil cover. The cover will be designed to reduce infiltration and leaching of contaminants to the underlying soil and groundwater, as well as eliminate off-site transport of mine wastes via wind or water.

Toxicity of contaminants will not be reduced for Alternative 2.

The volume of the wastes would not be changed under this alternative.

### 8.2.5 Short-Term Effectiveness

During implementation of this alternative, the public will be protected by establishing exclusionary work zones around the Site as appropriate. Employees of Doe Run, its representatives, and its contractors will be required to follow construction safety and exposure reduction guidelines as detailed in a site specific Health and Safety Plan, including carrying current 40-hour OSHA HAZWOPER training and 8-hour annual refresher training. Appropriate dust suppression methods will be used to minimize airborne contaminants during construction and suitable erosion control techniques will be implemented to reduce the potential for offsite transport of exposed wastes during rainfall events. It is expected that Alternative 2 can be implemented in 12-14 weeks, excluding revegetation.

### 8.2.6 Implementability

This alternative is both technically and administratively feasible, but will present challenges related to material transportation. Excavation and placement of waste rock, application of soil amendments, and establishment of vegetation can be accomplished using traditional construction methods.

Transportation of waste rock from their current locations to the Upper Repository will require existing access roads to be improved or expanded to facilitate haul trucks and other construction equipment.

Area 2 is comprised of several parcels of land, none of which are currently owned by Doe Run. Discussions with these landowners regarding their willingness to participate in the removal action (either via access agreement, permanent easement, or sale) are underway, but have not been completed.

### 8.2.7 Cost Screening

As shown in Table 11, the estimated cost to implement Alternative 2 is $6,050,000. A detailed cost breakdown is included in Appendix J.

### 8.2.8 Summary

Alternative 2 is retained for further consideration. This alternative may be a feasible and cost effective means of meeting the project objectives for the Block P Mine Complex waste rock piles. The ability to implement Alternative 2 will be largely dependent upon securing access to, and use of, the properties in the vicinity of Area 2.

## 8.3 Alternative 3 – Consolidate Waste Rock into Area 3

Alternative 3 entails consolidating the entire 260,000 cubic yards of waste rock from the Block P Mine Complex into an engineered repository constructed within Area 3. The repository will be capped with a soil cover and surface water will be diverted around the repository. The repository and former waste rock piles will be revegetated.

### 8.3.1 Overall Protection of Human Health and the Environment

Consolidating and covering the waste rock will reduce contaminant mobility and eliminate the potential for direct contact or inhalation exposure. Waste rock will be removed from both the Galena Creek floodplain and its tributary drainages and separated from potential groundwater interaction. Capping of the consolidated waste rock repository will reduce the volume of precipitation available to leach contaminants from the waste rock to groundwater or surface water. Revegetation will stabilize the surface of the repository and reduce the potential for future wind and water erosion.

### 8.3.2 Compliance with ARARs

A list of proposed state and federal ARARs for the Block P Mine Complex were previously included in the 2008 Work Plan for the Engineering Evaluation / Cost Analysis (Barr, 2008c). ARARs are

also included in Appendix H of this report. Surface water quality standards are applicable at the Site, and the releases of hazardous substances from the waste rock at the Block P Mine Complex do contribute to the heavy metals concentrations in Galena Creek exceeding Montana DEQ-7 standards. Fully attaining these standards is beyond the current scope of the removal action being considered. A final remedy decision under the USEPA's remedial program will address attainment of surface water quality standards. The following text describes how the actions proposed as part of Alternative 3 would meet the ARARs identified for the project.

Alternative 3 will eliminate direct contaminant loadings via surface water runoff to Galena Creek and eliminate contaminant leaching to groundwater due to infiltration of surface water through waste rock piles, thereby providing improvement in surface and groundwater quality. Because this EE/CA action does not address other sources of mining-related wastes in the watershed, full compliance with contaminant-specific ARARs in Galena Creek is not expected to be achievable as a result of this EE/CA action.

Groundwater quality in the vicinity of the Block P Mine Complex has been impaired by interaction of groundwater with abandoned mine workings and leaching of contaminants from waste rock piles. Removing waste rock piles and consolidating them within an engineered repository outside of the Galena Creek floodplain will significantly reduce or eliminate the interaction of waste rock with water, reducing the potential contaminant load to groundwater. Excavation of waste rock piles may also reduce contaminant loading resulting from interaction of abandoned mine workings with groundwater, but there is insufficient data at the present to quantify the potential reduction.

Ambient air monitoring to assess current inhalation exposure risks was not included in the scope of this EE/CA. Capping waste rock piles with a soil cover, however, will reduce the potential for future dust or particulate problems. Dust suppression activities will be conducted as needed during construction activities to reduce short-term exposure (detailed later in action specific ARARs).

Location specific requirements relating to working in floodplains, streambeds, and wetlands, would be followed to the extent practicable. Disturbed areas will be stabilized as needed with natural revetments and revegetated using species and techniques that maximize the potential for successful long-term revegetation. Because of the currently degraded nature of the Block P Mine Complex, this EE/CA action is not anticipated to impact any threatened or endangered species. Post-construction vegetative conditions in Area 3 would be similar to existing conditions with the construction of a vegetated soil cover. The work is expected to occur over a relatively short period of time and result

in an overall improvement of habitat in the vicinity of the Block P Mine Complex. All work will be conducted in accordance with state and federal historic preservation requirements and documentation submitted to the Montana State Historical Preservation Office and Federal Agencies as required.

Mine wastes are not regulated under MDEQ mining and reclamation laws, and are also generally exempt from federal regulation as a RCRA hazardous waste by the Bevill Amendment. Certain requirements of the Montana Solid Waste Management Act may be applicable and/or relevant and appropriate for a removal action that involves construction of a mine waste repository.

Best management practices (BMPs) will be used to ensure compliance with action-specific ARARs for stormwater runoff, dust suppression, grading and revegetation. Grading, soil amendments, seeding, mulching, erosion control, and plant species selection will be conducted to establish a permanent vegetative cover. The final grading and revegetation plan will also minimize changes in the existing site water balance. Overland flow would be directed around the Silver Bell Repository as much as possible.

Hydrology requirements set forth in the Montana Strip and Underground Mine Reclamation Act will be addressed by reducing infiltration through the waste rock piles and diverting surface flows around waste rock piles. Following construction activities to remove the waste rock from the creek valleys, the hydrologic balance will be returned as near as possible to pre-mining conditions. Implementation of Alternative 3 will substantially meet the hydrology requirements.

Site conditions require that Occupational Safety and Health Administration (OSHA) requirements covering employees working on contaminated sites be met. Initial 40-hour Hazardous Waste Operation and Emergency Response (HAZWOPER) training and 8-hour annual refresher training is required for all onsite workers. A site specific Health and Safety Plan which details activities to be conducted at the Site and appropriate levels of employee protection for the conditions will be followed (Barr, 2008d).

### 8.3.3 Long-Term Effectiveness

Alternative 3 will reduce the volume of uncontrolled mining wastes within the Galena Creek watershed and consolidate the waste rock associated with the Block P Mine Complex into an engineered repository located out of the Galena Creek floodplain and its tributary drainages. These actions will significantly and permanently reduce the potential for future direct contact, ingestion, and inhalation for both human and ecological receptors, as well as reduce the potential for contaminant loading to groundwater or surface water.

### 8.3.4 Reduction in Toxicity, Mobility, or Volume through Treatment

Alternative 3 reduces the mobility of contaminants by placing waste rock into an engineered repository that is capped with a soil cover. The cover will be designed to reduce infiltration and leaching of contaminants to the underlying soil and groundwater, as well as eliminate off-site transport of mine wastes via wind or water.

Toxicity of contaminants will not be reduced for Alternative 3.

The volume of the wastes would not be changed under this alternative.

### 8.3.5 Short-Term Effectiveness

During implementation of this alternative, the public will be protected by establishing exclusionary work zones around the Site as appropriate. Employees of Doe Run, its representatives, and its contractors will be required to follow construction safety and exposure reduction guidelines as detailed in a site specific Health and Safety Plan, including carrying current 40-hour OSHA HAZWOPER training and 8-hour annual refresher training. Appropriate dust suppression methods will be used to minimize airborne contaminants during construction and suitable erosion control techniques will be implemented to reduce the potential for offsite transport of exposed wastes during rainfall events. It is expected that Alternative 3 can be implemented in 12-14 weeks, excluding revegetation.

### 8.3.6 Implementability

This alternative is both technically and administratively feasible. Agreements with current landowners to access the various mine sites for the purposes of reclamation will need to be secured. Excavation, transport, and placement of waste rock are accomplished using traditional construction methods.

Area 3 is comprised of land not currently owned by Doe Run. Discussions with these private landowners regarding their willingness to participate in the removal action (either via access agreement, permanent easement, or sale) are underway, but have not been completed.

### 8.3.7 Cost Screening

As shown in Table 11, the estimated cost to implement Alternative 3 is $5,340,000. A detailed cost breakdown is included in Appendix J.

### 8.3.8 Summary

Alternative 3 is retained for further consideration. This alternative may be a feasible and cost effective means of meeting the project objectives for the Block P Mine Complex waste rock piles. The ability to implement Alternative 3 will be largely dependent upon securing access to, and use of, the private property within Area 3.

## 8.4 Alternative 4 – Excavation for Offsite Repository

Alternative 4 would require excavation of the approximately 260,000 cubic yards of waste rock and related materials and transport of the materials to an offsite engineered repository. Areas disturbed by excavation of the waste rock piles would be regraded and revegetated to improve surface water drainage, minimize erosion, and establish permanent vegetative cover. This alternative does provide a reduction in risk to both human health and the environment, it is readily implementable, and it would be effective over the long-term.

Alternative 4 will require use of property not currently owned by Doe Run. Given the estimated cost of this option, discussions with potential landowners in the Belt Creek valley have not been initiated to determine their willingness to participate in the removal action (either via access agreement, permanent easement, or sale).

Alternative 4 has a substantially higher cost ($12,090,000) than either Alternative 2 or Alternative 3 and does not provide a proportionately higher level of protection of human health and the environment. It is therefore not retained for further consideration.

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