PRELIMINARY DRAFT TECHNICAL MEMORANDUM
Revision 1

DEVELOPMENT AND SCREENING OF CANDIDATE ALTERNATIVES
MIDNITE MINE SUPERFUND SITE
WELLPINIT, WASHINGTON

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ABBREVIATIONS AND ACRONYMS

amsl	above mean sea level
ARAR	applicable or relevant and appropriate requirement
ARD	acid rock drainage
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	contaminant of concern
cy	cubic yards
EPA	Environmental Protection Agency
FML	flexible membrane liner
FS	feasibility study
HELP	Hydrologic Evaluation of Landfill Performance
MA	mined area
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NESHAPs	National Emissions Standards for Hazardous Air Pollutants
NORM	naturally-occurring radioactive material
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
$pCi/m^2/s$	picocuries per meter squared per second
PIA	potentially impacted area
PRB	permeable reactive barrier
RA	remedial action
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RME	reasonable maximum exposure
ROD	Record of Decision
TDA	tailings disposal area
UMTRCA	Uranium Mill Tailings Radiation Control Act

1.0 INTRODUCTION

This document presents candidate alternatives for evaluation in the Midnite Mine feasibility study (FS). Each candidate alternative is described and subjected to a preliminary evaluation of effectiveness, implementability, and cost consistent with U.S. Environmental Protection Agency (EPA) guidance (EPA 1988). Based on this screening, the alternatives recommended for detailed analysis in the FS are identified. Finally, key issues for the detailed analysis are identified. The site location is shown in Figure 1-1.

The primary objective of this phase of the FS is to develop an appropriate range of remedial alternatives for waste management that will protect human health and the environment and meet applicable or relevant and appropriate requirements (ARARs). The screening will reduce the large number of candidate alternatives to a smaller, more manageable number of alternatives, which will be analyzed more fully in the detailed analysis phase of the FS. The alternatives that have been developed are comprehensive, sitewide alternatives, consistent with EPA guidance.

The geographic scope of the alternatives includes the mined area (MA), as located within the MA boundary shown in Figure 1-2, and other mining-affected areas surrounding the MA. The MA is defined as the 343 acres where the surface has been disturbed by historical mining operations conducted between 1955 and 1981 (SMI 1996)[1]. The major features of the MA are shown in Figure 1-2 and include:

- Two open pits, Pit 3 and Pit 4, that are partially filled with water
- Areas of mine spoils and waste rock
- Ore and protore stockpiles
- Former open pits that have been backfilled with waste materials
- Other surface water, including surface impoundments, seeps, and ditches
- A water treatment facility and associated seep collection sumps and weirs
- Access and haul roads within the MA

Other mining-affected areas surrounding the MA include:

- Drainages that receive runoff from the MA
- Downwind areas
- Haul roads

Contaminated sediments in the Blue Creek delta in Lake Roosevelt are not included in the scope of the alternatives.

[1] This area does not include a potentially disturbed area encompassing approximately 7 acres, which is located north of the shop and office buildings and included within the MA boundary shown in Figure 1-2.

This technical memorandum is the second of two documents that have been prepared to provide an opportunity for stakeholders to provide early input into the FS. The first technical memorandum, titled "Remedial Action Objectives, Midnite Mine Superfund Site, Wellpinit, Washington" dated June 13, 2003 (EPA 2003a), presented preliminary remedial action objectives (RAOs) for the site. These memoranda will be revised and updated, based on stakeholder input, and incorporated into the draft FS.

This document provides an opportunity for stakeholders to provide early input into the development and analysis of alternatives. Following stakeholder input on this document, Sections 2 (Development of Candidate Alternatives), 3 (Descriptions of Candidate Alternatives) and 4 (Screening of Candidate Alternatives) will be updated and incorporated into the Draft FS as Section 4 (Development and Screening of Alternatives). This update may include appropriate modifications to the alternatives; the alternatives are not "locked in" by this current document. In addition, a document will be prepared that presents responses to comments received on this memorandum.

The FS represents one step in the remedy selection process under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Following completion of the FS, a Proposed Plan will be prepared that identifies the preferred alternative. The Proposed Plan will be distributed for public review and comment. Following the public comment period on the Proposed Plan, a Record of Decision (ROD) will be prepared that identifies the selected remedy.

The alternatives presented in this document have been developed to a level of detail that is adequate to support the alternative screening evaluation. Following the alternatives screening, additional detail will be developed, as needed, to support the detailed analysis in the FS, development of the preferred alternative in the Proposed Plan, and, ultimately, remedy selection in the ROD. However, the alternatives will not be developed in the FS to a level of detail adequate to support remedial design (RD) and remedial action (RA) necessary to implement the remedy selected in the ROD. Both RD and RA are post-ROD activities.

Clearly, some uncertainty regarding potential performance of the FS alternatives will remain after the detailed analysis has been completed. Additional information may be collected subsequent to the FS, as needed to support remedy selection or post-ROD RD/RA. The additional information may include further site characterization studies or treatability studies to evaluate the potential performance of remedial technologies.

The alternatives identified in this memorandum represent FS work in progress that will continue to evolve and be refined based on reviewer feedback. Please note that the alternatives are not mutually exclusive choices and do not limit the choice of a remedy, which is not formalized until the ROD. Thus, a preferred alternative, as developed in the Proposed Plan, or, subsequently, the selected remedy, as developed in the ROD, can mix the elements of the various alternatives developed in the FS, refine or modify those elements, or add to them. While the FS supplies information for helping select a remedy, information supplementing the FS may be incorporated into the remedy selection process at any time.

Figure 1-1 Site Location

Figure 1-2 Mined Area Features

2.0 DEVELOPMENT OF CANDIDATE ALTERNATIVES

The candidate alternatives development process consists of six steps (EPA 1988):

1. Development of RAOs
2. Development of general response actions
3. Identification of volumes of areas of media to which general response actions might be applied
4. Identification and screening of technologies
5. Identification and evaluation of technology process options
6. Assembly of retained technologies into alternatives that are designed to achieve the RAOs

Preliminary RAOs and general response actions have been developed for five media:

1. Surface and stockpiled material and sediment
2. Surface water
3. Groundwater
4. Air
5. Plants

The preliminary RAOs and general response actions were documented in a technical memorandum (EPA 2003a). Examples of general response actions include no action, institutional controls, containment, excavation and disposal, and treatment. A summary of the estimated volumes and areas of source material present in the MA to which general response actions might be applied (including ore, protore, and waste rock) is presented in Table 2-1.

The identification and screening of technologies was conducted using a two-step process. First, media-specific technologies and process options were identified and screened based on technical implementability. Second, the retained technologies and process options were screened based on effectiveness, implementability, and cost. Following the screening, retained technologies and process options were used to assemble remedial alternatives that address the site contamination.

Technologies and process options were identified for four waste media: surface and stockpiled material, sediment, surface water, and groundwater. Surface and stockpiled materials include backfilled or stockpiled ore, protore, waste rock, overburden, soil, and road materials. Sediment includes sediment present in open pits, ponds, and affected drainages. Surface water comprises seeps, ponded water, and water in open pits and affected drainages.

Technologies retained include use and access controls, covers, surface water controls, physical and hydraulic barriers, onsite and offsite disposal, ex-situ and in-situ physical/chemical treatment, and ex-situ and in-situ biological treatment.

The purposes of the technology screening are to identify a representative process option for each technology type retained for further consideration in the FS and to eliminate process options that do not appear promising. In some cases, more than one process option was retained for a technology type if two or more process options were sufficiently different in their performance that one would not adequately represent the other. Not all retained technologies and process options were used in the alternatives identified in this memorandum. Further, technologies and process options not retained for further consideration in the FS may be re-evaluated after the ROD, during RD, and could be implemented as part of a remedy selected in the ROD.

The results of the technology screening are available at EPA's Midnite Mine website:

<http://yosemite.epa.gov/R10/Cleanup.nsf/6ea33b02338c3a5e882567ca005d382f/25f296f579940d8b88256744000327a5?OpenDocument)>

Table 2-1
Summary of Ore and Protore and Waste Rock Volumes and Areas

Waste Type	Stockpile or Area	Estimated Footprint Area (acres)	Estimated Volume (cubic yards)
Ore and Protore	Protore Stockpile #1	1.7	45,000
	Protore Stockpile #2	1.4	40,500
	Suspected Protore Stockpile #1	2.5	71,000
	Suspected Protore Stockpile #2	0.5	2,500
	Ore Stockpile #3	2.4	72,000
	Protore Stockpile #4	4.8	250,000
	Ore and Protore Stockpile #5	2.4	42,000
	Ore and Protore Stockpile #6	14	611,000
	Ore Stockpile #7	2.4	64,000
	Lime Protore Stockpile #8	6.7	323,000
	Suspected Ore Stockpile Q2	1	21,000
	Total Ore and Protore	**40**	**1,540,000**
Waste Rock Piles	South Spoils	105.3	9,470,000
	East Dump	21	961,000
	Hillside Dump	26.7	2,450,000
	Pit 4 Dump and Ready-Line Area	10	382,000
	Area 5	34	1,530,000
	Total Waste Rock Piles	**197**	**14,800,000**
Waste Rock in Backfilled Pits	Boyd Pit (backfilled)	11.7	1,450,000
	Pit 2 (backfilled)	4.6	662,000
	Pit 2 West (backfilled)	1.2	86,000
	Adit Pit (partially backfilled)	1.1	11,000
	Total Waste Rock in Backfilled Pits	**19**	**2,200,000**
Totals		**256**	**18,500,000**

Source: U.S. EPA 2003b

3.0 DESCRIPTIONS OF CANDIDATE ALTERNATIVES

Five alternatives have been developed for the FS, including no action (Alternative 1), institutional controls (Alternative 2), and three active alternatives (Alternatives 3, 4, and 5). Alternatives 2 through 5 have 2 to 6 variants, which are distinguished using a letter designation (for example, Alternative 2a). The alternatives are listed below.

Alternative 1 – No Action

Alternative 2 – Institutional Controls and Monitoring

- Alternative 2a. Institutional Controls and Monitoring
- Alternative 2b. Institutional Control, Monitoring, and Continued Existing Water Treatment

Alternative 3 – Above Grade Containment of Surface and Stockpiled Materials, Open Pits Left Open, and Water Treatment

- Alternative 3a. In-Place Containment of Surface and Stockpiled Materials and Existing Water Treatment
- Alternative 3b. Consolidation and Containment of Surface and Stockpiled Materials and Upgraded Water Treatment
- Alternative 3c. Consolidation and Containment of Surface and Stockpiled Materials and Expanded Water Collection and Treatment
- Alternative 3d. Consolidation and Containment of Surface and Stockpiled Materials and In-Situ Groundwater and Pit Water Treatment
- Alternative 3e. Consolidation and Containment of Surface and Stockpiled Materials, Pit 4 Backfilled with Waste Rock, and Water Treatment

Alternative 4 – Open Pits Backfilled Above Static Groundwater Level, Consolidation and Containment of Remaining Surface and Stockpiled Materials, and Existing Water Treatment

- Alternative 4a. Consolidation of Surface and Stockpiled Materials in Unlined Pits and Water Treatment
- Alternative 4b. Consolidation of Surface and Stockpiled Materials in Lined Pits and Water Treatment
- Alternative 4c. Stabilization/Solidification and Consolidation of Surface and Stockpiled Materials in Pits and Water Treatment
- Alternative 4d. Amendment and Consolidation of Surface and Stockpiled Materials in Pits and Water Treatment in Pit 3
- Alternative 4e. Consolidation of Surface and Stockpiled Materials in Unlined Pits with Pit Drain and Water Treatment
- Alternative 4f. Consolidation of Surface and Stockpiled Materials in Pits, Placement of Thick Cap Over Entire MA, Water Treatment, and Expanded Institutional Controls (Restricted Residential Use Scenario)

Alternative 5 – Complete Pit Backfill with Surface and Stockpiled Materials and Water Treatment

- Alternative 5a. Consolidation of Ore, Protore, and Waste Rock in Open Pits with Pit Drains and Water Treatment
- Alternative 5b. Consolidation of Waste Rock in Open Pits, Disposal of Ore and Protore in Offsite Repository, and Water Treatment

3.1 COMMON ELEMENTS

Elements common to two or more candidate alternatives are described in this section. The common elements include institutional controls, monitoring, stormwater management, cover systems, water collection and treatment, stream sediments, and haul roads.

3.1.1 Institutional Controls

Each of the alternatives, except the no-action alternative, includes institutional controls. Since source materials would be left on site under each of the alternatives, these institutional controls would have to be maintained in perpetuity to limit exposure to contaminants of concern (COCs) and protect the integrity of containment systems.

Each alternative includes institutional controls to prohibit residential use where source materials would remain after remedy implementation, except the no-action alternative and Alternative 4f, which would allow restricted residential use. Under Alternatives 2, 3, and 4, the non-residential use area would encompass nearly the entire MA. Under Alternative 5, the non-residential use area would include Pit 3, Pit 4, the backfilled pits area, and potentially the area between Pit 3 and Pit 4. The purposes of this restriction are to limit exposure to COCs, particularly radon in air, and to protect the integrity of containment systems.

Each alternative includes institutional controls to prohibit development of affected groundwater or surface water as a drinking water source. This prohibition would remain in effect until the results of monitoring demonstrate that groundwater or surface water could be safely consumed or used for ceremonial or spiritual purposes. It is anticipated that an extended recovery period would be needed under any of the alternatives before affected groundwater could be safely used for these purposes.

Each alternative, except the no-action alternative and Alternative 5, includes access restrictions. Under Alternative 2, access to the MA would be restricted. Under Alternative 3, access to the open pits would be restricted. Under Alternative 4, access to the open pit highwalls would be restricted. Each of the alternatives would include information programs to inform users about potential risks associated with exposure to COCs in surface material, surface water, sediments, plants, and animal tissue.

3.1.2 Monitoring

Each of the alternatives would incorporate a site-wide, long-term monitoring program that would be designed to detect trends in environmental conditions within the MA, the drainages, and Blue Creek, including its delta in Lake Roosevelt. Data collected under the monitoring program also would be used to prepare the five-year reviews required under CERCLA when contamination is left on site. The program would include monitoring of surface water, groundwater, sediment, and biological resources. In addition, monitoring would be conducted to evaluate cap integrity and mass movement of any steeply sloped areas that may remain after remedy implementation.

3.1.3 Stormwater Management

Alternatives 3, 4, and 5 each include a stormwater management system that would promote runoff, reduce infiltration, and limit erosion and offsite migration of mining source materials. The stormwater management system would include ditches, drains, and settling ponds that would be integrated with the source materials cover systems to intercept clean surface water and convey it to the drainages downgradient of the MA.

3.1.4 Cover Systems

Cover systems to contain source materials within the MA are used under Alternatives 3, 4, and 5. The cover system designs aim to achieve several objectives, including:

- Eliminating the direct exposure pathway to COCs in source materials
- Reducing radon flux to meet the Uranium Mill Tailings Radiation Control Act (UMTRCA) (40 CFR 192.02) and National Emissions Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR 61) standard[2]
- Reducing external radiation exposures to acceptable levels
- Reducing percolation of surface water and diffusion of oxygen through acid rock drainage (ARD)-generating materials
- Supporting vegetation and limiting uptake of COCs through plant roots
- Meeting the longevity requirements of UMTRCA (200 to 1,000 years)
- Minimizing long-term operations and maintenance (O&M), to the extent practical

Two conceptual cover designs were developed for the alternatives screening analysis: a “thick cap” design for site waste materials with generally high radon emanation and ARD generation potential (generally ore and protore) and a “thin cap” design for materials with generally low radon emanation and ARD generation potential (generally waste rock) (Table 3-1).

For the alternatives screening analysis, it was assumed both covers would be homogeneous, vegetated, “water balance” (also called “evapotranspiration”) designs. Using a water balance design, water percolation is limited by storage and evapotranspiration within the cover, and low permeability clay or geosynthetic layers are not used. Clay or geosynthetics were not included at

[2] EPA considers UMTRCA and NESHAPs standards to be relevant and appropriate to CERCLA cleanups. OSWER Directive 9200.4-18 (EPA 1997)

this time because of concerns about the long-term effectiveness of these materials over the 200 to 1,000 year period required by UMTRCA. Depending on the thickness of soil covering and protecting these elements, clay may be subject to damage from vegetation roots or burrowing animals, and geosynthetics may be subject to chemical or physical breakdown. It was assumed both covers would be constructed of locally-available, loamy soil. Local sources of this material have not been identified at this time. Ultimately, the cover designs will depend on the types and quantities of materials that are available, and may include clay and geosynthetic design elements.

An additional cover design was developed for restricted future residential use. For residential use, the UMTRCA radon flux standard is not fully protective for the indoor air exposure pathway, and additional radon attenuation is needed. A thick, multilayer cover design was selected for the residential use scenario.

Conceptual cover designs were analyzed using analytical radon flux calculations (NRC 1989) and the Hydrologic Evaluation of Landfill Performance (HELP) version 3.07 model for evaluating surface water percolation (Schroeder, et al. 1994). Based on these analyses, the conceptual cover designs will meet the UMTRCA and NESHAPs standard (areawide average radon flux not to exceed 20 $pCi/m^2/s$, averaged over a period of at least one year) and reduce percolation of surface water by approximately 60 to 70 percent for the thin cap and greater than 90 percent for the thick cap. A summary of the conceptual cover designs is presented in Table 3-1.

The conceptual cover designs were not explicitly analyzed for attenuation of external radiation. Previous work at the site (SMI 1996) indicates that external radiation attenuation can be achieved using approximately 6 to 30 inches of earthen material, which is a lesser thickness range than would be required for reducing radon flux or surface water percolation to acceptable levels.

It is emphasized that the conceptual cover designs were selected for the alternatives screening analysis. Further evaluation of cover designs will be conducted during the detailed analysis in the FS, and the final cover designs, if covers are included as part of the selected remedy, will be developed during RD.

3.1.5 Water Collection and Treatment

Alternatives 2, through 5 include collection and treatment of impacted site water, to the extent treatment would be needed after source control measures have been implemented. The existing water collection system includes collection of contaminated seep water at the southern perimeter of the MA. This water and contaminated water collected in the site surface water management system is conveyed to Pit 3. Water in Pit 3 and Pit 4 is treated in the onsite water treatment system.

The water treatment system consists of barium chloride added to the water to precipitate radium, and lime added to the water to raise the pH and precipitate other metals and radionuclides in a sludge. Following sludge-thickening and clarification, the treated water is reacidified, filtered to remove suspended solids, and discharged to the Eastern Drainage. The sludge is dewatered using centrifugation and trucked to the mill in Ford, Washington, where it is disposed of in Tailings Disposal Area (TDA) 4. TDA 4 will be closed in the future and will no longer be available for sludge disposal once closure activities start. The date of closure has not been determined at this time, but it is estimated that TDA 4 closure activities will start some time within the period of 2006 to 2011 (Stoffel, personal communication).

If offsite disposal of sludge is used after closure of TDA 4, it is anticipated that the sludge would be classified as Class A low-level radioactive waste. In this case, the sludge would be subject to the limitations under compacts between states for disposal of low-level radioactive waste and would have to be disposed of at the licensed facility in Hanford, Washington, unless approval for out-of-state disposal is obtained from the Northwest Interstate Compact. The Hanford facility has restrictions on the water content of waste it can accept, and further dewatering of the sludge would be required prior to disposal. In addition, stabilization or solidification would be required if the dewatered sludge would form free liquids during transport. Approval from the State of Washington Department of Health would be required for disposal of sludge at the Hanford facility.

Currently, the treatment system does not operate during the winter months. One reason the system is shut down is the sub-freezing winter temperatures, which can freeze water in piping and other equipment. A second reason is steep and icy road conditions, which would increase the likelihood of an accident during sludge transport that could result in the release of radioactive sludge. The volume of sludge that may be stored on site is currently limited, which eliminates the option of storing sludge on site during extended periods of icy road conditions.

The National Pollutant Discharge Elimination System (NPDES) permit limits for the treatment system effluent have been established for uranium, radium, manganese, cadmium, copper, and zinc. Currently, the concentrations of all these constituents are significantly lower in the effluent than the permit limits. However, based on samples collected from the Outfall Pond, concentrations of some constituents, including uranium, manganese, and sulfate, are higher in the effluent than the Tribal water quality standards or background, whichever is higher.

3.1.6 Stream Sediments and Haul Roads

Contaminated sediments in the mine drainage streams and Blue Creek and contaminated haul road fill are potential sources of exposure to COCs. However, the quantities of contaminated materials in these areas and the associated cleanup costs are small compared to the quantities of contaminated material and cleanup costs within the MA. Therefore, cleanup actions for stream sediments and haul roads are not primary factors for screening alternatives, and ranges of cleanup options for these elements have not been developed at this stage. For the detailed analysis, ranges of removal, containment, and treatment options will be identified for these elements.

3.2 ALTERNATIVE 1: NO ACTION

Alternative 1 includes no actions to control exposures of humans and ecological receptors to contaminants. Under Alternative 1, operation of the existing water collection and treatment system would be discontinued. Maintenance of other engineered measures currently in place, such as revegetated waste materials and stormwater management systems, also would be discontinued. Consideration of the no action alternative is required by the National Oil and Hazardous Substances Contingency Plan (NCP).

3.3 ALTERNATIVE 2 AND VARIANTS: INSTITUTIONAL CONTROLS AND MONITORING

Under Alternative 2, institutional controls would be used to limit exposure of humans and, to a lesser extent, ecological receptors to site contaminants. No new removal, containment, or treatment actions would be implemented; however, Alternative 2b includes continued O&M of the existing water collection and treatment system. A long-term monitoring program would be implemented to detect trends in environmental conditions within the MA, the drainages, and Blue Creek, including its delta in Lake Roosevelt.

Two variants of Alternative 2 have been developed:

- Alternative 2a: Institutional Controls and Monitoring
- Alternative 2b: Institutional Controls, Existing Water Treatment, and Monitoring

3.3.1 Alternative 2a. Institutional Controls and Monitoring

Under Alternative 2a, a fence would surround the entire MA to limit access. Institutional controls would prohibit future development of the MA and other mining-affected areas for residential or industrial use. In the MA and other mining-affected areas, institutional controls would prohibit installation of groundwater wells. Fences or warning signage would be placed parallel to the Western and Central Drainages above flood elevation to reduce exposure to contaminated surface water and sediments in these drainages. Warning signage and informational programs would be used to inform potential users of the risks associated with recreating, practicing subsistence, or otherwise consuming plants, game animals, or water from mining-affected areas.

Under Alternative 2a, operation of the existing water collection and treatment system would be discontinued. No control would be exercised over water levels in Pits 3 and 4. Maintenance of other engineered measures currently in place, such as revegetated waste materials and stormwater management systems, also would be discontinued.

3.3.2 Alternative 2b. Institutional Controls, Continued Existing Water Treatment, and Monitoring

Alternative 2b would include the same elements as Alternative 2a, plus operation of the existing water collection and treatment system and maintenance of other measures currently in place. Sludge generated by the treatment system would continue to be disposed of at the Ford facility until closure of TDA 4 (between 2006 and 2011). An alternate sludge disposal method would be needed after closure of TDA 4. For FS analysis, it is assumed a lined sludge disposal cell would be constructed in the southwest part of the site in the vicinity of the former mine offices.

The plant currently operates 4 days per week, 24 hours per day, typically beginning in April and continuing until the water levels in the pits have been drawn down. Based on 2001 and 2002 plant operations data, the current sludge generation rate is approximately 800 tons per year. The facility operates under an NPDES permit that establishes discharge limits for uranium, radium, manganese, cadmium, copper, and zinc. The concentrations of these constituents in the effluent are consistently lower than the permit limits. However, based on water quality samples collected from the Outfall Pond, concentrations of uranium, manganese, and sulfate exceed tribal water quality standards and ecological screening benchmarks or background, whichever is higher.

3.4 ALTERNATIVE 3 AND VARIANTS

Alternative 3 variants include above-grade containment of mining waste materials. The open pits remain open (with the exception of Alternative 3e, which includes backfilling Pit 4). The cover system includes a “thick” cap over areas containing ore and protore and a “thin” cap over other areas containing waste rock (see Table 3-1). To protect the containment systems constructed under Alternative 3 and reduce human health risks, institutional controls would prohibit residential use in the MA.

Various water and sludge management options are evaluated under Alternative 3, including:

- Existing treatment
- Upgraded treatment
- Expanded collection (including groundwater in the drainages) and treatment

- In-situ treatment, including permeable reactive barriers (PRBs) at existing seep collection points and lime neutralization of pit water
- Disposal of sludge in an onsite repository
- Disposal of sludge in a licensed, offsite disposal facility

A key element of all Alternative 3 variants is reducing the volume of surface water that percolates through mining waste material, thereby reducing ARD generation and water treatment requirements. Based on hydrologic modeling presented in the Phase 1 Hydrologic Modeling Technical Memorandum (EPA 2002), interflow[3] that results from percolation through 164 acres of currently uncapped, disturbed area accounts for an estimated annual average of 38 million gallons of water collected at the seeps. The total measured (1992 to 2000) annual average of water collected at the seeps is 44 million gallons. The source-containment measures implemented under Alternative 3 would reduce percolation by an estimated 60 percent or more within the seep recharge area, which would substantially reduce seep flows.

Treatment of water in Pits 3 and 4 would be continued, as needed. The water level in Pit 4 would be maintained at current levels (less than elevation 3020 feet amsl). Although Pit 4 is a net groundwater sink, discharge from Pit 4 to the subsurface has occurred at water levels higher than about 3020 feet amsl. Some of that discharge historically has reemerged as seepage from the Pit 3 highwall.

Pit 3 also currently acts as a net groundwater sink. If the quality of water in Pit 3 improves to acceptable levels, the water elevation would be allowed to rise. Allowing the water level to rise should increase evaporation and reduce groundwater discharge into Pit 3, thereby reducing water treatment requirements. If pumping from Pit 3 was discontinued, it is anticipated that the water level would naturally rise to the elevation of the bedrock "lip" (estimated to be approximately 2700 feet amsl). The water level also could be manipulated by constructing a drainage system. For FS analysis, it is assumed a drainage system would be constructed at an elevation of 2660 feet amsl, and the collected contaminated water would be pumped to the treatment plant (elevation 2750 feet amsl). Alternatively, if the water meets water quality standards, an open channel or culvert would be excavated so that the water could drain by gravity to the Eastern Drainage. An elevation of 2660 feet amsl was assumed for FS analysis because water balance calculations presented in the technical memorandum "Revised Phase 1 Water Balance for the Midnite Mine" (SMI 1999) suggested that a net discharge from Pit 3 to the groundwater system may occur if the water level rises above this elevation.

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[3] At Midnite Mine, interflow consists of groundwater within the unconsolidated materials that generally flows on top of the pre-mining surface and converges toward the buried pre-mining drainages.

Following implementation of source containment measures, including a stormwater collection system, runoff water would be uncontaminated and would be discharged directly to the drainages. It is anticipated that use of Pit 3 for storage of contaminated seep and surface water flow could be phased out as seep flows decline as a result of source-containment measures. The need for an alternate storage facility for untreated water would be evaluated based on observed reductions in contaminated seep and surface water flows.

Selected containment or excavation and disposal of contaminated surface materials and sediments would be conducted under Alternative 3 in mining-affected areas outside of the MA (i.e., haul roads and drainages) to reduce potential exposures of humans and ecological receptors to COCs.

An overview summary of the elements of the Alternative 3 variants is presented in Table 3-2.

3.4.1 Alternative 3a. In-Place Containment of Surface and Stockpiled Materials and Existing Water Treatment

Alternative 3a includes regrading and in-place containment of surface and stockpiled material to reduce exposure to radionuclides and metals and percolation of surface water. The stockpiled ore and protore materials, the South Spoils, the Pit 4 Dump, and the East Dump would be regraded to a maximum sideslope of 3H:1V to increase stability and facilitate cap construction. Additional benches on long slopes would be constructed to enhance slope stability, limit surface erosion, and provide maintenance access. Stockpiles 5, 8, and Q2 would have to be relocated to allow regrading of the South Spoils to 3H:1V. These materials would be consolidated with Stockpiles 3 and 4. An estimated 2.3 million cubic yards of material would be regraded to flatten the South Spoils to 3H:1V. The Hillside Dump would not be regraded or capped. This area is largely revegetated and appears to be a lesser source of ARD than some other source areas.

A thick cap would be placed over areas containing ore or protore. A thin cap would be placed over the remaining areas. The estimated areas of thick and thin caps are approximately 60 and 170 acres, respectively. A conceptual capping plan for Alternative 3a is shown in Figure 3-1.

Water collection and treatment would continue as currently conducted, and use of Pit 3 for untreated water storage would be phased out. Sludge disposal at the Ford facility would continue until closure of TDA 4. An alternate sludge disposal location would be needed after closure of TDA 4. For FS analysis, it is assumed a lined sludge disposal cell would be constructed to Resource Conservation and Recovery Act (RCRA) Subtitle C standards in the southwest part of the site near the former mine offices.

3.4.2 Alternative 3b. Consolidation and Containment of Surface and Stockpiled Materials and Upgraded Water Treatment

Under Alternative 3b, ore and protore would be consolidated in the southern half of the site in an area above and adjacent to the backfilled pits. This area is centrally located and currently experiences a high rate of percolation. The consolidated ore and protore would be graded for drainage and capped using a thick cap, which would significantly reduce percolation. Other areas of the site containing waste rock, including the Hillside Dump, would be regraded to a maximum sideslope of 3H:1V and capped using a thin cap. One purpose of consolidating the ore and protore would be to reduce capping costs by reducing the area requiring a thick cap.

The estimated areas of thick and thin caps are approximately 30 and 230 acres, respectively. A conceptual capping plan for Alternative 3b is shown in Figure 3-2.

The elements of an upgraded treatment system have not been fully evaluated at this time, but may include processes to achieve the following objectives:

- Reduce sludge volume, thereby reducing sludge disposal costs.
- Reduce treated water COC concentrations to levels that do not exceed surface water quality standards or background, whichever is higher. Point-source discharges under CERCLA must meet ARARs (unless a waiver is obtained). Uranium, manganese, and sulfate concentrations in water samples collected from the Outfall Pond exceed tribal water quality standards or the selected background concentrations, whichever is higher.

Treatability studies would be required to evaluate the potential effectiveness and cost of an upgraded treatment system. For this alternatives screening evaluation, it is assumed that sludge would be dewatered using a filter press, and the dewatered sludge would be disposed of as Class A low-level radioactive waste at the Hanford, Washington, licensed disposal facility.

3.4.3 Alternative 3c. Consolidation and Containment of Surface and Stockpiled Materials and Expanded Water Collection and Treatment

Alternative 3c includes the same elements as Alternative 3b with the addition of expanded groundwater collection and treatment. The expanded water collection includes:

- Pumping water from the backfilled pits
- Groundwater collection trenches near the locations of the existing seep collection points

- Groundwater collection in areas further downgradient, where groundwater discharges to the Western, Central, and Eastern Drainages

The collected water would be treated using the upgraded water treatment system described under Alternative 3b, and treatment sludge would be disposed of at a licensed offsite disposal facility. The volume of water collected from the South Spoils seeps would diminish as a result of capping areas of the MA; it is assumed, therefore, that increased treatment plant capacity would not be needed to treat additional water collected from the backfilled pits and the downgradient areas.

Alternative 3c would be implemented in phases. Source control (containment) would be implemented first, followed by monitoring the effects of these measures on the quantity and quality of interflow and groundwater discharging at the seeps and within areas further downgradient. Based on the results of the monitoring, the additional water collection actions that would result in the greatest reductions in loads of COCs discharging to the drainages would be identified and implemented. Groundwater collection would be conducted using a combination of collection trenches and wells, as appropriate. Groundwater could also be treated in-situ using PRBs, if hydrogeologic conditions conducive to use of these systems exist, to avoid the cost of installing piping and pumping and treating water at the treatment plant. Use of PRBs could be evaluated during remedial design.

Current estimates of average groundwater discharge rates downgradient of the South Spoils seeps are summarized in Table 3-3. It is anticipated these discharges would be reduced to some extent by containment of MA source areas.

A conceptual capping plan for Alternative 3c is shown in Figure 3-2.

3.4.4 Alternative 3d. Consolidation and Containment of Surface and Stockpiled Materials and In-Situ Groundwater and Pit Water Treatment

Alternative 3d includes the same elements as Alternative 3b, except the Western, Central, and Eastern pumpback systems would be replaced by in-situ treatment using subsurface PRBs. In addition, Alternative 3d includes in-situ neutralization of water in Pit 3 using lime. Since in-situ treatment, if successful, would replace the existing pumpback system, the existing treatment system would operate at a greatly reduced rate or would be eliminated altogether. The reduced seepage rates anticipated after installation of the source material containment system would increase the likelihood that PRBs could be implemented successfully.

Treatability studies would be required to design the PRBs. Reactive materials in the PRBs might include zero valent iron, limestone, organic material (to create conditions suitable for growth of sulfate-reducing bacteria), or other materials. Although the PRBs would operate as passive treatment systems, O&M would be required. The O&M would include periodic removal and disposal or regeneration of spent reactive media.

Treatability studies also would be needed to evaluate whether lime addition could lower Pit 3 metal and radionuclide concentrations to levels that would allow discharge to surface water. The lime would be applied at the pit water surface, and it is assumed the lime and pit water would mix at depth as a result of thermal turnover of the pit lake. The degree of mixing that would occur, as well as the frequency that reapplication of lime would be required, is uncertain at this time. In-situ neutralization is currently being conducted under CERCLA in the White King pond in southern Oregon.

In-situ water treatment would use innovative technologies, and the effectiveness of the technologies is uncertain. PRBs for groundwater and lime neutralization for pit water have been selected as representative technologies for FS evaluation based on the documented use of these technologies at other sites. Based on the results of treatability studies, other in-situ treatment technologies may prove to be more effective for the site.

A conceptual capping plan for Alternative 3d is shown in Figure 3-2.

3.4.5 Alternative 3e. Consolidation and Containment of Surface and Stockpiled Materials, Pit 4 Backfilled with Waste Rock, and Water Treatment

Alternative 3e includes the same elements as Alternative 3b, except Pit 4 would be backfilled with waste rock from the adjacent Hillside Dump. For FS analysis, it is assumed all of the Hillside Dump would be replaced in Pit 4. The pit would not be lined. However, the backfill materials would be evaluated for acid generation and neutralization potential, and materials with net acid neutralization potential would be placed in the bottom of the pit and within the zone of groundwater fluctuation. The pit would be capped to limit surface water percolation and ARD generation. Backfilling Pit 4 would eliminate direct exposure to contaminated surface water and sediment in the pit, eliminate the pit highwalls, and restore the pre-mining topography and drainage patterns.

The estimated areas of thick and thin caps are approximately 30 and 230 acres, respectively. A conceptual capping plan for Alternative 3e is shown in Figure 3-3.

The estimated capacity of Pit 4 should be adequate to contain all of the waste rock in the Hillside Dump, if the waste rock is compacted as it is placed. The volume of waste rock in the Hillside Dump is approximately 2.45 million cubic yards. The volume of material excavated from Pit 4 during mining operations is approximately 3.18 million cubic yards.

3.5 ALTERNATIVE 4 AND VARIANTS

Alternative 4 includes partial backfilling of Pits 3 and 4 to above the long-term static groundwater elevation to eliminate direct exposure to contaminated surface water and sediment.

Pit 4 would be partially backfilled with waste rock from the Hillside Dump. Under Alternative 4, Pit 3 backfilling scenarios are:

- Unlined pit, backfilled using ore and protore (Alternative 4a)
- Lined pit, backfilled using ore and protore (Alternative 4b)
- Unlined pit, backfilled using solidified ore and protore (Alternative 4c)
- Unlined pit, backfilled using ore and protore amended with lime and organic material (Alternative 4d)
- Unlined pit, backfilled using ore and protore, with a passive drain to maintain the groundwater level below the ore and protore (Alternative 4e)

A restricted residential land use variant is evaluated under Alternative 4f. All other Alternative 4 variants include institutional controls that would prohibit residential use in the MA to limit human health risks and protect the containment systems.

Under alternatives that do not include a passive drain to maintain the groundwater level below the ore and protore, the long-term static groundwater elevation within the backfilled pits would likely be controlled by the lowest bedrock surface elevation at the perimeter of the pits (i.e., the pits would fill until groundwater “spilled” over the bedrock “lip”).[4] The long-term static groundwater elevation also could be manipulated by constructing a drainage system. For FS analysis, it is assumed groundwater pumping would be used to maintain a maximum water elevation of 2660 feet amsl (the water level currently fluctuates between approximately 2550 and 2570 feet amsl), and the collected contaminated water would be pumped to the treatment plant (elevation 2750 feet amsl). If the water is uncontaminated, an open channel or culvert would be excavated so that the water could drain by gravity to the Eastern Drainage. The pit would be backfilled to a minimum elevation of 2660 feet amsl to prevent groundwater from ponding in the pit. A conceptual plan for backfilling Pit 3 under Alternative 4 is shown in Figure 3-4.

The volume of fill required to backfill Pit 3 to 2660 feet amsl is approximately 2.1 million cubic yards. Backfill volumes and backfill footprint areas for various elevations are shown in Table 3-4a. In addition, a perimeter stormwater drainage system would be constructed to collect stormwater and seep water (if any) runoff from the highwalls and route this water to the treatment plant.

[4] The long-term static groundwater elevation in Pit 3 is not known at this time and may be lower than 2,700 feet, due to reductions in surface water percolation after upgradient source materials are capped.

Similarly, for Pit 4, a drainage system would be constructed that would limit the maximum groundwater elevation to 3060 feet amsl. The volume of fill required to backfill Pit 4 to 3060 feet amsl is approximately 420,000 cubic yards (Table 3-4b).

Since the pits would be backfilled, an alternate storage pond for untreated water may be required, particularly in the winter when the treatment plant normally does not operate. In addition, a temporary storage pond may be needed during remedy construction, depending on the staging of construction activities. The need for a permanent storage pond for untreated water would be evaluated based on observed reductions in contaminated seep and surface water flows.

The backfilled pits would be capped to reduce radon flux and surface water percolation. Mining waste materials that are not placed in open pits would be regraded to a maximum sideslope of 3H:1V and capped.

Water collection and treatment using the existing treatment system is included under each variant. With the exception of Alternative 4d, which includes in-situ water treatment in Pit 3, water management variants are not included at this time. Remedies that include backfilling the pits in combination with various water management options can be evaluated during the Proposed Plan phase, using information developed under Alternatives 3b, 3c, and 3d.

Selected containment or excavation and disposal of contaminated surface materials and sediments would be conducted under Alternative 4 in mining-affected areas outside of the MA (e.g., haul roads and drainages) to reduce potential exposures of humans and ecological receptors to COCs.

An overview summary of the elements of the Alternative 4 variants is presented in Table 3-5.

3.5.1 Alternative 4a. Consolidation of Surface and Stockpiled Materials in Unlined Pits and Water Treatment

Under Alternative 4a, the open pits would be partially backfilled with mining waste material. The pits would not be lined. The waste material in the pits would be capped, and the remaining mining waste on site would be consolidated and capped similar to Alternative 3b. A conceptual capping plan for Alternative 4a is shown in Figure 3-5. For this alternatives screening analysis, it is assumed ore and protore would be used to backfill the open pits below the long-term static groundwater level. Use of ore and protore to backfill the open pits would reduce the thick cap footprint from approximately 30 to 60 acres under Alternative 3 variants to approximately 19 acres under Alternative 4a.

Ore and protore would not be placed above an elevation of 2650 ft amsl to increase the probability that ore and protore would remain submerged during periods of low groundwater elevations. The amount of material needed to fill Pit 3 to a maximum elevation of 2650 ft amsl is approximately 1.8 million cubic yards, which is more than the total volume of 1.5 million cubic yards of ore and protore stockpiled on site. Materials placed above an elevation of 2650 feet amsl would be evaluated for acid generation and neutralization potential, and materials with net acid neutralization potential would be placed in this zone. Waste rock with varying characteristics has been intermixed at the site, which would increase the difficulty of providing suitable material for placement in this zone.

Use of ore and protore to backfill the open pits could be limited by the potential of these materials to generate excessive amounts of ARD. Submerged disposal of the ore and protore would limit the amount of oxygen that would come into contact with these materials, although oxygen would still be present in the groundwater. The pits would be capped to limit percolation of water and diffusion of oxygen through the unsaturated zone, which would also reduce acid generation. Treatability studies would be required to evaluate whether the open pits could be backfilled with ore and protore without generating excessive amounts of ARD.

Protection of groundwater and surface water under Alternative 4a would rely on the slow rates of dissolution of COCs in the pits and the slow rate of discharge from the pits to the groundwater system. Should future monitoring indicate discharge of unacceptable loads of COCs to the groundwater system, pump and treat could be conducted to prevent discharge of water from the pits.

3.5.2 Alternative 4b. Consolidation of Surface and Stockpiled Materials in Lined Pits and Water Treatment

Under Alternative 4b, ore and protore (and potentially other waste materials, depending on available volume) would be consolidated in Pit 3. The pit would be lined to reduce groundwater flow through the ore and protore. Pit 4 would be partially filled with waste rock from the Hillside Dump and would not be lined. For FS evaluation, it is assumed the liner would be constructed using a geosynthetic. Use of a geosynthetic would reduce the liner thickness and increase the pit volume available for disposal of waste materials compared to a clay liner. A liner constructed of clay or other materials (for example, spray-applied compounds) could be evaluated during remedial design.

The pit backfill would be capped with a thick cap. Because of the potential for the pit to fill with water and overflow when the liner is less permeable than the cap (the "bathtub" effect), the containment system would be designed so that the bottom liner is more permeable than the cap.

Assuming Pit 3 is backfilled to an elevation of 2660 feet amsl, the estimated volume of waste material that could be placed in the pit is approximately 2.1 million cy, and the estimated liner surface area is approximately 900,000 square feet.

A conceptual capping plan for Alternative 4b is shown in Figure 3-5.

3.5.3 Alternative 4c. Stabilization/Solidification and Consolidation of Surface and Stockpiled Materials in Pits and Water Treatment

Under Alternative 4c, ore and protore would be solidified into a concrete-like mass of low permeability and consolidated in Pit 3. The low permeability of the solidified mass would limit flow through the waste, ARD production, and radon flux. In addition, chemical reactions with the stabilization/solidification reagents would further stabilize and limit the mobility of metals and radionuclides in the ore and protore. A soil cover would be used to further reduce radon flux and provide for revegetation of the surface. A conceptual capping plan for Alternative 4c is shown in Figure 3-6.

Treatability studies would be required to evaluate the design and effectiveness of the stabilization/solidification process. Preprocessing (crushing) may be required to facilitate handling and mixing of the waste materials. Crushing the material would increase its reactivity if the stabilization/solidification process is not effective.

3.5.4 Alternative 4d. Amendment and Consolidation of Surface and Stockpiled Materials in Pits and Water Treatment in Pit 3

Alternative 4d includes submerged disposal of ore and protore in Pit 3, similar to Alternative 4a. However, under Alternative 4d, the ore and protore would be mixed (amended) with lime, or other material with ARD neutralization capacity, suitable organic material, and any necessary nutrients. The purpose of the amendments would be to limit production of ARD within backfilled Pit 3. The pit would be capped to reduce percolation, but groundwater would be allowed to freely migrate laterally through the amended waste material. Waste rock would be regraded and capped in place or mixed with lime and consolidated in Pit 4. Calc-silicate materials stockpiled on site may provide a source of lime; however, preprocessing (crushing) may be required.

It is assumed that dissolution of the lime would neutralize acidity generated by sulfide minerals, thereby limiting dissolution of metals and radionuclides into the groundwater. It is also assumed that use of the organic material as a carbon source by naturally-occurring microorganisms would result in anoxic conditions and growth of sulfate-reducing bacteria, which could result in precipitation of dissolved metals as insoluble sulfide minerals.

Creation of anoxic effects would potentially have other beneficial effects in addition to precipitation of metals as sulfides. Anoxic conditions would limit the mobility of uranium in groundwater. Uranium in a reduced state, which would occur in anoxic conditions, has low solubility, whereas uranium in an oxidized state is soluble even in circumneutral water. Anoxic conditions also would limit precipitation of iron oxyhydroxides, which tend to coat and reduce the effectiveness of the lime amendments.

Even in anoxic conditions, production of acid could occur due to the presence of ferric ion. However, the solubility of ferric ion decreases rapidly as pH increases. Therefore, increasing the pH through lime addition would reduce acid production by ferric ion.

If these effects occur as assumed, Pit 3 would act as an in-situ bioreactor that could limit ARD generation and remove dissolved metals from groundwater. If Pit 3 effectively acts as a bioreactor, contaminated water (for example, the water that is currently collected at the seeps) could be injected into the pit for treatment, and active water treatment and generation of sludge would be reduced or eliminated. In this case, it is probable that groundwater would discharge from the pits. Depending on the quality of this groundwater, it may be necessary to collect the water and conduct further treatment.

Treatability studies would be required to evaluate the design and effectiveness of this innovative neutralization and precipitation process. Should the process prove effective, it is probable that additional injections of lime, organic material, and/or nutrients would be required after the initial amendments are exhausted.

A conceptual capping plan for Alternative 4d is shown in Figure 3-5.

3.5.5 Alternative 4e. Consolidation of Surface and Stockpiled Materials in Unlined Open Pits with Pit Drain and Water Treatment

Under Alternative 4e, the open pits would be partially backfilled with ore and protore (Pit 3) and waste rock (Pit 4), similar to Alternative 4a. Under Alternative 4e, however, a passive drain would be installed in the bottom of Pit 3 to maintain the groundwater level below the reactive materials and reduce ARD generation. The need for a drain in Pit 4 has not been evaluated at this time. The passive drain would consist of a tunnel bored along a south-southwest alignment through the quartz monzonite to the Western Drainage south of the MA. A potential alternate alignment would run southeast to the Eastern Drainage south of the MA. Additional measures may be incorporated to limit any ARD generation or groundwater infiltration that may occur within the tunnel, if cost effective compared to water treatment. These measures may include constructing the tunnel with a liner to reduce groundwater infiltration into the tunnel or with a leaky bulkhead to maintain saturated conditions within the tunnel.

It is anticipated that the discharge from the drain tunnel would contain metals and radionuclides at concentrations that exceed water quality standards. Therefore, the discharge would be collected and treated in the existing water treatment system.

A conceptual capping plan for Alternative 4e is shown in Figure 3-5.

3.5.6 Alternative 4f. Consolidation of Surface and Stockpiled Materials in Pits, Placement of Thick Cap Over Entire MA, and Expanded Institutional Controls (Restricted Residential Use Scenario)

Restricted residential use would be allowed under Alternative 4f. The open pits would be backfilled above the long-term static groundwater elevation with ore, protore, and waste rock, and the entire MA would be covered with a thick cap to limit the exposure of future residents to radon and external radiation. Institutional controls would be used to:

- Prohibit excavation, except within designated easements, to enhance the integrity of the cap and limit exposure of potential residents
- Prohibit installation of drinking water wells
- Require installation of radon control systems in homes
- Prohibit construction of homes on the partially backfilled open pits

Based on preliminary results of the baseline (current conditions with no remedial actions) risk assessment, the lifetime reasonable maximum exposure (RME) cancer risk to future residents from inhalation of radon in indoor air would be approximately 2 in 10, or 2,000 to 200,000 times EPA's target risk range of 1 in 10,000 to 1 in 1,000,000 (URS 2003). Consequently, additional actions would be needed to mitigate these risks if residential use is permitted. The additional actions under Alternative 4f include disposal of high radon source materials (i.e., ore and protore) in non-residential areas (Pits 3 and 4), use of caps that provide a high degree of radon attenuation, and use of deed restrictions that require installation of radon control systems in homes.

A conceptual capping plan for Alternative 4f is shown in Figure 3-7.

3.6 ALTERNATIVE 5 AND VARIANTS

Alternative 5 includes complete backfill of the open pits with mining waste to pre-mining topography. Mining waste that could not be contained within the open pits would be mounded over the existing backfilled pits area and, if needed, the area between Pits 3 and 4 to enhance surface water runoff. These areas would be capped to limit surface water percolation and radon flux. A layer of suitable soil would be placed over excavated areas, as needed, to enhance revegetation of these areas.

After implementation of Alternative 5, areas containing mining waste would be limited to the existing open pits, backfilled pits, and, if needed, the area between Pits 3 and 4. To protect the integrity of the containment systems, institutional controls would prohibit residential or industrial use in these areas. Residential use would not be prohibited in areas of the MA where source materials would be removed to background concentrations or native material.

Under Alternative 5, mining waste would be removed from the area that drains to the Western Drainage, which should restore streamflow in the Western Drainage within the MA. This removal should result in reduced concentrations of metals and radionuclides in the Western Drainage, which currently is the source of the majority of seep water collected from the site.

Selected containment or excavation and disposal of contaminated surface materials and sediments would be conducted under Alternative 5 in mining-affected areas outside of the MA (e.g., haul roads and drainages) to reduce potential exposures of humans and ecological receptors to COCs.

An overview summary of the elements of the Alternative 5 variants is presented in Table 3-6.

3.6.1 Alternative 5a. Consolidation of Ore, Protore, and Waste Rock in Pits with Pit Drain and Water Treatment

Under Alternative 5a, the open pits would be completely backfilled with ore, protore, and waste rock. A passive drain, similar to that described under Alternative 4e, would be constructed to maintain the groundwater level in Pit 3 below the waste material and limit generation of ARD. In addition, passive drains would be constructed from Pit 4 and the backfilled pits to drain groundwater into Pit 3 and reduce ARD generation in these areas. The backfilled pits would be drained using directional boreholes from both Pit 2 and the Boyd Pit to Pit 3. Pit 4 would be drained using a drain tunnel.

The estimated capacity of Pit 3 is approximately 12.9 million cubic yards, and the estimated capacity of Pit 4 is approximately 3.2 million cubic yards. An estimated 17 million tons of waste rock remain on site, of which an estimated 2.2 million cubic yards are contained in the existing backfilled pits (EPA 2003b). There are an estimated 1.5 million cubic yards of ore and protore stockpiled on site (EPA 2003b). In addition, 2.9 million tons of ore were produced and hauled offsite to the mill in Ford (SMI 1996). Not including the existing backfilled pits, which would not be excavated, the combined total in-place volume of ore, protore, and waste rock on site is an estimated 16.3 million cubic yards. This volume is approximately 0.2 million cubic yards greater than the combined capacity of Pits 3 and 4.

Waste materials placed in the open pits would be compacted to increase the amount of waste material that could be contained in the pits. Nonetheless, based on initial estimates, the capacity of the open pits is unlikely to be adequate to contain all ore, protore, and waste rock on the site. Excess waste rock would be mounded over the existing backfilled pits area and in the area between Pit 3 and Pit 4, if necessary, to enhance surface water runoff. A thick cap would be placed over the filled pit areas, including the existing backfilled pits, to further limit production of ARD. The site would be regraded for proper drainage and revegetated. A conceptual capping plan for Alternative 5a is shown in Figure 3-8.

Water treatment would continue, as needed. Because all source materials would be contained in the drained pits or beneath low permeability covers within limited areas of the site, it is anticipated that the quality of water collected in the pit drainage system may approach background levels over time. Additional measures may be incorporated to limit ARD generation within the drainage tunnels, if cost effective compared to treatment of any ARD produced. These measures may include constructing the tunnels with liners to reduce groundwater infiltration, placing acid-neutralizing material within the tunnels, or constructing the Pit 3 tunnel with a leaky bulkhead to maintain saturated conditions within the tunnel. To the extent water treatment is needed, the treatment sludge would be disposed of in an offsite licensed disposal facility.

3.6.2 Alternative 5b. Consolidation of Waste Rock in Pits, Disposal of Ore and Protore in Offsite Repository, and Water Treatment

Under Alternative 5b, the open pits would be completely backfilled with waste rock to pre-mining topography. Ore and protore would be disposed of in a licensed offsite repository to eliminate residual risks from these materials at the site. A thick cap would be placed over the filled pit areas, including the existing backfilled pits, to limit production of ARD. The site would be regraded for proper drainage and revegetated. A conceptual capping plan for Alternative 5b is shown in Figure 3-8.

The ore and protore would be disposed of as naturally-occurring radioactive material (NORM). The nearest licensed facility, in Hanford, Washington, restricts the volume of NORM that can be accepted to 100,000 cubic feet per year. Therefore, the ore and protore would be taken to a licensed facility in either Grandview, Idaho or Clive, Utah.

Not including the existing backfilled pits, which would not be excavated, the total in-place volume of waste rock on site is an estimated 14.8 million cubic yards. This volume is approximately 1.3 million cubic yards less than the combined capacity of Pits 3 and 4. Nonetheless, the capacity of the open pits may not be adequate to contain all waste rock on the site, depending on the methods used and degree of compaction achieved during pit backfilling. Any excess waste rock would be mounded over the existing backfilled pits area to enhance surface water runoff.

Similar to Alternative 4, it is assumed for FS analysis that the maximum water level in the Pit 3 would be controlled at an elevation of 2660 ft amsl. Waste rock with net acid neutralization potential would be placed below this elevation to limit ARD generation within the pit. Waste rock with varying characteristics has been intermixed at the site, which will increase the difficulty of providing suitable material for placement in this zone. If present, water would be collected from the pit discharge and the seeps, and, if necessary, treated.

Figure 3-1 Conceptual Capping Plan -- Alternative 3a

Figure 3-2 Conceptual Capping Plan -- Alternatives 3b, 3c, and 3d

Figure 3-3 Conceptual Capping Plan -- Alternative 3e

Figure 3-4 Conceptual Backfill Plan for Pit 3 -- Alternative 4

Figure 3-5 Conceptual Capping Plan -- Alternatives 4a, 4b, 4d, and 4e

Figure 3-6 Conceptual Capping Plan -- Alternative 4c

Figure 3-7 Conceptual Capping Plan -- Alternative 4f

Figure 3-8 Conceptual Capping Plan -- Alternatives 5a and 5b

Table 3-1
Summary of Conceptual Cover Design

Cover	Waste	Cover type	Total Thickness (ft)	Cover design	Estimated radon flux[1] ($pCi/m^2/s$)		Estimated surface water percolation		
					Existing	Covered	Existing[2] (in/yr)	Covered[3] (in/yr)	Reduction
Thick cap	Ore and protore	Evapotranspiration	10	0-10 ft.: loam	140	<20	10-13	0.2	98%
Thin cap	Waste rock	Evapotranspiration	4	0-4 ft.: loam	32	<20	10-13	4.2	60%-70%
Multi-layer cap	Ore, protore, and waste rock (future residential use scenario)	Multi-layer	8.5	0-16 in.: topsoil 16-24 in.: topsoil and gravel mixture 24-38 in.: loam 38-50 in.: cobbles (biointrusion layer) 50-64 in.: loam 64-78 in.: sand FML @ 78 in. 78-102 in.: compacted clay	140	<<20	10-13	<0.1	>99%

Notes:
[1]Radon flux estimated using analytical radon flux estimation method presented in "Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Covers. Regulatory Guide 3.64" (NRC 1989).
[2]Estimated surface water percolation for existing conditions presented in "Phase 1 Hydrologic Modeling Technical Memorandum" (EPA 2002).
[3]Estimated surface water percolation for covered conditions estimated using the Hydrologic Evaluation of Landfill Performance (HELP) model version 3.07.
FML = flexible membrane liner

Table 3-2
Overview of Candidate Alternative 3

Site Element	Alternative				
	3a	3b	3c	3d	3e
Overview Description	In-Place Containment of Surface and Stockpiled Materials and Existing Water Treatment	Consolidation and Containment of Surface and Stockpiled Materials and Upgraded Water Treatment	Consolidation and Containment of Surface and Stockpiled Materials and Expanded Water Collection and Treatment	Consolidation and Containment of Surface and Stockpiled Materials and In-Situ Groundwater and Pit Water Treatment	Consolidation and Containment of Surface and Stockpiled Materials, Pit 4 Backfilled with Waste Rock, and Water Treatment
Surface Water Management	Collect clean runoff from undisturbed and capped areas and convey to drainages south of MA	Same as 3a	Same as 3a	Same as 3a	Same as 3a
Ore and Protore Stockpiles	Regrade in place and cap (thick cap)	Consolidate above backfilled pits and cap (thick cap)	Same as 3b	Same as 3b	Same as 3b
South Spoils	Regrade to 3H:1V and cap (thin cap)	Same as 3a	Same as 3a	Same as 3a	Same as 3a
Hillside Dump	No Action	Regrade to 3H:1V and cap (thin cap)	Same as 3b	Same as 3b	Consolidate in Pit 4 and cap (thin cap)
Other Waste Rock	Regrade to maximum 3H:1V and cap (thin cap); establish natural drainage patterns	Same as 3a	Same as 3a	Same as 3a	Same as 3a
Backfilled Pits	Regrade and cap (thick cap over ore and protore, thin cap over other areas)	Cap (thick cap)	Cap (thick cap), collect groundwater and treat	Same as 3b	Same as 3b

Table 3-2 (Continued)
Overview of Candidate Alternative 3

Site Element	Alternative				
	3a	3b	3c	3d	3e
Pit 3	Leave open, pump and treat water, allow water level to rise as water quality improves, sediment left in place	Same as 3a	Same as 3a	Leave open, treat water in-situ using lime addition, allow water level to rise as water quality improves, sediment left in place	Same as 3a
Pit 4	Leave open, pump and treat water, allow water level to rise as water quality improves, sediment left in place	Same as 3a	Same as 3a	Same as 3a	Backfill with waste rock from Hillside Dump and cap (thin cap); sediment buried beneath waste rock
Pit Highwalls	Fence to prevent access; no further action	Same as 3a	Same as 3a	Same as 3a	Pit 4 highwall eliminated; Pit 3 fenced to prevent access
Water Treatment	Existing system, with onsite sludge disposal after closure of Ford facility	Upgraded treatment system, with offsite sludge disposal after closure of Ford facility	Same as 3b	In-situ treatment	Same as 3a
South Spoils Seeps	Collect and treat, to the extent seeps exist after capping is implemented	Same as 3a	Same as 3a	Treat in-situ using PRBs	Same as 3a
PIA Seeps and Groundwater	No action	Same as 3a	Collect and treat or treat in-situ using PRBs	Same as 3a	Same as 3a
Drainage Sediments	Selected excavation, containment, or in-situ treatment	Same as 3a	Same as 3a	Same as 3a	Same as 3a
Haul Roads	Selected excavation or containment	Same as 3a	Same as 3a	Same as 3a	Same as 3a

Table 3-3
Estimated Average Interflow and Groundwater Discharge Rates Under Existing Conditions

Discharge Area	Estimated Average Interflow Discharge[1] (gpm)	Estimated Average Groundwater Discharge[2] (gpm)
Open Pits		
Pit 3	No estimate	16
Pit 4	No estimate	8
Total, Open Pits	No estimate	24
South Spoils Seeps		
Western Drainage	58	8
Central Drainage (Pollution Control Pond)	14	2
Eastern Drainage	1.4	<1
Total, South Spoils Seeps	73	11
Downgradient of the South Spoils Seeps		
Western Drainage	Included in estimated groundwater discharge	11
Central Drainage		<1
Eastern Drainage above Central Drainage		9
Eastern Drainage between Central Drainage and Western Drainage		3
Eastern Drainage below Western Drainage		8
Blue Creek		42
Total, Downgradient of the South Spoils Seeps		73
TOTAL	73	108

Notes:
[1]Average interflow discharges calculated as observed total flow minus observed baseflow, as reported in the Phase 1 Hydrologic Modeling Technical Memorandum (EPA 2002).
[2]Average groundwater discharges were estimated for steady-state conditions using the computer program MODFLOW, as described in the Phase 1 Hydrologic Modeling Technical Memorandum (EPA 2002).

Table 3-4a
Backfill Volumes and Areas for Pit 3

Backfill Surface Elevation (ft amsl)	Backfill Footprint (acres)	Backfill Volume (cy)
2580	6.9	450,000
2600	9.1	800,000
2620	11	1,200,000
2640	13	1,600,000
2660	15	2,100,000
2680	17	2,700,000
2700	19	3,300,000
Total Cut Area and Volume	41.7	12,900,000

Table 3-4b
Backfill Volumes and Areas for Pit 4

Backfill Surface Elevation (ft amsl)	Backfill Footprint (acres)	Backfill Volume (cy)
3010	2.1	76,000
3020	2.9	120,000
3030	3.6	170,000
3040	4.6	230,000
3050	5.8	320,000
3060	7.4	420,000
Total Cut Area and Volume	25.6	3,180,000

ft amsl = feet above mean sea level
cy = cubic yards

Table 3-5
Overview of Candidate Alternative 4

Site Element	Alternative					
	4a	**4b**	**4c**	**4d**	**4e**	**4f**
Overview Description	Consolidation of Surface and Stockpiled Materials in Unlined Pits and Water Treatment	Consolidation of Surface and Stockpiled Materials in Lined Pits and Water Treatment	Stabilization/Solidification and Consolidation of Surface and Stockpiled Materials in Pits and Water Treatment	Amendment and Consolidation of Surface and Stockpiled Materials in Pits and Water Treatment in Pit 3	Consolidation of Surface and Stockpiled Materials in Unlined Pits with Pit Drain and Water Treatment	Consolidation of Surface and Stockpiled Materials in Pits, Placement of Thick Cap Over Entire MA, and Expanded Institutional Controls (Restricted Residential Use Scenario)
Surface Water Management	Collect clean runoff from undisturbed and capped areas and convey to drainages south of MA	Same as 4a	Same as 4a	Same as 4a	Same as 4a	Same as 4a
Ore and Protore Stockpiles	Consolidate in Pit 3	Consolidate in lined Pit 3	Stabilize/solidify and consolidate in Pit 3	Amend with lime and organic material and consolidate in Pit 3	Same as 4a	Same as 4a
South Spoils	Regrade to 3H:1V and cap (thin cap)	Same as 4a	Same as 4a	Same as 4a	Same as 4a	Regrade to 3H:1V and cap (thick cap)

Table 3-5 (Continued)
Overview of Candidate Alternative 4

Site Element	Alternative					
	4a	4b	4c	4d	4e	4f
Hillside Dump	Partial consolidation in Pit 4; regrade to 3H:1V; and cap (thin cap),	Same as 4a	Same as 4a	Same as 4a	Same as 4a	Same as 4a, capped using thick cap
Other Waste Rock	Regrade to 3H:1V and cap (thin cap), establish natural drainage patterns	Same as 4a	Same as 4a	Same as 4a	Same as 4a	Regrade to 3H:1V and cap (thick cap)
Backfilled Pits	Regrade and cap (thin cap)	Same as 4a	Same as 4a	Same as 4a	Same as 4a	Same as 4a, capped using thick cap
Pit 3	Partial backfill with ore and protore and cap (thick cap); sediment buried beneath fill; install groundwater drain at approximately 2660 ft amsl	Line pit, partial backfill with ore and protore, and cap (thick cap); sediment buried beneath fill	Partial backfill with stabilized/solidified ore and protore and cover (soil cover); sediment buried beneath fill	Partial backfill with amended (with lime and organic material) ore and protore and cap (thick cap); sediment buried beneath fill	Excavate sediment; install gravity drain from pit bottom tunnel through quartz monzonite to discharge south of South Spoils; partial backfill with ore, protore, and sediment; and cap (thick cap)	Same as 4a

Table 3-5 (Continued)
Overview of Candidate Alternative 4

Site Element	Alternative					
	4a	4b	4c	4d	4e	4f
Pit 4	Partial backfill with waste rock from Hillside Dump and cap (thin cap); sediment buried beneath fill	Same as 4a	Same as 4a	Same as 4a	Same as 4a	Same as 4a
Pit Highwalls	Height reduced by partial backfill; fenced to prevent access; runoff collected in perimeter drain for treatment	Same as 4a	Same as 4a	Same as 4a	Same as 4a	Same as 4a
Water Treatment	Existing system, with onsite sludge disposal after closure of Ford facility	Same as 4a	Same as 4a	Treat water in-situ in Pit 3. Collect and treat any pit discharge exceeding water quality standards using existing system.	Existing system plus collection and treatment of drainage tunnel discharge (if needed). Onsite sludge disposal after closure of Ford facility.	Same as 4a (if needed)
South Spoils Seeps	Collect and treat, to the extent seeps exist after capping is implemented	Same as 4a	Same as 4a	Same as 4a	Same as 4a	No action; seeps expected to dry up with thick cap over site
PIA Seeps and	No action	Same as 4a	Same as 4a	Same as 4a	Same as 4a	Same as 4a

Table 3-5 (Continued)
Overview of Candidate Alternative 4

Site Element	Alternative					
	4a	4b	4c	4d	4e	4f
Groundwater						
Drainage Sediments	Selected excavation, containment, or in-situ treatment	Same as 4a	Same as 4a	Same as 4a	Same as 4a	Same as 4a
Haul Roads	Selected excavation or containment	Same as 4a	Same as 4a	Same as 4a	Same as 4a	Complete excavation or containment

Table 3-6
Overview of Candidate Alternative 5

Site Element	Alternative	
	5a	**5b**
Overview Description	Complete Backfill of Open Pits with Ore, Protore, and Waste Rock and Water Treatment	Complete Backfill of Pits with Waste Rock, Disposal of Ore and Protore in Existing Offsite Repository, and Water Treatment
Surface Water Management	Reestablish natural drainage patterns in Western Drainage; collect clean runoff from undisturbed and capped areas and convey to drainages south of MA	Same as 5a
Ore and Protore Stockpiles	Excavate and consolidate in Pit 3	Excavate and dispose of in licensed offsite facility
South Spoils	Excavate and consolidate in open pits	Same as 5a
Hillside Dump	Excavate and consolidate in open pits	Same as 5a
Other Waste Rock	Excavate and consolidate in open pits. Excess waste rock would be mounded over the existing backfilled pits area to enhance runoff.	Excavate and consolidate in open pits
Backfilled Pits	Cap (thick cap) and install gravity drain to Pit 3	Cap (thick cap)
Pit 3	Complete backfill with ore, protore, and waste rock and cap (thick cap); install gravity drain	Complete backfill with waste rock and cap (thick cap)
Pit 4	Complete backfill with waste rock and cap (thick cap); install gravity drain to Pit 3	Complete backfill with waste rock and cap (thick cap)
Pit highwalls	Pit highwalls eliminated by complete backfill	Same as 5a
Water Treatment	Existing system, with offsite sludge disposal after closure of Ford facility (if needed)	Same as 5a
South Spoils Seeps	Collect and treat, to the extent seeps exist and exceed water quality standards after consolidation and capping is implemented	Same as 5a
PIA Seeps and Groundwater	No action	Same as 5a
Drainage Sediments	Selected excavation, containment, or in-situ treatment	Same as 5a
Haul Roads	Selected excavation or containment	Same as 5a

4.0 SCREENING OF CANDIDATE ALTERNATIVES

In the screening step, each alternative is evaluated against the short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost. Because the purpose of the screening evaluation is to reduce the number of alternatives that will undergo a more thorough and extensive analysis, alternatives are evaluated more generally in this phase than during the detailed analysis. However, the screening evaluation must be sufficiently detailed to distinguish among alternatives.

Under the effectiveness evaluation, each alternative is evaluated for its effectiveness in providing protection of human health and the environment and the reductions in toxicity, mobility, or volume it will achieve. Both short- and long-term components of effectiveness are evaluated. Short-term effectiveness refers to the construction and implementation period, and long-term effectiveness refers to the period after the remedial action is complete.

Under the implementability evaluation, the technical and administrative feasibility of constructing, operating, and maintaining each alternative is evaluated. Technical feasibility refers to the ability to construct, reliably operate, and meet technology-specific regulations for process options until an RA is complete. It also includes O&M, replacement, and monitoring of technical components of an alternative after the RA is complete. Administrative feasibility refers to the ability to obtain approvals from other offices and agencies and the availability of services, capacity, equipment, and technical specialists.

The cost evaluation compares the relative costs of the alternatives. Cost are typically not defined with the level of accuracy desired for the detailed analysis (i.e., +50 percent to -30 percent); however, the relative accuracy of the estimates should be consistent so that cost decisions among alternatives will be sustained as the accuracy of cost estimates improves beyond the screening process. The O&M costs are evaluated as present-worth costs, using a 7 percent discount rate and 30-year performance period, consistent with EPA guidance (EPA 2000).

The results of the alternatives screening are summarized in Table 4-1.

4.1 ALTERNATIVE 1

4.1.1 Effectiveness

Alternative 1 includes no actions to limit exposures of human or ecological receptors to COCs in source materials, sediments, surface water, groundwater, air, and plants. Alternative 1 would attain none of the RAOs in the foreseeable future.

4.1.2 Implementability

Because Alternative 1 includes no actions, it is not evaluated for implementability.

4.1.3 Cost

Alternative 1 includes no actions, hence, there would be no cost.

4.1.4 Screening Assessment

Consideration of the no action alternative is required by the NCP. Consequently, Alternative 1 is retained for detailed analysis in the FS.

4.2 ALTERNATIVE 2 AND VARIANTS

4.2.1 Effectiveness

Both Alternative 2 variants would protect human health by reducing exposure to COCs in contaminated media, including source materials, sediments, surface water, groundwater, air, and plants, within the MA and other mine-affected areas using institutional controls, including access and use restrictions and informational programs. Use of institutional controls to reduce exposure to contaminated media is generally less reliable and permanent than engineered response actions such as containment or treatment. Alternative 2 generally would not reduce the exposure of ecological receptors to COCs, with the exception that fences would limit the access of large mammals to the MA.

Alternative 2b would provide additional protection from exposure to COCs in surface water in the drainages and Blue Creek relative to Alternative 2a by continuing the existing water collection and treatment program. Alternative 2b also would provide more protection from exposure to COCs in sediments than Alternative 2a by maintaining existing revegetated areas and the stormwater system, which would reduce erosion and transport of contaminated sediment.

4.2.2 Implementability

Alternative 2 would present relatively few implementability concerns. The primary implementability concern is disposal of water treatment sludge under Alternative 2b. Actions included under Alternative 2 are technically feasible, and the availability of materials and labor to conduct water treatment is not limited. Institutional controls included under Alternative 2 would be administratively implementable.[5]

An onsite sludge disposal cell could be constructed in a manner that would comply with the substantive requirements of waste management ARARs. If offsite disposal of sludge is used instead of onsite disposal, it is anticipated that the sludge could be disposed of at the licensed radioactive waste disposal facility in Hanford, Washington. The Hanford facility has adequate capacity for the volume of waste that would be generated until approximately 2053. The facility has restrictions on the water content of waste it can accept, and further dewatering of the sludge prior to disposal probably would be required. In addition, stabilization or solidification would be required if the dewatered sludge would form free liquids during transport. Approval from the State of Washington Department of Health would be required for disposal of sludge at the Hanford facility.

4.2.3 Cost

The cost to implement, operate, and maintain Alternative 2 would be relatively low. The greatest cost uncertainty would be related to disposal of sludge generated by the treatment system under Alternative 2b after closure of the current disposal location at the Ford facility. A significant cost would be associated with construction of an onsite disposal cell. If onsite disposal is not used, offsite disposal would be costly due to disposal fees, sludge transportation, and additional sludge processing that may be required. The cost of offsite disposal is uncertain because both the quantities of sludge that would be generated and the unit cost of disposal would vary annually. The Hanford facility is allowed a fixed maximum annual income by its license. As a result, the unit disposal cost would vary based on the total volumes and activities of waste disposed of at the facility by all generators within any year.

4.2.4 Screening Assessment

Alternative 2a would provide some protection of humans from exposure to COCs. However, Alternative 2a would not provide protection of the environment. It is less protective than existing measures being implemented by the mining company. Alternative 2a is not retained for detailed analysis in the FS.

Alternative 2b would provide additional protection of human health and the environment compared to Alternative 2a by treating contaminated surface water and reducing erosion of source materials in the MA. Alternative 2b also would provide a baseline similar to current

[5] Community and Tribal acceptance of institutional controls are not evaluated under the implementability criterion. Community and Tribal acceptance are evaluated based on comments received on the Proposed Plan, and this evaluation is presented in the Record of Decision.

conditions against which other, more comprehensive alternatives could be evaluated. Alternative 2b is retained for detailed analysis in the FS.

4.3 ALTERNATIVE 3 AND VARIANTS

4.3.1 Effectiveness

Alternative 3 variants would achieve generally adequate and similar levels of protection from exposure to COCs in surface and stockpiled material, sediment, groundwater, and air, with the primary exception that Alternative 3a would not reduce potential exposure to radon released from the Hillside Dump waste rock. The tradeoffs with respect to effectiveness mainly result from differences in the approaches used to protect surface water quality.

Alternative 3a would result in potential exposures at the Hillside Dump, as noted previously, which would be reduced by the other Alternative 3 variants. Alternative 3a would result in marginally higher releases of COCs to groundwater than the other Alternative 3 variants because percolation into the Hillside Dump waste rock would not be reduced. Alternative 3a would rely on access restrictions to reduce exposure of humans and other large mammals to surface water in the open pits.

Alternative 3b would result in a smaller volume of contaminated treatment residuals than Alternatives 3a, 3c, and 3e as a result of sludge dewatering.

Alternative 3c includes expanded water collection and treatment, and would likely result in the greatest improvements in water quality in the mine drainage streams and Blue Creek among the Alternative 3 variants.

Alternative 3d would potentially reduce the volume of contaminated treatment residuals produced compared to other Alternative 3 variants. Alternative 3d also would result in greater improvement in water quality in Pit 3 than other Alternative 3 variants. However, the performance and reliability of the technologies used to improve surface water quality is more uncertain than the technologies used under other Alternative 3 variants, and treatability studies would be required. Access restrictions may still be required to protect humans and other large mammals from surface water in the open pits.

Alternative 3e would eliminate the surface water exposure pathway in Pit 4. Although ecological receptors have begun to repopulate Pit 4 and consume water from Pit 4, the concentrations of COCs may exceed protective levels and Pit 4 could be considered an “attractive nuisance” to ecological receptors. The potential for poor quality groundwater to develop following placement of waste rock in Pit 4 would require evaluation.

4.3.2 Implementability

A primary implementability concern with Alternative 3 is the availability of clean cover material, including growth media. To date, suitable soil for construction of covers has not been identified at or near the site. If capping material is obtained from an offsite source that is not operating under an existing permit, a permit would be required to mine the material. Stripping soil from relatively large land areas to provide capping material may result in adverse environmental impacts, and reclamation of impacted areas may be required.

Alternative 3 is technically implementable. Disposal of sludge would be subject to similar implementability considerations as described in Section 4.2.2 for onsite (Alternatives 3a and 3e) or offsite (Alternatives 3b and 3c) disposal. Treatability studies would be required to design and select treatment media for in-situ water treatment included under Alternative 3d. There could be limitations in the availability of treatment media, depending on the media selected. Disposal of spent media would be subject to similar implementability considerations as described for treatment sludge in Section 4.2.2.

4.3.3 Cost

The estimated cost of Alternative 3a is the lowest of the Alternative 3 variants. The estimated cost of Alternative 3d is slightly higher, with higher capital costs for containment of Hillside Dump waste rock and construction of in-situ treatment systems but lower water treatment O&M costs. The estimated cost of Alternative 3b is higher than Alternative 3d due to higher O&M costs for active treatment and offsite sludge disposal compared to in-situ treatment. The estimated cost of Alternative 3c is higher than Alternative 3b because of the cost of expanded water collection and treatment. The estimated cost of Alternative 3e is the highest of all Alternative 3 variants, primarily due to the cost of consolidating the Hillside Dump waste rock in Pit 4.

The cost of each Alternative 3 variant is very sensitive to the volume of cover material required, the availability of cover material, and the distance the material must be hauled to the site. However, the effect of the uncertainty of cover material costs on the total estimated costs is approximately the same for all Alternative 3 variants.

In summary, the ranking of Alternative 3 variants with respect to relative cost, from lowest cost to highest cost, is 3a<3d<3b<3c<3e. However, the cost of the most expensive variant (3e) probably would not be more than 50% higher than the least expensive variant (3a).

4.3.4 Screening Assessment

Alternative 3a has the lowest estimated cost of the Alternative 3 variants. However, contaminated groundwater would continue to be released to surface water downgradient of the existing seep collection system. Because waste rock in the Hillside Dump would not be contained, there would be increased potential exposure to radon and increased loading of some COCs in groundwater relative to other Alternative 3 variants. Because other Alternative 3 variants (3c and 3d) appear to provide a greater risk reduction proportional to incremental costs, Alternative 3a is not retained for detailed analysis.

Alternative 3b would achieve similar levels of protectiveness as Alternative 3a, and the waste rock in the Hillside Dump would be contained. However, contaminated groundwater would also continue to be released to surface water downgradient of the existing seep collection system under Alternative 3b. Alternative 3b is not retained for detailed analysis, following the same reasoning used to eliminate Alternative 3a.

Alternative 3c would achieve similar levels of protectiveness as Alternative 3b, and contaminated groundwater would be collected and treated downgradient of the existing seep collection system, which would provide additional protection of humans and ecological receptors from COCs in the mine drainage streams and Blue Creek. Alternative 3c is therefore retained for detailed analysis.

Alternative 3d would potentially provide additional protection of humans and ecological receptors from exposures to COCs in open pit surface water relative to other Alternative 3 variants. Use of in-situ treatment under Alternative 3d would potentially reduce the long-term requirements for disposal of water treatment residuals. Although there is significant uncertainty about the long-term effectiveness of Alternative 3d, it potentially provides increased protection compared to alternatives that do not include in-situ pit water treatment and substantial O&M cost savings compared to alternatives that include active water treatment. Alternative 3d is therefore retained for detailed analysis.

Alternative 3e would eliminate a potential attractive nuisance to wildlife by backfilling Pit 4. However, the potential exists for poor quality groundwater to accumulate in and migrate out of a backfilled Pit 4. In addition, the estimated cost for containment of Hillside Dump waste rock in Pit 4 is greater than for in-place containment. Alternative 3e is therefore not retained for detailed analysis.

4.4 ALTERNATIVE 4 AND VARIANTS

4.4.1 Effectiveness

Alternative 4 variants would achieve generally adequate and similar levels of protection from exposure to COCs in surface and stockpiled material, sediment, groundwater, and air, and all variants would eliminate the exposure pathway to surface water in the open pits. With the exception of the restricted residential use variant, Alternative 4f, the tradeoffs with respect to effectiveness mainly result from differences in the approaches used to limit potential adverse effects to groundwater and surface water quality following placement of source materials in the open pits.

The quality of groundwater that would accumulate in the backfilled open pits under Alternative 4a is uncertain. If the groundwater contains sufficiently high levels of dissolved oxygen, or if the groundwater levels drops below the top of the backfilled ore and protore, ARD formation could occur. As a result, there is some potential that poor quality groundwater could accumulate in the pits and discharge to the surface water system downgradient of the MA. A treatability study would be required to evaluate the potential effects on surface water and groundwater.

Alternative 4b is less likely to result in poor groundwater quality in the pits than Alternative 4a because the ore and protore would be isolated from the groundwater system using a liner. However, the liner may not be fully effective due to the difficulty of installing a liner adjacent to the steep pit highwalls, including possible breaching of the liner due to hydrostatic pressures differentials between the inside and outside of the liner and differential settlement of materials inside and outside of the liner.

Alternative 4c would reduce water flow through the solidified/stabilized waste materials and would be expected to limit ARD generation to very low levels.

Alternative 4d would potentially reduce or eliminate production of contaminated treatment residuals. However, the performance and reliability of the in-situ treatment method used to improve water quality is uncertain, and a treatability study would be required.

Alternative 4e would reduce water flow through the source materials in the backfilled pits to very low levels and thereby limit ARD generation. The quality of water collected from the backfilled pits, the potential for additional ARD to form within the drain tunnel, and the need for treatment of the drain tunnel discharge would require further evaluation.

Alternative 4f would provide additional protection from radon and additional reduction of water percolation into source materials compared to the other Alternative 4 variants resulting from placement of a thick cap over all source materials. Since future residential use would be possible under Alternative 4f, the long-term integrity and effectiveness of the cap would depend, in part, on the effectiveness of institutional controls.

4.4.2 Implementability

Alternative 4 would have similar implementability considerations related to the availability of clean capping and backfill material as described under Alternative 3 in Section 4.3.2. Alternative 4f would require substantially more clean capping material than any other alternative. Under Alternative 4f, large volumes of clean capping material would be required to construct a thick cap over the entire site.

Disposal of sludge generated under Alternatives 4a, 4b, 4c, 4e, and 4f would be subject to similar implementability considerations as described for treatment sludge in Section 4.2.2. Alternative 4d could eliminate the need to identify an alternate long-term sludge disposal location.

Storage of untreated water is an implementability concern for Alternative 4. Construction activities would need to be sequenced so that adequate temporary untreated water storage capacity would be available after filling of Pit 3 was started. Following remedy construction, an alternate untreated water storage facility might be needed, particularly if year-round water treatment continued to be impractical.

There would be technical implementability considerations under Alternatives 4b, 4c, 4d, and 4e. Under Alternative 4b, the ability to construct a liner system adjacent to the steep pit highwalls would be a consideration. Under Alternative 4c, a treatability study would be required to design mix ratios and select reagents for stabilization/solidification of the ore and protore materials. Under Alternative 4d, treatability studies would be required to design and effectively operate the in-situ treatment of source materials and groundwater. Under Alternative 4e, detailed geotechnical and hydrogeological investigations would be required to select the best alignment for the passive drain tunnel. An additional concern under Alternative 4e is the possibility of plugging of the drain inlet, as a result of precipitation of metals and/or deposition of fine-grained soil, and the ability to conduct maintenance, should this condition occur.

The primary administrative implementability concern would be associated with Alternative 4f. Under Alternative 4f, the ability to implement the detailed land use management needed to protect the integrity of the cover systems under future residential use may be limited.

4.4.3 Cost

The estimated cost of Alternative 4a is the lowest of the Alternative 4 variants. Alternative 4d is the next highest, with higher capital costs than Alternative 4a due to the cost of amending the material placed in the open pits, but potentially lower operating costs resulting from in-situ water treatment in Pit 3.

The estimated costs of Alternatives 4b and 4e are the next highest, with higher costs than Alternatives 4a and 4d resulting from the cost of placing a liner in Pit 3 under Alternative 4b and the cost of installing a passive drain tunnel under Alternative 4e. The estimated costs cannot be differentiated between Alternatives 4b and 4e with the level of cost information available at the alternatives screening level.

The estimated costs of Alternatives 4c and 4f are substantially higher than the other Alternative 4 variants. The cost of solidification/stabilization of all ore and protore under Alternative 4c is very high. Alternative 4f has similar very high costs associated with constructing a thick cap over the entire site.

In summary, the ranking of Alternative 4 variants with respect to relative cost, from lowest cost to highest cost, is 4a<4d<4b≈4e<<4f<4c.

4.4.4 Screening Assessment

Alternative 4a would have the lowest capital costs of the Alternative 4 variants. However, Alternative 4a has uncertain effectiveness with respect to groundwater quality and associated water treatment requirements after the open pits have been backfilled. Alternative 4a is therefore not retained for detailed analysis.

Alternative 4b potentially provides greater protection of groundwater quality than Alternative 4a; however, the effectiveness and implementability of lining the pit highwalls are uncertain and the cost is higher than Alternatives 4a and 4d. Alternative 4b is therefore not retained for detailed analysis.

Alternative 4c also potentially provides greater protection of groundwater quality than Alternative 4a; however, the estimated cost is disproportionately high to the potential benefits. Alternative 4c is therefore not retained for detailed analysis.

Alternative 4d also potentially provides greater protection of groundwater quality than Alternative 4a. In addition, Pit 3 potentially could be used for in-situ treatment of contaminated water and eliminate concerns with long-term disposal of water treatment sludge. Although there is significant uncertainty about the long-term effectiveness of Alternative 4d, it potentially could realize substantial O&M cost savings compared to alternatives that include active treatment. Alternative 4d is therefore retained for detailed analysis.

Alternative 4e would reduce the potential for generation of ARD in Pit 3 by maintaining the groundwater level below the bottom of the ore and protore. Although the quantity and quality of water that would discharge from the passive drain, and the associated O&M costs, are uncertain, a passive drain would be a relatively reliable method of limiting ARD generation in Pit 3. Alternative 4e is therefore retained for detailed analysis.

Alternative 4f would further reduce radon flux and ARD generation relative to the other Alternative 4 variants by providing a thick cap over the entire site. Alternative 4f is the only variant that would enable restricted residential use. However, the cost of the alternative would be substantially greater than Alternatives 4a, 4b, 4d, and 4e, and its implementability would be further limited by the very large quantity of clean material that would be required for cap construction. Alternative 4f is therefore not retained for detailed analysis.

4.5 ALTERNATIVE 5 AND VARIANTS

4.5.1 Effectiveness

Alternative 5 would generally achieve the highest levels of protection from exposure to COCs in surface and stockpiled material, sediment, groundwater, and air of the candidate alternatives developed for the site. The source materials would be consolidated within a smaller area under Alternative 5 than under other alternatives. As a result, land use restrictions would be needed for a smaller area. Potential exposures and acid generation from the pit highwalls would be eliminated.

Alternative 5a would reduce water flow through the source materials in the backfilled pits to very low levels and thereby limit ARD generation. The quality of water collected from the backfilled pits, the potential for additional ARD to form within the drain tunnels, and the need for treatment of the drain tunnel discharge would require evaluation.

Alternative 5b would eliminate onsite risks to ore and protore by disposing of these materials in an offsite repository. There would be short-term effectiveness considerations associated with waste hauling, including traffic impacts and the potential for offsite releases. Although waste rock with net acid neutralization potential would be placed in the pits below the long-term groundwater elevation, there would be potential for poor water quality to develop in the pits because the pits are not drained.

4.5.2 Implementability

Alternative 5 would have similar implementability considerations related to the availability of clean capping and backfill material as described in Section 4.3.2, but the quantities required would be somewhat less compared to Alternatives 3 and 4. Disposal of sludge would be subject to similar implementability considerations as described for in Section 4.2.2 for offsite (Alternative 5a) or onsite (Alternative 5b) disposal; however, it is anticipated the volume of sludge generated would be less than under Alternatives 2, 3, and 4. The need for an alternate untreated water storage facility to replace Pit 3 is an additional consideration, as described in Section 4.4.2.

Under Alternative 5a, an implementability consideration would be the ability to construct and maintain the passive drains. Detailed geotechnical and hydrogeological investigations would be required to select the best alignments for the drains. Gaining access to the drains from Pit 4, Pit 2, and the Boyd Pit to conduct maintenance activities (for example, in case of plugging) would be extremely difficult because both ends would be buried beneath tens of feet of backfill.

Under Alternative 5b, the capacity and material acceptability criteria of offsite disposal facilities are considerations. The large volume of ore and protore could approach or exceed available capacity at the Grandview, Idaho facility, depending on the volume of materials accepted from other sources and whether additional capacity is developed. The Hanford facility will accept only 100,000 cubic feet of NORM per year; therefore, it is not a potential disposal site for the ore and protore. The Grandview and Clive, Utah facilities both have concentration limits of 0.05% uranium.

4.5.3 Cost

Alternative 5 would reduce the area of capping compared to Alternatives 3 and 4; therefore, the cost of Alternative 5 relative to other alternatives would depend on the final cap design and the cost of providing suitable capping material. Nonetheless, preliminary estimates indicate the costs of both Alternative 5 variants would be high relative to all Alternatives 1, 2, 3, and 4 variants, except Alternatives 4c and 4f. The relatively high costs are primarily due to the capital cost of consolidating very large volumes of mining waste in the open pits. The estimated cost of Alternative 5b is high relative to Alternative 5a due to the very high cost of offsite disposal of all ore and protore. The O&M costs of the Alternative 5 variants are relatively low because of the relatively small volumes of contaminated water that would require treatment and the relatively small cap areas that would require maintenance.

4.5.4 Screening Assessment

Alternative 5a would require relatively little O&M and would result in a relatively small disturbed area footprint. Alternative 5a would also limit impacts to groundwater and surface water. Although the cost of Alternative 5a is relatively high, it is retained for detailed analysis.

Alternative 5b would have similar benefits as Alternative 5a, and long-term onsite exposures to the most concentrated source materials would be eliminated by offsite disposal. However, the cost of Alternative 5b is high relative to Alternative 5a. Alternative 5b is therefore not retained for detailed analysis.

4.6 SUMMARY OF ALTERNATIVE SCREENING

The following alternatives have been retained at this time for detailed analysis in the FS.

- Alternative 1
- Alternative 2b
- Alternative 3c
- Alternative 3d
- Alternative 4d
- Alternative 4e
- Alternative 5a

The rationale for retaining these alternatives and screening out the remaining alternatives is presented in Sections 4.1 through 4.5.

Table 4-2 presents a summary of the retained alternatives. The table shows the range of remedial options carried forward for detailed analysis for each of the site elements. In addition, "no action" will be evaluated for each of the site elements under Alternative 1, which is not shown in Table 4-2.

As discussed in this memorandum, the remedial alternatives being developed for the FS represent work in progress. In particular, the alternatives will be refined based on reviewer feedback. It is also emphasized that the alternatives developed in the FS are not mutually exclusive choices and do not limit the choice of a remedy. That is, a preferred alternative, as developed in the Proposed Plan, or, subsequently, the selected remedy, as developed in the ROD, can mix the elements of the various alternatives developed in the FS, refine or modify those elements, or add to them. Moreover, although the FS supplies information for helping select a remedy, information supplementing the FS may be incorporated into the remedy selection process at any time.

Table 4-1
Summary of Alternatives Screening

Alternative	Description	Effectiveness	Implementability	Relative Cost		Screening Assessment
				Capital	O&M	
1	No Action	Does not protect human health or the environment	Not applicable	Low	Low	RETAINED Evaluation required by NCP
2a	Institutional Controls and Monitoring	Limited protection of human health, not protective of the environment	Readily implemented	Low	Low	NOT RETAINED Not protective
2b	Institutional Controls, Monitoring, and Continued Existing Water Treatment	Same as 2a, with reduced risks from exposure to surface water in the drainages and Blue Creek.	Implementable; alternate sludge disposal location must be identified.	Low	High	RETAINED
3a	In-Place Containment of Surface and Stockpiled Materials and Existing Water Treatment	Reduces risk from exposure to source materials and reduces loads of COCs in drainages and Blue Creek. Potential exposures to surface water in open pits. Potential exposure to radon at Hillside Dump.	Availability of capping material may be limited; alternate sludge disposal location must be identified.	Medium	Medium	NOT RETAINED - Less protective of surface water than Alternative 3c
3b	Consolidation and Containment of Surface and Stockpiled Materials and Upgraded Water Treatment	Similar to 3a, reduced exposure to radon at Hillside Dump.	Similar to 3a	Medium	Medium	NOT RETAINED Less protective of surface water than Alternative 3c
3c	Consolidation and Containment of Surface and Stockpiled Materials and Expanded Water Collection and Treatment	Similar to 3a, with additional improvements in surface water quality in drainages and Blue Creek.	Similar to 3a	Medium	Medium	RETAINED

Table 4-1 (Continued)
Summary of Alternatives Screening

Alternative	Description	Effectiveness	Implementability	Relative Cost		Screening Assessment
				Capital	O&M	
3d	Consolidation and Containment of Surface and Stockpiled Materials and In-Situ Groundwater and Pit Water Treatment	Similar to 3a, but with potentially improved water quality in open pits and reduced treatment residuals. A treatability study would be required to evaluate the effectiveness of in-situ treatment.	Similar to 3a, and requires treatability testing to design and implement in-situ treatment systems. May eliminate need for alternate sludge disposal after closure of Ford facility.	Medium	Low	RETAINED
3e	Consolidation and Containment of Surface and Stockpiled Materials, Pit 4 Backfilled with Waste Rock, and Water Treatment	Similar to 3a, plus surface water exposure pathway in Pit 4 would be eliminated. Potential for impacts to groundwater from waste rock placed in Pit 4 would require further evaluation.	Similar to 3a, and Pit 4 would need to be dewatered prior to fill placement.	Medium	Medium	NOT RETAINED Increased cost disproportionate to potential benefits relative to other Alternative 3 variants
4a	Consolidation of Surface and Stockpiled Materials in Unlined Pits and Water Treatment	Reduces risk from exposure to source materials, reduces loads of COCs in drainages and Blue Creek, and eliminates surface water exposure pathway in open pits. Potential for impacts to groundwater and surface water from source materials placed in open pits would require evaluation using treatability study.	Availability of capping material may be limited; alternate sludge disposal location must be identified. Alternate untreated water storage facility may be needed after Pit 3 is filled.	Medium	Medium	NOT RETAINED Potential for poor water quality in pits

Table 4-1 (Continued)
Summary of Alternatives Screening

Alternative	Description	Effectiveness	Implementability	Relative Cost		Screening Assessment
				Capital	O&M	
4b	Consolidation of Surface and Stockpiled Materials in Lined Pits and Water Treatment	Similar to 4a, but liner should limit groundwater and surface water impacts. Long-term effectiveness of liner would require evaluation.	Similar to 4a, and placement of liner adjacent to pit highwalls may be difficult.	High	Medium	NOT RETAINED - High cost and uncertain effectiveness and implementability
4c	Stabilization/Solidification and Consolidation of Surface and Stockpiled Materials in Pits and Water Treatment	Similar to 4a, but treatment should limit groundwater and surface water impacts.	Similar to 4a, and treatability studies would be required for stabilization/solidification. Material may require crushing prior to treatment.	Very High	Medium	NOT RETAINED - Very high cost
4d	Amendment and Consolidation of Surface and Stockpiled Materials in Pits and Water Treatment in Pit 3	Similar to 4a, but in-situ treatment may eliminate water treatment residuals. Long-term effectiveness of neutralization and in-situ water treatment would require evaluation.	Similar to 4a, and treatability studies would be required to design amendments and evaluate potential for water treatment in pits. May eliminate need for alternate sludge disposal after closure of Ford facility.	Medium	Low	RETAINED
4e	Consolidation of Surface and Stockpiled Materials in Unlined Pits with Pit Drain and Water Treatment	Similar to 4a, but pit drain should limit impacts on groundwater and surface water from source materials placed in Pit 3.	Similar to 4a, and a detailed geotechnical investigation would be required to select a suitable tunnel alignment. Ability to maintain passive drain, should plugging occur, may be limited.	High	Medium	RETAINED

Table 4-1 (Continued)
Summary of Alternatives Screening

Alternative	Description	Effectiveness	Implementability	Relative Cost		Screening Assessment
				Capital	O&M	
4f	Consolidation of Surface and Stockpiled Materials in Pits, Placement of Thick Cap Over Entire MA, and Expanded Institutional Controls (Restricted Residential Use Scenario)	Radon flux further reduced by thick cap over entire site, as exposure is potentially increased by residential use. Impacts to groundwater and surface water further reduced by thick cap. Cap integrity dependent on success of institutional controls.	Implementability limited by availability of very large volumes of clean material needed to construct thick cap. Detailed land use management needed to protect integrity of caps.	Very High	Low	NOT RETAINED Very high cost, implementability limited by availability of clean cover materials
5a	Consolidation of Ore, Protore, and Waste Rock in Pits with Pit Drain and Water Treatment	Reduces risk from exposure to source materials, reduces loads of COCs in drainages and Blue Creek, eliminates surface water exposure pathway in open pits, and eliminates ARD generation on highwalls. Source materials contained within a small area compared to other alternatives.	May reduce capping material requirements compared to other alternatives. Maintenance of passive drains from Pit 4, Pit 2, and the Boyd Pit would be extremely difficult, if needed. Alternate untreated water storage facility may be needed after Pit 3 is filled.	Very High	Low	RETAINED
5b	Consolidation of Waste Rock in Pits, Disposal of Ore and Protore in Offsite Repository, and Water Treatment	Similar to 5a, and residual onsite risk from ore and protore eliminated. Potential for impacts to groundwater and surface water from source materials placed in open pits would require evaluation using a treatability study.	Potential limitations of licensed facilities to accept all ore and protore due to the volumes and radionuclide concentrations.	Very High	Low	NOT RETAINED - Very high cost

Table 4-2
Summary of Retained Alternatives

Site Element	Alternative[1]					
	2b	3c	3d	4d	4e	5a
Overview Description	Institutional Controls, Monitoring, and Continued Existing Water Treatment	Above-Grade Consolidation and Containment of Surface and Stockpiled Materials and Expanded Water Collection and Treatment	Above-Grade Consolidation and Containment of Surface and Stockpiled Materials and In-Situ Groundwater and Pit Water Treatment	Amendment and Consolidation of Surface and Stockpiled Materials in Pits and Water Treatment in Pit 3	Consolidation of Surface and Stockpiled Materials in Unlined Pits with Pit Drain and Water Treatment	Complete Backfill of Pits with Ore, Protore, and Waste Rock and Water Treatment
Surface Water Management	Maintain existing surface water management system	Collect clean runoff from undisturbed and capped areas and convey to drainages south of MA	Same as 3c	Same as 3c	Same as 3c	Reestablish natural drainage patterns in Western Drainage; collect clean runoff from undisturbed and capped areas and convey to drainages south of MA
Ore and Protore Stockpiles	No action	Consolidate above backfilled pits and cap (thick cap)	Same as 3c	Amend with lime and organic material and consolidate in Pit 3	Consolidate in Pit 3	Consolidate in Pit 3
South Spoils	Maintain existing soil cover and vegetation	Regrade to 3H:1V and cap (thin cap)	Same as 3c	Regrade to 3H:1V and cap (thin cap)	Same as 4d	Excavate and consolidate in open pits
Hillside Dump	No action	Regrade to 3H:1V and cap (thin cap)	Same as 3c	Partial consolidation in Pit 4; regrade to 3H:1V; and cap (thin cap)	Same as 4d	Excavate and consolidate in open pits
Other Waste Rock	No action	Regrade to 3H:1V and cap (thin cap); establish natural drainage patterns	Same as 3c	Same as 3c	Same as 3c	Excavate and consolidate in open pits. Excess waste rock would be mounded over the existing backfilled

Table 4-2 (Continued)
Summary of Retained Alternatives

Site Element	Alternative[1]					
	2b	3c	3d	4d	4e	5a
						pits area to enhance runoff.
Backfilled Pits	No action	Cap (thick cap), collect and treat groundwater	Cap (thick cap)	Regrade and cap (thin cap)	Same as 4d	Cap (thick cap) and install gravity drain to Pit 3
Pit 3	Leave open, pump and treat water to maintain minimum 3 feet cover over sediment	Leave open, pump and treat water, allow water level to rise as water quality improves, sediment left in place	Leave open, treat water in-situ using lime addition, allow water level to rise as water quality improves, sediment left in place	Partial backfill with amended (with lime and organic material) ore and protore and cap (thick cap); sediment buried beneath fill	Excavate sediment; install gravity drain from pit bottom tunnel through quartz monzonite to discharge south of South Spoils; partial backfill with ore, protore, and sediment; and cap (thick cap)	Complete backfill with ore, protore, and waste rock and cap (thick cap); install gravity drain
Pit 4	Leave open, pump and treat water to maintain minimum 3 feet cover over sediment	Leave open, pump and treat water, allow water level to rise as water quality improves, sediment left in place	Same as 3c	Partial backfill with waste rock from Hillside Dump and cap (thin cap); sediment buried beneath fill	Same as 4d	Complete backfill with waste rock and cap (thick cap); install gravity drain to Pit 3
Pit highwalls	Fence to prevent access	Fence to prevent access	Same as 3c	Height reduced by partial backfill; fenced to prevent access; runoff collected in perimeter drain for treatment	Same as 4d	Pit highwalls eliminated by complete backfill
Cap Areas and Volumes[2]	No further capping included	Thin cap = 230 acres Thick cap = 30 acres Thin cap = 1,100,000 to 1,900,000 cy Thick cap = 500,000 to	Same as 3c	Thin cap = 267 acres Thick cap = 19 acres Thin cap = 1,300,000 to 2,200,000 cy Thick cap = 300,000	Same as 4d	Thin cap = 0 acres Thick cap = 87 acres Thin cap = 0 cy Thick cap = 1,400,000 to

Table 4-2 (Continued)
Summary of Retained Alternatives

Site Element	Alternative[1]					
	2b	3c	3d	4d	4e	5a
		600,000 cy		to 400,000 cy		1,700,000 cy
Water Treatment	Existing system, with onsite sludge disposal after closure of Ford facility	Upgraded treatment system, with offsite sludge disposal after closure of Ford facility	In-situ treatment	Treat water in-situ in Pit 3. Collect and treat any pit discharge water exceeding water quality standards using existing system.	Existing system plus collection and treatment of drainage tunnel discharge (if needed). Onsite sludge disposal after closure of Ford facility.	Existing system, with offsite sludge disposal after closure of Ford facility (if needed).
South Spoils Seeps	Collect and treat	Collect and treat, to the extent seeps exist after capping is implemented	Treat in-situ using PRBs	Collect and treat in Pit 3, to the extent seeps exist after capping is implemented.	Collect and treat, to the extent seeps exist after capping is implemented.	Collect and treat, to the extent seeps exist and exceed water quality standards after consolidation and capping is implemented
PIA Seeps and Groundwater	No action	Collect and treat or treat in-situ using PRBs	No action	No action	No action	No action
Drainage Sediments	No action	Selected excavation, containment, or in-situ treatment	Same as 3c	Same as 3c	Same as 3c	Same as 3c
Haul Roads	No action	Selected excavation or containment	Same as 3c	Same as 3c	Same as 3c	Same as 3c

Note:
[1]Alternative 1, which also was retained, is not included in this table because it entails no action for all site elements.
[2]Cap materials volumes are based on a thickness of 3 to 5 feet for the thin cap and 10 to 12 feet for the thick cap.

5.0 KEY ISSUES FOR DETAILED ANALYSIS OF ALTERNATIVES

Three key issues have been identified for the detailed analysis of alternatives in the draft FS:

- Availability of clean cover material
- Need for long-term water treatment and sludge disposal options
- Remedies for the open pits

5.1 AVAILABILITY OF CLEAN COVER MATERIAL

Large quantities of clean material may be required for construction of protective covers at the site. To date, suitable soil for construction of covers has not been identified at or near the site.[6] Soils are generally thin in the vicinity of the site. Soil types present within a 5-mile radius of the site generally contain high percentages of gravel and cobbles or bedrock is present at depths of about 3 feet and greater (USDA SCS 1982). Stripping soil from relatively large land areas to provide large quantities of capping material could create adverse environmental impacts at the borrow sites. As a result, obtaining permits for offsite borrow sources may be difficult, and reclamation of impacted areas may be required. If local cover material sources cannot be located, hauling material from relatively long distances could significantly increase the cost of the remedy and the amount of truck traffic on roads within the haul route.

Further evaluation of cover designs will be conducted during the detailed analysis in the FS. A focus of this evaluation will be to develop conceptual cover designs that minimize imported material costs and impacts. Final cover designs, if covers are included as part of the selected remedy, will be developed during remedial design.

5.2 NEED FOR LONG-TERM WATER TREATMENT AND SLUDGE DISPOSAL OPTIONS

Water quality in the mine drainage streams and Blue Creek is affected by contaminated groundwater and surface water released from the MA. Metals and radionuclides, including the human health risk drivers uranium and manganese, are present at concentrations above tribal water quality standards in these streams. To limit impacts to the mine drainage streams and Blue

[6] Suitable material for constructing protective covers for radon attenuation and water percolation control typically contains fine-grained material, which has lower permeability and better water retention properties that coarse-grained soil (sands and gravels). Radon flux is very sensitive to (increases with) the availability of interconnected air-filled pores (NRC 1989).

Creek, contaminated surface water and seep water is currently collected and treated in an onsite water treatment system.

Operation of the treatment system requires ongoing O&M and produces radioactive treatment sludge that must be properly disposed of. Currently, the sludge is disposed of in TDA 4 at the Ford facility. However, this disposal option will not be available after closure of TDA 4, which is expected to occur sometime during the period 2006 to 2011. Potential disposal options after closure of TDA 4 include disposal at the licensed facility in Hanford and onsite disposal. Additional sludge processing would be required for disposal at Hanford, including further dewatering and, potentially, stabilization or solidification. Onsite disposal would have lower disposal costs and would eliminate the potential for offsite releases of radioactive sludge during transport, but would require long-term management of the disposal area, including land use restrictions.

The loads of metals and radionuclides that would discharge in groundwater from the MA would be reduced if additional source control measures are implemented. However, the effects of such reductions on the need for water treatment, or whether water treatment would no longer be necessary, cannot be predicted with certainty at this time. In-situ passive groundwater treatment presents a possible remedy that could reduce or eliminate treatment residuals and reduce O&M requirements. The long-term effectiveness of in-situ passive treatment, including the ability of these technologies to achieve water quality standards, is uncertain at this time. Post-FS treatability studies would be required to reduce the level of uncertainty.

5.3 REMEDIES FOR THE OPEN PITS

A key remedy selection decision will be whether to backfill (partial or complete) the open pits or to leave the pits open. Issues that will be further evaluated as part of the detailed analysis of alternatives in the FS include:

- The post-remedy quality of water in the open pits, and the potential for unacceptable risks from exposure to this water
- The ability to effectively isolate source material used as pit backfill from groundwater and/or air or conduct in-situ treatment of this source material so that unacceptable impacts to groundwater and surface water do not occur as a result of ARD formation within the pits
- The cost tradeoffs between consolidating larger volumes of source materials with reduced capping requirements (backfilled pits) and consolidating smaller volumes of source materials with increased capping requirements (open pits)

- The extent to which institutional controls could be reduced and groundwater and surface water quality would be improved by reducing the area that the source materials are contained within

6.0 REFERENCES

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