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8. Detailed Analysis of Alternatives

Section 121 of CERCLA established five principal requirements for the selection of remedies. The remedies must:

- protect human health and the environment;
- comply with ARARs unless a waiver is justified;
- be cost-effective;
- utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and
- satisfy a preference for treatment as a principal element, or provide an explanation in the ROD as to why this preference was not met.

The five CERCLA requirements are further refined in 40 CFR §300.430(e)(9)(iii) into nine criteria for evaluating remedial alternatives to ensure that the important considerations are factored into remedy selection decisions. These criteria are derived from the statutory requirements of Section 121, as well as technical and policy considerations that have proven to be important for selecting among remedial alternatives. The nine-criterion analysis comprises two steps: an individual evaluation of each alternative with respect to each criterion; and a comparison of options to determine the relative performance of the alternatives and identify major trade-offs among them (i.e., relative advantages and disadvantages). The nine criteria are described below.

1. **Overall protection of human health and the environment.** Alternatives are assessed to determine whether they can adequately protect human health and the environment, in both the short- and long-term, from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site by eliminating, reducing, or controlling exposures to levels established during development of remediation goals consistent with 40 CFR §300.430(e)(2)(i). Overall protection of human health and the environment draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. Several alternatives presented in Section 7 were screened out in Section 7 due to their inability to be protective of human health and the environment. Although the urban resident was selected as the relevant future receptor in the 2004 ROD, alternatives are compared using the risks to the subsistence farmer since that was the receptor used to compare alternatives in the 2004 RI/FS.

2. **Compliance with ARARs.** The alternatives are assessed to determine whether they attain ARARs under federal environmental laws and state environmental or facility siting laws or provide grounds for invoking one of the waivers under paragraph 40 CFR 300.430(f)(1)(ii)(C).

3. **Long-term effectiveness and permanence.** Alternatives are assessed for the long-term effectiveness and permanence they afford, along with the degree of certainty that the alternative will prove successful. Factors that must be considered include the following:

- Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities. The characteristics of the residuals should be considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, and propensity to bioaccumulate.
- Adequacy and reliability of controls such as containment systems and institutional controls necessary to manage treatment residuals and untreated waste. This factor addresses in particular the uncertainties associated with land disposal for providing long-term protection from residuals; the assessment of the potential need to replace technical components of the alternative, such as a cap, slurry wall, or treatment system; and the potential exposure pathways and risks posed should the remedial action need replacement.

4. **Reduction of toxicity, mobility, or volume through treatment.** Evaluates which alternatives use recycling or treatment that reduces toxicity, mobility, or volume, including how treatment is used to address the principal threats posed by the site. Factors that are evaluated include the following:

   - Treatment or recycling processes the alternatives employ and materials they will treat;
   - Amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated, or recycled;
   - Degree of expected reduction in toxicity, mobility, or volume of the waste due to treatment or recycling and the specification of which reduction(s) are occurring;
   - Degree to which the treatment is irreversible;
   - Type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents; and
   - Degree to which treatment reduces the inherent hazards posed by principal threats at the site.

5. **Short-term effectiveness.** The short-term effects of alternatives must be assessed considering the following:

   - Short-term risks that might be posed to the community during implementation of an alternative;
   - Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures;
   - Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation; and
   - Time until protection is achieved.

6. **Implementability.** The ease or difficulty of implementing the alternatives must be assessed by considering the following types of factors as appropriate:

   - Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy.

- Administrative feasibility, including activities needed to coordinate with other offices and agencies and the ability and time required to acquire any necessary approvals and permits from other agencies (for offsite actions).
- Availability of services and materials, including the availability of adequate offsite treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to ensure necessary additional resources; the availability of services and materials; and availability of prospective technologies.

7. **Cost.** The types of costs that shall be assessed include the following:

   - Capital costs, including both direct and indirect costs;
   - Annual operation and maintenance costs; and
   - Net present value of capital and operation and maintenance costs.

8. **State acceptance.** Assessment of all State of Colorado concerns may not be completed until comments on the 2007 RI/FS are received but are discussed in the proposed plan issued for public comment. The State of Colorado's concerns from the 2004 RI/FS are taken into account. The State concerns that shall be assessed include the following:

   - The State's position and key concerns related to the preferred alternative and other alternatives; and
   - State comments on ARARs.

9. **Community acceptance.** This assessment includes determining which components of the alternatives interested persons in the community support, have reservations about, or oppose. This assessment may not be completed until comments on the proposed plan are received, although the community's comments from the 2004 RI/FS are taken into account.

Of the nine criteria, the first two are considered threshold criteria that must be attained by the selected remedial action. The next five criteria are the primary balancing criteria, which are considered together to identify significant trade-offs and determine the optimal alternative among those having passed the threshold criteria. The final two criteria are modifying criteria, which are evaluated following public comment on the RI/FS and Proposed Plan.

8.1 Site Disposition ARARs

A significant number of ARARs apply to the Site because of the nature of the materials of concern. EPA typically regulates metal contaminants, but the NRC regulates radionuclides. The primary focus for EPA is the risk or hazard associated with the material, while the NRC focuses on the radioactive material dose. At the State level, CDPHE regulates some of the matters that both EPA and NRC regulate. Different types of land use result in a variety of possible exposures and require different levels of cleanup protection. Multiple chemical and physical variables associated with metals in soil also complicate the regulatory picture making the development of numerical standards problematic. Ecological risk assessment is a developing science that adds uncertainties to the current decision-making process.

Primary ARARs for the Site are those that define the acceptable dose, risk, and hazard standards associated with the current conditions and final disposition of the property. Additional ARARs apply material handling standards required during excavation or removal operations. The following ARARs presented in Table 8-1 for soils and groundwater and surface water were determined to be major decision drivers for Site disposition. Additional ARARs that apply to remedial alternatives, including excavation and transportation, are summarized in Appendix I.

Table 8-1
ARARs for Soils, Groundwater, and Surface Water

Media	Site-Specific Applicable or Relevant and Appropriate Requirements and To Be Considered
Soil	10 CFR §20.1402 and 1403, NRC Standards for Protection Against Radiation, Radiological Criteria for Unrestricted and Restricted Use – Requires that exposures to onsite receptors do not result in a dose in excess of 25 mrem/yr plus ALARA, and 100 mrem/yr if institutional controls fail for restricted use cleanups.
	6 CCR 1007-1, §4.61.2 – 4.61.3, Colorado Radiation Control regulations, Radiological Criteria for Unrestricted and Restricted Use - Requires that exposures to onsite receptors do not result in a dose in excess of 25 mrem/yr plus ALARA, and 100 mrem/yr if institutional controls fail for restricted use cleanups.
	EPA Memorandum, Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination, OSWER No. 9200.4-18, August 1997 – Uses a risk-based approach to recommend limiting exposures to less than 15 mrem/yr for NCP compliance.
	EPA Memorandum, Reassessment of Radium and Thorium Soil Concentrations and Annual Dose Rates, July 22, 1996 – Initial discussion that resulted in the recommended 15 mrem/yr dose.
	EPA Memorandum, Use of Soil Cleanup Criteria in 40 CFR 192 as Remediation Goals for CERCLA Sites, Directive No. 9200.4-25, February 1998 – Clarification of the use of 40 CFR 192 for the development of radionuclide soil standards.
	40 CFR §192.12, Subpart B; 6 CCR 1007-1, Part 18 Appendix A —Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites, Standards – Limits radium-226 surface activities (up to 15 cm) to 5 pCi/g and subsurface activities (greater than 15 cm) to 15 pCi/g. For occupied or habitable structures it requires that remedial efforts result in an annual radon decay product concentration (including background) of less than 0.2 WL (in any case the concentration should not exceed 0.3 WL). And interior gamma shall not exceed background by more than 20 microroentgens per hour.
	40 CFR §192.02, Subpart A; 6 CCR 1007-1, Part 18 Appendix A —Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites, Standards – Specifies that the control of residual radioactive materials and their listed constituents shall be designed to be effective for up to 1,000 years, and in any case for at least 200 years. Also imposes limits on acceptable radon air concentrations and requires groundwater monitoring when necessary.
	CDPHE, Proposed Soil Remediation Objectives Policy Document, December 1997, as updated
	CDPHE, Revised Proposed Residential/Unrestricted Land-Use Standards, 2003, as updated
	EPA Region 9 Memorandum, Region 9 PRGs Table 2002 Update, October 2002 – Describes risk-based approach to soil cleanup and provides table of preliminary remediation goals for soils. CDPHE recommends the use of these PRGs for materials not covered by their proposed soil standards.

Table 8-1
ARARs for Soils, Groundwater, and Surface Water

Media	Site-Specific Applicable or Relevant and Appropriate Requirements and To Be Considered
Groundwater and Surface Water	40 CFR §192.02 Standards, §192.03 Monitoring, §192.04 Corrective Action, Subpart A—Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites – Details the requirements specific to groundwater.
	40 CFR §192.20 Guidance for implementation, §192.20 Criteria for applying supplemental standards, Subpart C – Implementation – Additional groundwater requirements.
	40 CFR 141.11, National Primary Drinking Water Regulations, Maximum contaminant levels for inorganic chemicals.
	40 CFR 141.15, National Primary Drinking Water Regulations, Maximum contaminant levels for uranium, radium-226, radium-228, and gross alpha particle radioactivity in community water systems.
	40 CFR 141.51, National Primary Drinking Water Regulations, Maximum contaminant level goals for inorganic contaminants.
	40 CFR 141.55, National Primary Drinking Water Regulations, Maximum contaminant level goals for radionuclides.
	5 CCR 1003-1, Colorado Primary Drinking Water Regulations, Maximum contaminant levels for uranium and arsenic, among other substances.
	5 CCR 1002-41, Colorado Department Of Health, Water Quality Control Commission Regulation No. 41, Basic Standards for Ground Water.
	5 CCR 1002-8, §3.1.1, Colorado Department Of Health, Water Quality Control Commission Regulation No. 8, Establishes basic standards, anti-degradation standard, and system for classifying State water.
	5 CCR 1002-38, Colorado Department Of Health, Water Quality Control Commission Regulation No. 38, Classifications And Numeric Standards South Platte River Basin (including Clear Creek as a tributary), Laramie River Basin, Republican River Basin, Smoky Hill River Basin.
	5 CCR 1002-31, Colorado Department Of Public Health And Environment, Water Quality Control Commission, Regulation No. 31, The Basic Standards And Methodologies For Surface Water, Section 31.8 Antidegradation Rule.

8.2 Analysis of Alternatives

This section presents the results of the analysis of each alternative with respect to the nine evaluation criteria.

8.2.1 Alternative 1: No-Further Action

Under Alternative 1, the affected soils would remain in the lined stockpiles, and a comprehensive, long-term program would be required to monitor air quality, surface water quality, groundwater quality, and radiation dose. Even though this alternative was screened out in Section 7 and was not selected in the 2004 RI/FS, it provides a baseline for comparison purposes.

8.2.1.1 Alternative 1 - Protection of Human Health and the Environment

Alternative 1, the no-further action alternative, does not provide adequate protection of human health and the environment. It does not address the risks associated with potential skin contact, inhalation, or ingestion of contaminants from the elevated material. With the 40 CFR §192.02(a) requirement of 1,000 years (or at least 200 years) of protection, the no-further action alternative is not appropriate. In that amount of time, land use could reasonably revert to the urban resident modeled in the baseline risk assessment, as modified by the 2004 ROD. The predicted dose of the impacted soil prior to segregation and stockpiling was as high as 190 mrem/yr and would be ten times higher if the RESRAD-predicted radon concentrations are applied. Total risk from radionuclides and metals, again prior to segregation and stockpiling, was up to 3.8×10^{-3} (disregarding radon) and the HI was predicted to be as high as 3.8. The risk to a residential receptor arising from radon emanation from Site soils would be 2,087 mrem/yr. Lead-contaminated soil could increase blood lead concentration up to 20 µg/dL. Groundwater would not meet the MCL for uranium at the point of compliance, and it could migrate into Clear Creek, a source of drinking water downstream of the site.

Even with an effective erosion and sediment control program, windborne particles would migrate offsite. Metals and radionuclides would be absorbed by vegetation, which again can migrate offsite in the form of leaves and debris.

A major weakness in the no-further action alternative is the failure to provide adequate protection of human health and the environment.

8.2.1.2 Alternative 1 - Compliance with ARARs

Assuming the urban resident receptor, the no-further action alternative fails to meet the ARARs presented in Section 8.1, as explained above in Section 8.2.1.1. The groundwater and surface water ARARs also are not met.

8.2.1.3 Alternative 1 - Long-term Effectiveness and Permanence

The alternative would provide no reduction in risk and does not reduce toxicity, mobility, or volume of Site contaminants. It would be a long-term source of possible contamination to groundwater and surface water.

8.2.1.4 Alternative 1 - Reduction of Toxicity, Mobility, or Volume through Treatment

No treatment is associated with no-further action, resulting in no reduction of toxicity, mobility, or volume.

8.2.1.5 Alternative 1 - Short-Term Effectiveness

The short-term effects of the no-further action alternative would be unchanged from the current risks posed by the elevated material. Because no excavation is required, there would be minimal risk to workers. No elevated short-term risks would result from implementation of this alternative.

8.2.1.6 Alternative 1 - Implementability

Alternative 1 is technically feasible; however, the administrative feasibility of this alternative is problematic because it would not likely meet the criteria for radioactive materials license decommissioning, and it will be problematic to get a solid waste disposal license.

8.2.1.7 Alternative 1 - Cost

Cost elements associated with the no-further action alternative include the long-term maintenance of fencing and storm-water controls and long-term monitoring of the groundwater. Assuming 100 years of maintenance and monitoring, the total present value of these requirements is estimated at $4.07 million. There is the cost of loss in property value for the 1 acre of land associated with the soil stockpiles. This loss of property value is estimated to be $0.46 million. Cost breakdown data for each alternative are provided in Section 8.3.7.

8.2.1.8 Alternative 1 - State Acceptance

State acceptance is unlikely because of possible metals and radionuclide exposure and lack of groundwater protection. The School and CDPHE have indicated that some proactive remedial action at the Site is required.

8.2.1.9 Alternative 1 - Community Acceptance

Comments received during an open house conducted by the School in 2004 indicated that local residents preferred offsite disposal, making community acceptance of no-further action unlikely.

8.2.2 Alternative 4A: Onsite Solidification of Stockpile B with Engineered Cap, Stockpile A shipped Offsite

The soil in Stockpile B would be consolidated for this option and disposed of onsite using solidified matrix (soil/concrete/fly ash mixture) with an engineered cap constructed over the top. An estimated 12,800 cubic yards of soil would be solidified. Stockpile A, containing an estimated 200 cubic yards, would be shipped offsite to a special waste facility.

Alternative 4A would begin with the shipping offsite of Stockpile A. Stockpile A soil will be placed in suitable containers and prepared for transport. Transport will be via truck to a railyard where the containers will be loaded on a train for transport out of state. This effort will be followed by the solidification operation preparation.

A properly sized area would be excavated to hold the total volume of the consolidated material and concrete/fly ash mixture. The required equipment would be mobilized to the Site, and required materials would be stockpiled. The affected soil would then be excavated and sorted for use in the process. After the solidification has been completed, the area would be re-graded and a cap would be installed using material from an offsite location. Fill would need to be placed over the remaining site to bring the area to a useable grade and control storm-water. A groundwater-monitoring network would need to be placed around the solidified matrix.

Institutional controls would include deed restrictions for the entire Site requiring radon mitigation for all structures as well as maintenance requirements for the 1 acre of land affected by the solidified matrix. Deed restrictions associated with the solidified matrix would include limiting construction activities and excavation and ensuring the integrity of the cap. Although construction has been allowed for some capped sites, it makes cap maintenance problematic. In accordance with 40 CFR §192.02(a), a long-term maintenance plan would be required to maintain cap integrity along with long-term groundwater monitoring.

8.2.2.1 Alternative 4A - Protection of Human Health and the Environment

Solidification of Stockpile B coupled with an engineered cap would eliminate the standard exposure pathways. The offsite disposal of Stockpile A would decrease the radon exposure potential, however, would do little to reduce the long-term risk from this option as compared to Alternative 4AA.

Solidification coupled with an engineered cap and an environmental covenant for radon mitigation and no disturbance of the cap would eliminate the standard exposure pathways. Assuming a house built directly over the solidified matrix (Alternative 4A), RESRAD predicts essentially no external dose for the urban residential receptor. This assumes clean cap and cover material was used over the solidified material. However, in the 2004 RI/FS, the risk to a subsistence farmer due to residual concentrations of contaminants below the DCGLs is estimated to be 1.1 E-06; the corresponding hazard index from residual metals was calculated to be 0.58. Residual radium-226 would be a continuing source of radon gas. Institutional controls are needed to ensure that radon abatement systems are a requirement for any structure or building construction at the Site. In the absence of institutional controls, RESRAD predicted a dose of 335 mrem/yr to an urban resident due to radon emanation into the house. The urban resident is not assumed to be a user of Site groundwater. Drinking water for the urban resident is assumed to be supplied from a public water supply.

The data set for the RESRAD model was generated from analytical results of samples collected from the soil stockpiles for waste characterization purposes (Table 8-2).

Table 8-2
RESRAD Predictions under Alternatives 4A, 4AA, 4B, and 4BB without Radon Mitigation (i.e., with failure of institutional controls)

Alternative / Receptor	RESRAD Dose (mrem/yr)
4A – Urban Residence over solidification cell from Stockpile B	335
4AA – Urban Residence over solidification cell from Stockpiles A and B	2087
4B – Urban Residence over engineered disposal cell from Stockpile B	335
4BB – Urban Residence over engineered disposal cell from Stockpiles A and B	2087

Institutional controls for the disposal area would be required to prevent the degradation of the cap or excavation into the solidified structure or disposal cell as well as to ensure radon mitigation techniques are employed for future residential development. Failure to maintain the institutional controls could jeopardize future protection of human health and the environment.

8.2.2.2 Alternative 4A - Compliance with ARARs

Alternative 4A complies with the ARARs listed in Section 8.1, with the exception of groundwater requirements and the radon standard. If the institutional controls failed, the expected dose would exceed 100 mrem/yr. Groundwater radionuclide activities and metals concentrations would be expected to decrease with time after the source material is controlled to prevent future releases to the groundwater. Short-term restrictions on groundwater use coupled with a limited groundwater-monitoring program would be needed to meet ARARs and provide unrestricted use of areas not affected by the disposal cell. Long-term groundwater monitoring would be required for the disposal areas.

8.2.2.3 Alternative 4A - Long-term Effectiveness and Permanence

If the cap is maintained, the alternative(s) would be effective; however, permanence is more difficult to predict. Using the 1,000-year life recommended by 40 CFR §192.02, it would be difficult to anticipate the permanence of the remedy. The solidified material would be more resistant to damage than the disposal cell, but loss of the cap would be problematic for all of the 4-series alternatives. Although cap designs are advertised as having life spans of this magnitude, there are no existing examples of this type of performance. A number of claims are made about caps providing a radon barrier but this is highly dependent on maintaining moisture content. Semiarid climates make prescribed moisture content difficult to maintain. The long-term integrity of the solidified matrix for Alternative 4A also is uncertain. Recent problems at the Shattuck Site, Operable Unit 8 at the Denver Radium Sites, demonstrate this uncertainty.

8.2.2.4 Alternative 4A - Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 4A addresses the toxicity (reduces bioavailability) and mobility of the material through treatment (solidification) and offsite disposal of the highest activity material, but the volume actually increases (typically 20 percent or more). Alternative 4A addresses the mobility and toxicity. There is no volume reduction.

8.2.2.5 Alternative 4A - Short-Term Effectiveness

Soil relocation activities pose an elevated short-term exposure risk to onsite workers, transportation workers, and nearby residents due to airborne particulate generation. Alternative 4A potentially would generate additional air particulate because of mixing and grinding operations. Direct exposure of workers during implementation of this alternative would be minimized through use of appropriate safety measures and procedural controls. Table 8-3 summarizes RESRAD-predicted worker doses and risks associated with soil-handling activities. Conservative parameters were used in the model to predict upper limits for the operation. Assumptions included direct access to the soil when in fact workers will spend most of their time in excavation equipment.

Table 8-3
RESRAD-Predicted Worker Doses for Excavation Activities under Alternative 4

Worker Exposure	Dose (mrem/yr)	Risk
Entire Site – 6 months	2.0	4.2×10^{-5}
Elevated Areas – 1 month	1.4	3.2×10^{-5}

Hazards associated with metals would be expected to be minimal during remedial operations. Risks associated with inhalation of fugitive dusts are controllable through air monitoring, the use of appropriate health and safety equipment, and dust suppression techniques. Air monitoring also would be used to identify potential offsite risks to the neighboring community.

A low to moderate risk to the local area would be associated with the truck traffic required to dispose of Stockpile A offsite and move equipment and supplies to the Site (i.e., traffic accidents). Access to State Highway 6 would limit the risk to the immediate neighborhood but could affect the local county (or counties). A small incremental increase in risk is associated with transportation of Stockpile A and equipment and supplies through the neighborhood.

8.2.2.6 Alternative 4A - Implementability

The technical feasibility of material solidification and onsite disposal with an engineered cap relies on the use of conventional technology. Necessary equipment and supplies are readily available for implementation of this alternative. This technology has been used successfully on a number of sites but failures have occurred because of improper determination of the necessary mix of soil and concrete. Pilot tests would be necessary to determine the proper mixture, but these tests can be misleading if there is significant soil heterogeneity.

The alternative is administratively feasible, but long-term institutional controls for the disposal areas must be considered. Permits may be required for onsite disposal, and these could take considerable time to obtain.

8.2.2.7 Alternative 4A - Cost

Cost elements associated with Alternative 4A include offsite disposal costs for Stockpile A, material handling and solidification, mobilization and demobilization of the equipment needed to produce the solidified structure, materials, installation of the cap, re-grading of the Site, installation of the groundwater monitoring wells, long-term maintenance of the cap, and long-term groundwater monitoring. Assuming 100 years of maintenance and monitoring, the total present value of these requirements is estimated at $5.18 million. In addition to the above net present value cost, costs are associated with the loss in property value because of the remaining contaminants (Section 8.3.7.1) and the land use restrictions ($0.46 million). The estimated schedule to implement Alternative 4A is about eight months.

Cost breakdown data for each alternative are provided in Section 8.3.7.

8.2.2.8 Alternative 4A - State Acceptance

The School would accept onsite disposal under the appropriate circumstances, which are not present here. Recent problems associated with onsite disposal with the Shattuck Chemical Superfund Site in nearby Denver may reduce CDPHE acceptance. Offsite disposal of Stockpile A would be acceptable to CDPHE. CDPHE has stated in meetings that it will not support an onsite disposal remedy. The onsite component of Alternative 4A would undergo close CDPHE scrutiny because of the Shattuck Site. EPA selected onsite stabilization and solidification for soils (concrete and fly ash) and natural attenuation for groundwater in the 1992 ROD for the Shattuck Site. At the time, this met the statutory preference for a remedy although it increased the mass of materials and created a monolith. EPA conducted a five-year-review of the Shattuck Site and found deficiencies in the monolith cover design, the integrity of the monolith, and the monolith's compliance program. Based on these findings, EPA could not be assured of the long-term protection of the original remedy. In addition to the technical concerns raised by the five-year review, the State, Denver elected officials, and the local community requested that EPA consider other alternatives to the onsite remedy to allow for unrestricted use of the Site. The monolith was demolished and shipped out of state.

8.2.2.9 Alternative 4A - Community Acceptance

Comments received during the open house conducted by the School in 2004 indicated that local residents preferred the offsite disposal of the material.

8.2.3 Alternative 4AA: Onsite Solidification of Stockpiles A and B with Engineered Cap

The affected soil would be consolidated for this option and disposed of onsite using solidified matrix (soil/concrete/fly ash mixture) with an engineered cap constructed over the top. An estimated 13,000 cubic yards of soil would be solidified. Alternative 4AA consolidates all soils with radionuclides above DCGLs and metals above proposed residential soil standards.

Alternative 4AA would begin with the solidification operation preparation. A properly sized area would be excavated to hold the total volume of the consolidated material and concrete/fly ash mixture. The required equipment would be mobilized to the Site and required materials would be stockpiled. The affected soil would then be sorted for use in the process. After the solidification has been completed, the area would be re-graded and a cap would be installed using the material from an offsite location. Fill would need to be placed over the remaining site to bring the area to a useable grade and control storm-water. A groundwater-monitoring network would need to be placed around the solidified matrix.

Institutional controls would include deed restrictions for the entire Site, requiring radon mitigation for all structures as well as maintenance requirements for the 1 acre of land affected by the solidified matrix. Deed restrictions associated with the solidified matrix would include limiting construction activities and excavation and ensuring the integrity of the cap. Although construction has been allowed for some capped sites, it makes cap maintenance problematic. In accordance with 40 CFR §192.02(a), a long-term maintenance plan would be required to maintain cap integrity along with long-term groundwater monitoring.

8.2.3.1 Alternative 4AA - Protection of Human Health and the Environment

Solidification coupled with an engineered cap and institutional controls would eliminate the standard exposure pathways. Assuming a house built directly over the solidified matrix (Alternative 4AA), RESRAD predicts essentially no external dose for the urban residential receptor. This assumes clean cap and cover material was used over the solidified material. However, in the 2004 RI/FS, the risk to a subsistence farmer due to residual concentrations of contaminants below the DCGLs is estimated to be 1.1 E-06; the corresponding hazard index from residual metals was calculated to be 0.58. Residual Ra-226 would be a continuing source of radon gas. Institutional controls are needed to ensure that radon abatement systems are a requirement for building construction at the Site. In the absence of institutional controls, RESRAD predicted a dose of 2,087mrem/yr to an urban resident due to radon emanation into the house. The urban resident is not assumed to be a user of Site groundwater. Drinking water for the urban resident is supplied from a public water supply.

The data set for the RESRAD model was generated from analytical results of samples collected from the soil stockpiles for waste characterization purposes.

Institutional controls for the disposal area would be required to prevent the degradation of the cap or excavation into the solidified structure or disposal cell as well as to ensure radon mitigation techniques are employed for future residential development. Failure to maintain the institutional controls could jeopardize future protection of human health and the environment.

8.2.3.2 Alternative 4AA - Compliance with ARARs

Alternative 4AA complies with the ARARs listed in Section 8.1, with the exception of groundwater requirements and the radon standard. If the institutional controls failed, the expected dose would exceed 100 mrem/yr. Groundwater radionuclide activities and metals concentrations would be expected to decrease with time once the source material is controlled. Short-term restrictions on groundwater use coupled with a limited groundwater-monitoring program would be needed to meet ARARs and provide unrestricted use of areas not affected by the disposal cell. Long-term groundwater monitoring would be required for the disposal areas.

8.2.3.3 Alternative 4AA - Long-term Effectiveness and Permanence

If the cap is maintained, the alternative(s) would be effective; however, permanence is more difficult to predict. Using the 1,000-year life recommended by 40 CFR §192.02, it would be difficult to anticipate the permanence of the remedy. The solidified material would be more resistant to damage than the disposal cell, but loss of the cap would be problematic for all Alternative 4 variations (4A, 4AA, 4B, and 4BB). Although cap designs are advertised as having life spans of this magnitude, there are no existing examples of this type of performance. A number of claims are made about caps providing a radon barrier but this is highly dependent on maintaining moisture content. Semiarid climates make prescribed moisture content difficult to maintain. The long-term integrity of the solidified matrix for Alternative 4AA also is uncertain. Recent problems at the Shattuck Site demonstrate this.

8.2.3.4 Alternative 4AA - Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 4AA addresses the toxicity (reduces bioavailability) and mobility of the material through treatment (solidification), but the volume actually increases (typically 20 percent or more). Alternative 4AA addresses the mobility and toxicity. There is no volume reduction.

8.2.3.5 Alternative 4AA – Short-Term Effectiveness

Excavation activities pose an elevated short-term exposure risk to onsite workers, transportation workers, and nearby residents due to airborne particulate generation. Alternative 4AA potentially would generate additional air particulate because of mixing and grinding operations. Direct exposure of workers during implementation of this alternative would be minimized through use of appropriate safety measures and procedural controls. Table 8-4 summarizes RESRAD-predicted worker doses and risks associated with excavation activities. Conservative parameters were used in the model to predict upper limits for the operation. Assumptions included direct access to the soil when in fact workers will spend most of their time in excavation equipment.

Table 8-4
RESRAD-Predicted Worker Doses for Excavation Activities under Alternative 4

Worker Exposure	Dose (mrem/yr)	Risk
Entire Site – 6 months	2.0	4.2×10^{-5}
Elevated Areas – 1 month	1.4	3.2×10^{-5}

Hazards associated with metals would be expected to be minimal during remedial operations. Risks associated with inhalation of fugitive dusts are controllable through air monitoring, the use of appropriate health and safety equipment, and dust suppression techniques. Air monitoring also would be used to identify potential offsite risks to the neighboring community.

A low to moderate risk to the local area would be associated with the truck traffic required to move equipment and supplies to the Site (i.e., traffic accidents). Access to State Highway 6 would limit the risk to the immediate neighborhood but could affect the local county (or counties). A small incremental increase in risk is associated with transportation of equipment and supplies through the neighborhood.

8.2.3.6 Alternative 4AA - Implementability

The technical feasibility of material solidification and placement of an engineered cap over the top relies on the use of conventional technology. Necessary equipment and supplies are readily available for implementation of this alternative. This technology has been used successfully on a number of sites but failures have occurred because of improper determination of the necessary mix of soil and concrete. Pilot tests would be necessary to determine the proper mixture, but these tests can be misleading if there is significant soil heterogeneity.

The alternative is administratively feasible, but long-term institutional controls for the disposal areas must be considered. Permits may be required for onsite disposal, and these could take considerable time to obtain.

8.2.3.7 Alternative 4AA - Cost

Cost elements associated with Alternative 4AA include material excavation and consolidation, mobilization and demobilization of the equipment needed to produce the solidified structure, materials, installation of the cap, re-grading of the Site, installation of the groundwater monitoring wells, long-term maintenance of the cap, and long-term groundwater monitoring. Assuming 100 years of maintenance and monitoring, the total present value of these requirements is estimated at $5.13 million. In addition to the above net present value cost, costs are associated with the loss in property value because of the remaining contaminants (Section 8.3.7.1) and the land use restrictions ($0.46 million). The estimated schedule for Alternative 4AA is about eight months.

Cost breakdown data for each alternative are provided in Section 8.3.7.

8.2.3.8 Alternative 4AA - State Acceptance

The School would accept onsite disposal under the appropriate circumstances, which are not present here. Recent problems associated with onsite disposal with the Shattuck Chemical

Superfund Site in nearby Denver and other reasons may reduce CDPHE acceptance. CDPHE has stated in meetings that it will not support an onsite disposal remedy.

Alternative 4B would undergo close CDPHE scrutiny because of the Shattuck Site as explained in Section 8.2.2.8.

8.2.3.9 Alternative 4AA - Community Acceptance

Comments received during the open house conducted in 2004 by the School indicated that local residents preferred offsite removal of the material.

8.2.4 Alternative 4B: Onsite Disposal of Stockpile B with Engineered Cell and Cap, Offsite Disposal of Stockpile A

Alternative 4B would begin with the offsite disposal of Stockpile A and then engineering and construction of a disposal cell. A properly sized area would be excavated to hold the cell. A clay liner base would be installed followed by a geosynthetic liner. Stockpile B soil would then be transferred into the cell. Once all of the material is in the disposal cell, a second geosynthetic liner will be placed over the cell (encapsulating the material) and a cap will be installed using the material from the School borrow area or an offsite location. Once the encapsulation has been completed, the area would be re-graded. Fill would need to be placed over the remaining site to bring the area to a useable grade and control storm-water.

Institutional controls for both alternatives would include deed restrictions for the entire Site, requiring radon mitigation for all structures as well as maintenance requirements for the acreage affected by the disposal cell. Deed restrictions associated with the disposal cell would include limiting construction activities and excavation and ensure the integrity of the cap. While construction has been allowed for some capped sites, it makes cap maintenance problematic. In accordance with 40 CFR §192.02(a), a long-term maintenance plan would be required to maintain cap integrity along with long-term groundwater monitoring.

8.2.4.1 Alternative 4B - Protection of Human Health and the Environment

Again, assuming a house built directly over the disposal cell (Alternative 4B), RESRAD predicts essentially no external dose for the urban residential receptor. Clean cap and cover materials were assumed. However, in the 2004 RI/FS, the risk to a subsistence farmer due to residual concentrations of contaminants below the DCGLs is estimated to be 1.1 E-06; the corresponding hazard index from residual metals is calculated to be 0.58. As with Alternative 4A, Ra-226 would be a continuing source of radon gas generating a long-term dose of 335 mrem/yr in the absence of institutional controls. Institutional controls are needed to ensure that radon abatement systems are a requirement for any structure built at the Site.

Additionally, institutional controls for the disposal area would be required to prevent the degradation of the cap or excavation into the solidified structure or disposal cell. Failure to maintain the institutional controls could jeopardize future protection of human health and the environment. RESRAD predicts a dose of 335 mrem/yr to a residential receptor due to radon emanation from Ra-226 below the cap.

8.2.4.2 Alternative 4B - Compliance with ARARs

Alternative 4B complies with the ARARs listed in Section 8.1, with the exception of groundwater requirements and the radon standard. If the institutional controls failed, the expected dose would exceed 100 mrem/yr. Groundwater radionuclide activities and metals concentrations would be expected to decrease with time once the source material is removed. Short-term restrictions on groundwater use coupled with a limited groundwater-monitoring program would be needed to meet ARARs. Long-term groundwater monitoring would be required for the disposal areas.

8.2.4.3 Alternative 4B - Long-term Effectiveness and Permanence

If the cap is maintained, the alternative would be effective; however, permanence is more difficult to predict. Using the 1,000-year life recommended by 40 CFR §192.02, it would be difficult to anticipate the permanence of the remedy. The material would be more resistant to damage than the disposal cell, but loss of the cap would be problematic for all of the 4-series alternatives. Although cap designs are advertised as having life spans of this magnitude, there are no existing examples of this type of performance. A number of claims are made about caps providing a radon barrier but this is highly dependent on maintaining moisture content. Semiarid climates make prescribed moisture content difficult to maintain.

8.2.4.4 Alternative 4B - Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 4B addresses the toxicity (reduces bioavailability) and mobility of the material through encapsulation, but the volume is not reduced. There is no volume reduction.

8.2.4.5 Alternative 4B - Short-Term Effectiveness

Soil relocation activities pose an elevated short-term exposure risk to onsite workers, transportation workers, and nearby residents due to airborne particulate generation. Alternative 4B potentially would generate additional air particulate because of mixing and grinding operations. Direct exposure of workers during implementation of this alternative would be minimized through use of appropriate safety measures and procedural controls. Table 8-5 summarizes RESRAD-predicted worker doses and risks associated with soil handling activities. Conservative parameters were used in the model to predict upper limits for the operation. Assumptions included direct access to the soil when in fact workers will spend most of their time in excavation equipment.

Table 8-5
RESRAD-Predicted Worker Doses for Excavation Activities under Alternative 4

Worker Exposure	Dose (mrem/yr)	Risk
Entire Site – 6 months	2.0	$4.2\text{x}10^{-5}$
Elevated Areas – 1 month	1.4	$3.2\text{x}10^{-5}$

Hazards associated with metals would be expected to be minimal during remedial operations. Risks associated with inhalation of fugitive dusts are controllable through air monitoring, the use of appropriate health and safety equipment, and dust suppression techniques. Air monitoring also would be used to identify potential offsite risks to the neighboring community.

A low to moderate risk to the local area would be associated with the truck traffic required to move equipment and supplies to the Site (i.e., traffic accidents). Access to State Highway 6 would limit the risk to the immediate neighborhood but could affect the local county (or counties). A small incremental increase in risk is associated with transportation of equipment and supplies through the neighborhood.

8.2.4.6 Alternative 4B - Implementability

The technical feasibility of material encapsulation and onsite disposal with an engineered cap relies on the use of conventional technology. Necessary equipment and supplies are readily available for implementation of this alternative. This technology has been used successfully on a number of sites.

The alternative is administratively feasible, but long-term institutional controls for the disposal areas must be considered. Permits may be required for onsite disposal, although they will likely take considerable time to obtain.

8.2.4.7 Alternative 4B - Cost

Cost elements associated with Alternative 4B include material excavation and consolidation, construction of the disposal cell, materials, installation of the cap, re-grading of the Site, installation of the groundwater monitoring wells, long-term maintenance of the cap, and long-term groundwater monitoring. Assuming 100 years of maintenance and monitoring, the total present value of these requirements is estimated at $5.21 million. In addition to the above net present value cost, there is a cost associated with the loss in property value because of the remaining contaminants and the land use restrictions ($0.46 million). The estimated schedule for Alternative 4B is about seven months.

8.2.4.8 Alternative 4B - State Acceptance

The School would accept onsite disposal under the appropriate circumstances, which are not present here. Recent problems associated with onsite disposal with the Shattuck Chemical Superfund Site in nearby Denver may reduce CDPHE acceptance. CDPHE has stated in meetings that it will not support an onsite remedy.

Alternative 4B would undergo close CDPHE scrutiny because of the Shattuck Site as explained in Section 8.2.2.8.

8.2.4.9 Alternative 4B - Community Acceptance

Comments received during the open house conducted by the School in 2004 indicated that local residents preferred the offsite removal of the material.

8.2.5 Alternative 4BB: Onsite Disposal of both Stockpiles A and B with Engineered Cell and Cap

Alternative 4BB would begin with both piles staying on site and the engineering and construction of a disposal cell. A properly sized area would be excavated to hold the cell. A clay liner base would be installed followed by a geosynthetic liner. The stockpiles would be mixed and transferred into the cell. Once all of the material is in the disposal cell, a second geosynthetic liner will be placed over the cell (encapsulating the material) and a cap will be installed using the material from an offsite location. Once the encapsulation has been completed, the area would be re-graded. Fill would need to be placed over the remaining Site to bring the area to a useable grade and control storm-water.

Institutional controls for both Alternatives 4B and 4BB would include deed restrictions for the entire Site, requiring radon mitigation for all structures as well as maintenance requirements for the 1 acre of land affected by the disposal cell. Deed restrictions associated with the disposal cell would include limiting construction activities and excavation and ensure the integrity of the cap. While construction has been allowed for some capped sites, it makes cap maintenance problematic. In accordance with 40 CFR §192.02(a), a long-term maintenance plan would be required to maintain cap integrity along with long-term groundwater monitoring.

8.2.5.1 Alternative 4BB - Protection of Human Health and the Environment

Again, assuming a house built directly over the disposal cell (Alternative 4BB), RESRAD predicts essentially no external dose for the urban residential receptor. Clean cap and cover materials were assumed. As with Alternative 4AA, Ra-226 would be a continuing long-term source of radon gas generating a dose of 2,087 mrem/yr in the absence of institutional controls. Institutional controls are needed to ensure that radon abatement systems are a requirement for any structure or building construction at the Site. However, in the 2004 RI/FS, the risk to a subsistence farmer due to residual concentrations of contaminants below the DCGLs is estimated to be 1.1 E-06; the corresponding hazard index from residual metals was calculated to be 0.58.

If clean cap and cover materials are used, the HI and risk associated with metals would be would be expected to be zero for Alternative 4BB.

Institutional controls for the disposal areas would be required to prevent the degradation of the cap or excavation into disposal cell as well as to ensure radon mitigation techniques are employed for future residential development. Failure to maintain the institutional controls could jeopardize future protection of human health and the environment. In the event of institutional control failure, RESRAD predicts a dose of 2,087 mrem/yr to a residential receptor due to radon emanation from Ra-226 below the cap.

8.2.5.2 Alternative 4BB - Compliance with ARARs

Alternative 4BB complies with the ARARs listed in Section 8.1, with the exception of groundwater requirements and the radon standard. If the institutional controls failed, the expected dose would exceed 100 mrem/yr. Groundwater radionuclide activities and metals concentrations would be expected to decrease with time once the source material is removed. Short-term restrictions on groundwater use coupled with a limited groundwater-monitoring program would be needed to meet ARARs. Long-term groundwater monitoring would be required for the disposal areas.

8.2.5.3 Alternative 4BB - Long-term Effectiveness and Permanence

If the cap is maintained, the alternative(s) would be effective; however, permanence is more difficult to predict. Using the 1,000-year life recommended by 40 CFR §192.02, it would be difficult to anticipate the permanence of the remedy. The solidified material would be more resistant to damage than the disposal cell, but loss of the cap would be problematic for all the 4-series alternatives. Although cap designs are advertised as having life spans of this magnitude, there are no existing examples of this type of performance. A number of claims are made about caps providing a radon barrier but this is highly dependent on maintaining moisture content. Semiarid climates make prescribed moisture content difficult to maintain.

8.2.5.4 Alternative 4BB - Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 4B addresses the toxicity (reduces bioavailability) and mobility of the material through encapsulation, but the volume is not reduced. Alternative 4BB addresses the mobility and toxicity. There is no volume reduction.

8.2.5.5 Alternative 4BB – Short-Term Effectiveness

Soil relocation activities pose an elevated short-term exposure risk to onsite workers, transportation workers, and nearby residents due to airborne particulate generation. Alternative 4BB potentially would generate additional air particulate because of mixing and grinding operations. Direct exposure of workers during implementation of this alternative would be minimized through use of appropriate safety measures and procedural controls. Table 8-6 summarizes RESRAD-predicted worker doses and risks associated with soil handling activities. Conservative parameters were used in the model to predict upper limits for the operation. Assumptions included direct access to the soil when in fact workers will spend most of their time in excavation equipment.

Table 8-6
RESRAD-Predicted Worker Doses for Excavation Activities under Alternative 4

Worker Exposure	Dose (mrem/yr)	Risk
Entire Site – 6 months	2.0	4.2×10^{-5}
Elevated Areas – 1 month	1.4	3.2×10^{-5}

Hazards associated with metals would be expected to be minimal during remedial operations. Risks associated with inhalation of fugitive dusts are controllable through air monitoring, the use of appropriate health and safety equipment, and dust suppression techniques. Air monitoring also would be used to identify potential offsite risks to the neighboring community.

A low to moderate risk to the local area would be associated with the truck traffic required to move equipment and supplies to the Site (i.e., traffic accidents). Access to State Highway 6 would limit the risk to the immediate neighborhood but could affect the local county (or counties). A small incremental increase in risk is associated with transportation of equipment and supplies through the neighborhood.

8.2.5.6 Alternative 4BB - Implementability

The technical feasibility of material encapsulation and onsite disposal with an engineered cap relies on the use of conventional technology. Necessary equipment and supplies are readily available for implementation of this alternative. This technology has been used successfully on a number of sites.

The alternative is administratively feasible, but long-term institutional controls for the disposal areas must be considered. Permits may be required for onsite disposal, although they would take considerable time to obtain.

8.2.5.7 Alternative 4BB - Cost

Cost elements associated with Alternative 4BB include material excavation and consolidation, construction of the disposal cell, materials, installation of the cap, re-grading of the Site, installation of the groundwater monitoring wells, long-term maintenance of the cap, and long-term groundwater monitoring. Assuming 100 years of maintenance and monitoring, the total present value of these requirements is estimated at $5.15 million. In addition to the above net present value cost, there is a cost associated with the loss in property value because of the remaining contaminants and the land use restrictions ($0.46 million). The estimated schedule for Alternative 4BB is about seven months.

8.2.5.8 Alternative 4BB - State Acceptance

The School would accept onsite disposal under appropriate circumstances, which are not present here. Recent problems associated with onsite disposal with the Shattuck Chemical Superfund Site in nearby Denver may reduce CDPHE acceptance. CDPHE has stated in meetings that it will not support an onsite disposal remedy.

Alternative 4BB would undergo close CDPHE scrutiny because of the Shattuck Site as explained in Section 8.2.2.8.

8.2.5.9 Alternative 4BB - Community Acceptance

Comments received during the open house conducted by the School in 2004 indicated that local residents preferred the removal of the material.

8.2.6 Alternative 5: 5A Offsite Disposal of All Affected Material Using One Landfill or 5B Excavation and Offsite Disposal of All Affected Material Using Two Landfills

Alternative 5 is the excavation and offsite disposal of the radionuclide- and metal-affected soil in Stockpiles A and B.

The material has already been consolidated into two stockpiles: Stockpile A (approximately 200 cubic yards with an average of 46 pCi/g Ra-226) and Stockpile B (approximately 12,800 cubic yards with an average of 13.5 pCi/g Ra-226). Stockpile A and Stockpile B would be shipped to an offsite licensed disposal facility under Alternative 5. Institutional controls are needed to ensure that radon abatement systems are a requirement for any structure or building construction at the Site.

Alternative 5A uses one landfill for both stockpiles. Several possible landfill options were considered: the U.S. Ecology facility in Idaho; the Clean Harbors Deer Trail facility in Colorado;

the CSI facility in Bennett, Colorado; the Envirocare landfill in Utah; and the BFI/Allied Waste Foothills Landfill in Jefferson County, Colorado. The costs and administrative feasibility for each one vary considerably.

The assumption used for Alternative 5B is that Stockpile A and Stockpile B would be disposed of at two different landfills because Stockpile A may not meet the landfill acceptance criteria for the landfill where Stockpile B may be accepted for disposal in a manner that best suits the remedy selection criteria under CERCLA for Stockpile B. Stockpile A averages 46 pCi/g Ra-226, whereas Stockpile B averages 13.5 pCi/g Ra-226. An alternative landfill would be used for Stockpile A. An estimated 13,000 cubic yards of material would be shipped offsite for disposal for both alternatives. Alternative 5B assumes 200 cubic yards (Stockpile A) would go to a different landfill than the landfill for Stockpile B due to the different Ra-226 concentrations in each stockpile and costs of disposal. Alternative 5B involves the disposal of Stockpile B at the Foothills Landfill and the disposal of Stockpile A at either the U.S Ecology landfill in Idaho or the Clean Harbors Deer Trail landfill in Colorado.

8.2.6.1 Alternative 5 - Protection of Human Health and the Environment

Both Alternatives 5A and 5B assume offsite disposal of all affected material above action levels. In the 2004 RI/FS, RESRAD predicted a dose of 6.0×10^{-2} mrem/yr and a risk of 1.1×10^{-6} (subsistence farmer); the corresponding hazard index from residual metals was calculated to be 0.58 for the Site property after the material has left the Site. These dose and risk levels assumed no backfilling of the Site. Re-grading operations required for storm-water control, safety, and Site restoration (to allow beneficial use of the Site) would reduce the dose and risk even further (assuming clean fill). The removal of the majority of the Ra-226 significantly reduces potential radon emanation rates. In 2007, RESRAD predicted a dose of 42 mrem/yr above background after both stockpiles are taken to offsite disposal facilities. A radon mitigation system would reduce exposure levels below background. Alternatives 5A and 5B are protective of human health and the environment.

8.2.6.2 Alternative 5 - Compliance with ARARs

Alternative 5 complies with the ARARs listed in Section 8.1, with the possible exception of some requirements for short-term groundwater monitoring. As shown in Table 8-7, even with the failure of institutional controls, the potential dose due the radon emanation into a future residence is 42 mrem/yr. This is less than the 100 mrem/yr limit allowing Alternative 5 to comply with ARARs. Landfill disposal criteria need to be addressed to determine which alternative would be appropriate for offsite disposal. Of all the alternatives considered, Alternative 5 appears to meet ARARs best.

Table 8-7
Dose Predictions under Alternative 5 with Failure of Institutional Controls

Alternative/Receptor	Predicted Dose with Failure of Institutional Controls
5 A and 5B Urban Resident	42 mrem/yr

8.2.6.3 Alternative 5 - Long-Term Effectiveness and Permanence

Disposal at a solid waste landfill successfully mitigates the potential long-term effects associated with the elevated metals and radionuclides on the Site. This alternative provides unrestricted use for the entire property.

8.2.6.4 Alternative 5 - Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative does not reduce the toxicity, mobility, or volume of affected material through treatment. All of the material is moved to an offsite landfill where it can be properly managed, but no treatment would be expected.

8.2.6.5 Alternative 5 – Short-Term Effectiveness

Excavation and transport activities pose an elevated short-term exposure risk to onsite workers, transportation workers, and nearby residents due to airborne particulate generation. Direct exposure of workers during implementation of this alternative would be minimized through use of appropriate safety measures and procedural controls. Table 8-8 summarizes RESRAD predicted worker doses and risks associated with excavation activities. Conservative parameters were used in the model to predict upper limits for the operation. Assumptions included direct access to the soil when in fact workers will spend most of their time in excavation equipment. Area factors also must be considered for the worker exposure.

Table 8-8
RESRAD-Predicted Worker Doses for Excavation Activities under Alternative 5

Worker Exposure	Dose (mrem/yr)	Risk
Entire Site – 6 months	2.0	4.2×10^{-5}
Elevated Areas – 1 month	1.4	3.2×10^{-5}

Hazards associated with metals would be expected to be minimal during remedial operations. Risks associated with inhalation of fugitive dusts are controllable through air monitoring, the use of appropriate health and safety equipment, and dust suppression techniques. Air monitoring also would be used to identify potential offsite risks to the neighboring community.

A low to moderate risk to the local area would be associated with the truck traffic required to move equipment and material (i.e., traffic accidents). Access to State Highway 6 would limit the risk to the immediate neighborhood but could affect the local county (or counties). A somewhat higher risk is associated with transportation of the material through the neighborhood.

Based on worker risk assessment evaluations, there is a small incremental short-term risk of potential adverse health consequences during a transportation-related accident. Exposure times would result in a risk significantly lower than the 1×10^{-6} threshold (assumes cleanup operations are completed within 24 hours and the only receptors are emergency response personnel). Typically access to transportation related spills is not allowed to members of the general public.

An accident involving an overturned truckload of affected material would have a small environmental risk if the material were to enter a drainage channel. However, the environmental risk would be limited because of the nature of the material (soil versus liquid) and containment procedures followed by emergency response teams.

Access to U.S. Highway 6 would eliminate the need to transport material and equipment through nearby residential areas. In the event that access to U.S. Highway 6 is not available, truck traffic through the 12th Street Historic District will likely result in public annoyance due to short-term noise and vibration in a residential area. Some operational noise would be expected that could be noticed by nearby residents.

8.2.6.6 Alternative 5 - Implementability

The technical feasibility of offsite disposal at a landfill relies on use of conventional excavation and transport technology. Necessary equipment is readily available for implementation of this alternative.

Factors involving the administrative feasibility of the alternative include obtaining approval from CDOT for access to State Highway 6 and meeting the landfill acceptance criteria requirements. New Horizons completed physical construction of an access lane on Highway 6 in 2004 under CDOT Access Permit No. 603100. Stoller used this access lane for disposal of the bagged soil in December 2005 under CDOT Access Permit 605167. It is likely that CDOT would issue another use permit to allow transport of additional soil using this access point.

The above-listed landfills in Section 8.2.6 are administratively feasible, except for the following landfills:

- The Waste Management facility near Colorado Springs, Midway, does not accept materials in excess of 10 pCi/g Ra-226; therefore, neither Stockpile A nor Stockpile B may be disposed of at this landfill. This landfill is not an option for Alternatives 5A and 5B.

- The CSI facility in Bennett, Colorado is not currently accepting material such as Stockpile A and Stockpile B due to an Adams County letter to CSI stating that the landfill should not accept this type of waste due to the litigation pending between Adams County and Clean Harbors related to the Clean Harbors facility's ability to accept NORM. This landfill is not an option for Alternatives 5A and 5B.

- The Foothills Landfill may only accept Stockpile B at this time. This landfill is an option for Alternative 5B but not for Alternative 5A. In April 2005, Stoller prepared a risk assessment, *Dose Assessment for the Emplacement of the CSMRI Site Containerized and Remaining Subsurface Soil into a RCRA Subtitle D Solid Waste Landfill*, which was approved by CDPHE on August 26, 2005. In order for the landfill to accept the bagged soil waste stream, analytical data demonstrating the nature of the material were supplied to BFI/Allied Waste for review. BFI/Allied Waste agreed that the material was not hazardous waste and with the CDPHE approval for them to accept the material; BFI/Allied Waste agreed to accept the waste stream. Since then, both CDPHE and BFI/Allied Waste have agreed that Stockpile B may be disposed of at the Foothills Landfill. The administrative feasibility of disposing of Stockpile A at the Foothills

Landfill is unlikely. A risk assessment for Stockpile A disposal at the Foothills Landfill has not been performed because the cost of performing such a risk assessment, along with the administrative cost of obtaining approval from CDPHE, outweighs the cost-savings benefits for the approximately 200 cubic yards of Stockpile A as compared to disposal of Stockpile A at one of the other landfills that have previously approved risk assessments for this type of material.

8.2.6.7 Alternative 5 - Cost

Cost elements associated with Alternative 5A include loading Stockpile A and Stockpile B into trucks, transportation to the selected landfills, and re-grading of the Site. After the offsite disposal is performed, a limited amount of groundwater monitoring is required. The total present value of these cost elements is estimated at $3.29 million. Property values are not significantly affected by this alternative because the land will be available for residential and other use with the environmental covenant (Section 8.3.7.1). The estimated schedule for Alternative 5A is about six months.

Cost elements associated with Alternative 5B include loading the stockpiled material into trucks, transportation to two locations, and re-grading of the Site. Stockpile A would go to the U.S. Ecology facility in Idaho, and Stockpile B would go to the Foothills Landfill in Colorado. Afterward a limited amount of groundwater monitoring is required. The total present value of these cost elements is estimated at $0.85 million. Property values are not significantly affected by this alternative because the land will be available for residential and other use with the environmental covenant (Section 8.3.7.1). The estimated schedule for Alternative 5B is about six months.

Cost breakdown data for each alternative are provided in Section 8.3.7.

8.2.6.8 Alternative 5 - State Acceptance

CDPHE has stated its preference for offsite disposal (Alternative 5). The School also prefers offsite disposal.

8.2.6.9 Alternative 5 - Community Acceptance

Comments received during an open house conducted by the School in 2004 indicated that local residents preferred this alternative.

8.3 Comparative Analysis of Alternatives

The purpose of this section is to evaluate the relative performance of each alternative in relation to the other alternatives. A brief summary of the alternatives and the nine evaluation criteria is presented in Table 8-9.

Table 8-9
Evaluation of Alternatives

Alternative	Protective of Human Health & Environment	ARAR Compliance	Long-term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume through Treatment	Short-term Effectiveness	Implementability (Feasibility)	Cost Ranking[1]	State Acceptance	Community Acceptance
1 - No further action	N	N	N	N	Y	L	2	N	N
4A - Onsite solidification and cap stockpile B, ship stockpile A offsite	Y	N	U	Y	Y	M	6	U	U
4AA - Solidify both stockpiles and cap	Y	N	U	Y	Y	M	4	U	U
4B - Onsite engineered disposal cell for stockpile B, ship stockpile A offsite	Y	N	U	N	Y	M	7	U	U
4BB - Onsite engineered disposal cell for both stockpiles	Y	N	U	N	Y	M	5	U	U
5A - Offsite disposal at solid waste facility	Y	Y	Y	N	Y	H	3	Y	Y
5B - Offsite disposal at two waste facilities	Y	Y	Y	N	Y	H	1	Y	Y

Notes: Y, addresses criteria; N, does not address criteria; U, uncertainty associated with this element; Implementability factors, highly feasible (H) through problematic (L); Rankings range lowest to highest cost
[1] Costs account for loss of property value for onsite remedies.

8.3.1 Protection of Human Health and the Environment

Alternative 1, the no-further action alternative, does not provide adequate protection of human health and the environment because it does not adequately address the exposure pathways. The alternative does not address the migration of metals and radionuclides to groundwater. Unauthorized Site access by neighborhood children also is a possibility with this alternative. Trespassers have already breached the existing security fence on a number of occasions. With a 1,000-year time horizon access to the Site is reasonably foreseeable.

Alternatives 4 and 5 effectively address the direct exposure pathways by either preventing access to the material using caps and a variety of containment options or by removing the material from the Site. In each case, institutional controls would be required to ensure that radon abatement systems are a requirement for any structure or building constructed on the Site. Groundwater fluctuations and the presence of a City of Golden water main provide potential mechanisms for migration of affected material. Table 8-10 summarizes some of the factors associated with the protection of human health and the environment criteria. Factors associated with the ARARs criteria also are included.

Table 8-10
Factors Associated with Protection of Human Health and the Environment Criteria and ARARs Criteria

Alternative	Risk $<10^{-4}$	Dose <15 mrem/yr	Dose <25 mrem/yr	Hazard Index <1	PbB <10 µg/dL	Soil Lead <400 mg/kg	Protective of Groundwater	Dose < 100 mrem/yr with institution control failure
1 - No further action	N	N	N	N	N	N	N	N
4A - Onsite solidification and cap Stockpile B, ship Stockpile A offsite	Y	Y	Y	Y	Y	Y	Y	N
4AA - Solidify both stockpiles and cap	Y	Y	Y	Y	Y	Y	Y	N
4B - Onsite engineered disposal cell for Stockpile B, ship Stockpile A offsite	Y	Y	Y	Y	Y	Y	Y	N
4BB - Onsite engineered disposal cell for both stockpiles	Y	Y	Y	Y	Y	Y	Y	N
5A - Offsite disposal at solid waste facility	Y	Y	Y	Y	Y	Y	Y	Y
5B - Offsite disposal at two waste facilities	Y	Y	Y	Y	Y	Y	Y	Y

Notes: Evaluation based on urban resident; Y, meets requirement; N, does not meet requirement; U, uncertainty associated with this element;

A short-term groundwater-monitoring program is required for Alternatives 4 and 5 because of residual metals and radionuclides remaining in the groundwater system. The solidified matrix or disposal cell associated with Alternative 4 would require long-term groundwater monitoring.

In the absence of institutional controls, the potential dose due to radon emanation into a residential structure ranges from 42 mrem/yr (Alternatives 5A and 5B) to 2,087 mrem/yr (Alternatives 1, 4AA, and 4BB). Alternative 5 would provide the most protection to human health and the environment.

8.3.2 Compliance with ARARs

Alternative 1 does not meet the ARARs that have been identified for the Site. Alternatives 4A, 4AA, 4B, and 4BB do not meet ARARs. With the failure of institutional controls, the dose to the urban resident exceeds 100 mrem/yr in each case. Alternatives 5A and 5B are compliant with ARARs by offsite disposal of the affected material.

Alternative 5 has the least uncertainty associated with the site-specific ARARs.

8.3.3 Long-Term Effectiveness and Permanence

8.3.3.1 Magnitude of Residual Risk

Alternative 1 has no long-term effectiveness or permanence because the material would remain in place and be a continuing source of hazard and risk to human health and the environment.

This alternative would have the largest remaining risk for the Site and surrounding area. Wind and water erosion would move the material offsite. Precipitation would continue to cause the material to migrate to groundwater. Access by neighborhood children would be a continuing problem. With a 1,000-year time horizon, other access to the Site is reasonably foreseeable.

The remaining alternatives would sufficiently address residual risk although some uncertainty is associated with the groundwater pathway for the 4 series alternatives. The alternatives that involve a cap would have a degree of uncertainty associated with long-term permanence. Cap breakdown could result in significant risks to human health and the environment.

8.3.3.2 Adequacy and Reliability of Controls

Alternatives in the 4 series rely on containment systems and institutional controls to ensure protection of human health and the environment. A number of uncertainties are associated with these types of controls and need to be addressed when evaluating the alternatives.

The provision in 40 CFR §192.02 requires the control measures to be effective for 1,000 years (at least 200 years). Long-term effectiveness of caps can be compromised by failure to implement institutional controls and the lack of maintenance. In addition to human activities, freeze-thaw cycles, vegetation, and burrowing animals can compromise cap material. The literature refers to problems with the leaching of mercury and arsenic from solidified matrixes (Alternative 4A). The magnitude of this effect would be site-specific but could be problematic in the long term.

Alternative 5, offsite disposal, has the least uncertainty associated with long-term effectiveness and permanence.

8.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives 4A and 4AA are the only alternatives that address the material through treatment. Toxicity and mobility are addressed because the matrix prevents material migration and reduces toxicity through reduced bioavailability. Properly maintained the solidified matrix would be expected to remain intact for an extended period of time. But as mentioned in Section 7.3, there is some question about the leaching of arsenic and mercury.

Alternatives in the 4 series use caps to address toxicity and mobility by limiting contact and infiltration. Onsite volumes are reduced or eliminated in Alternatives 4A, 4B, and 5, with the elimination of all affected material for Alternative 5. Alternatives in 5 produce no net reduction in metals or radionuclides, just relocation.

8.3.5 Short-Term Effectiveness

8.3.5.1 Risks to Community

All of the alternatives except Alternative 1 (no-further action) involve some short-term risk to the surrounding community. A low to moderate risk would be associated with the truck traffic required to move equipment or material (i.e., traffic accidents). Access to State Highway 6 would limit the risk to the immediate neighborhood but could affect the local county (or counties). A somewhat higher risk is associated with transportation of the material through the neighborhood. Based on the number of trucks required to complete the task, Alternatives 5A and 5B would be the highest risk, followed by Alternatives 4A and 4B.

Based on worker risk assessment evaluations (Section 8.3.5.2), there is a minimal short-term risk of potential adverse health consequences during a transportation-related accident. Exposure times would result in a risk significantly lower than the $1x10^{-6}$ threshold (assumes cleanup operations are completed within 24 hours and the only receptors are emergency response personnel). Typically access is not allowed to members of the general public.

The potential for air emissions during implementation of the selected remedial action will be controlled by dust control measures (e.g., limiting operations during high velocity winds and use of water spray). Control measures will be monitored by the installation of perimeter air monitoring to evaluate controls on a day-to-day basis.

Alternative 5 followed by Alternatives 4A and 4B have the highest short-term risk for the surrounding community because of the number of loads of affected soil. The risk applies only to traffic accidents, not to exposure to affected soils. The remaining alternatives would have a lesser effect on the community because of limited transportation operations.

8.3.5.2 Risks to Workers

A summary of short-term dose and risk to workers is provided in Table 8-11. The assessment assumes an average of 6 months of exposure to the Site materials. A second set of values is provided for the time spent in the areas of elevated concentrations. These values are provided to show the magnitude of the risk. Values for specific alternatives could be expected to be somewhat higher or lower but by less than an order of magnitude. The primary pathway is the radiation exposure route, but this would be limited by the amount of time spent in material handling equipment and required safety equipment. Crushing operations associated with Alternatives 4A and 4AA would generate the greatest inhalation risk, but again would be controlled by engineered safety equipment. Personal air monitoring equipment will be used to monitor workers during all onsite operations.

Table 8-11
Summary of RESRAD-Predicted Worker Doses for Excavation Activities

Worker Exposure	Dose (mrem/yr)	Risk
Entire Site – 6 months	2.0	$4.2x10^{-5}$
Elevated Areas – 1 month	1.4	$3.2x10^{-5}$

Hazards associated with metals would be expected to be minimal during remedial operations. Assuming two months of excavation operations in the elevated areas produced an HI of 0.28 and a risk of $2.0x10^{-7}$. Again these values would be mitigated by material handling equipment and safety equipment.

Worker exposure would be the greatest for Alternatives 4A and 4AA because of the mixing and grinding operations. Alternatives 4B, 5A, and 5B would have lesser risk.

8.3.5.3 Environmental Effects

Storm-water controls will be used to prevent affected material from leaving the Site and affecting environmental receptors. The largest short-term risk to the environment is a delay in schedule that would allow additional material to migrate to groundwater and eventually to Clear Creek. Extended schedule delays also could result in the re-vegetation of the Site along with a variety of insect or animal receptors. Materials such as mercury bioaccumulate and could be a long-term risk. Alternative 1 is the primary example of environmental risk.

A limited environmental risk is associated with transportation of the material to offsite landfills. An accident involving an overturned truckload of affected soil would have a small environmental risk if the material were to enter a drainage channel. However, the environmental risk would be limited because of the nature of the material (soil versus liquid) and containment procedures followed by emergency response teams.

8.3.5.4 Timeline

Estimated schedules for the alternatives are provided in Table 8-12.

Table 8-12
Estimated Schedules

Alternative	Description	Estimated Schedule (months)
1	No-further action	0
4A	Onsite solidification and cap stockpile B, ship stockpile A offsite	8
4AA	Solidify both stockpiles and cap	8
4B	Onsite engineered disposal cell for stockpile B, ship stockpile A offsite	7
4BB	Onsite engineered disposal cell for both stockpiles	7
5A	Offsite disposal at one waste facility	6
5B	Offsite disposal at two waste facilities	6

8.3.6 Implementability

8.3.6.1 Technical Feasibility

Alternative 1, no-further action, is relatively easy to implement.

Alternatives 4 and 5 are technically feasible. Each alternative involves standard construction and earth-moving techniques. Alternatives 4A and 4AA have the most uncertainty because a concrete/soil mixture would need to be determined. Proper installation of a disposal cell can be problematic (Alternatives 4B and 4BB). Alternatives 4 and 5 are sensitive to weather conditions especially during the winter months. Inclement weather conditions will reduce the ability to work efficiently. Wet or frozen soils typically require additional handling time depending on the type of equipment used. Compaction operations are especially problematic when soils are wet or frozen. Weather also can affect the placement of material at offsite disposal locations.

8.3.6.2 Administrative Feasibility

Alternatives 4 and 5 require truck access to the Site. New Horizons completed physical construction of an access lane on Highway 6 in 2004 under CDOT Access Permit No. 603100. Stoller used this access lane for disposal of the bagged soil in December 2005 under CDOT Access Permit 605167. It is likely that CDOT would issue another use permit to allow transport of additional soil using this access point. This approval will not affect the comparative analysis because it is an element common to each alternative.

Alternative 1 could require a license for leaving the material onsite. However, CERCLA typically exempts onsite remedies from licensing requirements, although certain substantive requirements must be met. The administrative feasibility for this alternative is high if no license is required because of the continuing requirements of the monitoring and institutional controls; otherwise it is low.

Alternative 4 may require a solid waste disposal license for onsite solidification or disposal cells. Again the CERCLA exemption may apply but have substantive requirements. If no license is required, the administrative feasibility for the leaving the material in place is medium to high because of the continuing requirements of the monitoring and institutional controls; otherwise it is low.

For Alternative 5, some existing landfills are authorized to accept wastes similar to the Site material, although ones in Adams County have uncertainty. The landfills must demonstrate the ability to protect human health and the environment. The administrative feasibility for these sites to accept the elevated materials is high.

8.3.6.3 Availability of Services and Materials

No limitations would be expected for the availability of the services or materials anticipated for any of the alternatives.

8.3.6.4 Availability of Disposal Facilities

The availability of disposal facilities is provided in Table 8-13.

Table 8-13
CSMRI Site Disposal Options Summary

Disposal Facility	Pile A	Pile B	Comments
Allied Waste – BFI Foothills Landfill, Golden, CO	No	Yes	Waste acceptance cut off excludes pile A from this option
Clean Harbors – Deer Trail Facility, Last Chance, CO	Maybe	Maybe	Pending satisfactory Indemnification
Waste Management – CSI Facility, Bennett, CO	No	No	County requested facility not take this type of waste, facility complying.
EnviroCare in Utah	Yes	Yes	Price eliminates this option from serious consideration.
Midway Landfill in Colorado Springs	No	No	Maximum acceptable Ra226 activity = 10 pCi/g
Waste Control Specialist –	No	Yes	Maximum acceptable Ra226 activity = 20 pCi/g,

Table 8-13
CSMRI Site Disposal Options Summary

Disposal Facility	Pile A	Pile B	Comments
WCS Facility, Andrews, TX			excluding pile A.
American Ecology – AEC Facility, Grand View, ID	Yes	Yes	

8.3.7 Cost

8.3.7.1 Detailed Cost Estimate

Cost estimates have been prepared for each of the remedial alternatives under consideration. Detailed cost estimates for each alternative are provided in Appendix J. The summarized cost information for each alternative is presented in Table 8-14. Detailed cost information for the offsite disposal alternatives were provided by the disposal facility. A number of vendors were contacted for actual cost bids for specific tasks such as transportation, surveying, geotechnical testing, liner installation, slurry wall installation, and consumables. Average industry costs were used for solidification equipment, monitoring well installation, and equipment rental.

Table 8-14
Cost Information for Each Alternative

Cost Breakout	Alternative Cost (in thousands of dollars)						
	1	4A	4AA	4B	4BB	5A	5B
Mobilization	0	58	58	65	65	28	28
Construct Site Facilities Costs	0	72	72	103	103	180	102
Soil Movement Costs	0	175	175	149	149	147	77
Solidification Costs	0	321	324	0	0	0	0
Construct Cell Costs		0	0	242	242	0	0
Disposal Costs	0	54	0	54	0	2870	580
Engineering Cap Costs	0	321	321	446	446	0	0
Stabilize Site and Monitoring Costs	4070	4,120	4,120	4,101	4,101	34	34
Demobilization	0	42	42	32	32	26	26
Total	4070	5184	5132	5206	5152	3285	847
Rank	3	6	4	7	5	2	1
Ratio to Least Expensive	4.8:1	6.1:1	6.1:1	6.1:1	6.1:1	3.8:1	1

Based on an appraisal performed on behalf of the Colorado School of Mines in December 2003 (Dyco Real Estate, Inc., December 17, 2003) the value of the CSMRI Site (without the Parfet property – Parfet property consists primarily of the previously described treed portion of the Site) was $2.4 million when considered for its highest and best use (i.e., residential development). This value was increased to $2.75 million based on a local realtor's opinion and increase in property values (Appendix K). However, this value would be for a site that never had any contamination. A "stigma" factor would need to be applied to the highest and best use value. For purposes of comparison, a 20-percent stigma value was applied to the property. Application of the stigma value would result in an estimated property value of $2.2 million. The appraisal considered the property to be of no marketable value if contamination remained on Site and it were to be utilized solely for recreational use. A partial property value loss would be applied to Alternative 4 for the loss of a percentage of land (disposal area). Table 8-15 summarizes the effect of including those costs. The addition of the property value also changes the relative ranking of the alternatives, with both versions of Alternative 5 being the most cost-effective alternatives. A copy of the Site appraisal document was included in Appendix I of the 2004 RI/FS.

Table 8-15
Cost Information for Each Alternative including Stigma Value
(in millions of dollars)

Alternative	Description	Cost from Spreadsheet	Property Value Loss	Total Cost
1	No further action	4.07	0.46	4.53
4A	Onsite solidification and cap Stockpile B, ship Stockpile A offsite	5.18	0.46	5.64
4AA	Solidify both stockpiles and cap	5.13	0.46	5.59
4B	Onsite engineered disposal cell for Stockpile B, ship Stockpile A offsite	5.21	0.46	5.67
4BB	Onsite engineered disposal cell for both stockpiles	5.15	0.46	5.61
5A	Offsite disposal at solid waste facility – all to Idaho	3.29	0	3.29
5B	Offsite disposal at two waste facilities – BFI and U.S. Ecology in Idaho	0.85	0	0.85

8.3.7.2 Cost Minimization/Alternative Risk

Cost risks associated with the various alternatives include weather delays (Alternatives 4 and 5), construction delays associated with access to U.S. Highway 6 (Alternatives 4 and 5), inability to determine a proper solidification mixture (pilot test for Alternative 4A), subcontractor problems (Alternatives 4 and 5), transportation problems (Alternatives 4 and 5), and landfill selection issues (Alternatives 4 and 5). Alternatives in the 4 series could have additional cost risks associated with licensing applications. Alternatives 4 and 5 have possible risks associated with meeting landfill acceptance criteria. Depending on the weight assigned to each of the risks, it would appear that Alternatives 4A and 5 have the highest number of potential cost risks. However, with the exception of the Alternative 4A pilot test, none of the identified risks appear to be capable of leading to the selection of another the remedial action.

8.3.8 State Acceptance

Alternative 1 is unacceptable to CDPHE and the School. Although the remaining alternatives meet the requirements of most of the ARARs, onsite disposal may be problematic because of the recent action at the Shattuck site and CDPHE statements that it does not support onsite disposal (Alternative 4).

8.3.9 Community Acceptance

Comments received during an open house conducted by the School indicated that local residents preferred offsite disposal of the material. Alternative 5 would have the highest community acceptance followed by Alternative 4.

8.4 Summary

Alternative 1 is not protective, does not comply with ARARs, and is the least likely to be accepted by CDPHE, the School, and the community. Alternative 4 meets most ARARs and is protective, but it has long-term maintenance and monitoring issues, technical uncertainty, and elevated costs. Alternative 5B is the preferred option because of the lack of maintenance and monitoring, elimination of uncertainties, and the lowest cost (as compared to Alternative 5A and Alternative 4). Alternative 5 also is the preferred alternative of CDPHE and the community. Alternative 5B is the preferred alternative of the School. The preferred landfill for Stockpile A is U.S. Ecology in Idaho at this time. The Foothills Landfill is the preferred facility for Stockpile B.