UPPER BLACKFOOT MINING COMPLEX

Repository Siting Study

Prepared for:

Montana Department of Environmental Quality Remediation Division

and

U.S. Department of Agriculture/Forest Service

September 20, 2011

REPOSITORY SITING STUDY

UPPER BLACKFOOT MNING COMPLEX

Prepared for:

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

and

Helena National Forest
2880 Skyway Drive
Helena, Montana 59602Prepared by:

Prepared by:

Pioneer Technical Services, Inc.
P. O. Box 3445
Butte, Montana 59702

September 20, 2011

TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1
- 1.1 PURPOSE AND SCOPE 1
- 1.2 REGULATORY AND SETTLEMENT BACKGROUND 1
- 1.3 SITE DESCRIPTION AND PROJECT HISTORY 2
- 1.4 DOCUMENT ORGANIZATION 4

2.0 OVERVIEW OF REPOSITORY SITE SELECTION PROCESS 5
- 2.1 FOREST SERVICE REPOSITORY DECISION 5
- 2.2 KEY CHANGES AFTER THE EE/CA AND FOREST SERVICE ACTION MEMO 5
- 2.3 REVIEW OF REPOSITORY IDENTIFICATION PROCESS TO DATE 6
- 2.4 FRESH LOOK FOR POTENTIAL REPOSITORY LOCATIONS 7
- 2.5 PRELIMINARY SCREENING OF THE FRESH LOOK REPOSITORY LOCATIONS 7

3.0 DESCRIPTION AND SCREENING OF PREVIOUSLY INVESTIGATED SITES 8
- 3.1 SITES IDENTIFIED IN THE EE/CA 8
  - 3.1.1 Paymaster Repository Site 9
  - 3.1.2 First Gulch Repository Site 11
  - 3.1.3 Horsefly Creek Repository Site 12
- 3.2 SITES IDENTIFIED AFTER THE EE/CA 13
  - 3.2.1 Shave Gulch (South Side of Drainage) Repository Site 13
  - 3.2.2 Section 35 Repository Site 15
- 3.3 SCREENING SUMMARY OF PREVIOUSLY IDENTIFIED SITES 16

4.0 DEVELOPMENT AND EVALUATION OF SPECIFIC ALTERNATIVES 17
- 4.1 KEY ASSUMPTIONS APPLICABLE TO ALL ALTERNATIVES 17
- 4.2 PRELIMINARY REPOSITORY STABILITY ANALYSIS 18
  - 4.2.1 Conceptual Cap and Liner Design for All Repository Sites 19
  - 4.2.2 General Considerations 20
  - 4.2.3 Material Shear Strength Parameters 21
  - 4.2.4 Compacted Colluvium from Section 35 Site (Cover Soil) 22
  - 4.2.5 Liner System 22
  - 4.2.6 Paymaster Repository Geometries 23
  - 4.2.7 Section 35 Repository Geometries 24
  - 4.2.8 Shave Gulch Repository Geometries 25
  - 4.2.9 First Gulch Repository Geometries 26
  - 4.2.10 Repository Global & Liner System Stability Analysis 26
  - 4.2.11 Liner System Deformation Analysis 28
- 4.3 SUMMARY OF STABILITY ANALYSES 28
- 4.4 DESCRIPTION AND EVALUATION OF ALTERNATIVES 29
  - 4.4.1 Paymaster Option 4 29
  - 4.4.2 Paymaster Option 6 33
  - 4.4.3 First Gulch Option 1 36
  - 4.4.4 Horsefly Creek 39

4.4.5 Section 35 42
4.4.6 Blackfoot River Site 1 45
4.4.7 Alice Creek Site 4 48
4.4.8 Alice Creek Site 7 52
4.4.9 McDonald Meadows Sites 55
4.4.10 State Section 18 Sites East of Rogers Pass 58
4.4.11 Hypothetical Site East of Rogers Pass 61
4.5 SCREENING OF ALTERNATIVES 64

5.0 COMPARISON OF ALTERNATIVES 67
5.1 EFFECTIVENESS (PROTECTIVENESS) 67
5.2 IMPLEMENTABILITY (FEASIBILITY) 69
5.3 COST 70
5.4 RECOMMENDED ALTERNATIVE 71

6.0 REFERENCES 72

LIST OF TABLES

Page

Table 4.1 Material Properties used in Stability Analysis 23
Table 4.2 Stability Analysis Results 27
Table 4.3 Paymaster Option 4 Evaluation 30
Table 4.4 Paymaster Option 6 Evaluation 33
Table 4.5 First Gulch Option 1 Evaluation 36
Table 4.6 Horsefly Creek Evaluation 39
Table 4.7 Section 35 Evaluation 42
Table 4.8 Blackfoot River Site 1 Evaluation 46
Table 4.9 Alice Creek Site 4 Evaluation 49
Table 4.10 Alice Creek Site 7 Evaluation 52
Table 4.11 McDonald Meadow Sites 3 and 4 Evaluation Summary 55
Table 4.12 State Section 18 Evaluation 59
Table 4.13 Hypothetical Site East of Rogers Pass Evaluation 62
Table 4.14 Alternatives Cost Comparison 66

LIST OF APPENDICES

Appendix A Project Summary Memos

Appendix B Slide 6.0 Failure Analyses Reports

Appendix C Cost Estimates

Appendix D Repository Site Photographs

LIST OF FIGURES (FIGURES TAB)

Figure 1.1 Upper Blackfoot Repository Sites, Site Location Map
Figure 1.2 Repository Sites Overview
Figure 1.3 UBMC Site Map
Figure 2.1 Fresh Look Sites
Figure 3.1 EE/CA Repository Sites
Figure 3.2 Repository Sites, Paymaster
Figure 3.3 Repository Sites, First Gulch
Figure 3.4 Repository Sites, Horsefly Creek
Figure 3.5 Repository Sites, Post EE/CA Sites
Figure 4.1 Paymaster Opt. 1, Plan View
Figure 4.2 Paymaster Opt. 1, Section View
Figure 4.3 Paymaster Opt. 2, Plan View
Figure 4.4 Paymaster Opt. 2, Section View
Figure 4.5 Paymaster Opt. 3, Plan View
Figure 4.6 Paymaster Opt. 3, Section View
Figure 4.7 Paymaster Opt. 4, Plan View
Figure 4.8 Paymaster Opt. 4, Section View
Figure 4.9 Paymaster Opt. 5, Plan View
Figure 4.10 Paymaster Opt. 5, Section View
Figure 4.11 Paymaster Opt. 6, Plan View
Figure 4.12 Paymaster Opt. 6, Section View
Figure 4.13 Paymaster Opt. 7, Plan View
Figure 4.14 Paymaster Opt. 7, Section View
Figure 4.15 Section 35 Opt. 1, Plan View
Figure 4.16 Section 35 Opt. 1, Section View
Figure 4.17 Section 35 Opt. 2, Plan View
Figure 4.18 Section 35 Opt. 2, Section View
Figure 4.19 Section 35 Opt. 3, Plan View
Figure 4.20 Section 35 Opt. 3, Section View
Figure 4.21 Shave Gulch Opt. 1, Plan View
Figure 4.22 Shave Gulch Opt. 1, Section View
Figure 4.23 Shave Gulch Opt. 2, Plan View
Figure 4.24 Shave Gulch Opt. 2, Section View
Figure 4.25 Shave Gulch Opt. 3, Plan View
Figure 4.26 Shave Gulch Opt. 3, Section View
Figure 4.27 Shave Gulch Opt. 4, Plan View
Figure 4.28 Shave Gulch Opt. 4, Section View
Figure 4.29 First Gulch Opt. 1
Figure 4.30 First Gulch Opt. 2
Figure 4.31 West Haul Roads
Figure 4.32 East Haul Roads
Figure 4.33 Blackfoot Site
Figure 4.34 Alice Creek 4
Figure 4.35 Alice Creek 7
Figure 4.36 McDonald Meadows Sites
Figure 4.37 Section 18

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

This Repository Siting Study has been prepared by Pioneer Technical Services, Inc. (Pioneer), for the Montana Department of Environmental Quality (DEQ) and the U.S. Department of Agriculture/Forest Service (Forest Service) – Region 1, under the provisions of DEQ Contract No. 407038, Task Order No. 51. The purposes of this study are to review previous information, provide supplemental information where available, and then recommend, based on the available information, the most appropriate location for constructing a mine waste repository for mining wastes at the Upper Blackfoot Mining Complex in Lewis and Clark County, Montana (**Figure 1.1**). The repository may be used to contain mine wastes from the Mike Horse tailing impoundment and other local abandoned mining operations associated with the UBMC located on Federal, State and Private lands, as well as tailings and other mine waste materials which have been deposited in the Blackfoot River and its tributaries.

1.2 REGULATORY AND SETTLEMENT BACKGROUND

In July 2007, Asarco prepared an Engineering Evaluation and Cost Analysis (EE/CA) for the Forest Service that evaluated removal options for the mining wastes on National Forest System lands (NFS) at the Upper Blackfoot Mining Complex (UBMC). The EE/CA (Hydrometrics 2007) evaluated several potential repository sites (a type of waste landfill) for containing the wastes, and the Forest Service selected the Paymaster Repository located on Asarco private lands as the repository of choice in the Action Memorandum of July 23, 2007 (the Forest Service decision document), issued by the Forest Service under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Other repository sites, including First Gulch, Old Mike Horse Townsite (eliminated in the EE/CA) and Horsefly Creek were also considered as alternatives in the EE/CA should there be significant technical issues with the Paymaster Repository identified during detailed engineering data collection and design. Approximate locations of these sites in relation to the UBMC mining area are shown on **Figure 1.2.**

Several important changes have occurred at the UBMC since the time that the EE/CA was prepared and the Action Memorandum was signed. In April 2008 the Forest Service, the Montana Department of Environmental Quality (DEQ) and the Montana Department of Justice (DOJ) (collectively "the Agencies") entered into the "*Settlement Agreement Regarding The Upper Blackfoot Mining Complex Site***"** (”Agreement") (DEQ/EPA/USFS 2008a) with Asarco and the Atlantic Richfield Company ("the Companies") as part of the Asarco bankruptcy proceedings. Under that agreement the Agencies were awarded funds to reclaim the UBMC. The settlement required the Agencies to enter into an agreement to stipulate how the Agencies would fund and manage the cleanup completed on the federal lands portion of the UBMC. This agreement, entitled, "Watershed Restoration Agreement Between the State of Montana and the United States Department of Agriculture, Forest Service Northern Region for the Clean Up of the NFS Portion of the Upper Blackfoot Mining Complex Site" (Watershed Agreement) (DEQ/DOJ/USFS 2008b)) was signed by the Agencies in April 2008. As part of another settlement in the bankruptcy, Asarco properties in the mining area were transferred to the

Montana Environmental Custodial Trust (Trust). In December 2008, the Agencies received the settlement funds from the Agreement (DEQ/EPA/USFS 2008a) with Asarco and ARCO for the response actions on NFS lands.

The purpose of the Watershed Agreement is to specify how settlement funds are to be used by the Agencies to fund cleanup actions on NFS lands, to facilitate a cooperative relationship between the Forest Service and the State, and to provide for Forest Service oversight of and involvement in the State's implementation of the cleanup on NFS lands. The cleanup actions agreed to in the Watershed Agreement include implementing the actions specified in the Forest Service's Action Memorandum for the NFS lands. Any other or additional cleanup actions on NFS lands that are to be implemented by the State are subject to review and approval by the Forest Service.

The Agencies agreed to take a site-wide approach to cleanup at the UBMC in order to maximize cleanup efficiencies and to reduce costs as much as feasible. The UBMC contains numerous individual waste sources that are located on either NFS lands or private lands, and has other waste sources that span both NFS and private lands. Segregating the waste sources by land ownership and completing cleanup as separate projects would likely complicate design and construction to a point where the two separate projects may conflict with, damage, or weaken one another and could significantly increase overall project costs and could increase risks to environmental receptors, pose construction safety concerns, and create potential operational/contractual conflicts. Eliminating the division of waste sources by land ownership will allow the Agencies to address waste sources based on relative risk to the environment and phase the project in a logical and manageable manner. This coordinated approach would be substantially benefitted by relocating wastes into a single repository capable of safely holding the waste materials from both NFS and private lands. Constructing multiple repositories would be more expensive and would approximately double long term operation, maintenance, and monitoring costs. The coordinated approach also resulted in a more accurate characterization and delineation of the waste sources. The estimated waste volume increased to approximately 600,000 cubic yards on USFS lands and 400,000 cubic yards on other lands for a combined total estimated waste volume of approximately 1,000,000 cubic yards.

1.3 SITE DESCRIPTION AND PROJECT HISTORY

The Upper Blackfoot Mining Complex is located 15 miles east of Lincoln, Montana along U.S. Highway 200 (**Figure 1-1**). The mining area is characterized by heavily forested, steep, mountainous terrain. Elevations range from approximately 5,000 feet above mean sea level where the Blackfoot River flows under Highway 279, to over 7,500 feet above mean sea level along the Continental Divide. Climatic conditions are typical of intermediate to high elevation regions of the Northern Rocky Mountains with winter temperatures less than 0 degrees Fahrenheit not uncommon. Precipitation falls mainly as snow with accumulations of several feet typical in higher elevation portions of the site.

Mining activity in the UBMC began with the discovery of silver, lead and zinc bearing ores in the late 1800s. Individual historic mines at the UBMC include the Mike Horse Mine, the Anaconda Mine, the Edith Mine, the Paymaster Mine, the Carbonate Mine, and the smaller

Capitol and Consolation Mines. Sporadic development and production occurred at these various mines between 1900 and 1945 with the most significant production occurring at the Mike Horse Mine in the late 1930s and early 1940s. A tailing impoundment was constructed in Beartrap Creek drainage in 1941 for disposal of tailings from the Mike Horse Mine.

Historic mining activities resulted in significant land disturbance and impairment of surface water and groundwater quality at the UBMC. Numerous investigations identified discharges to surface waters from the historic Mike Horse Mine and the Anaconda Mine adits, as well as erosion of metals-laden soils from mine waste piles located in and adjacent to streams. In addition to the long-term impacts, in 1975 heavy precipitation combined with blockage of a surface water diversion ditch caused the Mike Horse tailings impoundment to overtop and breach. As a result of the breach, large volumes of tailings and dam materials were washed downstream and deposited along the floodplains of Beartrap Creek and the Upper Blackfoot River, thus contributing to and expanding mining related impacts in the UBMC.

Asarco conducted mine reclamation activities at the UBMC from 1993 through 2007 that include removing several waste piles to three small repositories located on Asarco owned property, reclaiming some of the mine wastes in place, installing a semi-passive treatment system for adit water discharge from the Mike Horse and Anaconda Mine adits, and installing a water treatment plant. Asarco's responsibility for conducting cleanup actions at the site ceased with the closing of their bankruptcy in December 2009 (See summary provided in Section 1.2). A more complete description of the regulatory and permitting history of the site can be found in the Final Remedial Investigation Work Plan Upper Blackfoot Mining Complex (TetraTech, 2007).

The 2007 EE/CA prepared by Asarco for the Forest Service provided an evaluation of potential response actions to address the mining related impacts on NFS land within the UBMC. The EE/CA addressed removal action options, costs, implementability and effectiveness through evaluation of risks to human health and the environment for the various wastes sources located at the site including the materials in and behind the Mike Horse dam, as well as waste sources in and along Mike Horse Creek, Beartrap Creek and the Blackfoot River. The estimated volume of wastes to be removed in Alternative 4 in the EE/CA was 467,500 cubic yards (Hydrometrics, 2007). The analysis and rationale for selection of Alternative 4 and the Paymaster repository is discussed in the Action Memorandum (USFS 2007).

In January of 2009 per the Watershed Agreement, the State hired engineering firms to complete design-level investigations of the wastes on NFS lands and to perform a detailed analysis of the Paymaster repository site selected by the Forest Service. The investigation showed that the waste volume in the Mike Horse tailings impoundment was much higher than estimated in the EE/CA, which resulted in significant space and stability constraints at the Paymaster repository site, especially if the wastes from NFS and private lands are to be disposed in the same repository.

These issues raised serious concerns regarding the cost and suitability of the Paymaster Repository site. Because of these concerns, a search for other suitable repository sites was initiated. Some of the information from these additional investigations was incorporated into the

first geotechnical design reports (Terragraphics 2009, Spectrum Engineering 2009). The search for the best alternative repository site has continued since these initial reports.

In the spring of 2011, DEQ tasked Pioneer Technical Services, Inc. to complete an independent review of the process used to date to select a repository site and to identify issues with that process. The review portion of the project included a thorough review of all major decision documents as well as an in-depth review of the methods and conclusions used in the decision documents to select a repository site. Beyond this review, Pioneer was also tasked to take a fresh look at the area around the UBMC to identify any sites that may have been overlooked in the investigations completed to date. Pioneer was to then analyze the sites identified in previous documents, sites identified in the fresh look analysis and several sites proposed through public involvement in a logical method in order to identify the best overall repository site.

Since the decision selecting the final repository location will be made by the Agencies as part of a CERCLA removal action, the evaluation of alternatives presented here is conducted in accordance with the requirements of CERCLA and the NCP (the National Oil and Hazardous Substances Pollution Contingency Plan, the regulations implementing CERCLA), as well as applicable guidance under CERCLA. The final decision on a repository will be made through confirmation or modification of the Forest Service's 2007 Action Memorandum (USFS 2007) after consideration of public comment, in accordance with CERCLA and the NCP.

1.4 DOCUMENT ORGANIZATION

Chapter 1 includes an introduction to the project area, site-specific issues and the reasons for the preparing this report.

Chapter 2 presents an overview of the repository site selection process to date.

Chapter 3 provides brief summaries of the site investigations, issues identified, design considerations, the repository sites identified in the EE/CA, and the site investigations completed after the EE/CA and Action Memorandum.

Chapter 4 develops specific repository site alternatives for comparison. A geotechnical analysis of sites with existing data is used to identify key design constraints and successful repository design alternatives for sites with existing data and to identify how these successful repository design alternatives may be applied to other sites without existing data. Once specific configurations are identified for each potential repository site carried forward from Chapter 3, an assessment of site-specific implementability, protectiveness and costs is completed. This screening reduces the list of potential repository sites to a few alternatives for comparative analysis.

Chapter 5 includes a comparison of the viable alternatives selected for detailed analysis from Chapter 4.

Chapter 6 provides references for this report.

2.0 OVERVIEW OF REPOSITORY SITE SELECTION PROCESS

This section presents a brief overview of the repository site selection process to date. Previous decisions and information are summarized and supporting documents are referenced.

2.1 FOREST SERVICE REPOSITORY DECISION

The Forest Service Action Memorandum (July 23, 2007) followed the EE/CA (Hydrometrics 2007) and identified Site Wide Alternative 4 as the selected action for the site. Site Wide Alternative 4 included total removal of the Mike Horse Dam and impounded tailings, total removal of lower Mike Horse creek wastes, total removal of wastes within the Blackfoot River floodplain within the mining area, and removal of the concentrated and intermixed tailings within the active stream channel in Beartrap Creek. The estimated waste volume from the NFS lands of the site in Site Wide Alternative 4 in the EE/CA was 467,500 cubic yards. The preferred repository site for Site Wide Alternative 4 was the Paymaster repository with First Gulch and Horsefly Creek as options should the Paymaster site prove unsuitable.

2.2 KEY CHANGES AFTER THE EE/CA AND FOREST SERVICE ACTION MEMO

Since the EE/CA and Forest Service Action Memorandum were finalized, assumptions fundamental to the basic repository design and construction have changed significantly primarily because:

1. The estimated volume of wastes on NFS land has increased from 467,500 to approximately 600,000 cubic yards based on more detailed site characterization data.
2. The total potential waste volume from private lands is approximately 400,000 cubic yards, making the total potential site volume approximately 1,000,000 cubic yards.
3. Data collected by engineering contractors for DEQ under the Watershed Restoration Agreement identified significant technical issues with the Paymaster Repository site, such as its steep slopes, limited space, requirement of a structural berm to be constructed at the toe, and significant geochemistry issues. These issues raised serious concerns regarding the feasibility and effectiveness of the Paymaster Repository site as a standalone option.

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

2.3 REVIEW OF REPOSITORY IDENTIFICATION PROCESS TO DATE

Pioneer reviewed the documents pertaining to the USFS and DEQ repository investigations conducted to date, including the 2007 EE/CA (Hydrometrics 2007), the Forest Service Action Memorandum and referenced documents (USFS 2007), the 2009 Geotechnical/Geochemical Evaluation and Alternative Analysis (Spectrum 2009), the 2010 Preliminary Design Report (Spectrum and Terragraphics 2010), the 2010 Paymaster/Shave Data Summary Report (Terragraphics 2010b), the 2010 Impoundment Data Summary Report (Spectrum 2009), the 2010 Section 35 Data Summary Report (Terragraphics 2010a), 2011 Section 35 Data Summary Report Addendum (Terragraphics 2011) and the 2010 Repository Fact Sheet (DEQ 2010), as well as detailed conversations with DEQ and USFS staff . This summary of the actions and approach taken by the USFS and DEQ to find suitable repository sites identified missing information noted in the review and provides recommended corrections or clarifications, where applicable, but was not an exhaustive review of all possible information. The summary is presented in the March 22, 2011 memo to DEQ which is provided in **Appendix A**.

This review identified a few steps in the search for potential off-site repository locations (conducted during the EE/CA) that are either not fully documented within the scope of this review or require additional clarification. In order to clarify the record and to help ensure that potential suitable sites were not overlooked, Pioneer recommended revisiting the coarse filter analysis, adding potential new sites from a new analysis of the Geographic Information System (GIS) coarse filter, and manually adding new sites identified in the field.

Issues and recommendations noted in the review were:

- The process used to choose the Horsefly Creek repository site through the EE/CA appeared logical, but a critical review of the screening process was warranted to verify that other sites indentified in the 2006 repository siting study are not better alternatives.
- It is normal that additional potential locations beyond those identified in the 2006 coarse-filter study could be identified through site reconnaissance. The coarse-filter study is a starting point and experienced personnel often identify sites that computer studies cannot.
- A new coarse-filtering analysis may not be valuable because the previous study appears adequate within the limits of a coarse-filtering analysis. Time would be better spent doing more detailed analysis of the alternatives already indentified.
- The 2006 coarse-filter study should be updated by manually adding potential sites identified by on-site personnel in the last few years (Section 35, an existing gravel pit on private land, etc), and adding any new sites that are reasonable to consider.
- All of the alternatives located outside the mining area, including the manually added sites, should be re-screened to identify the best current alternative located outside the mining area.
- Once the best repository site located outside the mining area is identified, the off-area alternative should be compared against the Paymaster and/or Shave Gulch locations given the new information. The preferred alternative should be determined by comparing the alternatives using the typical CERCLA criteria, ARAR's, the alternative's ability to accommodate a coordinated effort, and other site-specific criteria.

- If the evaluations show that the off-area repository site is preferred, the updated screening analysis and alternatives comparison can be used to support the EE/CA amendment.
- Terminology used for each site needs to be corrected in some areas for consistency and readability.
- Terminology on the Paymaster design alternatives used in the recent reports needs to be carried consistently through any new reports to avoid confusion.
- The Paymaster stability analysis should be updated using the correct minimum horizontal acceleration factor (Fh) for this area of 0.11 instead of the 0.09 used in the study. This change may significantly alter the embankment design and could affect the final alternatives analysis.
- USFS and DEQ appear to be considering two different locations east of the Continental Divide. Pioneer recommends that both locations be evaluated in the updated analysis.

2.4 FRESH LOOK FOR POTENTIAL REPOSITORY LOCATIONS

The previous coarse filter analysis conducted for the EE/CA was updated with new potential locations identified in the field and new potential locations east of the Continental Divide. These areas and some recommended new sites are presented in the March 25, 2011, memo provided in **Appendix A**. These new sites, when evaluated alongside those identified previously provide a "fresh look" for potential repository locations outside the mining area. Figure 1 attached to the March 25 memo (**Appendix A**) shows the locations of the general areas identified previously and the new sites to be considered. Table 1 attached to the memo summarizes the locations and provides a brief description of the reasons for selection. The previous coarse filter analysis combined with the newly proposed sites provided more than 60 potential locations that might be suitable repository sites.

2.5 PRELIMINARY SCREENING OF THE FRESH LOOK REPOSITORY LOCATIONS

The process used to screen potential repository sites and the list of potential UBMC waste repository sites recommended for detailed evaluation is presented in the May 2, 2011, memo (**Appendix A**). Pioneer screened the sites identified from the previous coarse filter analysis and the proposed new sites as described in the March 25, 2011 memo.

Preliminary, numeric scoring criteria were developed for available space, slopes, capacity, hydrology, geology, geotechnical concerns, soil suitability, landownership, access, potential for borrow materials, distance from the mining area, distance to human and environmental receptors, visibility, and short-term construction safety concerns for each of the sites. The proposed scoring criteria and brief description of the factors considered are presented in Table 1 attached to the May 2, 2011, memo provided in **Appendix A**.

Sites screened during this process were then scored using the numeric preliminary scoring criteria. All of the criteria for each site were assessed and the scores entered into the preliminary scoring matrix presented in Table 2 attached to the May 2, 2011, memo provided in Appendix A. If an individual criterion or results of a site visit showed that the site was not at all suitable for use as a repository based on that single criterion, that alternative was designated as a "no go" alternative.

The preliminary scores given were based on the best available information, data sources, the site visits and a helicopter flyover. An exhaustive evaluation of each site was not possible within the scope of this study and the matrix was helpful to eliminate sites that are clearly not suitable. This level of detail is appropriate at this stage since the primary purpose of the screening exercise is to ensure that the best potential sites have at least been identified and not overlooked. The sites with the highest overall score represent the locations with the highest potential to be suitable/feasible repository locations. The preliminary repository rankings and sites recommended for detailed analysis are presented in Table 3 attached to the May 2, 2011, memo provided in **Appendix A**.

3.0 DESCRIPTION AND SCREENING OF PREVIOUSLY INVESTIGATED SITES

This section provides a brief description of repository site investigations completed prior to this current study. New information acquired since these investigations were completed has changed the conclusions or analyses. Where applicable, changes are identified in this section.

3.1 SITES IDENTIFIED IN THE EE/CA

The EE/CA (Hydrometrics 2007) includes a detailed analysis of potential repository options for the federal wastes within the UBMC identified at the time of the EE/CA. The repository sites evaluated in detail in the EE/CA include the West Impoundment, Old Townsite, Paymaster, First Gulch, and Horsefly Creek repository sites (**Figure 3.1**). The Forest Service identified ten possible repository sites within the mining area that were identified on maps, field reviewed and screened by the Forest Service (EE/CA Appendix E, USDA Forest Service, April 2006). Of the ten sites identified in the Forest Service Repository Siting Investigation Report (EE/CA Appendix E), only the Old Townsite and Paymaster were carried forward into the site wide alternatives evaluation in the EE/CA.

Outside the mining area, the Forest Service identified the First Gulch repository site; Asarco investigated the site and included it in the EE/CA. DEQ also conducted a search for a suitable site located outside the mining area, identified the Horsefly Creek repository site, and completed a limited site investigation of the Horsefly Creek site and a cost evaluation of the Horsefly Creek repository site is included in the EE/CA. The results of the investigations at First Gulch and Horsefly Creek are included in Appendix E of the EE/CA.

Numerous other possible repository sites were identified but were not evaluated in detail for various reasons. The rationale for discarding the repository sites not retained for detailed analysis is presented in Appendix E of the EE/CA.

A qualitative comparison of the repository sites retained for analysis in the EE/CA is found Section 6 of the EE/CA. The EE/CA states that each of the repositories with potential to accommodate larger waste volumes (Paymaster, First Gulch and Horsefly Creek) needed additional information on subsurface conditions. As the selected alternative, this information was collected for Paymaster in subsequent investigations completed by DEQ in 2009 and 2010.

Of the sites considered in the EE/CA evaluation, only the Paymaster, First Gulch, and Horsefly Creek sites will be carried forward in this report: the other sites were determined unsuitable or less effective in the previous reports.

This section provides a brief description of repository site investigations completed during and after the EE/CA and summarizes design information and assumptions used before starting this current study. This information was used to aid development of the site-specific repository alternatives presented later in this report as well as to document the difficulties encountered during these investigations. Note that this section summarizes the information as it was known or estimated at the time of the studies referenced below.

3.1.1 Paymaster Repository Site

The Paymaster Repository site is located in Township15N, R6W, Section 20 on private property that was owned by Asarco at the time of completion of the EE/CA (2007) (**Figures 3.1 and 3.2**). The property was transferred to the Montana Environmental Custodial Trust as part of the Asarco bankruptcy. The Paymaster Repository site includes an existing repository that was constructed in 1996 and 1997 along with the proposed repository expansion area to the west of the existing repository **(Figure 3.2**).

Three bedrock groundwater monitoring wells were installed in August 2006 to evaluate depth to groundwater and to sample subsurface bedrock. In addition, 10 test borings were drilled and 11 test pits were excavated in September of 2009 to evaluate the depth to groundwater and to sample subsurface soils. Results of these investigations showed that the Paymaster repository site is underlain by hard intrusive mineralized igneous rock and that groundwater was encountered at four locations at depths ranging from approximately 4.3 to 16 feet below the existing ground surface. Between 1 and 6 feet of silty sand and gravel (colluvium) was encountered near the surface across the site. Capacity estimates for the Paymaster site provided in the EE/CA are 200,000 – 300,000 cubic yards with a low profile structure and an estimated footprint of 6 acres and a potential for 500,000 cubic yards or more with an engineered retaining wall or structural berm (EE/CA, 2007).

The site is covered primarily by lodgepole pine, many of which are infested by the pine bark beetle. The existing repository is easily visible from US Highway 200 as it is the only cleared area along the southwestern slope above the Blackfoot River wetlands. The Blackfoot River wetlands lie directly below this site (less than 100 feet in some locations).

The Paymaster site is about 37 acres in size with slopes generally 4H:1V and locally 3H:1V. Groundwater monitoring shows that groundwater levels at their highest would be approximately 15 feet below the excavated repository surface (Spectrum and Terragraphics, 2010).

3.1.1.1 Geotechnical Analysis

In January 2009 DEQ initiated geotechnical investigations and analyses to determine potential repository configurations for the Paymaster site based on the existing information of the physical nature and estimated volume of wastes. A failure modes analysis was also prepared. The

impoundment tailings, constituting approximately half of the waste, were thought to present significant challenges for removal and long term repository stability and performance. A design waste volume of 800,000 cubic yards was utilized in these analyses.

Engineering concerns surfaced over the low structural strength of the tailings and the need for complicated engineering necessary to ensure stability based on conceptual configurations of the Paymaster repository. Two potential repository design concepts were developed to build in an acceptable factor of safety into the Paymaster repository site to address the concerns about the tailings strength: 1) a structurally sound perimeter berm, or, 2) an excavated basin into the slope. The reasons for these two options are tied to the poor strength properties of the tailings (Terragraphics 2009).

3.1.1.2 Geochemical Analysis

In the summer of 2009 ten test pits were dug and 11 subsurface borings were drilled at the Paymaster repository site to determine subsurface soil conditions and characteristics. Samples were evaluated for geotechnical and geochemical properties of the materials at various depth intervals. This investigation showed that the subsoils and colluvium of the Paymaster repository site are mineralized and that the subsoils have naturally high background metals concentrations. Additionally, these soils may leach metals that exceed Regional Screening Levels if they come into contact with water (Terragraphics, 2010b).

Anaconda Company exploration maps available in the Anaconda Company archives show background copper and zinc concentrations and relevant geologic features and mine workings in the vicinity of the proposed Paymaster repository expansion area. The figures reveal a number of ore vein systems extending almost to the east boundary of the proposed expansion area, with background copper and zinc concentrations ranging from 50 to 300 parts per million (ppm). Little background data, no mine workings, or geologic mapping are shown within the proposed repository expansion area. However, results from the 2009 testing indicate copper and zinc concentrations are as high as 2,940 ppm within the proposed expansion area, confirming that the repository expansion area has mineralized areas and indicates that disturbing the native materials could release metals.

3.1.1.3 Investigation Summary

The basin-type (‘bath tub’) conceptual repository design for the Paymaster site was discarded in light of the results of the summer 2009 field investigations. This design would have required excavating a substantial volume of mineralized material that has the potential to leach metals and would be unsuitable for backfilling and reconstructing waste removal areas. In addition, shallow bedrock was found in the western portion of the site which would require blasting to get to the desired excavation depths. Blasting in general is a very high cost excavating option and would disturb mineralized materials.

The structurally sound toe berm repository design concept was developed and an engineering analysis of potential configurations and materials handling was conducted (Spectrum and Terragraphics, 2010). In summary, the design of this type of repository relies on placement of the

toe of the berm right at the slope break above the Blackfoot River wetlands to provide the needed structural stability and to maximize the area available for placing wastes. The design required a berm approximately 50 feet tall to accommodate the total UBMC waste volume estimated at that time. The estimated volume of material needed to construct the structural toe berm was 254,000 cubic yards.

The structural toe berm design concept for the Paymaster is problematic as a whole site repository option because the geochemistry results of the site soils showed the potential to leach metals. The most likely and cheapest berm material for this design would be the soils excavated to build the repository foundation, and the leachable characteristic of these materials would require special material handling and would likely require an additional liner to ensure the berm itself would not become a contamination source. Alternatively, the excavated site soils could be handled as wastes and clean construction materials would need to be hauled in from another site, which would be counterproductive and costly. Other design challenges of the Paymaster site include the need for a low permeability bottom liner due to groundwater levels and likely blasting to maximize the repository size. Advantages of the Paymaster site include its proximity to the wastes to be removed and the ability to use off-highway haul trucks. This earlier report concluded that, while design is problematic, the Paymaster site should have the potential to hold the total UBMC site waste volume (Spectrum and Terragraphics, 2010).

3.1.1.4 Subsequent Information

During the review of previous reports, an error in the estimation of the horizontal seismic ground acceleration at the UBMC was found. Using the proper seismic ground acceleration, it is now known that the Paymaster cannot serve as a standalone repository option. See Section 4.2.2 for revised stability analyses.

3.1.2 First Gulch Repository Site

During the EE/CA preparation process the Forest Service acquired lands on the north side of US Highway 200 in the area of First Gulch, Second and Third Gulches in T15, R7W **(Figures 3.1 and 3.3)**. The Agencies conducted a reconnaissance field trip to determine whether any part of these lands could be a suitable repository and identified repository site possibilities in First Gulch. The Forest Service requested that Asarco conduct a limited investigation of the First Gulch area and subsequently selected a potential repository site.

A test pitting investigation was completed in fall 2006 and two monitoring wells were installed in May and June of 2007. The results are presented in Appendix E, and Figure 14 of Appendix F of the EE/CA (Hydrometrics 2007). Based on these investigations, the First Gulch site is underlain by less than 5 feet of relatively clean sand and gravel (colluvium) near the upper half of the site, but grades to greater than 10 feet of clean colluvium near the lower end of the site. Assuming half the site is underlain by 10 feet of colluvium, the First Gulch site appears to provide adequate volume for use as borrow material, but this material is of marginal quality due to the lack of fine-grained sized particles. The site should have enough locally available colluvium and topsoil material for repository construction and closure. Depth to groundwater

ranged from approximately 53 to 64 feet below the existing ground surface in the two monitoring wells when the wells were installed.

Preliminary repository design from the EE/CA indicated a footprint of approximately 13.5 acres, and a structural toe berm to maximize repository capacity. Based on a 10-foot high toe berm, a slope of 3.5 to 1 for the repository face, and an average fill thickness of 30 feet, the repository capacity was estimated to be about 500,000 CY, roughly equivalent to the combined volume for total removal at each of the EE/CA removal areas. A minimally engineered repository with no toe berm, a 3.5 to 1 slope, and average fill thickness of 20 feet would have a fill capacity of about 300,000 CY. (EE/CA, 2007)

3.1.3 Horsefly Creek Repository Site

Because of the potential need to dispose of the total waste volumes from the UBMC (federal and private land wastes) in a single repository, DEQ was concerned that the repository sites identified by ASARCO LLC and the Forest Service might be too small to contain the necessary volume. DEQ also had concerns about the technical suitability of the sites under consideration. In September 2006 DEQ performed a coarse filter screening evaluation of potential repository sites within a ten-mile radius of the impoundment using available GIS data. A report of the coarse-filter screening evaluation (Tetra Tech, September 6, 2006) is presented in Appendix E of the EE/CA. DEQ selected a potential repository site in the vicinity of Horsefly Creek due to its proximity to the impoundment, slopes, size, adequate space within a single land parcel (Stimson) and available access to the site. A field trip to the site with Forest Service specialists and DEQ was conducted in November 2006 and no resource concerns were identified on the property.

Horsefly Creek is a tributary to the Blackfoot River located approximately six miles west of the UBMC. DEQ identified a potential repository site immediately north of Horsefly Creek and about 0.6 miles southeast of the Blackfoot River in Township 14N, Range 7W, Section 3 (**Figures 3.1 and 3.4**). The potential repository site totals 77 acres in area and is located entirely on Stimson Lumber Company-owned land. The site slopes between 5% and 12% to the southwest (towards Horsefly Creek) and is generally open due to recent logging. The site is about 10 road miles from the tailings impoundment with the haul route including 2.5 miles on Mike Horse county road, 6.0 miles on Highway 200, and approximately 1.5 miles of new access road that would have to be constructed from Highway 200 to the site, assuming access from Highway 200. In addition to the 1.5 miles of new haul road, a bridge crossing would have to be constructed on the Blackfoot River for site access and mine waste hauling. Access via Highway 279 is feasible but would increase the total haul distance.

Stimson granted DEQ access to the property and DEQ conducted a limited site investigation at the Horsefly Creek site to provide information for the EE/CA. Field reconnaissance and test pit excavation was conducted in December 2006 and a report for the site was prepared by Tetratech, on December 26, 2006. This report is also included in Appendix E of the EE/CA. The screening methodology is also included in the December 26, 2006 Tetra Tech report. ASARCO included the evaluation of the Horsefly Creek site and a cost analysis in the EE/CA.

Based on the test pitting exploration, the Horesefly Creek site is underlain by at least 10 feet of clayey sand, gravel and cobbles (colluvium) and appears to provide adequate volume for use as borrow material for reclaiming waste removal areas in the UBMC as well as enough volume of materials locally for repository construction and closure. Depth to groundwater is expected to be greater than 20 feet below the existing ground surface across the site, but seepage was noted at approximately 4 feet below the existing ground surface in at least one of the test pits. The Horsefly Creek site has a total of approximately 77 acres available and has enough space to design several different repository configurations large enough to contain all of the wastes from the UBMC.

3.1.3.1 Subsequent Information

The area considered for the repository during the EE/CA process has a large number of surface drainage channels during spring runoff as observed during the 2011 flyover. It is also likely that the site may have experienced shallow groundwater conditions during the spring of 2011 but it was not possible to distinguish surface runoff from groundwater springs from the flyover. However, the site has ample space and there are several specific sites within the Horsefly Creek site that have better drainage and should be suitable repository sites.

3.2 SITES IDENTIFIED AFTER THE EE/CA

This section provides a brief description of repository sites identified and investigated after the EE/CA and summarizes design information and assumptions used before starting this current study. This information was used to aid development of the site-specific repository alternatives presented later in this report as well as to document the difficulties encountered during these investigations. Note that this section summarizes the information as it was known or estimated at the time of the studies referenced below.

3.2.1 Shave Gulch (South Side of Drainage) Repository Site

The Shave Gulch repository area lies east of Shave Creek, a mostly perennial stream, and north of the Blackfoot River in T15N,R7W, Section 21 (**Figure 3.5**). This potential repository site was identified after the EE/CA and is located on the opposite side of the drainage from the Shave Gulch (or Midnight Hill) site discussed in the EE/CA. The site is approximately 21 acres with average slopes of 4H:1V. It is located on NFS lands. This site has mature and submature lodgepole as it was partially logged sometime in the 1970s or earlier. Most of the pine is infested by pine bark beetle. This site is not visible when traveling west on Highway 200 but is visible in the background when traveling east.

Nine test pits were excavated and two test borings were drilled at the Shave Gulch site in September of 2009 to evaluate the depth to groundwater and to sample subsurface soils. Results of this investigation are similar to the Paymaster site with the presence of hard intrusive and potentially mineralized rock across the site. Groundwater was encountered at approximately 6 feet below the existing ground surface at one location near the north end of the site. The capacity estimate for the Shave Gulch site provided in the 2010 Preliminary Design Report (Spectrum and

Terragraphics 2010) is approximately 515,000 cubic yards with an estimated footprint of greater than 10 acres (EE/CA, 2007).

3.2.1.1 Geotechnical Analysis

The Shave Gulch repository geotechnical design also includes a structurally sound berm concept with an estimated capacity of 515,000 cubic yards of waste. The berm would be approximately 50 feet high and would require an estimated 288,000 cubic yards for its construction.

3.2.1.2 Geochemistry

Soil and bedrock was sampled at this site using nine test pits and two test borings. Soil geochemistry results are similar to the geochemistry results of the Paymaster site and indicate that the soils and colluvium have developed within a naturally mineralized area with high concentrations of iron, lead and manganese. Similar to the Paymaster site, these soils may leach metals that exceed Regional Screening Levels if they come into contact with water (Terragraphics, 2010b).

Anaconda Company exploration maps available in the Anaconda Company archives show background copper and zinc concentrations and relevant geologic features and mine workings in the vicinity of the proposed Shave Gulch repository site. Similar to the Paymaster site, the figures reveal a number of ore vein systems and mine workings in the vicinity of the proposed repository site. Background copper and zinc concentrations range from 200 to 1,500 ppm near the proposed repository site. Zinc concentrations from the 2009 testing correlate relatively well with the Anaconda Company mapping with copper concentrations from the 2009 testing range from 402 to 1,270 ppm within the proposed repository site.

3.2.1.3 Investigation Summary

Similar to the Paymaster repository site, the structurally sound berm design concept is problematic as a whole site repository option because the geochemistry results of the site soils identified the potential for leaching. The Shave Gulch site is also not large enough for the entire waste volume of the site. The excavated soils would require special material handling and would require a liner to ensure the berm itself would not become a contamination source. Alternatively, the excavated site soils could be handled as wastes and clean construction materials would need to be hauled in from another site (Spectrum and Terragraphics, 2010), which would be counterproductive and costly. The Shave Gulch repository site has similar advantages to the Paymaster site as it is close to the waste sources and off road haul trucks could be used (Spectrum and Terragraphics, 2010).

3.2.1.4 Subsequent Information

During the review of previous reports, an error in the estimated horizontal seismic ground acceleration at the UBMC was noted. The proper seismic ground acceleration affects the stability analysis and further reduces the limited capacity thereby reducing the viability of Shave Gulch as a repository option. See Section 4.2.2 for revised stability analyses.

3.2.2 Section 35 Repository Site

The Section 35 repository site is located on the northeast side of Highway 279 in T15N, R7W, Section 35 and is approximately 360 acres in size (**Figure 3.5**). The property is owned in part by Stimson Lumber Inc. with reserved rights owned by the Seiben Ranch Company. The vegetation is a mosaic of Douglas fir, lodgepole pine, harvest areas with submature regeneration, sagebrush, and grasslands. The property has been used for logging and sheep grazing for many years. A small perennial creek, Nora Creek bisects the site and the Blackfoot River flows through the west side of Section 35.

Montana DEQ and its engineering contractors started considering options to the repository sites analyzed in the EE/CA following the evaluations of the tailings characteristics and the design/cost issues with the existing repository sites in early 2009. They did an overview of the other lands identified in the September 6, 2006, Repository Siting Investigation (Tetra Tech, Inc, 2006) and revisited the Horsefly Creek repository site in October 2009. The Section 35 site was noted at that time due to its benched topography and proximity to Highway 279. The area appeared to have been overlooked in the 2006 Repository Investigation because the mapped topography incorrectly showed the slopes to be steeper than the query criterion. Upon checking on ownership, DEQ initiated discussions with the landowner Stimson Lumber for access to conduct a repository site investigation. In 2010, Stimson Lumber Co and Seiben Ranch Co., which holds certain development rights on the property, granted permission to complete a site investigation.

The repository site investigation started in June 2010 and was completed in August 2010. The results of the investigation are presented in the report, “Final Data Summary Report Section 35 Upper Blackfoot Mining Complex, November 18, 2010” (Terragraphics, 2010a). The information presented below is summarized from the Terragraphics report.

Field activities and analysis of Section 35 included excavating 25 test pits to collect soil and subsoil samples for geotechnical and geochemical testing, installing four peizometers, installing 6 monitoring wells, hydraulic conductivity testing, collecting groundwater samples from the wells, and sampling surface water.

3.2.2.1 Geochemical Results

Surface and groundwater quality based on samples collected from Nora Creek and the monitoring wells in Section 35 meet water quality standards. The section of the Blackfoot River that flows through the west side of the property has exceedences of acute and chronic aquatic life standards. These exceedences are attributed to the impacts to the river from the mine wastes or metals released from the UBMC. Soils testing for geochemical properties indicates that the site soils have low metals concentrations and do not present a potential to leach metals into the water.

3.2.2.2 Geotechnical Analysis

The Section 35 site has low sloping benched topography (10-20%) and at over 300 acres in size is large enough to allow for flexibility of design and site operations. The estimated storage

capacity is 1,141,000 cubic yards which could be accomplished in one larger repository or more than one smaller repositories.

Twenty-five test pits were excavated in April of 2010 and piezometers were installed in four of those test pits. In addition, six monitoring wells were installed between April and July of 2010 at the site to evaluate the depth to groundwater and to sample subsurface soils. Results of this investigation shows that the site is underlain by a mantle of soils and glacial till and overconsolidated glacial till overlying bedrock. Bedrock ranges from 40 to 50 feet deep in the lower elevation portions of the site to near surface outcrops on the ridge tops in the northern part of the site. Glacial till soils are typically well graded deposits of sand, silt and clay with lesser gravel. The soils are dense and compacted. Glacial outwash soils occur on the lower and mid level benches of the site and are thinner layers of well graded sand or sand and gravel. Samples tested for hydraulic conductivity suggest that the site includes materials that could be suitable for a repository liner.

Groundwater levels have been monitored across the site since August of 2010 using hand measurements and submersible water level transducers. The data collected to date show significant seasonal fluctuations in water levels in the wells in portions of the site in an unusually wet spring. The results showed fluctuations between the low and high readings in monitoring wells MW-01 through MW-04 and in all of the piezometers ranged from as little as one (1) foot to as much as 17 feet. The measurements in monitoring wells MW-05 and MW-06 fluctuated by 33 and 31 feet, respectively.

Water levels in the wells began to rise at the site during mid-April of 2011 and decreased during June and July of 2011. The reasons for the large fluctuations in these wells are currently under investigation and will be addressed in a separate report. Additional field data and analysis are needed to determine if the water levels observed in 2011 and associated fluctuations observed at the site are representative of the true groundwater level relative to the ground surface, or if the readings indicate presence of a confined bedrock aquifer system below the glacial till materials.

However, the data from monitoring wells MW-02 and MW-04 showed depths to water greater than 20 feet at the highest levels during this particularly wet spring, which should be suitable for repository construction and the data show that there are areas of the site with enough space and groundwater depths suitable for repository construction.

The conceptual design for a Section 35 repository site in the previous analysis included a low sloping 2H:1V berm at the toe that would need a volume of 295,000 cubic yards. This material would come from the repository excavation itself, with material left over for reclamation of both the repository and the UBMC waste excavation areas as geochemical properties of the soils and colluvial material of Section 35 would not result in leaching of metals.

3.3 SCREENING SUMMARY OF PREVIOUSLY IDENTIFIED SITES

Detailed information has been collected at each of the sites discussed in this section and all of the sites will be carried forward to evaluate if a suitable alternative can be designed at any or all of these locations. Based on the information presented above it should be technically feasible to

construct a repository at any of these sites and other factors need to be considered to determine if the site may be an effective alternative.

4.0 DEVELOPMENT AND EVALUATION OF SPECIFIC ALTERNATIVES

This section provides a brief description of the repository sites recommended for further analysis. Only essential information regarding each alternative as it pertains to the overall site cleanup strategy and this analysis is included. More detailed information is available on most of the sites evaluated previously in the various reference documents. For many of the new sites, only general information is available.

Because of the difficulties comparing sites with little or no data against sites with detailed data, consistent assumptions are used throughout the evaluation. In general, it is feasible to construct a repository of some configuration at any of the sites selected for screening. However, the costs, feasibility, and ability to meet UBMC goals differ considerably. Therefore, this analysis focuses on identifying the best overall alternative or combination of alternatives that can meet site-wide goals.

This evaluation is not exhaustive because of the of the data limitations but is sufficient to make an informed and reasonable decision. Based on design-level data at any given site, changes to the design and diversions from the assumptions used in this analysis will probably occur during design and construction, but similar and typically offsetting changes are expected for all alternatives considered.

Each of the alternatives is discussed, evaluated and screened to determine if the alternative is suitable for the overall site cleanup plan. In some cases the alternative may only be applicable to a portion of the waste material from the site, while in others the alternative could contain all of the wastes from the site. Where limitations associated with an alternative make it not feasible in any configuration, those limitations are discussed and that alternative is removed from further consideration.

4.1 KEY ASSUMPTIONS APPLICABLE TO ALL ALTERNATIVES

Key assumptions used in the evaluation include:

1. The volume of material from the NFS lands is 600,000 CY.
2. The volume of waste material from non-NFS land is 400,000 CY.
3. Approximately 400,000 CY of borrow material is needed for general site reclamation at the mining complex.
4. If borrow material is expected or known to be available from the repository excavation, back haul is assumed.
5. If borrow material is not available from the repository excavation, costs for a separate borrow area and hauling material from the borrow area are added to the cost of the alternative and impacts from an additional borrow source are considered in the analysis.
6. The potential Nora Creek Borrow Site is assumed for all alternatives if a separate off-site borrow area is required. This site is located in Section 25 of Township 15N Range 7W

(**Figure 4.31**). It was chosen for this analysis as the nearest NFS land with the potential to produce 400,000 cubic yards of borrow material.

7. On-road haul will be completed with road-legal loads.
8. Road improvements necessary for each alternative were estimated based on the assumed repository location and the best available existing road information. The road construction and/or improvement costs are included in each cost estimate.
9. The same cap design is used for all alternatives.
10. A synthetic repository bottom liner is used only for sites with known or suspected shallow groundwater concerns.
11. The cost comparison includes hauling, repository construction, land acquisition and borrow costs only.
12. Design, oversight, contingencies, and costs to excavate the waste and reclaim the excavated area are not included in this analysis, but can be assumed to be consistent across all the alternatives.

Other specific assumptions related to a specific alternative are discussed below.

4.2 PRELIMINARY REPOSITORY STABILITY ANALYSIS

Several of the repository sites considered in this comparison (those identified in the EE/CA and those investigated in 2009 and 2010) are well known and have well-documented or suspected engineering design concerns. In particular, the Paymaster, Shave Gulch, and First Gulch sites are adjacent to steep slopes and have limited space. Several potential repository configurations were developed for each of these sites and then evaluated to determine the stability of the configuration before carrying these alternatives through for a comparative evaluation. In each case several potential alternatives were developed until a stable configuration was achieved. This analysis was completed to:

1. Determine if a stable configuration was possible at each of the sites.
2. Eliminate from consideration unstable configurations.
3. Establish design, volume, and construction information for stable alternatives needed for the cost comparison.

Detailed information was also available for the Section 35 site. Several potential repository configurations were developed for the Section 35 site then evaluated to determine the stability of the configuration before carrying this alternative through for a detailed evaluation. This analysis was completed to:

1. Determine if a stable configuration was possible at this and similar sites.
2. Determine if similar designs should be stable at other sites with similar slopes and suitable geology.
3. Establish design, volume, and construction information for stable alternatives needed for the cost comparison.

4.2.1 Conceptual Cap and Liner Design for All Repository Sites

For purposes of evaluation, the repository design for each potential site includes an engineered composite cap to be placed over the compacted mine waste. The purpose of the cap is to minimize potential contact of incident precipitation (storm water and snowmelt) with the repository fill and associated contaminant migration via erosion and leaching. The cap would also eliminate potential human contact (via direct contact or airborne dust) with the mine waste.

The engineered cap includes, from bottom to top, a low permeability textured linear low density polyethylene (LLDPE) synthetic liner, overlain by a 200-mil drainage net layer, overlain by 24 inches of soil. The low permeability liner would be comprised of suitable material such as 60-mil textured LLDPE, which has permeability on the order of 10^{-12} cm/sec. The liner would restrict downward percolation into the underlying repository fill. The low permeability liner would be keyed into anchor trenches at both the upper and lower edges of the repository. A high permeability drainage layer would be placed over the low permeability liner in order to convey infiltrated water down slope and away from the repository. A typical drainage layer would include 200 mil drainage net (Geonet) with a permeability on the order of 10 cm/sec, and bonded with a 6 oz/sq yd. nonwoven geotextile. The geotextile prevents the overlying soil from infilling and plugging the drainage net. The extreme contrast between the liner and drainage net permeabilities would cause virtually all water that infiltrates the overlying soil layer to flow through the drainage net to the repository toe, and would prevent excessive head from building up on top of the liner.

The cover soil layer would consist of approximately 18 inches of subsoil and 6 inches of topsoil. The repository surface would be mulched, fertilized and seeded to promote vegetation establishment. The vegetation would prevent erosion of the soil cover, and promote evapotranspiration of incident precipitation falling on the repository surface.

HELP modeling results for the assumed engineered cap indicate that infiltration through the cap liner to the repository fill would be less than 0.1% of mean annual precipitation (EE/CA Appendix G). This equates to approximately 0.2 ft^3/day, or less than 1.44 gallons per day, per acre of water contacting the repository fill per acre of repository (Hydrometrics 2007).

Because some alternatives may have seasonally high groundwater or concern with the quality of underlying soils, a bottom liner system was also used in the stability analysis. The engineered liner includes, from bottom to top, a high-survivability geocushion layer, a low permeability textured LLDPE synthetic liner, overlain by a 200-mil drainage net layer, overlain by compacted waste materials. The low permeability liner would be a suitable liner material such as 60-mil LLDPE, which has permeability on the order of 10^{-12} cm/sec. The purpose of the liner would be to restrict downward percolation into the underlying native materials. The low permeability liner would be keyed into anchor trenches at both the upper and lower edges of the repository. A high permeability drainage layer would be placed over the low permeability liner in order to convey any drainage water from the waste materials down slope and to a leachate collection system. A typical drainage layer would include a drainage net with a permeability on the order of 10 cm/sec, and bonded with a 6 oz/sq yd. nonwoven geotextile. The geotextile prevents the overlying soil from infilling and plugging the drainage net. The extreme contrast between the

liner and drainage net permeabilities would cause virtually all water draining from the compacted waste materials to flow through the drainage net to the repository toe and the leachate collection system and prevent excessive head from building up on top of the plastic liner. This design also prevents movement of seasonal or unexpected groundwater upward into the waste materials and effectively isolates the waste material from underlying soils.

For the purposes of the geotechnical analysis, both top and bottom liners are assumed in all geotechnical stability alternatives. If the bottom liner is identified as the single failure mode, that particular alternative was examined to determine if the bottom liner is needed. If the bottom liner is needed, such a failure provides the basis for eliminating that design alternative. If the bottom liner is not needed for a specific alternative at a specific site, that design alternative can be considered successful and can be used in the detailed comparison of alternatives if the bottom liner failure is the only failure in the analysis.

4.2.2 General Considerations

The stability analyses were performed on critical cross-sections for the proposed Paymaster, Shave Gulch and Section 35 repositories. Roscience's Slide 6.0 stability analysis software (Rocscience , 2010) was used to perform 2D limit equilibrium analyses of the proposed repositories at final construction under global failure, base liner failure and cover liner failure conditions. Hand calculations for the base and cover liner systems were performed as a check of the software output. The Spencer Method of Slices was used for all analyses (Spencer, 1967). The Spencer Method, which satisfies both horizontal and vertical force and moment equilibrium and accounts for interslice shear forces within the sliding mass, is considered to be one of the most rigorous and complete methods of stability analysis, particularly for block analysis.

The stability analyses were performed under non-seismic and seismic conditions. In order to model the stability of the repositories under seismic conditions, a horizontal seismic coefficient (horizontal acceleration) of 0.2321g was introduced for the Paymaster and Shave Gulch sites and 0.2386g was introduced for the Section 35 site, where g is the acceleration of gravity. These seismic coefficients were obtained from the United States Geological Survey (USGS) Seismic Hazard Mapping of Peak Ground Accelerations (PGA's) at the subject sites using a 2,475 year event or 2 percent probability of exceedance in 50 years. This return period is typical for landfill design and has also been proposed by the Montana Dam Safety Division as a requirement on improved and new dams.

In addition to the PGA mapping information, the USGS Fault and Fold Database indicate that the nearest Quaternary (active) fault in the vicinity of the subject sites consists of a number of faults in and around Helena's North Valley, located approximately 16 to 25 miles southeast of the site. These faults have been responsible for numerous felt earthquakes and several destructive earthquakes, including a cluster of earthquakes in 1935 which caused structural damage within the city of Helena. Two of those earthquakes registered a magnitude 6.0 and 6.3 on the Richter scale. The presence of these faults and historical earthquake activity in the vicinity of the site strengthens the need to treat the repositories as a regulated waste landfill system during future stability analyses.

4.2.3 Material Shear Strength Parameters

To model the long-term performance of the repositories, stability analyses were performed in terms of effective stress, which uses shear strength values obtained from laboratory triaxial shear strength tests performed on the materials under undrained conditions (with consideration of pore pressures). The following subsections describe how the shear strength parameters were determined for the various repository materials that were modeled.

4.2.3.1 In-Situ Colluvium (Subgrade)

For the purpose of the preliminary analyses, it is assumed that the in-situ colluvium (subgrade soils) beneath the repositories is competent, with strengths significantly greater than the weakest interface within the repository. The in-situ colluvium (subgrade) at the Paymaster site is assumed to be homogenous and is based on direct shear testing performed on an undisturbed sample from Test Pit TP-2 at the Paymaster site, which is summarized in Appendix E of the EE/CA. The Paymaster site has areas of geothermally formed clays which lay at inconsistent angles and thicknesses across the hillside. The variability of these clays was not modeled within the scope of this evaluation. If Paymaster is chosen, the effect of these clays needs to be taken into consideration during design. Due to the lack of undisturbed subgrade testing at the Shave Gulch and Section 35 sites, these parameters were also used to model the subgrade for the Shave Gulch and Section 35 repository analyses.

4.2.3.2 Compacted Colluvium from Paymaster Site (Paymaster and Shave Gulch Berms)

The berms for Paymaster Option 1 and Shave Gulch Option 1 repositories are considered to be homogenous and are based on consolidated-undrained direct shear testing performed on remolded, recompacted and saturated samples of colluvium material from Test Pits TP-1, 4, 5, 6, 7 and 11 at the Paymaster site. In order to accurately replicate anticipated conditions in the field, the samples were compacted to approximately 90 percent of standard Proctor maximum density and optimum moisture prior to performing the triaxial shear tests. A summary of these lab results is described in a January 11, 2010, letter from Piedmont Engineering, which is included in Appendix F of the November 22, 2010, Data Summary Report for the Upper Blackfoot Mining Complex, by Terragraphics Environmental Engineering, Inc. (Terragraphics 2010b).

4.2.3.3 Tailings

The excavated tailings from the Mike Horse impoundment are considered to be placed and compacted in homogenous layers within the repository. Their shear strength is based on consolidated-undrained direct shear testing performed on remolded, recompacted and saturated samples of a mixture of 2 parts air dried silty sand (from Test Pits STP-5 and 7 at the Mike Horse Dam tailings impoundment) to 1 part slimes (from Test Pit TPSTP-1 at the Mike Horse Dam tailings impoundment) by volume. This ratio produced a mixture that increased the compacted strength of the slimes and was recommended by Piedmont Engineering as a preferred mixing ratio during placement of the tailings into the repository. In order to accurately replicate anticipated conditions in the field, the mixed samples were compacted to approximately 90 to 95 percent of standard Proctor maximum density and optimum moisture prior to performing the

triaxial shear tests. A summary of these lab tests is enclosed in a March 24, 2010, letter from Piedmont Engineering. (Spectrum and Terragraphics, 2010)

4.2.4 Compacted Colluvium from Section 35 Site (Cover Soil)

The cover soil for all repository options is considered to be homogenous and is based on consolidated-undrained direct shear testing performed on remolded, recompacted and saturated samples of colluvium material from Test Pits TP-13, 14, 21 and 22 at the Section 35 site. Data for this material was available and this material is assumed to be typical of the type of material that would be used for any alternative, regardless of the source. In order to accurately replicate anticipated conditions in the field, the samples were compacted to approximately 90 percent of standard Proctor maximum density and optimum moisture prior to performing the triaxial shear tests. A summary of these lab tests is described in a August 6, 2010, letter from Piedmont Engineering, which is included in Appendix F of the November 18, 2010, Data Summary Report for Section 35 of the Upper Blackfoot Mining Complex (Terragraphics, 2010a).

4.2.5 Liner System

The base and cover liner systems were modeled as a 1 foot thick homogenous layer of soil having shear strength properties of the weakest interface in the liner system, which is assumed to be the interface between 40-mil textured LLDPE geomembrane and non-woven geotextile. This approximation is commonly used for this type of analysis because modeling software programs do not support direct analysis of the extremely thin geomembrane liners. Shear strength values were provided from literature containing tables with typical design values. In general consensus with current practice, residual (large deformation) interface strengths were used for the cover liner system, while peak interface strengths were used for the base liner system. Material properties that were used for the stability analyses are shown in **Table 4.1**.

Table 4.1 - Material Properties used in Stability Analysis

Material	Unit Weight (γ) (lb/ft^3)	Friction Angle (ϕ) (degrees)	Cohesion (c) (lb/ft^2)	Source
In-Situ Colluvium (Subgrade)	124	0	40	EE/CA, App E
Compacted Colluvium (Paymaster Berm)	133	38	0	Piedmont, 1/11/2010
Tailings	149	33	0	Piedmont, 3/24/2010
Cover Soil	130	33	100	Piedmont, 8/6/2010
Base Liner System	120	24 (Peak)	0	Typical Values from Literature
Cover Liner System	120	13 (Residual)	0	Typical Values from Literature

4.2.6 Paymaster Repository Geometries

Because of the known complexities with the Paymaster Site, several design alternatives were developed and analyzed. Each of the alternatives is generally described below.

4.2.6.1 Paymaster Option 1- Imported Structural Berm, 3H:1V Slope, 1,000,000 CY

Paymaster Option 1 consists of constructing a berm at a 3H:1V slope using compacted colluvium soils, which will be imported from a non-mineralized borrow source area, and approximately 1,051,167 cubic yards of tailings placed at a 3H:1V slope behind the berm. The conceptual site plan and repository section are shown on **Figures 4.1 and 4.2**. Slide 6.0 outputs for the critical cross section are located in **Appendix B** and further describe the geometry, material properties and results of the analysis.

4.2.6.2 Paymaster Option 2-Berm Constructed of Tailings-3H:1V Slope, 1,000,000 CY

Paymaster Option 2 consists of constructing a berm at a 3H:1V slope using compacted tailings, and the remaining tailings (total of approximately 1,015,283 cubic yards) placed at a 3H:1V slope behind the berm. The conceptual site plan and repository section are shown on **Figures 4.3 and 4.4**. Slide 6.0 outputs for the critical cross section are located in **Appendix B** and further describe the geometry, material properties and results of the analysis.

4.2.6.3 Paymaster Option 3-Berm Constructed of Waste-4H:1V Slope, 1,000,000 CY

Paymaster Option 3 consists of constructing a berm at a 3H:1V slope using compacted tailings, and the remaining tailings (total of approximately 1,036,443 cubic yards) placed at a 4H:1V slope behind the berm. The conceptual site plan and repository section are shown on **Figures 4.5 and 4.6**. Slide 6.0 outputs for the critical cross section are located in **Appendix B** and further describe the geometry, material properties and results of the analysis.

4.2.6.4 Paymaster Option 4- Imported Structural Berm, 3H:1V Slope, 600,000 CY

Paymaster Option 4 consists of constructing a berm at a 3H:1V slope using compacted colluvium soils, which will be imported from a non-mineralized borrow source area, and approximately 624,005 cubic yards of tailings placed at a 3H:1V slope behind the berm. The conceptual site plan and repository section are shown on **Figures 4.7 and 4.8**.

4.2.6.5 Paymaster Option 5-Berm Constructed of Waste-3H:1V Slope, 600,000 CY

Paymaster Option 5 consists of constructing a berm at a 3H:1V slope using compacted tailings, and the remaining tailings (total of approximately 627,671 cubic yards) placed at a 3H:1V slope behind the berm. The conceptual site plan and repository section are shown on **Figures 4.9 and 4.10**. Slide 6.0 outputs for the critical cross section are located in **Appendix B** and further describe the geometry, material properties and results of the analysis.

4.2.6.6 Paymaster Option 6- Imported Structural Berm, 4H:1V Slope, 600,000 CY

Paymaster Option 6 consists of constructing a berm at a 3H:1V slope using compacted colluvium soils, which will be imported from a non-mineralized borrow source area, and approximately 612,776 cubic yards of tailings placed at a 4H:1V slope behind the berm. The conceptual site plan and repository section are shown on **Figures 4.11 and 4.12**.

4.2.6.7 Paymaster Option 7-Berm Constructed of Waste-4H:1V Slope, 600,000 CY

Paymaster Option 7 consists of constructing a berm at a 3H:1V slope using compacted tailings, and the remaining tailings (total of approximately 653,496 cubic yards) placed at a 4H:1V slope behind the berm. The conceptual site plan and repository section are shown on **Figures 4.13 and 4.14**. Slide 6.0 outputs for the critical cross section are located in **Appendix B** and further describe the geometry, material properties and results of the analysis.

4.2.7 Section 35 Repository Geometries

Because detailed data are available for Section 35 and the site may be similar in terms of slopes, space, soils, available area, etc. to other potential alternatives located outside the mining area, several design alternatives were developed and analyzed that may be applicable to those sites as well. Because of these similarities, some of the individual Section 35 alternatives described

below may be used as a surrogate stability analysis useful as a means of evaluating some of the other alternatives. Each of the alternatives is generally described below.

4.2.7.1 Section 35 Option 1-Tailings Placed Against Hill-6H:1V Slope, 1,000,000 CY

Section 35 Option 1 consists of placing approximately 1,027,990 cubic yards of tailings directly against the hill at a 6H:1V slope without the use of a berm. The conceptual site plan and repository section are shown on **Figures 4.15 and 4.16**.

4.2.7.2 Section 35 Option 2-Tailings Placed in Excavation on Hill, 4H:1V Slope, 1,000,000 CY

Section 35 Option 2 consists of an excavation into the hillside and placement of approximately 1,011,000 cubic yards of tailings into the excavation at an approximate 4H:1V slope without the use of a berm. The conceptual site plan and repository section are shown on **Figures 4.17 and 4.18**.

4.2.7.3 Section 35 Option 3-Tailings Placed Directly On Hill, 4H:1V Slope, 1,000,000 CY

Section 35 Option 3 consists of placing approximately 1,021,537 cubic yards of tailings directly on top of the hill at an approximate 3.8H:1V slope without the use of a berm. The conceptual site plan and repository section are shown on **Figures 4.19 and 4.20**.

4.2.8 Shave Gulch Repository Geometries

Because of the known complexities with the Shave Gulch site, several design alternatives were developed and analyzed. Each of the alternatives is generally described below.

4.2.8.1 Shave Gulch Option 1- Imported Structural Berm, 3H:1V Slope, 400,000 CY

Shave Gulch Option 1 consists of an excavation into the hillside, construction of a berm at a 3H:1V slope using compacted colluvium soils, which will be imported from a non-mineralized borrow source area, and approximately 396,640 cubic yards of tailings placed into the excavation at an approximate 3H:1V slope behind the berm. The conceptual site plan and repository section are shown on **Figures 4.21 and 4.22**. Slide 6.0 outputs for the critical cross section are located in **Appendix B** and further describe the geometry, material properties and results of the analysis.

4.2.8.2 Shave Gulch Option 2- Imported Structural Berm, 7H:1V Slope, 400,000 CY

Shave Gulch Option 2 consists of an excavation into the hillside, construction of a berm at a 2H:1V slope using compacted colluvium soils, which will be imported from a non-mineralized borrow source area, and approximately 400,000 cubic yards of tailings placed into the excavation at an approximate 6.7H:1V slope behind the berm. The conceptual site plan and repository section are shown on **Figures 4.23 and 4.24**.

4.2.8.3 Shave Gulch Option 3- Berm Constructed of Waste-3H:1V Slope, 400,000 CY

Shave Gulch Option 3 consists of an excavation into the hillside, construction of a berm at a 3H:1V slope using compacted tailings, and the remaining tailings (total of approximately 492,389 cubic yards) placed into the excavation at an approximate 3H:1V slope. The conceptual site plan and repository section are shown on **Figures 4.25 and 4.26**. Slide 6.0 outputs for the critical cross section are located in Appendix 3 and further describe the geometry, material properties and results of the analysis.

4.2.8.4 Shave Gulch Option 4- Berm Constructed of Waste-7H:1V Slope, 400,000 CY

Shave Gulch Option 4 consists of an excavation into the hillside, construction of a berm at a 2H:1V slope using compacted tailings, and the remaining tailings (total of approximately 400,000 cubic yards) placed into the excavation at an approximate 6.7H:1V slope. The conceptual site plan and repository section are shown on **Figures 4.27 and 4.28**. Slide 6.0 outputs for the critical cross section are located in **Appendix B** and further describe the geometry, material properties and results of the analysis.

4.2.9 First Gulch Repository Geometries

Because of the known complexities with the First Gulch site, several design alternatives were developed and analyzed. Each of the alternatives is generally described below.

4.2.9.1 First Gulch Option 1-Berm Constructed of Imported Soils-3.5H:1V Slope, 500,000 CY

First Gulch Option 1 consists of constructing a berm at a 2H:1V slope using compacted colluvium soils, which will be imported from a non-mineralized borrow source area, and approximately 500,000 cubic yards of tailings placed at a 3.5H:1V slope behind the berm. The conceptual site plan and repository section are shown on **Figure 4.29**.

4.2.9.2 First Gulch Option 2-Berm Constructed of Tailings-3.5H:1V Slope, 500,000 CY

First Gulch Option 2 consists of constructing a berm at a 2H:1V slope using compacted tailings, and the remaining tailings (total of approximately 500,000 cubic yards) placed at a 3.5H:1V slope behind the berm. The conceptual site plan and repository section are shown on **Figure 4.30**. Slide 6.0 outputs for the critical cross section are located in **Appendix B** and further describe the geometry, material properties and results of the analysis.

4.2.10 Repository Global & Liner System Stability Analysis

Based on the results of the stability analyses, the approximate minimum factors of safety for the critical cross sections are summarized in **Table 4.2** below. Generally, a factor of safety equal to or greater than 1.5 under non-seismic conditions and 1.0 under seismic conditions is considered acceptable for long-term stability.

Table 4.2 Stability Analysis Results.

Geometry	Factor of Safety (Using Slide 6.0 Software and Hand Calculations)					
	Static			Seismic		
	Global	Base Liner	Cover Liner	Global	Base Liner	Cover Liner
Paymaster Option 1	1.981	1.643	1.975	1.085	***0.930***	1.441
Paymaster Option 2	***1.452***	1.689	1.975	***0.829***	1.322	1.445
Paymaster Option 3	1.526	1.638	1.975	***0.878***	1.218	1.099
Paymaster Option 4	1.998	2.351	1.975	1.091	1.491	1.198
Paymaster Option 5	***1.394***	1.597	1.975	***0.826***	1.212	1.126
Paymaster Option 6	2.345	2.208	2.558	1.120	1.373	1.189
Paymaster Option 7	***1.454***	1.600	1.975	***0.864***	1.225	1.099
Section 35 Option 1	3.689	3.249	3.757	1.293	1.310	1.089
Section 35 Option 2	2.697	2.521	2.558	1.104	1.290	1.234
Section 35 Option 3	2.320	1.946	2.440	1.059	1.155	1.285
Shave Gulch Option 1*	1.718	1.650	1.975	***0.891***	1.271	***0.912***
Shave Gulch Option 2	1.565	4.486	4.181	1.040	1.725	1.079
Shave Gulch Option 3	***1.439***	1.566	1.975	***0.863***	1.239	***0.911***
Shave Gulch Option 4	***1.091***	1.529	1.650	***0.756***	1.409	1.073
First Gulch Option 1	2.187	1.968	2.264	1.052	1.295	1.334
First Gulch Option 2	***0.978***	***1.474***	***1.423***	***0.710***	1.228	1.330

Note: Values in ***red*** are below the acceptable design criteria for long-term stability.
*This option requires excavation into the geochemically active hillside; therefore, it is not a viable alternative.

The above analyses indicate that Options 4 and 6 of the Paymaster repository geometries, Option 2 of the Shave Gulch repository geometries, Option 1 of the First Gulch repository geometries and all of the Section 35 repository geometries meet the requirements for static and seismic long-term stability.

Paymaster Option 1 fails to meet the design criteria requirements for base liner stability under seismic load, First Gulch Option 1 fails to meet the design criteria requirements for base and cover liner stability under static conditions and Shave Gulch Options 1 and 3 fail to meet the design requirements for cover liner stability under seismic load. Paymaster Options 2, 3, 5 and 7,

Shave Gulch Options 1, 3 and 4 and First Gulch Option 2 fail to meet the design criteria requirements for global stability. It is important to note that these global failures occur only within the two foot of cover soil at the surface of the repositories and in some cases extend less than a foot into the tailings.

Additional minor shallow sloughing of the cover soil, which is not accounted for by this analysis, may be expected with all the repository options soon after construction. This additional shallow sloughing only affects a small portion of the repository, can be repaired easily, and typically stabilizes after vegetation is established.

4.2.11 Liner System Deformation Analysis

An approximation of the performance of the base and cover liner systems was performed for the Paymaster, Shave Gulch and Section 35 repository sites using a simplified seismic design procedure for geosynthetic-lined landfill systems. The simplified procedure (Bray, Rathje, Augello and Merry 1998) includes a screening analysis of the repositories to check for the potential for seismically induced permanent deformations. According to the screening analysis, if the yield acceleration of the liner system (the seismic acceleration required to fail the liner system) is greater than 75 percent of the peak ground acceleration, then the seismically induced permanent deformation of the liner systems will generally be less than typical allowable deformations (less than 15 cm for base sliding and less than 30 cm for cover sliding). The results of the screening analysis indicated that the cover and base liner systems for all repository geometries are safe from permanent seismic deformation with the design assumptions used in this analysis.

4.3 SUMMARY OF STABILITY ANALYSES

Based on the stability analyses, repository construction options are limited at the Paymaster, First Gulch and Shave Gulch Sites. Because of the combined space and slope limitations the maximum potential volume available in these repository sites is less than the 1,000,000 cubic yards necessary for use as a site-wide alternative. Because of this fact, each of these sites must be considered in combination with another repository to meet site-wide cleanup goals.

The Section 35 site has enough space available to construct a repository capable of holding 1,000,000 cubic yards and should be suitable for any site-wide cleanup alternative. Each of the three alternatives analyzed at this site is large enough for the assumed site-wide waste volume. This finding is also useful in evaluating other sites outside the mining area with similar slopes and available space. Several of the sites developed and discussed the subsequent sections of this report could be constructed with geometries similar to one of the three geometries analyzed at Section 35.

Because of the space constraints at the Shave Gulch site, the only stable configuration with a capacity of up to approximately 400,000 cubic yards required excavation into the hillside. The Shave Gulch site has known geochemical issues with the underlying rock materials. Excavating into the materials could release metals and cause a new contaminant source within the mining

area. Because of these factors, a suitable repository cannot be constructed at the Shave Gulch site and it will not be considered either as a standalone or as a portion of a combination alternative.

4.4 DESCRIPTION AND EVALUATION OF ALTERNATIVES

Based on the information from the summaries and analyses described above, several potential repository options were developed. Each of the options is generally described and discussed below. Key factors regarding the suitability of each site is presented in tabular format. All analyses are based on the best available data at the time of this analysis. Specific design criteria, assumptions of suitability, and cost are subject to change if additional site-specific data differ from what is available now.

The preliminary screening conducted in the May 2, 2011 memo combined with preliminary geotechnical analysis presented above reduced the list of potential alternatives to only those that can meet a minimum level of protectiveness if appropriate site-specific designs are utilized. These site-specific design considerations utilize additional engineering controls to reduce risks or import suitable materials to address less than ideal site conditions. These additional controls add cost and complexity and are therefore reflected in the cost estimates.

A cost estimate is provided for each alternative developed. The cost estimate provides information on the quantities and cost of materials needed to construct each alternative. Detailed quantity and cost estimate information for each alternative discussed below is provided in **Appendix C**. Similar assumptions were used in the cost estimates for all alternatives to provide a consistent basis of comparison. Detailed design information is not available for any of the alternatives: the cost estimates are suitable for comparison purposes only and should not be represented or considered as actual construction cost estimates.

The locations of the specific sites developed for comparison are shown on **Figures 4.31** and **4.32**.

It should be noted that all of the potential repository sites discussed in this section are technically feasible to design and construct, have been selected based on good anticipated overall performance, and can be designed to meet applicable requirements. This section is intended to reduce the list of suitable sites to the best available sites for a comparative analysis. The sites not carried forward to the comparative analysis remain viable alternatives and may be re-evaluated if future investigations and information show that the recommended alternative is not feasible or suitable.

4.4.1 Paymaster Option 4

The Paymaster Repository site is located in the southeast quadrant of Section 20 in Township 15N, Range 6W on private property that was owned by Asarco at the time of completion of the EE/CA, but was transferred to the Trust as part of the Asarco bankruptcy. The haul route from the Mike Horse Dam to the Paymaster repository site consists of approximately 2.3 miles of existing unpaved haul road.

4.4.1.1 Description and Evaluation

Paymaster Option 4 consists of constructing a berm at a 3H:1V slope using compacted colluvium soils imported from a non-mineralized borrow source area, and placing and compacting approximately 624,005 cubic yards of tailings at a 3H:1V slope behind the berm. The conceptual site plan and repository section are shown on **Figures 4.7** and **4.8**.

Table 4.3 - Paymaster Option 4 Evaluation

Site Characteristic	General	Evaluation Summary
Available Area and Setting	The site has approximately 17 acres of available space but the slopes are steep and the flatter areas at the base of the site are on or near the Blackfoot River Floodplain. This alternative covers approximately 12.4 Acres and could be expanded to increase capacity somewhat.	Because of the steep slopes and proximity to the Blackfoot River and a previously-constructed repository, the available area to construct the repository is limited by the existing repository and the natural topography.
Available Capacity (cy)	Site is stable for 600,000 CY and the volume could be increased up to approximately 800,000 CY by expanding the repository to the west.	Based on the various repository configurations evaluated in the stability analysis the waste capacity is limited and the site does not have enough space to contain the total UBMC waste volume of approximately 1,000,000 CY. The site does have enough volume for waste from the NFS lands and a portion of the Private lands if the repository foot print is maximized.
Groundwater Concerns	The site is close to the Blackfoot River and shallow groundwater is evident in the test Pits and wells installed during the detailed site investigation.	The available data show that the repository is within close proximity to groundwater in portions of the anticipate repository footprint. Because of these concerns, a bottom liner and drainage system are needed to isolate wastes from groundwater and to provide subsurface drainage for geotechnical stability of the repository.
Surface Water Concerns	The site has normal seasonal surface drainages and is located immediately adjacent to the Blackfoot River Flood plain.	The base of the repository is close to the Blackfoot River, but adequate separation can be maintained through the structural berm design and appropriate cap design.
Geotechnical Concerns	Because of the steep slopes and potential shallow groundwater concerns, the repository can only be constructed with an engineered structural toe berm.	The stability analysis showed that the tailings dam and tailings materials lack sufficient strength to be used as the structural toe berm. The structural toe berm needs to be constructed from an engineered granular material with adequate cohesive properties in order to meet long-term stability requirements. These materials need to be obtained off-site and trucked to the site.
Geochemistry Concerns	The underlying rock material at the Paymaster site is mineralized and has elevated metals concentrations similar to the waste materials at the UBMC. The colluvial materials at the site also showed elevated metals concentrations.	Because of the underlying mineralized rock, excavating into the site would release contaminants and likely would produce additional waste materials. The materials are not suitable for use in other areas of the site as clean borrow material and lack sufficient strength to be used as the structural toe berm. Care must be used when stripping soil

		and constructing the repository base to avoid cutting into these mineralized materials.
Suitable Soils	The topsoil and subsoil layers are very thin at the site ranging from a few inches to a few feet in thickness. The underlying rock material at the Paymaster site is mineralized and has elevated metals concentrations similar to the waste materials at the UBMC.	Because of the underlying mineralized rock, excavating into the site would release contaminants and likely would produce additional waste materials. These materials are not suitable for use in other areas of the site as clean borrow material. Care must be used when stripping soil and constructing the repository base to avoid cutting into these mineralize materials, which limits the amount of topsoil available for capping the repository and suitable materials need to be imported to construct the cap.
Potential Borrow Source	The topsoil and subsoil layers are very thin at the site ranging from a few inches to a few feet in thickness. The underlying rock material at the Paymaster site is mineralized and has elevated metals concentrations similar to the waste materials at the UBMC and is therefore not suitable as vegetative borrow, stream building material, or for use as the structural berm.	The site is not a suitable borrow source. Because of the thin soils, there may not be enough material available on site to construct the repository cap. Clean imported materials will be needed for the structural berm and for the repository cap. A separate borrow source will need to be developed outside the mining area to obtain materials for reclaiming other areas within the UBMC.
Land Ownership	Trust	Because the site is owned by the Trust, the Agencies should be able to obtain use of the Paymaster site as a repository.
Accessibility	The site is located inside the mining area and can be accessed easily from existing roads.	The site has existing access and only minimal improvements or maintenance will be required.
Haul Distance	2.9 Miles from Impoundment	The Paymaster site has the shortest haul distance of any alternative considered and the haul costs are correspondingly very low compared to other alternatives.
Distance From Residences	There are two residences within one mile of the Paymaster site.	The Paymaster site is located on trust owned land inside the mining area. There is a possibility of additional residences being constructed within a mile of the site on private land.
Visibility	The Paymaster site is visible from Meadow Creek Road and from several locations on Highway 200.	The visibility of the Paymaster site would decrease the aesthetic quality of the area. The hillside is currently forested and would need to be logged to construct the repository. The visual impacts may diminish somewhat over time as the cap vegetation improves, but because of the cap liner design the area cannot be reforested and the area must always be maintained as a large open area with short vegetation. This repository will blend fairly well with the hillside.
Short-Term Impacts	Short term impacts include typical construction-related impacts including dust, storm water erosion, and noise.	Because the Paymaster site is located inside the mining area many of the short-term impacts are limited to the mining area. However, material must be imported to construct the structural toe berm and borrow material will be imported from an off-site source for general site reclamation. Development of

		the off-site borrow sources expands the impacted area to a previously undisturbed area outside the mining area. These materials will be hauled over existing public roads and will cause short-term impacts and increase risks to the public throughout construction. These risks and impacts can be minimized through proper traffic control, load limit restrictions, maintenance, and other controls but the impacts cannot be eliminated.
Human Health and Safety	With proper design, construction and maintenance the site should provide acceptable overall protection of Human Health and safety. The repository can be designed to meet all ARAR's.	While design and construction is complicated due to space, slope, geotechnical, and geochemical constraints of the site, it can be constructed to provide adequate protection of human health and safety. However, because large quantities of materials will be hauled to the site over existing public roads there will be increased risks to the public throughout construction. These risks and impacts can be minimized through proper traffic control, load limit restrictions, maintenance, and other controls but the impacts cannot be eliminated.
Environmental Protectiveness	The Paymaster Repository site can be designed to meet all ARAR's and will provide similar environmental protectiveness to other alternatives.	This alternative provides adequate overall protection of the environment. However, repository construction may expose or disturb underlying mineralized rocks. The shallow groundwater and infiltration beneath the repository could create new metals-laden seeps which would require capture and treatment into perpetuity.
Feasibility	The Paymaster Repository site is located on Trust land, construction materials can be obtained, and the repository can be designed to meet all ARAR's.	Although this alternative is feasible, it requires complicated construction and careful quality control. Design, oversight, and construction costs will be correspondingly higher because of the space and other construction-related constraints at the site. The overall feasibility is high because the site is trust-owned and has few impediments to implementation.
Cultural, Special Resources, Recreation and Other Issues	No cultural or special resource issues were identified at this site. The site is located inside the mining area and is currently a popular hunting and recreation area.	Based on the work completed previously, there are no known special resource issues with this site.
Cost	$11,182,943	The estimated cost per cubic yard at the Paymaster Option 4 site is $18.64/CY.

4.4.1.2 Evaluation Summary

Because the Paymaster Option 4 site does not have enough space to contain the anticipated total site volume it cannot be considered as a standalone alternative. The site is feasible to construct and can be designed and constructed to meet ARAR's. However, there are significant concerns with disturbing the underlying mineralized materials and the potential to create new contaminated seeps which may require permanent capture and treatment. Locating borrow area(s) is the primary unknown for this site. This alternative is less expensive and has lower overall impacts compared to Paymaster Option 6 (see below) and will be carried forward as the primary alternative located inside the mining area to be considered in combination with another

repository. The combination of the Paymaster Site with another alternative such as Horsefly Creek or First Gulch will be considered as the "baseline alternative" because the Paymaster site was selected in the Action Memorandum (USFS 2007) and is in effect the basis of comparison with all other alternatives.

4.4.2 Paymaster Option 6

The Paymaster Repository site is located in the southeast quadrant of Section 20 in Township 15N, Range 6W on private property that was owned by Asarco at the time of completion of the EE/CA, but has since transferred to the Trustee responsible for administration of the Asarco bankruptcy settlement. The haul route from the Paymaster repository site and the Mike Horse Dam consists of approximately 2.3 miles of existing unpaved haul road.

4.4.2.1 Description and Evaluation

Paymaster Option 6 consists of constructing a berm at a 3H:1V slope using compacted colluvium soils imported from a non-mineralized borrow source area, and placing and compacting approximately 612,776 cubic yards of tailings placed at a 4H:1V slope behind the berm. The conceptual site plan and repository section are shown on **Figures 4.11** and **4.12**.

Table 4.4 - Paymaster Option 6 Evaluation

Site Characteristic	General	Evaluation Summary
Available Area and Setting	The site has approximately 17 acres of available space but the slopes are steep and the flatter areas at the base of the site are on or near the Blackfoot River Floodplain. This alternative covers approximately 17.4 Acres and could be expanded to increase capacity somewhat.	Because of the steep slopes and proximity to the Blackfoot River and a previously-constructed repository, the available area to construct the repository is limited by the existing repository and the natural topography.
Available Capacity (cy)	Site is stable for 600,000 CY with the edges of the repository expanded to the slope break limits on the hillside. In this configuration there is no room for expansion.	Based on the various repository configurations evaluated in the stability analysis the waste capacity is limited and the site does not have enough space to contain the total UBMC waste volume of approximately 1,000,000 CY. The site does have enough volume for waste from the NFS lands and a portion of the Private lands if the repository foot print is maximized.
Groundwater Concerns	The site is close to the Blackfoot River and shallow groundwater is evident in the test Pits and wells installed during the detailed site investigation.	The available data show that the repository is within close proximity to groundwater in portions of the anticipate repository footprint. Because of these concerns, a bottom liner and drainage system area needed to isolate wastes from groundwater and to provide subsurface drainage for geotechnical stability of the repository.
Surface Water Concerns	The site has normal seasonal surface drainages and is located immediately adjacent to the Blackfoot River Flood plain.	The base of the repository is close to the Blackfoot River, but adequate separation can be maintained through the structural berm design and appropriate cap design.

Geotechnical Concerns	Because of the steep slopes and potential shallow groundwater concerns, the repository can only be constructed with an engineered structural toe berm.	The stability analysis showed that the tailings dam and tailings materials lack sufficient strength to be used as the structural toe berm. The structural toe berm needs to be constructed from an engineered granular material with adequate cohesive properties in order to meet long-term stability requirements. These materials need to be obtained off-site and trucked to the site.
Geochemistry Concerns	The underlying rock material at the Paymaster site is mineralized and has elevated metals concentrations similar to the waste materials at the UBMC. The colluvial materials at the site also showed elevated metals concentrations.	Because of the underlying mineralized rock, excavating into the site would release contaminants and likely would produce additional waste materials. The materials are not suitable for use in other areas of the site as clean borrow material and lack sufficient strength to be used as the structural toe berm. Care must be used when stripping soil and constructing the repository base to avoid cutting into these mineralize materials.
Suitable Soils	The topsoil and subsoil layers are very thin at the site ranging from a few inches to a few feet in thickness. The underlying rock material at the Paymaster site is mineralized and has elevated metals concentrations similar to the waste materials at the UBMC.	Because of the underlying mineralized rock, excavating into the site would release contaminants and likely would produce additional waste materials. These materials are not suitable for use in other areas of the site as clean borrow material. Care must be used when stripping soil and constructing the repository base to avoid cutting into these mineralize materials, which limits the amount of topsoil available for capping the repository and suitable materials need to be imported to construct the cap.
Potential Borrow Source	The topsoil and subsoil layers are very thin at the site ranging from a few inches to a few feet in thickness. The underlying rock material at the Paymaster site is mineralized and has elevated metals concentrations similar to the waste materials at the UBMC and is therefore not suitable as vegetative borrow, stream building material, or for use as the structural berm.	The site is not a suitable borrow source. Because of the thin soils, there may not be enough material available on site to construct the repository cap. Clean imported materials will be needed for the structural berm and for the repository cap. A separate borrow source will need to be developed outside the mining area to obtain materials for reclaiming other areas within the UBMC.
Land Ownership	Trust	Because the site is owned by the Trust, the Agencies should be able to obtain use of the Paymaster site as a repository.
Accessibility	The site is located inside the mining area and can be accessed easily from existing roads.	The site has existing access and only minimal improvements or maintenance will be required.
Haul Distance	2.9 Miles from Impoundment	The Paymaster site has the shortest haul distance of any alternative considered and the haul costs are correspondingly very low compared to other alternatives.
Distance From Residences	There are two residences within one mile of the Paymaster site.	The Paymaster site is located on trust owned land inside the mining area. There is a possibility of additional residences being constructed within a mile of the site on private land.

Visibility	The Paymaster site is visible from Meadow Creek Road and from several locations on Highway 200.	The visibility of the Paymaster site would decrease the aesthetic quality of the area. The hillside is currently forested and would need to be logged to construct the repository. The visual impacts may diminish somewhat over time as the cap vegetation improves, but because of the cap liner design the area cannot be reforested and the area must always be maintained as a large open area with short vegetation. This repository will blend well into hillside and will be less obvious than Paymaster Option 4.
Short-Term Impacts	Short term impacts include typical construction-related impacts including dust, storm water erosion, and noise.	Because the Paymaster site is located inside the mining area many of the short-term impacts are limited to the mining area. However, material must be imported to construct the structural toe berm and borrow material will be imported from an off-site source for general site reclamation. Development of the off-site borrow sources expands the impacted area to a previously undisturbed area outside the mining area. These materials will be hauled over existing public roads and will cause short-term impacts and increase risks to the public throughout construction. These risks and impacts can be minimized through proper traffic control, load limit restrictions, maintenance, and other controls but the impacts cannot be eliminated.
Human Health and Safety	With proper design, construction and maintenance the site should provide acceptable overall protection of Human Health and safety. The repository can be designed to meet all ARAR's.	While design and construction is complicated due to space, slope, geotechnical, and geochemical constraints of the site, it can be constructed to provide adequate protection of human health and safety. However, because large quantities of materials will be hauled to the site over existing public roads there will be increased risks to the public throughout construction. These risks and impacts can be minimized through proper traffic control, load limit restrictions, maintenance, and other controls but the impacts cannot be eliminated.
Environmental Protectiveness	The Paymaster Repository site can be designed to meet all ARAR's and will provide similar environmental protectiveness to other alternatives.	This alternative provides adequate overall protection of the environment. However, repository construction may expose or disturb underlying mineralized rocks. The shallow groundwater and infiltration beneath the repository could create new metals-laden seeps which would require capture and treatment into perpetuity.
Feasibility	The Paymaster Repository site is located on Trust land, construction materials can be obtained, and the repository can be designed to meet all ARAR's.	Although this alternative is feasible, it requires complicated construction and careful quality control. Design, oversight, and construction costs will be correspondingly higher because of the space and other construction-related constraints at the site. The overall feasibility is high because the site is trust-owned and has few impediments to implementation.
Cultural, Special Resources, Recreation and Other Issues	No cultural or special resource issues were identified at this site. The site is located inside the mining area and is currently a popular hunting and recreation area.	Based on the work completed previously, there are no known special resource issues with this site.

Cost	$12,987,036	The estimated cost per cubic yard at the Paymaster Option 4 site is $21.65/CY.

4.4.2.2 Evaluation Summary

Because the Paymaster Option 6 site does not have enough space to contain the anticipated total site volume it cannot be considered as a standalone alternative. The site is feasible to construct and can be designed and constructed to meet ARAR's. Locating borrow area(s) is the primary unknown for this site. This alternative is more expensive and has slightly lower overall impacts compared to Paymaster Option 4 (see above) primarily because of the reduced visibility. Because this alternative provides no significant advantages compared with Paymaster Option 4, combined with the higher overall cost, Paymaster Option 6 will not be carried forward as an alternative.

4.4.3 First Gulch Option 1

The First Gulch repository area is located in First Gulch, which is in Sections 14 and 23 of Township 15N, Range 7W and north of Highway 200. The haul route from the Mike Horse Dam to the First Gulch repository site includes approximately 3 miles of existing unpaved haul road from the Mike Horse Dam to Highway 200, approximately 2.5 miles of MT Highway 200 and approximately 1 mile of haul road that will need to be improved or constructed to access the site.

4.4.3.1 Description and Evaluation

First Gulch Option 1 consists of constructing a berm at a 2H:1V slope using compacted colluvium soils obtained on-site and placing and compacting approximately 400,000 cubic yards of tailings at a 3.5H:1V slope behind the berm. The conceptual site plan and repository section are shown on **Figures 4.29** and **4.30**.

Table 4.5 – First Gulch Option 1 Evaluation

Site Characteristic	General	Evaluation Summary
Available Area and Setting	The site has approximately 17 acres of available space but the slopes are steep and the flatter areas at the base of the site are near the valley bottom. This alternative covers approximately 14.1 acres and has little room for expansion.	Because of the steep slopes the available area to construct the repository is limited by the existing natural topography.
Available Capacity (cy)	Site is stable for 400,000 CY which is enough capacity for the anticipated waste volume from the private lands.	Based on the various repository configurations evaluated in the stability analysis the waste capacity is limited and the site does not have enough space to contain the total UBMC waste volume of approximately 1,000,000 CY. Because the site could provide capacity for some, but not all of the anticipated waste volume, it could be used in conjunction with another repository.

Groundwater Concerns	The depth to groundwater is greater than 50 feet at this site.	The available data show that the depth to groundwater is typically greater than 50 feet throughout the site and a bottom liner and leachate collection system are probably not needed.
Surface Water Concerns	The site has normal seasonal surface drainages and has otherwise suitable separation from surface water.	The site has suitable separation from existing perennial streams and large seasonal drainages.
Geotechnical Concerns	Because of the steep slopes and space constraints, the repository can only be constructed with an engineered structural toe berm.	The stability analysis showed that the tailings dam and tailings materials lack sufficient strength to be used as the structural toe berm. The structural toe berm needs to be constructed from an engineered granular material with adequate cohesive properties in order to meet long-term stability requirements. The First Gulch site should have suitable materials available on-site to construct the structural toe berm.
Geochemistry Concerns	The investigations completed previously indicated no potential geochemical concerns at the site.	Materials excavated from this site can be used for construction of the structural toe berm and may produce limited quantities of materials suitable for use at the UBMC for general reclamation purposes.
Suitable Soils	The topsoil and subsoil layers are very thin at the site ranging from a few inches to a few feet in thickness. The underlying soils and rock should be suitable for typical repository excavation and construction purposes	The site soils are suitable for repository construction.
Potential Borrow Source	The topsoil and subsoil layers are typically thin at the site ranging from several inches to several feet in thickness. The upper portions of the site contain small quantities of materials suitable as borrow.	The site is a suitable borrow source for repository construction and there should be enough material on site to construct the structural toe berm and there is probably enough growth material available on site to construct the repository cap without imported materials. Due to the lack of fine-grained sized particles, a separate borrow source will need to be developed outside the mining area to obtain materials for reclaiming other areas within the UBMC.
Land Ownership	USFS	Because the site is owned by the USFS, a land purchase would not be required. However, legal agreement would be needed to place wastes from private lands on NFS system lands. This process may be time-consuming and complicated.
Accessibility	The site is located outside the mining area and can be accessed by an existing primitive road.	The road needs to be improved substantially to accommodate hauling and construction equipment. The highway entrance needs to be improved and small drainage structures need to be installed.
Haul Distance	6.7 miles from the impoundment	The First Gulch site has the second shortest haul distance of any alternative considered and the haul costs are correspondingly low compared to other alternatives.
Distance From Residences	Depending on where a repository is sited in First Gulch, there may be one residence within a mile of the site.	The First Gulch site is located on NFS system land outside the mining area. Future development could occur on adjacent private land.

Visibility	The First Gulch site is not visible from any improved roads.	The First Gulch site would decrease the aesthetic quality of the area. The hillside is currently forested or recently logged and would need to be logged or cleared to construct the repository. The visual impacts may diminish somewhat over time as the cap vegetation improves, but because of the cap liner design the area cannot be reforested and the area must always be maintained as a large open area with short vegetation.
Short-Term Impacts	Short term impacts include typical construction-related impacts including dust, storm water erosion, and noise.	Because the First Gulch site is located outside the mining area short-term and long-term impacts will extend outside the mining area. Because the site does not have sufficient borrow material for general UBMC reclamation, development of the off-site borrow sources expands the impacted area to two previously undisturbed areas outside the mining area. These waste and borrow materials will be hauled over existing public roads from two separate locations and will cause short-term impacts and increase risks to the public throughout construction. These risks and impacts can be minimized through proper traffic control, load limit restrictions, maintenance, and other controls but the impacts cannot be eliminated.
Human Health and Safety	With proper design, construction and maintenance the site should provide good overall protection of Human Health and safety. The repository can be designed to meet all ARAR's.	While design and construction is complicated due to space, slope, and geotechnical constraints of the site, it can be constructed to provide good protection of human health and safety. However, because large quantities of materials will be hauled to the site over existing public roads there will be increased risks to the public throughout construction. These risks and impacts can be minimized through proper traffic control, load limit restrictions, maintenance, and other controls but the impacts cannot be eliminated.
Environmental Protectiveness	The First Gulch Repository site can be designed to meet all ARAR's and will provide similar environmental protectiveness to other alternatives.	This alternative provides good overall protection of the environment. However, constructing the repository outside the mining area expands potential long-term impacts outside the mining area, but keeps the risks within the Blackfoot River drainage. As stated above, the repository is expected to be safe and effective and this alternative only provides minimal potential risks.
Feasibility	The First Gulch site is located on NFS System land, construction materials can be obtained, and the repository can be designed to meet all ARAR's.	Although this alternative is feasible, it requires complicated construction and careful quality control. Design, oversight, and construction costs will be correspondingly high because of the space and other construction-related constraints at the site. The overall feasibility is moderate to high because the site is on NFS system land and has few other impediments to implementation.
Cultural, Special Resources, Recreation and Other Issues	No cultural or special resource issues were identified at this site at this time. The area is north of Highway 200 and is designated as a Grizzly Bear Recovery Area. The site is located outside the mining area and is	An assessment of potential impacts to grizzly bears and recreational opportunities should be completed before implementing this alternative.

	currently used as a hunting and recreation area.	
Cost	$6,624,488	The estimated cost per cubic yard at the First Gulch site is $16.56/CY.

4.4.3.2 Evaluation Summary

Because the First Gulch site does not have enough space to contain the anticipated total site volume it cannot be considered as a standalone alternative. The site is feasible to construct and can be designed and constructed to meet ARAR's. The materials at the site are of adequate volume for use as borrow material, but are of marginal quality due to the lack of fine-grained sized particles. As a result, locating the off-site borrow area(s) is a primary unknown for this site. This alternative is a potential alternative for placing a portion of the waste from the UBMC; it should be carried forward and considered in combination with the Paymaster Option 4 repository as the "baseline" alternative. It should also be noted that while the First Gulch site is being carried forward as part of the "baseline" alternative, this site may also be paired with other sites.

4.4.4 Horsefly Creek

The Horsefly Creek repository area is located north of Horsefly Creek and about 0.6 miles south of the Blackfoot River in Township 14N, Range 7W, Section 3. The estimated distance one way from the Horsefly Creek site to Mike Horse Dam is approximately 10.5 miles, which includes approximately 3 miles of existing unpaved haul road from the Mike Horse Dam to Highway 200, approximately 6 miles along MT Highway 200 and approximately 1.5 miles of new access road that would have to be constructed from MT Highway 200 to the site.

4.4.4.1 Description and Evaluation

The approximate space available for the repository is shown on Figure **3.4**. The repository design and construction would be similar to Section 35 Option 2 shown on Figures **4.17** and **4.18**. It is important to note that this configuration can be shifted and/or recreated at several specific sites further uphill and away from the road and the configuration shown is used only as an illustration of how this alternative might be constructed.

Table 4.6 – Horsefly Creek Evaluation

Site Characteristic	General	Evaluation Summary
Available Area and Setting	The site has approximately 77 acres of available space with flatter areas at the base of the site near the valley bottom and slopes increasing toward the east side of the site near the ridge top. This alternative covers approximately 20 acres and has significant room available for expansion or to find the best possible location on the site.	The site has ample space and suitable slopes for locating the repository.
Available Capacity (cy)	The Horsefly Creek site has ample room to construct a repository with a capacity up to	Based on the various repository configurations evaluated in the stability analysis the site has ample

	and exceeding 1,000,000 CY.	space to contain the total UBMC waste volume of approximately 1,000,000 CY.
Groundwater Concerns	The depth to groundwater at the site is greater than 20 feet over large portions of the site. The lower flatter portions of the site show evidence of shallow groundwater.	The available data show that the depth to groundwater is typically greater than 20 feet throughout much of the site but there was seepage noted as shallow as 4 feet below the ground surface in at least one test pit. However, there should be sufficient room at the middle to upper slopes to construct a repository with sufficient separation from groundwater and a bottom liner and leachate collection system are not needed.
Surface Water Concerns	The site has numerous seasonal surface drainages and the lower portions of the site are very near to Horsefly Creek.	The site has suitable separation from existing perennial streams but careful site selection and site design are needed to control seasonal surface drainage and route these flows around the repository.
Geotechnical Concerns	Because of the flatter slopes and colluvial deposits there are no geotechnical concerns at this site	The stability analysis showed that a repository similar to Section 35 Option 1, 2, or 3 could be constructed at this site or similar sites with flat slopes and adequate space.
Geochemistry Concerns	The investigations completed previously indicated no potential geochemical concerns at the site.	Materials excavated from this site should produce sufficient quantities of materials suitable for use at the UBMC for general reclamation purposes. This site should contain the types and quantities of materials necessary.
Suitable Soils	The topsoil and subsoil layers are well developed for this region. The underlying soils and should be suitable for typical repository excavation and construction purposes.	The site soils are suitable for repository construction.
Potential Borrow Source	The topsoil and subsoil layers are well developed for this region ranging from a few feet to tens of feet in thickness. Portions of the site contain significant quantities of materials suitable as borrow.	The site is a suitable borrow source for repository construction and there should be enough material on site to construct the repository and to obtain borrow materials for reclamation at the UBMC. The repository site itself can be developed to obtain materials for reclaiming other areas within the UBMC.
Land Ownership	Stimson Lumber Company, with a Reserved Restrictive Easement held by Sieben Ranch Co.	A land purchase or exchange would be required. This process may be time-consuming and complicated.
Accessibility	The site is located outside the mining area and can be accessed by an existing primitive road.	Assuming access off of Highway 200, the road needs to be improved substantially to accommodate hauling and construction equipment. The highway entrance needs to be improved, a bridge needs to be installed across the Blackfoot River, and numerous small drainage structures need to be installed. The haul route would pass through private property and very near a residence immediately after exiting Highway 200 onto Horsefly Creek road, which proceeds updrainage very close to Horsefly Creek.
Haul Distance	10.6 Miles from the impoundment	The Horsefly Creek site has a haul length near the middle of the range of alternatives considered.
Distance From Residences	Depending on where a repository is sited, there may be up to 5 residences within a mile	The Horsefly Creek site is located on private land outside the mining area. There is potential for

	of the site.	development of private lands near the site. The size of the site allows for a buffer zone where a repository would likely be located.
Visibility	The Horsefly Creek site is not visible from any improved roads.	The Horsefly Creek site would decrease the aesthetic quality of the area. The hillside is currently open. The repository would be very evident within the space. The visual impacts could be reduced through careful design of the repository to minimize straight lines and abrupt slope changes. The impacts may diminish somewhat over time as the cap vegetation improves, but because of the cap liner design the area cannot be reforested and the area must always be maintained as a large open area with short vegetation.
Short-Term Impacts	Short term impacts include typical construction-related impacts including dust, storm water erosion, and noise.	Because the Horsefly Creek site is located outside the mining area short-term and long-term impacts will extend outside the mining area. Because the site does have sufficient borrow material for general UBMC reclamation, development of the borrow source at the repository site limits the impacted area to a single previously undisturbed area outside the mining area. The waste and borrow materials will be hauled over existing public roads and will cause short-term impacts and increase risks to the public throughout construction. These risks and impacts can be minimized through proper traffic control, load limit restrictions, maintenance, and other controls but the impacts cannot be eliminated.
Human Health and Safety	With proper design, construction and maintenance the site should provide good overall protection of Human Health and safety. The repository can be designed to meet all ARAR's.	Design and construction is relatively simple at this site because of the ample space, flat slopes, suitable geologic setting. The site can be constructed to provide good protection of human health and safety. However, because large quantities of materials will be hauled to and from the site over existing public roads there will be increased risks to the public throughout construction. These risks and impacts can be minimized through proper traffic control, load limit restrictions, maintenance, and other controls but the impacts cannot be eliminated.
Environmental Protectiveness	The Horsefly Creek repository site can be designed to meet all ARAR's and will provide similar environmental protectiveness to other alternatives.	This alternative provides good overall protection of the environment. However, constructing the repository outside the mining area expands potential long-term impacts outside the mining area. As stated above, the repository is expected to be safe and effective and this alternative only provides minimal potential risks.
Feasibility	The Horsefly Creek site is located on private land, construction materials can be obtained, and the repository can be designed to meet all ARAR's.	This alternative is feasible and it requires standard construction methods and typical quality control. Design, oversight, and construction costs should be typical for projects of this nature because of the adequate space and good overall site setting. The overall feasibility is moderate because the site is on private land that must be purchased, but has few other impediments to implementation.

Cultural, Special Resources, Recreation and Other Issues	No cultural or special resource issues were identified at this site at this time. The site is located outside the mining area and is currently used as a hunting and recreation area.	An assessment of potential impacts to recreational opportunities should be completed before implementing this alternative.
Cost	$11,790,733	The estimated cost per cubic yard at the Horsefly Creek site is $11.79/CY.

4.4.4.2 Evaluation Summary

Because the Horsefly Creek site has ample space to contain the anticipated total site volume it is considered as a standalone alternative. The site is feasible to construct and can be designed and constructed to meet ARAR's. The site should have suitable borrow material available which facilitates backhaul and limits repository and borrow area impacts to a single location. This alternative is a suitable site for placing wastes from the UBMC. Significant concerns with the Horsefly Creek Alternative include: the private landownership and the significant road improvements required.

4.4.5 Section 35

The Section 35 repository site is located on the north side of Highway 279 and in the northeast half of Section 35 in Township 15N, Range 7W. The haul route includes approximately 3 miles of existing unpaved haul road from the Mike Horse Dam to Highway 200, approximately 4 miles on Highway 200, approximately 1 mile on Highway 279 and up to approximately 0.5 mile of haul road that will need to be improved or constructed to access the site.

4.4.5.1 Description and Evaluation

Section 35 Option 2 consists of excavating into the hillside to obtain borrow materials and placing and compacting approximately 1,011,000 cubic yards of tailings into the excavation at an approximate 3.8H:1V slope. The alternative does not require a structural toe berm. A conceptual site plan and repository section are shown on **Figures 4.17** and **4.18**. It is important to note that this configuration can be shifted and/or recreated at several specific sites further uphill and away from the road and the configuration shown is used only as an illustration of how this alternative might be constructed.

Table 4.7 – Section 35 Evaluation

Site Characteristic	General	Evaluation Summary
Available Area and Setting	The site has a total of approximately 360 acres of available space with flatter areas at the base of the site near the valley bottom and slopes increasing toward the east side of the site near the ridge top. This alternative covers approximately 20.3 acres and has significant room available for expansion or to find the best possible location on the site.	The site has ample space and suitable slopes for locating the repository.

Available Capacity (cy)	The Section 35 site has ample room to construct a repository with a capacity up to and exceeding 1,000,000 CY.	Based on the various repository configurations evaluated in the stability analysis the site has ample space to contain the total UBMC waste volume of approximately 1,000,000 CY.
Groundwater Concerns	The depth to groundwater at the site exhibits relatively large seasonal fluctuations in portions of the site but is greater than 20 feet in at least three locations. The lower flatter portions of the site show evidence of shallow groundwater.	The available data show that the water level in wells at the site fluctuates seasonally by as much as 30 feet in some locations at the site but remains greater than 20 feet in at least three locations. There are areas near the wetlands with shallower groundwater. Additional field data and analysis are needed to determine if the water levels in the wells and associated fluctuations observed at the site are representative of the true groundwater level. Even at the highest water elevations recorded in the wells there are areas with sufficient room to construct a repository with adequate separation from groundwater, and a bottom liner and leachate collection system are not needed.
Surface Water Concerns	The site has a few seasonal surface drainages typical of small hilly areas. The lower portions of the site include Nora Creek, a small tributary to the Blackfoot River.	The site has suitable separation from existing perennial streams, but careful site selection and site design are needed to control seasonal surface drainage and route these flows around the repository and to avoid one spring on the site.
Geotechnical Concerns	Because of the flat slopes and glacial deposits over bedrock there are no geotechnical concerns at this site.	The stability analysis showed that Section 35 Option 1, 2, or 3 could be constructed at this site or similar sites with flat slopes and adequate space.
Geochemistry Concerns	The investigations completed previously showed no potential geochemical concerns at the site.	Materials excavated from this site should produce sufficient quantities of materials suitable for use at the UBMC for general reclamation purposes. This site should contain the types and quantities of materials necessary.
Suitable Soils	The topsoil and subsoil layers are well developed for this region. The underlying soils and should be suitable for typical repository excavation and construction purposes.	The site soils are suitable for repository construction. Test Pit data indicate layers of low permeability soils which are ideal for repository construction.
Potential Borrow Source	The topsoil and subsoil layers are well developed for this region ranging from a few feet to tens of feet in thickness. Portions of the site contain significant quantities of materials suitable as borrow.	The site is a suitable borrow source for repository construction and there should be enough material on site to construct the repository and to obtain borrow materials for reclamation at the UBMC. The repository site itself can be developed to obtain materials for reclaiming other areas within the UBMC.
Land Ownership	Stimson Lumber Company, with a Reserved Restrictive Easement held by Sieben Ranch Co.	A land purchase or exchange would be required. This process may be time-consuming and complicated.

Accessibility	The site is located outside the mining area and can be accessed by an existing primitive road.	The road needs to be improved to accommodate hauling and construction equipment. The highway entrance needs to be improved and few small drainage structures need to be installed.
Haul Distance	8.5 Miles from the impoundment	The Section 35 site has a haul length near the middle of the range of alternatives considered, but is one of the shortest of all standalone alternatives.
Distance From Residences	There are five residences within one mile of the site.	The Section 35 site is located on private land outside the mining area. The size of the site allows for a buffer zone where a repository would likely be located. Development of adjacent private land may occur.
Visibility	The Section 35 site is visible briefly while driving on Highway 279.	The Section 35 site would decrease the aesthetic quality of the area, particularly in the short term. The hillside is currently a mixture of open area and sparse timber and the repository would be evident within the space. The visual impacts could be reduced through careful design of the repository to minimize straight lines and abrupt slope changes. The impacts may diminish somewhat over time as the cap vegetation improves. Because of the low-permeability soils at the site, it may be possible to design the repository and cap without a synthetic liner or with a thicker cover soil layer which would reduce restrictions on the types of vegetation used.
Short-Term Impacts	Short term impacts include typical construction-related impacts including dust, storm water erosion, and noise.	Because the Section 35 site is located outside the mining area, short-term and long-term impacts will extend outside the mining area. Because the site does have sufficient borrow material for general UBMC reclamation, development of the borrow source at the repository site limits the impacted area to a single previously undisturbed area outside the mining area. The waste and borrow materials will be hauled over existing public roads and will cause short-term impacts and increase risks to the public throughout construction. These risks and impacts can be minimized through proper traffic control, load limit restrictions, maintenance, and other controls but the impacts cannot be eliminated.
Human Health and Safety	With proper design, construction and maintenance the site should provide good overall protection of Human Health and safety. The repository can be designed to meet all ARAR's.	Design and construction is relatively simple at this site because of the ample space, benched topography with shallow slopes, and suitable geologic setting. The site can be constructed to provide good protection of human health and safety. However, because large quantities of materials will be hauled to and from the site over existing public roads there will be increased risks to the public throughout construction. These risks and impacts can be minimized through proper traffic control, load

		limit restrictions, maintenance, and other controls but the impacts cannot be eliminated with the on-road haul.
Environmental Protectiveness	The Section 35 repository site can be designed to meet all ARAR's and will provide similar environmental protectiveness to other alternatives.	This alternative provides very good overall protection of the environment. However, constructing the repository outside the mining area expands potential long-term impacts outside the mining area, but keeps the risks within the impacted portion of the Blackfoot River drainage. As stated above, the repository is expected to be safe and effective and this alternative only provides minimal potential risks.
Feasibility	The Section 35 site is located on private land, construction materials can be obtained, and the repository can be designed to meet all ARAR's.	This alternative is feasible and it requires standard construction methods and typical quality control. Design, oversight, and construction costs should be typical for projects of this nature because of the adequate space and good overall site setting. The overall feasibility is moderate because the site is on private land that must be purchased, but has few other impediments to implementation.
Cultural, Special Resources, Recreation and Other Issues	No cultural or special resource issues were identified at this site at this time. The site is located outside the mining area and is currently used as a hunting and recreation area.	An assessment of potential impacts to recreational opportunities should be completed before implementing this alternative.
Cost	$9,883,271	The estimated cost per cubic yard at the Section 35 Option 2 site is $9.88/CY.

4.4.5.2 Evaluation Summary

Because the Section 35 site has ample space to contain the anticipated total site volume it is considered as a standalone alternative. The site is feasible to construct and can be easily designed and constructed to meet ARAR's. Because the site has ample space and suitable soils, the repository and borrow area can be co-located, which reduces the footprint and height of the repository. From a technical perspective, this alternative is a suitable site for placing wastes from the UBMC. The primary concerns with the Section 35 alternative are the private landownership and citizen concerns based on communications from residents in the area, which will be further identified during a public comment period.

4.4.6 Blackfoot River Site 1

The Blackfoot River repository Site 1 is located on State of Montana owned land in the southeast corner of Section 12, Township 14N, Range 8W. The site is just south of MT Highway 200 and is located adjacent to an operating Solid Waste Transfer Station. Topography is relatively flat and vegetation at the site consists of native grasses and sagebrush. The haul route from the Mike Horse Dam to the Blackfoot River Site 1 includes approximately 3 miles of existing unpaved haul road from the Mike Horse Dam to Highway 200, approximately 9 miles of MT Highway

200 and less than a mile of unpaved road that would need to be improved or constructed to provide heavy haul access to the site.

4.4.6.1 Description and Evaluation

The approximate space available for the repository is shown on **Figure 4.33**. The repository design and construction would be similar to Section 35 Option 1 shown on **Figures 4.15** and **4.16**.

Table 4.8 – Blackfoot River Site 1 Evaluation

Site Characteristic	General	Evaluation Summary
Available Area and Setting	The site has approximately 50 acres of available space with the entire bench being very flat. This alternative covers approximately 20 acres and has significant room available for expansion or to find the best possible location on the site.	The site has ample space and suitable slopes for locating the repository.
Available Capacity (cy)	The Blackfoot River site has ample room to construct a repository with a capacity up to and exceeding 1,000,000 CY.	Based on the various repository configurations evaluated in the stability analysis the site has ample space to contain the total UBMC waste volume of approximately 1,000,000 CY.
Groundwater Concerns	The estimated depth to groundwater at the site is greater than 20 feet over large portions of the site.	No site-specific data were available, but the publicly available data indicate that the depth to groundwater should be greater than 20 feet at this site. However, the site is between the Blackfoot River and the Landers Fork and the bench is probably coarse alluvial material subject to large fluctuations in groundwater elevations. Because of this concern, a bottom liner and leachate collection system are included in the conceptual design for this analysis.
Surface Water Concerns	The site is very flat with minimal surface drainages that connect directly to the Blackfoot River.	The site has suitable separation from existing perennial streams but careful site selection and site design are needed to control seasonal surface drainage and route these flows around the repository.
Geotechnical Concerns	Because of the flat slopes and alluvial deposits there are no geotechnical concerns at this site.	The stability analysis showed that a repository similar to Section 35 Option 1 could be constructed at this site or similar sites with flat slopes and adequate space.
Geochemistry Concerns	Based on the geology of the site, there are no geochemical concerns.	Materials excavated from this site could produce some materials suitable for use at the UBMC for general reclamation purposes although this site is not expected to contain all of the types and quantities of materials necessary.
Suitable Soils	Based on the geology of the site, it should contain suitable soils.	Based on the geology, the site soils should be suitable for repository construction.

Potential Borrow Source	Based on the geology and the alluvial setting, the site is not expected to be a suitable borrow source for reclamation purposes at the UBMC.	The site is probably a suitable borrow source for repository construction and there should be enough growth material available on site to construct the repository cap without imported materials. A separate borrow source will need to be developed outside the mining area to obtain materials for reclaiming other areas within the UBMC.
Land Ownership	State	Because the site is owned by the State of Montana, it is assumed that use of the area can be obtained.
Accessibility	The site is located outside the mining area and can be accessed by an existing gravel road.	The road needs to be improved to accommodate hauling and construction equipment. The highway entrance needs to be improved and a few small drainage structures need to be installed. The haul route would pass through or near the entrance to the trash transfer station immediately after exiting Highway 200.
Haul Distance	12.8 Miles from the impoundment	The Blackfoot River site has a one of the longest haul distances of the alternatives considered.
Distance From Residences	At least one residence and a NFS campground are within one mile of the Blackfoot River site.	The Blackfoot River site is located on state land outside the mining area. Future development of adjacent land may occur.
Visibility	The Blackfoot River site is highly visible from Highway 200 from several angles.	The Blackfoot River site would significantly decrease the aesthetic quality of the area. The terrace is currently wide open and the repository would be very evident within the space. It would be very difficult to reduce the visual impacts because of the very flat topography of the site.
Short-Term Impacts	Short term impacts include typical construction-related impacts including dust, storm water erosion, and noise.	Because the Blackfoot River site is located outside the mining area short-term and long-term impacts will extend outside the mining area. Because the site does not have sufficient borrow material for general UBMC reclamation, development of the off-site borrow sources expands the impacted area to two previously undisturbed areas outside the mining area. These waste and borrow materials will be hauled over existing public roads from two separate locations and will cause short-term impacts and increase risks to the public throughout construction. These risks and impacts can be minimized through proper traffic control, load limit restrictions, maintenance, and other controls but the impacts are significant and cannot be eliminated.
Human Health and Safety	With proper design, construction and maintenance the site should provide acceptable overall protection of Human Health and safety. The repository can be designed to meet all ARAR's.	Design and construction is relatively simple at this site because of the ample space, flat slopes, and suitable geologic setting. The site can be constructed to provide acceptable protection of human health and safety. However, because large quantities of materials will be hauled to and from the site over existing public roads there will be increased risks to the public throughout construction. These risks and impacts can be minimized through proper traffic control, load limit restrictions, maintenance, and other controls but the impacts cannot be eliminated.

Environmental Protectiveness	The site can be designed to meet all ARAR's and will provide similar environmental protectiveness to other alternatives.	This alternative provides acceptable overall protection of the environment. However, constructing the repository outside the mining area expands potential long-term impacts outside the mining area. As stated above, the repository is expected to be safe and effective and this alternative only provides minimal potential risks.
Feasibility	The Blackfoot River site is located on state land, construction materials can be obtained, and the repository can be designed to meet all ARAR's.	This alternative is feasible and it requires standard construction methods and typical quality control. Design, oversight, and construction costs should be typical for projects of this nature because of the adequate space and good overall site setting. The overall feasibility is high because the site is on state land and has few other impediments to implementation.
Cultural, Special Resources, Recreation and Other Issues	No cultural or special resource issues were identified at this site at this time. The site is located outside the mining area and is currently used as a hunting and recreation area.	An assessment of potential impacts to cultural resources, special resources and recreational opportunities should be completed before implementing this alternative.
Cost	$13,999,034	The estimated cost per cubic yard at the Blackfoot River site is $14.00/CY.

4.4.6.2 Evaluation Summary

Because the Blackfoot River site has ample space to contain the anticipated total site volume it is considered as a standalone alternative. The site is feasible to construct and can be designed and constructed to meet ARAR's. Significant concerns with the Blackfoot River Alternative include: the long haul route, high visibility, proximity to the Blackfoot River and Landers Fork, groundwater fluctuations and cost. This alternative is a potentially safe site for placing wastes from the UBMC but because of the concerns identified above combined with the high cost compared to other alternatives with equal or better overall performance, this alternative should not be considered further. If the recommended alternative becomes infeasible after further study, this site may be re-evaluated and could be used as the preferred alternative.

4.4.7 Alice Creek Site 4

The Alice Creek 4 repository site is located on State of Montana owned land in the southwest corner of Section 16, Township 15N, Range 7W. The site is north of MT Highway 200 and has relatively flat topography with abundant aspen stands. The site is not visible from MT Highway 200 and can be accessed from the Mike Horse Dam via approximately 3 miles of existing unpaved haul road from the Mike Horse Dam to Highway 200, approximately 6 miles of MT Highway 200 and approximately 3.5 miles of existing unpaved road that will need to be improved to provide heavy haul access to the site.

4.4.7.1 Description and Evaluation

The approximate space available for the repository is shown on Figure 4.35. The repository design and construction would be similar to Section 35 Option 1 shown on **Figures 4.15** and **4.16**.

Table 4.9 – Alice Creek Site 4 Evaluation

Site Characteristic	General	Evaluation Summary
Available Area and Setting	The site has approximately 140 acres of available space with flatter areas at the base of the site near the valley bottom and slopes increasing toward the east side of the site near the ridge top. This alternative covers approximately 20 acres and has significant room available for expansion or to find the best possible location on the site.	The site has ample space and suitable slopes for locating the repository.
Available Capacity (cy)	This site has ample room to construct a repository with a capacity up to and exceeding 1,000,000 CY.	Based on the various repository configurations evaluated in the stability analysis the site has ample space to contain the total UBMC waste volume of approximately 1,000,000 CY.
Groundwater Concerns	The depth to groundwater at portions of the site should be greater than 20 feet. The lower flatter portions of the site show evidence of shallow groundwater.	The available data show that the depth to groundwater could typically be greater than 20 feet throughout much of the site but there was seepage and wetland-type vegetation noted in many places during the field review. Fluctuations in groundwater elevations are not known. Because of the potential groundwater concerns, this alternative includes a bottom liner and leachate collection system.
Surface Water Concerns	The site has numerous seasonal surface drainages and the lower portions of the site are very near to obvious wetland areas.	The site has suitable separation from existing perennial streams but careful site selection and site design are needed to avoid wetland areas, control seasonal surface drainage and route these flows around the repository.
Geotechnical Concerns	Because of the moderate slopes there are no geotechnical concerns at this site	The stability analysis showed that a repository similar to Section 35 Option 1 could be constructed at this site or similar sites with moderate slopes and adequate space.
Geochemistry Concerns	Based on the geology of the site, there are no geochemistry concerns.	Materials excavated from this site could produce sufficient quantities of materials suitable for repository construction and use at the UBMC for general reclamation purposes. This site should contain the types and quantities of materials necessary.
Suitable Soils	The site soils are expected to be suitable for repository construction.	The topsoil and subsoil layers are expected to be well developed for this region. The underlying soils should be suitable for typical repository excavation and construction purposes.

Potential Borrow Source	The topsoil and subsoil layers are well developed for this region ranging from a few feet to tens of feet in thickness. Portions of the site may contain significant quantities of materials potentially suitable as borrow.	The site is a suitable borrow source for repository construction and there should be enough material on site to construct the repository and to obtain borrow materials for reclamation at the UBMC. Because of the shallow groundwater concerns, the repository site itself should not be developed to obtain materials for reclaiming other areas within the UBMC, but a separate borrow area near the repository could be developed which would facilitate back haul.
Land Ownership	State	Because the site is owned by the State of Montana, it is assumed that use of the area can be obtained.
Accessibility	The site is located outside the mining area and can be accessed by an existing gravel road.	The road needs to be improved substantially to accommodate hauling and construction equipment. Additional fill would be required to stabilize the road prism in several locations and numerous small drainage structures need to be installed. The haul route would pass through private property, near private residences, and through or near sensitive wetland areas.
Haul Distance	12.5 miles from the impoundment	This site has a haul length near the middle of the range of alternatives considered.
Distance From Residences	Depending on where a repository is sited, there may be two residences within a mile of the site.	The repository site is located on state land outside the mining area. Future development of adjacent private land may occur.
Visibility	The repository site is visible from Alice Creek Road.	The repository would decrease the aesthetic quality of the area. The hillside is currently open and is visible from many angles and locations along Alice Creek road, and the repository would be very evident within the space. The visual impacts could be reduced through careful design of the repository to minimize straight lines and abrupt slope changes. The impacts may diminish somewhat over time as the cap vegetation improves, but because of the cap liner design the area cannot be reforested and the area must always be maintained as a large open area with short vegetation.
Short-Term Impacts	Short term impacts include typical construction-related impacts including dust, storm water erosion, and noise.	Because this site is located outside the mining area short-term and long-term impacts will extend outside the mining area. Because the site does have sufficient borrow material for general UBMC reclamation, development of the borrow source at the repository site limits the impacted area to a single previously undisturbed areas outside the mining area. The waste and borrow materials will be hauled over existing public roads and will cause short-term impacts and increase risks to the public throughout construction. These risks and impacts can be minimized through proper traffic control, load limit restrictions, maintenance, and other controls but the impacts cannot be eliminated.
Human Health and Safety	With proper design, construction and maintenance the site should provide good overall protection of Human Health and	Design and construction is relatively simple at this site because of the ample space, flat slopes, suitable geologic setting. The site can be constructed to

	safety. The repository can be designed to meet all ARAR's.	provide good protection of human health and safety. However, because large quantities of materials will be hauled to and from the site over existing public roads there will be increased risks to the public throughout construction. These risks and impacts can be minimized through proper traffic control, load limit restrictions, maintenance, and other controls but the impacts cannot be eliminated.
Environmental Protectiveness	The Alice Creek Site 4 repository can be designed to meet all ARAR's and will provide similar environmental protectiveness to other alternatives.	This alternative provides good overall protection of the environment. However, constructing the repository outside the mining area expands potential long-term impacts outside the mining area. As stated above, the repository is expected to be safe and effective and this alternative only causes minimal potential risks.
Feasibility	The Alice Creek Site 4 repository is located on state land, construction materials can be obtained, and the repository can be designed to meet all ARAR's.	This alternative is feasible and it requires standard construction methods and typical quality control. Design, oversight, and construction costs should be typical for projects of this nature because of the adequate space and good overall site setting. The overall feasibility is high because the site is on state land and has few other impediments to implementation.
Cultural, Special Resources, Recreation and Other Issues	No cultural or special resource issues were identified at this site at this time. The area is north of Highway 200 and is designated as a Grizzly Bear Recovery Area. The site is located outside the mining area and is currently a very popular hunting, fishing, wildlife viewing, and wilderness access area.	An assessment of potential impacts to grizzly bears and recreational opportunities should be completed before implementing this alternative.
Cost	$14,471,733	The estimated cost per cubic yard at the Alice Creek Site 4 repository is $14.47/CY, which is near the middle of cost per cubic yard ratios for the alternatives considered.

4.4.7.2 Evaluation Summary

Because the Alice Creek Site 4 repository has ample space to contain the anticipated total site volume it is considered as a standalone alternative. The site is feasible to construct and can be designed and constructed to meet ARAR's. Significant concerns with this alternative include: the long haul route, high visibility, proximity to Alice Creek and sensitive wetland and wildlife habitat areas, cost, impacts to grizzly bears, and impacts to recreational opportunities. This alternative is a potentially safe site for placing wastes from the UBMC but because of the concerns identified above combined with the high cost compared to other alternatives with equal or better overall performance, this alternative should not be considered further. If the recommended alternative becomes infeasible after further study, this site may be re-evaluated and could be used as the preferred alternative.

4.4.8 Alice Creek Site 7

The Alice Creek 7 repository site is located on land owned by the Courtesy Land & Livestock Company near the intersection of Sections 21, 22, 28 and 29, Township 15N, Range 7W. The site is north of MT Highway 200 and has low to moderately sloping topography with some mature conifer growth. The site is not visible from MT Highway 200 and can be accessed from the Mike Horse Dam via approximately 3 miles of existing unpaved haul road from the Mike Horse Dam to Highway 200, approximately 3.5 miles of MT Highway 200 and approximately 1.5 miles of existing unpaved road that will need to be improved or constructed to provide heavy haul access to the site.

4.4.8.1 Description and Evaluation

The approximate space available for the repository is shown on **Figure 4.36**. The repository design and construction would be similar to Section 35 Option 1 shown on **Figures 4.15** and **4.16**.

Table 4.10 – Alice Creek Site 7 Evaluation

Site Characteristic	General	Evaluation Summary
Available Area and Setting	The site has approximately 120 acres of available space with flatter areas at the base of the site near the valley bottom and slopes increasing toward the west side of the site near the ridge top. This alternative covers approximately 20 acres and has significant room available for expansion or to find the best possible location on the site.	The site has ample space and suitable slopes for locating the repository.
Available Capacity (cy)	This site has ample room to construct a repository with a capacity up to and exceeding 1,000,000 CY.	Based on the various repository configurations evaluated in the stability analysis the site has ample space to contain the total UBMC waste volume of approximately 1,000,000 CY.
Groundwater Concerns	The depth to groundwater at portions of the site may be greater than 20 feet. The lower flatter portions of the site show evidence of shallow groundwater.	The available data indicate that the depth to groundwater should typically be greater than 20 feet throughout much of the site but there was seepage and wetland-type vegetation noted in many places during the field review. There may be sufficient room at the middle to upper slopes to construct a repository with adequate separation from groundwater but fluctuations in groundwater elevations are unknown. Because of the potential groundwater concerns, this alternative includes a bottom liner and leachate collection system.
Surface Water Concerns	The site has several seasonal surface drainages and the lower portions of the site are very near to apparent wetland areas.	The site has suitable separation from existing perennial streams but careful site selection and site design are needed to avoid wetland areas, control seasonal surface drainage and route these flows around the repository.

Geotechnical Concerns	Because of the low to moderately sloping topography and suitable geology there are no obvious geotechnical concerns at this site.	The stability analysis showed that a repository similar to Section 35 Option 1could be constructed at this site or similar sites with flat slopes and adequate space.
Geochemistry Concerns	Based on the geology of the site, no geochemistry concerns are anticipated.	Materials excavated from this site could produce sufficient quantities of materials suitable for repository construction and may be suitable use at the UBMC for general reclamation purposes. This site may contain the types and quantities of materials necessary.
Suitable Soils	The site soils should be suitable for repository construction.	The topsoil and subsoil layers are expected to be well developed for this region. The underlying soils should be suitable for typical repository excavation and construction purposes.
Potential Borrow Source	The topsoil and subsoil layers are anticipated to be well developed for this region ranging from a few feet to tens of feet in thickness. Portions of the site are expected contain significant quantities of materials potentially suitable as borrow.	Based on review of readily available data and the site setting, the area should be suitable borrow source for repository construction and there should be enough material on site to construct the repository and to obtain borrow materials for reclamation at the UBMC. Because of the potential shallow groundwater concerns, the repository site itself should not be developed to obtain materials for reclaiming other areas within the UBMC, but a separate borrow area near the repository could be developed which would facilitate back haul.
Land Ownership	Private	Because the site is privately owned, a land purchase or exchange would be required. This process may be time-consuming and complicated.
Accessibility	The site is located outside the mining area and can be accessed by an existing gravel road.	The road needs to be improved substantially to accommodate hauling and construction equipment. Additional fill would be required to stabilize the road prism in several locations and numerous small drainage structures need to be installed. The haul route would pass through private property, near private residences, and through or near sensitive wetland areas.
Haul Distance	7.9 miles from the impoundment	This site has one of the shortest haul distances of the alternatives considered.
Distance From Residences	There is one residence within one mile of the site.	The repository site is located on private land outside the mining area. There is a full-time resident near the site and there is property near and adjacent to the site that could be developed.
Visibility	The repository site is visible from Alice Creek Road.	The repository would decrease the aesthetic quality of the area. The area is currently forested and the repository would be very evident within the space. The visual impacts could be reduced through careful design of the repository to minimize straight lines and abrupt slope changes. The impacts may diminish somewhat over time as the cap vegetation improves, but because of the cap liner design the area cannot be reforested and the area must always be maintained as a large open area with short vegetation.

Short-Term Impacts	Short term impacts include typical construction-related impacts including dust, storm water erosion, and noise.	Because this site is located outside the mining area short-term and long-term impacts will extend outside the mining area. Because the site probably has sufficient borrow material for general UBMC reclamation, development of the borrow source at the repository site limits the impacted area to a single previously undisturbed area outside the mining area. The waste and borrow materials will be hauled over existing public roads and will cause short-term impacts and increase risks to the public throughout construction. These risks and impacts can be minimized through proper traffic control, load limit restrictions, maintenance, and other controls but the impacts cannot be eliminated.
Human Health and Safety	With proper design, construction and maintenance the site should provide overall protection of Human Health and safety. The repository can be designed to meet all ARAR's.	Design and construction is relatively simple at this site because of the ample space, flat slopes, and potentially suitable geologic setting. The site can be constructed to provide protection of human health and safety. However, because large quantities of materials will be hauled to and from the site over existing public roads there will be increased risks to the public throughout construction. These risks and impacts can be minimized through proper traffic control, load limit restrictions, maintenance, and other controls but the impacts cannot be eliminated.
Environmental Protectiveness	The Alice Creek Site 7 repository can be designed to meet all ARAR's and will provide similar environmental protectiveness to other alternatives.	This alternative provides overall protection of the environment. However, constructing the repository outside the mining area expands potential long-term impacts outside the mining area. As stated above, the repository is expected to be safe and effective and this alternative only causes minimal potential risks.
Feasibility	The Alice Creek Site 7 repository is located on private land, construction materials can be obtained, and the repository can be designed to meet all ARAR's.	This alternative is feasible and it requires standard construction methods and typical quality control. Design, oversight, and construction costs should be typical for projects of this nature because of the adequate space and overall site setting. The overall feasibility is moderate because the site is on private land that needs to be purchased prior to implementation.
Cultural, Special Resources, Recreation and Other Issues	No cultural or special resource issues were identified at this site at this time. The area is north of Highway 200 and is designated as a Grizzly Bear Recovery Area. The site is located outside the mining area and is currently a very popular hunting, fishing and wildlife viewing area, even though the land is private.	An assessment of potential impacts to grizzly bears and recreational opportunities should be completed before implementing this alternative.
Cost	$11,647,816	The estimated cost per cubic yard at the Alice Creek Site 7 repository is $11.65/CY.

4.4.8.2 Evaluation Summary

Because the Alice Creek Site 7 repository has ample space to contain the anticipated total site volume it is considered as a standalone alternative. The site is feasible to construct and can be designed and constructed to meet ARAR's. Significant concerns with this alternative include: private land ownership, high visibility, proximity to Alice Creek and sensitive wetland and wildlife habitat areas, cost, impacts to grizzly bears, and impacts to recreational opportunities. This alternative is a potentially safe site for placing wastes from the UBMC and should be carried forward for comparison to other alternatives.

4.4.9 McDonald Meadows Sites

The McDonald Meadows 3 and 4 repository sites are located between the Landers' Fork of the Blackfoot River and Hardscrabble Creek about nine miles northeast of Lincoln on the north side of MT Highway 200. Site 3 is located in T15N, R7W, Section 29 and Site 4 is located in T15N, R7W, Sections 31 and 32. The approximate locations are shown on **Figure 4.34**

Both sites are on land owned by Seiben Ranch Company, are approximately 250 acres in total size and have relatively flat topography. The vicinity of the two sites has been variously harvested for timber, but has some mature conifer stands. The vicinity around the McDonald Meadow sites has been extensively explored as a gold prospect and potential gold mine. Thus, it includes numerous roads, monitoring wells and other site wide information that was developed as part of the mining company's mining application to the State of Montana.

The sites are not visible when traveling on MT Highway 200. The estimated distance one way from Sites 3 and 4 to Mike Horse Dam is approximately 13 miles, which includes approximately 3 miles of existing unpaved haul road from the Mike Horse Dam to MT Highway 200, approximately 6 miles along MT Highway 200 and the remainder on unimproved unpaved roads that need to be improved to facilitate hauling.

4.4.9.1 Description and Evaluation

The approximate space available for the repository is shown on **Figure 4.34**. The repository design and construction would be similar to Section 35 Option 3 shown on **Figures 4.19** and **4.20**. Because these sites are located in essentially the same place in nearly identical settings, they are evaluated as a single alternative.

Table 4.11 – McDonald Meadow Sites 3 and 4 Evaluation Summary

Site Characteristic	General	Evaluation Summary
Available Area and Setting	Each site has approximately 30-40 acres of available space near the ridge top. This alternative covers approximately 20 acres and has significant room available for expansion or to find the best possible	The site has ample space and suitable slopes for locating the repository.

	location on the site.	
Available Capacity (cy)	Both sites have ample room to construct a repository with a capacity up to and exceeding 1,000,000 CY.	Based on the various repository configurations evaluated in the stability analysis the site has ample space to contain the total UBMC waste volume of approximately 1,000,000 CY.
Groundwater Concerns	The anticipated depth to groundwater at both sites is greater than 50 feet over large portions of the site.	The available data show that the depth to groundwater is typically greater than 50 feet throughout much of the site but there are areas with vegetation that suggests that shallow groundwater may be present in some areas. However, there is sufficient room at the middle to upper slopes to construct a repository with sufficient separation from groundwater and a bottom liner and leachate collection system are not needed.
Surface Water Concerns	The site has a few seasonal surface drainages but surface runoff concerns are minimal at the ridge top locations.	The site has suitable separation from existing perennial streams but careful site selection and site design are needed to control seasonal surface drainage and route these flows around the repository.
Geotechnical Concerns	Because of the flat slopes there are no geotechnical concerns at this site.	The stability analysis showed that a repository similar to Section 35 Option 3 could be constructed at this site or similar sites with flat slopes and adequate space near a ridge top.
Geochemistry Concerns	These sites are located on a very large active gold mine claim. The ore body is an oxide ore body near the surface and geochemistry concerns are not anticipated near the ridge top.	Materials excavated from this site should produce sufficient quantities of materials suitable for use at the UBMC for general reclamation purposes. This site should contain the types and quantities of materials necessary.
Suitable Soils	The site soils are expected to be suitable for repository construction.	The topsoil and subsoil layers are expected to be suitable for typical repository excavation and construction purposes.
Potential Borrow Source	The topsoil and subsoil layers are expected to be well developed for this region and should range from a few feet to tens of feet in thickness. Portions of the site should contain significant quantities of suitable borrow materials.	The site is expected to be a suitable borrow source for repository construction and there should be enough material on site to construct the repository and to obtain borrow materials for reclamation at the UBMC. The repository site itself can be developed to obtain materials for reclaiming other areas within the UBMC.
Land Ownership	Private	Because the site is privately owned, a land purchase or exchange would be required. This process may be time-consuming and complicated. It is unclear how the mineral claims may affect property values, purchase options, or future security of these repository sites.
Accessibility	The site is located outside the mining area and can be accessed by an existing primitive road.	The road needs to be improved substantially to accommodate hauling and construction equipment. The highway entrance needs to be improved, and numerous small drainage structures need to be installed.
Haul Distance	MM-3 12.7 miles from the impoundment MM-4 13.4 miles from the impoundment	The MM-3 and MM-4 sites have haul distances near the middle of the range of alternatives considered.

Distance From Residences	There are no residences in the vicinity of these sites.	These sites are located on private land outside the mining area. Private land may be developed in the future for residences or mineral exploration.
Visibility	These sites are not readily visible from any improved roads.	Either repository site would decrease the aesthetic quality of the area. The hillside is currently a mixture of forest and open parks and the repository would be very evident within the space. The visual impacts could be reduced through careful design of the repository to minimize straight lines and abrupt slope changes. The impacts may diminish somewhat over time as the cap vegetation improves, but because of the cap liner design the area cannot be reforested and the area must always be maintained as a large open area with short vegetation.
Short-Term Impacts	Short term impacts include typical construction-related impacts including dust, storm water erosion, and noise.	Because these sites are located outside the mining area short-term and long-term impacts will extend outside the mining area. Because the site does have sufficient borrow material for general UBMC reclamation, development of the borrow source at the repository site limits the impacted area to a single previously undisturbed area outside the mining area. The waste and borrow materials will be hauled over existing public roads and will cause short-term impacts and increase risks to the public throughout construction. These risks and impacts can be minimized through proper traffic control, load limit restrictions, maintenance, and other controls but the impacts cannot be eliminated.
Human Health and Safety	With proper design, construction and maintenance the site should provide overall protection of Human Health and safety. The repository can be designed to meet all ARAR's.	Design and construction is relatively simple at this site because of the ample space, flat slopes, suitable geologic setting. The site can be constructed to provide protection of human health and safety. However, because large quantities of materials will be hauled to and from the site over existing public roads there will be increased risks to the public throughout construction. These risks and impacts can be minimized through proper traffic control, load limit restrictions, maintenance, and other controls but the impacts cannot be eliminated.
Environmental Protectiveness	These repository sites can be designed to meet all ARAR's and will provide similar environmental protectiveness to other alternatives.	These alternatives provide overall protection of the environment. However, constructing the repository outside the mining area expands potential long-term impacts outside the mining area. As stated above, the repository is expected to be safe and effective and this alternative only provides minimal potential risks.
Feasibility	These sites are located on private land, construction materials can be obtained, and the repository can be designed to meet all ARAR's. The mineral rights issues may make this alternative not feasible.	These alternatives may be feasible and require standard construction methods and typical quality control. Design, oversight, and construction costs should be typical for projects of this nature because of the adequate space and overall site setting. The overall feasibility is considered low because the site is on private land with a very large gold deposit that must be purchased, but has few other impediments to implementation.

Cultural, Special Resources, Recreation and Other Issues	No cultural or special resource issues were identified at this site at this time. The area is north of Highway 200 and is designated as a Grizzly Bear Recovery Area. The site is located outside the mining area and the publicly owned areas near the site are currently popular hunting, fishing and wildlife viewing areas.	An assessment of potential impacts to grizzly bears and recreational opportunities should be completed before implementing this alternative.
Cost	MM-3: $13,416,941 MM-4: $13,892,547	The estimated cost per cubic yard at the MM-3 Site is $13.42/CY and at the MM-4 is $13.89.

4.4.9.2 Evaluation Summary

Because the MM-3 and MM-4 sites have ample space to contain the anticipated total site volume each is considered as a standalone alternative. Each of the sites is feasible to construct and can be designed and constructed to meet ARAR's. Significant concerns with this alternative include: private land ownership, mineral rights and ownership, cost, impacts to grizzly bears, and impacts to recreational opportunities. This alternative is a potentially safe site for placing wastes from the UBMC but because of the concerns identified above, particularly the mineral rights issue, combined with the high cost compared to other alternatives with equal or better overall performance, this alternative should not be considered further. If the recommended alternative becomes infeasible after further study, these alternatives may be re-evaluated and could be used as the preferred alternative.

4.4.10 State Section 18 Sites East of Rogers Pass

In order to respond to citizen requests that the agencies evaluate the cost of hauling waste east of the divide, the agencies chose the nearest, potentially suitable state-owned property east of Rogers Pass. The Section 18 repository sites consist of two potential repository sites, Section 18-1 and 18-2, which are located east of the Continental Divide on State of Montana land. The site is in the south half of Section 18, Township 17N, Range 5W and is north of MT Highway 200 and east of MT Highway 434. Topography is relatively flat and vegetation at the site consists of native grasses and small shrubs. The haul route from the Mike Horse Dam to the Section 18 site includes approximately 3 miles of existing unpaved haul road from the Mike Horse Dam to Highway 200, approximately 15 miles of Highways 200 and 434 and approximately 1.5 miles of new access road that would have to be constructed from Highway 434 to the site.

4.4.10.1 Description and Evaluation

The approximate space available for the repository is shown on Figure 4.37. The repository design and construction would be similar to Section 35 Option 2 shown on **Figures 4.17** and **4.18**. Because these sites are located in essentially the same place in nearly identical settings, they are evaluated as a single alternative.

Table 4.12 – State Section 18 Evaluation

Site Characteristic	General	Evaluation Summary
Available Area and Setting	The site has up to 40 acres of available space with flat areas available to construct a repository. This alternative covers approximately 20 acres and has significant room for available for expansion or to find the best possible location on the site.	The site has ample space and suitable slopes for locating the repository.
Available Capacity (cy)	The site has ample room to construct a repository with a capacity up to and exceeding 1,000,000 CY.	Based on the various repository configurations evaluated in the stability analysis the site has ample space to contain the total UBMC waste volume of approximately 1,000,000 CY.
Groundwater Concerns	The depth to groundwater at the site should be greater than 20 feet over most of the site.	The available data indicate that the depth to groundwater should be greater than 20 feet throughout the site There is sufficient room at the site to construct a repository with sufficient separation from groundwater and a bottom liner and leachate collection system are not needed.
Surface Water Concerns	The site has typical seasonal surface drainages.	The site has suitable separation from existing perennial streams, including the North and Middle Forks of the Dearborn River, but careful site selection and site design are needed to control seasonal surface drainage and route these flows around the repository.
Geotechnical Concerns	Because of the flat slopes there are no geotechnical concerns at this site	The stability analysis showed that a repository similar to Section 35 Option 2 could be constructed at this site or similar sites with flat slopes and adequate space.
Geochemistry Concerns	Based on the site geology there are no potential geochemical concerns at the site.	Materials excavated from this site should produce sufficient quantities of materials suitable for use at the UBMC for general reclamation purposes. This site should contain the types and quantities of materials necessary.
Suitable Soils	The site soils should be suitable for repository construction.	The topsoil and subsoil layers are typically thin in this area. The underlying soils and should be suitable for typical repository excavation and construction purposes.
Potential Borrow Source	The topsoil and subsoil layers should range from a few feet to tens of feet in thickness. Portions of the site should contain significant quantities of materials suitable as borrow.	The site is anticipated to be a suitable borrow source for repository construction and there should be enough material on site to construct the repository and possibly to obtain borrow materials for reclamation at the UBMC. The repository site itself can be developed to obtain materials for reclaiming other areas within the UBMC.
Land Ownership	State	Because the site is owned by the State of Montana, it is assumed that use of the area can be obtained.
Accessibility	The site is located outside the mining area and can be accessed by an existing primitive road.	The road needs to be improved substantially to accommodate hauling and construction equipment. The highway entrance needs to be improved and numerous small drainage structures need to be

		installed. The haul route would pass through private property and close to a residence immediately after exiting Highway 200.
Haul Distance	20.4 Miles from the impoundment	The site has the longest haul length of all alternatives considered.
Distance From Residences	Depending on where a repository was sited, there may be one residence within one mile of the site.	The site is located on state land outside the mining area. Future development of adjacent private land is possible.
Visibility	The site is not visible from any improved roads.	The site would decrease the aesthetic quality of the area. The landscape is very open and the repository would be very evident within the space. The visual impacts could be reduced through careful design of the repository to minimize straight lines and abrupt slope changes. The impacts may diminish somewhat over time as the cap vegetation improves and the short vegetation may blend acceptably well with the typical short vegetation in this area.
Short-Term Impacts	Short term impacts include typical construction-related impacts including dust, storm water erosion, noise, and traffic delays throughout the haul route.	Because the site is located outside the mining area short-term and long-term impacts will extend outside the mining area. Because the site does have sufficient borrow material for general UBMC reclamation, development of the borrow source at the repository site limits the impacted area to a single previously undisturbed areas outside the mining area. The waste and borrow materials will be hauled over existing public roads and will cause short-term impacts and increase risks to the public throughout construction. These risks and impacts can be minimized through proper traffic control, load limit restrictions, maintenance, and other controls but the impacts cannot be eliminated.
Human Health and Safety	With proper design, construction and maintenance the site should provide overall protection of Human Health and safety. The repository can be designed to meet all ARAR's.	Design and construction is relatively simple at this site because of the ample space, flat slopes, suitable geologic setting. The site can be constructed to provide protection of human health and safety. However, because large quantities of materials will be hauled to and from the site over existing public roads there will be increased risks to the public throughout construction. These risks and impacts can be minimized through proper traffic control, load limit restrictions, maintenance, and other controls but the impacts cannot be eliminated.
Environmental Protectiveness	The site can be designed to meet all ARAR's and will provide similar environmental protectiveness to other alternatives.	This alternative provides overall protection of the environment. However, constructing the repository outside the mining area expands potential long-term impacts well outside the mining area. As stated above, the repository is expected to be safe and effective and this alternative only provides minimal potential risks. Constructing the repository on the east site of the Continental Divide expands potential environmental impacts well outside the Blackfoot River basin and introduces the contaminants to a drainage not previously

		associated with the UBMC.
Feasibility	The Section 18 repository is located on state land, construction materials can be obtained, and the repository can be designed to meet all ARAR's.	This alternative is feasible and it requires standard construction methods and typical quality control. Design, oversight, and construction costs should be typical for projects of this nature because of the adequate space and overall site setting. The overall feasibility is high because the site is on state land and has few other impediments to implementation.
Cultural, Special Resources, Recreation and Other Issues	No cultural or special resource issues were identified at this site at this time. The site is located outside the mining area and is currently used as agricultural land.	A complete assessment of historic, cultural, and natural resources is needed before implementing this alternative.
Cost	$15,034,436	The estimated cost per cubic yard at this site is $15.03/CY.

4.4.10.2 Evaluation Summary

Because either of the Section 18 sites (18-1 or 18-2) has ample space to contain the anticipated total site volume it is considered as a standalone alternative. Each of the sites is feasible to construct and can be designed and constructed to meet ARAR's. Significant concerns with this alternative include: cost, potential historic issues, potential natural resource issues, and potential cultural concerns. Potential permitting issues for this site may be more complex because it is located well outside the Upper Blackfoot drainage. This alternative is a potentially safe site for placing wastes from the UBMC but because of the concerns identified above, particularly the high cost compared to other alternatives with equal or better overall performance, this alternative should not be considered further. If the recommended alternative becomes infeasible after further study, this site may be re-evaluated and could be used as the preferred alternative.

4.4.11 Hypothetical Site East of Rogers Pass

In order to provide a cost estimate for an area east of Rogers Pass that is closer than the nearest potentially suitable state-owned property, a hypothetical repository site located in or near Township 16N, Range 6W in Lewis and Clark County was identified as the closest location to the mining area with potentially suitable geology and topography. The haul route from the Mike Horse Dam to this area includes approximately 3 miles of existing unpaved haul road from the Mike Horse Dam to Highway 200, approximately 12 miles of Highways 200 and approximately 1.5 miles of new access road that would have to be constructed from MT Highway 200 to the site.

4.4.11.1 Description and Evaluation

A specific site within this area has not been identified. Instead, this alternative represents a hypothetical site located in the closest potentially suitable geologic setting on the east site of the continental divide. The approximate general area where this repository could be located is illustrated on Figure 4.32. The repository design and construction would be similar to Section 35 Option 2 shown on **Figures 4.17** and **4.18**. The overall site evaluation would be nearly identical to the State Section 18 alternative with the exception of land ownership and haul distance.

Table 4.13 – Hypothetical Site East of Rogers Pass Evaluation

Site Characteristic	General	Evaluation Summary
Available Area and Setting	The site has up to 40 acres of available space with flat areas available to construct a repository. This alternative covers approximately 20 acres and has significant room for available for expansion or to find the best possible location on the site.	The site has ample space and suitable slopes for locating the repository.
Available Capacity (cy)	The site has ample room to construct a repository with a capacity up to and exceeding 1,000,000 CY.	Based on the various repository configurations evaluated in the stability analysis the site has ample space to contain the total UBMC waste volume of approximately 1,000,000 CY.
Groundwater Concerns	The depth to groundwater at the site should be greater than 20 feet over most of the site.	The available data indicate that the depth to groundwater should be greater than 20 feet throughout the site There is sufficient room at the site to construct a repository with sufficient separation from groundwater and a bottom liner and leachate collection system are not needed.
Surface Water Concerns	The site has typical seasonal surface drainages.	The site has suitable separation from existing perennial streams but careful site selection and site design are needed to control seasonal surface drainage and route these flows around the repository.
Geotechnical Concerns	Because of the flat slopes there are no geotechnical concerns at this site.	The stability analysis showed that a repository similar to Section 35 Option 2could be constructed at this site or similar sites with flat slopes and adequate space.
Geochemistry Concerns	Based on the site geology there are no potential geochemical concerns at the site.	Materials excavated from this site should produce sufficient quantities of materials suitable for use at the UBMC for general reclamation purposes. This site should contain the types and quantities of materials necessary.
Suitable Soils	The site soils should be suitable for repository construction.	The topsoil and subsoil layers are typically thin in this area. The underlying soils should be suitable for typical repository excavation and construction purposes.
Potential Borrow Source	The topsoil and subsoil layers should range from a few feet to tens of feet in thickness. Portions of the site should contain significant quantities of materials suitable as borrow.	The site is anticipated to be a suitable borrow source for repository construction and there should be enough material on site to construct the repository and to possibly obtain borrow materials for reclamation at the UBMC. The repository site itself can be developed to obtain materials for reclaiming other areas within the UBMC.
Land Ownership	Private	Because the site is privately owned, a land purchase or exchange would be required. This process may be time-consuming and complicated.
Accessibility	The site is located outside the mining area and can be accessed by an existing primitive road.	The road needs to be improved substantially to accommodate hauling and construction equipment. The highway entrance needs to be improved and numerous small drainage structures need to be installed. The haul route would pass through private property and close to residences immediately after

		exiting Highway 200.
Haul Distance	17.4 Miles from the impoundment	The site has the second longest haul length of all alternatives considered.
Distance From Residences	Depending on the location, multiple residences may exist within one mile of a repository within this area.	This area is private land outside the mining area. Future development of private land is possible.
Visibility	The site is not visible from any improved roads.	The site would decrease the aesthetic quality of the area. The landscape is very open and the repository would be very evident within the space. The visual impacts could be reduced through careful design of the repository to minimize straight lines and abrupt slope changes. The impacts may diminish somewhat over time as the cap vegetation improves and the short vegetation may blend acceptably well with the typical short vegetation in this area.
Short-Term Impacts	Short term impacts include typical construction-related impacts including dust, storm water erosion, noise, and traffic delays throughout the haul route.	Because the site is located outside the mining area short-term and long-term impacts will extend outside the mining area. Because the site should have sufficient borrow material for general UBMC reclamation, development of the borrow source at the repository site limits the impacted area to a single previously undisturbed areas outside the mining area. The waste and borrow materials will be hauled over existing public roads and will cause short-term impacts and increase risks to the public throughout construction. These risks and impacts can be minimized through proper traffic control, load limit restrictions, maintenance, and other controls but the impacts cannot be eliminated.
Human Health and Safety	With proper design, construction and maintenance the site should provide overall protection of Human Health and safety. The repository can be designed to meet all ARAR's.	Design and construction is relatively simple at this site because of the ample space, flat slopes, suitable geologic setting. The site can be constructed to provide protection of human health and safety. However, because large quantities of materials will be hauled to and from the site over existing public roads there will be increased risks to the public throughout construction. These risks and impacts can be minimized through proper traffic control, load limit restrictions, maintenance, and other controls but the impacts cannot be eliminated.
Environmental Protectiveness	The site can be designed to meet all ARAR's and will provide similar environmental protectiveness to other alternatives.	This alternative provides overall protection of the environment. However, constructing the repository outside the mining area expands potential long-term impacts well outside the mining area. As stated above, the repository is expected to be safe and effective and this alternative only provides minimal potential risks. Constructing the repository on the east site of the Continental Divide expands potential environmental impacts well outside the Blackfoot River basin and introduces contaminants to a drainage not previously associated with the

		UBMC.
Feasibility	The site is located on private land, construction materials can be obtained, and the repository can be designed to meet all ARAR's.	This alternative is feasible and it requires standard construction methods and typical quality control. Design, oversight, and construction costs should be typical for projects of this nature because of the adequate space and overall site setting. The overall feasibility is moderate because the site is on private land that must be purchased, but has few other impediments to implementation.
Cultural, Special Resources, Recreation and Other Issues	No cultural or special resource issues were identified at this site at this time. The site is located outside the mining area and is currently used as agricultural land.	A complete assessment of historic, cultural, and natural resources is needed before implementing this alternative.
Cost	$14,234,854	The estimated cost per cubic yard at this site is $14.23/CY.

4.4.11.2 Evaluation Summary

Because the hypothetical site is assumed to have ample space to contain the anticipated total site volume it is considered as a standalone alternative. The site should be feasible to construct and can be designed and constructed to meet ARAR's. Significant concerns with this alternative include: cost, potential historic issues, potential natural resource issues, potential cultural concerns, and land purchase complications. Potential permitting issues for this site may be more complex because it is located well outside the Upper Blackfoot drainage. This alternative is a potentially safe site for placing wastes from the UBMC but because of the concerns identified above, including the high cost compared to other alternatives with equal or better overall performance; this alternative should not be considered further. If the recommended alternative becomes infeasible after further study, this site may be re-evaluated and could be used as the preferred alternative.

4.5 SCREENING OF ALTERNATIVES

All of the potential repository sites discussed in Sections 4.4 and 4.5 of this report are considered to be technically feasible to design and construct. Therefore, sites which are removed from further consideration in this section are not eliminated from consideration completely and may be re-evaluated if the recommended alternative is determined to be less suitable than previously thought.

The Paymaster and First Gulch Sites are not considered as standalone alternatives because they do not have the capacity to serve as a standalone alternative. These two alternatives were combined because they were fully vetted in the EE/CA and, if used together, they have adequate capacity for the total site volume. This combination alternative provides the best basis for comparison of the other alternatives to the alternative selected in the Action Memorandum, and is therefore considered the "baseline alternative". Because of the Trust and NFS system landownership and readily available data, the combination alternative could be implemented relatively quickly. Each of these sites has significant technical issues that would complicate design, both require importing large quantities of materials, and together are the most expensive

site-wide alternative considered. First Gulch has steep slopes, limited space, and would require a structural toe berm. Paymaster has steep slopes, limited space, would require a structural toe berm, and has significant geochemistry issues that need to be controlled through careful design and construction. However, this alternative was retained because it represents the approach initially selected in the EE/CA and is effectively the "baseline" alternative.

The Horsefly Creek site was retained as a standalone alternative. The site has reasonable cost combined with similar or better overall protectiveness to the other alternatives. The large potential capacity, suitable site slopes, soils, and geology, availability of borrow materials, and reasonable costs combine to make the Horsefly Creek site a sound alternative. The primary concerns with the site are the safety concern with the haul road passing very near a permanent residence, resource impacts of a road near Horsefly Creek, unknown groundwater fluctuations, significant seasonal surface runoff and the higher costs compared to at least one other alternative.

The Section 35 site is retained as a standalone alternative. The site has the lowest cost of all alternatives as well as better overall protectiveness than the other alternatives. The low permeability soils, benched topography with suitable slopes, and availability of borrow materials give the site the highest protectiveness of all alternatives considered. Private landownership issues, residents' concerns are the primary concerns with this site. The site is located within a mile of five existing residences. All residences are located up gradient from the site. The size of the site offers the opportunity to create some buffer with respect to nearby residents and provides adequate separation from potential environmental receptors.

Blackfoot River Site 1 was not considered further because of the high cost combined with high short and long-term impacts without affording significantly better protectiveness than other alternatives. This site is very near the Blackfoot river well below the primary impact area and would significantly alter the character of the river corridor.

Alice Creek Site 4 was not considered further because of the high cost combined with high short-term impacts without affording significantly better protectiveness than other alternatives. This site is very near Alice Creek and numerous sensitive wetland areas. The site would significantly alter the character of this very popular recreation and wildlife habitat area. The site may require mitigation because it is located in a grizzly bear recovery area.

Alice Creek Site 7 is retained as a standalone alternative because of its close proximity to the site, available space, relatively easy access, and relatively low cost compared to other alternatives. This site is very near Alice Creek, is privately owned, is located near existing residences, and is near visible sensitive wetland areas and careful siting and design would be required to minimize these potential issues. The site may alter the character of the area at the intersection of Highway 200 and Highway 279. The site may require mitigation because it is located in a grizzly bear recovery area.

McDonald Meadow Sites 3 and 4 were not considered further because of the high cost combined without affording significantly better protectiveness than other alternatives, as well as significant concerns regarding the status of the mineral rights on this private property. These mineral rights significantly complicate acquisition and if the property is mined in the future the repositories

may be disturbed, compromised or relocated. The site may require mitigation because it is located in a grizzly bear recovery area.

State Section 18 was not considered further because of the very high cost combined with high short-term impacts without affording significantly better protectiveness than other alternatives. This site is located well outside the mining area and across the Continental Divide and therefore expands potential impacts out of the impacted portion of the Blackfoot River drainage and into the Dearborn River drainage.

The hypothetical site east of Rogers pass was not considered further because of the high cost combined with high short-term impacts without affording significantly better protectiveness than other alternatives. This site would be located well outside the mining area and across the Continental Divide and therefore expands potential impacts out of the impacted portion of the Blackfoot River drainage and into the Dearborn River drainage. This option assumes that a suitable site can be located on a willing landowner's property. It has not been determined at this time if such a site exists. Given the high haul costs, several better options exist and expending the effort to locate and investigate this alternative would not be prudent at this time.

A cost comparison table for all alternatives considered is presented in **Table 4.15**. The table provides a total cost estimate, approximate capacity, and cost per cubic yard for each alternative considered.

Table 4.15 – Alternatives Cost Comparison

Alternative Name	Total Cost Estimate ($)	Approximate Waste Capacity (CY)	Cost/CY ($)
Paymaster Option 4	$11,182,943	600,000	$18.64
Paymaster Option 6	$12,987,036	600,000	$21.65
First Gulch Option 1	$6,624,488	400,000	$16.56
Horsefly Creek	$11,790,733	1,000,000	$11.79
Section 35 Option 2	$9,883,271	1,000,000	$9.88
Blackfoot River Site 1	$13,999,034	1,000,000	$14.00
Alice Creek Site 4	$14,471,733	1,000,000	$14.47
Alice Creek Site 7	$11,647,816	1,000,000	$11.65
McDonald Meadow Site 3	$13,416,941	1,000,000	$13.42
McDonald Meadow Site 4	$13,892,547	1,000,000	$13.89
State Section 18	$15,034,436	1,000,000	$15.03
Hypothetical Site East of Rogers Pass	$14,234,854	1,000,000	$14.23
Paymaster Option 4/First Gulch Option 1	$15,237,461	1,000,000	$15.24

Based on the information presented above, three potentially feasible alternatives remain for the site in addition to the "baseline" alternative (a combination of Paymaster Option 4 and First Gulch Option 1 alternatives). These remaining alternatives are:

- Horsefly Creek.
- Alice Creek Site 7
- Section 35.
- Paymaster Alternative 4/First Gulch Combination ("baseline").

5.0 COMPARISON OF ALTERNATIVES

This section presents a summarized comparison of the key distinguishing factors between the remaining alternatives presented in Section 4.5 and provides reasoning for selection of the recommended alternative.

5.1 EFFECTIVENESS (PROTECTIVENESS)

Section 35 is expected to be one of the most protective of all alternatives considered. Section 35 has at least three suitable repository sites and has suitable soils and geology. Separation from surface and groundwater is adequate in at least three locations at the site, but careful site selection and design will be required to ensure appropriate separation and meet ARAR's. The large size of the site and varied physical settings provide flexibility for siting and designing a repository. Borrow materials are available at or adjacent to the repository site and only one area outside the mining area will need to be disturbed. The site setting and low permeability soils provide one of the safest and most secure repository sites of all alternatives considered. The Section 35 site is located within the already-impacted portion of the Blackfoot River and would not expand potential impacts outside that portion of the drainage basin. The favorable site conditions allow design parameters to be optimized and thus create the safest and most protective repository of all alternatives considered.

Based on the available data the Horsefly Creek site provides good overall protectiveness. Horsefly Creek has suitable repository sites and has suitable soils and geology. It is anticipated that the separation from surface and groundwater should be adequate in portions of the site but the actual groundwater levels are unknown. Borrow materials are available at the repository site and only one area outside the mining area will need to be disturbed. The site setting and suitable soils facilitate design and construction of a safe and secure repository. The site is not visible from any improved roads, which distinguishes it from other potential repository sites. Separation from surface and ground water is better at Horsefly Creek than at the Paymaster site and is expected to be better than at the Alice Creek Site. The Horsefly Creek site has more seasonal surface water drainages than Section 35, and careful site selection and design are needed to manage the surface water. The soils are more permeable than at the Section 35 site making the site somewhat less protective than Section 35. The on-road haul to Horsefly Creek causes impacts to the public through hauling waste and borrow materials, but these impacts are short

term, manageable and are present in all alternatives considered. Assuming access from Highway 200, this haul route is more disruptive than the Section 35 route because it passes very near a residence and is significantly longer than the haul to First Gulch, Alice Creek 7, or Section 35. An alternative haul route from Highway 279 may be feasible, but would increase costs at this site.

The Alice Creek Site 7 site should provide good overall protectiveness. Based on available information, the site has a few suitable repository sites and should have suitable soils and geology. It is anticipated that the separation from surface and groundwater should be adequate in portions of the site but the actual groundwater levels are unknown. Borrow materials are anticipated to be available near the repository site and only one area outside the mining area will need to be disturbed. The site setting and suitable soils should facilitate design and construction of a safe and secure repository. The site is visible from Highway 200 and Highway 279, and careful siting and design are needed to minimize visual impacts. Based on observations during the Spring of 2011, separation from surface and ground water at Alice Creek 7 is expected to be similar to Horsefly Creek, better than at the Paymaster site, and not as good as Section 35. The permeability of the soils at the site is unknown. The on-road haul to Alice Creek Site 7 causes impacts to the public through hauling waste and borrow materials, but these impacts are short term, manageable and are present in all alternatives considered. The waste haul route is less disruptive than the Section 35 or Horsefly Creek sites because hauling could be limited to Highway 200 above the intersection with Highway 279 by constructing a new access road.

The combined Paymaster/First Gulch Alternative provides potentially adequate overall protectiveness. There are significant concerns with the overall protectiveness of the Paymaster Site because of the marginal geotechnical stability, close proximity to the Blackfoot River and the potential to disturb underlying mineralized materials during repository construction. Repository siting options are limited due to space constraints at both sites. Geochemistry concerns at the Paymaster site complicate construction but may be manageable with adequate oversight and quality control. However, even with strict grade and quality control, it will be challenging to prepare the repository subgrade to facilitate liner installation without cutting into mineralized areas. Disturbing these materials could mobilize metals and create metals-contaminated seeps which could require permanent capture and treatment. These costs were not considered in the cost estimate and the overall costs would be higher if capture and treatment are required. These factors combine to reduce the overall protectiveness of the Paymaster/First Gulch alternative to below the overall protectiveness of the other alternatives considered.

Separation from surface and groundwater is good at First Gulch but is minimal at the Paymaster site which requires a bottom liner and drainage system. The toe of the Paymaster Repository is located a few hundred feet from the Blackfoot River. The marginal slope stability and close proximity to the river reduce potential long-term protectiveness of the Paymaster site and are a potential risk to the Blackfoot River.

Reclamation borrow materials are not available at either the First Gulch or the Paymaster site and another area outside the mining area will need to be disturbed to obtain structural materials and general site reclamation materials. All of these materials will be hauled to the site over existing public roads.

The on-road haul route causes impacts to the public through hauling waste and borrow materials but these impacts are short term, manageable and are present in all alternatives considered. The waste haul route is less disruptive than the Section 35 or Horsefly Creek sites because waste hauling is limited to Highway 200 above the intersection with Highway 279. However, more borrow materials will be imported to construct the Paymaster structural toe berm and for general site reclamation, which offset the shorter haul distance to the First Gulch site.

5.2 IMPLEMENTABILITY (FEASIBILITY)

All of the sites that were evaluated in this report have unknowns associated with implementability. Generally, sites that are privately owned have additional implementability issues that state, trust or NFS land do not. Each of the remaining alternatives selected is technically feasible to design and construct. The construction techniques are known and commonly employed. Construction at the Paymaster/First Gulch site is the most complicated, has the most risk, and may require additional groundwater capture and control, but it should be possible to complete. Landownership is a primary issue that influences the implementability of these alternatives.

The Paymaster/First Gulch combination alternative has the highest potential implementability because the properties are currently owned by USFS and the Trust. Some specific agreements will be needed to secure approval to place wastes from private lands on NFS Land, and this process is not fully tested. Additionally, a borrow source would have to be identified and agreements would have to be executed to utilize or purchase borrow materials. The lack of suitable borrow material for construction and reclamation reduce the feasibility of this option.

The Section 35 site is privately owned and must be acquired to implement this alternative. The purchase process may be difficult and is the main deterrent to implementing this alternative.

The Horsefly Creek site is owned by the same parties as the Section 35 site, and must be acquired to implement this alternative. It therefore has similar implementability to the Section 35 Alternative.

The Alice Creek Site 7 is privately owned and must be acquired to implement this alternative. It therefore is judged to have similar implementability to the Section 35 and Horsefly Creek Alternatives.

The Paymaster/First Gulch alternative has the fewest anticipated issues related to land ownership and the greatest issues related to constructability. Horsefly Creek, Alice Creek Site 7, and Section 35 have more significant issues with landownership and virtually no issues with constructability. Based on the information to date, the landownership issues associated with Horsefly Creek and Section 35 may be easier to resolve than the constructability issues associated with the Paymaster, and therefore, the Paymaster/First Gulch alternative is estimated to have the lowest overall implementability. There is no existing information related to the possibility of acquiring the Alice Creek 7 site and it is unknown if acquisition will be more or less difficult than Section 35 or Horsefly Creek.

5.3 COST

With a total estimated cost of $15,237,461 the combined Paymaster/First Gulch Alternative is the most expensive alternative considered. This alternative is approximately one and a half times (1.5 times) as expensive as the Section 35 Alternative. The high cost reflects the technical difficulties constructing repositories at these less than ideal sites. The high costs stem from difficult excavation, the need to construct structural toe berms (with imported material at the Paymaster site), and the need to import borrow materials from a third site. Disturbing the underlying mineralized materials could mobilize metals and create metals-contaminated seeps which could require permanent capture and treatment. These costs were not considered in the cost estimate; the overall costs would be higher if capture and treatment are required. These sites are also expected to have the highest long-term monitoring and maintenance costs because there are two complex sites to monitor and maintain.

With a total estimated cost of $11,790,733, the Horsefly Creek site is the second most expensive alternative retained for comparison, although the cost is nearly identical to Alice Creek Site 7. This alternative is more expensive than the Section 35 alternative primarily due to the longer haul and more extensive road improvements needed to implement this alternative. Long-term monitoring and maintenance costs should be similar to Section 35 but lower than Paymaster/First Gulch.

With a total estimated cost of $11,647,816 the Alice Creek site is the second least expensive alternative retained for comparison, although the cost is nearly identical to Horsefly Creek. This alternative is more expensive than the Section 35 alternative primarily due to the anticipated need for a bottom liner. Long-term monitoring and maintenance costs should be similar to Section 35 and Horsefly Creek but lower than Paymaster/First Gulch.

With a total estimated cost of $9,883,271, the Section 35 alternative site is the least expensive alternative retained for comparison, and the least expensive cost per yard. The lower cost is due to the shorter haul and less extensive road improvements needed to implement this alternative when compared to Horsefly Creek, the simplicity of design and construction, and the availability of borrow materials when compared to the Paymaster/First Gulch alternative, and the ability to construct the repository without the bottom liner anticipated at Alice Creek Site 7. The cost would increase approximately $300,000 to $400,000 if a borrow area was developed adjacent to the site rather than as a part of the repository excavation in order to increase separation from groundwater. Long-term monitoring and maintenance costs should be similar to Horsefly Creek and Section 35, but lower than Paymaster/First Gulch.

5.4 RECOMMENDED ALTERNATIVE

Based on the analysis completed in this report, Section 35 is the recommended alternative. The site has the best overall protectiveness at the lowest cost. Key considerations include:

- Section 35 provides equal or better protection of surface water and groundwater than all other alternatives.
- The site has specific locations available with the most suitable soils and geology of all sites considered.
- The low permeability soils reduce potential impacts to groundwater and potential for off-site migration of contaminants.
- The site has suitable slopes and ample space that allow the most advantageous location to be selected.
- Given the large size of the site, more than one repository could be constructed (if needed) to address special waste needs.
- Because of the large space, benched topography, and varied vegetation, the repository can be sited and shaped to minimize visual impacts and to provide the best protection of surface water and groundwater.
- The site has large quantities of borrow materials available for repository construction and general site reclamation.
- The borrow materials could be obtained from the repository excavation, reducing site disturbance, area, height, and visual impacts.
- Design and construction are expected to be relatively simple.
- It has a higher overall estimated implementability compared to the Paymaster/First Gulch alternative due to constructability concerns with the Paymaster/First Gulch locations.
- It has nearly identical implementability compared to the Horsefly Creek and the Alice Creek Site 7 alternatives.
- It is the least expensive alternative considered.

6.0 REFERENCES

Bray, J.D., E.M. Rathje, A.J. Augello and S.M. Merry, 1998. Simplified Seismic Design Procedure for Geosynthetic-Lined, Solid Waste Landfills, Geosynthetics International, Volume 5, Nos. 1-2. January 2, 1998.

DEQ/EPA/USFS, 2008a. Watershed Restoration Agreement Between the State of Montana and the United States Department of Agriculture, Forest Service Northern Region for the Clean Up of the NFS Portion of the Upper Blackfoot Mining Complex Site (Watershed Agreement). April 25, 2008.

DEQ/EPA/USFS 2008b. Settlement Agreement Regarding The Upper Blackfoot Mining Complex Site (Agreement). April 25, 2008.

DEQ/Spectrum/Terragraphics, 2010. Upper Blackfoot Mining Complex Preliminary Design Report. February 2010.

MBMG, 2005. Probabilistic Earthquake Hazard Maps for the State of Montana, Special Publication 117, Montana Bureau of Mines and Geology, plate 2b.

Hydrometrics, 2007. Engineering Evaluation and Cost Analysis for the Mike Horse Dam and Impounded Tailings, Lower Mike Horse Creek, Beartrap Creek and the Blackfoot River Floodplain Removal Areas, Upper Blackfoot Mining Complex Site, prepared for USDA Forest Service and ASARCO. July, 2007.

Montana Department of Environmental Quality, 2010. Upper Blackfoot Mining Complex Fact Sheet. November 2010.

Rocscience, 2010. Rocscience Slide 6.0 Software. http://rocscience.com/products/8/Slide

Spectrum Engineering, 2009. Mike Horse Impoundment and Floodplain 2009 Investigation Report Tailings Handling Impoundment Dewatering Floodplain Test Pits Geotechnical & Geochemical Properties of Tailings and Alluvium, prepared for Montana Department of Environmental Quality. September 24, 2010.

Spectrum and Terragraphics 2010. Upper Blackfoot Mining Complex Preliminary Design Report. February 2010.

Spencer, 1967. Spencer, E., "A Method of Analysis of the Stability of Embankments Assuming Parallel Inter-Slice Forces." Geotechnique, Vol. 17, No. 1, 1967, pp. 11-26.

Terragraphics, 2009. Geotechnical and Geochemical Evaluation and Alternative Analysis Reports. June 29, 2009.

Terragraphics, 2010a. Final Data Summary Report Section 35 Upper Blackfoot Mining Complex, prepared for Montana Department of Environmental Quality. November 18, 2010.

Terragraphics, 2010b. Final Paymaster/Shave Data Summary Report Upper Blackfoot Mining Complex, prepared for Montana Department of Environmental Quality. November 22, 2010.

Terragraphics, 2011. Final Data Summary Report Addendum Section 35 Upper Blackfoot Mining Complex, prepared for Montana Department of Environmental Quality. April 14, 2011.

TetraTech, 2007. Final Remedial Investigation Work Plan Upper Blackfoot Mining Complex. December 2007.

USFS, 2005. Evaluation of Mike Horse Dam, A Report Prepared for the USDA Forest Service by Stephen Romero, USFS Missoula. January 2005.

USFS, Helena National Forest, 2007. Action Memorandum for the Removal Action for the Mike Horse Dam and Impounded Tailings, Lower Mike Horse Creek, Beartrap Creek and the Upper Blackfoot River Creek, Beartrap Creek and the Upper Blackfoot River Floodplain Removal Areas, Upper Blackfoot Mining Complex Site. Helena National Forest, Lincoln Ranger District, Lewis and Clark County, Montana, prepared for USDA Forest Service. July, 2007.

Appendix A

Project Summary Memos

Appendix B

Slide 6.0 Failure Analyses Reports

Appendix C

Cost Estimates

Appendix D

Repository Site Photographs

Figures