RILEY PASS ABANDONED URANIUM MINES
HARDING COUNTY, SOUTH DAKOTA

Final
Engineering Evaluation/Cost Analysis (EE/CA)

U.S. Department of Agriculture/Forest Service – Region 1
P. O. Box 7669
Missoula, Montana 59807

November 2006

FINAL
ENGINEERING EVALUATION/COST ANALYSIS (EE/CA)
FOR THE
RILEY PASS ABANDONED URANIUM MINES
HARDING COUNTY, SOUTH DAKOTA

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TABLE OF CONTENTS

Page

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION

This Engineering Evaluation/Cost Analysis (EE/CA) was prepared for the U.S. Department of Agriculture/Forest Service (USFS) Region 1 by Pioneer Technical Services, Inc. (Pioneer), under Contract Number 53-0343-7-0010, Delivery Order Number 53-0343-7-0010. The Final Report was prepared under Original Contract Number/Delivery Task Order No. 53-0343-7-0010/43-0343-9-0183 and New Contract Number/Delivery Task Order No. GS-10F-0071P/AG-0343-D-05-0031.

The primary purpose of this report is to present the detailed analysis of response action alternatives for the Riley Pass Site in accordance with the National Oil and Hazardous Substances Contingency Plan (NCP). Also presented are the site background, waste characteristics, Applicable or Relevant and Appropriate Requirements (ARARs) (Appendix A), risk assessment, and preliminary development and screening of response action alternatives.

The Riley Pass Site is located in the North Cave Hills region approximately 25 miles north of Buffalo, South Dakota, (Harding County Seat) and 100 miles north of Belle Fourche, South Dakota. The Sioux District office of the Custer National Forest of the USFS is located in Camp Crook, South Dakota, approximately 50 miles southwest of the Riley Pass Site. Ludlow, South Dakota, is the nearest town to the Riley Pass Site and is located approximately five miles due east (Figure 1-1).

The Riley Pass Site includes steep-sided and generally flat-topped buttes that are rimmed with sandstone cliffs. The Riley Pass Site uranium mines are abandoned lignite strip mines located on relatively flat areas along the top of the buttes. Mining features at the site include bluffs, overburden piles (spoils), hazardous openings, and highwalls. Samples of spoils materials have been characterized as high organic sandy clay and clayey sand. The bluffs are located primarily within the Sioux District of the Custer National Forest, but a small fraction of the site is situated on private land. The total disturbed area relating to the 12 bluffs is approximately 250 acres of highwalls, pit floors, and spoils piles. The majority of the spoils were pushed over the edges of the buttes onto the steep slopes below the rimrocks during mining. Additional spoils have been deposited on these slopes by subsequent water and/or wind transport.

Pioneer performed two sampling and analysis events at the Riley Pass Site. The objective of the investigations was to gather additional data to augment the data previously collected by Denver, Knight, Pièsold Environmental Consultants, Inc. (Denver, Knight, Pièsold, 1991) (Appendix B). The first event occurred in August 1999, and included sampling 9 mined bluffs (Bluffs A through I) in the main disturbed area (Pete's Creek and Schleichart Draw) and the existing sediment ponds. During the second event in August 2000, three additional mined bluffs located west of the main disturbed area were sampled (Bluffs J, K, and L), and associated surface water and sediment samples were also collected (USDA/USFS-Pioneer, 2002). These analytical data are provided in Appendix C.

Following delivery of the 2002 site investigation report for the Riley Pass Site, the USFS concluded that additional data were needed to support the decision making process at the site. In 2004, the USFS contracted Portage Environmental, Inc. (Portage) to complete additional human health and ecological risk assessments at the site. Bluffs B and H were selected by the USFS for further investigation. These bluffs were selected because historic data indicated they represent the range of chemical and radiochemical conditions at the Riley Pass Site. Bluff H generally represents the highest levels of contamination found at the site. Bluff B represents the lower end of contamination but contains a much larger area of disturbance, and therefore, more widespread contamination. This human health and ecological assessment report is used as a technical support document for this EE/CA. The report and data from Portage is included in Appendix D.

The sampling and analysis strategy was developed to evaluate the following:

- Nature and extent of mining spoils; and
- Impact of these spoils on the adjacent drainage sediments and surface water.

These data were required to determine whether the abandoned uranium mines may be affecting human health or the environment. The information gathered from the investigations was used to determine the extent and volume of the disturbed areas and to estimate risks from metals and radionuclides contributed by each of the individual mined bluffs.

These data were further analyzed to determine approximate waste volumes that were used to calculate the cost estimates for this EE/CA. The cost tables are included in Appendix E.

Threatened and Endangered Species information for the Riley Pass Site are included in Appendix F.

Comment Responses are included in Appendix G of this report. These written comments were by the U.S. Forest Service and the associated responses to the comments documented in the summary table. If applicable, changes were also incorporated into the text of the report.

1.1 REPORT ORGANIZATION

This EE/CA is organized into 11 sections. The contents of each section are briefly described in the following paragraphs:

SECTION 2.0 BACKGROUND - presents a background description of the Riley Pass Site Abandoned Uranium Mines. Significant site features described in this section include: a detailed history of past mining activities; geologic, hydrologic, and climatic characteristics of the site; the biological setting, such as the wildlife and fisheries resources and the vegetation indigenous to the area; and threatened and endangered species concerns, as well as the cultural setting issues, such as present and future land uses.

SECTION 3.0 WASTE CHARACTERISTICS AND SUMMARY OF EXISTING SITE DATA - describes the characteristics of the wastes present at the site, including waste types, volume estimates, and contaminant concentrations, as well as an evaluation of existing data derived from previous response actions or investigations.

SECTION 4.0 SUMMARY OF THE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS - presents the South Dakota State and Federal government requirements which are considered ARARs for the response action effort. Requirements discussed in this section are chemical-, location-, and action-specific in nature.

SECTION 5.0 SUMMARY OF THE RISK ASSESSMENT - presents a summary of the risk assessment performed for the site. Contaminant sources, routes of exposure, and receptors are evaluated to determine the relative threats posed by each source within the project boundary and each exposure pathway.

SECTION 6.0 RESPONSE ACTION OBJECTIVES AND GOALS - presents the response action objectives and applicable cleanup standards.

SECTION 7.0 DEVELOPMENT AND SCREENING OF RESPONSE ACTION ALTERNATIVES - preliminarily identifies and screens potentially applicable response action alternatives. Response action alternatives are evaluated based on effectiveness, implementability, and cost.

SECTION 8.0 DETAILED ANALYSIS OF RESPONSE ACTION ALTERNATIVES - presents the detailed analysis of response action alternatives pertaining to the seven NCP evaluation criteria.

SECTION 9.0 COMPARATIVE ANALYSIS OF RESPONSE ACTION ALTERNATIVES - presents a comparative analysis of the response action alternatives consistent with the NCP.

SECTION 10.0 PREFERRED ALTERNATIVE - presents the recommended preferred alternative and summarizes the reasoning behind choosing this alternative.

SECTION 11.0 REFERENCES - lists the references cited in the text.

2.0 BACKGROUND

2.1 MINING HISTORY

Prior to 1954, mining claims were almost non-existent in Harding County, South Dakota. Only a few coal claims were located prior to 1920. During the late 1950s and early 1960s, relatively extensive, unrestricted strip mining occurred on the Sioux District land during removal of uranium-bearing lignite coal beds permitted under the General Mining Laws and Public Law 357 (requiring no form of restoration). Approximately 1,000 acres of land have been reported to be disturbed by excavation, spoils deposition, and subsequent erosional deposition from the original source sites (USFS, 1964).

Mining in the area consisted of removal of overburden to allow access to the uranium-bearing lignite coal beds, which in places were 80 feet below the original ground surface. The mines cover approximately 250 acres of highwalls, pit floor, and spoils. For purposes of identification the acreage is broken into 12 bluffs. These bluffs are shown on Figure 2-1. During mining, much of the overburden was piled on the outer edges of the rimrock. The highly erosive spoils remained piled on the pit floor. An 80-foot highwall and some radioactive materials were left exposed when mining ceased in 1964. In late 1989, the USFS constructed 5 sediment ponds to trap sediment leaving the mined areas. Three ponds were constructed in Schleichart Draw, and two ponds are in individual tributaries of upper Pete's Creek. In 1990, a USFS contractor cleaned out 2 of the 5 ponds. Sediments were moved back on top of the area surrounding the ponds. No samples were collected at that time. In 1997, the sediment ponds were cleaned.

2.2 CLIMATE

The climate in the area is classified as continental marked by cold winters and hot summers, exhibiting large daily and seasonal temperature fluctuations. The region is considered semi-arid; precipitation is irregular and droughts are common.

The USFS records from 1931 through 1973 report average annual precipitation at Ludlow, South Dakota, at 14.8 inches. Approximately 73% or 10.8 inches of this precipitation appears in the form of rain during May through September. Significant precipitation occurs during convective storms, often accompanied by strong winds and occasional flash flooding. June is the wettest month of the year, with an average rainfall slightly over three inches.

In Redig, South Dakota, 40 miles south of Cave Hills, 2 out of 10 years average less than 9 inches of precipitation from April through September. Seasonal snowfall averages 33 inches. However, due to consistent winds, very little of this is effective precipitation (except in sheltered areas). Wind direction is predominantly from the north-northwest, averaging 10 miles per hour for the year. In spring, the average seasonal wind speed is highest at 16 miles per hour.

Average monthly temperatures range from 17 degrees Fahrenheit (^{o}F) in January to 72 ^{o}F in July. Low relative humidity is characteristic of the area, resulting in an estimated average annual potential evaporation of 39 inches. The region averages 115 frost-free days with September 15 and May 15 being the average period of first and last frost, respectively.

2.3 GEOLOGY, HYDROGEOLOGY, HYDROLOGY

2.3.1 Regional Setting

The Riley Pass Site is situated on a divide in the North Cave Hills that separates the Schleichart Draw/Campbell Creek drainage and the Crooked Creek/Pete's Creek drainage. Schleichart Draw, which runs south from Riley Pass, drains the western and southern portions of the site, and Pete's Creek, which runs northeast, drains the eastern and northern portion of the site. In the region of the mine, these streams are divided into tributary channels, most of which are ephemeral.

2.3.2 Local Geological Setting

The North Cave Hills region of South Dakota is comprised of late Tertiary (Paleocene) sediment. The North Cave Hills are an outcrop of the Tongue River member of the Fort Union formation. Estimated thickness of this formation is in excess of 600 feet. However, only the lower portion remains in the North Cave Hills due to erosion. The Ludlow member underlies the sandstone rimrocks of the Tongue River member (USDA/SCS, 1984).

Lithologic characteristics of the Tongue River formation are massive, gray to tan sandstone, with interbedded siltstone, claystone, lignite and carbonaceous shale. The formation contains many lenticular beds of quartzite and thick persistent beds of lignite. The formation has large deposits of uranium-bearing lignite in the Medicine Pole and North Cave Hills areas and at Lodge Pole Butte. It is this uranium-bearing lignite that was mined at the Riley Pass Site from 1956 to 1964.

The area surrounding the abandoned mine site exhibits two distinct sandstone outcroppings, which appear as rimrock cliffs. The lower rimrock is the basal sandstone of the Tongue River member. This sandstone also creates the pit floor for past uranium mining. The sandstone is approximately 80 feet thick, nearly level, and somewhat fractured. The uranium-bearing lignite bed lies immediately above this sandstone. The stripped material is a heterogeneous mix of the Tongue River formation interbedded rock types.

An oil well adjacent to and southwest of Bluff B was drilled in 1962. The oil well is now abandoned, but at the time of production averaged 42,000 barrels yearly.

2.3.3 Hydrogeologic Setting

Static water levels within a 5-mile radius of the bluffs range from 12 feet to approximately 300 feet below ground surface (bgs). This information was obtained from well logs that are discussed in more detail in the Site Investigation Report (see Appendix C of the *Final Site Investigation Report for the Riley Pass Uranium Mines Harding, South Dakota* [USDA/USFS-Pioneer, 2002]). Well logs within a five-mile radius of the site were obtained from the South Dakota Department of Environmental and Natural Resources.

Well locations are shown on Figure 2-2. These well logs do not serve to characterize the hydrology, but do show groundwater use in the vicinity of the site.

2.3.4 Surface Water Hydrology

The North Cave Hills area serves as the headwaters of the South and North Forks of the Grand River which flows into the Missouri River at Mobridge, South Dakota, 200 miles away.

The construction of the Schleichart Draw Reservoir was constructed as a stock water dam and unrelated to the abandoned uranium mines, as was the Schleichart Draw Ducks Unlimited Pond located below Schleichart Draw Reservoir. Sediments from the mines, mainly Bluff B, have been transported to the reservoir as reported in the U.S. Environmental Protection Agency (EPA) Watershed Profile (http://www.epa.gov/surf2/hucs/10130305). Bluff B is approximately 1.25 miles away from Schleichart Draw Reservoir and approximately 1.5 miles away from the Schleichart Draw Ducks Unlimited Pond.

The South Fork Grand is listed as U.S. Geological Survey (USGS) Cataloging Unit 10130302.

2.4 CURRENT SITE SETTING

2.4.1 Location and Topography

The abandoned uranium strip mines are located in the North Cave Hills area of Harding County, South Dakota. The Sioux District Office of the Custer National Forest of the USFS primarily administers the area, but a small fraction is also situated on private land. The mines cover approximately 250 acres of highwalls, pit floor, and spoils in Sections 20, 21, 22, 23, 25, 26, 27, 29, 35, and 36 of Township 22 North, Range 5 East of the Black Hills Meridian and are broken into 12 bluffs (Table 2-1). These bluffs are shown on Figure 2-1. The sites are bordered by USFS, private, and U.S. Department of Interior/Bureau of Land Management (BLM) land.

TABLE 2-1
BLUFF IDENTIFICATION

BLUFF IDENTIFICATION	LEGAL DESCRIPTION	LAND STATUS
A and B	T22N, R5E, Sec. 22	USFS
H	T22N, R5E, Sec. 25	Private
B, C, D, and E	T22N, R5E, Sec. 26	Partial USFS, Partial Private
B	T22N, R5E, Sec. 27	USFS
E, F, and I	T22N, R5E, Sec. 35	USFS
G, H, and I	T22N, R5E, Sec. 36	USFS (bordered on east in Sec. 31 22N, 6E by BLM)
J	T22N, R5E, Sec. 20	USFS
K	T22N, R5E, Sec. 21	USFS
L	T22N, R5E, Sec. 29	USFS

Site elevations typically range from approximately 3,100 to 3,400 feet above mean sea level (amsl).

2.4.2 Vegetation/Wildlife

The North Cave Hills form a diverse and varied landscape compared with the surrounding short and midgrass prairies. The rimrock hills, with their complex slopes and aspects, create unique microclimates and diverse vegetation. Several habitat types have been recognized by the USFS in this region. Landscapes include hardwood draws, ponderosa pine woodlands, and several grassland ecosystems.

The hardwood draw ecosystem is dominated by box elder (*Acer negundo*) and green ash (*Fraxinus pennsylvanica*). Understory composition includes numerous shrub and grass species. While the aerial extent of the ecosystem may be limited, it is important to wildlife.

Ponderosa pine (*Pinus ponderosa*) ecosystems are scattered throughout the North Cave Hills along the cliffs where unique soil and microclimatic conditions exist. Understory composition is variable depending on these same factors. Several shrub species often compose the understory of the ponderosa ecosystems.

The grasslands of the area are typical of the northern Great Plains region. Indicator species include: blue gamma (*Bouteloua Gracilis*), western wheatgrass (*Agroyron smithii*), prairie junegrass (*Koeleria cristata*), and needle and thread grass (*Stipa comata*). Scattered shrubs and small trees can also be found in this area. The grassland ecosystems in the North Cave Hills are found on the shallow nearly level highlands, rolling lower slopes, and on southerly aspects.

Important shrubland and understory species include: common juniper (*Juniperus communis*), wolfberry or snowberry (*Symphoricarpos occidentalis*), western wild rose (*Rosea woodsii*), skunkbrush (*Rhus triobata*), and little bluestem grass (*Andropogon scoparius*). These are important browse species for large wild ungulate populations in the area.

Inland salt grass (*Distichlis stricta*) should also be mentioned due to its occurrence throughout the region both on and off the mine site.

The USFS provided a list of potential threatened, endangered, and sensitive plant and wildlife species for the Riley Pass Site. A copy of this information is included in Appendix F of this EE/CA. Known and suspect sensitive plants that occur in the Riley Pass Site are listed on Table 2-2. Dakota buckwheat (*Eriogonum visherii*), Mountain bluebells (*Mertensia ciliata*), and Prairie gentian (*Gentiana affinis*) are known sensitive plants in the Riley Pass Site. Suspected sensitive plants include Barr's milkvetch (*Astragalus barrii*) and Golden stickleaf (*Mentzelia pumila*).

Antelope, deer, and grouse are the main wildlife resources in the county. Coyotes and red fox are the chief predators. Schleichart Draw Reservoir was reported to have been a trout pond for a number of years prior to mining.

The sensitive and threatened and endangered species are described in more detail in Table 2-2. The USFS sensitive species include Baird's sparrow (*Ammodramus bairdii*), Townsend's big-eared bat (*Plecotus townsendi*), Bighorn sheep (*Ovis canadensis*), Black-backed woodpecker (*Picoides arcticus*), Boreal owl (*Aegolius funereus*), Dakota skipper butterfly (*Hesperia dacotae*), Regal fritillary butterfly (*Speyeria idalia*), Tawny cresent butterfly (*Phycoies batesii*), Ferruginous hawk (*Buteo regalis*), Fisher (*Martes pennanti*), Ruffed grouse (*Banasa umbellus*), Sage grouse (*Centrocercus urophasianus*), and the Northern bog lemming (*Synaptomys borealis artemisiae*). The threatened and endangered species include the American burying beetle (*Nicrophorus americanus*), the Bald eagle (*Haliaeetus leucocephalus*), the Black-footed ferret (*Mustela nigripes*), the Eskimo curlew (*Numenius borealis*), the Grey wolf (*Canis lupus*), the Least tern (*Sterna a. athalassus*), the Peregrine falcon (*Falco peregrinus*), the Piping plover (*Charadrius melodus*), and the Whooping crane (*Grus Americana*).

2.4.3 Historic or Archaeologically Significant Features

The North Cave Hills contain the highest concentration of archaeologically significant sites in the Northern Plains. The area is also considered sacred to the Lakota, Crow, Northern Cheyenne, and the Hidatsa Tribes. As of 2001, there are over 170 major archeological sites on record for the North Cave Hills, including open occupation, rock shelters, petroglyphs and stone rings. A part of the proposed Ludlow Cave Historic District lies within the project area. The Riley Pass Site has recorded historic significance as a pioneer wagon route dating to the 1890s. In addition, historically significant American Indian sites are present.

A cultural resource inventory for the Riley Pass Site was conducted for the Custer National Forest Service in March 2001.

TABLE 2-2
POTENTIAL THREATENED, ENDANGERED, AND SENSITIVE PLANT AND WILDLIFE SPECIES POSSIBLY PRESENT AT OR NEAR RILEY PASS SITE

COMMON NAME	SCIENTIFIC NAME	CUSTER NATIONAL FOREST
PLANTS:		
Dakota buckwheat	*Eriogonum visherii*	Sensitive
Barr's milkvetch	*Astragalus barrii*	Suspected Sensitive
Golden stickleaf	*Mentzelia pumila*	Suspected Sensitive
Mountain bluebells	*Mertensiz ciliata*	Sensitive
Prairie gentian	*Gentiana affinis*	Sensitive
Western prairie fringed orchid	*Platanthera praeclara*	Sensitive
WILDLIFE:		
Baird's sparrow	*Ammodramus bairdii*	Sensitive
Townsend's big-eared bat	*Plecotus townsendi*	Sensitive
Bighorn sheep	*Ovis canadensis*	Sensitive
Black-backed woodpecker	*Picoides arcticus*	Sensitive
Boreal owl	*Aegolius funereus*	Sensitive
Dakota skipper butterfly	*Hesperia dacotae*	Sensitive
Regal fritillary butterfly	*Speyeria idalia*	Sensitive
Tawny cresent butterfly	*Phycoies batesii*	Sensitive
Ferruginous hawk	*Buteo regalis*	Sensitive
Fisher	*Martes pennanti*	Sensitive
Ruffed grouse	*Bonasa umbellus*	Sensitive
Sage grouse	*Centrocercus urophasianus*	Sensitive
Mountain plover	*Charadrius montanus*	Sensitive
Northern bog lemming	*Synaptomys borealis artemisiae*	Sensitive
American burying beetle	*Nicrophorus americanus*	Threatened & Endangered
Bald eagle	*Haliaeetus leucocephalus*	Threatened & Endangered
Black-footed ferret	*Mustela nigripes*	Threatened & Endangered
Eskimo Curlew	*Numenius borealis*	Threatened & Endangered
Gray wolf	*Canis lupus*	Threatened & Endangered
Least tern	*Sterna a. athalassus*	Threatened & Endangered
Peregrine falcon	*Falco peregrinus*	Threatened & Endangered
Piping plover	*Charadrius melodus*	Threatened & Endangered
Whooping crane	*Grus americana*	Threatened & Endangered

2.4.4 Population and Land Use

The Riley Pass Site is located in the North Cave Hills region approximately 25 miles north of Buffalo, South Dakota, (Harding county Seat) and 100 miles north of Belle Fourche, South Dakota. Ludlow, South Dakota, is the nearest town to the Riley Pass Site and is located approximately five miles due east (Figure 1-1).

According to the U.S. Census Bureau, the Harding County population in 2000 was 1,353. The estimated population in 2004 was 1,244, an 8.1 percent decrease in population. Currently, close to 30 people spanning all age groups, reside within 2 miles of separate contaminated bluffs.

Ranching is the principal enterprise in Harding County. Cattle and sheep are the main types of livestock. Approximately 88% of the county acreage is rangeland and about 12% is used for cultivated crops for tame pasture and hay.

There were some questions regarding the impacts from past mining activity in the North Cave Hills area on cattle performance. Pioneer contacted four veterinarians and the South Dakota Cooperative Extension Service via letter requesting any information regarding this matter. The South Dakota Cooperative Extension Service supplied articles that are summarized regarding molybdenosis in cattle in the North Cave Hills area:

- *"Progress Report on the Harding County Copper Deficiency Trials"*, March 1, 1977 by J. R. Johnson, G. H. Deutscher, and D. B. Hewlett.
- *"Investigation of Beef Cattle Copper Deficiency In Northwestern South Dakota,"* November, 1977, by G. Deutscher, J. Johnson, R. Emerick and R. Moul.
- *"Copper Injections and Supplementation for Range Beef Cows and Calves,"* 1982, by G. Deutscher, J.R. Johnson, R. J. Emerick, R.E Moul, and D.L. Whittington.
- *"Molybdenosis in an Area Underlain by Uranium-bearing Lignites in the Northern Great Plains",* May 1983, by Laura R. Stone, James A. Erdman, Gerald L. Feder, and Heinrich D. Holland.

The general conclusions from the studies indicate marginal levels of copper in the forage accompanied by elevated intakes of molybdenum and sulfates may cause a copper deficiency in cattle, especially young cattle and calves, under the conditions in northwestern South Dakota. The level of copper appears to decrease throughout the season, impacting the cattle more as the season progresses.

This indicates that the result of high molybdenum in soils, which exist throughout this geologic region, is not due to the mines directly. These studies also indicate that improved herd health and calf gains can be obtained by treatment with copper on ranges having marginal forage copper levels, especially if livestock water contains elevated levels of sulfate.

In addition to ranching, hunting is a common recreation within Harding County. For example, 7,000 hunting licenses (over 3 times the county resident population) are issued in Harding County each year. The licenses issued include bird tags, antelope, mule deer, and white tail deer. These numbers reflect both archery and rifle season.

3.0 WASTE CHARACTERISTICS AND SUMMARY OF EXISTING SITE DATA

The objective of the Riley Pass Site investigation was to evaluate the abandoned mine wastes at the site while generating a database that meets the requirements necessary to complete a risk assessment and detailed analysis of response action alternatives. The initial *Final Site Evaluation Report for the Riley Pass Site Harding, South Dakota* (USDA/USFS-Pioneer, 2002) presents the results of the response action investigation activities conducted by Pioneer. The analytical results from the 1999 and 2000 sampling efforts are included in Appendix C of this EE/CA. Following delivery of the 2002 site investigation report for Riley Pass, the USFS concluded that additional data were needed to support the decision making process at the site.

In 2004, the USFS contracted Portage to complete an additional human health and ecological risk assessment of the site. Bluffs B and H were selected by the USFS for further investigation. They were selected because historic data indicated they represent the range of chemical and radiochemical conditions at the site. Bluff H generally represents the highest levels of contamination found at the site. Bluff B represents the lower end of contamination but contains a much larger area of disturbance, and therefore, more widespread contamination. The report is used as a technical support document for this EE/CA. The report and analytical results are included in Appendix D of this EE/CA. Historic data from the 1990 and 1991 investigations conducted on Bluff B by Denver, Knight, Pièsold of Denver, Colorado (Denver, Knight, Pièsold, 1990 and 1991) are also included for comparison. The analytical results from Denver, Knight, Pièsold are provided in Appendix B of this EE/CA. The data generated to support two primary tasks are summarized as follows:

Risk Assessment Data Requirements:

- Establish background soil concentrations with at least four background samples;
- Characterize metals concentration variations in waste sources and assess the zero to six-inch zone for direct contact and air emission potential;
- Evaluate the physical and chemical properties of the source materials that may affect contaminant migration including: pH, organic carbon content, and particle size distribution;
- Characterize impacts to surface water with strategically located surface water samples along Schleichart Draw/Campbell Creek drainage and the Crooked Creek/Pete's Creek drainage; and
- Assess surface water uses and estimate other ecological uses.

Feasibility Study Data Requirements:

- Determine accurate areas and volumes of the contaminant source materials on Bluffs A through L;
- Assess the hydrologic configurations of Schleichart Draw/Campbell Creek and Crooked Creek/Pete's Creek channels; and

- Determine the optional locations and soil characteristics for waste consolidation site(s) and/or cover soil borrow sites.

Sampling and analysis followed the previously prepared *Sampling and Analysis Plan for the Riley Pass, South Dakota Uranium Mines Site Investigation* (USDA/USFS-Pioneer, 1999) and the *Amendment to the Sampling and Analysis Plan for the Riley Pass, South Dakota Uranium Mines Site Investigation* (USDA/USFS-Pioneer, 2000). The field sampling activities included collection of source area soil samples; potentially impacted stream water and sediment samples; potentially impacted pond sediment samples; and background soil, sediment, and surface water samples from non-impacted locations. Additional tasks included field radiation surveys to further characterize radiation levels and to aid in selecting sample locations. Several samples were relocated at the time of sampling relative to the sampling plan, based on the assessment of drainage impacts from the various sources. Sampling followed the procedures discussed in Section 3.0 of the *Sampling and Analysis Plan for the Riley Pass, South Dakota Uranium Mines Site Investigation* (USDA/USFS-Pioneer, 1999).

The principal techniques used for data acquisition in these site investigations included shovel test pits, field mapping, and soil and water sampling. Samples were collected using standard operating procedures (SOPs) that are contained in the *Sampling and Analysis Plan for the Riley Pass, South Dakota Uranium Mines Site Investigation* (USDA/USFS-Pioneer, 1999) and were analyzed according to the Laboratory Analytical Protocol (LAP) (USDA/USFS-Pioneer 1999). Analytical data were evaluated for quality assurance according to the *Quality Assurance Plan for the Riley Pass, South Dakota Uranium Mines Site Investigation* (USDA/USFS-Pioneer, 1999).

The site characterization field program conducted by Pioneer included collecting solid matrix samples for the following types of analyses:

- Target analyte list (TAL) metals in source area soils and sediment via commercial laboratory. Total metals analyses were generally completed for all solid sampling intervals during the 1999 and 2000 site investigation. The total metals analyses determined relative concentrations of the following elements: arsenic, copper, molybdenum, lead, selenium, thorium, uranium, and vanadium. Radiochemistry analyses were also performed for Radium 226 ($radium^{226}$) and Uranium 235 ($Uranium^{235}$). Laboratory analyses for the metals were performed at the HKM Laboratories in Butte, Montana. Radiochemistry analyses were performed by CORE Lab (1999 samples) and Enviro Test Laboratories, L.L.C. (2000 samples) also located in Casper, Wyoming..

- Target analyte list metals in surface water via commercial laboratory. Total metals analyses were generally completed for all surface water sampling collected during the 1999 and 2000 site investigations. The total metals analyses determined relative concentrations of the following elements: arsenic, copper, molybdenum, lead, selenium, thorium, uranium, vanadium, pH, and Total Suspended Solids (TSS). Dissolved metals analyses were performed on the 2000 surface water samples and determined relative concentrations of the following elements: arsenic, copper, molybdenum, lead, selenium, thorium, uranium, and vanadium.

Radiochemistry analyses were also performed for $radium^{226}$ and $uranium^{235}$. Laboratory analyses for the metals were performed at the HKM Laboratories in Butte, Montana. Radiochemistry analyses were performed by CORE Lab (1999 samples) and Enviro Test Laboratories, L.L.C. (2000 samples) both located in Casper, Wyoming.

Soil chemical analyses for the 1999 samples included organic matter, nitrate, weak and strong phosphorus, bicarbonate, postassium, soil pH, and cation exhange capacity. Soil chemical analyses for the 2000 samples included all the 1999 analyses plus the recommended fertilizer application rates of nitrogen, phosphate, and potash. Soil physical analysis for the 1999 samples included field capacity, wilting point, and available moisture. Soil physical analysis for the 2000 samples included all the 1999 analyses plus the U.S. Department of Agriculture (USDA) textural classification and percent coarse, sand, silt, and clay analysis.

The following sections address the analytical results generated by the field sampling activities conducted at the Riley Pass Site by Denver, Knight, and Pièsold of Denver, Colorado. Each environmental medium (source area soils, stream sediments, and surface water) is discussed individually. Appendix B of this EE/CA contains the analytical results for the 1990 and 1991 sampling events.

3.1 DENVER, KNIGHT, PIÈSOLD INVESTIGATION RESULTS

Denver, Knight, Pièsold of Denver, Colorado, was retained by the USFS in 1990 and 1991 to evaluate existing conditions, develop plausible response action alternatives, and provide a cost estimate for each alternative. Denver, Knight, Pièsold's investigation was limited to Bluff B. The 1990 and 1991 investigation included water quality analyses and radiological measurements. All previously collected data by Denver, Knight, Pièsold are presented in Appendix B of this EE/CA.

The radionuclide of primary concern at the uranium site is $radium^{226}$. $Radium^{226}$ emits gamma radiation which contributes to the external gamma exposure of people, but is also the primary contributor for radiation exposure to people, either from ingestion or inhalation of $radium^{226}$ directly or by its decay to radon gas.

Radiological surveys at uranium mine sites generally consist of preliminary evaluations of the natural background gamma exposure rate for the area, and the gamma exposure rates associated with the mine site. Since $radium^{226}$ emits gamma radiation, gamma readings above natural background in disturbed mine areas indicate the presence of elevated levels of $radium^{226}$. To estimate the actual $radium^{226}$ concentration in the mine wastes, mine waste samples are collected from the areas representative in the range of gamma readings. These samples are radiochemically analyzed for $radium^{226}$ concentrations and estimates of the $radium^{226}$ concentrations can be made by evaluating only the gamma readings.

A radiological screening survey was conducted at the Riley Pass Site near Buffalo, South Dakota, on April 2 through 4, 1990 by Denver, Knight, Pièsold. Gamma surveys were conducted using an Eberline PRM-7 microR (μR) meter which had been calibrated against a Pressurized Ionization Chamber at Colorado State University.

Natural background gamma readings, determined on an undisturbed area southwest of the major disturbed area, ranged from 12 to 14 μR per hour (μR/hr). This range of gamma readings generally corresponds to a range of $radium^{226}$ soil concentrations from 0.5 to 1.0 picocuries per gram (pCi/g). During this study, only three sample locations have corresponding gamma readings and $radium^{226}$ analyses with which to derive a correlation equation. The regression equation derived by Denver, Knight, Pièsold was: $Radium^{226}$ (pCi/g) = 0.33 x (μR/hr) - 7.57.

The gamma survey conducted throughout the site indicated readings ranging from 12 to 1,400 μR/hr (see Appendix B of this EE/CA). Pioneer's initial site visit (June 1999), found gamma levels ranging from 70 to 5,000 μR/hr. However, no accurate relationship between gamma readings and analytical sample results could be established.

Water samples were also collected as part of an Environmental Assessment performed in 1991. Eight samples were collected from the area: five from springs, two from sediment ponds, and one from ponded water in the mine pit. Water in the area is somewhat saline due to climate and geology. It exhibits high concentrations of sodium, sulfate, and anionic species such as arsenic and molybdenum. Off-site water quality is similar to that from the disturbed areas at the mine site, suggesting that pre-mine water quality was poor.

Ten soil samples were collected at the site in April 1990, and analyzed for physical soil properties. Complete soil analyses were run on 4 samples collected by the USFS in the fall of 1979. Mechanical analyses were performed on several samples of spoil materials from the site, which have been characterized as having high organic sandy clay and clayey sand. Samples have yielded natural moisture values ranging from 5.4% to 31.4%. A summary of laboratory test results, including natural moisture and density and optimum moisture and proctor density, is presented in Appendix B of this EE/CA.

3.2 PIONEER TECHNICAL SERVICES, INC. INVESTIGATION RESULTS

The following sections address the analytical results generated by the field sampling activities conducted at the Riley Pass Site by Pioneer in August 1999 and 2000. Each environmental medium (source area soils, stream sediments, and surface water) is discussed individually. The analytical results for the 1999 and 2000 sampling events are provided in Appendix C of this EE/CA.

3.2.1 Background Sampling

Background sediment, surface water, and soil samples were collected from undisturbed drainages and bluffs outside the influence of mining but in the same geologic formations as were mined. These samples provide data for comparison to the potentially impacted areas. Soil samples from bluffs outside the mined areas are identified as RP-SS-Xn, with associated, sediment (RP-SE-Xn) and surface water samples (RP-SW-Xn). Analytical results are included in Appendix C of this EE/CA in Tables C-1, C-2, and C-3. Four representative composite background soil samples were collected at the site and designated as RP-SS-X1 through RP-SS-X4. Soil sample locations are shown on Figure 3-1.

The average background concentrations were significantly higher in arsenic, molybdenum, selenium, and uranium than average concentrations in the western United States (Shacklette and Boerngen, 1984), probably due to the mineralization found in this stratigraphic unit.

3.2.2 Lignite Sampling

Five discrete samples of the uranium-bearing lignite were collected from Bluff B (RP-SS-B2), Bluff G (RP-SS-G2), Bluff H (RP-SS-H3), Bluff J (RP-SS-J1), and Bluff K (RP-SS-K1) representing exposed source materials at the Riley Pass Site. These samples were exposed mainly as a result of mining in the area; however, some were exposed by natural erosion. Analytical results for the lignite samples are included in Appendix C of this EE/CA and summarized in Table C-1. The lignite sample locations are shown on Figure 3-2. Concentrations greater than three times background of arsenic, molybdenum, thorium, uranium, $radium^{226}$, and $uranium^{235}$ were documented from Samples RP-SS-B2, RP-SS-G2, RP-SS-H3, and RP-SS-K1. The sample RP-22-K1 was also higher than three times background of vanadium. Concentrations greater that three times background of molybdenum, uranium, $radium^{226}$, and $uranium^{235}$ were documented from Sample RP-SS-J1.

3.2.3 Source Area Sampling

The site contains 12 separate waste source bluffs. These bluffs are located in Sections 20, 21, 22, 23, 25, 26, 27, 29, 35, and 36 of Township 22 North, Range 5 East, Black Hills Meridian (Figure 2-1). At each of these 12 source areas, at least 1 representative composite soil sample was collected from the spoils. Two representative composite soil samples were collected at Bluffs B, G, I, J and K. Three representative composite soil samples were collected at Bluff H. Soil sample locations are shown on Figure 3-1.

Bluff A

Bluff A is located approximately 0.25 miles north of Bluff B in Township 22 North, Range 5 East, Sections 22 and 23. The estimated spoils volume is 25,250 cubic yards (cy), with a total disturbed area of 3 acres, of which approximately 1 acre is unvegetated spoils. These spoils materials are located on the south side of Bluff A and drain towards a dry draw that adjoins a large spoils pile area associated with Bluff B.

The spoils are extremely steep (approximately 1.5 horizontal [H]:1 vertical [V]) with very little vegetation. The remaining areas of Bluff A are also disturbed and exhibit little vegetation. However, they are not contributing as much sediment as the 1-acre spoils pile.

The analytical results for soil samples collected from Bluff A are included in Appendix C of this EE/CA and summarized in Tables C-1, C-4, C-5, and C-6. Concentrations greater than three times background of molybdenum, uranium, $radium^{226}$, and $uranium^{235}$ were documented for Bluff A during the 1999 sampling investigation.

Organic matter content on Bluff A was 8.4%. Amendments are recommended to enhance revegetation and are included in the associated cost tables. Prior to completing the detailed response action design for Bluff A, it should be re-sampled and the results reevaluated to confirm amendments and nutrients required to establish vegetation.

Bluff B

Bluff B encompasses approximately 150 acres of spoils piles (overburden), highwalls, and open pits in parts of Township 22 North, Range 5 East, Sections 22, 23, 26 and 27. Bluff B has an estimated spoils volume of 1,140,000 cy. Riley Pass, a significant historic pioneer wagon route during the 1890s, is approximately 500 feet north of the site.

The waste materials (spoils/overburden) have been a major source of sedimentation to Pete's Creek to the east of Bluff B and Schleichart Draw to the southeast. A majority of the bluff is either barren or sparsely vegetated and shows signs of severe wind and surface water erosion. Sediment from the east half of the site is currently being carried approximately .75 miles and deposited on the main access road to Riley Pass and the adjoining private property. Sediment basins have been installed and maintained by the USFS in Upper Pete's Creek and Schleichart Draw. However, due to the amount of sediment eroding from the site, frequent maintenance of the basins is required.

Due to the predominant soil type present, sandy clay and silty clay, soil piping and tunneling with occasional sink holes are present. Piping and large gullies are most prevalent in areas where the overburden was placed along or below the rimrocks. Some of the pipes that have formed are 10 to 15 feet in diameter, and gullies up to 25 feet in depth have formed in places subject to concentrated surface water flow.

The mined pit floors are generally at or near bedrock. Some spoils have been placed along the edges that erode to the land below Bluff B. Small, shallow ponds have formed in some of the areas creating small retention basins, which during snowmelt and small storm events assist in controlling some of the surface water erosion. Water from these ponds most likely evaporates or seeps through the bedrock during the summer months.

The analytical results for soil samples collected from Bluff B are included in Appendix C of this EE/CA and are summarized in Tables C-1, C-4, C-5 and C-6. Sample RP-SS-B2, a lignite sample, is discussed in the lignite section (see Section 3.2.2). Concentrations greater than three times background of $radium^{226}$ and $uranium^{235}$ were documented from Sample RP-SS-B1 during the 1999 sampling investigation.

Organic amendment of Bluff B is advised due to the low organic matter content (1.2%). Prior to completing the detailed response action design for Bluff B, it should be re-sampled, and the results reevaluated to confirm amendments and nutrients required to establish vegetation.

Bluff C

Bluff C, located in Township 22 North, Range 5 East, Section 26, encompasses approximately 10 acres with good vegetation of the spoils piles and exposed bedrock. This bluff is approximately 4,257 feet south, southeast of Bluff B. Spoils piles and berms are small in nature and are scattered throughout the site. Based on visual estimation, there is approximately 600 cy of spoils materials present at Bluff C. There are no signs of active erosion from the berms or spoil piles and existing vegetation cover at the site is approximately 85 to 90%.

The analytical results for soil samples collected from Bluff C are included in Appendix C of this EE/CA and summarized in Tables C-1, C-4, and C-5. Concentrations greater than three times background of arsenic, molybdenum, thorium, uranium, $radium^{226}$, and $uranium^{235}$ were documented for Bluff C during the 1999 sampling investigation along the toe of the southwest berms and spoils piles. Given the existing stable nature of Bluff C, only minimal response action work is assumed to be necessary.

Organic matter content on Bluff C was 8.9%. Amendments are recommended to enhance revegetation and are included in the associated cost tables. Prior to completing the detailed response action design for Bluff C, it should be re-sampled, and the results reevaluated to confirm amendments and nutrients required to establish vegetation.

Bluff D

Bluff D, located in Township 22 North, Range 5 East, Section 26, encompasses approximately 5.2 acres, with good vegetation of the spoils piles and berms. Bluff D is approximately 4,157 feet southeast of Bluff B. There are some areas of exposed bedrock located within the site. There are no active signs of erosion from the berms or spoil piles. Vegetation cover at the site is approximately 85 to 90%. There are small areas of naturally exposed bedrock in locations that have not been disturbed by mining activities.

The analytical results for soil samples collected from Bluff D are included in Appendix C of this EE/CA and summarized in Tables C-1, C-4, and C-5. Concentrations greater than three times background of arsenic, molybdenum, uranium, $radium^{226}$, and $uranium^{235}$ were documented for Bluff D during the 1999 sampling investigation. Locations of elevated contaminants include the bedrock/unvegetated areas located on the northeast side of the bluff.

Organic matter content on Bluff D was 9.4%. Amendments are recommended to enhance revegetation and are included in the associated cost tables. Prior to completing the detailed response action design for Bluff D, it should be re-sampled, and the results will be reevaluated to confirm amendments and nutrients required to establish vegetation.

Bluff E

Bluff E encompasses approximately two acres, with good vegetation of the spoils piles and berms. Bluff E is approximately 5,355 feet southeast of Bluff B in Township 22 North, Range 5 East, Sections 26 and 35. There are some areas of exposed bedrock located within the site.

There are no signs of erosion from the berms or spoils piles and vegetation cover at the site is approximately 90 to 95%.

The analytical results for soil samples collected from Bluff E are included in Appendix C of this EE/CA and summarized in Tables C-1, C-4, and C-5. Concentrations greater than three times background of $radium^{226}$ and $radium^{235}$ were documented for Bluff E during the 1999 sampling investigation on the southeast and west sides of the bluff. Given the existing stable nature of Bluff E, only minimal response action work is assumed to be necessary.

Organic matter content on Bluff E was 9.9%. Amendments are recommended to enhance revegetation and are included in the associated cost tables. Prior to completing the detailed response action design for Bluff E, it should be re-sampled, and the results reevaluated to confirm amendments and nutrients required to establish vegetation.

Bluff F

Bluff F, located approximately 6,418 feet southeast of Bluff B in Township 22 North, Range 5 East, Section 35, encompasses approximately two acres, with good vegetation of the spoils piles and berms. There are some areas of exposed bedrock located within the site. There are no signs of erosion from the berms or spoils piles and vegetation cover at the site is approximately 90 to 95%.

The analytical results for soil samples collected from Bluff F are included in Appendix C of this EE/CA and summarized in Tables C-1, C-4, C-5 and C-6. Concentrations greater than three times background of molybdenum, $radium^{226}$, and $uranium^{235}$ were documented for Bluff F during the 1999 sampling investigation at the bedrock/unvegetated areas located on the north and east side of the bluff.

Organic matter content on Bluff F was 5.1%. Amendments are recommended to enhance revegetation and are included in the associated cost tables. Prior to completing the detailed response action design for Bluff F, it should be re-sampled, and the results reevaluated to confirm amendments and nutrients required to establish vegetation.

Bluff G

Bluff G encompasses approximately five acres, of which approximately two acres consist of exposed bedrock. This bluff is approximately 7,698 feet southeast of Bluff B in Township 22 North, Range 5 East, Section 36. There are also several bare and eroding steep (1.5H:1V) slopes, where the materials have been pushed off the rimrock. Previous sampling results have indicated one acutely contaminated area (RP-SS-G2 [lignite sample]) that has been left on top of the bluff. The greater portion (approximately 90%) of the top of the bluff has been excavated down to bedrock with very little vegetation present. On some of the less steep slopes, vegetation is present with approximately 40 to 60% vegetative cover. The southwest steep slope would be very difficult to regrade due to excessive steepness and limited access to the slope. Equipment access to the bluff would be difficult and would entail traveling through Bluffs I_1 and I_2 and then traveling across a small saddle that has been filled in with waste materials. Currently, the materials in the saddle are sparsely vegetated and there are no signs of erosion.

The largest spoils pile is located below the rimrock on the southwest side of the bluff. It encompasses approximately one acre with extremely steep side slopes (1.5H:1V), very little vegetation, and severe erosion gullies and rills present on the face of the slope. Spoils material volume is estimated to be approximately 46,000 cy. A smaller, more vegetated spoils pile (approximately 40 to 60% vegetation cover) is located along and below the rimrock on the southeast side of the bluff, it encompasses approximately half an acre, with an estimated volume of approximately 23,400 cy.

There are several berms/spoils piles along the north and east side of the bluff. Surface erosion is localized to two areas on the berms/spoils piles on the north side of the bluff. A hot spot of contamination (0.4 to 0.6 millirem per hour [mrem/hr]) is located within the spoils pile on the east side. The volume of materials is estimated to be approximately 300 cy.

Additionally, a small spoils pile is located in a saddle between Bluffs I_1 and G. These materials were used as road construction material between the bluffs. It encompasses approximately half an acre with an estimated volume of approximately 550 cy. The spoils material is poorly vegetated, but is moderately stable, showing very little surface erosion.

Access to Bluff G is gained by traveling over Bluff I. Consequently, prior to any response action activities being completed at Bluff I, reclamation of Bluff G should be completed.

The analytical results for soil samples collected from Bluff G are included in Appendix C of this EE/CA and summarized in Tables C-1, C-4, and C-5. Sample RP-SS-G2 (a lignite sample) is discussed in Section 3.2.2. Concentrations greater than three times background of arsenic, molybdenum, uranium, $radium^{226}$, and $uranium^{235}$ were documented for Sample RP-SS-G1 during the 1999 sampling investigation.

Organic matter content on Bluff G was 4.4%. Amendments are recommended to enhance revegetation and are included in the associated cost tables. Prior to completing the detailed response action design for Bluff G, it should be re-sampled, and the results reevaluated to confirm amendments and nutrients required to establish vegetation.

Bluff H

Bluff H encompasses approximately 30 acres. Bluff H is approximately 10,274 feet southeast of Bluff B in Township 22 North, Range 5 East, Sections 25 and 36. The site consists of several spoils piles (approximately 553,850 cy) that have been placed along and over the rimrock edges. These slopes are generally very steep (1.5H:1V) and show signs of severe water erosion, especially on the northwest and northeast spoils piles. Vegetation growth on the side slopes is very limited (<10% cover). There is a pit area with unstable highwalls on the southwest portion of the site. Pioneer personnel identified one hot spot (RP-SS-H3 [lignite sample]) at the base of the northwest high wall on Bluff H.

A portion of the spoils piles on the north and northeast side of the bluff is currently located on private property. A spoils pile of approximately 1.1 acres in size with an estimated volume of 54,350 cy is located on the northwest corner of the bluff. The slope is extremely steep (1.5H:1V) and barren of vegetation. There is one large erosion gully located on the south portion of the spoils pile. The water and sediment from this gully flows into an intermittent dry draw/drainage. However, some of the sediments are being deposited on private property located adjacent to Bluff H.

The spoils pile located on the northeast end of the bluff is moderately vegetated. There are erosion gullies and rills that are transporting sediment onto private property and into an intermittently dry draw/drainage. Approximately one third of this spoils pile is currently situated on private property. A large spoils pile located on the west side of bluff encompasses approximately three acres, with an estimated volume of 340,150 cy. The spoils are sparsely vegetated with numerous erosion gullies and rills. One large erosion gully (approximately 12 feet in depth) is located on the south end of the spoils pile, and drains into an intermittent dry draw/drainage.

A spoils pile containing approximately 159,340 cy of spoils, and encompassing approximately 4 acres is located on the south end of the bluff. This spoils pile is moderately vegetated with limited signs of surface erosion.

The analytical results for soil samples collected from Bluff H are included in Appendix C of this EE/CA and summarized in Tables C-1, C-4, and C-5. Sample RP-SS-H3 (a lignite sample) is discussed in Section 3.2.2. Concentrations greater than three times background of arsenic, molybdenum, uranium, radium^{226}, and uranium^{235} were documented for Sample RP-SS-H1. In Sample RP-SS-H2, concentrations were less than three times background for all analyzed metals performed during the 1999 sampling investigation.

Organic matter content on Bluff H was 6.5% in Sample RP-SS-H1 and 1.8% in RP-SS-H2. Amendments are recommended to enhance revegetation and are included in the associated cost tables. Prior to completing the detailed response action design for Bluff H, it should be re-sampled, and the results reevaluated to confirm amendments and nutrients required to establish vegetation.

Bluff I

Bluff I is located approximately .25 mile south of Bluff F along an unmarked USFS road in Township 22 N, Range 5 East, Sections 35 and 36. The disturbed area of Bluff I_1 is 16.5 acres, Bluff I_2 is 4 acres, and Bluff I_3 is 1.6 acres. Bluff I_1 has an estimated total volume of approximately 135,380 cy of spoils. Bluff I_2 has an estimated total volume of 20,170 cy of spoils and Bluff I_3 has an estimated 57,300 cy of spoils. The combined disturbed area for Bluff I encompasses approximately 22 acres with an estimated total volume of 212,840 cy of spoils. The majority of the waste materials are unvegetated and eroding into an intermittently dry draw north of the bluff. Vegetation has established itself along the southern highwalls and moderately within the pit areas.

The spoils piles and waste materials have been placed on and over the northern edge of the rimrock and are considered the primary source of sedimentation of the draw north of the bluff. Additionally, approximately four acres on the west side of Bluff I have been disturbed from past mining activities.

Access to Bluff G is gained by traveling over Bluff I. Consequently, prior to any response action activities being completed at Bluff I, reclamation of Bluff G should be completed.

Two soil samples (RP-SS-I1 and RP-SS-I2) were collected from Bluff I. The analytical results for soil samples collected from Bluff I are included in Appendix C of this EE/CA and summarized in Tables C-1, C-4, C-5 and C-6. Past sampling results indicate that only $uranium^{235}$ exceeded three times the background concentration for Sample RP-SS-I2. Sample RP-SS-I1 concentrations were less than three times background for all analyzed metals performed during the 1999 sampling investigation.

Organic matter content of Bluff I was 1.2% in Sample RP-SS-I1 and 4.8% in RP-SS-I2. Amendments are recommended to enhance revegetation and are included in the associated cost tables. Prior to completing the detailed response action design for Bluff I, it should be re-sampled, and the results re-evaluated to confirm amendments and nutrients required to establish vegetation.

Bluff J

Bluff J is located approximately 3 air miles northwest of Riley Pass, in Township 22 North, Range 5 East, Section 20. The site is accessed by traveling south approximately 3.5 miles from Harding County Road 733 on Craig Pass Road. Bluff J lies approximately .25 mile south of the Y+ Ranch residence.

Bluff J encompasses approximately four acres and consists of dozer cuts, highwalls, spoils piles/berms and road cuts into the side of the bluff. Results from previous sampling investigations indicate this site exhibits relatively high radioactivity (0.05 to 0.85 mrem/hr). The radioactive area is located to the west of the bluff and is approximately 600 feet by 200 feet and consists of black fine-grained sandy silt with no vegetation. However, it appears that these materials have become wind blown in the past and now encompass an area of approximately two acres. The highwalls on the south and east portions of the bluff are mostly stable and revegetated, the large spoils materials located near the black sands are revegetated (approximately 90 to 95% vegetative cover). Runoff from the black sands area drains toward a small, low flow stream located to the west. This stream flows toward a stock watering pond near the residence.

In 2000, two soil samples (RP-SS-J1 and RP-SS-J2) were collected from Bluff J. The analytical results are included in Appendix C of this EE/CA and summarized in Tables C-1, C-4, and C-5. Sample RP-SS-J1 (a lignite sample) is discussed in Section 3.2.2. Concentrations greater than three times background of $radium^{226}$ were documented for sample RP-SS-J2 in the 2000 investigation.

Organic matter content on Bluff J was 6.3% in Sample RP-SS-J1 and 13.0% in RP-SS-J2. Amendments are recommended to enhance revegetation and are included in the associated cost tables. Prior to completing the detailed response action design for Bluff J, it should be re-sampled, and the results reevaluated to confirm amendments and nutrients required to establish vegetation.

Bluff K

Bluff K_1 is located approximately 3 air miles northwest of Riley Pass, in Township 22 North, Range 5 East, Section 21. The site is accessed by traveling south approximately 3.5 miles from Harding County Road 733, on Craig Pass Road. Bluff K_1 is located approximately .75 mile southeast of the Y+ Ranch residence.

Bluff K_1 encompasses approximately two acres and consists of two spoils piles/berms within an open grass meadow in the middle of a bluff. There are no signs of erosion from the berms or spoils piles and vegetation at the site consists of approximately 90 to 95% vegetative cover. There are no highwalls associated with this bluff. One acutely contaminated area (RP-SS-K1 [lignite sample] 0.1mrem/hr) was observed during the previous sampling investigation conducted by Pioneer in 2000. It is located at the end of a small dozer cut within the berm materials, and is located on the southeast portion of the site. The hot spot has an estimated volume of approximately 40 cy. The remaining berm materials surrounding the hot spot have an estimated volume of approximately 800 cy. The spoils pile is located at the north end of the bluff and has an estimated volume of 2,200 cy.

Bluff K_2 is located approximately three air miles northwest of Riley Pass, in Section 21, Range 5 East, Township 22 North. The site is accessed by traveling south on the Craig Pass Road approximately 3.5 miles from Harding County Road 733. Bluff K_2 lies approximately .75 mile southeast of the Y+ Ranch residence. Bluff K_2 is separated from Bluff K_1 by USFS Route 132, which lies approximately 500 feet to the southeast of Bluff K_2.

Bluff K_2 encompasses approximately five acres, and consists of two benches and highwalls with spoils piles located along the edge of the benches. There are small erosion rills on the faces of the spoils piles; vegetation at the site is approximately 80 to 85% vegetative cover on the flat benches and approximately 30 to 40% vegetative cover on the faces of the spoils piles. There are 2 small highwalls/bench walls associated with this site that are approximately 10 to 15 feet in height.

In 2000, two soil samples (RP-SS-K1 and RP-SS-K2) were collected from Bluffs K_1 and K_2. The analytical results are included in Appendix C of this EE/CA and summarized in Tables C-1, C-4, and C-5. Sample RP-SS-K1 (a lignite sample) is discussed in Section 3.2.2. No concentrations greater than three times background were documented for Sample RP-SS-K2 during the 2000 investigation.

Organic amendment of Bluff K is advised due to the low organic matter content (1.2% for Sample RP-SS-K1 and 1.5% for RP-SS-K2). Prior to completing the detailed response action design for Bluff K, it should be re-sampled, and the results should be reevaluated to confirm amendments and nutrients required to establish vegetation.

Bluff L

Bluff L is located approximately 3 air miles southwest of Riley Pass, in Township 22 North, Range 5 East, Section 29. The site is accessed by traveling south approximately 3.5 miles from Harding County Road 733, on Craig Pass Road, turning south on Craig Pass Road and traveling approximately 2 miles to the site.

Bluff L encompasses approximately eight acres, and consists of several small spoils piles, old roads, and dozer cuts scattered throughout the site. One larger spoils pile, approximately 44,100 cy, is located on the north end of the site in a dry draw. There are several small erosion rills and gullies that have formed on the face of this spoils pile. Vegetation at the site consists of approximately 85 to 90% vegetative cover in flatter areas and approximately 65 to 70% vegetative cover on the steeper faces of the spoils pile. There is an exposed lignite coal seam on the east side of the large spoils pile.

The analytical results for soil samples collected from Bluff L are included in Appendix C in this EE/CA and summarized in Tables C-1, C-4, and C-5. No metal concentrations at the site have been documented greater than three times background concentrations.

Organic amendment of Bluff L is advised due to the low organic matter content (0.6%). Prior to completing the detailed response action design for Bluff L, it should be re-sampled, and the results reevaluated to confirm amendments and nutrients required to establish vegetation.

3.2.4 Surface Water and Stream Sediment Sampling

Seventeen surface water samples were collected during the 1999 and 2000 field investigations; 14 in the Schleichart Draw drainage, 2 in the Crooked Creek drainage, and 1 in the Campbell Creek drainage. Surface water sample locations are shown on Figure 3-3. Table C-2 in Appendix C of this EE/CA presents the analytical results of these sampling efforts. Five surface water samples (including the duplicate) were collected downstream from mined Bluffs B, I, and J. The remaining samples were collected from the sediment ponds and upstream and downstream the Schleichart Draw Reservoir and the Ducks Unlimited Pond. Surface water analyses included: total metals (arsenic, copper, lead, molybdenum, selenium, thorium, uranium, and vanadium); radiochemistry (radium^{226} and uranium^{235}); pH; and TSS.

During the 1999 sampling event, surface water samples (RP-SW-SP1 through -SP5) were collected from the 5 USFS sediment ponds, upstream and downstream the Schleichart Reservoir (RP-SW-SP6 and -SP7), upstream and downstream the Ducks Unlimited Pond (RP-SW-SP7 and -SP8), a background location (RP-SW-X1), and from 2 other locations where water was present (RP-SW-B3 and -I1). A duplicate sample was also collected at Sample RP-SW-I1 and was labeled as RP-SW-I5. Surface water sample locations are shown on Figure 3-3. Twelve surface water samples were collected (including the duplicate sample) from 11 locations. All samples except RP-SW-B3, which followed significant precipitation the night before, were collected on August 12, 1999.

During the 2000 sampling event, surface water samples were collected upstream and downstream the Ducks Unlimited Pond (RP-SW-SD2 and –SD1), another background location (RP-SW-X2), and from two locations where water was present adjacent to and downgradient of Bluff J (RP-SW-J2 and -J3). Surface water sample locations are shown on Figure 3-3. Five surface water locations were sampled during the 2000 site visit.

All measured contaminant concentrations in water except total uranium and $uranium^{235}$ exceeded three times background water downstream from Bluff I (RP-SW-I1 through -I5). Bluff B (RP-SW-B3) and Bluff J (RP-SW-J2 and -J3) were below three times background for total uranium and $uranium^{235}$. Since only four locations with available surface water flow were sampled, Samples RP-SW-I1 through -I5 were collected after a storm event. These data can provide meaningful information relative to the release of contaminants from sources at the site to surface water.

Surface water upstream of the Schleichart Draw Reservoir (RP-SW-SP6) exceeded three times background for arsenic, copper, lead, molybdenum, selenium, thorium, vanadium, $radium^{226}$, and TSS. Surface water downstream of the Schleichart Draw Reservoir (RP-SW-SP7) exceeded three times background for arsenic, copper, lead, molybdenum, vanadium, $radium^{226}$, and TSS, but at significantly lower concentrations than the upstream sample, indicating the reservoir is removing contaminants from surface water. Surface water below the Ducks Unlimited Pond (RP-SW-SP8) exceeded three times background only for molybdenum and $radium^{226}$, and again, all contaminants were at significantly lower concentrations than the sample collected upstream of the Ducks Unlimited Pond, indicating the pond is also removing constituents from surface water. Re-sampling upstream and downstream of the Ducks Unlimited Pond (RP-SW-SD2 and -SD1, respectively) in 2000 showed only arsenic exceeding background concentrations at both locations. Arsenic, molybdenum, and TSS concentrations were higher downstream of this pond than upstream.

Surface water sample data were compared with the EPA's Acute Ambient Water Quality Criteria (AAWQC) (EPA, 1996) and the State of South Dakota Surface Water Criteria. The AAWQC only exist for arsenic (360 µg/L), copper (17.7 µg/L), and lead (82 µg/L). The AAWQC for arsenic and lead were exceeded for all the sediment ponds and above the Schleichart Draw Reservoir, but not below. The AAWQC for copper was exceeded for all the sediment ponds above and below the Schleichart Draw Reservoir, but not below the Ducks Unlimited Pond. The AAWQC for copper and lead were exceeded for Sample RP-SW-I1.

Following the collection of each water sample, a sediment sample was collected from the streambed or sediment pond. A total of 44 stream sediment samples were collected during the field investigation: 21 in the Pete's Creek drainage, 13 in the Schleichart Draw drainage, 6 in the Crooked Creek drainage, and 4 in the Campbell Creek drainage. Sediment samples were collected downstream from mined bluffs and in potentially impacted impoundments. Two types of sediment samples were collected at each location: a standard composite sample for chemical analysis; and a width integrated streambed sample for particle size analysis. Sediment analyses included: total metals (arsenic, copper, lead, molybdenum, selenium, thorium, uranium, and vanadium); radiochemistry (radium^{226} and uranium^{235}); and particle size analysis.

In 1999, 33 sediment samples were collected; 22 were collected in dry drainages and did not have a co-located surface water sample. In 2000, 11 sediment samples were collected; 8 were collected in dry drainages and did not have a co-located surface water sample. The sediment sampling effort included background sediment samples. Sediment sample locations are shown on Figure 3-4. Tables C-3 and C-6 in Appendix C of this EE/CA present the analytical results of these sampling efforts.

Arsenic concentrations in sediment downstream from Bluffs D, F, G, and H exceed three times local background. Molybdenum concentrations exceed three times background downstream from Bluffs B, C, D, F, G, H, and I. Radium^{226} concentrations in sediment downstream from Bluffs B, C, D, F, and H, and Sediment Pond 2 exceed three times local background. Uranium^{235} concentrations exceed three times background downstream from Bluffs B, C, D, and F.

The sediment particle size data show a significant reduction in the median grain size (the D50 coefficient) occurring at all downstream sample locations relative to the background locations for each of the bluffs, except for Bluffs A, C, E, G, J, and K, the western sides of Bluffs F and H, the northern side of Bluff $I_{(1)}$, and the southeastern end of Bluff B. A few of the sediment particle size sample locations show greater amounts of fine-grained materials (less than #200 Mesh, silt) relative to the background sediment (30% fines).

All of the sediment pond samples (RP-SE-SP1 through -SP5) have both significant median grain size reduction and significant fine sediment relative to background, indicating that they are performing their function of removing sediment. Stream sediments downstream from the Schleichart Draw Reservoir have 20% more fines than the upstream sediment (79% versus 59%). Similarly, stream sediments downstream from the Ducks Unlimited Pond have 5% more fines than the upstream sediment (84% versus 79%). This may be due to the lower ponds removing more of the larger size sediment than the fines.

Overall, most drainages appeared to have grasses growing in and around where the samples were collected.

3.3 PORTAGE ENVIRONMETAL, INC. INVESTIGATION RESULTS (2004)

This section addresses the analytical results generated by the field sampling activities conducted at the Riley Pass Site by Portage in July 2004. For this investigation only Bluffs B and H were sampled. These two bluffs were selected by the USFS because historic data indicated they represent the range of chemical and radiochemical conditions at the site. Bluff H generally represents the highest levels of contamination. Bluff B represents the lower end of contamination but involves a much larger disturbance area, and therefore, more widespread contamination. The 2004 site investigation included the following activities: field observations, on-site and regional radioactivity measurements, and the collection of 21 discrete background, overburden, and lignite samples. Soil samples were analyzed for the following elements arsenic, molybdenum, selenium, isotopic uranium, radium^{226}, and Thorium^{230} (Th^{230}). The analytical results for soil samples collected from Bluff B and Bluff H are provided in Appendix D of this EE/CA.

Concentrations greater than three times background of arsenic, molybdenum, selenium, uranium, $radium^{226}$, and $Thorium^{230}$ were documented at Bluff B in both the overburden and lignite samples. Samples collected at Bluff H exhibited similar trends with all measured constituents greater than three times background.

Gamma rate ranges in Bluff B were determined to be 10,000 to 35,000 counts per minute (cpm) 15.8 to 38.6 µRem/h, averaging 15,000 cpm (21.1 µRem/h). Weathered ore piles ranged from 30,000 to 200,000 cpm (34.6 to 133.1 µRem/h) averaging 60,000 cpm (56.6 µRem/h). The lignite piles exhibited gamma rate ranges of 100,000 to 200,000 cpm (81.4 to 133.1 µRem/h), with an average of 150,000 cpm (08.5 µRem/h). The mine floor, with exposed sandstone, ranged from 20,000 to 50,000 cpm (25.9 to 49.7 µRem/h), and averaged 40,000 cpm (42.4 µRem/h). The majority of undisturbed areas with possible overburden interfaces ranged from 4,000 to 6,000 cpm (8.3 to 11.0 µRem/h), averaging 5,000 cpm (9.7 µRem/h). Gamma rate ranges on Bluff H were typically 6,000 to 60,000 cpm (11.0 to 56.6 µRem/h), averaging 40,000 cpm (42.4 µRem/h). Weathered ore and slag piles ranged 40,000 to 60,000 cpm (42.4 to 56.6 µRem/h), averaging 50,000 cpm (49.7 µRem/h). The lignite area exhibited gamma rate ranges of 80,000 to >800,000 cpm (69.4 to 356.4 µRem/h), with an average of 100,000 cpm (81.4 µRem/h).

3.4 ASSESSMENT OF PHYSICAL HAZARDS

Field observations indicate that there are some physical hazards located throughout the site. The physical hazards include highwalls and soils piping (i.e., creation of underground tunnels due to surface water erosion). Highwalls exist on Bluffs B, H, I and J. Bluffs I and J highwalls appear moderately stable. Due to the sandy clay and silty clay soil type present on Bluff B, soil piping and tunneling with occasional sink holes are present. There are also large gullies present on Bluffs G, H and I. These are concerns for people recreating in the area, as well as for people and equipment present during any construction activities that will take place at the bluffs.

3.5 GENERAL CHARACTERIZATION

Field Global Positioning System (GPS) equipment was used to locate all sampling points. Also, the GPS technology was used to outline and estimate the disturbed areas associated with the various bluffs.

4.0 SUMMARY OF THE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Section 121(d)(2) of CERCLA, 42 United States Code (USC) § 962 1(d)(2), certain provisions of the current NCP, 40 CFR Part 300 (1990), and guidance policy issued by the EPA require that Remedial Actions (RAs) taken pursuant to CERCLA authority shall require or achieve compliance with substantive provisions of ARARs, criteria, or limitations from the State environmental and facility citing laws, and from Federal environmental laws at the completion of RA, and/or during implementation of the RA, unless a waiver is granted. These requirements are threshold standards that any selected remedy must meet. The EPA calls standards, requirements, criteria, or limitations identified pursuant to Section 121(d) "ARARs". The ARARs for this removal action are set forth and discussed in Appendix A.

5.0 BASELINE HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENTS

The baseline human health risk assessment was performed for the Riley Pass Uranium Mines Site by Portage Environmental, Inc. (Portage, 2006), and was conducted in general accordance with the NCP (EPA, 1990) and other EPA guidance. The full text and appendices of the risk assessment report are included as Appendix D. A summary of the Portage risk assessment follows.

Historic mining activities at the Riley Pass Uranium Mines exposed lignite ores and spread these materials throughout the mined areas. These ores contain elevated concentrations of chemical and radiochemical contaminants. The resulting physical state of the site has resulted in contamination of soils and surface water, both through mixing during mining operations and through various natural transport mechanisms. Further exacerbating this include: the physical characteristics of the geologic material; the relatively steep terrain; and the regional climate. The particles that comprise the Riley Pass mine wastes are small and highly susceptible to both wind and surface water erosion. The arid conditions of the North Cave Hills result in extended periods where soils contain virtually no moisture. As a result, storm events and wind readily disperse contaminated media to both on and off-site locations. The physical state and mobility of the mine wastes at Riley Pass increase the likelihood that people and ecological receptors will be exposed.

5.1 HUMAN HEALTH RISKS

The Custer National Forest, Sioux Ranger District documented the users of the Riley Pass Uranium Mines area by identifying those persons or groups who use the site regularly, and gathering site-specific information detailing the amount of time each spends at the site. This information forms the basis for determining potential exposure to people due to contact with contaminated mine wastes, and contact with contaminants that originated at the site. Based on their findings, the following people are most at risk for exposure to contaminants or direct radiation (in no particular order):

- Cattle ranchers (holders of grazing permits at Riley Pass);
- Recreational visitors (hunters, hikers, campers, and archeologists);
- American Indians (use the site for cultural purposes); and
- USFS employees and contractors (maintaining and dredging on-site sediment ponds, monitoring of grazing activities, and other work).

5.1.1 Exposure Summary

Site-specific use data coupled with site-specific analytical and field-screening data form the basis for this risk assessment. Using this information, a profile of individual site users was developed by applying industry standard criteria (EPA, Department of Energy, Nuclear Regulatory Commission, etc.). The result is a site-specific exposure evaluation for each of the site users. This assessment concludes that three of the site users have complete and significant pathways for exposure to contaminated mine wastes. The following summarizes their use and routes of exposure.

Grazing Permit Holder. According to the Custer National Forest Management Plan, there are three cattle ranchers who hold grazing permits affected by mine wastes. They spend 60 days each year tending cattle in the North Cave Hills. The routes of exposure affecting the permit holders include: inhalation of contaminated windblown or suspended dusts; direct contact or incidental ingestion of contaminated surface soils and sediment; and ingestion of contaminated beef grazed on-site.

Recreational Visitor (Hunter). According to the Custer National Forest Management Plan, recreational hunters spend the greatest amount of time at Riley Pass of all recreational users (4 hours per day, 32 days per year). The routes of exposure affecting recreational hunters include: inhalation of contaminated windblown or suspended dusts; direct contact or incidental ingestion of contaminated surface soils and sediment; and ingestion of contaminated deer meat.

American Indian Site User. Estimates established by the Custer National Forest Archeology staff indicate American Indians use the mined areas at Riley Pass for traditional purposes, with three tribes using the site regularly. The predominant uses are foot traffic and sitting overlooking the landscape. Individual use is documented at 25 hours per year, per person. American Indians exposure pathways at the site include: inhalation of contaminated windblown or suspended dusts; and direct contact or incidental ingestion of contaminated surface soils and sediment.

5.1.2 Toxicity Summary

A fundamental principal of toxicology is 'dose determines the toxic properties of a contaminant'. The toxic properties of contaminants can change depending on the dose received. Accordingly, toxicity factors (cancer slope factors for carcinogens and chronic reference doses for systemic toxins) have been developed by the EPA to support quantitative risk assessment. For this assessment, contaminant toxicity was determined in accordance with EPA guidance. Toxicity values for ecological risk were obtained from a variety of commonly used and accepted sources.

5.1.3 Risk Summary

Once exposure and toxicity were fully evaluated, the carcinogenic risks and non-carcinogenic effects were determined for the receptors identified previously. Risk is characterized by comparing the quantitative estimates of exposure with the quantitative estimates of toxicity. For exposure to carcinogens, an incrementally increased risk of cancer is predicted based on exposure averaged over a lifetime.

The EPA considers carcinogenic risks in the range of 1×10^{-4} to 1×10^{-6} a concern that warrants an evaluation. Non-carcinogenic effects are expressed in terms of hazard quotients. A hazard quotient greater then 1 indicates that the estimated exposure exceeds the expected safe level. The following summarizes the risks and non-carcinogenic effects based on a reasonable maximum exposure (RME) scenario for each of the Riley Pass receptors. Given the geological make-up of the area, the carcinogenic risks for the natural background at times falls between 1×10^{-4} and 1×10^{-6}. Therefore a carcinogenic risk value of 1×10^{-6} was selected as a target goal in order to consistently evaluate effects of all impacts and potential actions at the site. Evaluation of carcinogenic risks and non-carcinogenic effects were also evaluated by Portage using the central tendency exposure (CTE) scenario.

Grazing Permit Holder. Unacceptable carcinogenic risks were identified for the grazing permit holders for both arsenic and radionuclides. Considering all exposure pathways and depending on where exposure occurs (e.g., Bluff B, Bluff H or Lignite) carcinogenic risks from arsenic, based on the RME for the permit holder, range from 7 x 10^{-5} to 2 x 10^{-4}. The RME risks from radionuclides range from 2 x 10^{-5} to 2 x 10^{-3}. Total carcinogenic risk for the permit holder ranges from 1 x 10^{-4} to 2 x 10^{-3}. Non-carcinogenic hazard quotients range from 0.4 to 5.7 for the permit holder.

Recreational Visitor (Hunter). Unacceptable carcinogenic risks were also identified for the recreational hunter for both arsenic and radionuclides. Considering all exposure pathways and depending on where exposure occurs (e.g., Bluff B, Bluff H or Lignite) RME risks from arsenic for the recreational hunter range from 1 x 10^{-5} to 2 x 10^{-4}. The RME carcinogenic risks from radionuclides range from 8 x 10^{-6} to 8 x 10^{-4}. Total carcinogenic risk for the recreational visitor ranges from 2 x 10^{-5} to 1 x 10^{-3}. Non-carcinogenic hazard quotients range from 0.1 to 1.0 for the recreational visitor.

American Indian Site User. Elevated carcinogenic risks were also noted for American Indian site users. Considering all exposure pathways and depending on where exposure occur (Bluff B, Bluff H or Lignite) RME risks from arsenic to American Indians range from 2 x 10^{-6} to 2 x 10^{-5}. The RME risks from radionuclides range from 8 x 10^{-7} to 6 x 10^{-5}. Total carcinogenic risk for the American Indian site user ranges from 1 x 10^{-4} to 2 x 10^{-3}. Non-carcinogenic hazard quotients were below 1 for the American Indian site user.

The human health carcinogenic risk values and non-carcinogenic Hazard Quotients (HQs) for each Contaminant of Concern (COC) are summarized in Table 5-1. The table utilizes the 2006 modified risk estimates from Bluff H, as representative of the overall site risks.

TABLE 5-1
RILEY PASS URANIUM MINE SITE
SUMMARY OF NON-CARCINOGENIC HAZARD QUOTIENTS (HQ)
AND CARCINOGENIC RISK ESTIMATES FOR BLUFF H

Non-carcinogenic HQ Summary	Permit Holder	Recreational Visitor
Arsenic (non-carcinogenic)	1.1	0.2
Molybdenum	0.1	0.01
Total HQ	1.2	0.2
Carcinogenic Risk Summary		
Arsenic (carcinogenic)	2×10^{-4}	4×10^{-5}
Radionuclides (carcinogenic)	1×10^{-4}	4×10^{-5}
Total Carcinogenic Risk	3×10^{-4}	8×10^{-5}

From Portage 2006 (Appendix D), Tables 3-2, 3-3, 3-4, 3-5, and 3-6, Bluff H values.

Table 5-1 shows that human health carcinogenic risk values are significantly above the EPA level of concern (1×10^{-6}). The non-carcinogenic HQs are not significantly elevated above 1.0. The table also demonstrates that arsenic is the primary COC with respect to carcinogenic risk.

5.2 ECOLOGICAL RISKS

The ecological risk assessment found significant potential for ecological impacts at the site. Key findings included:

- Concentrations of contaminants of potential concern (COPCs) at the site are well above area background levels, cover large areas, and encompass nearly all of the mined areas.
- COPC concentrations exceed various ecological benchmarks, indicating the potential for adverse effects on ecological health.
- Hazard quotients derived in this site-specific risk assessment are well above 1.0 for most species evaluated. Concentrations of COPCs in soil, water, and sediment all contribute to potential ecological hazard.

The calculated ecologic hazard quotients (EQs) for each COC are summarized in Table 5-2, utilizing the Bluff H EQs.

TABLE 5-2
RILEY PASS URANIUM MINE SITE
SUMMARY OF ECOLOGIC HAZARD QUOTIENT (EQ) VALUES

Contaminant of Concern	Terrestrial Animal EQ	Terrestrial Plant EQ
Arsenic	300	50
Molybdenum	70	300
Selenium	0.9	2.0
Radionuclides	2.1	0.3
Total EQ	370	350

From Portage 2006 (Appendix D), Tables 4-1, 4-4, and 4-5, Bluff H values.

6.0 RESPONSE ACTION OBJECTIVES AND GOALS

6.1 ARAR-BASED CLEANUP GOALS

6.1.1 Surface Water

Maximum Contaminant Levels (MCLs), Acute Aquatic Life Standards (AALS) and State Human Health Standards are common ARARs for the surface water medium. The more stringent of these standards is identified as the ARAR-based goal. Acute rather than chronic aquatic life standards are appropriate since long-term monitoring data are not available for surface water at the site. The only COCs at the site with a MCL or AALS are arsenic and radium^{226}. The surface water at the Riley Pass Site, Schleichart Draw, and Pete's Creek are not specifically listed for beneficial uses by South Dakota; therefore, neither are drinking water sources. However, all streams in South Dakota are assigned the beneficial uses of fish and wildlife propagation; recreation and stock waters; and irrigation waters. Table 6-1 presents potential ARAR-based cleanup goals for surface water, assuming potential use as drinking water.

TABLE 6-1
ARAR-BASED CLEANUP GOALS FOR SURFACE WATER

CHEMICAL	TYPE	CONCENTRATION
Arsenic	Drinking Water MCL	10 μg/L
Arsenic	AALS (Federal)	340 μg/L
Uranium	Drinking Water MCL	30 μg/L
Radium^{226}	Drinking Water MCL	5 pCi/L

μg/L – micrograms per Liter
pCi/L - picocuries per Liter

6.1.2 Soil

Chemical-specific ARARs are not available at this time for the soil medium.

6.2 RISK-BASED CLEANUP GOALS

Risk-based soil concentrations (RBSCs) for both the carcinogenic and non-carcinogenic estimates of human health risk are calculated for the exposure scenarios at the Riley Pass Site. These concentrations were derived using exposure assumptions contained in Portage (2006) and are the same as those used in Section 5.0. **These target soil concentrations would reduce the risk of excess incidence of cancer to 1 x 10^{-6} (or to 1 x 10^{-5}, depending on the acceptable risk level for the site) and the non-carcinogenic HQ to 1.0 (EPA, 1989). However, some of these calculated RBSCs are below local background soil concentrations.** These calculated concentrations are presented in Table 6-2. Note that radium^{226} comprises approximately 45% of the permit holder's total radionuclide risk and approximately 30% of the recreational visitor's total radionuclide risk, per the risk assessment (Portage, 2006). Calculated RBSCs assume the same ratios between $radium^{226}$ and other radionuclides.

TABLE 6-2
RISK-BASED SOIL CONCENTRATIONS FOR THE RILEY PASS SITE

Contaminant of Concern	Permit Holder	Recreational Visitor	Ecologic-Animal	Ecologic-Plant	Background Concentration 95%UCL
Noncarcinogenic:					
Arsenic	420 mg/kg	NR	1.6 mg/kg	9.6 mg/kg	39 mg/kg
$Radium^{226}$	ND	ND	50 pCi/g	NR	2.3 pCi/g
Carcinogenic:					
Arsenic @10^{-6} risk	2.3 mg/kg	12 mg/kg	ND	ND	39 mg/kg
$Radium^{226}$ @10^{-6}	3.1 pCi/g	5.8 pCi/g	ND	ND	2.3 pCi/g

mg/kg – milligrams per kilogram
pCi/g - picocuries per gram
ND = Not Determined, no reference dose data.
NR = Not Required, HQ/EQ is less than one.
UCL = Upper Confidence Level

Risk reductions necessitated by the risk assessment to attain human health RBSCs (or background) for each bluff are shown below in Table 6-3. Although it is clear from Table 5-1 that arsenic is the more significant risk contributor, radionuclides, especially $radium^{226}$, are also important components of the overall risk.

Reducing soil arsenic concentrations to background (39 milligrams per kilogram [mg/kg]) would result in a residual cancer risk at 2×10^{-5} for the permit holder and 3×10^{-6} for the recreational visitor; these risk levels are above the target cancer risk of 1.0×10^{-6}. However, reducing the $radium^{226}$ soil concentration to the 1×10^{-6} cancer risk level (3.1 pCi/g for the permit holder, and 5.8 pCi/g for the recreational visitor) results in soil concentrations of $radium^{226}$ above the local background of 2.3 pCi/g.

TABLE 6-3
TARGET RISK REDUCTIONS TO ATTAIN HUMAN HEALTH RISK-BASED SOIL CONCENTRATIONS

COC Exposure Risk Level:	Radium[226] Permit Holder 1×10^{-6}	Radium[226] Recreational 1×10^{-6}	Arsenic Permit Holder 2×10^{-5} (Bkgd)	Arsenic Recreational 3×10^{-6} (Bkgd)
BLUFF A	96%	93%	81%	81%
BLUFF B	74%	51%	66%	66%
BLUFF C	99%	98%	95%	95%
BLUFF D	96%	93%	93%	93%
BLUFF E	93%	86%	NR	NR
BLUFF F	88%	78%	83%	83%
BLUFF G	94%	89%	90%	90%
BLUFF H	93%	87%	87%	87%
BLUFF I	10%	NR	75%	75%
BLUFF J	60%	25%	22%	22%
BLUFF K	NR	NR	17%	17%
BLUFF L	NR	NR	NR	NR
Target COC concentration	3.1 pCi/g	5.8 pCi/g	39 mg/Kg (background)	39 mg/Kg (background)

NR = Risk reduction not required.

7.0 DEVELOPMENT AND SCREENING OF RESPONSE ACTION ALTERNATIVES

The Riley Pass Site consists of steep-sided and generally flat-topped buttes that are rimmed with sandstone cliffs. The Riley Pass Site uranium mines are abandoned lignite strip mines located on relatively flat areas along the top of the buttes. Mining features at the site include minor to extensively disturbed bluffs, overburden piles (spoils), hazardous openings and high walls.

Samples of spoils materials have been characterized as sandy clay and clayey sand (e.g., fine grained). The total disturbed area at the site (including all 12 bluffs) is approximately 250 acres (see Figure 2-1). During past mining activities, large quantities of spoils were pushed over the edges of the buttes onto the steep slopes below the rimrocks. Additional spoils have been deposited on these slopes by subsequent water and/or wind transport.

Treatment of the different media types is dependent on the concentration of metals and/or radioactive contaminants in the media, as well as the physical characteristics of the media. The following provides a brief description of each of the primary contaminated media.

Overburden Spoils - Consist of geologic material, rock, and gangue material that generally do not contain sufficient economic quantities of target constituents for recovery. The spoils materials contain non-mineralized and low-grade mineralized rock removed from above the mineral resource and placed in piles close to the mined areas. The nature and extent of the mineralization, climatic conditions, and soils type of the foundation soils determine the potential of the materials to impact groundwater or surface water quality.

In general, spoils materials contain low-grade minerals and are subject to percolation of precipitation and runoff. Relatively low quantities of natural organic matter and nutrients hinder the establishment of vegetation on these materials. The lack of vegetation on the relatively fine-grained materials contributes significantly to the erosion occurring at the site.

Open Pits – Consist of areas in which the overburden and ore have been removed, creating a pit with near vertical slopes and exposed mineralized surfaces. The nature and extent of the mineralization, and climatic conditions, determines the potential of the material to impact groundwater and/or surface water quality. The composition of the exposed rock and soils and drainage patterns surrounding the pit determine the severity of soil erosion and runoff during storm events.

In general, open pits contain relatively low-grade mineralization and are subject to the same percolation during precipitation and runoff events.

The near vertical slopes associated with open pits and high walls also pose potential physical hazards to recreationists and livestock using the area. However, vertical and near vertical slopes exist frequently in nature, and conventional risk assessment methodologies do not address mitigation of risks associated with eliminating potential physical hazards. Consequently, the risk reduction specifically associated with reduction of high walls in the response action alternatives described in the following sections is negligible.

7.1 IDENTIFICATION OF RESPONSE ACTION TECHNOLOGIES AND PROCESS OPTIONS

The purpose of identifying and screening technology types and process options is to eliminate those technologies that are not feasible, while retaining potentially effective options. General response actions are progressively refined into technology types and process options. The process options are screened and those retained are used to develop response action alternatives. General response actions, technology types, and process options potentially applicable to the waste sources present at the Riley Pass Site are briefly discussed in this section.

General response actions and process options are evaluated for the solid mine wastes (overburden spoils and open pits). No evaluation has been conducted for surface water, groundwater, or off-site stream sediments primarily because reclamation of the contaminated waste sources at each of the bluffs will mitigate impacts to the other environmental media. General response actions potentially capable of meeting the reclamation objectives are identified in Table 7-1. Response actions for the solid mine wastes include No Action, Institutional Controls, Engineering Controls, Excavation and Treatment, and *In-situ* Treatment.

TABLE 7-1
GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS FOR CONTAMINATED SOLID MEDIA AT THE RILEY PASS SITE

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE	PROCESS OPTIONS
No Action	Not Applicable	Not Applicable
Institutional Controls	Access Restrictions	Fencing Land Use Control
Engineering Controls	Containment	Soil Cover Multimedia Cover Asphalt/Concrete Cover
	Surface Controls	Consolidation Grading Revegetation Erosion Protection Run-on/Runoff Control
	On-Site Disposal	Fully Encapsulated Repository Other Repository
	Off-Site Disposal	Haz. Waste Landfill Solid Waste Landfill Permitted Tailings Facility
Excavation and Treatment	Fixation/Stabilization	Pozzolan/Cement Based
	Reprocessing	Milling/Smelter
	Physical/Chemical Treatment	Soil Washing Acid Extraction Alkaline Leaching
	Thermal Treatment	Fluidized Bed Reactor Rotary Kiln Multi-Hearth Kiln Vitrification
In-situ Treatment	Physical/Chemical Treatment	Stabilization/Solidification Soil Flushing
	Thermal Treatment	Vitrification

In Section 7.2, feasible technologies are presented as response action alternatives and are subjected to an initial/preliminary screening based on effectiveness, implementability, and cost. The purpose of the initial screening of alternatives is to identify those alternatives appropriate for a subsequent, detailed analysis. The initial screening also assists in identifying technology (process option) specific data needs for detailed site characterization as well as needs for possible treatability studies. Alternatives that pass the initial screening process are evaluated in detail in Section 8.0.

7.1.1 No Action

Under the No Action Alternative, future remediation or monitoring would not occur at the site. The No Action Alternative is a stand-alone response that is used as a baseline against which candidate response action alternatives are compared.

7.1.2 Institutional Controls

Potentially applicable Institutional Controls consist of land use and access restrictions. Land use restrictions would limit the potential future uses for the land. Limitations may be applicable in the case of No Action, on-site disposal, capping in-place, or other response action alternatives that would result in leaving contaminated materials on-site that could be compromised by future activities (e.g., grazing, recreation, etc.).

Institutional Controls involve implementing access restrictions, such as fencing and land use control. These restrictions are implemented to preclude the future development of impacted areas or to protect an implemented remedy. This type of action does not, in itself, achieve a specific cleanup goal. However, Institutional Controls will be considered as adjacent technologies to accompany other response action alternatives. Institutional Controls that are developed as part of an alternative are enforced by the local government. Therefore, the local government must be involved in the development and eventual implementation of an Institutional Control.

7.1.3 Engineering Controls

Engineering controls are used primarily to reduce the mobility of contaminants by creating a barrier that prevents the transport of wastes from the contaminated source to the surrounding environment. Engineering controls do not reduce the volume or toxicity of the hazardous materials. Engineering controls typically applied include containment/capping, revegetation, run-on/runoff control, and/or disposal.

7.1.3.1 Containment

Containment technologies are used as source control measures to isolate surface water from the contaminated media, to minimize infiltration (and subsequent formation of leachate) of surface water/precipitation into the underlying contaminated media by increasing evapotranspiration processes, and to reduce the potential health risk that may be associated with exposure (direct contact or airborne releases of particulate) to the contaminated media. The cap or cover design is a function of the degree of hazard posed by the contaminated media and may vary in complexity from a simple vegetated soil cover to a multi-layered Resource Conservation and Recovery Act (RCRA) cap. The RCRA cap performance standards are included in 40 CFR 264.310, which addresses RCRA landfill closure requirements. These performance standards may not always be appropriate, particularly in instances where the toxicity of the contaminated media is relatively low, where the cap is intended to be temporary, where there is very low precipitation, or where the wastes are not leached by infiltrating rain water. Specific cap construction is partially driven by the desired land use following cap construction.

Capping is appropriate whenever contaminated materials are left in-place at a site, such as when total excavation and removal or treatment would be cost prohibitive. Capping is considered to be a standard construction practice. Equipment and construction methods associated with capping are readily available, and design methods and requirements are well understood.

7.1.3.2 Surface Controls

Similar to containment, surface control measures are used primarily to reduce contaminant mobility. Surface controls may be appropriate in more remote areas where direct human contact is not a primary concern (human receptors not living or working directly on or near the site). Surface control process options include consolidation, grading, revegetation, and erosion protection. These process options are usually integrated as a single response action alternative. Consolidation involves grouping similar waste types in a common area for subsequent management or treatment. Consolidation is especially applicable when multiple waste sources are present at a site and one or more of the sources require removal from particularly sensitive areas (e.g., floodplain, residential area, or heavy traffic area) or when treating one large combined waste source in a particular location rather than several smaller waste sources dispersed throughout an area.

Grading is the general term for techniques used to reshape the ground surface to reduce slopes, manage surface water infiltration and runoff, and to aid in erosion control. The spreading and compaction steps used in grading are routine construction practices. The equipment and methods used in grading are similar for all surfaces, but will vary slightly depending on wastes type and the surrounding terrain (e.g., steepness). Periodic maintenance and regrading may be necessary to eliminate depressions formed as a result of settlement/subsidence or erosion.

Revegetation involves adding soil amendments and/or topsoil to the waste's surface to provide nutrients, organic material, and neutralizing agents and/or to improve the water storage capacity of the contaminated media, as necessary. This action is used to establish native vegetative species to provide an erosion resistant ground surface that helps protect the ground surface from surface water and wind erosion and reduces net infiltration through the contaminated media by increasing evapotranspiration processes. In general, revegetation includes the following steps: 1) selecting appropriate plant species; 2) preparing the seed bed, which may require deep application (tilling) of soil amendments as necessary; 3) seeding/planting; 4) mulching and/or chemical stabilization; and 5) fertilizing and maintenance.

Erosion protection includes using erosion resistant materials, such as mulch, natural or synthetic fabric mats, riprap, and/or surface water diversion ditches, to reduce the erosion potential at the contaminated media's surface. The erosion resistant materials are placed in areas susceptible to surface water erosion (concentrated flow or overland flow) or wind erosion. Proper erosion protection design requires knowledge of drainage area characteristics, average slopes, soil texture, vegetation types and abundance, and precipitation data.

7.1.3.3 On-Site Disposal

Permanent on-site disposal is used as a source control measure. On-site disposal involves placing the contaminated media in an engineered containment facility located within the site boundary. On-site disposal options may be applied to pre-treated or untreated contaminated materials, depending upon the chemical characteristics of the material. The design configuration of an on-site containment facility would depend on the toxicity and type of materials requiring disposal. The design could range in complexity from a relatively simple, unlined, and covered impoundment to a double-lined impoundment equipped with double leachate collection systems and RCRA-type cap. Materials failing to meet the Toxicity Characteristic Leachate Procedure (TCLP) criteria may require disposal in a repository conforming to the performance standards for a RCRA landfill closure.

7.1.3.4 Off-Site Disposal

Off-site disposal involves placing excavated contaminated materials in an engineered containment facility located outside the site boundary. Off-site disposal options may be applied to pre-treated or untreated contaminated materials and would depend on TCLP results. Materials failing to meet the TCLP criteria would require disposal in a RCRA-permitted treatment, storage, and disposal (TSD) facility. Conversely, less toxic materials could possibly be disposed of in an off-site permitted sanitary landfill or tailings disposal facility in compliance with other applicable laws. Off-site disposal is most attractive when dealing with relatively small quantities of wastes located relatively near the disposal facility.

7.1.4 Excavation and Treatment

Excavation and treatment incorporates the removal of contaminated media and subsequent treatment via a specific treatment process that chemically, physically, or thermally results in a reduction of contaminant toxicity and/or volume. Treatment processes have the primary objective of either: 1) concentrating the metal contaminants for additional treatment or recovery of valuable contaminants; or 2) reducing the toxicity of the hazardous contaminants.

Excavation can be completed using conventional earth moving equipment and accepted hazardous materials handling procedures. Precautionary measures, such as stream diversion or isolation, would be necessary for excavating materials contained in the floodplain of a stream. Containment and/or treatment of water encountered during excavation may also be necessary.

7.1.4.1 Fixation/Stabilization

Fixation/stabilization technologies are used to treat materials by physically encapsulating them in an inert matrix (stabilization) and/or chemically altering them to reduce the mobility and/or toxicity of their contaminants (fixation). These technologies generally involve mixing materials with binding agents under prescribed conditions to form a stable matrix. Fixation/stabilization is an established technology for treating inorganic contaminants. The technology incorporates a reagent or combination of reagents to facilitate a chemical and/or physical reduction of the mobility of contaminants in the solid media. Lime/fly ash-based treatment processes and pozzolan/cement-based treatment processes are potentially applicable fixation/stabilization technologies.

7.1.4.2 Reprocessing

Reprocessing involves excavating and transporting the waste materials to an existing permitted mill or smelter facility for processing and economic recovery of target metals. Applicability of this option depends on the willingness of an existing permitted facility to accept and process the materials and dispose of the wastes. Although reprocessing at active facilities has been conducted in the past, permit limitations, Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) liability, and process constraints all limit the feasibility of this process option. In addition to these limitations, costs associated with this alternative are very high (transportation costs in addition to processing costs). In order for a milling facility or smelter to accept the materials, pre-concentration of the target metals would likely be required, and the by-product waste resulting from pre-concentrating would still contain elevated metals concentrations requiring proper disposal.

7.1.4.3 Physical/Chemical Treatment

Physical treatment processes use physical characteristics to concentrate contaminants into a relatively small volume for disposal or further treatment. Chemical treatment processes treat contaminants through adding a chemical reagent that removes or fixes the contaminants. The net result of chemical treatment processes is a reduction of toxicity and/or mobility of contaminants in the solid media. Chemical treatment processes often work in conjunction with physical processes to wash the contaminated media with water, acids, bases, or surfactants. Potentially applicable physical/chemical treatment process options include: soil washing, acid extraction, and alkaline leaching.

Soil washing is an innovative treatment process, which consists of washing the contaminated media (with water) in a heap, vat, or agitated vessel to dissolve water soluble contaminants. Soil washing requires that contaminants be readily soluble in water and sized sufficiently small so that dissolution can be achieved in a practical retention time. Dissolved metal contaminants contained in the wash solution are precipitated as insoluble compounds, and the treated solids are dewatered before additional treatment or disposal. The precipitates form a sludge, which would require additional treatment such as dewatering or stabilization prior to disposal.

Acid extraction applies an acidic solution to the contaminated media in a heap, vat, or agitated vessel. Depending on temperature, pressure, and acid concentration, varying quantities of the metal contaminants present in the contaminated media would be solubilized. A broader range of contaminants can be expected to be acid soluble at ambient conditions using acid extraction versus soil washing; however, sulfide compounds may only be acid soluble under extreme conditions of temperature and pressure. Dissolved contaminants are subsequently precipitated for additional treatment and/or disposal.

Alkaline leaching is similar to acid extraction in which a leaching solution (in this case ammonia, lime, or caustic soda) is applied to the contaminated media in a heap, vat, or agitated vessel. Alkaline leaching is potentially effective for leaching the majority of metals from the contaminated media; however, the removal of arsenic is not well documented.

7.1.4.4 Thermal Treatment

Under thermal treatment technologies, heat is applied to the contaminated media to volatilize and oxidize metals and render them amenable to additional processing and/or to vitrify the contaminated media into a glass-like, non-toxic, non-leachable matrix. Potentially applicable moderate temperature thermal processes that volatilize metals and form metallic oxide particulates include the fluidized bed reactor, the rotary kiln, and the multi-hearth kiln. Potentially applicable high temperature thermal treatment processes include vitrification. All components of the contaminated media are melted and/or volatilized under high temperature vitrification. Volatile contaminants and gaseous oxides of sulfur are driven off as gases in the process, and the non-volatile, molten materials containing contaminants are cooled, and in the process, vitrified.

Thermal treatment technologies can be applied to wet or dry contaminated media; however, the effectiveness may vary somewhat with variable moisture content and particle size. Crushing may be necessary as a pre-treatment step, especially for large and/or variable particle sizes, such as in waste rock dumps. Moderate temperature thermal processes should only be considered as pre-treatment for other treatment options. This process concentrates the contaminants into a highly mobile (and potentially more toxic) form. High temperature thermal processes immobilize most metal contaminants into a vitrified slag, which would have to be properly disposed. The volatile metals would be removed and/or concentrated into particulate metal oxides, which would likely require disposal as hazardous wastes. Thermal treatment costs are extremely high compared to other potentially applicable remedial technologies.

7.1.5 *In-Situ* Treatment

In-situ treatment involves treating the contaminated media in-place. *In-situ* technologies reduce the mobility and toxicity of the contaminated media and may reduce worker exposure to the contaminated materials; however, *in-situ* technologies allow a lesser degree of control, in general, than *ex-situ* treatment options.

7.1.5.1 Physical/Chemical Treatment

Potentially applicable *in-situ* physical/chemical treatment technologies include stabilization/ solidification, soil flushing, and dewatering.

In-situ stabilization/solidification is similar to conventional stabilization in that a solidifying agent (or combination of agents) is used to create a chemical or physical change in the mobility and/or toxicity of the contaminants. The *in-situ* process uses deep mixing techniques to allow maximum contact of the solidifying agents with the contaminated media.

Soil flushing is an innovative process that injects an acidic or basic reagent or chelating agent into the contaminated media to solubilize metals. The solubilized metals are extracted using established dewatering techniques, and the extracted solution is then treated to recover metals or is disposed as aqueous waste. Low permeability materials may hinder proper circulation, flushing solution reaction, and ultimate recovery of the solution. Currently, soil flushing has only been demonstrated at pilot scale.

Dewatering is a common pre-treatment process used to extract water from contaminated solid media. Common dewatering options include well-field extraction, extraction trenches, surface water diversion, and gravity draining of stockpiled saturated materials. Dewatering is most effective in conjunction with additional remedial technologies that reduce contaminant toxicity, mobility, or volume.

7.1.5.2 Thermal Treatment

In-situ vitrification is an innovative process used to melt contaminated solid media in-place to immobilize metals into a glass-like, inert, non-leachable solid matrix. Vitrification requires significant energy to generate sufficient current to force the solid media to act as a continuous electrical conductor. This technology is seriously inhibited by high moisture content. Gases generated by the process must be collected and treated in an off-gas treatment system. *In-situ* vitrification has only been demonstrated at pilot scale, and treatment costs are extremely high compared to other treatment technologies.

7.2 SITE-SPECIFIC ALTERNATIVES

The Riley Pass Site is a very large site (consisting of numerous waste sources spread out over a very large area), and complete cleanup at this site will be costly. Consequently, the most sensible way to approach reclamation at this site includes focusing on the highest risk sources, and performing the most aggressive treatment on those sources that provide the greatest reduction in risk for the amount of funding expended.

The site consists of 12 distinct bluffs that were subjected to varying degrees of mining activity in the past. The mining-related disturbance is relatively small at several of the bluffs (e.g., Bluffs C, D, E, F, K, and L) and the limited disturbance results in negligible to low-level environmental impacts in the form of sedimentation problems. Conversely, the mining-related disturbance at several other bluffs is excessive (e.g., Bluffs A, B, G, H, I), which results in some potential risks to human health and considerable potential risks to environmental resources. Additionally, several of the bluffs contain relatively small quantities of more acutely contaminated materials, where complete removal and containment is warranted.

For the reasons stated above, potential response action alternatives are developed for each bluff independently in this section, as requested by the USFS. This way, resource managers can evaluate and eventually select appropriate response action options for each bluff on a site-specific basis. The response action alternatives developed in this section are grouped into six general categories (see Table 7-2), ranging from no action to complete removal and containment of selected materials and reduction of high walls. The alternatives primarily focus on mitigating erosion and sedimentation problems at the site; however, each alternative is not necessarily applicable to each bluff. For example, Alternative 5 is not applicable to Bluff C, because the mining-related disturbance at Bluff C is relatively small and Bluff C does not contain any known areas of acutely contaminated materials. Conversely, a relatively small quantity of acutely contaminated material is located at Bluff J, and Bluff J is situated in close proximity to a residence; consequently, complete removal of this relatively small quantity of contaminated material is warranted.

TABLE 7-2:
RESPONSE ACTION ALTERNATIVES FOR THE RILEY PASS SITE

ALTERNATIVE	GENERAL DESCRIPTION
Alternative 1	No Action
Alternative 2	Institutional Controls
Alternative 3	Minimal Grading and Sediment Control
Alternative 4	Comprehensive Grading and Sediment Control
Alternative 5	Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, and Sediment Control
Alternative 6	Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, Sediment Control, and Reduction of High Walls

7.3 PRELIMINARY EVALUATION AND SCREENING OF ALTERNATIVES

The alternatives identified in Section 7.2 are described, developed, and then subjected to a preliminary evaluation and screening in this section. The evaluation and screening at this stage are based on the anticipated effectiveness, implementability, and relative costs of the alternatives. The preliminary screening has been conducted to identify those alternatives that are obviously not as cost effective or implementable as other alternatives that would provide a similar degree of risk reduction, thereby reducing the number of response action alternatives requiring detailed evaluation in Section 8.0 of this document.

The evaluation of effectiveness includes determining the ability of an alternative to effectively reduce adverse human health or environmental impacts sufficiently to achieve the response action goals. The response action goals include overall protection of human health and the environment, compliance with ARARs, and short- and long-term effectiveness and/or performance related to reducing toxicity, mobility, and/or volume of contaminants. The effectiveness screening criteria includes consideration of the nature and extent of the contamination, as well as site-specific conditions, such as geology, hydrology, hydrogeology, climate, current land use, and potential future land use.

The implementability of each alternative is evaluated to consider the technical and administrative feasibility of constructing, operating, and maintaining each response action alternative. Technical feasibility considerations include applicability of the alternative to the waste source(s), availability of the required equipment and expertise to execute the alternative and overall reliability of the alternative. Administrative feasibility considerations include logistical and scheduling constraints. The evaluation of implementability also considers appropriate combinations of alternatives with respect to site-specific conditions.

Cost screening consists of developing conservative, order-of-magnitude cost estimates for each response action alternative based on similar sets of assumptions. Costs have been developed by analyzing data available from screening and implementing response action alternatives at similar sites, particularly past abandoned mine reclamation activities conducted by the U.S. Army Corps of Engineers (USACE) Department of Interior/Bureau of Land Management (BLM), USFS and Montana Department of Environmental Quality/Mine Waste Cleanup Bureau (DEQ/MWCB). Unit and total costs presented in the cost evaluations are structured to account for contaminated materials handling, adverse site conditions, and contingency.

Volume estimates are based on aerial survey data collected by the USFS in June 2000.

7.3.1 Identification of Response Action Alternatives for Bluff A

Bluff A is located approximately .25 miles north of Bluff B in Township 22 North, Range 5 East, Section 22 and 23. The estimated spoils volume is 25,250 cy, with a total disturbed area of 3 acres, of which approximately 1 acre is unvegetated spoils. These spoils materials are located on the south side of the bluff and drain towards a dry draw that adjoins a large spoils pile area associated with Bluff B.

The spoils are extremely steep (approximately 1.5H:1V), with very little vegetation, the remaining areas of Bluff A are also disturbed and exhibit little vegetation; however, they are not contributing as much sediment as the 1-acre spoils pile. Concentrations greater than three times background of molybdenum, uranium, radium^{226}, and uranium^{235} were documented for Bluff A during the 1999 sampling investigation.

7.3.1.1 Alternative 1: No Action

The No Action Alternative means that no actual response action activities will occur at the site to control contaminant migration or to reduce toxicity or volume.

Effectiveness - Protection of human health and the environment would not be achieved under the No Action Alternative. Prevention of direct human contact would not be achieved. The contaminant sources present at Bluff A would continue to potentially impact the environment. Toxicity, mobility, and volume of contaminants would not be reduced under the No Action Alternative.

Implementability - Technical and administrative feasibility evaluation criteria do not apply to this alternative.

Cost Screening - No capital or operating costs would be incurred under this alternative.

Maintenance costs would continue to be incurred from sediment leaving the site. The total present-worth cost of the continued maintenance for this alternative has been estimated at $463,476.15. The cost details associated with maintenance under this alternative are included in Table E-1 (Appendix E). The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs discounted at 7.0%.

Screening Summary - This alternative has been retained for further evaluation as required by the NCP.

7.3.1.2 <u>Alternative 2: Institutional Controls (Fence and Land Use Restrictions)</u>

The Institutional Controls Alternative includes erecting fences around selected waste sources and the high walls to restrict access to contaminated sources and safety hazards present. Additionally, land use restrictions could be placed to restrict recreational activities near the contaminated sources.

Effectiveness - This alternative is not protective of environmental resources. It is not fully protective of human health if implemented as a stand-alone alternative because the waste sources will continue to be exposed and available for direct contact. Toxicity, mobility, and volume of the contaminated media would not be reduced under this alternative.

Implementability - Institutional controls can be easily implemented based on the criteria of applicability, availability, and reliability. This alternative is considered applicable for minimizing the potential for direct contact and restricting access to the safety hazards present at the site. Fencing materials and construction contractors are readily available to minimize direct contact with the sources. Reliability of this alternative for its intended purpose (protection from direct contact) is considered good as long as enforcement of the institutional controls is maintained by the regulatory agencies. Due to the logistical simplicity of implementing institutional controls, administrative feasibility is considered very good.

Cost Screening - Costs associated with institutional controls would be relatively low compared to other response action measures; however, a considerable amount of fencing materials would be required to fully enclose the sources present at the site. Capital costs associated with construction of an 8-foot tall, chain-link fence would run approximately $64,000.00 or $20 per linear foot. Total capital cost can vary widely depending on which feature would require fencing and assuming no consolidation of contaminated materials. The total present-worth cost has been estimated at $527,476.15. The cost details associated with implementing this alternative as described are included in Table E-2 (Appendix E). The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

Screening Summary - Institutional controls will not be considered further as a stand-alone response action alternative, but may be used in conjunction with other selected treatment alternatives.

7.3.1.3 Alternative 3: Minimal Grading and Sediment Control

Alternative 3 involves construction of one sediment basin located near the center of the bluff, within the disturbed area. The purpose of this sediment basin would be to contain sediment within the disturbed area of the bluff to eliminate off-site transport of sediment. As part of this alternative, run-on/runoff control ditches would be incorporated into the design to control storm water. Selected spoils piles currently located on top of the bluff would be regraded, amended with organics and seeded (Figure 7-1). As part of the grading plan, the small area located on the north side of the bluff containing high concentrations of radium^{226} and uranium^{235} would be covered with a minimum of two feet of clean spoils materials. No regrading or reclamation would be completed on the spoils located on the side slopes.

Conceptual Design and Assumptions

Based on the available data and the above considerations, the conceptual design of Alternative 3 includes:

- Improving the existing access road from Schleichart Draw to Bluff A by blading/grading to facilitate safe access of heavy equipment and construction crews;
- Construction of an internal sediment basin at location shown on Figure 7-1;
- Regrading of the selected spoils piles where shown on Figure 7-1;
- Construction of run-on/runoff control ditches;
- Revegetation of the regraded/recontoured selected spoil piles;
- Revegetation of all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of a 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluff A is in fair to poor condition, and is approximately two miles in length. This unimproved dirt road would require some improvements and maintenance during the construction period by blading/regrading to facilitate safe access to the site.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary erosion protection of the disturbed surfaces.

Run-on/runoff controls would be designed as an integral part of the bluff stabilization. Run-on/runoff controls would consist of constructing ditches to divert runoff toward the sediment basin.

Effectiveness – The purpose of this alternative is to minimize human exposure to the contaminants and to stabilize erosive areas. The purpose of the sediment basin and establishing vegetation on the regraded surfaces is to limit the mobility of the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic materials would likely be marginal, at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation would minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since no actual treatment of the contaminants would be conducted. The overall effectiveness of Alternative 3 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. Regrading and incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $760,363.58. The cost details associated with implementing this alternative as described are included in Table E-3 (Appendix E). The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of upgrading and maintaining the access road to Bluff A from Schleichart Draw can be completed for an estimated single lump sum of $5,000 ($2,500 per mile).
- Construction of sediment basin can be completed for an estimated lump sum of $20,000.
- Grading of the selected waste materials and spoils (approximately 2.0 acres) can be completed for an estimated $6,000 ($3,000 per acre).
- Construction of approximately 900 linear feet of run-on/runoff ditches can be completed for an estimated cost of $6,300 ($7.00 per linear foot).
- Total surface area at Bluff A requiring vegetation via drill seeding and mulching under this alternative is approximately 2.5 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $5,000 ($2,000 per acre for fertilizer, seed, and mulch).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.1.4 Alternative 4: Comprehensive Grading and Sediment Control

Alternative 4 consists of regrading the waste materials located on the south side of Bluff A to 4H:1V slope, incorporation of organic amendments and revegetation. Additionally, an internal sediment basin would be constructed in conjunction with run-on/runoff control ditches designed to control storm water. Selected spoils piles currently located on top of the bluff would be regraded, amended, and revegetated. As part of the grading plan, the small area located on the north side of the bluff containing high concentrations of $radium^{226}$ and $uranium^{235}$ would be covered with a minimum of two feet of clean spoils materials.

Regrading of side slopes materials would increase the footprint size from approximately 1 acre to approximately 2.5 acres in size (Figure 7-1).

Conceptual Design and Assumptions

Based on the available data and the above considerations, the conceptual design of Alternative 4 includes:

- Improving the existing access road from Schleichart Draw to Bluff A by blading/grading to facilitate safe access of heavy equipment and construction crews;
- Regrading the side slopes of waste materials to 4H:1V slope;
- Construction of an internal sediment basin at location shown on Figure 7-1;
- Regrading of the selected spoils piles where shown on Figure 7-1;
- Construction of run-on/runoff control ditches;
- Revegetation of the regraded/recontoured waste materials;
- Revegetation of all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of a 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluff A is in fair to poor condition, and is approximately two miles in length. This unimproved dirt road would require some improvements and maintenance during the construction period by blading/regrading to facilitate safe access to the site.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary erosion protection of the disturbed surfaces. Run-on/runoff controls would be designed as an integral part of the bluff stabilization. Run-on/runoff controls would consist of constructing ditches to divert runoff toward the sediment basin.

Effectiveness –The purpose of this alternative is to minimize human exposure to the contaminants and to stabilize erosive areas. The purpose of the sediment basin and establishing vegetation on the regraded surfaces is to limit the mobility of the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic materials would likely be marginal, at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation would minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since no actual treatment of the contaminants would be conducted. The overall effectiveness of Alternative 4 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness

Implementability – This alternative is both technically and administratively feasible. Incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $906,953.50. The cost details associated with implementing this alternative as described are included in Table E-4 (Appendix E). The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of upgrading and maintaining the access road to Bluff A from Schleichart Draw can be completed for an estimated single lump sum of $5,000 ($2,500 per mile).
- Construction of sediment basin can be completed for an estimated lump sum of $20,000.
- Regrading of the side slopes waste materials (approximately 2.5 acres) can be completed for an estimated cost of $18,750 ($7,500 per acre).
- Grading of the selected waste materials and spoils (approximately 2.0 acres) can be completed for an estimated $6,000 ($3,000 per acre).
- Construction of approximately 400 linear feet of run-on/runoff ditches can be completed for an estimated cost of $2,800 ($7.00 per linear foot).
- Total surface area at Bluff A requiring vegetation via drill seeding and mulching under this alternative is approximately 6 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $12,000 ($2,000 per acre).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.1.5 Alternative 5: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, and Sediment Control

Alternative 5 consists of regrading the side slope waste materials located on the south side of Bluff A to 4H:1V, loading out and hauling excess waste materials from the side slopes to the top of Bluff A (Figure 7-1). Alternative 5 also includes grading and compaction of the hauled waste materials and construction of an internal sediment basin and run-on/runoff control ditches designed to control storm water. As part of the grading plan, the small area located on the north side of the bluff containing high concentrations of radium^{226} and uranium^{235} would be covered with a minimum of two feet of clean spoils materials.

Any access spurs created to access the waste materials would be obliterated and reclaimed, as part the response action of the bluff.

By hauling excess materials from the side slopes, the footprint size is expected to decrease from approximately 2 acres to approximately 1.5 acres under this alternative. All disturbed areas would be amended and seeded.

Conceptual Design and Assumptions

Based on the available data and the above considerations, the conceptual design of Alternative 5 includes:

- Improving the existing access road from Schleichart Draw to Bluff A by blading/grading to facilitate safe access of heavy equipment and construction crews;
- Regrading the side slope waste materials to 4H:1V slope;
- Excavation, loadout, and hauling of excess waste materials from the regraded side slopes to the top of Bluff A;
- Construction of an internal sediment basin at location shown on Figure 7-1;
- Regrading and compaction of waste materials as shown on Figure 7-1;
- Construction of run-on/runoff control ditches;
- Revegetate and mulch the regraded/recontoured waste materials;
- Obliteration of all access road spurs;
- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of a 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluff A is in fair to poor condition, and is approximately two miles in length. This unimproved dirt road will require some improvements and maintenance during the construction period by blading/regrading to facilitate safe access to the site.

Construction of access road spur would be required to haul the excess materials from the regraded side slopes area to the top of Bluff A.

Run-on/runoff control ditches would be designed as an integral part of the bluff stabilization. Run-on/runoff controls would consist of constructing ditches to divert runoff toward the sediment basin.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the disturbed surfaces.

Effectiveness –The purpose of this alternative is to minimize human exposure to the contaminants and to stabilize erosive areas. The purpose of the sediment basin and establishing vegetation on the regraded surfaces is to limit the mobility of the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal, at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation will minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since no actual treatment of the contaminants would be conducted. The overall effectiveness of Alternative 5 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. Incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $952,176.10. The cost details associated with implementing this alternative as described are included in Table E-5 (Appendix E). The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following primary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of upgrading and maintaining the access road to Bluff A from Schleichart Draw can be completed for an estimated single lump sum of $5,000 ($2,500 per mile).
- Regrading of the side slopes waste materials (approximately 1.5 acres) can be completed for an estimated cost of $11,250 ($7,500 per acre).
- Excavating a maximum of approximately 6,000 cy of waste materials from their current location, transporting, and consolidating them on Bluff A can be completed for an estimated cost of $42,000 ($7.00 per cy).

- Grading and compaction of waste materials and spoils (approximately 3 acres), can be completed for an estimated cost of $9,000 ($3,000 per acre).
- Construction of sediment basin can be completed for an estimated lump sum of $20,000.
- Construction of approximately 400 linear feet of run-on/runoff ditches can be completed for an estimated cost of $2,800 ($7.00 per linear foot).
- Total surface area at Bluff A requiring vegetation via drill seeding and mulching under this alternative is approximately 5.5 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $11,000 ($2,000 per acre).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.1.6 Alternative 6: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, Sediment Control, and Reduction of High Walls

Alternative 6 is not applicable to Bluff A due to a lack of significant high walls associated with the bluff.

7.3.2 Identification of Response Action Alternatives for Bluff B

Bluff B encompasses approximately 150 acres of spoils piles (overburden), high walls, and open pits in parts of Township 22 North, Range 5 East, Sections 22, 23, 26, and 27. Bluff B has an estimated spoil volume of 1,140,000 cy. Riley Pass was a significant historic pioneer wagon route during the 1890s and is approximately 500 feet north of the site.

The waste materials (spoils/overburden) have been a major source of sedimentation to Pete's Creek to the east of Bluff B and Schleichart Draw to the southeast. A majority of the Bluff is either barren or sparsely vegetated and shows signs of severe wind and surface water erosion. Sediment from the east half of the site is currently being carried approximately .75 miles and deposited on the main access road to Riley Pass and the adjoining private property. Sediment basins have been installed and maintained by the USFS in Upper Pete's Creek and Schleichart Draw. However, due to the amount of sediment eroding from the site, frequent maintenance of the basins is required.

Due to the predominant soil type present (sandy/clay and silty/clay), soil piping and tunneling, with occasional sink holes are present. Piping and large gullies are most prevalent in areas where the overburden was placed along or below the rimrocks. Some of the pipes that have formed are up to 10 to 15 feet in diameter, and gullies up to 25 feet in depth have formed in places subject to concentrated surface water flow.

The mined pit floors are generally at or near bedrock and are open sided toward the rimrock edge, except for where spoils are located, which have been placed along the edge. Small, shallow ponds have formed in some of the areas, creating small retention basins, which, during snowmelt and small storm events, assist in controlling some of the surface water erosion. Water from these ponds most likely evaporates or seeps through the bedrock during the summer months.

Concentrations greater than three times background of arsenic, molybdenum, thorium, uranium, radium^{226}, and uranium^{235} were documented for Bluff B during the 1999 sampling investigation.

7.3.2.1 Alternative 1: No Action

The No Action Alternative means that no actual response action activities will occur at the site to control contaminant migration or to reduce toxicity or volume.

Effectiveness - Protection of human health and the environment would not be achieved under the No Action Alternative. Prevention of direct human contact would not be achieved. The contaminant sources present at Bluff B would continue to impact the environment. Toxicity, mobility, and volume of contaminants would not be reduced under the No Action Alternative.

Implementability - Technical and administrative feasibility evaluation criteria do not apply to this alternative.

Cost Screening - No capital or operating costs would be incurred under this alternative. Maintenance costs would continue to be incurred from sediment leaving the site. The total present-worth cost of the continued maintenance for this alternative has been estimated at $432,453.65. The cost details associated with maintenance under this alternative are included in Table E-6 (Appendix E). The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs discounted at 7.0%.

Screening Summary - This alternative has been retained for further evaluation as required by the NCP.

7.3.2.2 Alternative 2: Institutional Controls

The Institutional Controls Alternative includes erecting fences around selected waste sources and high walls to restrict access to contaminated sources and safety hazards present. Additionally, land use restrictions could be placed to restrict recreational activities near the contaminated sources.

Effectiveness - This alternative is not protective of environmental resources. It is not fully protective of human health if implemented as a stand-alone alternative because the waste sources will continue to be exposed and available for direct contact. Toxicity, mobility, and volume of the contaminated media would not be reduced under this alternative.

Implementability - Institutional controls can be easily implemented based on the criteria of applicability, availability, and reliability. This alternative is considered applicable for minimizing the potential for direct contact and restricting access to the safety hazards present at the site. Fencing materials and construction contractors are readily available to minimize direct contact with the sources. Reliability of this alternative for its intended purpose (protection from direct contact) is considered good as long as enforcement of the institutional controls is maintained by the regulatory agencies. Due to the logistical simplicity of implementing institutional controls, administrative feasibility is considered very good.

Cost Screening - Costs associated with institutional controls would be relatively low compared to other response action measures; however, a considerable amount of fencing materials would be required to fully enclose the sources present at the site. Capital cost associated with construction of an 8-foot tall, chain-link fence would be approximately $340,000.00 or $20 per linear foot. Total capital cost can vary widely depending on which feature would require fencing and assuming no consolidation of contaminated materials. The total present-worth cost has been estimated at $1,243,995.65. The cost details associated with implementing this alternative as described are included in Table E-7 (Appendix E). The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs discounted at 7.0 % in addition to capital cost.

Screening Summary - Institutional controls will not be considered further as a stand-alone response action alternative but may be used in conjunction with other selected treatment alternatives.

7.3.2.3 Alternative 3: Minimal Grading and Sediment Control

Alternative 3 includes grading the disturbed areas on the top portion of the bluff, as well as the spoils materials placed along and over the rimrock edge. Side slopes on the south and southeast sides would be graded to 4H:1V. Partial removal of waste materials would occur in the south and southeast portions of the bluff. Partial removal is necessary to remove areas containing high concentrations of $radium^{226}$ and $uranium^{235}$, and also to avoid placing more waste materials within the drainages of Schleichart Draw and Upper Pete's Creek. Waste materials containing high concentrations of $radium^{226}$ and $uranium^{235}$ would be placed in the waste consolidation area located in the southwest pit (Figure 7-2). Five sediment basins would be constructed, four would be located on top of the bluff and one would be located below the bluff on the west side. This sediment basin would control sediments from being transported across the County road and onto private property. As part of this alternative, run-on/runoff control ditches would be incorporated into the design to control storm water events. All regraded areas would be amended with organic material and seeded.

Conceptual Design and Assumptions
Based on the available data and the above considerations, the conceptual design of Alternative 3 includes:

- Improving the existing access road from Schleichart Draw to Bluff B by blading/grading to facilitate safe access of heavy equipment and construction crews;
- Regrading of disturbed areas on top of the bluff;
- Regrading the side slopes waste materials to 4H:1V slope;
- Excavation, loadout, and hauling of waste materials from the south and southeast portions of the bluff to the southwest pit area where shown on Figure 7-2;
- Construction of sediment basins at location shown on Figure 7-2;

- Grading and compaction of waste materials in the waste consolidation area where shown on Figure 7-2;
- Construction of run-on/runoff control ditches;
- Revegetate and mulch the regraded/disturbed areas;
- Obliteration of all access road spurs;
- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of a 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluff B is in fair condition, and is approximately two miles in length. This unimproved dirt road would require some improvements and maintenance during the construction period by blading and regrading to facilitate safe access to the site.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats will be applied to promote temporary protection of the disturbed surfaces.

Run-on/runoff controls would be designed as an integral part of the bluff stabilization. Run-on/runoff controls would consist of constructing ditches to divert runoff to the sediment basins and away from the rimrock edges.

Effectiveness – The purpose of this alternative is to minimize human exposure to the contaminants. The purpose of the sediment basins and establishment of vegetation on the regraded surfaces is to limit the mobility of the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation would minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since actual treatment of the contaminants would not be conducted. The overall effectiveness of Alternative 3 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. The regrading and incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $7,759,079.93. The cost details associated with implementing this alternative as described are included in Table E-8

(Appendix E). The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of upgrading and maintaining the access road to Bluff B from Schleichart Draw can be completed for an estimated single lump sum of $5,000 ($2,500 per mile).
- Construction of sediment basin can be completed for an estimated lump sum of $100,000 ($20,000 per basin).
- Grading of waste materials and spoils located on top of the bluff (approximately 112 acres) can be completed for an estimated $336,000 ($3,000 per acre).
- Excavation, hauling, and placement of approximately 65,600 cy of graded waste materials into the waste consolidation area can be completed for an estimated cost of $459,200 ($7.00 per cy).
- Regrading of the side slope waste materials (approximately 21 acres) can be completed for an estimated cost of $157,500 ($7,500 per acre).
- Construction of approximately 1,200 linear feet of run-on/runoff ditches can be completed for an estimated cost of $8,400 ($7.00 per linear foot).
- Total surface area at Bluff B requiring vegetation via drill seeding and mulching under this alternative is approximately 140 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $280,000 ($2,000 per acre).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.2.4 Alternative 4: Comprehensive Grading and Sediment Control

Alternative 4 is not applicable to Bluff B.

7.3.2.5 Alternative 5: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, and Sediment Control

Alternative 5 includes regrading the disturbed areas on the top portion of the bluff, as well as the spoils material placed along and over the rimrock edge. All side slopes would be graded to 4H:1V. Partial removal of waste materials would occur in the south and southeast portions of the bluff. Partial removal is necessary to remove areas containing high concentrations of radium^{226} and uranium^{235}, and also to avoid placing more waste materials within the drainages of Schleichart Draw and Upper Pete's Creek. Waste materials containing high concentrations of radium^{226} and uranium^{235} would be placed in the waste consolidation area located in the southwest pit (Figure 7-2). Additionally, excess waste materials from the side slopes would be excavated, hauled, and placed next to the high walls or within the waste consolidation area. Construction of four sediment basins would occur on top of the bluff, and one sediment basin would be located below the bluff on the west side. This sediment basin would control sediments from being carried across the County road and onto private property. As part of this alternative, run-on/runoff control ditches would be incorporated into the design to control storm water events. All regraded areas would be amended with organic material and seeded.

By placing the excess waste materials next to the high walls, this reduces footprint size of the regraded slopes, while reducing the physical hazards associated with the high wall.

Conceptual Design and Assumptions

Based on the available data and the above considerations, the conceptual design of Alternative 5 includes:

- Improving the existing access road from Schleichart Draw to Bluff B by blading/grading to facilitate safe access of heavy equipment and construction crews;
- Regrading of disturbed areas on top of the bluff;
- Regrading the side slope of waste materials to 4H:1V slope;
- Excavation and hauling of waste materials from the south and southeast portions of the bluff Figure 7-2;
- Excavation, hauling, and consolidation of excess waste materials from the side slopes;
- Construction of sediment basins at location shown on Figure 7-2;
- Construction of run-on/runoff control ditches;
- Revegetate and mulch the regraded/disturbed areas;
- Obliteration of all access road spurs;
- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of a 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluff B is in fair to poor condition, and is approximately two miles in length. This unimproved dirt road will require some improvements and maintenance during the construction period by blading/regrading to facilitate safe access to the site. Additionally, construction of access spur roads would be required to haul the excess materials from the regraded side slope area to the top of Bluff B.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats will be applied to promote temporary protection of the disturbed surfaces.

Run-on/runoff controls would be designed as an integral part of the bluff stabilization. Run-on/runoff controls would consist of constructing ditches to divert runoff toward the sediment basins.

Effectiveness –The purpose of this alternative is to minimize human exposure to the contaminants. The purpose of the sediment basins and establishing vegetation on the regraded surfaces is to limit the mobility of the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would be marginal, at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation would minimize human biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since no actual treatment of the contaminants would be conducted. The overall effectiveness of Alternative 5 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. Incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $12,943,003.93. The cost details associated with implementing this alternative as described are included in Table E-9 (Appendix E). The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of upgrading and maintaining the access road to Bluff B from Schleichart Draw can be completed for an estimated single lump sum of $5,000 ($2,500 per mile).
- Construction of sediment basins can be completed for an estimated lump sum of $100,000 ($20,000 per basin).
- Grading of the waste materials and spoils on top of the bluff (approximately 112 acres) can be completed for an estimated $336,000 ($3,000 per acre).
- Excavation, hauling and placement of approximately 65,600 cy of waste materials into the waste consolidation area can be completed for an estimated cost of $459,200 ($7.00 per cy).
- Regrading of the side slopes waste materials (approximately 42 acres) can be completed for an estimated cost of $315,000 ($7,500 per acre).
- Excavation, hauling and consolidation of the excess side slopes waste materials (approximately 362,300 cy) can be completed for an estimated cost of $2,536,100 ($7.00 per cy).
- Construction of approximately 1,200 linear feet of run-on/runoff ditches can be completed for an estimated cost of $8,400 ($7.00 per linear foot).
- Total surface area at Bluff B requiring vegetation via drill seeding and mulching under this alternative is approximately 160 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $320,000 ($2,000 per acre).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.2.6 Alternative 6: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, Sediment Control, and Reduction of High Walls

Alternative 6 consists of regrading the disturbed areas on the top portion of the bluff, as well as the spoils material placed along and over the rimrock edge. Side slopes would also be graded to 4H:1V. Partial removal of waste materials would occur in the south and southeast portions of the bluff. Partial removal is necessary to remove areas containing high concentrations of $radium^{226}$ and $uranium^{235}$, and also to avoid placing more waste materials within the drainages of Schleichart Draw and Upper Pete's Creek. Waste materials containing high concentrations of $radium^{226}$ and $uranium^{235}$ would be placed in the waste consolidation area located in the southwest pit (Figure 7-2). Additionally, excess waste materials from the side slopes would be excavated, hauled, and placed next to the high walls or within the waste consolidation area. Five sediment basins will be constructed within the disturbed areas, four sediment basins will be located on top of the bluff, and one will be located below the bluff on the west side. The west sediment basin would prevent sediments from being carried across the County road and onto private property. As part of this alternative, run-on/runoff control ditches would be incorporated into the design to control storm water. Reduction of the high walls (physical hazard) would be accomplished through placement of excess waste materials along the toe of the high walls and/or cutting back of the tops of the high walls. All regraded areas would be amended with organic material and seeded.

Conceptual Design and Assumptions

Based on the available data and the above considerations, the conceptual design of Alternative 5 includes:

- Improving the existing access road from Schleichart Draw to Bluff B by blading/grading to facilitate safe access of heavy equipment and construction crews;
- Regrading disturbed areas on top of the bluff;
- Regrading of the side slope waste materials to 4H:1V slope;
- Excavation and hauling of waste materials from the south and southeast portions of the bluff as shown on Figure 7-2;
- Excavation, hauling, and consolidation of excess waste materials from the side slopes;
- Reduction of the high wall physical hazards shown on Figure 7-2;
- Construction of sediment basins at location shown on Figure 7-2;
- Construction of run-on/runoff control ditches;
- Revegetate and mulch the regraded/disturbed areas;
- Obliteration of all access road spurs;
- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of a 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluff B is in fair to poor condition, and is approximately two miles in length. This unimproved dirt road will require some improvements and maintenance during the construction period by blading/regrading to facilitate safe access to the site. Additionally, construction of access spur roads would be required to haul the excess materials from the regraded side slope area to the top of Bluff B.

Run-on/runoff control ditches would be designed as an integral part of the bluff stabilization. Run-on/runoff controls would consist of constructing ditches to divert runoff toward the sediment basins.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats will be applied to promote temporary protection of the disturbed surfaces.

Effectiveness –The purpose of this alternative is to minimize human exposure to the contaminants. The purpose of the sediment basins and establishing vegetation on the regraded surfaces is to limit the mobility of the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal, at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation would minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since actual treatment of the contaminants would not be conducted. The overall effectiveness of Alternative 6 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. Incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $13,559,311.93. The cost details associated with implementing this alternative as described are included in Table E-10 (Appendix E). The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of upgrading and maintaining the access road to Bluff B from Schleichart Draw can be completed for an estimated single lump sum of $5,000 ($2,500 per mile).
- Construction of sediment basins can be completed for an estimated lump sum of $100,000 ($20,000 per basin).

- Grading of the waste materials and spoils on top of the bluff (approximately 112 acres) can be completed for an estimated $336,000 ($3,000 per acre).
- Excavation, hauling and placement of approximately 65,600 cy of waste materials into the waste consolidation area can be completed for an estimated cost of $459,200 ($7.00 per cy).
- Regrading of the side slopes waste materials (approximately 42 acres) can be completed for an estimated cost of $315,000 ($7,500 per acre).
- Excavation, hauling and consolidation of the excess side slopes waste materials (approximately 362,300 cy) can be completed for an estimated cost of $2,536,100 ($7.00 per cy).
- Reduction of high wall physical hazards can be completed for an estimated cost of $162,000 ($18,000 per acre).
- Construction of approximately 1,200 linear feet of run-on/runoff ditches can be completed for an estimated cost of $8,400 ($7.00 per linear foot).
- Total surface area at Bluff B requiring vegetation via drill seeding and mulching under this alternative is approximately 170 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $340,000 ($2,000 per acre).

Screening Summary – The only difference between this Alternative and Alternative 5 includes addressing the existing high walls associated with Bluff B. Vertical and near vertical slopes exist frequently in nature, and conventional risk assessment methodologies do not address mitigation of risks associated with eliminating potential physical hazards; consequently, no additional risk reduction would be observed over Alternative 5, yet the additional expenditure is expected to be significant. Alternative 6 will not be retained for detailed analysis.

7.3.3 **Identification of Response Action Alternatives for Bluff C**

Bluff C, located in Township 22 North, Range 5 East, Section 26, encompasses approximately 10 acres size with good vegetation of the spoils piles and exposed bedrock. This bluff is approximately 4,257 feet south, southeast of Bluff B. Spoils piles and berms are small in nature and scattered throughout the site. Based on visual estimation, there is approximately 600 cy of spoils material present at Bluff C. There are no signs of active erosion from the berms or spoil piles and existing vegetation cover at the site is approximately 85 to 90%. Concentrations greater than three times background of arsenic, thorium, uranium, molybdenum, radium^{226}, and uranium^{235} were documented for Bluff C during the 1999 sampling investigation, along the toe of the southwest berms and spoils piles. Given the existing stable nature of Bluff C, only minimal response action work is assumed to be necessary. Consequently, only three alternatives are evaluated.

7.3.3.1 Alternative 1: No Action

The No Action Alternative means that no actual response action activities will occur at the site to control contaminant migration or to reduce toxicity or volume.

Effectiveness - Protection of human health and the environment would not be achieved under the No Action Alternative. Prevention of direct human contact would not be achieved. The contaminant sources present at Bluff C would continue to potentially impact the environment.

Toxicity, mobility, and volume of contaminants would not be reduced under the No Action Alternative.

Implementability - Technical and administrative feasibility evaluation criteria do not apply to this alternative.

Cost Screening - No capital or operating costs would be incurred under this alternative.

Screening Summary - This alternative has been retained for further evaluation as required by the NCP.

7.3.3.2 Alternative 2: Institutional Controls

The Institutional Controls Alternative includes erecting fences around selected waste sources to restrict access to contaminated sources and safety hazards present.

Effectiveness - This alternative is not protective of environmental resources. It is not fully protective of human health if implemented as a stand-alone alternative because the waste sources will continue to be exposed and available for direct contact. Toxicity, mobility, and volume of the contaminated media would not be reduced under this alternative.

Implementability - Institutional controls can be easily implemented based on the criteria of applicability, availability, and reliability. This alternative is considered applicable for minimizing the potential for direct contact and restricting access to the safety hazards present at the site. Fencing materials and construction contractors are readily available to minimize direct contact with the sources. Reliability of this alternative for its intended purpose (protection from direct contact) is considered good as long as enforcement of the institutional controls is maintained by the regulatory agencies. Due to the logistical simplicity of implementing institutional controls, administrative feasibility is considered very good.

Cost Screening - Costs associated with institutional controls would be relatively low compared to other response action measures; however, a considerable amount of fencing materials would be required to fully enclose the sources present at the site. Capital cost associated with construction of an 8-foot tall, chain-link fence would be approximately $25,000 or $20 per linear foot. Total capital cost can vary widely depending on which feature would require fencing and assuming no consolidation of contaminated material. The total present-worth cost has been estimated at $306,684.30. The cost details associated with implementing this alternative as described are included in Table E-11 (Appendix E). The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

Screening Summary - Institutional controls will not be considered further as a stand-alone response action alternative but may be used in conjunction with other selected treatment alternatives.

7.3.3.3 Alternative 3: Minimal Grading and Sediment Control

Alternative 3 includes smoothing of the spoils and berm piles located on top of the bluff and using the excess materials evenly spread over areas of high concentrations of molybdenum, radium^{226}, uranium^{235}, and exposed bedrock (minimum 24 inches of cover). After regrading, the material would then be amended with organic material and seeded (Figure 7-3).

Conceptual Design and Assumptions

Based on the available data and the above considerations, the conceptual design of Alternative 3 includes:

- Improving the existing access road from Schleichart Draw to Bluff C by blading/grading to facilitate safe access of heavy equipment and construction crews;
- Regrading the spoils and berm piles where shown on Figure 7-3;
- Revegetate and mulch the regraded spoils and berm piles;
- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road from Schleichart Draw to Bluff C is in fair condition, and is approximately one mile in length. This unimproved dirt road would require some improvements and maintenance during the construction period by blading/regrading to facilitate safe access to the site.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats will be applied to promote temporary protection of the disturbed surfaces.

Effectiveness – The purpose of this alternative is to minimize human exposure to the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal, at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation would minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since actual treatment of the contaminants would not be conducted. The overall effectiveness of Alternative 3 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. The regrading and incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $469,784.03. The cost details associated with implementing this alternative as described are included in Table E-12 (Appendix E). The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of upgrading and maintaining the access road to Bluff C from Schleichart Draw can be completed for an estimated single lump sum of $2,500 ($2,500 per mile).
- Grading of the spoils and berm piles (approximately 1.5 acre) can be completed for an estimated $3,000 ($2,000 per acre).
- Total surface area at Bluff C requiring vegetation via drill seeding and mulching under this alternative is approximately 1.5 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $4,000 ($2,000 per acre).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.3.4 Alternative 4: Comprehensive Grading and Sediment Control

Due to the existing stable nature of Bluff C, only minimal response action work is assumed to be necessary. Alternative 4 is not applicable to Bluff C.

7.3.3.5 Alternative 5: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, and Sediment Control

Due to the existing stable nature of Bluff C, only minimal response action work is assumed to be necessary. Alternative 5 is not applicable to Bluff C.

7.3.3.6 Alternative 6: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, Sediment Control, and Reduction of High Walls

Due to the existing stable nature of Bluff C, only minimal response action work is assumed to be necessary. Alternative 6 is not applicable to Bluff C.

7.3.4 Identification of Response Action Alternatives for Bluff D

Bluff D, located in Township 22 North, Range 5 East, Section 26, encompasses approximately 5.2 acres, with good vegetation of the spoils piles and berms. Bluff D is approximately 4,157 feet southeast of Bluff B. There are some areas of exposed bedrock located within the site. There are no active signs of erosion from the berms or spoil piles. Vegetation cover at the site is approximately 85 to 90%. There are small areas of naturally exposed bedrock in locations that have not been disturbed by mining activities. Concentrations greater than three times background of arsenic, molybdenum, uranium, radium^{226}, and uranium^{235} were documented for Bluff D during the 1999 sampling investigation. Locations of elevated contaminants include the bedrock/unvegetated areas located on the northeast side of the bluff.

Given the existing stable nature of Bluff D, only minimal response action work is assumed to be necessary. Consequently, only three response action alternatives will be evaluated.

7.3.4.1 Alternative 1: No Action

The No Action Alternative means that no actual response action activities will occur at the site to control contaminant migration or to reduce toxicity or volume.

Effectiveness - Protection of human health and the environment would not be achieved under the No Action Alternative. Prevention of direct human contact would not be achieved. The contaminant sources present at the Bluff D area would continue to potentially impact the environment. Toxicity, mobility, and volume of contaminants would not be reduced under the No Action Alternative.

Implementability - Technical and administrative feasibility evaluation criteria do not apply to this alternative.

Cost Screening - No capital or operating costs would be incurred under this alternative.
Screening Summary - This alternative has been retained for further evaluation as required by the NCP.

7.3.4.2 Alternative 2: Institutional Controls

The Institutional controls Alternative includes erecting fences around selected waste sources to restrict access to contaminated sources and safety hazards present.

Effectiveness - This alternative is not protective of environmental resources. It is not fully protective of human health if implemented as a stand-alone alternative because the waste sources will continue to be exposed and available for direct contact. Toxicity, mobility, and volume of the contaminated media would not be reduced under this alternative.

Implementability - Institutional controls can be easily implemented based on the criteria of applicability, availability, and reliability. This alternative is considered applicable for minimizing the potential for direct contact and restricting access to the safety hazards present at the site. Fencing materials and construction contractors are readily available to minimize direct contact with the sources. Reliability of this alternative for its intended purpose (protection from direct contact) is considered good as long as enforcement of the institutional controls is maintained by the regulatory agencies. Due to the logistical simplicity of implementing institutional controls, administrative feasibility is considered very good.

Cost Screening - Costs associated with institutional controls would be relatively low compared to other response action measures; however, a considerable amount of fencing materials would be required to fully enclose the sources present at the site. Capital cost associated with construction of an 8-foot tall, chain-link fence would be approximately $33,200.00 or $20 per linear foot. Total capital cost can vary widely depending on which feature would require fencing and assuming no consolidation of contaminated materials.

The total present-worth cost has been estimated at $316,125.20. The cost details associated with implementing this alternative as described are included in Table E-13 (Appendix E). The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

Screening Summary - Institutional controls will not be considered further as a stand-alone response action alternative but may be used in conjunction with other selected treatment alternatives.

7.3.4.3 Alternative 3: Minimal Grading and Sediment Control

Alternative 3 includes smoothing of the spoils and berm piles located on top of the bluff and using the excess materials to evenly spread over areas of high concentrations of arsenic, molybdenum, $radium^{226}$, and $uranium^{235}$ and exposed bedrock (minimum of 24 inches). After regrading, the materials would then be amended with organic material and seeded (Figure 7-4).

Conceptual Design and Assumptions

Based on the available data and the above considerations, the conceptual design of Alternative 3 includes:

- Improving the existing access road from Schleichart Draw to Bluff D by blading and regrading to facilitate safe access of heavy equipment and construction crews;
- Regrading the spoils and berm piles where shown on Figure 7-4;
- Revegetate and mulch the regraded spoils and berm piles;
- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluff D is in fair condition, and is approximately one mile in length. This unimproved dirt road would require some improvements and maintenance during the construction period by blading and regrading to facilitate safe access to the site.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the disturbed surfaces.

Effectiveness – The purpose of this alternative is to minimize human exposure to the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation would minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since actual treatment of the contaminants would not be conducted. The overall effectiveness of Alternative 3 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. The regrading and incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $494,098.95. The cost details associated with implementing this alternative as described are included in Table E-14 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of upgrading and maintaining the access road to Bluff D from Schleichart Draw can be completed for an estimated single lump sum of $2,500 ($2,500 per mile).
- Grading of the spoils and berm piles (approximately 1.5 acre) can be completed for an estimated $3,000 ($2,000 per acre).
- Total surface area at Bluff D requiring vegetation via drill seeding and mulching under this alternative is approximately 2 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $4,000 ($2,000 per acre).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.4.4 Alternative 4: Comprehensive Grading and Sediment Control

Due to the existing stable nature of Bluff D, only minimal response action work is assumed to be necessary. Alternative 4 is not applicable to Bluff D.

7.3.4.5 Alternative 5: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, and Sediment Control

Due to the existing stable nature of Bluff D, only minimal response action work is assumed to be necessary. Alternative 5 is not applicable to Bluff D.

7.3.4.6 Alternative 6: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, Sediment Control, and Reduction of High Walls

Due to the existing stable nature of Bluff D, only minimal response action work is assumed to be necessary. Alternative 6 is not applicable to Bluff D.

7.3.5 Identification of Response Action Alternatives for Bluff E

Bluff E encompasses approximately two acres, with good vegetation of the spoils piles and berms. Bluff E is approximately 5,355 feet southeast of Bluff B in Township 22 North, Range 5 East, Sections 26 and 35. There are some areas of exposed bedrock located within the site. There are no signs of erosion from the berms or spoils piles and vegetation cover at the site is approximately 90 to 95%. Concentrations greater than three times background of radium^{226} and uranium^{235} were documented for Bluff E during the 1999 sampling investigation at the southeast and west side of the bluff. Given the existing stable nature of Bluff E, only minimal response action work is assumed to be necessary. Consequently, only three response action alternatives will be evaluated.

7.3.5.1 Alternative 1: No Action

The No Action Alternative means that no actual response action activities will occur at the site to control contaminant migration or to reduce toxicity or volume.

Effectiveness - Protection of human health and the environment would not be achieved under the No Action Alternative. Prevention of direct human contact would not be achieved. The contaminant sources present at Bluff E would continue to potentially impact the environment. Toxicity, mobility, and volume of contaminants would not be reduced under the No Action Alternative.

Implementability - Technical and administrative feasibility evaluation criteria do not apply to this alternative.

Cost Screening - No capital or operating costs would be incurred under this alternative.

Screening Summary - This alternative has been retained for further evaluation as required by the NCP.

7.3.5.2 Alternative 2: Institutional Controls

The Institutional controls Alternative includes erecting fences around selected waste sources to restrict access to contaminated sources and safety hazards present.

Effectiveness - This alternative is not protective of environmental resources. It is not fully protective of human health if implemented as a stand-alone alternative because the waste sources will continue to be exposed and available for direct contact. Toxicity, mobility, and volume of the contaminated media would not be reduced under this alternative.

Implementability - Institutional controls can be easily implemented based on the criteria of applicability, availability, and reliability. This alternative is considered applicable for minimizing the potential for direct contact and restricting access to the safety hazards present at the site. Fencing materials and construction contractors are readily available to minimize direct contact with the sources. Reliability of this alternative for its intended purpose (protection from direct contact) is considered good as long as enforcement of the institutional controls is maintained by the regulatory agencies. Due to the logistical simplicity of implementing institutional controls, administrative feasibility is considered very good.

Cost Screening - Costs associated with institutional controls would be relatively low compared to other response action measures; however, a considerable amount of fencing materials would be required to fully enclose the sources present at the site. Capital cost associated with construction of an 8-foot tall, chain-link fence would run approximately $27,000.00 or $20 per linear foot. Total capital cost can vary widely depending on which feature would require fencing and assuming no consolidation of contaminated materials.

The total present-worth cost has been estimated at $309,180.66. The cost details associated with implementing this alternative as described are included in Table E-15 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

Screening Summary - Institutional controls will not be considered further as a stand-alone response action alternative but may be used in conjunction with other selected treatment alternatives.

7.3.5.3 Alternative 3: Minimal Grading and Sediment Control

Alternative 3 includes smoothing of the spoils and berm piles located on top of the bluff and using the excess material evenly spread over areas of exposed bedrock (minimum of 12 inches). After regrading, the materials would then be amended organically and seeded (Figure 7-5).

Conceptual Design and Assumptions

Based on the available data and the above considerations, the conceptual design of Alternative 3 includes:

- Improving the existing access road from Schleichart Draw to Bluff E by blading and regrading to facilitate safe access of heavy equipment and construction crews;
- Regrading the spoils and berm piles where shown on Figure 7-5;
- Revegetate and mulch the regraded spoils and berm piles;
- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluff E is in fair condition, and is approximately 1.5 miles in length. This unimproved dirt road would require some improvements and maintenance during the construction period by blading and regrading to facilitate safe access to the site.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the disturbed surfaces.

Effectiveness – The purpose of this alternative is to minimize human exposure to the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal, at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy.

Once established, the vegetation would minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since actual treatment of the contaminants would not be conducted. The overall effectiveness of Alternative 3 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. The regrading and incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $454,222.36. The cost details associated with implementing this alternative as described are included in Table E-16 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of upgrading and maintaining the access road to Bluff E from Schleichart Draw can be completed for an estimated single lump sum of $3,750 ($2,500 per mile).
- Grading of the spoils and berm piles (approximately 1 acre) can be completed for an estimated $2,000 ($2,000 per acre).
- Total surface area at Bluff E requiring vegetation via drill seeding and mulching under this alternative is approximately 1.5 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $3,000 ($2,000 per acre).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.5.4 Alternative 4: Comprehensive Grading and Sediment Control

Due to the existing stable nature of Bluff E, only minimal response action work is assumed to be necessary. Alternative 4 is not applicable to Bluff E.

7.3.5.5 Alternative 5: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, and Sediment Control

Due to the existing stable nature of Bluff E, only minimal response action work is assumed to be necessary. Alternative 5 is not applicable to Bluff E.

7.3.5.6 Alternative 6: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, Sediment Control, and Reduction of High Walls

Due to the existing stable nature of Bluff E, only minimal response action work is assumed to be necessary. Alternative 6 is not applicable to Bluff E.

7.3.6 Identification of Response Action Alternatives for Bluff F

Bluff F, located approximately 6,418 feet southeast of Bluff B in Township 22 North, Range 5 East, Section 35, encompasses approximately two acres, with good vegetation of the spoils piles and berms. There are some areas of exposed bedrock located within the site. There are no signs of erosion from the berms or spoils piles and vegetation cover at the site is approximately 90 to 95%. Concentrations greater than three times background of molybdenum, radium^{226}, and uranium^{235} were documented for Bluff F during the 1999 sampling investigation, at the bedrock/unvegetated areas located on the north and east side of the bluff. Given the existing stable nature of Bluff F, only minimal response action work is assumed to be necessary. Consequently, only three response action alternatives are evaluated.

7.3.6.1 Alternative 1: No Action

The No Action Alternative means that no actual response action activities will occur at the site to control contaminant migration or to reduce toxicity or volume.

Effectiveness - Protection of human health and the environment would not be achieved under the No Action Alternative. Prevention of direct human contact would not be achieved. The contaminant sources present at the Bluff F area would continue to potentially impact the environment. Toxicity, mobility, and volume of contaminants would not be reduced under the No Action Alternative.

Implementability - Technical and administrative feasibility evaluation criteria do not apply to this alternative.

Cost Screening - No capital or operating costs would be incurred under this alternative.

Screening Summary - This alternative has been retained for further evaluation as required by the NCP.

7.3.6.2 Alternative 2: Institutional Controls

The Institutional Controls Alternative includes erecting fences around selected waste sources to restrict access to contaminated sources and safety hazards present.

Effectiveness - This alternative is not protective of environmental resources. It is not fully protective of human health if implemented as a stand-alone alternative because the waste sources will continue to be exposed and available for direct contact. Toxicity, mobility, and volume of the contaminated media would not be reduced under this alternative.

Implementability - Institutional controls can be easily implemented based on the criteria of applicability, availability, and reliability. This alternative is considered applicable for minimizing the potential for direct contact and restricting access to the safety hazards present at the site. Fencing materials and construction contractors are readily available to minimize direct contact with the sources. Reliability of this alternative for its intended purpose (protection from direct contact) is considered good as long as enforcement of the institutional controls is maintained by the regulatory agencies. Due to the logistical simplicity of implementing institutional controls, administrative feasibility is considered very good.

Cost Screening - Costs associated with institutional controls would be relatively low compared to other response action measures; however, a considerable amount of fencing materials would be required to fully enclose the sources present at the site. Capital cost associated with construction of an 8-foot tall, chain-link fence would run approximately $29,000 or $20 per linear foot. Total capital cost can vary widely depending on which feature would require fencing and assuming no consolidation of contaminated materials.

The total present-worth cost has been estimated at $314,158.82. The cost details associated with implementing this alternative as described are included in Table E-17 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

Screening Summary - Institutional controls will not be considered further as a stand-alone response action alternative but may be used in conjunction with other selected treatment alternatives.

7.3.6.3 Alternative 3: Minimal Grading and Sediment Control

Alternative 3 includes smoothing of the spoils and berm piles located on south and west portions of the bluff and using the excess material to evenly spread over areas of high concentrations of arsenic, molybdenum, radium^{226}, uranium^{235}, and exposed bedrock located on the north and east side of the bluff (minimum of 24 inches). After regrading, the materials would then be amended with organic materials and seeded (Figure 7-6).

Conceptual Design and Assumptions

Based on the available data and the above considerations, the conceptual design of Alternative 3 includes:

- Improving the existing access road from Schleichart Draw to Bluff F by blading and regrading to facilitate safe access of heavy equipment and construction crews;
- Regrading the spoils and berm piles where shown on Figure 7-6;
- Revegetate and mulch the regraded spoils and berm piles;
- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluff F is in fair condition, and is approximately two miles in length. This unimproved dirt road would require some improvements and maintenance during the construction period by blading and regrading to facilitate safe access to the site.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the disturbed surfaces.

Effectiveness – The purpose of this alternative is to minimize human exposure to the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal, at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation would minimize human biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since actual treatment of the contaminants would not be conducted. The overall effectiveness of Alternative 3 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. The regrading and incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $498,070.95. The cost details associated with implementing this alternative as described are included in Table E-18 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of upgrading and maintaining the access road to Bluff F from Schleichart Draw can be completed for an estimated single lump sum of $5,000 ($2,500 per mile).
- Grading of the spoils and berm piles (approximately 2 acres) can be completed for an estimated $4,000 ($2,000 per acres).
- Total surface area at Bluff F requiring vegetation via drill seeding and mulching under this alternative is approximately 2.5 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $5,000 ($2,000 per acre).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.6.4 Alternative 4: Comprehensive Grading and Sediment Control

Due to the existing stable nature of Bluff F, only minimal response action work is assumed to be necessary. Alternative 4 is not applicable to Bluff F.

7.3.6.5 Alternative 5: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, and Sediment Control

Due to the existing stable nature of Bluff F, only minimal response action work is assumed to be necessary. Alternative 5 is not applicable to Bluff F.

7.3.6.6 Alternative 6: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, Sediment Control, and Reduction of High Walls

Due to the existing stable nature of Bluff F, only minimal response action work is assumed to be necessary. Alternative 6 is not applicable to Bluff F.

7.3.7 Identification of Response Action Alternatives for Bluff G

Bluff G encompasses approximately five acres, of which approximately two acres consists of exposed bedrock. This bluff is approximately 7,698 feet southeast of Bluff B in Township 22 North, Range 5 East, Section 36. There are also several bare and eroding steep (1.5H:1V) slopes, where the materials have been pushed off the rimrock. Previous sampling results have indicated one acutely contaminated area (hot spot) that has been left on top of the bluff. The greater portion (approximately 90%) of the top of the bluff has been excavated down to bedrock with very little vegetation present. On some of the less steep slopes, vegetation is present with approximately 40 to 60% vegetative cover. The southwest steep slope would be very difficult to regrade due to excessive steepness and limited access to the slope. Equipment access to the bluff would be difficult and would entail traveling through Bluff I_1 and I_2 and then traveling across a small saddle that has been filled in with waste materials. Currently the materials in the saddle are sparsely vegetated; however, it is not showing signs of erosion.

The largest spoils pile is located along and below the rimrock on the southwest side of the bluff. It encompasses approximately one acre, with extremely steep side slopes (1.5H:1V), very little vegetation, and severe erosion gullies and rills present on the face of the slope. Spoils material volume is estimated to be approximately 46,000 cy. A smaller, more vegetated (approximately 40 to 60% vegetative cover) spoils pile is located along and below the rimrock on the southeast side of the bluff. It encompasses approximately half an acre, with an estimated volume of approximately 23,400 cy.

There are several berms/spoils piles along the north and east side of the bluff. Surface erosion is localized to two areas on the berms/spoils piles on the north side of the bluff. Within the spoils pile on the east side is a known contamination hot spot (0.4 to 0.6 mrem/hr), of which the volume of materials is estimated to be approximately 300 cy.

Additionally, a small spoils pile is located in a saddle between Bluff I_1 and G. This material was used as road construction material between the bluffs. It encompasses approximately 0.5 acre, with an estimated volume of approximately 550 cy. The spoils material is poorly vegetated, but is moderately stable, showing very little surface erosion.

Concentrations greater than three times background of arsenic, molybdenum, thorium, uranium, $radium^{226}$, and $uranium^{235}$ were documented on the north and east sides of Bluff G during the 1999 sampling investigation.

7.3.7.1 Alternative 1: No Action

The No Action Alternative means that no actual response action activities will occur at the site to control contaminant migration or to reduce toxicity or volume.

Effectiveness - Protection of human health and the environment would not be achieved under the No Action Alternative. Prevention of direct human contact would not be achieved. The contaminant sources present at Bluff B would continue to potentially impact the environment. Toxicity, mobility, and volume of contaminants would not be reduced under the No Action Alternative.

Implementability - Technical and administrative feasibility evaluation criteria do not apply to this alternative.

Cost Screening - No capital or operating costs would be incurred under this alternative.

Screening Summary - This alternative has been retained for further evaluation as required by the NCP.

7.3.7.2 Alternative 2: Institutional Controls

The Institutional Controls Alternative includes erecting fences around selected waste sources and the high walls to restrict access to contaminated sources and safety hazards present. Additionally, land use restrictions could be placed to restrict recreational activities near the contaminated sources.

Effectiveness - This alternative is not protective of environmental resources. It is not fully protective of human health if implemented as a stand-alone alternative because the waste sources will continue to be exposed and available for direct contact. Toxicity, mobility, and volume of the contaminated media would not be reduced under this alternative.

Implementability - Institutional controls can be easily implemented based on the criteria of applicability, availability, and reliability. This alternative is considered applicable for minimizing the potential for direct contact and restricting access to the safety hazards present at the site. Fencing materials and construction contractors are readily available to minimize direct contact with the sources. Reliability of this alternative for its intended purpose (protection from direct contact) is considered good as long as enforcement of the institutional controls is maintained by the regulatory agencies. Due to the logistical simplicity of implementing institutional controls, administrative feasibility is considered very good.

Cost Screening - Costs associated with institutional controls would be relatively low compared to other response action measures; however, a considerable amount of fencing materials would be required to fully enclose the sources present at the site. Capital cost associated with construction of an 8-foot tall, chain-link fence would run approximately $42,000 or $20 per linear foot. Total capital cost can vary widely depending on which feature would require fencing and assuming no consolidation of contaminated material.

The total present-worth cost has been estimated at $346,640.95. The cost details associated with implementing this alternative as described are included in Table E-19 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

Screening Summary - Institutional controls will not be considered further as a stand-alone response action alternative but may be used in conjunction with other selected treatment alternatives.

7.3.7.3 Alternative 3: Minimal Grading and Sediment Control

Alternative 3 is not applicable to Bluff G due to the presence of acutely contaminated materials within the Bluff.

7.3.7.4 Alternative 4: Comprehensive Grading and Sediment Control

Alternative 4 is not applicable to Bluff G due to the presence of acutely contaminated materials within the Bluff.

7.3.7.5 Alternative 5: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, and Sediment Control

Alternative 5 includes regrading of the berms and spoils piles located on the north and east sides of the bluff, as well as the spoils material placed along and over the rimrock edge on the west and east side of the bluff. Side slopes would be graded to 4H:1V. Grading would also be completed on the waste materials located between Bluff I_1 and Bluff G. Waste materials located along the southeast portion of the bluff, which contain high concentrations of arsenic, molybdenum, $radium^{226}$, and $uranium^{235}$ would be placed in a designated waste consolidation area located in the southwest pit area of Bluff I_1 (Figure 7-7). Once all waste materials have been placed in the consolidation area, a cover soil cap would be placed over the waste materials, amended with organic material and vegetated. Additionally, all regraded or disturbed areas would be amended with organic material and seeded.

Conceptual Design and Assumptions

Based on the available data and the above considerations, the conceptual design for Alternative 5 includes:

- Improving the existing access road from Schleichart Draw to Bluff G by blading/grading to facilitate safe access of heavy equipment and construction crews;
- Regrading of the berms/spoils piles located on the north and east portions of the bluff;
- Regrading of waste materials located in the saddle between Bluff I_1 and Bluff G;
- Regrading of the west and east side slopes to 4H:1V slope;
- Excavation, hauling, and consolidation of waste materials from the southeast portions of the bluff, to the waste consolidation area at Bluff I_1 (see Figure 7-7);
- Excavation, hauling, and consolidation of waste materials from the southeast portions of the bluff to the waste consolidation area at Bluff B (see Figures 7-2 and 7-7);
- Revegetate and mulch the regraded areas;
- Obliteration of all access road spurs;
- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of a 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluff G is in fair condition, and is approximately 2.5 miles in length. This unimproved dirt road will require some improvements and maintenance during the construction period by blading and regrading to facilitate safe access to the site.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the disturbed surfaces.

Effectiveness – The purpose of this alternative is to minimize human exposure to the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal, at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation would minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since actual treatment of the contaminants would not be conducted. The overall effectiveness of Alternative 5 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. The regrading and incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total-present-worth cost has been estimated to range from $730,150.25 to $1,217,060.25 (for hauling contaminated materials to a nearby waste consolidation area at Bluff I_1 or to a common/centralized waste consolidation area Bluff B, respectively). The cost details associated with implementing this alternative as described are included in Tables E-20 and E-21 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of upgrading and maintaining the access road to Bluff G from Schleichart Draw can be completed for an estimated single lump sum of $6,250 ($2,500 per mile).
- Grading of waste materials and spoils located on the north and east sides of the bluff and in the saddle (approximately 1 acre) can be completed for an estimated $3,000 ($3,000 per acre).
- Excavation, hauling, and placement of approximately 300 cy of acutely contaminated waste materials to the Bluff I_1 waste consolidation area can be completed for an estimated cost of $5,400 ($18.00 per cy).
- Excavation, hauling, and placement of approximately 300 cy of acutely contaminated waste materials to the Bluff B waste consolidation area can be completed for an estimated cost of $6,900 ($23.00 per cy).
- Regrading of the west and east side slopes waste materials (approximately 5 acres) can be completed for an estimated cost of $37,500 ($7,500 per acre).

- Total surface area at Bluff G requiring vegetation via drill seeding and mulching under this alternative is approximately 6.5 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $13,000 ($2,000 per acre).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.7.6 Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, Sediment Control, and Reduction of High Walls

Alternative 6 is not applicable to Bluff G due to a lack of significant high walls associated with the bluff.

7.3.8 Identification of Response Action Alternatives for Bluff H

Bluff H encompasses approximately 30 acres. Bluff H is approximately 10,274 feet southeast of Bluff B in Township 22 North, Range 5 East, Sections 25 and 36. The site consists of several spoils piles (approximately 553,850 cy) that have been placed along and over the rimrock edges. These slopes are generally very steep (1.5H:1V) and show signs of severe surface water erosion, especially on the northwest and northeast spoils piles. Vegetation growth on the side slopes is very limited (<10% vegetative cover). There is a pit area with unstable high walls on the southwest portion of the site. Pioneer personnel identified one hot spot at the base of the northwest high wall. Additionally, laboratory results indicate that arsenic, molybdenum, uranium, and radium^{226}, and uranium^{235} concentrations are greater than three times the background concentrations within the bluff. Parts of the spoils piles on the north and northeast side of the bluff are currently on private property.

Located in the northwest corner of the bluff is a spoils pile of approximately 1.1 acres in size with an estimated volume of 54,350 cy. The slope is extremely steep (1.5H:1V) and completely barren of vegetation; there is one large erosion gully located on the south portion of the spoils pile. The water and sediment from this gully flows into an intermittent dry draw/drainage; however, some of the sediment is being deposited on private property that is located adjacent to this bluff.

The spoils pile located on the northeast end of Bluff H is moderately vegetated; however, there are erosion gullies and rills that are transporting sediment onto private property and into an intermittently dry draw/drainage. Approximately one-third of this spoils pile is currently on private property.

A large spoils pile located on the west side of bluff, which encompasses approximately 3 acres, and has an estimated volume of 340,150 cy. The spoils are sparsely vegetated with numerous erosion gullies and rills. One large erosion gully (approximately 12 feet in depth) is located on the south end of the spoils pile, and drains into an intermittent dry draw/drainage.

A spoils pile containing approximately 159,340 cy of material, and encompassing approximately 4 acres in size, is located on the south end of the bluff. This spoils pile is moderately vegetated with limited signs of surface erosion.

7.3.8.1 Alternative 1: No Action

The No Action Alternative means that no actual response action activities will occur at the site to control contaminant migration or to reduce toxicity or volume.

Effectiveness - Protection of human health and the environment would not be achieved under the No Action Alternative. Prevention of direct human contact would not be achieved. The contaminant sources present at Bluff H would continue to potentially impact the environment. Toxicity, mobility, and volume of contaminants would not be reduced under the No Action Alternative.

Implementability - Technical and administrative feasibility evaluation criteria do not apply to this alternative.

Cost Screening - No capital or operating costs would be incurred under this alternative.

Screening Summary - This alternative has been retained for further evaluation as required by the NCP.

7.3.8.2 Alternative 2: Institutional Controls

The Institutional Controls Alternative includes erecting fences around selected waste sources and the high walls to restrict access to contaminated sources and safety hazards present. Additionally, land use restrictions could be placed to restrict recreational activities near the contaminated sources.

Effectiveness - This alternative is not protective of environmental resources. It is not fully protective of human health if implemented as a stand-alone alternative because the waste sources will continue to be exposed and available for direct contact. Toxicity, mobility, and volume of the contaminated media would not be reduced under this alternative.

Implementability - Institutional controls can be easily implemented based on the criteria of applicability, availability, and reliability. This alternative is considered applicable for minimizing the potential for direct contact and restricting access to the safety hazards present at the site. Fencing materials and construction contractors are readily available to minimize direct contact with the sources. Reliability of this alternative for its intended purpose (protection from direct contact) is considered good as long as enforcement of the institutional controls is maintained by the regulatory agencies. Due to the logistical simplicity of implementing institutional controls, administrative feasibility is considered very good.

Cost Screening - Costs associated with institutional controls would be relatively low compared to other response action measures; however, a considerable amount of fencing materials would be required to fully enclose the sources present at the site. Capital cost associated with

construction of an 8-foot tall, chain-link fence would run approximately $100,000.00 or $20 per linear foot. Total capital cost can vary widely depending on which feature would require fencing and assuming no consolidation of contaminated materials.

The total present-worth cost has been estimated at $528,110.50. The cost details associated with implementing this alternative as described are included in Table E-22 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

Screening Summary - Institutional controls will not be considered further as a stand-alone response action alternative but may be used in conjunction with other selected treatment alternatives.

7.3.8.3 Alternative 3: Minimal Grading and Sediment Control

Alternative 3 includes regrading selected spoils piles located on the north and west sides of the bluff, as well as the spoils materials placed along the rimrock edge. Partial removal of waste materials from the grading may be necessary if waste materials containing high concentrations of arsenic, molybdenum, radium^{226}, and uranium^{235} are encountered. The construction of three sediment control basins and run-on/runoff control ditches would be incorporated into the design to control storm water (see Figure 7-8). All regraded areas would be amended with organic material and seeded.

Conceptual Design and Assumptions

Based on the available data and the above considerations, the conceptual design of Alternative 3 includes:

- Improving the existing access road from Schleichart Draw to Bluff H by blading and grading to facilitate safe access of heavy equipment and construction crews;
- Regrading selected areas on top of the bluff;
- Construction of sediment basins at locations shown on Figure 7-8;
- Construction of run-on/runoff control ditches;
- Revegetate and mulch the regraded and disturbed areas;
- Obliteration of all access road spurs;
- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of a 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluff H is in fair to poor condition, and is approximately two miles in length. This unimproved dirt road would require some improvements and maintenance during the construction period by blading and regrading to facilitate safe access to the site.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the disturbed surfaces.

Run-on/runoff controls would be designed as an integral part of the bluff stabilization. Run-on/runoff controls will consist of constructing ditches to divert runoff toward the sediment basins and away from the rimrock edges.

Effectiveness – The purpose of this alternative is to minimize human exposure to the contaminants. The purpose of the sediment basins and establishment of vegetation on the regraded surfaces is to limit the mobility of the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal, at best with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation would minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since actual treatment of the contaminants would not be conducted. The overall effectiveness of Alternative 3 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. The regrading and incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total-present-worth cost has been estimated at $893,340.14. The cost details associated with implementing this alternative as described are included on Table E-23 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of upgrading and maintaining the access road to Bluff H from Schleichart Draw can be completed for an estimated single lump sum of $10,000 ($2,500 per mile).
- Construction of sediment basins can be completed for an estimated lump sum of $60,000 ($20,000 per basin).
- Grading of selected waste materials and spoils located on top of the bluff (approximately 8 acres) can be completed for an estimated $24,000 ($3,000 per acre).
- Construction of approximately 950 linear feet of run-on/runoff ditches can be completed for an estimated cost of $6,650 ($7.00 per linear foot).
- Total surface area at Bluff H requiring vegetation via drill seeding and mulching under this alternative is approximately 8.5 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $17,000 ($2,000 per acre).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.8.4 Alternative 4: Comprehensive Grading and Sediment Control

Alternative 4 includes regrading selected spoils piles located on the north and west sides of the bluff, as well as the spoils materials placed along the rimrock edge. Side slopes located on the west, north, and northeast portions of the bluff would be graded to 4H:1V. Grading of the side slopes to 4H:1V would increase the footprint size and increase the volume of waste materials placed on private property. Partial removal of waste materials from the grading may be necessary if waste materials containing high concentrations of arsenic, molybdenum, $radium^{226}$, and $uranium^{235}$ are encountered. These materials would be placed in the waste consolidation area where shown on Figure 7-8. Three sediment basins would be constructed on top of the bluff to assist in controlling the mobility of the sediments during storm events. As part of this alternative, run-on/runoff control ditches would be incorporated into the design to control storm water. All regraded areas would be amended with organic material and seeded.

Conceptual Design and Assumptions

Based on the available data and the above considerations, the conceptual design of Alternative 4 includes:

- Improving the existing access road from Schleichart Draw to Bluff H by blading and grading to facilitate safe access of heavy equipment and construction crews;
- Regrading of selected spoils and waste materials on top of the bluff;
- Regrading of the side slopes to 4H:1V shown on Figure 7-8;
- Construction of sediment basins at locations shown on Figure 7-8;
- Construction of run-on/runoff control ditches;
- Revegetate and mulch the regraded and disturbed areas;
- Obliteration of all access road spurs;
- Revegetating and mulching of all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of a 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluff H is in fair to poor condition, and is approximately four miles in length. This unimproved dirt road would require some improvements and maintenance during the construction period by blading and regrading to facilitate safe access to the site.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the disturbed surfaces.

Run-on/runoff controls would be designed as an integral part of the bluff stabilization to reduce mobility of sediments during storm events.

Effectiveness –The purpose of this alternative is to minimize human exposure to the contaminants. The purpose of the sediment basins and establishing vegetation on the regraded surfaces is to limit the mobility of the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal, at best with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation would minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since actual treatment of the contaminants would not be conducted. The overall effectiveness of Alternative 4 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. Incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $1,813,791.80. The cost details associated with implementing this alternative as described are included in Table E-24 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of upgrading and maintaining the access road to Bluff H from Schleichart Draw can be completed for an estimated single lump sum of $10,000 ($2,500 per mile).
- Construction of sediment basins can be completed for an estimated lump sum of $60,000 ($20,000 per basin).
- Grading of the selected waste materials and spoils on top of the bluff (approximately 21 acres) can be completed for an estimated $63,000 ($3,000 per acre).
- Regrading of the side slopes waste materials (approximately 8 acres) can be completed for an estimated cost of $60,000 ($7,500 per acre).
- Construction of approximately 950 linear feet of run-on/runoff ditches can be completed for an estimated cost of $6,650 ($7.00 per linear foot).
- Total surface area at Bluff H requiring vegetation via drill seeding and mulching under this alternative is approximately 30 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $60,000 ($2,000 per acre).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.8.5 Alternative 5: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, and Sediment Control

Alternative 5 includes regrading selected spoils piles located on the north and west sides of the bluff, as well as the spoils materials placed along the rimrock edge. Side slopes located on the west, north, and northeast portions of the bluff would be graded to 4H:1V. Excess waste materials would be excavated and hauled to the waste consolidation area located at the base of the western high wall as shown on Figure 7-8. Partial removal of waste materials from the grading of spoils piles located along the edge of the rimrock may be necessary if waste materials containing high concentrations of arsenic, molybdenum, radium^{226}, and uranium^{235} are encountered. These materials would be placed in the waste consolidation area. Three sediment basins would be constructed on top of the bluff to help control the mobility of the sediments during storm events. As part of this alternative, run-on/runoff control ditches would be incorporated into the design to control storm water. All regraded areas would be amended with organic material and seeded.

Conceptual Design and Assumptions
Based on the available data and the above considerations, the conceptual design of Alternative 5 includes:

- Improving the existing access road from Schleichart Draw to Bluff H by blading and grading to facilitate safe access of heavy equipment and construction crews;
- Regrading of selected spoils piles on top of the bluff where shown on Figure 7-8;
- Regrading of the west, north and northeast side slopes to 4H:1V;
- Excavation, hauling, and consolidation of excess waste materials from the side slopes;
- Construction of three sediment basins at locations shown on Figure 7-8;
- Construction of run-on/runoff control ditches;
- Revegetate and mulch the regraded and disturbed areas;
- Obliteration of all access road spurs;
- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of a 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluff H is in fair to poor condition, and is approximately four miles in length. This unimproved dirt road would require some improvements and maintenance during the construction period by blading/regrading to facilitate safe access to the site. Additionally, construction of access spur roads would be required to haul the excess materials from the regraded side slopes area to the top of Bluff H.

Run-on/runoff control ditches would be designed as an integral part of the bluff stabilization to divert storm water toward the sediment basins.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the disturbed surfaces.

Effectiveness –The purpose of this alternative is to minimize human exposure to the contaminants. The purpose of the sediment basins and establishing vegetation on the regraded surfaces is to limit the mobility of the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal, at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation would minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since actual treatment of the contaminants would not be conducted. The overall effectiveness of Alternative 5 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. Incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $2,070,586.80. The cost details associated with implementing this alternative as described are included in Table E-25 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of upgrading and maintaining the access road to Bluff H from Schleichart Draw can be completed for an estimated single lump sum of $10,000 ($2,500 per mile).
- Construction of sediment basins can be completed for an estimated lump sum of $60,000 ($20,000 per basin).
- Grading of the selected waste materials and spoils on top of the bluff (approximately 21 acres) can be completed for an estimated $63,000 ($3,000 per acre).
- Regrading of the side slopes waste materials (approximately 8 acres) can be completed for an estimated cost of $60,000 ($7,500 per acre).
- Excavation, hauling and placement of the excess side slopes materials (approximately 22,000 cy) of waste materials into the waste consolidation area can be completed for an estimated cost of $154,000 ($7.00 per cy).
- Construction of approximately 950 linear feet of run-on/runoff ditches can be completed for an estimated cost of $6,650 ($7.00 per linear foot).

- Total surface area at Bluff H requiring vegetation via drill seeding and mulching under this alternative is approximately 30 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $60,000 ($2,000 per acre).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.8.6 Alternative 6: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, Sediment Control, and Reduction of High Walls

Alternative 6 includes regrading selected spoils piles located on the north and west sides of the bluff, as well as the spoils materials placed along the rimrock edge. Side slopes located on the west, north, and northeast portions of the bluff would be graded to 4H:1V. Excess waste materials would be excavated and hauled to the waste consolidation area located at the base of the western high wall where shown on Figure 7-8. Partial removal of waste materials from the grading of spoils piles located along the edge of the rimrock may be necessary if waste materials containing high concentrations of arsenic, molybdenum, radium^{226}, and uranium^{235} are encountered. These materials would also be placed in the waste consolidation area. The western and southern high walls would be regraded and resloped to reduce the physical hazards associated with them. Currently the condition of the high walls is unstable with large boulders and rock debris falling from face of the high walls. Three sediment basins would be constructed on top of the bluff to control the mobility of the sediments during storm events. As part of this alternative, run-on/runoff control ditches would be incorporated into the design to control storm water. All regraded areas would be amended with organic material and seeded.

Conceptual Design and Assumptions

Based on the available data and the above considerations, the conceptual design of Alternative 6 includes:

- Improving the existing access road from Schleichart Draw to Bluff H by blading and regrading to facilitate safe access of heavy equipment and construction crews;
- Regrading of selected spoils piles on top of the bluff as shown on Figure 7-8;
- Regrading of the west, north, and northeast side slopes to 4H:1V;
- Excavation, hauling, and consolidation of excess waste materials from the side slopes;
- Sloping and regrading of the western and southern high walls as shown on Figure 7-8
- Construction of three sediment basins at location as shown on Figure 7-8;
- Reduction of high walls where shown on Figure 7-8;
- Construction of run-on/runoff control ditches;
- Revegetate and mulch the regraded and disturbed areas;
- Obliteration of all access road spurs;
- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of a 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluff H is in fair to poor condition, and is approximately four miles in length. This unimproved dirt road would require some improvements and maintenance during the construction period by blading and regrading to facilitate safe access to the site.

Additionally, construction of access spur roads would be required to haul the excess materials from the regraded side slopes area to the top of Bluff H.

Run-on/runoff control ditches would be designed as an integral part of the bluff stabilization to divert storm water runoff and sediment toward the sediment basin.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the disturbed surfaces.

Effectiveness –The purpose of this alternative is to minimize human exposure to the contaminants. The purpose of the sediment basins and establishing vegetation on the regraded surfaces is to limit the mobility of the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal, at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation will minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since actual treatment of the contaminants would not be conducted. The overall effectiveness of Alternative 6 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. Incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $2,199,851.40. The cost details associated with implementing this alternative as described are included in Table E-26 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of upgrading and maintaining the access road to Bluff H from Schleichart Draw can be completed for an estimated single lump sum of $10,000 ($2,500 per mile).
- Construction of sediment basins can be completed for an estimated lump sum of $60,000 ($20,000 per basin).

- Grading of the selected waste materials and spoils on top of the bluff (approximately 21 acres) can be completed for an estimated $63,000 ($3,000 per acre).
- Regrading of the side slopes waste materials (approximately 8 acres) can be completed for an estimated cost of $60,000 ($7,500 per acre).
- Excavation, hauling, and placement of the excess side slopes materials (approximately 22,000 cy) of waste materials into the waste consolidation area can be completed for an estimated cost of $154,000 ($7.00 per cy).
- Regrading and sloping of the high walls can be completed for an estimated cost of $36,000 ($18,000 per acre).
- Construction of approximately 950 linear feet of run-on/runoff ditches can be completed for an estimated cost of $6,650 ($7.00 per linear foot).
- Total surface area at Bluff H requiring vegetation via drill seeding and mulching under this alternative is approximately 32 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $64,000 ($2,000 per acre).

Screening Summary – The only difference between this Alternative and Alternative 5 includes addressing the existing high walls associated with Bluff H. Vertical and near vertical slopes exist frequently in nature, and conventional risk assessment methodologies do not address mitigation of risks associated with eliminating potential physical hazards; consequently, no additional risk reduction would be observed over Alternative 5, yet the additional expenditure is expected to be significant. Alternative 6 will not be retained for detailed analysis.

7.3.9 **Identification of Response Action Alternatives for Bluffs $_{I1 \text{ and } 2}$**

Bluffs I_{1and2} are located approximately .25 miles south of Bluff F along an unmarked USFS road in Township 22 North, Range 5 East, Sections 35 and 36. The disturbed area at Bluff I_1 is 16.5 acres and Bluff I_2 is 4 acres. Bluff I_1 has an estimated total volume of approximately 135,380 cy of spoils. Bluff I_2 has an estimated total volume of 20,170 cy of spoils. The combined disturbed areas for Bluffs I_{1and2} encompass approximately 22 acres with an estimated total volume of 155,550 cy of spoils (Figure 7-9). The majority of the waste materials are unvegetated and eroding into an intermittently dry draws north and west of the bluff. Vegetation has established itself along the southern high walls and moderately within the pit areas.

The spoils piles and waste materials have been placed on and over the northern edge of the rimrock and are considered the primary source of sedimentation of the draws north and west of the bluff. Additionally, approximately four acres on the west side of the bluff have been disturbed from past mining activities. Past sampling results indicate that only $uranium^{235}$ exceeded three times the background concentration, and no acutely contaminated areas are known to exist within the bluff.

Access to Bluff G is gained by traveling over Bluff I_1. Consequently, prior to any response action activities being completed at Bluff I_{1and2}, reclamation of Bluff G should be completed. One response action alternative being considered for Bluff G places approximately 300 cy of spoils materials (hot spot) in a consolidation area at Bluffs I_{1and2}. This material would then be covered with soils from Bluffs I_{1and2}. Any response action work near the high wall area would require that a buffer zone surrounding the archeological sites be marked to avoid having the sites disturbed.

7.3.9.1 Alternative 1: No Action

The No Action Alternative means that no actual response action activities will occur at the site to control contaminant migration or to reduce toxicity or volume.

Effectiveness - Protection of human health and the environment would not be achieved under the No Action Alternative. Prevention of direct human contact would not be achieved. The contaminant sources present at Bluffs I_{1and2} would continue to potentially impact the environment. Toxicity, mobility, and volume of contaminants would not be reduced under the No Action Alternative.

Implementability - Technical and administrative feasibility evaluation criteria do not apply to this alternative.

Cost Screening - No capital or operating costs would be incurred under this alternative.

Screening Summary - This alternative has been retained for further evaluation as required by the NCP.

7.3.9.2 Alternative 2: Institutional Controls

The Institutional Controls Alternative includes erecting fences around selected waste sources and high walls to restrict access to contaminated sources and safety hazards present. Additionally, land use restrictions could be placed to restrict recreational activities near the contaminated sources.

Effectiveness - This alternative is not protective of environmental resources. It is not fully protective of human health if implemented as a stand-alone alternative because the waste sources will continue to be exposed and available for direct contact. Toxicity, mobility, and volume of the contaminated media would not be reduced under this alternative.

Implementability - Institutional controls can be easily implemented based on the criteria of applicability, availability, and reliability. This alternative is considered applicable for minimizing the potential for direct contact and restricting access to the safety hazards present at the site. Fencing materials and construction contractors are readily available to minimize direct contact with the sources. Reliability of this alternative for its intended purpose (protection from direct contact) is considered good as long as enforcement of the institutional controls is maintained by the regulatory agencies. Due to the logistical simplicity of implementing institutional controls, administrative feasibility is considered very good.

Cost Screening - Costs associated with institutional controls would be relatively low compared to other response action measures; however, a considerable amount of fencing materials would be required to fully enclose the sources present at the site. Capital cost associated with

construction of an 8-foot tall, chain-link fence would run approximately $110,000.00 or $20 per linear foot. Total capital cost can vary widely depending on which feature would require fencing and assuming no consolidation of contaminated materials.

The total present-worth cost has been estimated at $550,519.50. The cost details associated with implementing this alternative as described are included in Table E-27 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

Screening Summary - Institutional controls will not be considered further as a stand-alone response action alternative but may be used in conjunction with other selected treatment alternatives.

7.3.9.3 Alternative 3: Minimal Grading and Sediment Control

Alternative 3 includes regrading of the spoils piles located along the edge of the rimrock, on the north side of the bluff. The spoils piles would be graded in a manner to convey any storm water away from the bluff edge and towards the high wall/pit area located on the south side of the bluff. One sediment basin would be constructed on the east side of the bluff (see Figure 7-9). As part of this alternative, run-on/runoff control ditches would be incorporated into the design to control storm water. All regraded areas would be amended with organic materials and seeded.

Conceptual Design and Assumptions
Based on the available data and the above considerations, the conceptual design for Alternative 3 includes:

- Improving the existing access road from Schleichart Draw to Bluffs $I_{1 and 2}$ by blading and regrading to facilitate safe access of heavy equipment and construction crews;
- Regrading of selected spoils piles located along the edge of the bluff as shown on Figure 7-9;
- Construction of a sediment basin at the location where shown on Figure 7-9;
- Construction of run-on/runoff control ditches;
- Revegetate and mulch the regraded and disturbed areas;
- Obliteration of all access road spurs;
- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of a 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluffs $I_{1 and 2}$ is in fair condition, and is approximately two miles in length. This unimproved dirt road would require some improvements and maintenance during the construction period by blading and regrading to facilitate safe access to the site.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the disturbed surfaces.
Run-on/runoff controls would consist of constructing ditches to divert runoff toward the sediment basin and away from the rimrock edges.

Effectiveness – The purpose of this alternative is to minimize human exposure to the contaminants. The purpose of the sediment basins and establishment of vegetation on the regraded surfaces is to limit the mobility of the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal, at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation will minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since actual treatment of the contaminants would not be conducted. The overall effectiveness of Alternative 3 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. The regrading and incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $1,011,078.18. The cost details associated with implementing this alternative as described are included in Table E-28 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of upgrading and maintaining the access road to Bluffs $I_{1\&2}$ from Schleichart Draw can be completed for an estimated single lump sum of $5,000 ($2,500 per mile).
- Construction of sediment basin can be completed for an estimated lump sum of $20,000 ($20,000 per basin).
- Grading of selected waste materials and spoils located along the north edge of the bluff (approximately 12 acres) can be completed for an estimated $34,500 ($3,000 per acre).
- Construction of approximately 1,200 linear feet of run-on/runoff ditches can be completed for an estimated cost of $8,400 ($7.00 per linear foot).
- Total surface area at Bluffs I_{1and2} requiring vegetation via drill seeding and mulching under this alternative is approximately 12.5 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $25,000 ($2,000 per acre).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.9.4 Alternative 4: Comprehensive Grading and Sediment Control

Alternative 4 is not applicable to Bluffs I_{1and2}.

7.3.9.5 Alternative 5: Comprehensive Grading, Consolidation of Excess Materials, and Sediment Control

Alternative 5 includes regrading and partial removal of selected spoils piles located along the edge of the rimrock on the north side of the bluff (see Figure 7-9). The spoils piles would be graded in a manner to convey any storm water away from the bluff edge and towards the high wall/pit area located on the south side of the bluff. The excess excavated spoils would be placed in the waste consolidation area at the base of the high wall where shown on Figure 7-9. The partial removal of the spoils piles from the edge of the rimrock bluff would facilitate restoration of the bluff to approximately the pre-mining state. Additionally, if the hot spot from Bluff G is placed in this waste consolidation area, cover soil materials would be required. Spoils located below the rimrock (side slopes) would be graded to 4H:1V slope. One sediment basin would be constructed on the east side of the bluff (Figure 7-9) and run-on/runoff control ditches would be incorporated into the design to control storm water. All regraded areas would be amended with organic material and seeded.

Conceptual Design and Assumptions

Based on the available data and the above considerations, the conceptual design of Alternative 5 includes:

- Improving the existing access road from Schleichart Draw to Bluffs I_{1and2} by blading and grading to facilitate safe access of heavy equipment and construction crews;
- Regrading of selected spoils and waste materials along the north edge of the bluff;
- Excavation, hauling, and placement of selected spoils piles located on the rimrock edge to the waste consolidation area as shown on Figure 7-9;
- Regrading of the side slopes to 4H:1V slope shown on Figure 7-9;
- Construction of a sediment basin as shown on Figure 7-9;
- Construction of run-on/runoff control ditches;
- Revegetate and mulch the regraded/disturbed areas;
- Obliteration of all access road spurs;
- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of a 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluffs I_{1and2} is in fair condition, and is approximately two miles in length. This unimproved dirt road would require some improvements and maintenance during the construction period by blading and regrading to facilitate safe access to the site.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the disturbed surfaces.

Run-on/runoff controls would be designed as an integral part of the bluff stabilization to reduce mobility of sediments during storm events.

Effectiveness –The purpose of this alternative is to minimize human exposure to the contaminants. The purpose of the sediment basins and establishing vegetation on the regraded surfaces is to limit the mobility of the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal, at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation will minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since actual treatment of the contaminants would not be conducted. The overall effectiveness of Alternative 5 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. Incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $1,993,118.95. The cost details associated with implementing this alternative as described are included in Table E-29 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of upgrading and maintaining the access road to Bluffs I_{1and2} from Schleichart Draw can be completed for an estimated single lump sum of $5,000 ($2,500 per mile).
- Grading waste materials and spoils along the north edge of the bluff (approximately 14 acres) can be completed for an estimated $42,000 ($3,000 per acre).
- Excavation, hauling, and placement of selected waste materials and spoils piles into the waste consolidation area (approximately 63,000 cy) can be completed for an estimated $441,000 ($7.00 per cy).
- Regrading of the side slopes waste materials (approximately 3.5 acres) can be completed for an estimated cost of $26,250 ($7,500 per acre).
- Construction of one sediment basin can be completed for an estimated lump sum of $20,000 ($20,000 per basin).

- Construction of approximately 1,200 linear feet of run-on/runoff ditches can be completed for an estimated cost of $8,400 ($7.00 per linear foot).
- Total surface area at Bluffs I_{1and2} requiring vegetation via drill seeding and mulching under this alternative is approximately 18 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $36,000 ($2,000 per acre).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.9.6 Alternative 6: Comprehensive Grading, Consolidation of Excess Materials, Sediment Control, and Reduction of High Walls

Alternative 6 includes regrading and partial removal of selected spoils piles located along the edge of the rimrock on the north side of the bluff (see Figure 7-9). The spoils piles would be graded in a manner to convey any storm water away from the bluff edge and towards the high wall/pit area (south side). The excess excavated spoils would be placed in the waste consolidation area at the base of the high wall where shown on Figure 7-9. The partial removal of the spoils piles from the edge of the rimrock bluff would facilitate restoration of the bluff to approximately the pre-mining state. Additionally, if the hot spot from Bluff G is placed in this waste consolidation area, cover soil materials would be required. Spoils located below the rimrock (side slopes) would be graded to 4H:1V slope. The high walls along the southern edge of the bluff would be regraded and resloped to reduce the physical hazards associated with them. Any response action work on top of the high wall/bluff would require that buffer zones be placed around archeological sites to avoid disturbance during construction. One sediment basin located on the east side of the bluff (see Figure 7-9) and run-on/runoff control ditches would be incorporated into the design to control storm water events. All regraded areas would be amended with organic materials and seeded.

Conceptual Design and Assumptions

Based on the available data and the above considerations, the conceptual design of Alternative 6 includes:

- Improving the existing access road from Schleichart Draw to Bluffs I_{1and2} by blading and regrading to facilitate safe access of heavy equipment and construction crews;
- Regrading of selected spoils and waste materials along the north edge of the bluff;
- Excavation, hauling, and placement of selected spoils piles located on the north rimrock edge to the waste consolidation area as shown on Figure 7-9;
- Regrading of the side slopes to 4H:1V slope shown on Figure 7-9;
- Regrading and sloping of the high walls located on the south edge as shown on Figure 7-9;
- Construction of a sediment basin as shown on Figure 7-9;
- Construction of run-on/runoff control ditches;
- Revegetate and mulch the regraded and disturbed areas;
- Obliteration of all access road spurs;
- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and

- Installation of a 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluffs $I_{1\&2}$ is in fair condition, and is approximately two miles in length. This unimproved dirt road would require some improvements and maintenance during the construction period by blading and regrading to facilitate safe access to the site.

Run-on/runoff control ditches would be designed as an integral part of the bluff stabilization to divert storm water toward the sediment basin and away from the bluff edge.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the disturbed surfaces.

Effectiveness –The purpose of this alternative is to minimize human exposure to the contaminants. The purpose of the sediment basins and establishing vegetation on the regraded surfaces is to limit the mobility of the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal, at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation will minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since actual treatment of the contaminants would not be conducted. The overall effectiveness of Alternative 6 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. Incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $2,508,443.15. The cost details associated with implementing this alternative as described are included in Table E-30 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of upgrading and maintaining the access road to Bluffs I_{1and2} from Schleichart Draw can be completed for an estimated single lump sum of $5,000 ($2,500 per mile).

- Grading of waste materials and spoils along the north edge of the bluff (approximately 14 acres) can be completed for an estimated $42,000 ($3,000 per acre).
- Excavation, hauling, and placement of selected waste materials and spoils piles into the waste consolidation area (approximately 63,000 cy) can be completed for an estimated $441,000 ($7.00 per cy).
- Regrading of the side slopes waste materials (approximately 3.5 acres) can be completed for an estimated cost of $26,250 ($7,500 per acre).
- Regrading and sloping of the high walls (approximately 4 acres) can be completed for an estimated cost of $72,000 ($18,000 per acre).
- Construction of one sediment basin can be completed for an estimated lump sum of $20,000 ($20,000 per basin).
- Construction of approximately 1,200 linear feet of run-on/runoff ditches can be completed for an estimated cost of $8,400 ($7.00 per linear foot).
- Total surface area at Bluffs I_{1and2} requiring vegetation via drill seeding and mulching under this alternative is approximately 22 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $44,000 ($2,000 per acre).

Screening Summary – The only difference between this Alternative and Alternative 5 includes addressing the existing high walls associated with Bluffs I_{1and2}. Vertical and near vertical slopes exist frequently in nature, and conventional risk assessment methodologies do not address mitigation of risks associated with eliminating potential physical hazards; consequently, no additional risk reduction would be observed over Alternative 5, yet the additional expenditure is expected to be significant. Alternative 6 will not be retained for detailed analysis.

7.3.10 Identification of Response Action Alternatives for Bluff I3

Bluff I_3 is located approximately 200 yards south of Bluff I_1 along an unmarked USFS Road in Township 22 North, Range 5 East, Sections 35 and 36. Bluff I_3 is approximately 1.6 acres with an estimated 57,300 cy of spoils (Figure 7-9). The majority of the waste materials are vegetated; however, there are areas of little to no vegetation, which is actively eroding onto the unmarked USFS Road west of the bluff.

Sampling of the waste materials was not completed at this location during the 2000 site investigation. Laboratory results from Bluff I_1 are expected to be representative of the waste materials at this location. Results from Bluff I_1 indicate that only uranium^{235} exceeded three times the background concentration, and no acutely contaminated areas are known to exist within the bluff.

7.3.10.1 <u>Alternative 1: No Action</u>

The No Action Alternative means that no actual response action activities will occur at the site to control contaminant migration or to reduce toxicity or volume.

Effectiveness - Protection of human health and the environment would not be achieved under the No Action Alternative. Prevention of direct human contact would not be achieved. The contaminant sources present at Bluff I_3 would continue to potentially impact the environment.

Toxicity, mobility, and volume of contaminants would not be reduced under the No Action Alternative.

Implementability - Technical and administrative feasibility evaluation criteria do not apply to this alternative.

Cost Screening - No capital or operating costs would be incurred under this alternative.

Screening Summary - This alternative has been retained for further evaluation as required by the NCP.

7.3.10.2 Alternative 2: Institutional Controls

The Institutional Controls Alternative includes erecting fences around selected waste sources and high walls to restrict access to contaminated sources and safety hazards present. Additionally, land use restrictions could be placed to restrict recreational activities near the contaminated sources.

Effectiveness - This alternative is not protective of environmental resources. It is not fully protective of human health if implemented as a stand-alone alternative because the waste sources will continue to be exposed and available for direct contact. Toxicity, mobility, and volume of the contaminated media would not be reduced under this alternative.

Implementability - Institutional controls can be easily implemented based on the criteria of applicability, availability, and reliability. This alternative is considered applicable for minimizing the potential for direct contact and restricting access to the safety hazards present at the site. Fencing materials and construction contractors are readily available to minimize direct contact with the sources. Reliability of this alternative for its intended purpose (protection from direct contact) is considered good as long as enforcement of the institutional controls is maintained by the regulatory agencies. Due to the logistical simplicity of implementing institutional controls, administrative feasibility is considered very good.

Cost Screening - Costs associated with institutional controls would be relatively low compared to other response action measures; however, a considerable amount of fencing materials would be required to fully enclose the sources present at the site. Capital cost associated with construction of an 8-foot tall, chain-link fence would run approximately $38,400.00 or $20 per linear foot. Total capital cost can vary widely depending on which feature would require fencing and assuming no consolidation of contaminated materials.

The total present-worth cost has been estimated at $337,456.90. The cost details associated with implementing this alternative as described are included in Table E-31 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

Screening Summary - Institutional controls will not be considered further as a stand-alone response action alternative but may be used in conjunction with other selected treatment alternatives.

7.3.10.3 Alternative 3: Minimal Grading and Sediment Control

Alternative 3 includes regrading of the spoils piles located along the edge of the rimrock, on the west side of the bluff. The spoils piles would be graded in a manner to convey any storm water away from the USFS road (see Figure 7-9). As part of this alternative, run-on/runoff control ditches would be incorporated into the design to control storm water. All regraded areas would be amended with organic materials and seeded.

Conceptual Design and Assumptions

Based on the available data and the above considerations, the conceptual design for Alternative 3 includes:

- Improving the existing access road from Schleichart Draw to Bluff I_3 by blading and regrading to facilitate safe access of heavy equipment and construction crews;
- Regrading of selected spoils piles located along the edge of the bluff as shown on Figure 7-9;
- Construction of a sediment basin at the location where shown on Figure 7-9;
- Construction of run-on/runoff control ditches;
- Revegetate and mulch the regraded and disturbed areas;
- Obliteration of all access road spurs;
- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of a 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluff I_3 is in fair condition, and is approximately two miles in length. This unimproved dirt road would require some improvements and maintenance during the construction period by blading and regrading to facilitate safe access to the site.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the disturbed surfaces.

Run-on/runoff controls would consist of constructing ditches to divert runoff toward the sediment basin and away from the rimrock edges.

Effectiveness – The purpose of this alternative is to minimize human exposure to the contaminants. The purpose of the sediment basins and establishment of vegetation on the regraded surfaces is to limit the mobility of the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal, at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation will minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since actual treatment of the contaminants would not be conducted. The overall effectiveness of Alternative 3 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. The regrading and incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $490,276.21. The cost details associated with implementing this alternative as described are included in Table E-32 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of upgrading and maintaining the access road to Bluff I_3 from Schleichart Draw can be completed for an estimated single lump sum of $5,000 ($2,500 per mile).
- Grading of selected waste materials and spoils located along the north edge of the bluff (approximately 1.6 acres) can be completed for an estimated $4,800 ($3,000 per acre).
- Construction of approximately 400 linear feet of run-on/runoff ditches can be completed for an estimated cost of $2,800 ($7.00 per linear foot).
- Total surface area at Bluff I_3 requiring vegetation via drill seeding and mulching under this alternative is approximately 2 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $4,000 ($2,000 per acre).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.10.4 Alternative 4: Comprehensive Grading and Sediment Control

Alternative 4 is not applicable to Bluff I_3.

7.3.10.5 Alternative 5: Comprehensive Grading, Consolidation of Excess Materials, and Sediment Control

Alternative 5 is not applicable to Bluff I_3.

7.3.10.6 Alternative 6: Comprehensive Grading, Consolidation of Excess Materials, Sediment Control, and Reduction of High Walls

Alternative 6 is not applicable to Bluff I_3.

7.3.11 Identification of Response Action Alternatives for Bluff J

Bluff J is located approximately 3 air miles northwest of Riley Pass (see Figure 7-10) in Township 22 North, Range 5 East, Section 20. The site is accessed by traveling south approximately 3.5 miles from Harding County Road 733 on Craig Pass Road. Bluff J lies approximately .25 miles south of the Y+ Ranch residence.

Bluff J encompasses approximately four acres and consists of dozer cuts, high walls, spoils piles/berms and road cuts into the side of the bluff. Results from previous sampling investigations indicate this site exhibits relatively high radioactivity (0.05 to 0.85 mrem/hr). The radioactive area is located to the east of the bluff and is approximately 600 feet by 200 feet and consists of black fine-grained sand silt with no vegetation. However, it appears that these materials have become wind blown in the past and now encompass an area of approximately two acres. The high walls on the south and east portions of the bluff are mostly stable and revegetated, the large spoils materials located near the black sands are revegetated (approximately 90 to 95% vegetative cover); however, the area in general (both USFS and private property) has been heavily grazed by cattle. There are no fences currently separating the private property from the USFS property. Runoff from the black sands area drain toward a small, low flow stream located to the west. This stream then flows toward a stock watering pond near the residence.

Concentrations greater than three times background of molybdenum, uranium, radium^{226}, and uranium^{235} were documented for Bluff J during the 2000 sampling investigation.

7.3.11.1 Alternative 1: No Action

The No Action Alternative means that no actual response action activities will occur at the site to control contaminant migration or to reduce toxicity or volume.

Effectiveness - Protection of human health and the environment would not be achieved under the No Action Alternative. Prevention of direct human contact would not be achieved. The contaminant sources present at Bluff J would continue to potentially impact the environment. Toxicity, mobility, and volume of contaminants would not be reduced under the No Action Alternative.

Implementability - Technical and administrative feasibility evaluation criteria do not apply to this alternative.

Cost Screening - No capital or operating costs would be incurred under this alternative.

Screening Summary - This alternative has been retained for further evaluation as required by the NCP.

7.3.11.2 Alternative 2: Institutional Controls

The Institutional Controls Alternative includes erecting fences around selected waste sources and high walls to restrict access to contaminated sources and safety hazards present. Additionally, land use restrictions could be placed to restrict recreational activities near the contaminated sources.

Effectiveness - This alternative is not protective of environmental resources. It is not fully protective of human health if implemented as a stand-alone alternative because the waste sources will continue to be exposed and available for direct contact. Toxicity, mobility, and volume of the contaminated media would not be reduced under this alternative.

Implementability - Institutional controls can be easily implemented based on the criteria of applicability, availability, and reliability. This alternative is considered applicable for minimizing the potential for direct contact and restricting access to the safety hazards present at the site. Fencing materials and construction contractors are readily available to minimize direct contact with the sources. Reliability of this alternative for its intended purpose (protection from direct contact) is considered good as long as enforcement of the institutional controls is maintained by the regulatory agencies. Due to the logistical simplicity of implementing institutional controls, administrative feasibility is considered very good.

Cost Screening - Costs associated with institutional controls would be relatively low compared to other response action measures; however, a considerable amount of fencing materials would be required to fully enclose the sources present at the site. Capital cost associated with construction of an 8-foot tall, chain-link fence would run approximately $26,000 or $20 per linear foot. Total capital cost can vary widely depending on which feature would require fencing and assuming no consolidation of contaminated materials.

The total present-worth cost has been estimated at $373,452.00. The cost details associated with implementing this alternative as described are included in Table E-33 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

Screening Summary - Institutional controls will not be considered further as a stand-alone response action alternative but may be used in conjunction with other selected treatment alternatives.

7.3.11.3 Alternative 3: Minimal Grading and Sediment Control

Alternative 3 includes the moving of spoils piles currently located between the black sand waste materials and the high walls, over the black sand waste materials. The spoils piles would be placed over the black sand waste materials a minimum thickness of three feet, and graded in a manner to create positive drainage (see Figure 7-10). All regraded areas would be amended with organic material and seeded.

Conceptual Design and Assumptions
Based on the available data and the above considerations, the conceptual design of Alternative 3 includes:

- Improving the existing access road from Craig Pass Road to Bluff J by blading and regrading to facilitate safe access of heavy equipment and construction crews;
- Regrading of spoils piles over the black sands waste materials as shown on Figure 7-10;
- Revegetate and mulch the regraded and disturbed areas;
- Obliteration of all access road spurs;
- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of a 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluff J is in fair condition and is less than one mile in length. This road would require maintenance during construction to facilitate safe access to the site.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the disturbed surfaces.

Effectiveness – The purpose of this alternative is to minimize human exposure to the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal, at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation will minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since actual treatment of the contaminants would not be conducted. The overall effectiveness of Alternative 3 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. The regrading and incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $636,782.85. The cost details associated with implementing this alternative as described are included in Table E-34 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of constructing the access road to Bluff J from the Craig Pass Road can be completed for an estimated single lump sum of $2,500 ($2,500 per mile).
- Grading of spoils materials over the black sand waste materials (approximately 3 acres) can be completed for an estimated $9,000 ($3,000 per acre).
- Total surface area at Bluff J requiring vegetation via drill seeding and mulching under this alternative is approximately 4.5 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $9,000 ($2,000 per acre).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.11.4 Alternative 4: Comprehensive Grading and Sediment Control

Alternative 4 is not applicable to Bluff J.

7.3.11.5 Alternative 5: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, and Sediment Control

Alternative 5 includes excavation, hauling, and placement of the black sands waste materials into a waste consolidation area located on Bluff B (Figure 7-10). The excavated area would then be covered with organic amended soil from the spoils piles. Soil from the spoils piles would be placed over the black sand waste materials in the waste consolidation area at a minimum depth of three feet; all regraded areas would be amended with organic material and seeded.

Conceptual Design and Assumptions
Based on the available data and the above considerations, the conceptual design of Alternative 5 includes:

- Improving the existing access road from Craig Pass Road to Bluff J by blading and grading to facilitate safe access of heavy equipment and construction crews;
- Improving the existing access road from Bluff J to Bluff B by blading and grading to facilitate safe access of heavy equipment and construction crews;
- Excavation, hauling, and placement of black sands waste materials to the waste consolidation area as shown on Figure 7-10;
- Excavation, hauling, and consolidation of black sands waste materials to the waste consolidation area at Bluff B (see Figures 7-2 and 7-10);
- Backfilling the excavated area with amended soil;
- Placing amended soil over the waste consolidation area;

- Revegetate and mulch the regraded and disturbed areas;
- Obliteration of all access road spurs;
- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of a 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluff J is in fair condition and is approximately one mile in length. This road would require maintenance during construction to facilitate safe access to the site.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the disturbed surfaces.

Effectiveness –The purpose of this alternative is to minimize human exposure to the contaminants. The purpose of the sediment basins and establishing vegetation on the regraded surfaces is to limit the mobility of the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal, at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation would minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since actual treatment of the contaminants would not be conducted. The overall effectiveness of Alternative 5 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. Incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated to range from $847,905.03 to $1,060,744.73 (for hauling contaminated materials to a nearby waste consolidation area at Bluff J or to a common/centralized waste consolidation area at Bluff B, respectively). The cost details associated with implementing this alternative as described are included in Table E-35 and Table E-36 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of constructing the access road to Bluff J from Craig Pass Road can be completed for an estimated single lump sum of $2,500 ($2,500 per mile).
- Cost of constructing the access road to Bluff B from Bluff J can be completed for an estimated single lump sum of $13,750 ($2,500 per mile).
- Excavation, hauling, and placement of black sand waste materials (approximately 6,500 cy) into the waste consolidation area at Bluff J can be completed for an estimated cost of $45,500 ($7.00 per cy).
- Excavation, hauling, and placement of black sand waste materials into the waste consolidation area at Bluff B (approximately 6,500 cy) can be completed for an estimated cost of $195,000 ($30.00 per cy).
- Backfilling the excavated area with amended soil (approximately 6,500 cy) can be completed for an estimated cost of $32,500 ($5.00 per cy).
- Apply amended soil over waste consolidation area can be completed for an estimated cost of $23,100 ($3.00 per cy).
- Total surface area at Bluff J requiring vegetation via drill seeding and mulching under this alternative is approximately 5.5 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $11,000 ($2,000 per acre).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.11.6 Alternative 6: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, Sediment Control, and Reduction of High Walls

Alternative 6 is not applicable to Bluff J due to a lack of significant high walls associated with the bluff.

7.3.12 Identification of Response Action Alternatives for Bluff $_{K1}$

Bluff K_1 is located approximately 3 air miles northwest of Riley Pass (see Figure 7-11) in Township 22 North, Range 5 East, Section 21. The site is accessed by traveling south approximately 3.5 miles from Harding County Road 733 on Craig Pass Road. Bluff K_1 lies approximately .75 miles southeast of the Y+ Ranch residence.

Bluff K_1 encompasses approximately two acres and consists of two spoils piles/berms within an open grass meadow in the middle of the bluff. There are no signs of erosion from the berms or spoils piles, and vegetation at the site consists of approximately 90 to 95% vegetative cover. There are no high walls associated with this site. One acutely contaminated area (hot spot) (0.1 mrem/hr) was observed during a previous sampling investigation conducted by Pioneer (2000), it is located at the end of a small dozer cut within the berm materials, and is located near the southeast portion of the site. The hot spot has an estimated volume of approximately 40 cy. The remaining berm materials surrounding the hot spot have an estimated volume of approximately 800 cy. The spoils pile is located at the north end of the site and has an estimated volume of 2,200 cy.

Concentrations greater than three times background of arsenic, molybdenum, thorium, uranium, vanadium, $radium^{226}$, and $uranium^{235}$ were documented for Bluff K_1 during the 2000 sampling investigation.

7.3.12.1 Alternative 1: No Action

The No Action Alternative means that no actual response action activities will occur at the site to control contaminant migration or to reduce toxicity or volume.

Effectiveness - Protection of human health and the environment would not be achieved under the No Action Alternative. Prevention of direct human contact would not be achieved. The contaminant sources present at Bluff K_1 area would continue to potentially impact the environment. Toxicity, mobility, and volume of contaminants would not be reduced under the No Action Alternative.

Implementability - Technical and administrative feasibility evaluation criteria do not apply to this alternative.

Cost Screening - No capital or operating costs would be incurred under this alternative.

Screening Summary - This alternative has been retained for further evaluation as required by the NCP.

7.3.12.2 Alternative 2: Institutional Controls

The Institutional Controls Alternative includes erecting fences around area to restrict access to contaminated sources. Additionally, land use restrictions could be placed to restrict recreational activities near the contaminated sources.

Effectiveness - This alternative is not protective of environmental resources. It is not fully protective of human health if implemented as a stand-alone alternative because the waste sources will continue to be exposed and available for direct contact. Toxicity, mobility, and volume of the contaminated media would not be reduced under this alternative.

Implementability - Institutional controls can be easily implemented based on the criteria of applicability, availability, and reliability. This alternative is considered applicable for minimizing the potential for direct contact and restricting access to the safety hazards present at the site. Fencing materials and construction contractors are readily available to minimize direct contact with the sources. Reliability of this alternative for its intended purpose (protection from direct contact) is considered good as long as enforcement of the institutional controls is maintained by the regulatory agencies. Due to the logistical simplicity of implementing institutional controls, administrative feasibility is considered very good.

Cost Screening - Costs associated with institutional controls would be relatively low compared to other response action measures; however, a considerable amount of fencing materials would be required to fully enclose the sources present at the site. Capital cost associated with

construction of an 8-foot tall, chain-link fence would run approximately $41,600.00 or $20 per linear foot. Total capital cost can vary widely depending on which feature would require fencing and assuming no consolidation of contaminated materials. Maintenance costs would likely be less than $4,160.00 per year.

The total present-worth cost has been estimated at $350,584.10. The cost details associated with implementing this alternative as described are included in Table E-37 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

Screening Summary - Institutional controls will not be considered further as a stand-alone response action alternative but may be used in conjunction with other selected treatment alternatives.

7.3.12.3 Alternative 3: Minimal Grading and Sediment Control

Alternative 3 includes regrading the spoils pile and berm over the existing hot spot at Bluff K_1. The grading would be completed in a manner to create positive drainage over the hot spot while matching the approximate contours of the surrounding ground (see Figure 7-11). Excess materials from the spoils/berms would be spread evenly over the site. Run-on/runoff control ditches would be constructed to divert storm water from USFS Route 132 around the regraded areas on the southeast side; all regraded areas would be amended with organic material and seeded.

Conceptual Design and Assumptions

Based on the available data and the above considerations, the conceptual design of Alternative 3 includes:

- Improving the existing access road from Craig Pass Road to Bluff K_1 by blading and grading to facilitate safe access of heavy equipment and construction crews;
- Regrading of spoils pile and berm materials over the hot spot where shown on Figure 7-11;
- Construction of run-on/runoff control ditches;
- Revegetate and mulch the regraded and disturbed areas;
- Obliteration of all access road spurs;
- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of a 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluff K_1 is in fair condition and is less than one mile in length. This road would require maintenance during construction to facilitate safe access to the site.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch would be applied to promote temporary protection of the disturbed surfaces.

Effectiveness – The purpose of this alternative is to minimize human exposure to the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal, at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation will minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since actual treatment of the contaminants would not be conducted. The overall effectiveness of Alternative 3 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. The regrading and incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $456,603.75. The cost details associated with implementing this alternative as described are included in Table E-38 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of constructing the access road to Bluff K_1 from Craig Pass Road can be completed for an estimated single lump sum of $2,500 ($2,500 per mile).
- Grading of spoils pile and berm materials over the hot spot (approximately 2 acres) can be completed for an estimated $6,000 ($3,000 per acre).
- Construction of approximately 300 linear feet of run-on/runoff control ditches can be completed for an estimated cost of $2,100 ($7.00 per linear foot).
- Total surface area at Bluff K_1 requiring vegetation via drill seeding and mulching under this alternative is approximately 2.5 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $5,000 ($2,000 per acre).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.12.4 Alternative 4: Comprehensive Grading and Sediment Control

Alternative 4 is not applicable to Bluff K_1.

7.3.12.5 Alternative 5: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, and Sediment Control

Alternative 5 includes excavation, hauling, and placement of the hot spot waste materials into a waste consolidation area located at Bluff B (see Figure 7-11). The excavated waste materials would be placed in haul trucks with sealed end gates and tarps placed over the loads to avoid loss of materials during transport. The waste consolidation area at Bluff B can be accessed from Bluff K_1 by way of USFS Route 132. The excavated area at Bluff K_1 would be graded using materials from the spoils pile and berm to approximately match existing contours; all regraded areas would be amended with organic material and seeded.

Conceptual Design and Assumptions
Based on the available data and the above considerations, the conceptual design of Alternative 5 includes:

- Improving the existing access road from Craig Pass Road to Bluff K_1 by blading and regrading to facilitate safe access of heavy equipment and construction crews;
- Improving the existing USFS Route 132 access road from Bluff K_1 to Bluff B by blading and regrading to facilitate safe access of heavy equipment;
- Excavation, hauling, and placement of hot spot waste materials in the waste consolidation area at Bluff B;
- Grading of the spoils pile and berm materials as shown on Figure 7-11;
- Construction of a run-on/runoff control ditch;
- Revegetate and mulch the regraded and disturbed areas;
- Obliteration of all access road spurs;
- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of a 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluff K_1 is in fair condition and is less than one mile in length. USFS Route 132 is in fair condition and is approximately 4.5 miles in length. These roads would require maintenance during construction to facilitate safe access to the site.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the disturbed surfaces.

Effectiveness –The purpose of this alternative is to minimize human exposure to the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal, at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation will minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since actual treatment of the contaminants would not be conducted. The overall effectiveness of Alternative 5 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. Incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $335,043.00. The cost details associated with implementing this alternative as described are included in Table E-39 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of constructing the access road to Bluff K_1 from Craig Pass Road can be completed for an estimated single lump sum of $2,500 ($2,500 per mile).
- Cost of constructing the access road to Bluff B from Bluff K_1 can be completed for an estimated single lump sum of $11,250 ($2,500 per mile).
- Excavation, hauling, and placement of the hot spot waste materials into the waste consolidation area at Bluff B (approximately 40 cy) can be completed for an estimated cost of $1,200 ($30.00 per cy).
- Grading of spoils piles and berm materials (approximately 2 acres) can be completed for an estimated $6,000 ($3,000 per acre).
- Construction of approximately 300 linear feet of run-on/runoff control ditches can be completed for an estimated cost of $2,100 ($7.00 per linear foot).
- Total surface area at Bluff K_1 requiring vegetation via drill seeding and mulching under this alternative is approximately 2.5 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $5,000 ($2,000 per acre).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.12.6 Alternative 6: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, Sediment Control, and Reduction of High Walls

Alternative 6 is not applicable to Bluff K_1 due to a lack of significant high walls associated with the bluff.

7.3.13 **Identification of Response Action Alternatives for Bluff $_{K2}$**

Bluff K_2 is located approximately 3 air miles northwest of Riley Pass (see Figure 7-11) in Township 22 North, Range 5 East, Section 21. The site is accessed by traveling south approximately 3.5 miles from the Harding County Road 733 along the Craig Pass Road. Bluff K_2 lies approximately .75 miles southeast of the Y+ Ranch residence. Bluff K_2 is separated from Bluff K_1 by USFS Route 132, which lies approximately 500 feet to the southeast of Bluff K_2.

Bluff K_2 encompasses approximately five acres and consists of two benches and high walls with spoils piles along the edge of the benches. Several small erosion rills are present on the faces of the spoil piles; vegetation at the site is approximately 80 to 85% vegetative cover on the flat benches and approximately 30 to 40% vegetative cover on the faces of the spoils piles. There are two small high walls/bench walls associated with this site that are approximately 10 to 15 feet in height.

No concentrations greater than three times background were documented for Sample RP-SS-K2 during the 2000 sampling investigation.

7.3.13.1 Alternative 1: No Action

The No Action Alternative means that no actual response action activities will occur at the site to control contaminant migration or to reduce toxicity or volume.

Effectiveness - Protection of human health and the environment would not be achieved under the No Action Alternative. Prevention of direct human contact would not be achieved. The contaminant sources present at Bluff K_2 area would continue to potentially impact the environment. Toxicity, mobility, and volume of contaminants would not be reduced under the No Action Alternative.

Implementability - Technical and administrative feasibility evaluation criteria do not apply to this alternative.

Cost Screening - No capital or operating costs would be incurred under this alternative.

Screening Summary - This alternative has been retained for further evaluation as required by the NCP.

7.3.13.2 Alternative 2: Institutional Controls

The Institutional Controls Alternative includes erecting fences around the area to restrict access to contaminated sources. Additionally, land use restrictions could be placed to restrict recreational activities near the contaminated sources.

Effectiveness - This alternative is not protective of environmental resources. It is not fully protective of human health if implemented as a stand-alone alternative because the waste sources will continue to be exposed and available for direct contact. Toxicity, mobility, and volume of the contaminated media would not be reduced under this alternative.

Implementability - Institutional controls can be easily implemented based on the criteria of applicability, availability, and reliability. This alternative is considered applicable for minimizing the potential for direct contact and restricting access to the safety hazards present at the site. Fencing materials and construction contractors are readily available to minimize direct contact with the sources. Reliability of this alternative for its intended purpose (protection from direct contact) is considered good as long as enforcement of the institutional controls is maintained by the regulatory agencies. Due to the logistical simplicity of implementing institutional controls, administrative feasibility is considered very good.

Cost Screening - Costs associated with institutional controls would be relatively low compared to other response action measures; however, a considerable amount of fencing materials would be required to fully enclose the sources present at the site. Capital cost associated with construction of an 8-foot tall, chain-link fence would run approximately $74,880.00 or $20 per linear foot. Total capital cost can vary widely depending on which feature would require fencing and assuming no consolidation of contaminated materials.

The total present-worth cost has been estimated at $353,656.50. The cost details associated with implementing this alternative as described are included in Table E-40 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

Screening Summary - Institutional controls will not be considered further as a stand-alone response action alternative but may be used in conjunction with other selected treatment alternatives.

7.3.13.3 Alternative 3: Minimal Grading and Sediment Control

Alternative 3 includes regrading spoils piles/berm materials and the high walls and bench walls to a slope of 4H:1V. The high walls could be easily addressed under general grading activities at this particular bluff. Grading would be completed in a manner to match the approximate contours of the surrounding ground (see Figure 7-11). All regraded areas would be amended with organic material and seeded.

Conceptual Design and Assumptions

Based on the available data and the above considerations, the conceptual design of Alternative 3 includes:

- Improving the existing access road from Craig Pass Road to Bluff K_2 by blading and regrading to facilitate safe access of heavy equipment and construction crews;
- Regrading of spoils piles/berm materials and high walls as shown on Figure 7-11;
- Revegetate and mulch the regraded and disturbed areas;
- Obliteration of all access road spurs;

- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of a 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluff K_2 is in fair condition and is approximately less than one mile in length. This road would require maintenance during construction to facilitate safe access to the site.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch would be applied to promote temporary protection of the disturbed surfaces.

Effectiveness – The purpose of this alternative is to minimize human exposure to the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal, at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation will minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since actual treatment of the contaminants would not be conducted. The overall effectiveness of Alternative 3 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. The regrading and incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $553,609.16. The cost details associated with implementing this alternative as described are included in Table E-41 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of constructing the access road to Bluff K_2 from Craig Pass Road can be completed for an estimated single lump sum of $2,500 ($2,500 per mile).
- Grading of spoils piles/berm materials, including the high walls (approximately 4 acres) can be completed for an estimated $13,500 ($3,000 per acre).

- Total surface area at Bluff K_2 requiring vegetation via drill seeding and mulching under this alternative is approximately 4.5 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $9,000 ($2,000 per acre).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.13.4 Alternative 4: Comprehensive Grading and Sediment Control

Due to the existing stable nature of Bluff K_2, only minimal response action work is assumed to be necessary. Alternative 4 is not applicable to Bluff K_2.

7.3.13.5 Alternative 5: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, and Sediment Control

Due to the existing stable nature of Bluff K_2, only minimal response action work is assumed to be necessary. Alternative 5 is not applicable to Bluff K_2.

7.3.13.6 Alternative 6: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, Sediment Control, and Reduction of High Walls

Due to the existing stable nature of Bluff K_2, only minimal response action work is assumed to be necessary. Alternative 6 is not applicable to Bluff K_2. Reduction of the high walls associated with Bluff K_2 would be addressed through general grading activities under Alternative 3.

7.3.14 Identification of Response Action Alternatives for Bluff L

Bluff L is located approximately 3 air miles southwest of Riley Pass (See Figure 7-12) in Township 22 North, Range 5 East, Section 29. The site is accessed by traveling south approximately 3.5 miles from Harding County Road 733 on Craig Pass Road, turning south on Craig Pass Road and traveling approximately 2 miles to the site.

Bluff L encompasses approximately eight acres, and consists of multiple small spoils piles, old roads, and dozer cuts scattered throughout the site. One larger spoils pile, approximately 44,100 cy, is located on the north end of the site in a dry draw. Several small erosion rills and gullies have formed on the face of this spoils pile. In general, vegetation at the site is approximately 85 to 90% vegetative cover in flatter areas and approximately 65 to 70% vegetative cover on the steeper faces of the spoils pile. There is an exposed lignite coal seam on the east side of the large spoils pile within the highwall. No metal concentrations at this site have been documented above the background concentrations.

7.3.14.1 Alternative 1: No Action

The No Action Alternative means that no actual response action activities will occur at the site to control contaminant migration or to reduce toxicity or volume.

Effectiveness - Protection of human health and the environment would not be achieved under the No Action Alternative. Prevention of direct human contact would not be achieved. The contaminant sources present at Bluff L would continue to potentially impact the environment. Toxicity, mobility, and volume of contaminants would not be reduced under the No Action Alternative.

Implementability - Technical and administrative feasibility evaluation criteria do not apply to this alternative.

Cost Screening - No capital or operating costs would be incurred under this alternative.

Screening Summary - This alternative has been retained for further evaluation as required by the NCP.

7.3.14.2 Alternative 2: Institutional Controls

The Institutional Controls Alternative includes erecting fences around the area to restrict access to contaminated sources and physical hazards. Additionally, land use restrictions could be placed to restrict recreational activities near the contaminated sources and hazards.

Effectiveness - This alternative is not protective of environmental resources. It is not fully protective of human health if implemented as a stand-alone alternative because the waste sources will continue to be exposed and available for direct contact. Toxicity, mobility, and volume of the contaminated media would not be reduced under this alternative.

Implementability - Institutional controls can be easily implemented based on the criteria of applicability, availability, and reliability. This alternative is considered applicable for minimizing the potential for direct contact and restricting access to the safety hazards present at the site. Fencing materials and construction contractors are readily available to minimize direct contact with the sources. Reliability of this alternative for its intended purpose (protection from direct contact) is considered good as long as enforcement of the institutional controls is maintained by the regulatory agencies. Due to the logistical simplicity of implementing institutional controls, administrative feasibility is considered very good.

Cost Screening - Costs associated with institutional controls would be relatively low compared to other response action measures; however, a considerable amount of fencing materials would be required to fully enclose the sources present at the site. Capital cost associated with construction of an 8-foot tall, chain-link fence would run approximately $100,000.00 or $20 per linear foot. Total capital cost can vary widely depending on which feature would require fencing and assuming no consolidation of contaminated materials.

The total present-worth cost has been estimated at $490,883.50. The cost details associated with implementing this alternative as described are included in Table E-42 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

Screening Summary - Institutional controls will not be considered further as a stand-alone response action alternative but may be used in conjunction with other selected treatment alternatives.

7.3.14.3 Alternative 3: Minimal Grading and Sediment Control

Alternative 3 includes regrading spoils piles/berm materials and dozer cuts that are scattered throughout the site. Grading would be completed in a manner to match the approximate contours of the surrounding ground (see Figure 7-12) and cover the exposed lignite. All regraded areas would be amended with organic material and seeded.

Conceptual Design and Assumptions
Based on the available data and the above considerations, the conceptual design of Alternative 3 includes:

- Improving the existing access road from Craig Pass to Bluff L by blading and regrading to facilitate safe access of heavy equipment and construction crews;
- Regrading of spoils piles/berm materials, road and dozer cuts as shown on Figure 7-12;
- Construction of run-on/runoff control ditches;
- Revegetate and mulch the regraded and disturbed areas;
- Obliteration of all access road spurs;
- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of a 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluff L is in fair condition and is approximately three miles in length. This road would require maintenance during construction to facilitate safe access to the site.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch would be applied to promote temporary protection of the disturbed surfaces.

Effectiveness – The purpose of this alternative is to minimize human exposure to the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal, at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation will minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since actual treatment of the contaminants would not be conducted. The overall effectiveness of Alternative 3 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. The regrading and incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $710,862.81. The cost details associated with implementing this alternative as described are included in Table E-43 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following primary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of constructing and/or improving the access road to Bluff L from Craig Pass can be completed for an estimated single lump sum of $7,500 ($2,500 per mile).
- Grading of spoils piles/berm materials, roads and dozer cuts (approximately 6.5 acres) can be completed for an estimated $19,500 ($3,000 per acre).
- Construction of approximately 400 linear feet of run-on/runoff control ditches can be completed for an estimated cost of $2,800 ($7.00 per linear foot).
- Total surface area at Bluff L requiring vegetation via drill seeding and mulching under this alternative is approximately 7 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $14,000 ($2,000 per acre).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.14.4 Alternative 4: Comprehensive Grading and Sediment Control

Alternative 4 is not applicable to Bluff L.

7.3.14.5 Alternative 5: Comprehensive Grading, Consolidation and Containment of Excess Material, and Sediment Control

Alternative 5 includes regrading of the spoils piles/berm materials, and dozer cuts that are scattered throughout the site. Grading would be completed in a manner to match the approximate contours of the surrounding ground. Side slopes of spoils piles located on the north side of the bluff would be graded to 4H:1V. Excess waste materials would be excavated and hauled to the waste consolidation area on Bluff L where shown on Figure 7-12. Removing the excess spoils materials from the side slopes would aid in restoring the drainage patterns to approximately the pre-mining state. As part of this alternative, run-on/runoff control ditches would be incorporated into the design to control storm water events. All regraded areas would be amended with organic material and seeded.

Conceptual Design and Assumptions

Based on the available data and the above considerations, the conceptual design of Alternative 5 includes:

- Improving the existing access road from Craig Pass to Bluff L by blading and regrading to facilitate safe access of heavy equipment and construction crews;
- Regrading of spoils piles, old roads, and dozer cuts scattered throughout the site as shown on Figure 7-12;
- Regrading of the north spoils pile side slopes to 4H:1V as shown on Figure 7-12;
- Excavation, hauling, and consolidation of excess waste materials from the side slopes;
- Construction of run-on/runoff control ditches;
- Revegetate and mulch the regraded and disturbed areas;
- Obliteration of all access road spurs;
- Revegetating and mulching all disturbed areas upon completion of the construction activities (roads, staging areas, stockpile areas, etc.); and
- Installation of a 4-strand barbed wire fence to exclude livestock from the reclaimed areas.

The current access road to Bluff L is in fair condition and is approximately three miles in length. This unimproved dirt road would require improvements and maintenance during the construction period by blading and regrading to facilitate safe access to the site. Additionally, construction of access spur roads would be required to haul the excess materials from the regraded side slopes area to the top of Bluff L.

Run-on/runoff control ditches would be designed as an integral part of the bluff stabilization to divert storm water runoff.

Seeding would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the disturbed surfaces.

Effectiveness –The purpose of this alternative is to minimize human exposure to the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. The vegetative success without the use of organic matter would likely be marginal, at best, with additional amendments possibly being required as part of the maintenance in areas of vegetative failure. Therefore, organic amendment is included as an integral part of the revegetation strategy. Once established, the vegetation will minimize human and terrestrial biota exposure to the contaminants via direct contact and inhalation of entrained dust. The toxicity or volume of the wastes would not be reduced under this alternative since actual treatment of the contaminants would not be conducted. The overall effectiveness of Alternative 5 would be enhanced by carefully selecting appropriate native plant species that are adapted to the existing site conditions. Long-term monitoring and control programs would be necessary to ensure continued effectiveness.

Implementability – This alternative is both technically and administratively feasible. Incorporation of soil amendments and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

Cost Screening – The total present-worth cost has been estimated at $1,091,286.26. The cost details associated with implementing this alternative as described are included in Table E-44 (Appendix E). The total cost includes the present-worth value for 30 years of annual maintenance and monitoring costs discounted at 7.0% in addition to capital cost.

The following preliminary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- Cost of upgrading and maintaining the access road to Bluff L from Craig Pass can be completed for an estimated single lump sum of $7,500 ($2,500 per mile).
- Grading of the spoils piles, old roads, and dozer cuts (approximately 6.5 acres) can be completed for an estimated $19,500 ($3,000 per acre).
- Regrading of the side slopes waste materials (approximately 2 acres) can be completed for an estimated cost of $15,000 ($7,500 per acre).
- Excavation, hauling, and placement of the excess side slope materials (approximately 26,000 cy) of waste materials into the waste consolidation area can be completed for an estimated cost of $182,000 ($7.00 per cy).
- Construction of approximately 400 linear feet of run-on/runoff ditches can be completed for an estimated cost of $2,800 ($7.00 per linear foot).
- Total surface area at Bluff L requiring vegetation via drill seeding and mulching under this alternative is approximately 8.5 acres (excluding contractor access road spurs, staging areas, etc.). This task can be completed for an estimated cost of $17,000 ($2,000 per acre).

Screening Summary – This alternative has been retained for detailed analysis since regrading and stabilization may be feasible and a cost effective remedy for the site.

7.3.14.6 Alternative 6: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, Sediment Control, and Reduction of High Walls

Alternative 6 is not applicable to Bluff L due to a lack of significant high walls associated with the bluff.

7.4 SUMMARY OF ALTERNATIVE SCREENING

Table 7-3 summarizes the findings of the preliminary evaluation and screening of response action alternatives applicable to each bluff at the Riley Pass Site. Costs summarized on this table are total present worth costs, which include operating and maintenance costs. See Appendix E for cost details for each bluff and associated alternatives.

The four alternatives retained for detailed analyses include:

- Alternative 1 No Action;
- Alternative 3 Minimal Grading and Sediment Control;
- Alternative 4 Comprehensive Grading and Sediment Control; and
- Alternative 5 Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials and Sediment Control.

TABLE 7-3
PRELMINARY EVALUATION AND SCREENING OF ALTERNATIVES

ALTERNATIVE	EFFECTIVENESS	IMPLEMENTABLE	ESTIMATED TOTAL-PRESENT-WORTH COST	RETAINED FOR DETAILED ANALYSIS
Alternative 1:				
Bluff A	N/A	N/A	$463,476.00	YES
Bluff B	N/A	N/A	$432,454.00	YES
All Other Bluffs	N/A	N/A	$0.00	YES
Alternative 2:				
Bluff A	Low	YES	$527,476.00	NO
Bluff B	Low	YES	$1,243,996.00	NO
Bluff C	Low	YES	$306,684.00	NO
Bluff D	Low	YES	$316,125.00	NO
Bluff E	Low	YES	$309,181.00	NO
Bluff F	Low	YES	$314,159.00	NO
Bluff G	Low	YES	$346,641.00	NO
Bluff H	Low	YES	$528,110.00	NO
Bluff I_1 & I_2	Low	YES	$550,520.00	NO
Bluff I_3	Low	YES	$337,457.00	NO
Bluff J	Low	YES	$373,452.00	NO
Bluff K_1	Low	YES	$350,584.00	NO
Bluff K_2	Low	YES	$353,656.00	NO
Bluff L	Low	YES	$490,884.00	NO
Alternative 3:				
Bluff A	Moderate	YES	$760,364.00	YES
Bluff B	Moderate	YES	$7,759,080.00	YES
Bluff C	High	YES	$469,784.00	YES
Bluff D	High	YES	$494,099.00	YES
Bluff E	High	YES	$454,222.00	YES
Bluff F	High	YES	$498,071.00	YES
Bluff H	Moderate	YES	$893,340.00	YES
Bluff I_1 and I_2	Moderate	YES	$1,011,078.00	YES
Bluff I_3	Moderate	YES	$490,276.00	YES
Bluff J	Moderate - High	YES	$636,783.00	YES
Bluff K_1	Moderate - High	YES	$456,604.00	YES
Bluff K_2	Moderate	YES	$553,609.00	YES
Bluff L	Moderate	YES	$710,863.00	YES
Alternative 4:				
Bluff A	Moderate – High	YES	$906,954.00	YES
Bluff H	Moderate – High	YES	$1,813,792.00	YES
Alternative 5:				
Bluff A	High	YES	$952,176.00	YES
Bluff B	High	YES	$12,943,004.00	YES
Bluff G	High	YES	$730,150.00 - $1,217,060.00	YES
Bluff H	High	YES	$2,070,587.00	YES
Bluff I_1 and I_2	High	YES	$1,993,119.00	YES
Bluff J	High	YES	$847,905.00 - $1,060,745.00	YES
Bluff K_1	High	YES	$335,043.00	YES
Bluff L	High	YES	$1,091,286.00	YES
Alternative 6:				
Bluff B	High	YES	$13,559,312.00	NO
Bluff H	High	YES	$2,199,851.00	NO
Bluff I_1 and I_2	High	YES	$2,508,443.00	NO

8.0 DETAILED ANALYSIS OF RECLAMATION ALTERNATIVES

The purpose of the detailed analysis is to evaluate, in detail, reclamation alternatives for their effectiveness, implementability, and cost to control and reduce the toxicity, mobility, and/or volume of contaminated mine wastes at the Riley Pass Site. Only those reclamation alternatives that were retained after the preliminary evaluation and screening, as presented in Section 7.2, are included. For clarity, the retained alternative numbers are carried over from Section 7.2. **The reclamation alternatives evaluated in detail are applicable to the contaminated solid media; no reclamation alternatives for groundwater, surface water, or contaminated stream sediments are analyzed in detail. The rationale for not directly developing reclamation alternatives for these environmental media is based primarily on the presumption that reclaiming the contaminant source(s) will subsequently reduce any problems associated with groundwater, surface water, or stream sediments at a significantly reduced cost.**

As required by the CERCLA and NCP, reclamation alternatives that were retained after the initial evaluation and screening have been evaluated individually against the following criteria:

- Overall protection of human health and the environment;
- Compliance with ARARs;
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume through treatment;
- Short-term effectiveness;
- Implementability; and
- Cost.

Supporting agency and community acceptance are additional criteria that will be addressed after South Dakota and the public have reviewed the evaluations presented. The analysis criteria have been used to address the CERCLA requirements and considerations with EPA guidance (EPA, 1988), as well as additional technical and policy considerations. These criteria serve as the basis for conducting the detailed analysis and subsequently selecting the preferred reclamation alternative(s). The criteria listed above are categorized into three groups, each with distinct functions in selecting the preferred alternative. These groups include:

- Threshold Criteria - overall protection of human health and the environment and compliance with ARARs;

- Primary Balancing Criteria - long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost; and

- Modifying Criteria - state and community acceptance.

Overall protection of human health and the environment and compliance with applicable or relevant and appropriate requirements are threshold criteria that must be satisfied for an alternative to be eligible for selection. Long-term effectiveness and permanence; reduction of toxicity, mobility, or volume; short-term effectiveness; implementability; and cost are the primary balancing factors used to weigh major trade-offs between alternative hazardous waste management strategies. State and community acceptance are modifying considerations that are formally considered after public comment is received on the proposed plan and the EE/CA report (Federal Register, No. 245, 51394-50509, December 1988). Each of these criteria is briefly described in the following paragraphs.

The overall protection criterion evaluates how the alternative, as a whole, protects and maintains human health and the environment. The overall assessment of protection is based on a combination of factors assessed under other evaluation criterion, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

Compliance with ARARs criterion assesses how each alternative complies with applicable or relevant and appropriate standards, criterion, advisories, or other guidelines. Waivers will be identified, if necessary. The following factors will be addressed for each alternative during the detailed analysis of ARARs:

- Compliance with chemical-specific ARARs;
- Compliance with action-specific ARARs;
- Compliance with location-specific ARARs; and
- Compliance with appropriate criterion, advisories, and guidelines.

Long-term effectiveness and permanence evaluates the alternative's effectiveness in protecting human health and the environment after response objectives have been met. The following components of the criterion will be addressed for each alternative:

- Magnitude of remaining risk;
- Adequacy of controls; and
- Reliability of controls.

The reduction of toxicity, mobility, or volume assessment evaluates anticipated performance of the specific treatment technologies. This evaluation focuses on the following specific factors for a particular reclamation alternative:

- Treatment process, remedies they will employ, and materials they will treat;
- Volume of contaminated materials that will be destroyed or treated, including how principle threat(s) will be addressed;
- Degree of expected reduction in toxicity, mobility, or volume measured as a percentage of reduction (or order of magnitude);
- Degree to which the treatment will be irreversible; and
- Type and quantity of treatment residuals that will remain following treatment.

Short-term effectiveness evaluates an alternative's effectiveness in protecting human health and the environment during the construction and implementation period until the response objectives are met. Factors that will be considered under this criterion include:

- Protection of the surrounding community during reclamation actions;
- Protection of on-site workers during reclamation actions;
- Protection from environmental impacts; and
- Time until removal response objectives are achieved.

Implementability evaluates the technical and administrative feasibility of alternatives and the availability of required resources. Analysis of this criterion will include the following factors and subfactors:

Technical Feasibility

- Construction and operation;
- Reliability of the technology;
- Ease of undertaking additional reclamation actions (if necessary); and
- Monitoring considerations.

Administrative Feasibility

- RCRA disposal restrictions;
- Institutional controls; and
- Permitting requirements.

Availability of Services and Materials

- Adequate off-site treatment, storage capacity, and disposal services;
- Necessary equipment and specialists, and provisions to ensure any necessary additional resources;
- Timing of the availability of technologies under considerations; and
- Services and materials.

The cost assessment evaluates the estimated capital costs associated with each alternative. Cost screening consists of developing conservative, order-of-magnitude cost estimates based on similar sets of site-specific assumptions. Cost estimates for each alternative will consider the following factors:

Capital Costs

- Construction costs;
- Equipment costs;
- Land and site development costs;
- Disposal costs;
- Legal fees, license, and permit costs;
- Startup and troubleshooting costs; and
- Contingency allowances.

Annual Costs

- Operating labor;
- Disposal residues;
- Administrative costs;
- Insurance, taxes, and licensing;

- Contingency funds; and
- Rehabilitation costs.

Cooperating Agency acceptance will evaluate the technical and administrative issues and concerns the state may have regarding each of the alternatives. USFS acceptance will also focus on legal issues and compliance with USFS statutes and regulations.

Community acceptance will incorporate public concerns into the analyses of the alternatives.

The final step of this analysis is to conduct a comparative analysis of the alternatives. The comparative analysis includes a discussion of the alternatives' relative strengths and weaknesses with respect to each of the criterion and how reasonable key uncertainties could change expectations of their relative performance.

Once completed, this evaluation will be used to select the preferred alternative(s). The selection of the preferred alternative(s) will be documented in a Notice of Decision by the USFS. Public meetings to present the alternatives will be conducted and significant oral and written comments will be addressed in writing.

8.1 QUANTITATIVE EVALUATION OF THRESHOLD CRITERIA

In the following detailed evaluations of threshold criteria, each reclamation alternative contains quantitative estimates of risk reduction as well as estimates regarding whether ARARs would be attained by implementing the alternative. To quantitatively assess the threshold criteria (overall protection of human health and the environment, and attainment of ARARs), the exposure pathways of concern that were identified in the baseline risk assessment (human health and ecologic) were evaluated to determine the risk reduction required to achieve the desired residual risk level (HQ < 1 and EQ < 1 and carcinogenic risk $< 1 \times 10^{-6}$). Each alternative was then modeled to ascertain the degree of risk reduction achieved, either through reduced contaminant loadings to an exposure pathway or reduced surface area available for certain exposures. The resulting risk reduction estimates are then compared to one another to determine whether the relative risk reduction provided by a specific alternative is greater than another; these risk reductions are also compared to the reduction required to alleviate excess risk via the specific pathway or media, as determined in the risk assessments. The risk reduction models also estimate resultant contaminant concentrations in the various media, which are then compared to media- and contaminant-specific ARARs.

Modeling estimates and assumptions are used in an attempt to quantify risk reduction and determine whether ARARs would be attained. In the course of performing this quantitative analysis, several assumptions and estimates are necessarily employed. Some of the assumptions are based on standard CERCLA risk assessment guidance, while others are based on site-specific observations and professional judgment. Many of the estimates are based on conservative (worst-case) scenarios, but since alternatives are compared to one another on a relative basis, these assumptions are consistent. The evaluation findings should, therefore, not be considered absolute (i.e., attainment of ARARs); however, the relative risk reduction differences between alternatives are meaningful and can be used to evaluate the alternatives.

The human health baseline risk assessment determined that the greatest human health risks at the Riley Pass Site are the exposure of the cattle rancher and recreational visitor to site-derived arsenic and total radionuclides (primarily radium^{226}). To evaluate risk reduction for these contaminants via the two exposure scenarios, each reclamation alternative is modeled for risk reduction and compared to the reduction required to achieve the levels of protectiveness (recreational and cattle rancher) as dictated by the risk assessment. Refer to Table 6-3 for location-, exposure-, and contaminant-specific risk reduction targets. Human health based risk reduction ranges from 0% to 95% for arsenic (cleanup to background concentration) and from 0% to 99% for radium^{226} (cleanup to 1×10^{-6} risk concentration), depending on location (bluff) and exposure scenario.

In the following evaluations of risk reduction, the permit holder exposure scenario, the 1×10^{-6} risk level, and radium^{226} (except bluffs I and K) are used for comparison to the risk reduction achieved by each alternative. These represent the highest level of risk reduction and are the most conservative approach to evaluating alternatives.

The ecologic risk assessment identified two exposures: terrestrial animals and terrestrial plants. These receptors are primarily affected by exposure to arsenic and molybdenum at the site. The terrestrial animal exposures necessitate a 99.7% reduction in arsenic soil concentrations, while the terrestrial plant exposures involve a 99.7% reduction in molybdenum soil concentrations.

Two of these three exposure pathways (cattle rancher and recreational visitor) were modeled to evaluate the relative risk reductions and attainment of ARARs afforded by each alternative. These calculations involved a combination of measured data collected at the site (wastes and surface water concentrations), and modeled impacts (i.e., surface water loading). A discussion of how the evaluations were performed and the assumptions used follows for each pathway.

The exposure pathways were empirically modeled using only reductions in exposed surface area to estimate reduction in exposures. Assumptions used to evaluate the reduction of exposure to surface wastes include the following: alternatives that employed only revegetated covers or caps were assigned a 65% long-term effectiveness for preventing exposure, and sources placed in a waste consolidation area or repository were assumed to have been 85% removed from exposures via this pathway.

8.2 ALTERNATIVE 1: NO ACTION

The No Action Alternative is required for analysis by CERCLA and the NCP when evaluating alternatives in detail; the No Action Alternative is used to provide a baseline for comparing other alternatives. Under this alternative, no permanent reclamation activities would be implemented. Consequently, long-term human health and environmental risks associated with the on-site contamination would remain unchanged, with the contaminant sources at the site continuing to pose a threat to human health and environmental resources.

8.2.1 Overall Protection of Human Health and the Environment

The No Action Alternative provides no control of exposures to contaminated materials and no reduction in risk to human health or the environment. It allows for the continued exposure to surface soil contaminants and continued degradation of surface water quality.

Protection of human health would not be achieved under the No Action Alternative. Prevention of human exposure to COCs via the pathways of concern, as identified in the human health risk assessment, would not occur. Human exposure to arsenic and radium^{226} via contaminated surface soil would not be reduced.

Protection of the environment would also not be achieved under the No Action Alternative. Prevention of ecologic exposures via the scenarios identified in the ecologic risk assessment would not occur; terrestrial wildlife exposure to arsenic and terrestrial plant exposure to molybdenum would persist.

A risk reduction achievement matrix (Table 8-1) was developed to assess whether the alternative affords sufficient protection to human health and the environment for the exposure scenarios and source bluffs identified in the human health risk assessment and the ecological risk assessment. The conclusions presented in the table are based on worst-case modeling results subject to the limitations and assumptions used in the models.

TABLE 8-1
RISK REDUCTION ACHIEVEMENT MATRIX - ALTERNATIVE 1

	Target Risk Reductions		**Reduction by Alternative 1**
	Human Health*	**Ecologic**	
BLUFF A	96%	100%	0%
BLUFF B	74%	100%	0%
BLUFF C	99%	100%	0%
BLUFF D	96%	99%	0%
BLUFF E	93%	NR	0%
BLUFF F	88%	99%	0%
BLUFF G	94%	100%	0%
BLUFF H	93%	100%	0%
BLUFF I	75% (Arsenic)	79%	0%
BLUFF J	60%	98%	0%
BLUFF K	17% (Arsenic)	89%	0%
BLUFF L	NR	NR	0%

NR = Risk reduction not required.
* Assumes the permit holder exposure, 1 x 10^{-6} risk level, and $radium^{226}$ (except bluffs I and K where Arsenic is used).

8.2.2 Compliance with ARARs

A comprehensive list of Federal and State ARARs has been developed for the Riley Pass Site and is summarized in Section 4.0 and presented in detail in Appendix A. The ARARs are divided into contaminant-specific, location-specific, and action-specific requirements. Contaminant-specific ARARs are waste-related requirements which specify how a waste must be managed, treated, and/or disposed depending upon the classification of the waste material. Location-specific ARARs specify how the remedial activities must take place depending upon where the wastes are physically located (e.g., in a stream or floodplain, wilderness area, or sensitive environment, etc.), or where the wastes may be treated or disposed and what authorizations (permits) may be required. Action-specific ARARs are technology- or activity-based requirements, or are limitations on actions taken with respect to hazardous substances. Action-specific ARARs do not determine the preferred reclamation alternative, but indicate how the selected alternative must be achieved.

Under the No Action Alternative, no contaminated materials would be treated, removed, or actively managed. Consequently, the No Action Alternative would not satisfy Federal or State ARARs. A water quality ARARs attainment matrix (Table 8-2) was developed to assess whether the alternative can achieve ARARs for those contaminants and media where they are currently exceeded. The conclusions presented in the table are based on worst-case modeling results subject to the limitations and assumptions used in the models (see Section 8.1 for discussion).

TABLE 8-2
WATER QUALITY ARARs ATTAINMENT FOR ALTERNATIVE 1

Alternative 1	Arsenic - Drinking Water	Arsenic - Acute Aquatic Life	Total Uranium - Drinking Water	$Radium^{226}$ - Drinking Water
Modeled Surface Water conc.	1,420 µg/L	1,420 µg/L	194 µg/L	10.3 pCi/L
Surface Water ARAR	10 µg/L	340 µg/L	30 µg/L	5 pCi/L
Surface Water ARAR met?	No	No	No	No

µg/L – micrograms per Liter
pCi/L - picocuries per Liter

8.2.3 Long-Term Effectiveness and Permanence

No controls or long-term measures would be placed on the contaminated materials at the site; consequently, all current and future risks would remain the same as described in the baseline risk assessment (Section 5.0). Therefore, the No Action Alternative would not be effective at minimizing risks from exposure to these materials.

8.2.4 Reduction of Toxicity, Mobility, or Volume, Through Treatment

The No Action Alternative would provide no reduction in toxicity, mobility, or volume of the contaminated materials.

8.2.5 Short-Term Effectiveness

In the short term, the No Action Alternative would pose no additional threats to the community or the environment because the current site conditions would not be changed. The identical level of risk, as identified in the risk assessment (Section 5.0), would continue to exist in the short and long term.

8.2.6 Implementability

There would be no implementability concerns posed by the No Action Alternative since no action would be taken.

8.2.7 Costs

The capital cost for implementing this alternative would be zero since no action would be taken. However, there are operating and maintenance costs associated with Bluffs A and B. These operating and maintenance costs are summarized on Table 8-3. Detailed cost estimates can be found in the cost tables located in Appendix E.

TABLE 8-3
ESTIMATED COST FOR ALTERNATIVE 1

INDIVIDUAL BLUFF	ESTIMATED COST
Bluff A	$463,476.00
Bluff B	$432,454.00
All Other Bluffs	$0.00

8.3 ALTERNATIVE 3: MINIMAL GRADING AND SEDIMENT CONTROL

Section 7.0 of this document presents the conceptual design, design assumptions, logistics, and construction details associated with Alternative 3 as it applies to all bluffs, with the exception of Bluff G, for which Alternative 3 is not applicable. Alternative 3 is not applicable to Bluff G due to the presence of acutely contaminated materials within the Bluff.

8.3.1 Overall Protection of Human Health and the Environment

This alternative would provide a means of reducing exposure to the COCs and would only stabilize limited portions of the waste sources with respect to migration to surface water. However, while implementing this alternative would be an improvement over current site conditions, some of the wastes would not be covered with clean soil and the potential for future contaminant releases to surface water would continue to exist; additionally, several waste sources would still be physically located in close proximity to surface water conveyances. Consequently, the reduction in risk to human health and the environment would not be sufficient to achieve the risk reductions dictated by the risk assessment. Alternative 3 would allow for the continued, though reduced, exposure to surface soil contaminants and degradation of surface water quality.

Some protection of human health would be achieved under this alternative. Reduction of human exposures to COCs via the pathway of concern, as identified in the human health risk assessment, would occur. Soil ingestion exposure to COCs via contaminated surface soil would be reduced, by providing a vegetative barrier between the contaminated soil and the human receptor.

Some protection of the environment would be achieved under this alternative. Reduction of ecologic exposures, via the scenarios identified in the ecologic risk assessment, would occur; however, terrestrial wildlife exposure to arsenic and terrestrial plant exposure to molybdenum would persist.

A risk reduction achievement matrix (Table 8-4) was developed to assess whether the alternative affords sufficient protection to human health and the environment for the exposure scenarios and source bluffs identified in the human health risk assessment (Section 5.1) and the ecologic risk assessment (Section 5.2). The conclusions presented in the table are based on worst-case modeling results subject to the limitations and assumptions used in the models (Section 8.1).

TABLE 8-4
RISK REDUCTION ACHIEVEMENT MATRIX - ALTERNATIVE 3

	Target Risk Reductions		**Reduction by Alternative 3**
	Human Health*	**Ecologic**	
BLUFF A	96%	100%	21%
BLUFF B	74%	100%	56%
BLUFF C	99%	100%	13%
BLUFF D	96%	99%	26%
BLUFF E	93%	NR	49%
BLUFF F	88%	99%	54%
BLUFF G	94%	100%	18%
BLUFF H	93%	100%	40%
BLUFF I	75% (Arsenic)	79%	61%
BLUFF J	60%	98%	58%
BLUFF K	17% (Arsenic)	89%	57%
BLUFF L	NR	NR	21%

NR = Risk reduction not required.
* Assumes the permit holder exposure, 1 x 10^{-6} risk level, and $radium^{226}$ (except bluffs I and K where Arsenic is used).

8.3.2 Compliance with ARARs

All location-specific and action-specific ARARs would be met by implementing this alternative. There are no chemical-specific ARARs that apply to in-place stabilization/containment of contaminated solid media. Some chemical-specific water quality ARARs are not expected to be achieved under this alternative. **The reclamation alternatives evaluated in detail are applicable to the contaminated solid media; no reclamation alternatives for groundwater, surface water, or contaminated stream sediments are analyzed in detail. The rationale for not directly developing reclamation alternatives for these environmental media is based primarily on the presumption that reclaiming the contaminant source(s) will subsequently reduce any problems associated with groundwater, surface water, or stream sediments at a significantly reduced cost.** A water quality ARARs attainment matrix (Table 8-5) was developed to assess whether the alternative can achieve ARARs for those contaminants and media where they are exceeded. The conclusions presented in the table are based on worst-case modeling results subject to the limitations and assumptions used in the models (see Section 8.1 for discussion).

TABLE 8-5
WATER QUALITY ARARs ATTAINMENT FOR ALTERNATIVE 3

Alternative 3	Arsenic - Drinking Water	Arsenic - Acute Aquatic Life	Total Uranium - Drinking Water	Radium^{226} - Drinking Water
Modeled Surface Water conc.	460 μg/L	460 μg/L	62 μg/L	3.1 pCi/L
Surface Water ARAR	10 μg/L	340 μg/L	30 μg/L	5 pCi/L
Surface Water ARAR met?	No	No	No	Yes

μg/L – micrograms per Liter
pCi/L - picocuries per Liter

8.3.3 Long-Term Effectiveness and Permanence

Under this alternative, the graded and revegetated surfaces of the spoils piles and sediment controls would have to be maintained to ensure that they continue to perform as designed; consequently, long-term monitoring and frequent inspection and maintenance would be required. The reclaimed surfaces of the spoils piles may be susceptible to settlement, ponding of surface water, erosion, and disruption of cover integrity by vehicles, deep-rooting vegetation, and burrowing animals. However, the reclaimed surfaces and runoff control structures could be easily inspected and the required maintenance could be easily determined.

Grading and revegetation of the spoils piles would stabilize these sources by providing an erosion-resistant, vegetated surface that would provide some protection from surface water and wind erosion, and would reduce net infiltration through the contaminated media by increasing evapotranspiration processes. Revegetation would consequently reduce the threat of direct contact and inhalation of airborne contaminants by on-site and nearby receptors. The long-term effectiveness of revegetation would be enhanced by determining proper amendments, and selecting appropriate plant species that are adapted to the growing seasons and site environments.

Over the long term, the water quality and sediment environment (benthic community) in Schleichart Draw, Upper Pete's Creek, and the intermittently dry drainages surrounding the bluffs is expected to improve by implementing this alternative. These streams and drainages are expected to benefit because the contaminant sources impacting the streams and drainages would be stabilized with respect to surface water erosion. Additionally, the in-place grading and sediment control strategy would improve the aesthetic quality of the area. The long-term effectiveness should be monitored by frequent inspections of the reclaimed wastes and subsequently maintained, when necessary.

8.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The primary objective of this alternative is to provide a reduction in contaminant mobility; the volume or toxicity of the contaminants would not be reduced by implementing this alternative.

In-place grading and revegetation of the spoils piles and berm materials would stabilize the sources and reduce contaminant mobility via surface water and wind erosion. Potential groundwater impacts would also be reduced by decreasing infiltration through the waste sources by increasing evapotranspiration processes. The mobility of the on-site contaminants is expected to be reduced to an extent that would result in an overall (all pathways and all routes of exposure considered) risk reduction of 58% (based on modeling results).

8.3.5 Short-Term Effectiveness

It is anticipated that the construction phase of this alternative would be accomplished in a relatively short time period (several bluffs per field season); therefore, impacts associated with construction activities would be short term and minimal. On-site workers would be adequately protected during the construction phase by utilizing appropriate personal protective equipment and by following proper operating and safety procedures; however, short-term air quality impacts to the surrounding environment may occur due to the relatively large volumes of wastes requiring handling. Control of fugitive dust emissions would be accomplished by applying water (via water truck) to surfaces receiving heavy vehicular traffic, or in construction areas, etc. Short-term impacts to the surrounding community are expected to be minimal due to the relatively remote location of the project site and the small resident population. The only measurable short-term impacts to the surrounding community would involve increased vehicle traffic (and associated safety hazards, noise, and dust generation) in the vicinity of Buffalo, South Dakota, and the surrounding private property located near the site as a result of the construction. Application of water to roads in these areas may become necessary if dust generation is significant.

8.3.6 Implementability

This alternative is both technically and administratively feasible, and could be implemented in a relatively short period of time. The grading and revegetation steps required are considered conventional construction practices; materials and construction methods are readily available. Also, design methods and requirements are well documented and well understood. However, the construction steps required to implement this alternative are considered moderately difficult (due mostly to the rough/steep terrain and limited space for maneuvering in the vicinity of several of the waste sources). The greatest challenge related to implementability of this alternative includes work on the waste sources located in close proximity to rimrock edges. Careful planning for laying out the sequence of the necessary construction steps would be required both in the design and construction phases of this alternative.

8.3.7 Costs

Costs associated with implementing Alternative 3 are summarized in Table 8-6. Detailed cost estimates can be found in the cost tables located in Appendix E.

TABLE 8-6
ESTIMATED COST FOR ALTERNATIVE 3

INDIVIDUAL BLUFF	ESTIMATED COST
Bluff A	$760,364.00
Bluff B	$7,759,080.00
Bluff C	$469,784.00
Bluff D	$494,099.00
Bluff E	$454,222.00
Bluff F	$498,071.00
Bluff H	$893,340.00
Bluff I_1 and Bluff I_2	$1,011,078.00
Bluff I_3	$490,276.00
Bluff J	$636,783.00
Bluff K_1	$456,604.00
Bluff K_2	$553,609.00
Bluff L	$710,863.00

8.4 ALTERNATIVE 4: COMPREHENSIVE GRADING AND SEDIMENT CONTROL

Section 7.0 of this document presents the conceptual design, design assumptions, logistics, and construction details associated with Alternative 4 as it applies to Bluffs A and H.

8.4.1 Overall Protection of Human Health and the Environment

This alternative would provide a means of reducing exposure to the COCs and would stabilize the surfaces of the sources with respect to migration to surface water. However, this alternative only applies to 2 of the 12 source bluffs and would be implemented as a supplement to another alternative. By itself, the reduction in risk to human health and the environment would not be sufficient to achieve the risk reductions dictated by the risk assessment.

Some additional protection of human health would be achieved under this alternative. Reduction of human exposures to COCs, as identified in the human health risk assessment, would occur. Soil ingestion exposure to COCs via contaminated surface soil would be reduced.

Some additional protection of the environment would be achieved under this alternative. Reduction of ecologic exposures, via the scenarios identified in the ecologic risk assessment, would occur; however, terrestrial wildlife exposure to arsenic and terrestrial plant exposure to molybdenum would persist

A risk reduction achievement matrix (Table 8-7) was developed to assess whether the alternative affords sufficient protection to human health and the environment for the exposure scenarios and source bluffs identified in the human health risk assessment (Section 5.1) and the ecologic risk assessment (Section 5.2). The conclusions presented in the table are based on worst-case modeling results subject to the limitations and assumptions used in the models (Section 8.1).

TABLE 8-7
RISK REDUCTION ACHIEVEMENT MATRIX - ALTERNATIVE 4

	Target Risk Reductions		Reduction by Alternative 4
	Human Health*	Ecologic	
BLUFF A	96%	100%	30%
BLUFF H	93%	100%	58%

NR = Risk reduction not required.
* Assumes the permit holder exposure, 1 x 10^{-6} risk level, and $radium^{226}$.

8.4.2 Compliance with ARARs

All location-specific and action-specific ARARs would be met by implementing this alternative. There are no chemical-specific ARARs that apply to in-place stabilization/containment of contaminated solid media. Some chemical-specific water quality ARARs are not expected to be achieved under this alternative. **The reclamation alternatives evaluated in detail are applicable to the contaminated solid media; no reclamation alternatives for groundwater, surface water, or contaminated stream sediments are analyzed in detail. The rationale for not directly developing reclamation alternatives for these environmental media is based primarily on the presumption that reclaiming the contaminant source(s) will subsequently reduce any problems associated with groundwater, surface water, or stream sediments at a significantly reduced cost.** A water quality ARARs attainment matrix (Table 8-8) was developed to assess whether the alternative can achieve ARARs for those contaminants and media where they are exceeded. The conclusions presented in the table are based on worst-case modeling results subject to the limitations and assumptions used in the models (see Section 8.1 for discussion).

TABLE 8-8
WATER QUALITY ARARs ATTAINMENT FOR ALTERNATIVE 4

Alternative 4	Arsenic - Drinking Water	Arsenic - Acute Aquatic Life	Total Uranium - Drinking Water	$Radium^{226}$ - Drinking Water
Modeled Surface Water conc.	310 µg/L	310 µg/L	51 µg/L	2.4 pCi/L
Surface Water ARAR	10 µg/L	340 µg/L	30 µg/L	5 pCi/L
Surface Water ARAR met?	No	Yes	No	Yes

µg/L – micrograms per Liter
pCi/L - picocuries per Liter

8.4.3 Long-Term Effectiveness and Permanence

Under this alternative, the graded surfaces and sediment control structures would have to be maintained to ensure that they continue to perform as designed; consequently, long-term monitoring and frequent inspection and maintenance would be required. The graded surfaces would be susceptible to settlement, ponding of surface water, erosion, and disruption of the surface integrity by vehicles, deep-rooting vegetation, and burrowing animals. However, the surfaces and structures could be easily inspected and the required maintenance could be easily determined.

General site and slope grading of the spoils piles/berms and revegetation would stabilize the wastes by providing an erosion-resistant, vegetated surface that would provide protection from surface water and wind erosion, and would reduce net infiltration through the contaminated media by increasing evapotranspiration processes. Revegetation would consequently reduce the threat of direct contact and inhalation of airborne contaminants by on-site and nearby receptors. The long-term effectiveness of revegetation would be enhanced by determining proper amendments and selecting appropriate plant species adapted to the growing seasons and the local site environment (as opposed to selecting native species exclusively).

Over the long term, the water quality and sediment environment (benthic community) in the intermittently dry drainages would be improved by implementing this alternative. The contaminant sources most likely to impact the drainages would be graded to a stable slope configuration, as opposed to their current, unstable condition. Additionally, the comprehensive grading strategy would improve the aesthetic quality of the area. The long-term effectiveness should be monitored by frequent inspections of the reclaimed wastes and subsequently maintained, when necessary.

8.4.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The primary objective of this alternative is to provide a major reduction in contaminant mobility; waste volume or toxicity would not be reduced by this alternative. Comprehensive grading of the side slopes and the top of the bluff, and revegetation, would stabilize the wastes and reduce contaminant mobility via surface water and wind erosion. Potential groundwater impacts would also be reduced by decreasing infiltration through the waste sources (via increasing evapotranspiration processes). The mobility of the on-site contaminants is expected to be reduced to an extent that would result in an overall (all pathways and all routes of exposure considered) risk reduction of 65% (based on modeling results).

8.4.5 Short-Term Effectiveness

It is anticipated that the construction phase of this alternative would be accomplished in a relatively short time period (several bluffs per field season); therefore, impacts associated with construction would be short term and minimal. On-site workers would be adequately protected during the construction phase by utilizing appropriate personal protective equipment and by following proper operating and safety procedures; however, short-term air quality impacts to the surrounding environment may occur due to the relatively large volumes of wastes requiring handling. Control of fugitive dust emissions would be accomplished by applying water (via water truck) to surfaces receiving heavy vehicular traffic, or in construction areas, etc. Short-term impacts to the surrounding community are expected to be minimal due to the relatively remote location of the project site and the small resident population. The only measurable short-term impacts to the surrounding community would involve increased vehicle traffic (and associated safety hazards, noise, and dust generation) in the vicinity of Buffalo, South Dakota, and the surrounding private property located near the sites as a result of the construction. Application of water to roads in these areas may become necessary if dust generation is significant.

8.4.6 Implementability

This alternative is both technically and administratively feasible, and could be implemented in a relatively short period of time. The comprehensive grading and revegetation steps required are considered conventional construction practices; materials and construction methods are readily available. Also, design methods and requirements are well documented and well understood. However, the construction steps required to implement this alternative are considered moderately difficult (due mostly to the rough/steep terrain and limited space for maneuvering in the vicinity of several of the waste sources). The greatest challenge related to implementability of this alternative includes work on the waste sources located in close proximity to the rimrock edges and working on extremely steep slopes. Careful planning for laying out the sequence of the necessary construction steps would be required both in the design and construction phases of this alternative.

8.4.7 Costs

Costs associated with implementing Alternative 4 are summarized in Table 8-9. Detailed cost estimates can be found in the cost tables located in Appendix E.

TABLE 8-9
ESTIMATED COST FOR ALTERNATIVE 4

INDIVIDUAL BLUFF	ESTIMATED COST
Bluff A	$906,954.00
Bluff H	$1,813,792.00

8.5 ALTERNATIVE 5: COMPREHENSIVE GRADING, CONSOLIDATION AND CONTAINMENT OF ACUTELY CONTAMINATED MATERIALS, AND SEDIMENT CONTROL

Section 7.0 of this document presents the conceptual design, design assumptions, logistics, and construction details associated with Alternative 5 as it applies to Bluffs A, B, G, H, I, J, K_1, and L.

8.5.1 Overall Protection of Human Health and the Environment

This alternative would provide a means of reducing exposure to the COCs and would stabilize the surfaces of the sources with respect to migration to surface water. However, the reduction in risk to human health and the environment would not be sufficient to achieve the risk reductions dictated by the risk assessment.

Some protection of human health would be achieved under this alternative. Reduction of human exposures to COCs via the pathways of concern, as identified in the human health risk assessment, would occur. Exposure to COCs via contaminated surface soil would be reduced.

Some protection of the environment would be achieved under this alternative. Reduction of ecologic exposures, via the scenarios identified in the ecologic risk assessment, would occur; however, terrestrial wildlife exposure to arsenic and terrestrial plant exposure to molybdenum would persist.

A risk reduction achievement matrix (Table 8-10) was developed to assess whether the alternative affords sufficient protection to human health and the environment for the exposure scenarios and source bluffs identified in the human health risk assessment (Section 5.1) and the ecologic risk assessment (Section 5.2). The conclusions presented on the table are based on worst-case modeling results subject to the limitations and assumptions used in the models (Section 8.1).

TABLE 8-10
RISK REDUCTION ACHIEVEMENT MATRIX - ALTERNATIVE 5

	Target Risk Reductions		Reduction by Alternative 5
	Human Health*	Ecologic	
BLUFF A	96%	100%	73%
BLUFF B	74%	100%	84%
BLUFF G	94%	100%	81%
BLUFF H	93%	100%	76%
BLUFF I	75% (Arsenic)	79%	53%
BLUFF J	60%	98%	81%
BLUFF K	17% (Arsenic)	89%	78%
BLUFF L	NR	NR	63%

NR = Risk reduction not required.
* Assumes the permit holder exposure, 1 x 10^{-6} risk level, and $radium^{226}$ (except bluffs I and K where Arsenic is used).

8.5.2 Compliance with ARARs

All location-specific and action-specific ARARs would be met by implementing this alternative. There are no chemical-specific ARARs that apply to in-place stabilization/containment of contaminated solid media. Some chemical-specific water quality ARARs are not expected to be achieved under this alternative. **The reclamation alternatives evaluated in detail are applicable to the contaminated solid media; no reclamation alternatives for groundwater, surface water, or contaminated stream sediments are analyzed in detail. The rationale for not directly developing reclamation alternatives for these environmental media is based primarily on the presumption that reclaiming the contaminant source(s) will subsequently reduce any problems associated with groundwater, surface water, or stream sediments at a significantly reduced cost.** A water quality ARARs attainment matrix (Table 8-11) was developed to assess whether the alternative can achieve ARARs for those contaminants and media where they are exceeded. The conclusions presented in the table are based on worst-case modeling results subject to the limitations and assumptions used in the models (see Section 8.1 for discussion).

TABLE 8-11
WATER QUALITY ARARs ATTAINMENT FOR ALTERNATIVE 5

Alternative 5	Arsenic - Drinking Water	Arsenic - Acute Aquatic Life	Total Uranium - Drinking Water	$Radium^{226}$ - Drinking Water
Modeled Surface Water conc.	150 μg/L	150 μg/L	26 μg/L	0.9 pCi/L
Surface Water ARAR	10 μg/L	340 μg/L	30 μg/L	5 pCi/L
Surface Water ARAR met?	No	Yes	Yes	Yes

μg/L – micrograms per Liter
pCi/L - picocuries per Liter

8.5.3 Long-Term Effectiveness and Permanence

Under this alternative, the soil covers over the waste consolidation areas, graded surfaces, and sediment control structures would have to be maintained to ensure that they continue to perform as designed; consequently, long-term monitoring and frequent inspection and maintenance would be required. The soil covers and graded surfaces would be susceptible to settlement, ponding of surface water, erosion, and disruption of cover integrity by vehicles, deep-rooting vegetation, and burrowing animals. However, the surfaces and sediment control structures could be easily inspected and the required maintenance could be easily determined.

Excavation, hauling, consolidation of contaminated materials, grading and revegetation of the spoils materials would stabilize the wastes by providing an erosion-resistant, vegetated surface that would provide protection from surface water and wind erosion, and would reduce net infiltration through the contaminated media by increasing evapotranspiration processes. Consolidation, covering and revegetation of the acutely contaminated materials would consequently reduce the threat of direct contact and inhalation of airborne contaminants by on-site and nearby receptors. The long-term effectiveness of revegetation would be enhanced by determining proper amendments and selecting appropriate plant species adapted to the growing seasons and site environment.

For Bluffs I and L, no acutely contaminated materials would require removal and consolidation. However, removal and consolidation of spoils materials from sensitive areas are included as part of this reclamation alternative for Bluffs I and L.

Over the long term, the water quality and sediment environment (benthic community) in Schleichart Draw, Upper Pete's Creek, and the surrounding intermittent dry drainages would be improved by implementing this alternative. The acutely contaminant sources most likely to impact the streams and drainages would be removed from their current, potentially unstable locations and placed in a more stable location. Additionally, the comprehensive grading and containment strategy would improve the aesthetic quality of the area. The long-term effectiveness should be monitored by frequent inspections of the reclaimed site and subsequently maintained, when necessary.

8.5.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The primary objective of this alternative is to provide a major reduction in contaminant mobility; waste volume or toxicity would not be reduced by this alternative. Removal, consolidating of acutely contaminated wastes to a stable location, grading, and revegetating would stabilize the wastes and reduce contaminant mobility via surface water and wind erosion. Potential groundwater impacts would also be reduced by decreasing net infiltration through the waste sources. The mobility of the on-site contaminants is expected to be reduced to an extent that would result in an overall (all pathways and all routes of exposure considered) risk reduction of 85% (based on modeling results).

8.5.5 Short-Term Effectiveness

It is anticipated that the construction phase of this alternative would be accomplished in a relatively short time period (several bluffs per field season); therefore, impacts associated with construction would be short term and minimal. On-site workers would be adequately protected during the construction phase by utilizing appropriate personal protective equipment and by following proper operating and safety procedures; however, short-term air quality impacts to the surrounding environment may occur due to the large volume of wastes requiring handling. Control of fugitive dust emissions would be accomplished by applying water (via water truck) to surfaces receiving heavy vehicular traffic, or in construction areas, etc. Short-term impacts to the surrounding community are expected to be minimal due to the remote location of the project site and the small resident population. Short-term impacts to the surrounding community would involve increased vehicle traffic (and associated safety hazards, noise, and dust generation) in the vicinity of Buffalo, South Dakota, and the surrounding private property located near the site as a result of the construction. Application of water to roads in these areas may become necessary if dust generation is significant.

8.5.6 Implementability

This alternative is both technically and administratively feasible, and could be implemented in a relatively short period of time. The excavation, hauling, consolidation, grading, covering, and revegetation steps required are considered conventional construction practices; materials and construction methods are readily available. Also, design methods and requirements are well documented and well understood. However, the construction steps required to implement this alternative are considered moderately difficult (due mostly to the rough/steep terrain and limited space for maneuvering in the vicinity of several of the waste sources). The greatest challenge related to implementability of this alternative includes work on the spoils piles and berm materials located in close proximity to rimrock edges and working on extremely steep slopes. Careful planning for laying out the sequence of the necessary construction steps would be required both in the design and construction phases of this alternative.

8.5.7 Costs

Costs associated with implementing Alternative 5 are summarized in Table 8-12. Detailed cost estimates can be found in the cost tables located in Appendix E.

TABLE 8-12
ESTIMATED COST FOR ALTERNATIVE 5

INDIVIDUAL BLUFF	ESTIMATED COST
Bluff A	$952,176.00
Bluff B	$12,943,004.00
Bluff G	$730,150.00 - $1,217,060.00
Bluff H	$2,070,587.00
Bluff I_1 and I_2	$1,993,119.00
Bluff J	$847,905.00 - $1,060,745.00
Bluff K_1	$335,043.00
Bluff L	$1,091,286.00

9.0 RILEY PASS SITE COMPARATIVE ANALYSIS OF ALTERNATIVES

This section provides a comparison of the reclamation alternatives retained for the Riley Pass Site. The comparison focuses mainly on the following criteria: 1) the relative protectiveness of human health and the environment that would be provided by the alternatives; 2) the long-term effectiveness that would be provided by the alternatives; and 3) the estimated attainment of chemical-specific ARARs for each alternative. Modeling results are used in the comparisons to contrast the two threshold criteria of "overall protection of human health and the environment" and "compliance with ARARs" for each alternative. The primary balancing criteria are also compared, although the evaluation of each of these criteria is very similar due to the technical similarities in the alternatives themselves, with the exception of costs. Table 9-1 presents a summary of the alternatives with respect to the first seven NCP evaluation criteria.

Of the alternatives retained for the site, Alternative 5 provides the greatest overall protectiveness of human health and the environment (for those bluffs to which the alternative is applicable [A, B, G, H, I_1, I_2, J, K_1, and L]). Alternative 5 is expected to provide approximately 15% to 20% greater risk reduction than Alternatives 3 or 4; however, none of the alternatives are expected to provide adequate risk reduction over the long term to meet the requirements of the risk assessment for the exposures evaluated. This is in part due to the standard assumption that the covers installed over the wastes may deteriorate over time creating a pathway for future exposures to the site wastes. Consequently, long-term monitoring and maintenance would be required regardless of which alternatives were implemented at the Riley Pass Site. As indicated in Section 5.0 of this document, arsenic is the contaminant at the site that is the ultimate driver of the human health risk assessment; however, to achieve adequate human health risk reduction, $radium^{226}$ also is a major contributor to overall site risk and is well above background levels (see section 6.2). As long as the wastes containing $radium^{226}$ at the site are adequately covered with soil (i.e., minimum of 24 inches of clean soil cover), and the covers are maintained over the long term, exposure to $radim^{226}$ will be negligible. Therefore, maintenance of any reclamation alternative implemented at the site is extremely important.

Each of the alternatives is expected to achieve compliance with all action- and location-specific ARARs; however, none of the alternatives are expected to attain compliance with all chemical-specific ARARs. Specifically, drinking water standards for arsenic are expected to be exceeded in surface water regardless of which alternative may be implemented. This may not be a major issue if Pete's Creek and Schleichart Draw are not used as sources of drinking water. Acute aquatic life criteria are expected to be satisfied by implementing Alternatives 4 or 5.

The proposed alternatives are somewhat similar to one another. Under none of the proposed alternatives would the wastes actually be treated to reduce contaminant volume or toxicity; however, each of the alternatives would provide varying degrees of reduction in contaminant mobility. In general, the greater the reduction in contaminant mobility provided by a specific alternative, the greater the cost.

The short-term effectiveness is expected to be similar for each of the alternatives. The alternatives are all technically similar, and the construction steps required to implement them would be similar as well. Each of the proposed alternatives may have short-term impacts to

Pete's Creek and Schleichart Draw due to the need to work in close proximity to the drainages. However, Best Management Practices (BMPs) would be required to be implemented as part of the construction phase to minimize potential impacts to surface water resources.

Each of the proposed alternatives may have short-term impacts on residents or recreational users in the vicinity of the site, including increased noise and dust levels and increased traffic dangers. Air quality impacts would likely be greater for Alternative 5, compared to the other alternatives, due to the need to excavate and haul greater volumes of materials.

The implementability of most of the alternatives is expected to be similar. All alternatives use conventional design and construction techniques. For ease of construction, Alternative 3 would probably be the easiest alternative to implement because it involves general grading and revegetation of spoils piles and construction of sediment control structures. Alternative 5 would likely be the most difficult and time consuming to implement due to the need to excavate and haul waste sources to consolidation areas. However, the volume of materials requiring excavation and hauling under Alternative 5 is not large, and would not be significantly more time consuming to implement than the other alternatives. Any of the alternatives would require the import of a significant amount of organic materials; materials availability and scheduling of delivery may make any of the alternatives somewhat difficult to implement.

Table 9-1 indicates the estimated total costs associated with each alternative. Of the various alternatives considered for the site, Alternative 3 is the least costly to implement. Alternative 4 is the next least expensive alternative, and Alternative 5 is the most costly; however, Alternatives 4 and 5 are expected to attain more chemical-specific ARARs in surface water (specifically the aquatic life standard for arsenic).

While none of the alternatives by themselves would attain a level of human health and ecologic risk reduction that complies with the risk reduction goals for the site, Alternative 5 provides the greatest overall protectiveness of human health and the environment (for those bluffs to which the alternative is applicable [A, B, G, H, I_1 and I_2, J, and K_1]). The required reduction in ecologic risk at the site (to comply with the risk reduction goals for the site) would be extremely difficult or impossible to attain. The concentrations of arsenic and selenium that are required for no effect on terrestrial plants are below local background soil concentrations.

Estimated reclamation costs are summarized in Table 9-2. Additionally, reduction in human health and ecologic risks provided by each alternative are summarized in Table 9-2. Table 9-2 shows that there is a relatively wide range in overall risk reduction and cost-effectiveness provided by each of the alternatives. As indicated in Table 9-2, Bluffs B, H, C, and G contribute the vast majority of human health and environmental risk at the site (ranked in order of relative contribution of risk at the site). These four bluffs are estimated to contribute approximately 97% of the total risk applicable to the entire site. Consequently, implementing the most aggressive reclamation activities at these bluffs will maximize risk reduction at the site. The remaining bluffs each contribute 1% or less of the risk applicable to the entire site.

TABLE 9-1: COMPARATIVE ANALYSIS OF ALTERNATIVES

Assessment Criteria	Alternative 1: No Action	Alternative 3: Minimal Grading and Sediment Control	Alternative 4: Comprehensive Grading and Sediment Control	Alternative 5: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated Materials, and Sediment Control
Overall Protectiveness of Public Health, Safety, and Welfare -	No reduction in risk.	Minimal stabilization of sources is expected to reduce human and ecologic exposures by 44% overall based on a risk of 10^{-6}.	Comprehensive stabilization of sources is expected to reduce human and ecologic exposures by 8% overall overall based on a risk of 10^{-6}.	Consolidation / containment of selected wastes is expected to reduce human and ecologic exposures by 73% overall overall based on a risk of 10^{-6}.
Environmental Protectiveness -	No protection offered.			
Compliance with ARARs -				
Chemical Specific	MCL for As, U, and Ra in on-site SW not attained. Aquatic Life Criterion for As in on-site SW not attained	MCL for As and U in on-site SW not attained. Aquatic Life Criterion for As in on-site SW not attained	MCL for As and U in on-site SW not attained.	MCL for As in on-site SW not attained.
Location Specific	None Apply	All location-specific ARARs would be met.	All location-specific ARARs would be met.	All location-specific ARARs would be met.
Action Specific	None Apply	All action-specific ARARs would be met.	All action-specific ARARs would be met.	All action-specific ARARs would be met.
Long-Term Effectiveness and Permanence -				
Magnitude of Residual Risk	No reduction in CoC levels in any environmental media, except by natural degradation/erosion.	44% risk reduction expected overall. Level of risk reduction would not attain rancher, recreational, or ecologic compliance for the site.	8% risk reduction expected overall. Level of risk reduction would not attain rancher, recreational, or ecologic compliance for the site.	73% risk reduction expected overall. Level of risk reduction would not attain rancher, recreational, or ecologic compliance for the site.
Adequacy and Reliability of Controls	No controls over any on-site contamination, no reliability.	Stabilization controls are adequate for intended purposes; however, long-term reliability is questionable due to physical location of some sources in floodplains.		Acutely contaminated waste sources would be removed and effectively isolated from human and environmental receptors.
Reduction of Toxicity, Mobility, and Volume -				
Treatment Process Used and Materials Treated	None.	Stabilization via grading and revegetation to reduce mobility of CoCs. Future impacts to SW (Pete's Creek and Schleichart Draw) may be reduced.	Comprehensive stabilization of sources expected to provide significant reduction in mobility of CoCs for all pathways.	Removal and containment of selected sources expected to provide a significant reduction in mobility of CoCs for all pathways.
Volume of Contaminated Materials Treated	No reduction in CoC toxicity, mobility, or volume.	Only exposed surfaces would be treated.	Only exposed surfaces would be treated.	No volume actively treated; however, over 100,000 cy of acutely contaminated materials removed and isolated from human and environmental receptors.
Expected Degree of Reduction	Minimal, via natural degradation only. (potential for future increases in mobility of contaminants).	Volume of wastes would not be reduced; however, mobility of CoCs would be moderately reduced.	Vol. or tox. of CoCs not reduced; however, considerable reduction in mobility expected.	Vol. or tox. of CoCs not reduced; however, significant reduction in mobility expected.
Short-Term Effectiveness -				
Protection of Community During Reclamation Action	Not applicable.	Fugitive emissions control may be required during construction.	Fugitive emissions control may be required during construction.	Fugitive emissions control may be required during construction.
Protection of On-Site Workers During Reclamation Action	Not applicable.	Expected to be sufficient. Safety hazards likely more prevalent than hazards associated with wastes.	Expected to be sufficient. Safety hazards likely more prevalent than hazards associated with wastes.	Expected to be sufficient. Safety hazards likely more prevalent than hazards associated with wastes.
Environmental Impacts	Same as baseline conditions.	Environmental (SW) impacts possible due to waste treatment activities near active stream channels and floodplains.	Environmental (SW) impacts possible due to waste treatment activities near active stream channels and floodplains.	Environmental (SW) impacts possible due to waste treatment activities near active stream channels and floodplains.
Time Until Reclamation Action Objectives are Achieved	Not applicable.	Multiple bluffs per field season.		Multiple bluffs per field season.
Implementability -				
Ability to Construct and Operate	No construction or operation involved.	Moderately difficult to implement due to location and steepness of terrain.	Moderately difficult to implement due to location and steepness of terrain.	Moderately difficult to implement due to location and steepness of terrain.
Ease of Implementing More Action if Necessary	Not applicable.	Easily implementable (additional erosion control / stabilization, etc.) if determined to be necessary.	Easily implementable (additional erosion control / stabilization, etc.) if determined to be necessary.	Easily implementable (additional erosion control / stabilization, etc.) if determined to be necessary.
Availability of Services and Capacities	Not applicable.	Available locally and within the state.	Available locally and within the state.	Available locally and within the state.
Availability of Equipment and Materials	Not applicable.	Available locally and within the state.	Available locally and within the state.	Available locally and within the state.
Estimated Capital Cost	**$0.00**	**Varies Bluff-Specific**	**Varies Bluff-Specific**	**Varies Bluff-Specific**

TABLE 9-2: ALTERNATIVES COST EFFECTIVENESS COMPARISON SUMMARY

ALTERNATIVE 3				
Source	**Average Site-Wide Risk Contribution**	**Average Risk Reduction**	**Estimated Cost**	**Cost per 1% Reduction in Risk**
BLUFF A	0.6%	20.8%	$760,364	$36,556
BLUFF B	68.4%	56.0%	$7,759,080	$138,555
BLUFF C	7.7%	13.0%	$469,784	$36,137
BLUFF D	2.1%	26.0%	$494,099	$19,004
BLUFF E	0.1%	48.8%	$454,222	$9,308
BLUFF F	0.5%	54.2%	$498,071	$9,190
BLUFF G	4.4%	0.0%	$0	$0
BLUFF H	13.0%	17.8%	$893,340	$50,188
BLUFF I_1, I_2, I_3	1.8%	39.9%	$1,501,354	$37,628
BLUFF J	0.3%	60.6%	$636,783	$10,508
BLUFF K_1 & K_2	1.1%	57.9%	$1,010,213	$17,448
BLUFF L	0.1%	56.9%	$710,863	$12,493
ENTIRE SITE	100%	44.2%	$15,188,173	$343,935

ALTERNATIVE 4				
Source	**Average Site-Wide Risk Contribution**	**Average Risk Reduction**	**Estimated Cost**	**Cost per 1% Reduction in Risk**
BLUFF A	0.6%	30.0%	$906,954	$30,232
BLUFF B	68.4%	0.0%	$0	$0
BLUFF C	7.7%	0.0%	$0	$0
BLUFF D	2.1%	0.0%	$0	$0
BLUFF E	0.1%	0.0%	$0	$0
BLUFF F	0.5%	0.0%	$0	$0
BLUFF G	4.4%	0.0%	$0	$0
BLUFF H	13.0%	57.6%	$1,813,792	$31,489
BLUFF I_1, I_2, I_3	1.8%	0.0%	$0	$0
BLUFF J	0.3%	0.0%	$0	$0
BLUFF K_1 & K_2	1.1%	0.0%	$0	$0
BLUFF L	0.1%	0.0%	$0	$0
ENTIRE SITE	100%	7.7%	$2,720,746	$355,653

ALTERNATIVE 5				
Source	**Average Site-Wide Risk Contribution**	**Average Risk Reduction**	**Estimated Cost**	**Cost per 1% Reduction in Risk**
BLUFF A	0.6%	72.5%	$952,176	$13,133
BLUFF B	68.4%	85.0%	$12,943,004	$152,271
BLUFF C	7.7%	0.0%	$0	$0
BLUFF D	2.1%	0.0%	$0	$0
BLUFF E	0.1%	0.0%	$0	$0
BLUFF F	0.5%	0.0%	$0	$0
BLUFF G	4.4%	80.5%	$730,150	$9,070
BLUFF H	13.0%	76.3%	$2,070,587	$27,137
BLUFF I_1, I_2, I_3	1.8%	53.2%	$1,993,119	$37,465
BLUFF J	0.3%	81.3%	$847,905	$10,429
BLUFF K_1	1.1%	77.9%	$335,043	$4,301
BLUFF L	0.1%	62.8%	$1,091,286	$17,377
ENTIRE SITE	100%	73.4%	$20,963,270	$285,603

10.0 PREFERRED ALTERNATIVE

Based on the conclusions of the detailed analysis and comparative analysis of alternatives, a combination of several alternatives is recommended as the preferred alternative at the Riley Pass Site.

As indicated in Section 9.0, Bluffs B, C, G, and H contribute the vast majority of human health and environmental risk at the Riley Pass Site. These four bluffs are estimated to contribute approximately 97% of the total risk at the entire site. Consequently, implementing the most aggressive reclamation activities at these bluffs (Alternative 5: Comprehensive Grading, Consolidation and Containment of Acutely Contaminated materials, and Sediment Control) is recommended to maximize risk reduction at the site Additionally, Alternative 5 is recommended as the preferred alternative for Bluffs J and K_1, because these bluffs contain some acutely contaminated materials, and the difference in cost in implementing Alternative 5 for these bluffs is not significantly greater than implementing Alternative 3 or Alternative 4.

Although Bluff C contributes to human health and environmental risk for the site, given the lack of acutely contaminated material versus the surface area of the Bluff, the implementation of Alternative 5 would not be justified. Therefore, alternative 3 (Minimal Grading and Sediment Control) would be the preferred alternative.

The remaining Bluffs A, D, E, F, $I_{1 \& 2}$, I_3, K_2, and L are all generally small contributors to the total risk at the site; consequently, only minimal reclamation work is necessary to stabilize eroding areas to aid in reducing sedimentation problems. Alternative 3 (Minimal Grading and Sediment Control), is recommended as the preferred alternative for Bluffs A, C, D, E, F, $I_{1 \& 2}$, I_3, K_2, and L. Table 10-1 summarizes the preferred alternative applicable to each individual bluff at the Riley Pass Site, including estimated costs.

TABLE 10-1
PREFERRED ALTERNATIVES SUMMARY
FOR THE RILEY PASS SITE

INDIVIDUAL BLUFF	PREFERRED ALTERNATIVE	ESTIMATED COST*
Bluff A	Alternative 3	$760,364.00
Bluff B	**Alternative 5**	$12,943,004.00
Bluff C	Alternative 3	$469,784.00
Bluff D	Alternative 3	$494,099.00
Bluff E	Alternative 3	$454,222.00
Bluff F	Alternative 3	$498,071.00
Bluff G	**Alternative 5**	$730,150.00 - $1,217,060.00
Bluff H	**Alternative 5**	$2,070,587.00
Bluff I_1 & I_2	Alternative 3	$1,011,078.00
Bluff I_3	Alternative 3	$490,276.00
Bluff J	**Alternative 5**	$847,905.00 - $1,060,745.00
Bluff K_1	**Alternative 5**	$335,043.00
Bluff K_2	Alternative 3	$553,609.00
Bluff L	Alternative 3	$710,863.00

* The estimated cost for reclamation of Bluffs G and J is variable to account for whether acutely contaminated wastes would be consolidated nearby, or hauled to a general/centralized consolidation area.

11.0 REFERENCES

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