Tables

Flat Creek IMM Superfund Site

OU1 Feasibility Study Report

September 9, 2011

Table ES-1
Summary of Comparative Analysis of Alternatives

Remedial Alternative	*Description*	*Threshold Criteria*		*Balancing Criteria*					
		Overall Protection of Human Health and the Environment	*Compliance with ARARs*	*Long-Term Effectiveness and Permanence*	*Reduction of Toxicity, Mobility, or Volume through Treatment*	*Short-Term Effectiveness*	*Implementability*	*Present Value Cost (Dollars)*	
1	No Further Action	⓿ Not protective of human health and the environment and does not meet PRAOs.	⓿ Not compliant with chemical-specific ARARs since no further action is taken.	⓿ No additional cleanup measures are initiated and contaminated soils are left exposed.	⓿ No treatment; therefore, does not reduce toxicity, mobility, or volume of contaminants through treatment.	⓿ No additional cleanup measures are initiated and contaminated soils are left exposed. Thus there are no short-term effectiveness issues for this alternative.	⓿ No action is taken other than 5-year site reviews. Since no new remedial action is taken, this alternative has no implementability issues.	$	$123,000
2	In-Place Capping of Contaminated Soils	❸ Alternative 2 addresses the PRAOs primarily through in-place capping of contaminated soils using covers to reduce risks from contact with these materials. Capping provides an exposure barrier to the contaminated soils. However contaminated soils still remain beneath covers across a large extent of the site and could pose risks if the covers are compromised. Land use controls would be implemented to protect and restrict use of covered areas, and provide awareness of risks from potential exposure to contaminated soils.	❹ Addresses the location- and action-specific ARARs through adherence of the ARARs during implementation of the remedial action. Contaminated soils still remain beneath covers across a large extent of OU1 and could pose risks if the covers are compromised. Thus compliance with chemical-specific ARARs is more questionable in the future than other alternatives.	❸ Alternative 2 addresses contaminated soils primarily through in-place capping using covers to reduce risks from contact with these soils. Capping provides an exposure barrier to the contaminated soils. However, contaminated soils still remain beneath covers across a large extent of OU1 and could pose risks if the covers are compromised. Thus, long-term effectiveness and permanence is not as certain as for remedies that remove contaminated soils for disposal.	⓿ No treatment; therefore, does not reduce toxicity, mobility, or volume of contaminants through treatment.	❹ Addresses short-term risks to workers, the community, and the environment. Land use controls could be quickly implemented to address potential exposure to contaminated soils. While construction of covers would involve surface disturbance of contaminated soils, short-term risks to workers would be mitigated through the use of safety measures such as PPE. Short-term risks to workers, the community, and the environment could be mitigated through measures such as water-based dust suppression. Trucks used to haul offsite borrow used to construct the covers slightly increase short-term risks to the community. Transport and placement of borrow has potential environmental impacts from equipment emissions and disturbance of borrow locations.	❸ The construction resources and materials needed to construct the quantity of covers for this alternative should be available, but borrow materials would require transportation to the properties requiring covers. There may be difficulties transitioning covers into existing grades on properties that are relatively level while still facilitating residential uses. There may be additional difficulties associated with implementation of institutional controls. Access controls would be relatively easy to install. Maintenance of the covered areas and monitoring, especially on residential properties, could provide difficulties in the future.	$$	$1,292,000
3	Excavation and Disposal of Contaminated Soils at Licensed Solid Waste Facilities	❹ Alternative 3 addresses the PRAOs primarily through excavation of the majority of contaminated soils and offsite disposal at licensed solid waste disposal facilities. Thus long-term protection of human health and the environment is more certain than alternatives that leave contaminated soils in place at OU1. Land use controls would be implemented on a limited basis to protect and restrict use of areas with remaining contaminated soils and provide awareness of risks from potential exposure to contaminated soils.	❺ Addresses the location- and action-specific ARARs through adherence of the ARARs during implementation of the remedial action. Addresses chemical-specific ARARs by excavation and disposal of contaminated soils within licensed solid waste facilities.	❹ Address contaminated soils through excavation and disposal at offsite licensed disposal facilities Excavation and disposal outside of OU1 increases the long-term effectiveness and permanence of the remedy for locations where excavation of contaminated soils take place.	⓿ No treatment; therefore, does not reduce toxicity, mobility, or volume of contaminants through treatment.	❸ Requires disturbance of a large amount of contaminated soils across the site and a longer duration of construction, which poses increased short-term risks to workers and the community than the predominately surface disturbance activities under Alternative 2. Hauling of contaminated soils for offsite disposal at licensed solid waste facilities as well as transport of borrow materials for backfilling excavations increases truck traffic and related risks workers and to the community as compared to Alternative 2. Excavation and transport of contaminated soils longer distances to the offsite disposal facilities as well as transport and placement of borrow has potential environmental impacts from equipment emissions and disturbance of borrow locations.	❸ Excavation of contaminated soils could be difficult in areas of underground utilities, trees, roads, and near structures. The construction resources and materials needed to backfill excavations for this alternative should be available, but borrow materials would require transportation to the properties requiring backfill. Logistical coordination is needed since both contaminated soils and offsite borrow would be transported simultaneously. Offsite disposal of large volumes of contaminated soils requires coordination with trucks transporting backfill to excavation areas as well as additional coordination with the offsite disposal facilities. The ability to obtain the necessary approvals and the logistics of transporting and disposing of large volumes of contaminated soils for long distances to offsite disposal facilities decreases the implementability of this alternative. There may be additional difficulties associated with implementation of institutional controls, although their use would be limited to a few properties. Monitoring, especially on residential properties, could provide difficulties in the future.	$$$$	$2,811,000

Summary of Comparative Analysis of Alternatives

Remedial Alternative	*Description*	*Threshold Criteria*		*Balancing Criteria*					
		Overall Protection of Human Health and the Environment	*Compliance with ARARs*	*Long-Term Effectiveness and Permanence*	*Reduction of Toxicity, Mobility, or Volume through Treatment*	*Short-Term Effectiveness*	*Implementability*	*Present Value Cost (Dollars)*	
4	Excavation and Disposal of Contaminated Soils at the Mine Waste Joint Repository	❹ Similar to Alternative 3, except that contaminated soils are disposed of at the Wood Gulch Repository rather than disposed of at offsite licensed disposal facilities.	❺ Addresses the location- and action-specific ARARs through adherence of the ARARs during implementation of the remedial action. Addresses chemical-specific ARARs by excavation and disposal of contaminated soils within the Wood Gulch Repository.	❹ Similar to Alternative 3, except contaminated soils are disposed of at the nearby Wood Gulch Repository rather than at offsite licensed disposal facilities.	⓿ No treatment; therefore, does not reduce toxicity, mobility, or volume of contaminants through treatment.	❹ Similar to Alternative 3, excavation of contaminated soils and backfilling poses similar short-term risks to workers, community, and the environment. However the truck traffic for disposal of contaminated soils would occur within or near OU1 due to the use of the Wood Gulch Repository, resulting in fewer safety risks and reduced environmental impacts.	❹ Excavation of contaminated soils could be difficult in areas of underground utilities, trees, roads, and near structures. The construction resources and materials needed to backfill excavations for this alternative should be available, but borrow materials would require transportation to the properties requiring backfill. Logistical coordination would be required since both contaminated soils and offsite borrow would be transported simultaneously. The disposal of contaminated soils at the Wood Gulch Repository should be relatively easy to coordinate since the repository will be managed under OU3. There may be additional difficulties associated with implementation of institutional controls, although their use would be limited to a few properties. Monitoring, especially on residential properties, could provide difficulties in the future.	$$	$1,496,000
5	Excavation of Contaminated Soils, Treatment, and Disposal of Treated Soils at the Mine Waste Joint Repository	❹ Similar to Alternative 4, except the contaminated soils are treated using solidification/stabilization prior to disposal at the Wood Gulch Repository. Since contaminated soils are treated prior to disposal at the Wood Gulch Repository, overall protection of human health and the environment is more certain than alternatives that do not treat the newly-excavated contaminated soils prior to disposal.	❺ Addresses the location- and action-specific ARARs through adherence of the ARARs during implementation of the remedial action. Addresses chemical-specific ARARs by excavation, treatment, and disposal of contaminated soils within the Wood Gulch Repository.	❺ Similar to Alternative 4, except the newly-excavated contaminated soils are treated via solidification/stabilization prior to disposal at the Wood Gulch Repository. The additional treatment of newly-excavated soils increases the long-term effectiveness and permanence of the remedy compared to remedies without additional treatment due to the added protection from leaching of contaminants to surrounding soils and groundwater.	❸ The contaminated soils would by treated by solidification/stabilization prior to disposal of the soils in the Wood Gulch Repository. Treatment would provide additional protection to surrounding soils and groundwater from contaminated soils that contain concentrations of lead, arsenic, and antimony that are potentially leachable.	❸ Similar to Alternative 4, except that there is an additional step of treating newly-excavated contaminated soils by stabilization. This step involves additional contact with contaminated soils and the stabilizing agent by workers during treatment as well as additional truck traffic to deliver the stabilization agent which potentially increase safety risks and environmental impacts.	❸ Similar to Alternative 4, but includes treatment of contaminated soils using stabilization which requires additional coordination for delivery of stabilization agents as well as implementation of the treatment process before disposal at the Wood Gulch Repository.	$$$$	$2,174,000

Notes:

1. The detailed analysis of retained alternatives involves a qualitative assessment of the degree to which remedial alternatives address evaluation criteria.
   The numerical designations for the qualitative ratings system used in this table are not used to quantitatively assess remedial alternatives (for instance, individual rankings for an alternative are not additive).

Legend for Qualitative Ratings System:

Threshold and Balancing Criteria (Excluding Cost)		Balancing Criteria (Present Value Cost in Dollars)	
⓿	**None**	⓿	**None ($0)**
❶	**Low**	$	**Low ($0 through $0.75M)**
❷	**Low to Moderate**	$$	**Low to Moderate ($0.75M through $1.5M)**
❸	**Moderate**	$$$	**Moderate ($1.5M through $2.25M)**
❹	**Moderate to High**	$$$$	**Moderate to High ($2.25M through $3M)**
❺	**High**	$$$$$	**High (Greater than $3M)**

Table 4-1
Identification and Technical Implementability Screening of Potentially Applicable Remedial Technologies/Process Options
Contaminated Soils

General Response Actions	*Remedial Technology*	*Process Option*	*Description of Option*	*Screening Comments*	*Retained*
No Action	None	None	No action would be taken. Contaminated soils would remain in their existing conditions.	Required by NCP as baseline for comparison.	Yes
Monitoring	Physical and/or Chemical Monitoring	Non-Intrusive Visual Inspection	A non-intrusive (surficial) visual inspection of the immediate ground surface to determine the presence or absence of contaminated soils.	Potentially implementable process option.	Yes
		Intrusive Visual Inspection	An intrusive visual inspection of the subsurface (using excavations or boreholes) to determine the presence or absence of contaminated soils.	Potentially implementable process option.	Yes
		Sample Collection and Analysis	Soil samples would be collected for chemical analysis. Chemical analysis of metals is typically performed using TAL analysis.	Potentially implementable process option.	Yes
Land Use Controls	Institutional Controls	Governmental Controls, Proprietary Controls, and Informational Devices	Contact with contaminated soils would be controlled through legal instruments. Examples of governmental controls include but are not limited to local zoning, permits, codes, or regulations. Examples of proprietary controls include but are not limited to instruments such as easements and covenants. Examples of informational devices include but are not limited to state registries of contaminated properties, deed notices, and advisories.	Potentially implementable process option.	Yes
	Community Awareness Activities	Informational and Educational Programs	Community informational and educational programs would be undertaken to enhance awareness of potential hazards and remedies for contaminated soils.	Potentially implementable process option.	Yes
	Access Controls	Posted Warnings	Warning signs would be used to warn people of dangers posed by contaminated soils.	Potentially implementable process option.	Yes
Containment	Surface Source Controls	Grading	Contaminated soils would be contoured to promote drainage and facilitate other surface source control technologies.	Potentially implementable process option.	Yes
		Revegetation	Covered or uncovered areas of contaminated soils would be planted with native vegetation.	Potentially implementable process option.	Yes
		In Situ Mixing	Contaminated soils would be mixed with underlying uncontaminated soil or fill materials.	Potentially implementable process option.	Yes
		Soil or Rock Exposure Barrier/Cover	Contaminated soils would be covered with a layer of clean soil or rock with sufficient thickness to eliminate surface exposure.	Potentially implementable process option.	Yes

General Response Actions	*Remedial Technology*	*Process Option*	*Description of Option*	*Screening Comments*	*Retained*
Containment – Continued	Surface Source Controls – Continued	Asphalt or Concrete Exposure Barrier/Cover	Contaminated soils would be covered with layers of asphalt or concrete with sufficient thickness to eliminate surface exposure.	Potentially implementable process option.	Yes
		Geosynthetic Multi-Layer Exposure Barrier/Cover	Contaminated soils would be covered with geosynthetic material (such as geomembrane or a geosynthetic clay liner [GCL]) along with protective vegetative or rock layers to eliminate surface exposure.	Potentially implementable process option.	Yes
Removal/ Transport/Disposal Removal/ Transport/ Disposal	Removal	Mechanical Excavation	Contaminated soils would be excavated using mechanical methods.	Potentially implementable process option.	Yes
		Pneumatic Excavation (Vacuum Extraction/ Pumping)	Contaminated soils would be excavated using vacuum hoses, vacuum trucks, or other pneumatic conveyance system.	Potentially implementable process option.	Yes
	Transport	Mechanical Transport (Hauling/Conveying)	Excavated contaminated soils would be transported by truck or other mechanical conveyance method.	Potentially implementable process option.	Yes
		Hydraulic Transport (Slurrying)	Excavated contaminated soils would be transported in slurry form using a pipeline or other hydraulic conveyance system.	Potentially implementable process option.	Yes
		Pneumatic Transport (Vacuum Extraction/ Pumping)	Excavated contaminated soils would be transported using vacuum hoses, vacuum trucks, or other pneumatic conveyance system.	Potentially implementable process option.	Yes
	Disposal	Disposal – Mine Waste Joint Repository	Excavated contaminated soils would be disposed of at a local repository, specifically engineered for the disposal of lead, arsenic, and antimony contamination from the site.	Potentially implementable process option.	Yes
		Disposal – Licensed Solid Waste Disposal Facility	Excavated contaminated soils would be disposed of at an existing permitted landfill authorized for disposal of lead, arsenic, and antimony contamination.	Potentially implementable process option.	Yes
Treatment	Biological Treatment	Phytoremediation	Lead, arsenic, and antimony in contaminated soils would be treated/removed using select plant species.	Potentially implementable process option.	Yes
	Physical and/or Chemical Treatment	Ex Situ Pozzolan- or Cement-Based Stabilization/Solidification	Excavated contaminated soils would be mixed with a pozzolan- or cement-based binding agent before disposal.	Potentially implementable process option.	Yes
		In Situ Pozzolan- or Cement-Based Stabilization/Solidification	Contaminated soils would be mixed in situ with a pozzolan- or cement-based binding agent using a deep soil auger mixing/injection technique.	Potentially implementable process option.	Yes
		Soil Washing	Contaminated soils would be flushed with a site-specific washing solution; flushed lead, arsenic, and antimony would be collected for further treatment and/or disposal.	Potentially implementable process option.	Yes

General Response Actions	***Remedial Technology***	***Process Option***	***Description of Option***	***Screening Comments***	***Retained***
Treatment – Continued	Physical and/or Chemical Treatment – Continued	Soil Flushing	A washing solution (as with soil washing) would be circulated through contaminated soils with the use of injection and extraction wells or trenches; flushed lead, arsenic, and antimony would be collected for further treatment and/or disposal.	Not technically feasible for site application because of the shallow nature of the soil contamination.	No
		Electrokinetics	In-situ contaminated soil is electrically charged with direct current, causing the transport/removal of ions, particles, and water.	Not technically feasible for site application because of the shallow and unsaturated nature of the soil contamination.	No
		Neutralization	Contaminated soils would be mixed with an alkaline material such as agricultural lime ($CaCO_3$) or hydrated lime ($Ca(OH)_2$) to neutralize acidity. Process may involve excavation and treatment or amendment to the top layer of contaminated soil.	Potentially implementable process option.	Yes
		Ex Situ Chemical Immobilization/ Stabilization	Excavated contaminated soils would be treated with chemicals to bind metals in the soil and reduce the bioavailability and mobility of metals before disposal	Potentially implementable process option.	Yes
		In Situ Chemical Immobilization/ Stabilization	In-situ contaminated soils would be treated with chemicals to bind metals in the soil and reduce the bioavailability and mobility of metals.	Potentially implementable process option.	Yes
	Thermal Treatment	In Situ Vitrification	An electrical current would be passed between electrodes inserted into in-place contaminated soils to cause melting. The melted matrix is then allowed to cool in place into a solid vitrified glass mass.	Not feasible for site application because of the shallow nature of the soil contamination.	No
		Ex Situ Electric Arc Vitrification	An electrical current would be passed between electrodes in a furnace creating an electrical arc. Contaminated soils placed in the furnace form a molten bath that cools to form a vitrified glass mass. The vitrified glass mass is an inert waste	Potentially implementable process option.	Yes
Reuse, Reclamation, Recovery	Remining/ Reprocessing	Flotation, Leaching, and Smelting - Licensed Offsite Facility	Contaminated soils would be excavated and processed using methods such as flotation, leaching, and smelting to separate valuable metals from the mine waste. This technology is intended to represent the potential for generation of materials that could be sold for a positive cost benefit, whereas treatment technologies are intended to treat and dispose of the waste with no potential for positive cost benefit.	Potentially implementable process option.	Yes

Notes:

1. The screening process for technical implementability involves a qualitative assessment of the degree to which process options address evaluation criteria presented in Section 4.5.
2. Shading indicates remedial technologies/process options have been eliminated from further consideration based on lack of technical implementability. Remaining (unshaded) remedial technologies/process options have been retained for additional screening in Table 4-2.

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Table 4-2
Screening of Potentially Applicable Remedial Technologies/Process Options Based on Effectiveness, Implementability, and Relative Cost
Contaminated Soils

General Response Actions	*Remedial Technology*	*Process Option*	*Description of Option*	*Effectiveness*		*Implementability*		*Relative Cost*		*Reasons for Elimination of Process Option from Consideration*	*Process Option Viability with Respect to Assembly of Remedial Alternatives*
								Capital Cost	*O&M Cost*		
No Action	None	None	No action would be taken. Contaminated soils would remain in their existing conditions.	⓿	No protection of human health or the environment and no compliance with ARARs.	⓿	Easily implemented but is not acceptable to regulatory agencies and does not meet ARARs.	⓿	⓿	Retained	Required by NCP as stand-alone alternative.
Monitoring	Physical and/or Chemical Monitoring	Non-Intrusive Visual Inspection	A non-intrusive (surficial) visual inspection of the immediate ground surface to determine the presence or absence of contaminated soils.	❷	Protects people by monitoring contaminant concentrations and migration. Does not directly affect people and does not physically address contaminated soils.	❺	Easily implemented using available technical labor resources.	$	⓿	Retained	Viable for short- and long-term site monitoring.
		Intrusive Visual Inspection	An intrusive visual inspection of the subsurface (using excavations or boreholes) to determine the presence or absence of contaminated soils.	❷	Protects people by monitoring contaminant concentrations and migration. Does not directly affect people and does not physically address contaminated soils.	❺	Easily implemented using available technical labor resources.	$$	⓿	Retained	Viable for short- and long-term site monitoring.
		Sample Collection and Analysis	Soil samples would be collected for chemical analysis. Chemical analysis of metals is typically performed using TAL analysis.	❷	Protects people by monitoring contaminant concentrations and migration. Does not directly affect people and does not physically address contaminated soils.	❺	Easily implemented using available technical labor and equipment resources.	$$	⓿	Retained	Viable for short- and long-term site monitoring.
Land Use Controls	Institutional Controls	Governmental Controls, Proprietary Controls, and Informational Devices	Contact with contaminated soils would be controlled through legal instruments. Examples of governmental controls include but are not limited to local zoning, permits, codes, or regulations. Examples of proprietary controls include but are not limited to instruments such as easements and covenants. Examples of informational devices include but are not limited to state registries of contaminated properties, deed notices, and advisories.	❷	Restricts future uses of the site that are not protective of human health and the environment but does not physically address contaminated soils.	❸	Implemented using legal instruments and labor resources; potential public resistance.	$$	$	Retained	Potentially viable process option for combination with access controls, containment and/or disposal technologies that leave contaminated soils on site.
	Community Awareness Activities	Informational and Educational Programs	Community informational and educational programs would be undertaken to enhance awareness of potential hazards and remedies for contaminated soils.	❷	Protects people by enhancing awareness of potential site hazards and remedies. Does not physically address contaminated soils.	❺	Easily implemented using available technical and community involvement labor resources.	$	$	Retained	Potentially viable process option for combination with all other technologies.
	Access Controls	Posted Warnings	Warning signs would be used to warn people of dangers posed by contaminated soils.	❷	Protects people by enhancing awareness of potential site hazards and remedies through warnings, though people may choose to ignore warnings.	❺	Easily implemented and resources readily available.	$$	$	Retained	Potentially viable process option for combination with institutional controls or containment and/or disposal technologies in which contaminated soils are left on site.

General Response Actions	Remedial Technology	Process Option	Description of Option		Effectiveness		Implementability	Relative Cost: Capital Cost	Relative Cost: O&M Cost	Reasons for Elimination of Process Option from Consideration	Process Option Viability with Respect to Assembly of Remedial Alternatives
Containment	Surface Source Controls	Grading	Contaminated soils would be contoured to promote drainage and facilitate other surface source control technologies.	❷	Facilitates other containment technologies. It does not protect receptors by itself.	❹	Easily implemented using available construction resources. Requires some maintenance for long-term protectiveness.	$$	$$	Effectiveness	Eliminated from consideration.
		Revegetation	Covered or uncovered areas of contaminated soils would be planted with native vegetation.	❷	Reduces erosion of fill surfaces, reduces exposure of contaminants to receptors, and facilitates other containment technologies. It does not protect receptors by itself.	❹	Easily implemented using available construction resources. Requires minor maintenance for long-term protectiveness.	$	$	Effectiveness	Eliminated from consideration.
		In Situ Mixing	Contaminated soils and associated soils would be mixed with underlying uncontaminated soil or fill materials.	❷	Reduces future lead, arsenic, and antimony releases from surface soils after implementation; however, there is potential for subsurface contaminated soils to migrate back to the surface over time through natural and/or human activities. It does not protect receptors by itself.	❸	Implemented using available construction resources. Difficulty may be encountered in homogenizing contaminated soils with underlying soils and depth to bedrock may preclude in situ mixing at some locations. May require re-application over time if subsurface contaminated soils migrate to the surface. Must be combined with institutional and access controls.	$$$	$$	Effectiveness	Eliminated from consideration.
		Soil or Rock Exposure Barrier/Cover	Contaminated soils would be covered with a layer of clean soil or rock with sufficient thickness to eliminate surface exposure.	❸	Protects people by eliminating surface exposure of contaminated soils. Prevents erosion and transport by air and water. Will not prevent leaching of metals to groundwater.	❹	Implemented using available construction resources and materials. Must be combined with institutional and access controls. Requires some maintenance for long-term protectiveness.	$$$	$$	Retained	Viable as a long-term solution.
		Asphalt or Concrete Exposure Barrier/Cover	Contaminated soils would be covered with layers of asphalt or concrete with sufficient thickness to eliminate surface exposure.	❹	Protects people by eliminating surface exposure contaminated soils. Prevents erosion and transport by air and water. Would prevent leaching of metals to groundwater.	❸	Implemented using available construction resources and materials. Must be combined with institutional and access controls. Requires some maintenance for long-term protectiveness. Difficult to obtain and transport large quantities of concrete and asphalt.	$$$$	$$$	Retained	Viable as a long-term solution.
		Geosynthetic Multi-Layer Exposure Barrier/Cover	Contaminated soils would be covered with geosynthetic material (such as geomembrane or a GCL) along with protective vegetative or rock layers to eliminate surface exposure.	❹	Protects people by eliminating surface exposure of contaminated soils. Prevents erosion and transport by air and water. Would prevent leaching of metals to groundwater.	❸	Implemented using available construction resources; however, special material and labor resources are required to install the geosynthetic material. Care must be taken during installation to avoid damage to the geosynthetic. Must be combined with institutional and access controls. Requires some maintenance for long-term protectiveness.	$$$$	$$	Retained	Viable as a long-term solution.
Removal/Transport/ Disposal	Removal	Mechanical Excavation	Contaminated soils would be excavated using mechanical methods.	❹	Protects people by eliminating future exposure to contaminated soils after implementation. Must be combined with containment, transport, disposal, and/or treatment technologies.	❹	Implemented using available construction resources.	$$$	⓿	Retained	Viable as a long-term solution; must be combined with transport, disposal, and/or treatment technologies.
		Pneumatic Excavation (Vacuum Extraction/ Pumping)	Contaminated soils would be excavated using vacuum hoses, vacuum trucks, or other pneumatic conveyance system.	❹	Protects people by eliminating future exposure to contaminated soils after implementation. Must be combined with transport, containment, disposal, and/or treatment technologies.	❸	Efficient for soils and gravel or smaller particle sizes; however, filtering and containment of air stream would be required. High abrasive wear on equipment may occur depending on type of job performed.	$$$	⓿	Retained	Viable as a long-term solution; must be combined with transport, disposal, and/or treatment technologies.
	Transport	Mechanical Transport (Hauling/Conveying)	Excavated contaminated soils would be transported by truck or other mechanical conveyance method.	❸	Protects people by eliminating future exposure to contaminated soils after implementation. Must be combined with removal, containment, disposal, and/or treatment technologies.	❹	Easily implemented using available construction resources; efficient for all sizes of materials. Useful for onsite or offsite actions.	$$$$	⓿	Retained	Viable as a long-term solution; must be combined with removal, disposal, and/or treatment technologies.

General Response Actions	Remedial Technology	Process Option	Description of Option	Effectiveness	Implementability	Relative Cost: Capital Cost	Relative Cost: O&M Cost	Reasons for Elimination of Process Option from Consideration	Process Option Viability with Respect to Assembly of Remedial Alternatives
Removal/Transport/ Disposal - Continued	Transport - Continued	Hydraulic Transport (Slurrying)	Excavated contaminated soils would be transported in slurry form using a pipeline or other hydraulic conveyance system.	❸ Protects people by eliminating future exposure to contaminated soils. Must be combined with removal, containment, disposal, and/or treatment technologies.	❶ Efficient for soils and gravel or smaller particle sizes. Difficult to implement for contaminated soils in a residential setting. Difficult to transport debris or may require higher flow velocities, which can cause more abrasive wear on equipment. Treatment of water used for transport would be required, and it is unknown whether current water supply systems can handle the additional volume requirements.	$$$$	⓿	Implementability, Cost	Eliminated from consideration.
		Pneumatic Transport (Vacuum Extraction/ Pumping)	Excavated contaminated soils would be transported using vacuum hoses, vacuum trucks, or other pneumatic conveyance system.	❸ Protects people by eliminating future exposure to contaminated soils. Effective in transporting small and fine material after excavation. Must be combined with removal, containment, disposal, and/or treatment technologies.	❸ Efficient for soils and gravel or smaller particle sizes; however, filtering and containment of air stream would be required. Only useful for onsite transport. High abrasive wear on equipment may occur depending on type of job performed.	$$$	⓿	Retained	Viable as a long-term solution; must be combined with removal, disposal, and/or treatment technologies.
	Disposal	Disposal – Mine Waste Joint Repository	Excavated contaminated soils would be disposed of at a local repository, specifically engineered for the disposal of lead, arsenic, and antimony contamination from the site.	❸ Protects people by eliminating exposure to contaminated soils and provides containment of contaminated soils within an engineered mine waste repository; degree of protection is dependent on future O&M of the repository. Must be combined with removal, transport, containment, and/or treatment technologies.	❸ Implemented using available construction resources. Design, construction, and approval of mine waste repository required before implementation of disposal. Institutional and access controls as well as O&M required for long-term protectiveness of the mine waste repository.	$$$$	$$$	Retained	Viable as a long-term solution; must be combined with removal and transport technologies.
		Disposal – Licensed Solid Waste Disposal Facility	Excavated contaminated soils would be disposed of at an existing permitted landfill authorized for disposal of lead, arsenic, and antimony contamination.	❹ Protects people by eliminating exposure to contaminated soils and provides containment of contaminated soils within engineered licensed solid waste disposal facility with routine O&M. Must be combined with removal, transport, and/or treatment technologies.	❹ Implemented using authorized licensed commercial or governmental disposal facility that accepts contaminated soils. Requires approval of disposal facility.	$$$	⓿	Retained	Viable as a long-term solution; must be combined with removal and transport technologies.
Treatment	Biological Treatment	Phytoremediation	Lead, arsenic, and antimony in contaminated soils would be treated/removed using select plant species.	❷ Protects people by plant uptake of lead, arsenic, and antimony. Effectiveness of phytoremediation depends on the contaminants present in each location, the plant species used, and the growing conditions of each location. Reduces exposure to receptors and environment over time. Species capable of addressing lead, arsenic, and antimony may not be suitable for establishment at a particular location. May take an extended period of time to see full effectiveness of phytoremediation.	❷ Implemented using available construction resources. Contaminated soils are scattered over site, which include large quantities that vary in depth and extent. Difficult to manage plant growth and upkeep over a large site with scattered contamination. Species capable of addressing lead, arsenic, and antimony may not be suitable for establishment at a particular location. Requires maintenance for long-term protectiveness.	$$$	$$$	Effectiveness, Implementability	Eliminated from consideration.
	Physical and/or Chemical Treatment	Ex Situ Pozzolan- or Cement-Based Stabilization/Solidification	Excavated contaminated soils would be mixed with a pozzolan- or cement-based binding agent before disposal.	❹ Protects people by binding contaminated soils within a solid inert matrix. Effectiveness of stabilization may decrease over time due to development of freeze-thaw cracking. Relatively easy to determine that contaminated soils are fully treated, Surface source controls are required to protect people, animals, and the environment from release of contaminated soils during implementation. Must be combined with removal, transport, and disposal technologies.	❸ Implemented using available construction resources. Difficult to obtain and transport large quantities of binding agent and homogenize binding agent with heterogeneous contaminated soils. Requires some maintenance for long-term protectiveness.	$$$$	⓿	Retained	Viable as a long-term solution; must be combined with removal, transport, and disposal process options.

General Response Actions	Remedial Technology	Process Option	Description of Option	Effectiveness	Implementability	Relative Cost: Capital Cost	Relative Cost: O&M Cost	Reasons for Elimination of Process Option from Consideration	Process Option Viability with Respect to Assembly of Remedial Alternatives
Treatment - Continued	Physical and/or Chemical Treatment - Continued	In Situ Pozzolan- or Cement-Based Stabilization/Solidification	Contaminated soils would be mixed in situ with a pozzolan- or cement-based binding agent using a deep soil auger mixing/injection technique.	❸ Protects people by binding contaminated soils within a solid inert matrix. Contaminated soils would be treated in place, which minimizes exposure to people and the environment. Difficult to ensure contaminated soils are fully treated in the subsurface. Effectiveness of stabilization may decrease over time due to development of freeze-thaw cracking near the surface.	❶ Implemented using available construction resources. Contaminated soils are scattered over site, which include large quantities that vary in depth and extent. Difficult to obtain and transport large quantities of binding agent and homogenize binding agent with contaminated soils. Difficult to implement for contaminated soils in a residential setting. Requires some maintenance for long-term protectiveness.	$$$$	⓿	Implementability	Eliminated from consideration.
		Soil Washing	Contaminated soils would be flushed with a site-specific washing solution; flushed lead, arsenic, and antimony would be collected for further treatment and/or disposal.	❸ Soil washing is an effective treatment process for fine soils contaminated with metals, by flushing the fines with a washing solution. It is not as effective at reducing metal concentrations from mine waste. Flushed washing solution would need to be collected for treatment and disposal. Must be combined with removal, transport, and disposal technologies.	❷ Implemented using available construction resources. Difficult to obtain and transport washing solution to a remote location. Difficulty may be encountered in finding a staging area large enough for the consolidation and treatment of site wastes, as well as disposing of the spent washing liquids. May be difficult to implement for contaminated soils in a residential setting.	$$$$$	⓿	Implementability, Cost	Eliminated from consideration.
		Neutralization	Contaminated soils would be mixed with an alkaline material such as $CaCO_3$ or $Ca(OH)_2$ to neutralize acidity. Process may involve excavation and treatment or amendment to the top layer of contaminated soil.	❷ Would address acid generation issues, but would not fully protect people from exposure to lead, arsenic, and antimony in contaminated soils. Effectiveness of agent may decrease over time due to continued exposure to acidity in soils.	❸ Implemented using available construction resources. Contaminated soils are scattered over site, which include large quantities that vary in depth and extent. Difficult to obtain and transport large quantities of neutralization agent and homogenize agent with contaminated soils. May be difficult to implement for contaminated soils in a residential setting. Requires some maintenance for long-term protectiveness.	$$$	$$$	Effectiveness, Implementability	Eliminated from consideration.
		Ex Situ Chemical Immobilization/ Stabilization	Excavated contaminated soils would be treated with chemicals to bind metals in the soil and reduce the bioavailability and mobility of metals before disposal.	❸ Does not completely protect receptors from exposure to contaminants if inhaled or ingested, but when combined with removal, transport, and disposal technologies, it will provide additional leaching protection for contaminated soils. Stabilization agents can reduce bioavailability of lead by up to 40%. Phosphate-based agents can mobilize arsenic and antimony, therefore may only have limited applicability to contaminated soils. Must be combined with removal, transport, and disposal technologies.	❸ Implemented using available construction resources. Difficult to obtain and transport large quantities of chemicals and homogenize chemicals with heterogeneous contaminated soils. Requires some maintenance for long-term protectiveness.	$$$$	$$$	Retained	Viable as a long-term solution; must be combined with removal, transport, and disposal process options.
		In Situ Chemical Immobilization/ Stabilization	In-situ contaminated soils would be treated with chemicals to bind metals in the soil and reduce the bioavailability and mobility of metals.	❷ Difficult to ensure contaminated soils are fully treated in the subsurface. Does not completely protect receptors from exposure to contaminants if inhaled or ingested. Stabilization agents can reduce bioavailability of lead by up to 40%. Phosphate-based agents can mobilize arsenic and antimony, therefore may only have limited applicability to contaminated soils. Although stabilization agents can reduce the bioavailability of metals, the reduction may not be sufficient to meet RGs for many properties with elevated lead, arsenic, and antimony.	❷ Implemented using available construction resources. Difficult to obtain and transport large quantities of chemicals and homogenize chemicals with heterogeneous contaminated soils. Difficult to implement for contaminated soils in a residential setting. Requires some maintenance for long-term protectiveness.	$$$$	$$$	Effectiveness, Implementability	Eliminated from consideration.

General Response Actions	Remedial Technology	Process Option	Description of Option	Effectiveness	Implementability	Relative Cost		Reasons for Elimination of Process Option from Consideration	Process Option Viability with Respect to Assembly of Remedial Alternatives
						Capital Cost	O&M Cost		
Treatment - Continued	Thermal Treatment	Ex Situ Electric Arc Vitrification	An electrical current would be passed between electrodes in a furnace creating an electrical arc. Contaminated soils placed in the furnace form a molten bath that cools to form a vitrified glass mass. The vitrified glass mass is an inert waste.	❹ Protects people by converting contaminated soils to an inert form. The treatment is inert-regulated material and soil can be used for site restoration. Surface source controls are required to protect people, animals, and the environment during initial processing. Must be combined with removal and transport technologies.	❶ Implemented using a patented, demonstrated, and commercialized technology. However, the literature does not indicate that electric arc furnace units are widely available commercially for remediation of contaminated soils. Thus, contaminated soils would be required to be transported off site for treatment (one demonstration location identified is in New Jersey). Mobilization of a temporary onsite treatment facility is possible but has not been demonstrated in the literature and could pose numerous setup and startup difficulties. The technology requires a significant, reliable source of electrical power. The system requires off-gas treatment system to address air emissions.	$$$$$	⓿	Implementability, Cost	Eliminated from consideration.
Reuse, Reclamation, Recovery	Remining/ Reprocessing	Flotation, Leaching, and Smelting – Licensed Offsite Facility	Contaminated soils would be excavated and processed using methods such as flotation, leaching, and smelting to separate valuable metals from the contaminated soil. This technology is intended to represent the potential for generation of materials that could be sold for a positive cost benefit, whereas treatment technologies are intended to treat and dispose of the waste with no potential for positive cost benefit.	❸ Protects people by converting contaminated soils to valuable metals. The effectiveness would depend on the content of potentially useful metals in the contaminated material versus the content of deleterious metals in the contaminated material. To be viable, would require contaminated soils with high recoverable metals content.	❷ Implemented using available construction resources. Implementability would depend on the cost to convert the contaminated soils to metals versus the estimated value of those metals. The nearest lead smelting facilities to the site in the U.S. are over 1,000 miles; therefore, the cost of transporting the waste to the facilities would likely outweigh the potential value of any metals that could be recovered. Requires approval of facility for acceptance of contaminated soil; arsenic is typically not acceptable at high concentrations.	$$$$	⓿	Implementability	Eliminated from consideration

Notes:

1. The screening process for effectiveness, implementability, and relative cost involves a qualitative assessment of the degree to which process options address evaluation criteria presented in Section 4.6. The numerical designations for the qualitative ratings system used in this table are not used to quantitatively assess process options (for instance, rankings for a process option are not additive).
2. Shading indicates remedial technologies/process options have been eliminated from further consideration based on lack of effectiveness, implementability, and/or disproportionate cost relative to other process options within the same GRA. Remaining (unshaded) remedial technologies/process options have been retained for assembly into remedial action alternatives as discussed in Section 5.
3. The following sources of technical information were used to identify and screen remedial technologies and process options:

Federal Remediation Technologies Roundtable (FRTR). 2007. Remediation Technologies Screening Matrix and Reference Guide, Version 4.0.

Interstate Technology Regulatory Council (ITRC). Mining Waste Treatment Technology Selection. <http://www.itrcweb.org/miningwaste-guidance/technology_overviews.htm>

U. S. Environmental Protection Agency (EPA). 1994. Superfund Innovative Technology Evaluation (SITE) Technology Capsule, Geosafe Corporation, In Situ Vitrification Technology. November.

U. S. Environmental Protection Agency (EPA). 1998. Superfund Innovative Technology Evaluation (SITE) Technology Capsule, Geotech Development Corporation Cold Top Ex-Situ Vitrification Technology. March.

U. S. Environmental Protection Agency (EPA). 1999. Presumptive Remedy for Metals-in-Soil Sites. September

U. S. Environmental Protection Agency (EPA). 2000. Introduction to Phytoremediation. February.

U. S. Environmental Protection Agency (EPA). 2000. Abandoned Mine Site Characterization and Cleanup Handbook. August.

Legend for Qualitative Ratings System: The following ratings were used for evaluation and presentation of effectiveness, implementability, and relative cost:

Effectiveness and Implementability		Relative Cost	
⓿	**None**	⓿	**None**
❶	**Low**	$	**Low**
❷	**Low to moderate**	$$	**Low to moderate**
❸	**Moderate**	$$$	**Moderate**
❹	**Moderate to high**	$$$$	**Moderate to high**
❺	**High**	$$$$$	**High**

Table 4-3
Retained Remedial Technologies/Process Options
Contaminated Soils

General Response Actions	*Remedial Technology*	*Process Option*	*Description of Option*	*Process Option Viability with Respect to Assembly of Remedial Alternatives*
No Action	None	None	No action would be taken. Contaminated soils would remain in their existing conditions.	Required by NCP as stand-alone alternative.
Monitoring	Physical and/or Chemical Monitoring	Non-Intrusive Visual Inspection	A non-intrusive (surficial) visual inspection of the immediate ground surface to determine the presence or absence of contaminated soils.	Viable for short- and long-term site monitoring.
		Intrusive Visual Inspection	An intrusive visual inspection of the subsurface (using excavations or boreholes) to determine the presence or absence of contaminated soils.	Viable for short- and long-term site monitoring.
		Sample Collection and Analysis	Soil samples would be collected for chemical analysis. Chemical analysis of metals is typically performed using graphite furnace atomic absorption methods.	Viable for short- and long-term site monitoring.
Land Use Controls	Institutional Controls	Governmental Controls, Proprietary Controls, and Informational Devices	Contact with contaminated soils would be controlled through legal instruments. Examples of governmental controls include but are not limited to local zoning, permits, codes, or regulations. Examples of proprietary controls include but are not limited to instruments such as easements and covenants. Examples of informational devices include but are not limited to state registries of contaminated properties, deed notices, and advisories.	Potentially viable process option for combination with access controls, containment and/or disposal technologies that leave contaminated soils on site.
	Community Awareness Activities	Informational and Educational Programs	Community informational and educational programs would be undertaken to enhance awareness of potential hazards and remedies for contaminated soils.	Potentially viable process option for combination with all other technologies.
	Access Controls	Posted Warnings	Warning signs would be used to warn people of dangers posed by contaminated soils.	Potentially viable process option for combination with institutional controls or containment and/or disposal technologies in which contaminated soils are left on site.
Containment	Surface Source Controls	Soil or Rock Exposure Barrier/Cover	Contaminated soils would be covered with a layer of clean soil or rock with sufficient thickness to eliminate surface exposure.	Viable as a long-term solution.
		Asphalt or Concrete Exposure Barrier/Cover	Contaminated soils would be covered with layers of asphalt or concrete with sufficient thickness to eliminate surface exposure.	Viable as a long-term solution.
		Geosynthetic Multi-Layer Exposure Barrier/Cover	Contaminated soils would be covered with geosynthetic material (such as geomembrane or a GCL) along with protective vegetative or rock layers to eliminate surface exposure.	Viable as a long-term solution.

Table 4-3 (continued)

General Response Actions	***Remedial Technology***	***Process Option***	***Description of Option***	***Process Option Viability with Respect to Assembly of Remedial Alternatives***
Removal/Transport/ Disposal	Removal	Mechanical Excavation	Contaminated soils would be excavated using mechanical methods.	Viable as a long-term solution; must be combined with transport, disposal, and/or treatment technologies.
		Pneumatic Excavation (Vacuum Extraction/ Pumping)	Contaminated soils would be excavated using vacuum hoses, vacuum trucks, or other pneumatic conveyance system.	Viable as a long-term solution; must be combined with transport, disposal, and/or treatment technologies.
	Transport	Mechanical Transport (Hauling/Conveying)	Excavated contaminated soils would be transported by truck or other mechanical conveyance method.	Viable as a long-term solution; must be combined with removal, disposal, and/or treatment technologies.
		Pneumatic Transport (Vacuum Extraction/ Pumping)	Excavated contaminated soils would be transported using vacuum hoses, vacuum trucks, or other pneumatic conveyance system.	Viable as a long-term solution; must be combined with removal , disposal, and/or treatment technologies.
	Disposal	Disposal – Mine Waste Joint Repository	Excavated contaminated soils would be disposed of at a local repository, specifically engineered for the disposal of lead, arsenic, and antimony contamination from the site.	Viable as a long-term solution; must be combined with removal and transport technologies.
		Disposal – Licensed Solid Waste Disposal Facility	Excavated contaminated soils would be disposed of at an existing permitted landfill authorized for disposal of lead, arsenic, and antimony contamination.	Viable as a long-term solution; must be combined with removal and transport technologies.
Treatment	Physical and/or Chemical Treatment	Ex Situ Pozzolan- or Cement-Based Stabilization/Solidification	Excavated contaminated soils would be mixed with a pozzolan- or cement-based binding agent before disposal.	Viable as a long-term solution; must be combined with removal, transport, and disposal process options.
		Ex Situ Chemical Immobilization/ Stabilization	Excavated contaminated soils would be treated with chemicals to bind metals in the soil and reduce the bioavailability and mobility of metals before disposal.	Viable as a long-term solution; must be combined with removal, transport, and disposal process options.

Table 5-1
Remedial Technologies/Process Options Evaluated for Assembly Into Remedial Alternatives

General Response Actions	Remedial Technology	Process Option	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
No Action	None	None	✓				
Monitoring	Physical and/or Chemical Monitoring	Non-Intrusive Visual Inspection	✓	✓	✓	✓	✓
		Intrusive Visual Inspection		✓	✓	✓	✓
		Sample Collection and Analysis		✓	✓	✓	✓
Land Use Controls	Institutional Controls	Governmental Controls, Proprietary Controls, and Informational Devices		✓	✓	✓	✓
	Community Awareness Activities	Informational and Educational Programs		✓	✓	✓	✓
	Access Controls	Posted Warnings		✓			
Containment	Surface Source Controls	Soil or Rock Exposure Barrier/Cover		✓			
		Asphalt or Concrete Exposure Barrier/Cover		✓			
		Geosynthetic Multi-Layer Exposure Barrier/Cover		✓			
Removal/Transport/Disposal	Removal	Mechanical Excavation			✓	✓	✓
		Pneumatic Excavation (Vacuum Extraction/ Pumping)			✓	✓	✓
	Transport	Mechanical Transport (Hauling/Conveying)			✓	✓	✓
		Pneumatic Transport (Vacuum Extraction/ Pumping)			✓	✓	✓
	Disposal	Disposal – Mine Waste Joint Repository				✓	✓
		Disposal – Licensed Solid Waste Disposal Facilities			✓		
Treatment	Physical and/or Chemical Treatment	Ex Situ Pozzolan- or Cement-Based Stabilization/Solidification					✓
		Ex Situ Chemical Immobilization/Stabilization					✓

Notes:

1. Check mark designations indicate that remedial technology/process option could be evaluated as a potential component of the indicated remedial alternative.
2. Shaded boxes indicate the process options are not considered for the remedial alternative(s) in question.
3. Where similar process options have been indicated for the same remedial alternative (such as pozzolan- or cement-based stabilization/solidification versus chemical immobilization/stabilization), the most representative process has been selected for evaluation and costing. However, that does not preclude use of the similar alternate processes during implementation of the selected remedy.
4. Descriptions of remedial technologies/process options are provided in Table 4-3. Descriptions of remedial alternatives are provided in Section 5.3.

   Alternative 1: No Further Action

   Alternative 2: In-Place Capping of Contaminated Soils

   Alternative 3: Excavation and Disposal of Contaminated Soils at Licensed Solid Waste Facilities

   Alternative 4: Excavation and Disposal of Contaminated Soils at the Mine Waste Joint Repository

   Alternative 5: Excavation of Contaminated Soils, Treatment, and Disposal of Treated Soils at the Mine Waste Joint Repository

Remedial Alternative	***Description***	***Threshold Criteria***		***Balancing Criteria***					
		Overall Protection of Human Health and the Environment	***Compliance with ARARs***	***Long-Term Effectiveness and Permanence***	***Reduction of Toxicity, Mobility, or Volume through Treatment***	***Short-Term Effectiveness***	***Implementability***	***Present Value Cost (Dollars)***	
1	No Further Action	⓿ Not protective of human health and the environment and does not meet PRAOs.	⓿ Not compliant with chemical-specific ARARs since no further action is taken.	⓿ No additional cleanup measures are initiated and contaminated soils are left exposed.	⓿ No treatment; therefore, does not reduce toxicity, mobility, or volume of contaminants through treatment.	⓿ No additional cleanup measures are initiated and contaminated soils are left exposed. Thus there are no short-term effectiveness issues for this alternative.	⓿ No action is taken other than 5-year site reviews. Since no new remedial action is taken, this alternative has no implementability issues.	$	$123,000
2	In-Place Capping of Contaminated Soils	❸ Alternative 2 addresses the PRAOs primarily through in-place capping of contaminated soils using covers to reduce risks from contact with these materials. Capping provides an exposure barrier to the contaminated soils. However contaminated soils still remain beneath covers across a large extent of the site and could pose risks if the covers are compromised. Land use controls would be implemented to protect and restrict use of covered areas, and provide awareness of risks from potential exposure to contaminated soils.	❹ Addresses the location- and action-specific ARARs through adherence of the ARARs during implementation of the remedial action. Contaminated soils still remain beneath covers across a large extent of OU1 and could pose risks if the covers are compromised. Thus compliance with chemical-specific ARARs is more questionable in the future than other alternatives.	❸ Alternative 2 addresses contaminated soils primarily through in-place capping using covers to reduce risks from contact with these soils. Capping provides an exposure barrier to the contaminated soils. However, contaminated soils still remain beneath covers across a large extent of OU1 and could pose risks if the covers are compromised. Thus, long-term effectiveness and permanence is not as certain as for remedies that remove contaminated soils for disposal.	⓿ No treatment; therefore, does not reduce toxicity, mobility, or volume of contaminants through treatment.	❹ Addresses short-term risks to workers, the community, and the environment. Land use controls could be quickly implemented to address potential exposure to contaminated soils. While construction of covers would involve surface disturbance of contaminated soils, short-term risks to workers would be mitigated through the use of safety measures such as PPE. Short-term risks to workers, the community, and the environment could be mitigated through measures such as water-based dust suppression. Trucks used to haul offsite borrow used to construct the covers slightly increase short-term risks to the community. Transport and placement of borrow has potential environmental impacts from equipment emissions and disturbance of borrow locations.	❸ The construction resources and materials needed to construct the quantity of covers for this alternative should be available, but borrow materials would require transportation to the properties requiring covers. There may be difficulties transitioning covers into existing grades on properties that are relatively level while still facilitating residential uses. There may be additional difficulties associated with implementation of institutional controls. Access controls would be relatively easy to install. Maintenance of the covered areas and monitoring, especially on residential properties, could provide difficulties in the future.	$$	$1,292,000
3	Excavation and Disposal of Contaminated Soils at Licensed Solid Waste Facilities	❹ Alternative 3 addresses the PRAOs primarily through excavation of the majority of contaminated soils and offsite disposal at licensed solid waste disposal facilities. Thus long-term protection of human health and the environment is more certain than alternatives that leave contaminated soils in place at OU1. Land use controls would be implemented on a limited basis to protect and restrict use of areas with remaining contaminated soils and provide awareness of risks from potential exposure to contaminated soils.	❺ Addresses the location- and action-specific ARARs through adherence of the ARARs during implementation of the remedial action. Addresses chemical-specific ARARs by excavation and disposal of contaminated soils within licensed solid waste facilities.	❹ Address contaminated soils through excavation and disposal at offsite licensed disposal facilities Excavation and disposal outside of OU1 increases the long-term effectiveness and permanence of the remedy for locations where excavation of contaminated soils take place.	⓿ No treatment; therefore, does not reduce toxicity, mobility, or volume of contaminants through treatment.	❸ Requires disturbance of a large amount of contaminated soils across the site and a longer duration of construction, which poses increased short-term risks to workers and the community than the predominately surface disturbance activities under Alternative 2. Hauling of contaminated soils for offsite disposal at licensed solid waste facilities as well as transport of borrow materials for backfilling excavations increases truck traffic and related risks workers and to the community as compared to Alternative 2. Excavation and transport of contaminated soils longer distances to the offsite disposal facilities as well as transport and placement of borrow has potential environmental impacts from equipment emissions and disturbance of borrow locations.	❸ Excavation of contaminated soils could be difficult in areas of underground utilities, trees, roads, and near structures. The construction resources and materials needed to backfill excavations for this alternative should be available, but borrow materials would require transportation to the properties requiring backfill. Logistical coordination is needed since both contaminated soils and offsite borrow would be transported simultaneously. Offsite disposal of large volumes of contaminated soils requires coordination with trucks transporting backfill to excavation areas as well as additional coordination with the offsite disposal facilities. The ability to obtain the necessary approvals and the logistics of transporting and disposing of large volumes of contaminated soils for long distances to offsite disposal facilities decreases the implementability of this alternative. There may be additional difficulties associated with implementation of institutional controls, although their use would be limited to a few properties. Monitoring, especially on residential properties, could provide difficulties in the future.	$$$$	$2,811,000

Remedial Alternative	Description	Threshold Criteria		Balancing Criteria					
		Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume through Treatment	Short-Term Effectiveness	Implementability	Present Value Cost (Dollars)	
4	Excavation and Disposal of Contaminated Soils at the Mine Waste Joint Repository	❹ Similar to Alternative 3, except that contaminated soils are disposed of at the Wood Gulch Repository rather than disposed of at offsite licensed disposal facilities.	❺ Addresses the location- and action-specific ARARs through adherence of the ARARs during implementation of the remedial action. Addresses chemical-specific ARARs by excavation and disposal of contaminated soils within the Wood Gulch Repository.	❹ Similar to Alternative 3, except contaminated soils are disposed of at the nearby Wood Gulch Repository rather than at offsite licensed disposal facilities.	⓿ No treatment; therefore, does not reduce toxicity, mobility, or volume of contaminants through treatment.	❹ Similar to Alternative 3, excavation of contaminated soils and backfilling poses similar short-term risks to workers, community, and the environment. However the truck traffic for disposal of contaminated soils would occur within or near OU1 due to the use of the Wood Gulch Repository, resulting in fewer safety risks and reduced environmental impacts.	❹ Excavation of contaminated soils could be difficult in areas of underground utilities, trees, roads, and near structures. The construction resources and materials needed to backfill excavations for this alternative should be available, but borrow materials would require transportation to the properties requiring backfill. Logistical coordination would be required since both contaminated soils and offsite borrow would be transported simultaneously. The disposal of contaminated soils at the Wood Gulch Repository should be relatively easy to coordinate since the repository will be managed under OU3. There may be additional difficulties associated with implementation of institutional controls, although their use would be limited to a few properties. Monitoring, especially on residential properties, could provide difficulties in the future.	$$	$1,496,000
5	Excavation of Contaminated Soils, Treatment, and Disposal of Treated Soils at the Mine Waste Joint Repository	❹ Similar to Alternative 4, except the contaminated soils are treated using solidification/stabilization prior to disposal at the Wood Gulch Repository. Since contaminated soils are treated prior to disposal at the Wood Gulch Repository, overall protection of human health and the environment is more certain than alternatives that do not treat the newly-excavated contaminated soils prior to disposal.	❺ Addresses the location- and action-specific ARARs through adherence of the ARARs during implementation of the remedial action. Addresses chemical-specific ARARs by excavation, treatment, and disposal of contaminated soils within the Wood Gulch Repository.	❺ Similar to Alternative 4, except the newly-excavated contaminated soils are treated via solidification/stabilization prior to disposal at the Wood Gulch Repository. The additional treatment of newly-excavated soils increases the long-term effectiveness and permanence of the remedy compared to remedies without additional treatment due to the added protection from leaching of contaminants to surrounding soils and groundwater.	❸ The contaminated soils would by treated by solidification/stabilization prior to disposal of the soils in the Wood Gulch Repository. Treatment would provide additional protection to surrounding soils and groundwater from contaminated soils that contain concentrations of lead, arsenic, and antimony that are potentially leachable.	❸ Similar to Alternative 4, except that there is an additional step of treating newly-excavated contaminated soils by stabilization. This step involves additional contact with contaminated soils and the stabilizing agent by workers during treatment as well as additional truck traffic to deliver the stabilization agent which potentially increase safety risks and environmental impacts.	❸ Similar to Alternative 4, but includes treatment of contaminated soils using stabilization which requires additional coordination for delivery of stabilization agents as well as implementation of the treatment process before disposal at the Wood Gulch Repository.	$$$$	$2,174,000

Notes:

1. The detailed analysis of retained alternatives involves a qualitative assessment of the degree to which remedial alternatives address evaluation criteria.
   The numerical designations for the qualitative ratings system used in this table are not used to quantitatively assess remedial alternatives (for instance, individual rankings for an alternative are not additive).

Legend for Qualitative Ratings System:

Threshold and Balancing Criteria (Excluding Cost)		Balancing Criteria (Present Value Cost in Dollars)	
⓿	**None**	⓿	**None ($0)**
❶	**Low**	$	**Low ($0 through $0.75M)**
❷	**Low to Moderate**	$$	**Low to Moderate ($0.75M through $1.5M)**
❸	**Moderate**	$$$	**Moderate ($1.5M through $2.25M)**
❹	**Moderate to High**	$$$$	**Moderate to High ($2.25M through $3M)**
❺	**High**	$$$$$	**High (Greater than $3M)**