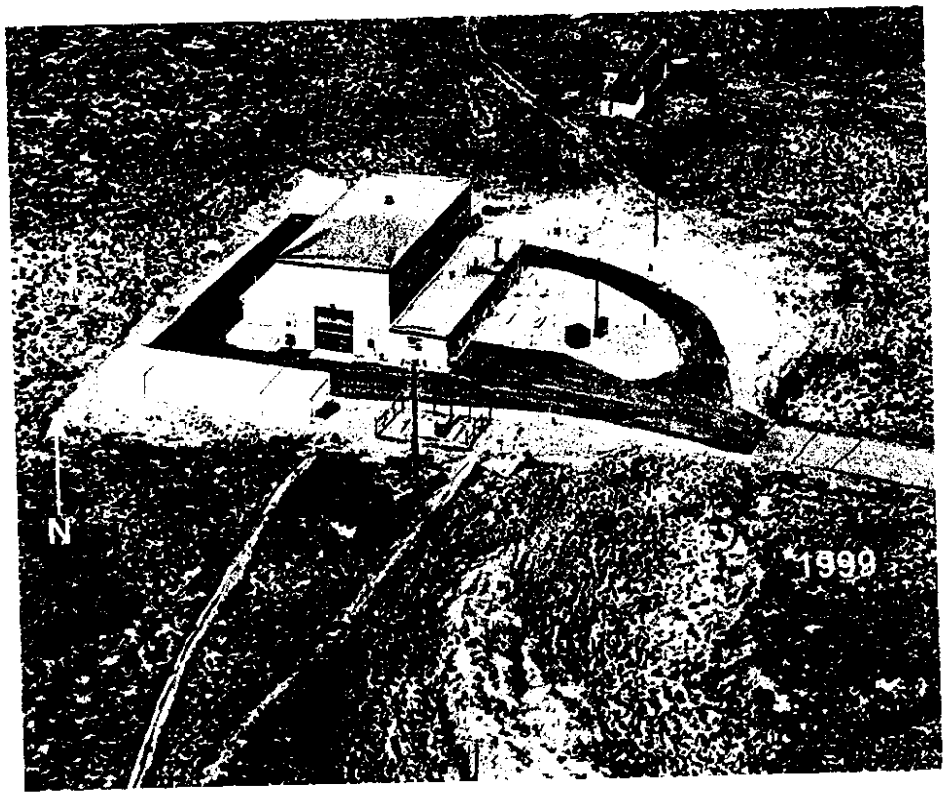

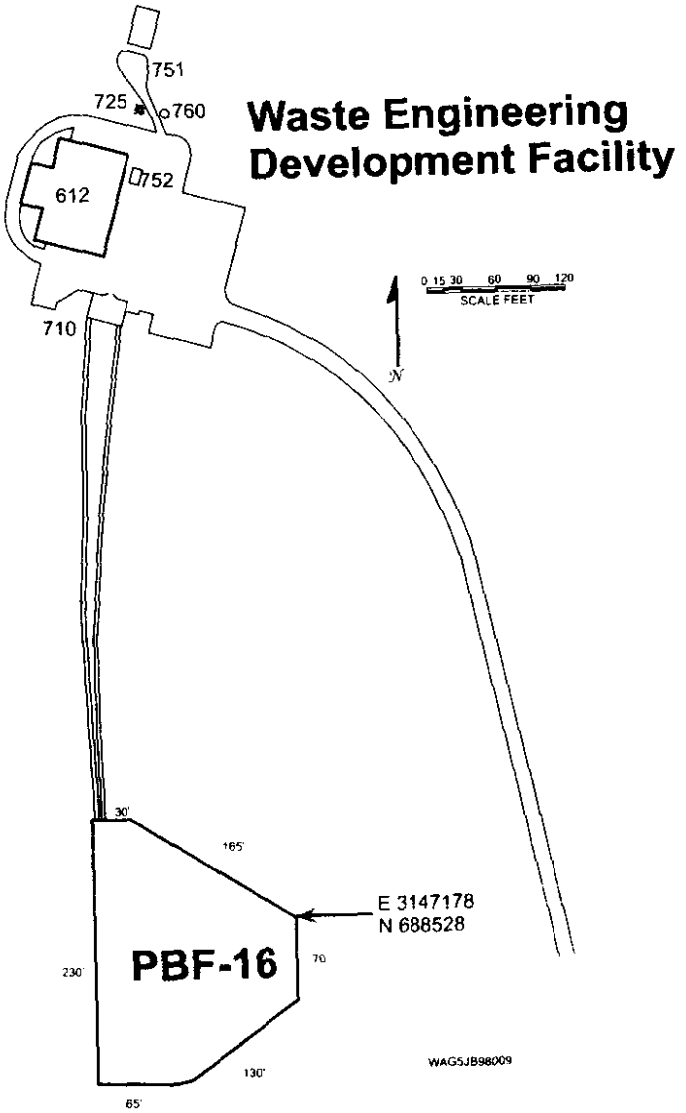

Figure19. Sketch of Site PBF-16 relative to an aerial photograph of the Waste Engineering Development Facility (i.e., SPERT-II).

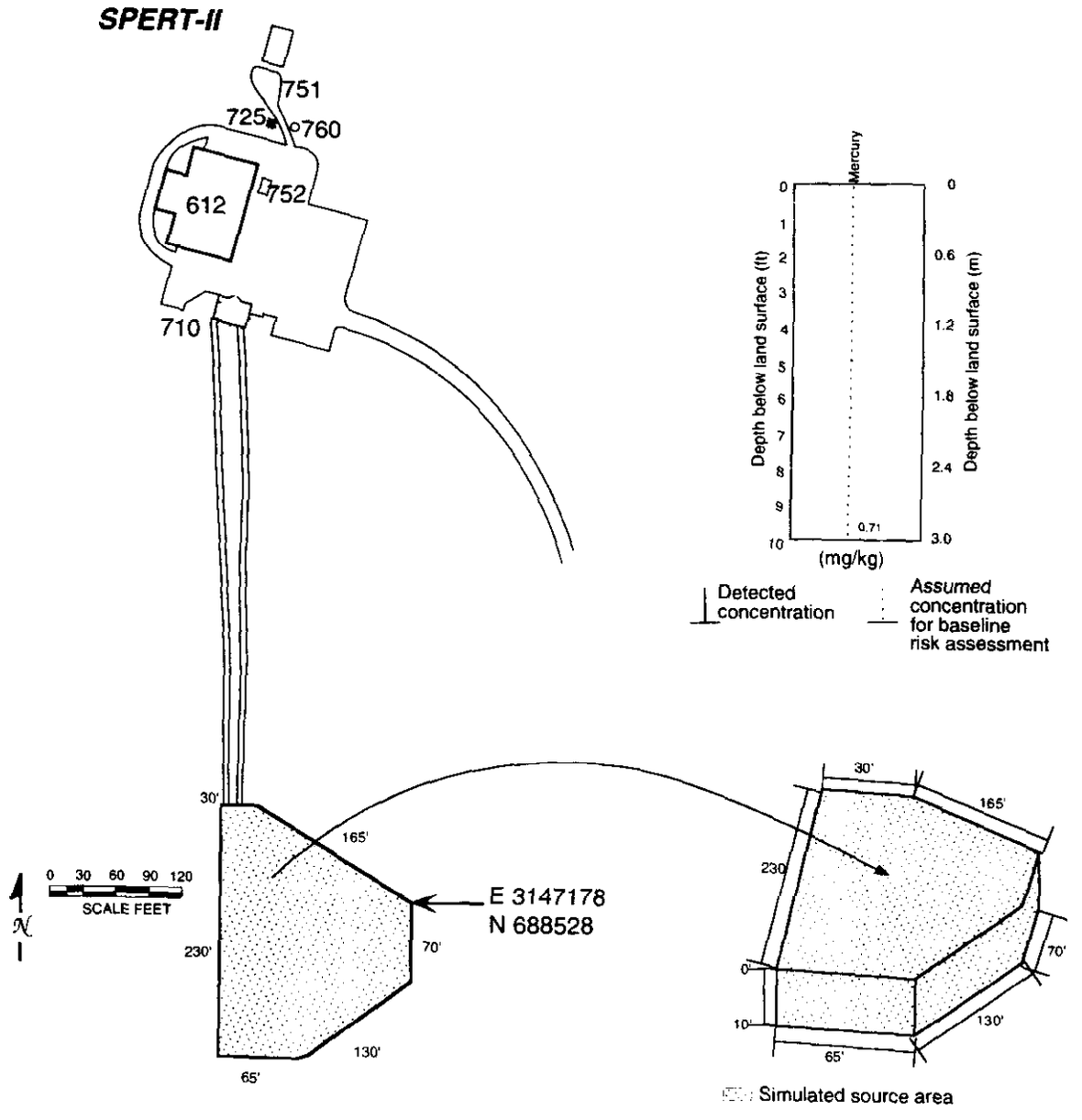

Figure 20. Site PBF-16, SPERT-II Leach Pond.

8.6 Remediation Objectives for the Contaminated Soil Sites

Remediation objectives based on the unacceptable risks discussed above were developed for the contaminated soil sites ARA-01, ARA-12, ARA-23, ARA-25, and PBF-16 (Sections 8.1.3, 8.2.3, 8.3.3, 8.4.3, and 8.5.3). Human health risk in excess of 1E-04 is posed primarily by external exposure to ionizing radiation. The radioactive contaminants of concern are Ag-108m, Cs-137, and Ra-226. Dermal adsorption of arsenic and ingestion of Ra-226, arsenic, and lead pose secondary human health risks. Ecological hazard quotients greater than 10 are from exposure to selenium, thallium, copper, mercury, and lead in the soil. A summary of the risks for the contaminated soil sites is provided in Table 7.

The following land-use assumptions were used in the development of the remedial action objectives for WAG 5 remediation:

- Institutional controls until 2095 will include current security controls, site access controls, radiological controls, and worker monitoring
- For 2095 and beyond, homes could be built anywhere within WAG 5 and a water supply well could be drilled adjacent to the home.

The following remedial action objectives were developed to protect human health and the environment for the contaminated soil sites:

- Inhibit direct exposure to radionuclide COCs that would result in a total excess cancer risk greater than or equal to 1 in 10,000 for current and future workers and future residents
- Inhibit dermal adsorption of contaminants of concern that would result in a total excess cancer risk greater than or equal to 1 in 10,000 or a hazard index of 2 or greater for current and future workers and future residents
- Inhibit ecological receptor exposures to contaminated soil with concentrations of contaminants greater than or equal to 10 times background values and that result in an HQ greater than or equal to 10.

To meet these objectives, remediation goals were established. The remediation goals for the contaminated soil sites and the basis for each goal are provided in Table 16. These goals are at the upper end of the acceptable risk range because conservative parameters were used in the risk assessment, because risk from background concentrations at the INEEL exceed 1E-06, and because EPA radiation standards, which apply to risks from exposure to radionuclides, are generally set at a risk level of 1 in 10,000.

Remediation goals can be satisfied by either cleaning up to the identified contaminant concentration (see Table 16) or by removing all soil down to the basalt interface. Removing soil down to basalt will be protective because surface exposure pathways will be eliminated. The RI/FS for WAG 5 (Holdren et al. 1999) showed that groundwater exposure pathways pose a cumulative risk less than 1E-04 and a hazard index less than 1 for the baseline no action alternative. Removal of contaminated soil from WAG 5 will further reduce the potential groundwater risk. Therefore, remediation to retrieve residual contamination that may have migrated into the fractured basalt would not be justified. The estimated soil volumes exceeding cleanup goals for the contaminated soil sites are provided in Table 17. An approximate total of 39,000 m^3 (i.e., 1.4 million ft^3 or about 51,000 yd^3) of contaminated soil will be remediated.

Table 16. Remediation goals for WAG 5 contaminated soil sites.

Site	Contaminant of Concern	Soil Concentration Remediation Goal[a]	Derivation	Reference	Risk Scenario
ARA-01	Arsenic	10 mg/kg[b]	1E-04 dermal absorption risk	Calculated[b]	100-year future residential
	Selenium	2.2 mg/kg	10 times background	Rood, Harris, and White (1996)	Ecological
	Thallium	4.3 mg/kg	10 times background	Rood, Harris, and White (1996)	Ecological
ARA-12	Ag-108m	0.75 pCi/g[c]	1E-04 external exposure risk	Giles (1999a)	100-year future residential
	Copper	220 mg/kg	10 times background	Rood, Harris, and White (1996)	Ecological
	Mercury	0.5 mg/kg	10 times background	Rood, Harris, and White (1996)	Ecological
	Selenium	2.2 mg/kg	10 times background	Rood, Harris, and White (1996)	Ecological
ARA-23	Cs-137	23 pCi/g	1E-04 external exposure risk	Fromm (1996)	100-year future residential
ARA-25	Arsenic	5.8 mg/kg[d]	Background concentration	Rood, Harris, and White (1996)	100-year future residential
	Cs-137	23 pCi/g	1E-04 external exposure risk	Fromm (1996)	100-year future residential
	Ra-226	*2.1 or 1.2 pCi/g*[e]	*Background concentration*	*Giles (1998a)*	*100-year future residential*
	Copper	220 mg/kg	10 times background	Rood, Harris, and White (1996)	Ecological
	Lead	400 mg/kg	EPA	Statutes[f]	Ecological and human health
PBF-16	Mercury	0.5 mg/kg	10 times background	Rood, Harris, and White (1996)	Ecological

a. Except as noted, remediation goals are calculated values based on 10 times the background concentration reported by Rood, Harris, and White (1996) for ecological contaminants of concern, and 100 times the 1E-06 risk-based concentration reported by Fromm (1996) for radionuclides for the hypothetical residential scenario 100 years in the future.

b. Arsenic is the only human health contaminant of concern at ARA-01. Therefore, a remediation goal based on a 1E-04 risk for a single contaminant was calculated. Carcinogenic risk estimates and noncarcinogenic hazard indices are linearly related to the soil concentration used in the risk calculations. The maximum detected arsenic concentration of 40.6 mg/kg at ARA-25 equates to a dermal absorption risk of 4E-04 and a hazard quotient of 3 in the 100-year future residential scenario. The arsenic remediation goal was calculated by dividing the maximum concentration by the risk (or hazard quotient), then multiplying by the threshold value (i.e., 1E-04 for carcinogens, 1 for noncarcinogens). For carcinogens, the calculation for the remediation goal is RG = [(40.6 mg/kg)/(4E-04)] × (1E-04) = 10.1 mg/kg. For noncarcinogens, the calculation is RG = [(40.6 mg/kg)/3] × 1 = 13.5 mg/kg. The arsenic remediation goal for ARA-01 is the lesser, more protective, of the two values, rounded to 10 mg/kg.

c. The calculation for the remediation goal, presented in Giles (1999a), is based on the revised half-life of 418 years for Ag-108m (Firestone and Shirley 1999).

d. ARA-25 has three human health contaminants of concern, excluding lead. Remediation goals for two of the three contaminants (i.e., arsenic and Ra-226) are background values. For the third, Cs-137, the 1E-04 risk-based concentration is given.

e. The remediation goal is the average INEEL background value for Ra-226 reported by Giles (1998a) because the 1E-04 risk-based concentration derived from Fromm (1996), 0.55 pCi/g, is below the INEEL average background concentration. A goal of 2.1 pCi/g will be used for comparison of sample results that may include interference from U-235. Otherwise, a goal of 1.2 pCi/g will be used. Further details are available in Giles (1998a).

f. On July 14, 1994, the EPA issued guidance recommendations for lead in paint, dust, and soil under the authority of Section 1021, Title X of the Housing and Community Development Act of 1992, and Section 403 of the Toxic Substance Control Act. The current approach to addressing lead in soil at CERCLA and RCRA sites was established in Office of Solid Waste and Emergency Response Directive 9555.4-12 (EPA 1994b).

Table 17. Areas, depths, and volumes of contaminated soil for WAG 5 contaminated soil sites.

Site	Site Name	Soil Area (m^2)	Soil Area (ft^2)	Soil Depth (m)	Soil Depth (ft)	Soil Volume (m^3)	Soil Volume (ft^3)
ARA-01	ARA-I Chemical Evaporation Pond	2,987	32,155	0.6	2	1,821	64,310
ARA-12	ARA-III Radioactive Waste Leach Pond and Ag-108m Contaminated Soil	5,011	53,933	0.3	1	1,503	53,933
ARA-23	ARA-I and –II Radiologically Contaminated Surface Soil and Subsurface Structures	233,187	2,510,000	0.15	0.5	35,538	1,255,000
ARA-25	ARA-I Contaminated Soil Beneath the ARA-626 Hot Cells	36	384	1.5	5	54	1,920
PBF-16	SPERT-II Leach Pond	279	3,000	1.4	4.5	382	13,500
Total		241,500	2,599,472			39,298	1,388,663

8.7 Description of Alternatives for the Contaminated Soil Sites

Five remedial alternatives were developed for the contaminated soil sites: Alternative 1, no action; Alternative 2, limited action; Alternative 3, excavation, consolidation, and containment with an engineered barrier within WAG 5; Alternative 4, removal and disposal; and Alternative 5, removal, ex situ soil sorting, and disposal. Two alternatives, Alternative 2, limited action, and Alternative 3a (a subcategory of Alternative 3), excavation, consolidation, and containment within WAG 5 with a native soil cover, were screened out in the feasibility study because they did not provide adequate ecological protection or sufficient human health protection beyond the 100-year period of institutional control. Though Alternative 1, no action, does not satisfy threshold criteria, it was retained for detailed evaluation to serve as the baseline for comparing other remedial action alternatives.

8.7.1 Alternative 1, No Action

The no action alternative, Alternative 1, consists of soil, air, and groundwater monitoring. No active remediation would be performed under this alternative to alter existing site conditions.

8.7.2 Alternative 3b, Excavation, Consolidation, and Containment with an Engineered Barrier

Implementation of Alternative 3b, excavation, consolidation, and containment with an engineered barrier within WAG 5, would involve the excavation of soil present in concentrations greater than remediation goals, consolidation of the soil on a site within the WAG 5 area, and containment with an engineered barrier. Conventional excavation equipment, soil vacuuming equipment, or a combination of both would be used under this alternative. Verification sampling would be conducted to ensure that all contamination at concentrations exceeding remediation goals was removed. Excavated areas more than 0.3 m (1 ft) deep would be backfilled with uncontaminated soil or sloped to promote drainage. Shallow excavations would be contoured to blend with the existing landscape. Institutional controls would be required because the remediation goals are based on the soil concentrations equivalent to a risk of 1E-04 100 years in the future. In addition, the consolidated soil area would require management.

With the soil contamination consolidated into a single area within WAG 5, an engineered barrier would be used to inhibit contaminant migration and limit exposures to protect human health and the environment. The barrier would be designed to meet the remedial action objectives for protecting human and ecological receptors from exposures to contaminated soil. The cap would consist of a 0.3-m (1-ft) layer of basalt cobbles underlain and overlain by 0.2-m (8-in.) layers of gravel and covered with a 0.6-m (2-ft) layer of basalt riprap. Environmental monitoring, cap-integrity monitoring, and maintenance (e.g., repairing any observable degradation such as cracks, erosion, and biotic intrusion) would be conducted on an annual basis. Access restrictions such as fencing and signs also would be maintained. Air monitoring and groundwater monitoring would be performed under INEEL Site-wide programs.

8.7.3 Alternatives 4a and 4b, Removal and Disposal

Removal and disposal Alternatives 4a and 4b for WAG 5 contaminated soil sites would deploy conventional construction equipment, soil vacuuming equipment, or a combination of both, to excavate contaminated soil. The contaminated soil would be disposed of at the INEEL or at a permitted off-Site facility. A combination of verification sampling and radiological surveying would be conducted at the removal sites to ensure that all contamination at concentrations exceeding remediation goals was removed. Following cleanup, the excavations exceeding 0.3 m (1 ft) in depth would be backfilled with uncontaminated soil or sloped to promote drainage. Shallow excavations would be contoured to blend with the existing landscape. Under Alternative 4a, the excavated soil would be disposed of at the INEEL, while excavated soil would be disposed of off the INEEL under Alternative 4b. Disposal at the INEEL CERCLA Disposal Facility (ICDF) or another facility on the INEEL is considered in Alternative 4a while a private disposal facility located off the INEEL is addressed in Alternative 4b.

8.7.4 Alternatives 5a and 5b, Removal, Ex Situ Sorting, and Disposal

The removal, ex situ treatment, and disposal alternative was developed for the radiologically contaminated soil with concentrations that exceed human health remediation goals (i.e., Sites ARA-12, ARA-16, ARA-23, and ARA-25). Conventional construction equipment would be used to excavate the soil. The soil would be processed through a segmented-gate separation apparatus to sort the soil into two categories: above the remediation goal criteria and below the remediation goal criteria. Soils with concentrations less than the remediation goals would be returned to the excavation, and soil with concentrations above the remediation goals would be shipped for disposal. Under this alternative, soil from the sites with an ecological risk only, ARA-01 and PBF-16, would be excavated and disposed of with the radiologically contaminated soil.

Following remediation, the excavations exceeding 0.3 m (1 ft) in depth would be backfilled with uncontaminated soil or sloped to promote drainage. Shallow excavations would be contoured to blend with the existing landscape. Alternatives 5a and 5b differ only in the final disposal location of the contaminated soil. Disposal at the ICDF or another facility within the INEEL is considered in Alternative 5a while a private disposal facility located off the INEEL is addressed in Alternative 5b.

During June 1999, a treatability study was conducted to determine whether the segmented gate system technology could segregate excavated soil to the specified remediation goal of 23pCi/g for Cs-137 and to confirm the feasibility study cost estimate for processing WAG 5 soil. Both sediment-type and windblown deposition soil were tested. Sites ARA-12 and ARA-25 are sites with sediment-type deposition, and ARA-16 and ARA-23 are sites with windblown deposition. Testing results demonstrated that the system could not sort either contaminated soil type to the 23-pCi/g Cs-137 level. The system could, however, successfully sort at the higher, industrial use level of 110 pCi/g. However, because the remediation goal was established for residential use, the segmented gate system would not be effective in meeting the remediation objectives.

8.7.5 Comparison of Elements and Distinguishing Features of Each Alternative

The relative performance of each alternative is described in Table 18.

8.8 Comparative Analysis of Alternatives for the Contaminated Soil Sites

The alternatives were evaluated using the nine evaluation criteria as specified by CERCLA (40 CFR 300.43[f][5][i]). The purpose of this comparison is to identify the relative advantages and disadvantages associated with each alternative. The comparative analyses of alternatives for the nine criteria are summarized below.

8.8.1 Overall Protection of Human Health and the Environment

Alternatives 4a, removal and disposal on the INEEL; 4b, removal and disposal off the INEEL; 5a, removal, ex situ sorting, and disposal on the INEEL; and 5b, removal, ex situ sorting, and disposal off the INEEL, provide the most overall protection of human health and the environment and are equivalent relative to human health protection. Alternative 3b, excavation, consolidation, and containment using an engineered barrier, would meet human health and ecological risk remedial action objectives, but is regarded as less effective than 4a, 4b, 5a, or 5b because of uncertainties that the engineered barrier would provide sufficient protection from the longer-lived radionuclide Ag-108m and because contaminated media would remain within WAG 5.

8.8.2 Compliance with Applicable or Relevant and Appropriate Requirements

The applicable or relevant and appropriate requirements (ARARs) for Alternative 1, no action, would not be met. Alternatives 3b, excavation, consolidation, and containment using an engineered barrier; 4a, removal and disposal on the INEEL; 4b, removal and disposal off the INEEL; 5a, removal, ex situ sorting, and disposal on the INEEL; and 5b, removal, ex situ sorting, and disposal off the INEEL, would meet ARARs and are ranked equally.

8.8.3 Long-Term Effectiveness and Permanence

Alternative 1, no action, would provide the least long-term effectiveness and permanence. Alternatives 4a, removal and disposal on the INEEL; 4b, removal and disposal off the INEEL; 5a, removal, ex situ sorting, and disposal on the INEEL; and 5b, removal, ex situ sorting, and disposal off the INEEL, would provide the highest degree of long-term effectiveness and permanence because contaminated soil would be removed from WAG 5. Engineering or administrative controls at the individual sites would not be required if all soil above remediation goals were removed. Alternative 3b, excavation, consolidation, and containment using an engineered barrier, would be less effective and permanent and also would require monitoring, maintenance, and 5-year reviews during the institutional control period.

8.8.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Only Alternatives 5a, removal, ex situ sorting, and disposal on the INEEL; and 5b, removal, ex situ sorting, and disposal off the INEEL, would reduce the volume of radiologically contaminated soil requiring disposal and were rated highest among the alternatives relative to this criterion.

Table 18. Detailed analysis summary of remediation alternatives for WAG 5 contaminated soil sites.

Criteria	Alternative 1 No Action	Alternative 3b Excavation, Consolidation, and Containment Using an Engineered Barrier	Alternative 4a Removal and Disposal on the INEEL	Alternative 4b Removal and Disposal off the INEEL	Alternative 5a Removal, Ex Situ Sorting, and Disposal on the INEEL	Alternative 5b Removal, Ex Situ Sorting, and Disposal off the INEEL
Overall protection of human health and the environment						
Human health protection	Would not reduce risk.	Cap would prevent exposure to contaminated soil for 400 years.	Would eliminate potential exposure to contaminated soil by removing contamination from WAG 5.	Would eliminate potential exposure to contaminated soil by removing contamination from WAG 5.	Would eliminate potential exposure to contaminated soil by removing contamination from WAG 5.	Would eliminate potential exposure to contaminated soil by removing contamination from WAG 5.
Environmental protection	Allows continued ecological exposures.	Cap would prevent exposure to contaminated soil for 400 years.	Would eliminate potential ecological exposure to contaminated soil by removing contamination from WAG 5.	Would eliminate potential ecological exposure to contaminated soil by removing contamination from WAG 5.	Would eliminate potential ecological exposure to contaminated soil by removing contamination from WAG 5.	Would eliminate potential ecological exposure to contaminated soil by removing contamination from WAG 5.
Compliance with applicable or relevant and appropriate requirements (ARARs)						
Action-specific						
Idaho Fugitive Dust Emissions—IDAPA 16.01.01.650 et seq.	Would not meet ARAR.	Would meet ARAR by eliminating potential for windblown-soil contamination.	Would meet ARAR by eliminating potential for windblown-soil contamination.	Would meet ARAR by eliminating potential for windblown- soil contamination.	Would meet ARAR by eliminating potential for windblown soil contamination.	Would meet ARAR by eliminating potential for windblown soil contamination.
Idaho Hazardous Waste Management Act—IDAPA 16.01.05.004 et seq.	Not applicable	Would meet ARAR.	Would meet ARAR.	Would meet ARAR.	Would meet ARAR.	Would meet ARAR.
Resource Conservation and Recovery Act—40 CFR 264 and 268	Not applicable	Would meet ARAR.	Would meet ARAR.	Would meet ARAR.	Would meet ARAR.	Would meet ARAR.
Idaho Toxic Air Pollutants—IDAPA 16.01.210, .585, and .586	Not applicable	Would meet ARAR through use of engineering controls.	Would meet ARAR through use of engineering controls.	Would meet ARAR through use of engineering controls.	Would meet ARAR through use of engineering controls.	Would meet ARAR through use of engineering controls.
NESHAP-40 CFR 61.91 and .92	Would not meet ARAR.	Would meet ARAR through use of engineering controls.	Would meet ARAR through use of engineering controls.	Would meet ARAR through use of engineering controls.	Would meet ARAR through use of engineering controls.	Would meet ARAR through use of engineering controls.
Location-specific						
Storm Water Discharges—40 CFR 122.26	Not applicable	Would meet ARAR through use of engineering controls.	Would meet ARAR through use of engineering controls.	Would meet ARAR through use of engineering controls.	Would meet ARAR through use of engineering controls.	Would meet ARAR through use of engineering controls.

Table 18. (continued).

Criteria	Alternative 1 No Action	Alternative 3b Excavation, Consolidation, and Containment Using an Engineered Barrier	Alternative 4a Removal and Disposal on the INEEL	Alternative 4b Removal and Disposal off the INEEL	Alternative 5a Removal, Ex Situ Sorting, and Disposal on the INEEL	Alternative 5b Removal, Ex Situ Sorting, and Disposal off the INEEL
Native American Graves Protection and Repatriation Act—25 USC 32	Would meet ARAR.	Would meet ARAR through surveys and assessments and actions deemed necessary.	Would meet ARAR through surveys and assessments and actions deemed necessary.	Would meet ARAR through surveys and assessments and actions deemed necessary.	Would meet ARAR through surveys and assessments and actions deemed necessary.	Would meet ARAR through surveys and assessments and actions deemed necessary.
National Archeological and Historic Preservation Act—36 CFR 800	Would meet ARAR.	Would meet ARAR through surveys and assessments and actions deemed necessary.	Would meet ARAR through surveys and assessments and actions deemed necessary.	Would meet ARAR through surveys and assessments and actions deemed necessary.	Would meet ARAR through surveys and assessments and actions deemed necessary.	Would meet ARAR through surveys and assessments and actions deemed necessary.
To be considered (TBC)						
Radiation Protection of the Public and Environment—DOE Order 5400.5	Would not meet TBC because no controls would be implemented.	Would meet TBC through use of engineering and institutional controls and best management practices.	Would meet TBC through use of engineering and institutional controls and best management practices.	Would meet TBC through use of engineering and institutional controls and best management practices.	Would meet TBC through use of engineering and institutional controls and best management practices.	Would meet TBC through use of engineering and institutional controls and best management practices.
Long-term effectiveness and permanence						
Magnitude of residual risk	No change from existing risk.	Source-to-receptor pathways would be eliminated while cap remains in place.	No residual risk would remain at WAG 5.	No residual risk would remain at WAG 5.	No residual risk would remain at WAG 5.	No residual risk would remain at WAG 5.
Adequacy and reliability of controls	No control and, therefore, no reliability.	Barrier is estimated to provide control over contaminated soil for at least 400 years.	Disposal facility is assumed to provide adequate and reliable control over soil disposed of for the period of institutional controls.	Disposal facility is assumed to provide adequate and reliable control over soil disposed of for the period of institutional controls.	Disposal facility is assumed to provide adequate and reliable control over soil disposed of for the period of institutional controls.	Disposal facility is assumed to provide adequate and reliable control over disposed soil for the period of institutional controls.
Reduction of toxicity, mobility, or volume through treatment						
Treatment process used	Not applicable	Not applicable	Not applicable	Not applicable	Soil separation	Soil separation
Amount destroyed or treated	Not applicable	Not applicable	Not applicable	Not applicable	All soil contaminated with Cs-137 above the remediation goal would be subjected to treatment, which is more than 94% of the soil to be remediated.	All soil contaminated with Cs-137 above the remediation goal would be subjected to treatment, which is more than 94% of the soil to be remediated.

Table 18. (continued).

Criteria	Alternative 1 No Action	Alternative 3b Excavation, Consolidation, and Containment Using an Engineered Barrier	Alternative 4a Removal and Disposal on the INEEL	Alternative 4b Removal and Disposal off the INEEL	Alternative 5a Removal, Ex Situ Sorting, and Disposal on the INEEL	Alternative 5b Removal, Ex Situ Sorting, and Disposal off the INEEL
Reduction of toxicity, mobility, or volume	Not applicable	Not applicable	Not applicable	Not applicable	Based on results of the treatability study conducted in June 1999, less than 2% reduction in soil volume could be achieved	Based on results of the treatability study conducted in June 1999 (Giles 1999b), less than 2% reduction in soil volume could be achieved
Irreversible treatment	Not applicable	Not applicable	Not applicable	Not applicable	Yes	Yes
Type and quantity of residuals remaining after treatment	Not applicable	Not applicable	Not applicable	Not applicable	Based on results of the treatability study, more than 98% of the soil that would require disposal would still be above the remediation goal after treatment.	Based on results of the treatability study, more than 98% of the soil that would require disposal would still be above the remediation goal after treatment.
Statutory preference for treatment	Not applicable	Not applicable	Not applicable	Not applicable	Meets preference.	Meets preference.
Short-term effectiveness						
Community protection	Would not increase potential risks to the public.	Would not increase potential risks to the public.	Would not increase potential risks to the public.	Would be slight increase in potential risks to the public during off-Site transportation.	Would not increase potential risks to the public.	Would be slight increase in potential risks to the public during off-Site transportation.
Worker protection	Not applicable	Workers would be protected by administrative and engineering controls.	Workers would be protected by administrative and engineering controls.	Workers would be protected by administrative and engineering controls.	Workers would be protected by administrative and engineering controls.	Workers would be protected by administrative and engineering controls.
Environmental impacts	No change from existing conditions.	Limited to disturbances from vehicle and material transport activities associated with excavation, transportation, and barrier construction. The use of dust suppressants would limit the potential for airborne contamination in the form of fugitive dust.	Limited to disturbances from vehicle and material transport activities associated with excavation and transportation. The use of dust suppressants would limit the potential for airborne contamination in the form of fugitive dust.	Limited to disturbances from vehicle and material transport activities associated with excavation and transportation. The use of dust suppressants would limit the potential for airborne contamination in the form of fugitive dust.	Limited to disturbances from vehicle and material transport activities associated with excavation and transportation. The use of dust suppressants would limit the potential for airborne contamination in the form of fugitive dust.	Limited to disturbances from vehicle and material transport activities associated with excavation and transportation. The use of dust suppressants would limit the potential for airborne contamination in the form of fugitive dust.
Time until action is complete	Not applicable	Approximately 18 to 24 months	Approximately 18 to 24 months	Approximately 18 to 24 months	Approximately 18 to 24 months	Approximately 18 to 24 months

Table 18. (continued).

Criteria	Alternative 1 No Action	Alternative 3b Excavation, Consolidation, and Containment Using an Engineered Barrier	Alternative 4a Removal and Disposal on the INEEL	Alternative 4b Removal and Disposal off the INEEL	Alternative 5a Removal, Ex Situ Sorting, and Disposal on the INEEL	Alternative 5b Removal, Ex Situ Sorting, and Disposal off the INEEL
Implementability						
Ability to construct and operate	No construction or operation would be implemented.	Would involve available construction technology.	Would involve available excavation and transportation technology.	Would involve available excavation and transportation technology.	Would involve available excavation, treatment, and transportation technology.	Would involve available excavation, treatment, and transportation technology.
Ease of implementing additional action if necessary	May require repeat of feasibility study and record of decision process.	Additional remedial actions would be difficult because the barrier is intended to prevent access to contamination. Barrier would require removal.	Additional remedial action would not be necessary because all contaminated soil and debris would be removed.	Additional remedial action would not be necessary because all contaminated soil and debris would be removed.	Could require additional excavation and transportation of soil.	Could require additional excavation and transportation of soil.
Ability to monitor effectiveness	Monitoring of conditions is readily implemented.	Barrier performance can be monitored through radiation surveys and can be visually assessed on the basis of physical integrity.	The effectiveness in removing all contaminated materials associated with the site would be easily monitored.	The effectiveness in removing all contaminated materials associated with the site would be easily monitored.	The effectiveness in removing all contaminated materials associated with the site would be easily monitored.	The effectiveness in removing all contaminated materials associated with the site would be easily monitored.
Ability to obtain approvals and coordinate with regulatory agencies	No approvals required.	Disposal of a landfill within WAG 5 may not be accepted by agencies.	No difficulties identified.	No difficulties identified.	No difficulties identified.	No difficulties identified.
Availability of services and capacity	None required.	Barrier design and services reside within DOE and are considered readily available to the INEEL.	Services would be available either on the INEEL or through subcontractor. Disposal capability is assumed to exist at the INEEL.	Services would be available either on the INEEL or through subcontractor.	Services would be available either at the INEEL or through subcontractors. Disposal capability is assumed to exist on the INEEL.	Services would be available either on the INEEL or through subcontractors.
Availability of equipment, specialists, and materials	None required.	Equipment and materials are readily available at the INEEL or within surrounding communities.	Equipment and materials would be readily available at the INEEL or within the surrounding community.	Equipment and materials would be readily available at the INEEL or within the surrounding community.	Equipment and materials would be either available on the INEEL through subcontractors or would be purchased. Trained specialists would be available within the communities surrounding the INEEL.	Equipment and materials would be either available at the INEEL through subcontractors or would be purchased. Trained specialists would be available within the communities surrounding the INEEL.
Availability of technology	None required.	Readily available at the INEEL.	Readily available at the INEEL.	Readily available at the INEEL.	Available through subcontractors.	Available through subcontractors.

Table 18. (continued).

Criteria	Alternative 1 No Action	Alternative 3b *Excavation*, Consolidation, and Containment Using an Engineered Barrier	Alternative 4a Removal and Disposal on the INEEL	Alternative 4b Removal and Disposal off the INEEL	*Alternative 5a* Removal, Ex Situ Sorting, and Disposal on the INEEL	*Alternative 5b* Removal, Ex Situ Sorting, and Disposal off the INEEL
Cost (net present value, 5% discount rate)[a]						
Capital Cost	$1 million	$10 million	$14 million	$29 million	$20 million	$27 million
Operation and Maintenance Cost	$7 million	$8 million	NA	NA	NA	NA
Total Cost	$8 million	$18 million	$14 million	$29 million	$20 million	$27 million

a. Details of the cost estimates are provided in the RI/FS report (Holdren et al. 1999, Appendix K).

8.8.5 Short-Term Effectiveness

Alternative 1, no action, would be the most effective in the short term because no actions resulting in additional worker exposure would occur. No off-Site exposures would occur because none of the sites are located near inhabited areas and public roads in the vicinity are sufficiently distant to preclude exposure. No additional environmental impacts would result from this alternative other than the extant conditions. Contaminant migration from surface soil via wind and water erosion is of concern. Therefore, the no action alternative would not satisfy remedial action objectives.

Alternative 3b, excavation, consolidation, and containment using an engineered barrier, and Alternative 4a, removal and disposal on the INEEL, are considered equally effective for short-term protection because both involve about the same degree of soil excavation and transport. Alternative 4b, removal and disposal off the INEEL, is considered slightly less effective because of some increase in potential risk to the public in the event of an accident during transportation to an off-Site disposal facility. Alternative 5a, removal, ex situ sorting, and disposal on the INEEL, and Alternative 5b, removal, ex situ sorting, and disposal off the INEEL, would be less effective than Alternatives 3b, 4a, and 4b in the short term because additional worker exposure would result from the increased handling of radiologically contaminated soil during the separation process. In the short term, Alternative 5b is the least effective of these options because of the potential risk to the public from off-Site transportation.

8.8.6 Implementability

Each of the alternatives is technically implementable. Alternative 1, no action, would be the most implementable because it would require no change in existing site conditions. Alternatives 3b, excavation, consolidation, and containment using an engineered barrier; 4a, removal and disposal on the INEEL; and 4b, removal and disposal off the INEEL, are equally implementable. All use conventional excavation equipment and rely on construction techniques that are known to be effective. Alternatives 5a, removal, ex situ sorting, and disposal on the INEEL, and 5b, removal, ex situ sorting, and disposal off the INEEL, are considered less implementable because of the lack of effectiveness of the segmented gate system in reducing the volume of radiologically contaminated soil at WAG 5 sites.

8.8.7 Cost

Alternative 4a, removal and disposal on the INEEL, is the least costly. Alternative 1, no action, is higher in cost because of long-term monitoring of the sites during the period of institutional control. Alternatives 3b, excavation, consolidation, and containment using an engineered barrier; 4b, removal and disposal off the INEEL; 5a, removal, ex situ sorting, and disposal on the INEEL; and 5b, removal, ex situ sorting, and disposal off the INEEL, have increased capital and operating and maintenance costs over those of Alternatives 1 and 4a. Alternative 3b is the most costly because of the capital costs involved in constructing the engineered barrier.

8.8.8 State Acceptance

The IDHW has been involved in the development and review of the OU 5-12 Comprehensive RI/FS report (Holdren et al. 1999), the Proposed Plan (DOE-ID 1999b), and this ROD. All comments received from IDHW on these documents have been resolved and the documents revised accordingly. In addition, IDHW has participated in public meetings where public comments and concerns have been received and responses offered. The IDHW concurs with the selected remedial alternative contained in this ROD for the contaminated soil sites and is a signatory to the ROD with DOE and EPA.

8.8.9 Community Acceptance

Community participation in the remedy selection process and Proposed Plan reviews included participation in the public meetings held May 17 through 19, 1999 (see Section 3). The 30-day public comment period was May 10, 1999, through June 9, 1999. The Responsiveness Summary, presented as Part 3 of this ROD, includes verbal and written comments received from the public and the DOE responses to these comments. Representatives of the EPA and IDHW assisted in the development of the responses.

In general, the public was supportive of the preferred alternative for the contaminated soil sites. One stakeholder representing the Sho-Ban tribe questioned the need for removing the soil from 42 acres at the ARA-23 site because the irreplaceable native ecosystem would be destroyed. As indicated in the Responsiveness Summary, removal of the contaminated soil is required to satisfy the CERCLA threshold criteria for protection of human health and the environment and compliance with the regulations.

8.9 Selected Remedy for the Contaminated Soil Sites

The selected remedy for the WAG 5 contaminated soil sites is Alternative 4a, removal and disposal of the contaminated soil at the INEEL. This remedy was selected based on the results of the comparative analysis of alternatives. Alternative 4a is the least costly alternative that meets threshold criteria (i.e., the remedy provides overall protection of human health and the environment and satisfies ARARs), is easily implemented because the required equipment already exists at the INEEL, and the long-term effectiveness is high because contamination will be permanently removed from the sites. The estimated time required to complete remediation is 18 to 24 months. The following activities will be conducted to complete remediation of the five contaminated soil sites ARA-01, ARA-12, ARA-23, ARA-25, and PBF-16:

- Soil contaminated with concentrations in excess of the remediation goals will be removed using conventional earth-moving equipment (e.g., scrapers and backhoes). Remediation goals are identified in Table 16.

- Real-time analyses will be used before and during excavation to delineate the extent of contamination for removal. Soil sampling and laboratory analysis will be used to verify that remediation goals have been satisfied.

- Areas that have been excavated to depths greater than 0.3 m (1 ft) will be backfilled with uncontaminated soil or sloped to promote drainage. All excavations will be contoured to match the surrounding terrain and vegetated.

- Contaminated soil will be characterized and sent to the ICDF or another location within the INEEL for permanent disposal.

- Institutional controls consisting of signs, access controls, and land-use restrictions will be maintained until remediation is complete. Post-remediation institutional control requirements will be identified based on the results of post-remediation sampling. Institutional controls will not be required after remediation if all contaminated media are removed to basalt or if contaminant concentrations are comparable to local background values. Otherwise, institutional controls will be maintained until discontinued bases on the results of a 5-year review.

- Five-year reviews will be conducted for remediated sites with institutional controls.

Removal of contaminated soil will be achieved using conventional excavation equipment. The relatively shallow depths of contaminated soils at WAG 5 sites will allow for excavation using front-end loaders, backhoes, and soil vacuum equipment.

Areas planned for excavation will be gridded, characterized, and excavated in discrete depth intervals. Real-time gamma surveys and real-time inductively coupled plasma spectrometry will be used both before and during excavation to delineate the extent of contamination for removal and to reduce the volume of uncontaminated soil removed. Excavation will proceed only to the depths at which contamination above the remediation goals is encountered. Sampling and analysis of soils underlying clean intervals will be used to verify that all soil with contaminant concentrations above the remediation goals is removed.

Current radiological control practices will be implemented to minimize radiation exposure to the operators. Radiological controls could consist of limiting the amount of time an operator can work in the area, requiring personnel to wear personal protective clothing, and using distance and shielding to reduce radiation exposure. Air emissions will be controlled by the use of water sprays or soil fixatives to suppress dust during soil excavation and removal.

Dump trucks will be positioned near the excavation so that loaders and backhoes can place the contaminated soil directly into the dump truck. A tarp will be unrolled over the truck box and secured to prevent accidental release during transit. The dump trucks will transport the soil to the ICDF or another approved location on the INEEL.

Though existing paved roadways between WAG 5 and the proposed location near the Idaho Nuclear Technology and Engineering Center (INTEC) for the ICDF could be used, the transportation distance will be greatly reduced by using the existing two-track dirt road between PBF and the INTEC. The dirt road will be widened and leveled, and a gravel base will be added. Roadway modification was not evaluated in the feasibility study, but a cost-benefit study is presently under way. If it is shown that the reduction in transportation costs will justify the expense of upgrading the road, a NEPA evaluation will be conducted. Construction to upgrade the roadway as described would be initiated only after approval of the appropriate NEPA documentation.

Following remediation, excavations exceeding 0.3 m (1 ft) in depth will be backfilled with uncontaminated soil or sloped to promote drainage. Shallow excavations will be contoured to blend with the existing landscape. Sites will be vegetated in accordance with INEEL guidelines (DOE-ID 1989).

Post-remediation requirements for institutional controls at each soil site, such as signs, access controls, and deed restrictions, will be determined after soil removal. Institutional controls will not be required if all soil down to basalt is removed or if soil concentrations are comparable to background values. Otherwise, institutional controls will be maintained until discontinued based on the results of a 5-year review.

8.9.1 Estimated Cost for the Selected Remedy

The estimated cost for implementing Alternative 4a, removal and disposal on the INEEL, is $13.8 million. The elements of the cost estimate are summarized in Table 19 and details of the cost estimate are provided in the WAG 5 Comprehensive RI/FS report (Holdren et al. 1999, Appendix K). The costs are presented in net present value, which allows for the equal comparison of long-term and short-term alternatives while factoring in inflation. Cost estimates are based on the use and operation of excavation equipment and disposal. Cost allowances are used to account for shielding requirements, air pollution controls, monitoring equipment and analyses, waste characterization, and packaging.

Table 19. Cost estimate summary for Waste Area Group 5 contaminated soil sites selected remedy.

Planned Activity		Cost (Fiscal Year 1998 dollars)
FFA/CO management and oversight		
	WAG 5 management	375,000
Remedial design		
	Remedial design/remedial action scope of work	54,000
	Remedial action work plan	63,000
	Packaging, shipping, transportation documentation	48,000
	Remedial action report	48,000
	Data collection and management for first 5-year review	141,000
	Safety analysis documentation	101,000
	Sampling and analysis plan	108,000
	Pre-final inspection report	8,000
	Legal review	32,000
	Total title design package	71,000
	Site characterization	1,273,000
Remedial action—construction subcontract		
	Construction subcontract	4,197,000
	Onsite soil repository disposal fee	4,243,000
Project construction management		705,000
CAPITAL COST SUBTOTAL		11,467,000
	Contingency @ 30%	3,440,000
TOTAL CAPITAL COST IN FY-98 DOLLARS		14,907,000
TOTAL CAPITAL COST IN NET PRESENT VALUE		13,797,000
Operations		
	Program management	NA
	Data collection and management for 5-year reviews	NA
	Maintenance	NA
	Decontamination and dismantlement	NA
	Surveillance	NA
OPERATIONS AND MAINTENANCE COST SUBTOTAL		NA
	Contingency @ 30%	NA
TOTAL OPERATIONS AND MAINTENANCE COST IN FISCAL YEAR 1998 DOLLARS		NA
TOTAL OPERATIONS AND MAINTENANCE COST IN NET PRESENT VALUE		NA
TOTAL PROJECT COST IN NET PRESENT VALUE		13,797,000

8.9.2 Estimated Outcomes of the Selected Remedy

Cleanup of the contaminated soil sites to meet the remediation goals (see Table 16) can be achieved by soil excavation within 24 months after remediation is initiated. Cleanup to these goals will provide protection of ecological receptors, future workers, and residents. The institutional controls will provide protection of current workers. Current land-use projections (DOE-ID 1996a) indicate that these areas are designated for continued industrial use. However, the cleanup goals also will ensure adequate protection of future residents if these areas become available for residential use after the 100-year institutional control period assumed for the risk assessment.

8.10 Statutory Determinations for the Contaminated Soil Sites

8.10.1 Overall Protection of Human Health and the Environment

Alternative 4a, removal and disposal on the INEEL, provides highly effective, long-term protection of human health and the environment. The removal of all contaminated soil from WAG 5 would eliminate potential long-term human health and environmental concerns associated with future exposure to, or contaminant migration from, uncontrolled release sites. The ICDF or other INEEL disposal facility would provide isolation of the contaminated soil (1) within a controlled area in which waste management controls are in place and (2) for at least the period of institutional control.

Alternative 4a is protective of the environment during implementation because mitigative measures to prevent contaminant migration during excavation activities would be implemented. However, short-term protection of human health is considered only moderate because workers could receive direct exposure to contaminated soil during excavation. However, all potential risks during implementation could be controlled through administrative and engineering controls. Waste generated during remedial actions would consist of only relatively small quantities of equipment decontamination fluids and discarded personal protective equipment.

8.10.2 Compliance with ARARs and To-Be-Considered Guidance

The selected remedy meets the identified ARARs as shown in Table 20. Available data indicate that no RCRA hazardous waste is present at WAG 5 contaminated soil sites. This conclusion will be verified through analysis and waste designation during excavation. If any soil is determined to be classified as RCRA-regulated waste, the RCRA ARARs listed will apply. The soil will be disposed of at a compliant facility, such as the ICDF. Therefore, the RCRA ARARs will be met. Compliance with the emission control ARARs would be ensured by implementing air monitoring and dust suppression techniques during excavation. Department of Energy Order 5400.5, "Radiation Protection of the Public and the Environment," would be met by implementing and enforcing applicable provisions of the order. The selected alternative is, therefore, capable of complying with ARARs and to-be-considered guidance (TBC).

8.10.3 Cost Effectiveness

The selected remedy is cost-effective because it is the least costly alternative that satisfies threshold criteria. When compared to other potential remedial actions, the selected remedy provides the best balance between cost and effectiveness in protecting human health and the environment.

Table 20. ARARs and TBCs for the selected alternative—removal, and on-site disposal—for WAG 5 contaminated soil sites.

Category	Citation	Reason	Relevancy
Action Specific ARARs			
Rules for the Control of Air Pollution in Idaho	Toxic Substances IDAPA 16.01.01.161 Toxic Air Emissions IDAPA 16.01.01.585 and .586	The release of carcinogenic and noncarcinogenic contaminants into the air must be estimated before the start of construction, controlled, if necessary, and monitored during excavation and sorting of soil.	A[a]
	Fugitive Dust IDAPA 16.01.01.650 and .651	Requires control of dust at all times, especially during excavation, sorting, and removal of soil.	
	Requirements for Portable Equipment IDAPA 16.01.01.500.02	Portable equipment for sorting and removal of soil, and any portable support equipment must be operated to meet state and federal air emissions rules.	A
National Emission Standards for Hazardous Air Pollutants (NESHAP)	Radionuclide Emissions from DOE Facilities 40 CFR 61.92 Emission Monitoring 40 CFR 61.93 Emission Compliance 40 CFR 61.94(a)	Limits exposure of radioactive contamination release to 10 mrem/year for the off-Site receptor and establishes monitoring and compliance requirements.	A
Resource Conservation and Recovery Act—Standards for Owners and Operators of Hazardous Waste Treatment Storage and Disposal Units	General Waste Analysis IDAPA 16.01.05.008 (40 CFR 264.13 (a)(1-3))	Analysis requirements apply only to RCRA-hazardous soil and secondary waste generated during remediation.	A
	General Inspections IDAPA 16.01.05.008 (40 CFR 264.15)	For soil sites determined to be RCRA hazardous, regular inspections must be performed during remediation.	A

Table 20. (continued).

Category	Citation	Reason	Relevancy
	Preparedness and Prevention IDAPA 16.01.05.008 (40 CFR 264, Subpart C)	Applies to soil excavation, sorting, and decontamination activities at any site determined to be RCRA hazardous.	A
	Contingency Plan and Emergency Procedures IDAPA 16.01.05.008 (40 CFR 264, Subpart D)	Applies to soil excavation, sorting, and decontamination activities at any site determined to be RCRA hazardous.	A
	Equipment Decontamination IDAPA 16.01.05.008 (40 CFR 264.114)	All equipment used during remediation must be decontaminated if RCRA hazardous waste is contacted.	A
	Use and Management of Containers IDAPA 16.01.05.008 (40 CFR 264.171–177)	Applicable to RCRA hazardous soil and associated hazardous secondary waste generated by remediation that is managed in containers.	A
Resource Conservation and Recovery Act—Land Disposal Restrictions	Treatment Standards IDAPA 16.01.05.011 (40 CFR 268.40 (a)(b)(e))	Any RCRA hazardous soil and associated hazardous secondary waste must meet land disposal restrictions criteria before disposal.	A
	Treatment Standards for Hazardous Debris IDAPA 16.01.05.011 (40 CFR 268.45 (a–d))		A
	Universal Treatment Standards IDAPA 16.01.05.011 (40 CFR 268.48 (a))		A
	Alternative Treatment Standards for Contaminated Soil IDAPA 16.01.05.011 (40 CFR 268.49)		A

Table 20. (continued).

Category	Citation	Reason	Relevancy
Location-Specific ARARs			
National Historic Preservation Act	Historic properties owned or controlled by Federal agencies 16 USC 470 h-2 Identifying Historic Properties 36 CFR 800.4 Assessing Effects 36 CFR 800.5	The site must be surveyed for cultural and archeological resources before construction and for appropriate actions taken to protect any sensitive resources.	A
Native American Graves Protection and Repatriation Act	Custody 25 USC 3002 (43 CFR 10.6) Repatriation 25 USC 3005 (43 CFR 10.10)	The site must be surveyed for cultural and archeological resources before construction and for appropriate actions taken to protect any sensitive resources.	A
To-be-considered (TBC) guidance			
Radiation Protection of the Public and the Environment	DOE Order 5400.5, Chapter II (1)(a,b)	Limits the effective dose to the public from exposure to radiation sources and airborne releases.	—[b]

a. A = Applicable.
b. TBCs are not classified as applicable or relevant and appropriate.

8.10.4 Use of Permanent Solutions and Alternative Treatment Technologies

The selected remedy provides a permanent solution because contaminated soil will be permanently removed and contained in a facility off WAG 5, which will be designed for long-term isolation and protection. All COCs at the soil sites are radionuclides and toxic heavy metals. Presently, no technology is available that can reduce the toxicity of these contaminants. Only options that can reduce contaminant mobility or reduce the volume of contaminated soil are considered effective remediation strategies. Use of technologies such as in situ vitrification and stabilization can reduce contaminant mobility but will not significantly reduce the risk from external exposure to radiation. Hence, these technologies would not meet the primary human health remedial action objectives for the radionuclide soil sites. In addition, heavy metals over long periods of time will leach from such treated soil and, hence, future protection of the environment could not be guaranteed. Therefore, the most effective alternative would involve permanent removal of the contaminated soil.

8.10.5 Preference for Treatment as a Principal Element

Treatment technologies exist to reduce the mobility of radionuclides and heavy metals in soil and also to reduce the volume of soil contaminated with these contaminants, but no technology exists that can reduce the toxicity of radionuclides and heavy metals. Natural radioactive decay is the only means by which toxicity reduction of radionuclides occurs. Technologies to reduce the mobility and volume of contaminated soil were considered in the feasibility study and evaluated to the extent determined to be technically feasible and cost-effective. However, no treatment technologies currently exist that proved to be viable and cost-effective.

Soil sorting by use of a segmented gate system was evaluated in the feasibility study and a subsequent treatability study performed during June 1999. The results of this study indicated the volume reduction of radioactively contaminated soil was insignificant (Giles 1999b). Hence, this treatment technology (Alternative 5) was eliminated from further consideration.

Though technologies are available that could remove heavy metals from soil, the volume of soil contaminated with heavy metals is small and the concentrations of heavy metals are too low to be effectively treated by any of the currently available technologies. Therefore, treatment to reduce the volume of heavy metal contaminated soil was not pursued.

Technologies to reduce contaminant mobility, such as stabilization, vitrification, and containment, also were considered in the feasibility study. Neither stabilization nor vitrification would reduce the human health risk caused by radiation exposure, nor would they permanently isolate heavy metals from the environment. Hence these technologies were eliminated from consideration.

8.10.6 Five-Year Reviews

Five-year reviews will be conducted for all sites with institutional controls. Land use will be restricted at all contaminated soil sites until remediation is implemented as prescribed in this ROD. Land-use controls will not be required after remediation if all contaminated soil is removed to basalt or if contaminant concentrations are comparable to local background values. Otherwise, institutional controls will be maintained until discontinued based on the results of a 5-year review.