RI/FS-EIS DOCUMENT: DOE/EIS-0185D
PROPOSED PLAN: DOE/OR/21548-160

Proposed Plan for Remedial Action at the Chemical Plant Area of the Weldon Spring Site

November 1992

U.S. Department of Energy
Oak Ridge Field Office
Weldon Spring Site Remedial Action Project

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prepared by

U.S. Department of Energy, Oak Ridge Field Office, Weldon Spring Site Remedial Action Project

with technical assistance from

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The following is a list of the acronyms, initialisms, and abbreviations (including units of measure) used in this document. Acronyms used in tables only are defined in the respective tables.

ACRONYMS, INITIALISMS, AND ABBREVIATIONS

AEC	U.S. Atomic Energy Commission
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
BA	baseline assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended
CFR	Code of Federal Regulations
DNT	dinitrotoluene
DOE	U.S. Department of Energy
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
FS	feasibility study
MSA	material staging area
NEPA	National Environmental Policy Act of 1969
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NPL	National Priorities List
NRC	U.S. Nuclear Regulatory Commission
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
RCRA	Resource Conservation and Recovery Act, as amended
RI	remedial investigation
ROD	record of decision
TCLP	toxicity characteristic leachate procedure
TNT	trinitrotoluene
TSA	temporary storage area

UNITS OF MEASURE

cm	centimeter
ft	foot
g	gram
ha	hectare
in.	inch
kg	kilogram
km	kilometer
L	liter
m	meter
m^2	square meter
m^3	cubic meter
mg	milligram
mi	mile
mrem	millirem
pCi	picocurie
rem	roentgen equivalent man
t	metric ton
s	second
yd^3	cubic yard
yr	year

1 INTRODUCTION

This proposed plan addresses the management of contaminated material at the chemical plant area of the Weldon Spring site and nearby properties in St. Charles County, Missouri. The site consists of a chemical plant area and a noncontiguous limestone quarry, both of which are radioactively and chemically contaminated as a result of past processing and disposal activities. Explosives were produced at the chemical plant in the 1940s, and uranium and thorium materials were processed in the 1950s and 1960s. Various liquid, sludge, and solid wastes were disposed of at the chemical plant area and in the quarry during that time. The Weldon Spring site is listed on the National Priorities List (NPL) of the U.S. Environmental Protection Agency (EPA), and the U.S. Department of Energy (DOE) is conducting cleanup activities at the site under its Environmental Restoration and Waste Management Program.

Site cleanup activities are being conducted in accordance with both the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, and the National Environmental Policy Act (NEPA). For remedial action sites, it is DOE policy to integrate NEPA values into the procedural and documentational requirements of CERCLA, wherever practicable. An integrated remedial investigation/feasibility study-environmental impact statement (RI/FS-EIS) has been prepared in accordance with CERCLA and NEPA to assess site problems and to analyze alternatives for managing the contaminated material. The content of the documents prepared for this project is not intended to represent a statement on the legal applicability of NEPA to remedial actions conducted under CERCLA.

The DOE is currently preparing a programmatic EIS for environmental restoration and waste management (DOE 1992b), and the document is expected to be issued as a draft for public comment in the fall of 1993. The draft implementation plan for the programmatic EIS (DOE 1992a) listed a number of NEPA documents prepared for site-specific actions, many of which are considered to qualify as interim actions for the programmatic EIS under the conditions established in Title 40, Code of Federal Regulations, Part 1506.1(c) [40 CFR 1506.1(c)]; the 1987 draft EIS for the Weldon Spring site was included in that list. At this time, the action proposed for the chemical plant area of the Weldon Spring site is considered an appropriate interim action because it is justified independently of the program, would be accompanied by an adequate environmental impact statement, and does not prejudice the ultimate decision on the program by determining subsequent development or limiting alternatives. Before issuing the record of decision (ROD) pursuant to the RI/FS-EIS for the Weldon Spring site, DOE will further review these conditions to ensure that they are met at that time.

Three major evaluation documents have been prepared to support cleanup decisions for the chemical plant area of the Weldon Spring site and related properties: (1) the RI report, which presents information on the nature and extent of contamination (DOE 1992e); (2) the baseline assessment (BA), which evaluates potential impacts to human health and the environment that might occur if no cleanup action were taken (DOE 1992c); and (3) the FS report, which develops and evaluates remedial action alternatives (DOE 1992d). The RI/FS is the source of information presented in this proposed plan. Together, the RI, BA, FS, and this proposed plan make up the RI/FS-EIS for remedial action at the chemical plant area.

The purposes of this proposed plan are as follows:

- Present to the public a notice and brief analysis of the remedial action activities being considered for the chemical plant area, pursuant to Section 117(a) of CERCLA.

- Describe the alternatives for this remedial action.

- Identify the currently preferred alternative and present the rationale for this preference.

- Indicate that a contingency remedy is being considered to provide treatment flexibility.

- Summarize key information from the RI, BA, and FS; serve as a companion document to those reports; and support the administrative record file for this action.

- Provide information on the public's role in the decision-making process for this action.

The currently preferred alternative has been identified from an analysis of available site information and an evaluation of various alternatives for remedial action at the chemical plant area. However, a final determination has not yet been made; the alternative selected for implementation will be documented in the ROD, following receipt and consideration of public comments and any significant new information that may become available. In publishing this proposed plan, DOE encourages public review and comment on the RI/FS-EIS. Information on the proposed remedial action may be found in the RI, BA, FS, and supporting technical reports in the administrative record for this action (Chapter 7). The remedial action alternatives are evaluated in detail in Chapters 5, 6, and 7 of the FS and are summarized in Chapters 5 and 6 of this proposed plan.

Consideration of community input may result in modifications to the ultimate remedial action selected, so the final decision may differ from the preferred alternative identified in this plan. Therefore, public comment on each alternative in this plan and on supporting information for the alternatives is an important element of the decision-making process for the remedial action, as it is for all cleanup decisions regarding the Weldon Spring site.

The proposed plan is organized as follows:

- Chapter 2 presents the history and setting of the Weldon Spring site and briefly describes the contaminated material at the chemical plant area.

- Chapter 3 defines the scope of the remedial action and its role in the Weldon Spring Site Remedial Action Project.

- Chapter 4 summarizes the risks associated with possible exposures to site contaminants in the absence of remedial action and identifies proposed cleanup levels for soil.
- Chapter 5 briefly describes the final alternatives considered for the remedial action.
- Chapter 6 summarizes the evaluation of final alternatives for managing the contaminated material, identifies the currently preferred alternative, and discusses a possible contingency remedy to provide treatment flexibility.
- Chapter 7 presents the community's role in this action.
- Chapter 8 is a list of the references cited in this proposed plan.

2 SITE DESCRIPTION

The physical setting and history of the Weldon Spring site are described briefly in Sections 2.1 and 2.2, respectively. The contamination at the chemical plant area is summarized in Section 2.3. These topics are discussed in considerable detail in the RI and BA (DOE 1992e and 1992c).

2.1 PHYSICAL SETTING

The Weldon Spring site is located in St. Charles County, Missouri, about 48 km (30 mi) west of St. Louis (Figure 1). The site consists of two noncontiguous areas: the 88-ha (217-acre) chemical plant area, which is about 3.2 km (2 mi) southwest of the junction of Missouri (State) Route 94 and U.S. Route 40/61, and a 3.6-ha (9-acre) limestone quarry, which is about 6.4 km (4 mi) south-southwest of the chemical plant area. Both the chemical plant area and the quarry are accessible from State Route 94 and are fenced and closed to the public. The proposed remedial action focuses on alternatives for remediating the chemical plant area and certain nearby properties, and the following description is limited to those locations. Separate documentation has been completed for cleanup actions at the quarry, and additional documentation is forthcoming (see Chapter 3).

The chemical plant area contains about 40 buildings (currently being dismantled), four waste retention ponds referred to as raffinate pits, two ponds (Ash Pond and Frog Pond), and two former dump areas (North Dump and South Dump) (Figure 2). Much of the land surface around the buildings is paved or covered with gravel; the remainder of the site contains a variety of grasses and scattered small shrubs and trees. Most of the site is routinely mowed, and little undisturbed or natural habitat exists except in the northern quadrant. That area is essentially grassland and old-field habitat, with some secondary forest growth.

The chemical plant area is bordered by the August A. Busch Memorial Wildlife Area to the north, the Weldon Spring Wildlife Area to the south and east, and the U.S. Army Reserve and National Guard Training Area to the west (Figure 3). A state of Missouri highway maintenance facility is located on State Route 94, just northeast of the entry gate to the site, and Francis Howell High School is located about 1 km (0.6 mi) east of the site. The two closest communities are Weldon Spring and Weldon Spring Heights, about 3.2 km (2 mi) east of the site; these communities have a combined population of about 850. The largest city in the county is St. Charles; it is located about 24 km (15 mi) northeast of the site and has a population of about 50,000.

Several small areas of soil on the adjacent Army property and wildlife areas are contaminated as a result of previous activities at and releases from the chemical plant; these areas have been designated as vicinity properties. The DOE is responsible for the vicinity properties associated with past activities conducted by the U.S. Atomic Energy Commission (AEC) at the Weldon Spring site. In addition, three lakes in the wildlife area to the north contain

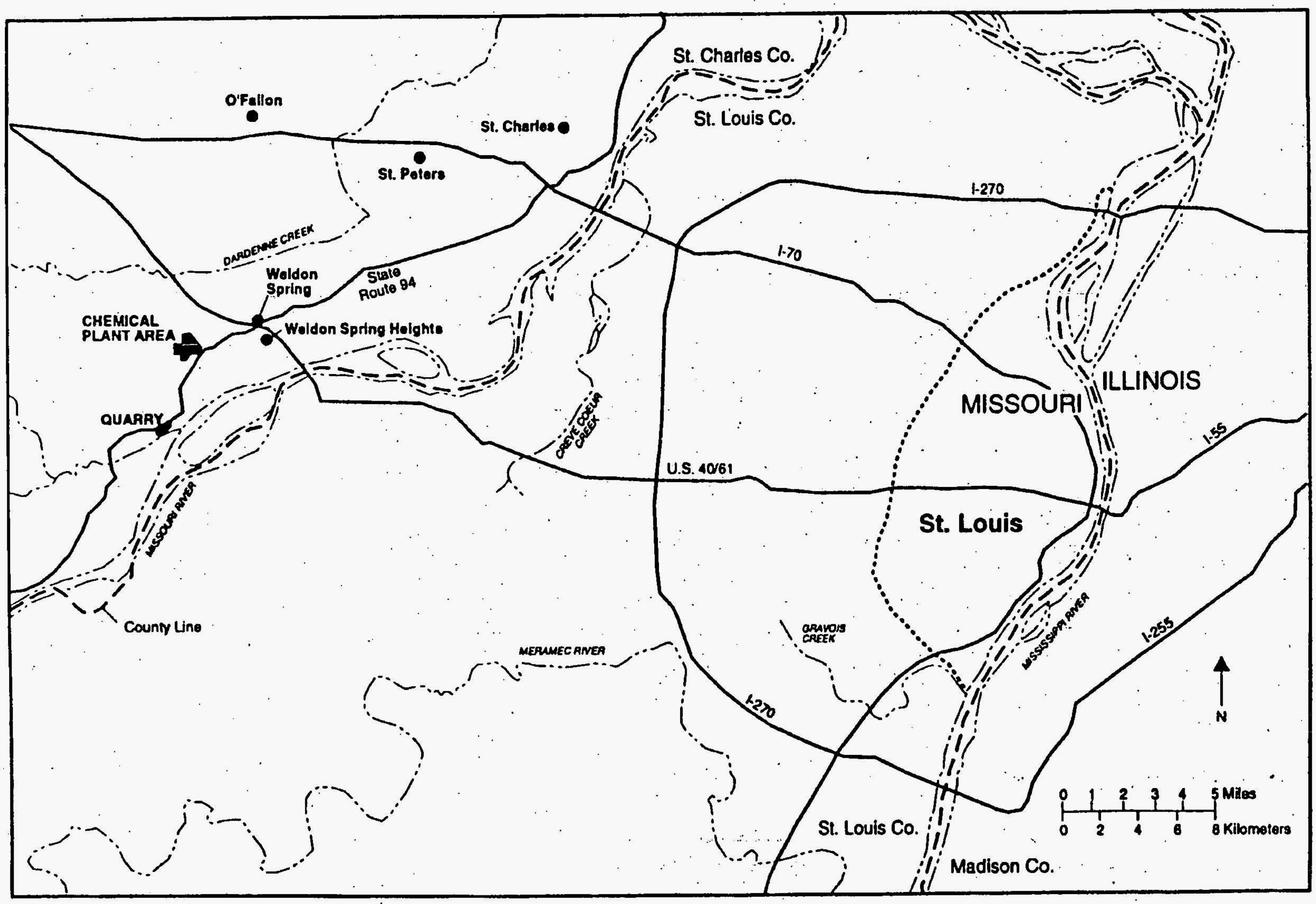


FIGURE 1 Location of the Weldon Spring Site

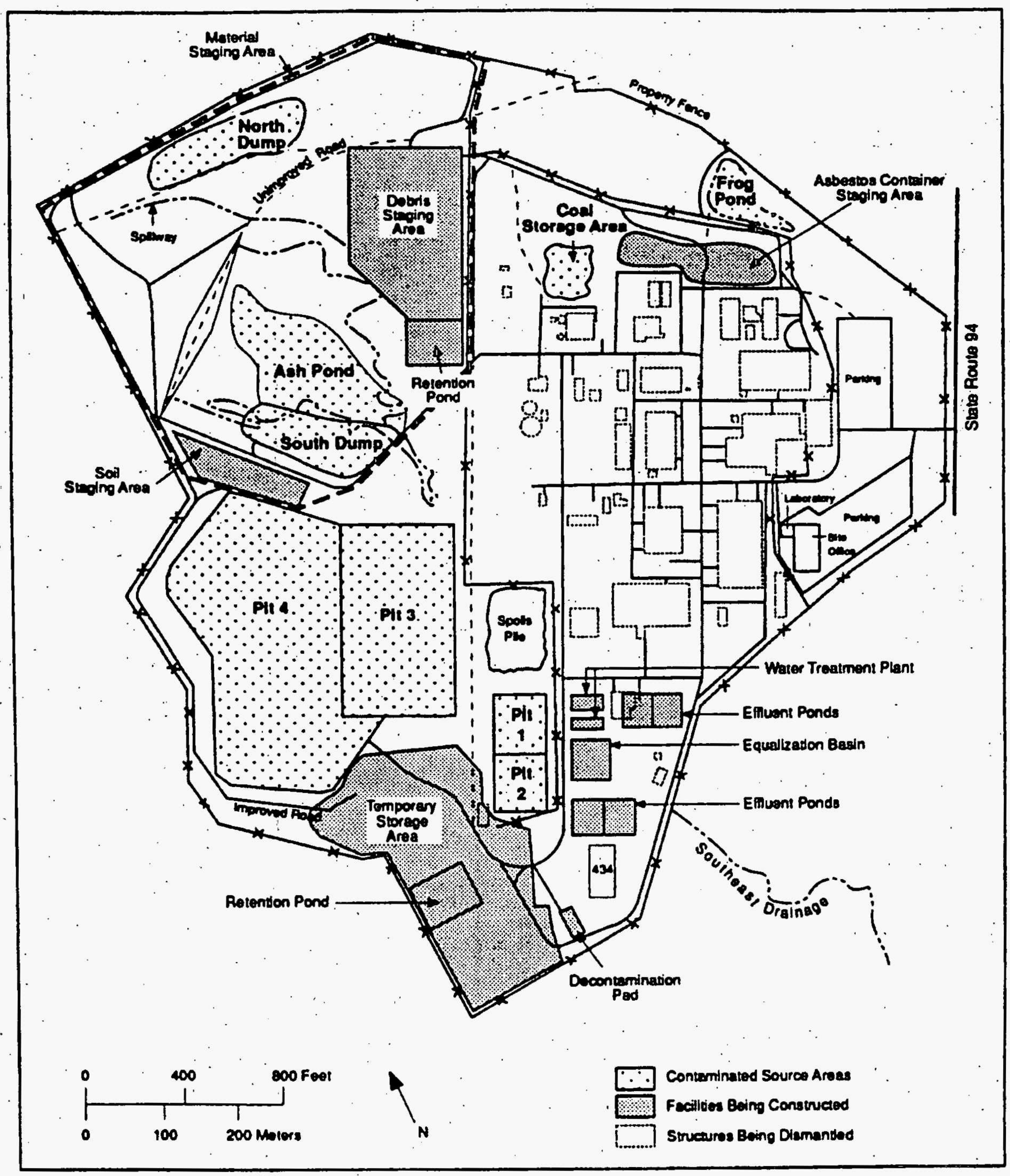


FIGURE 2 General Layout of the Chemical Plant Area

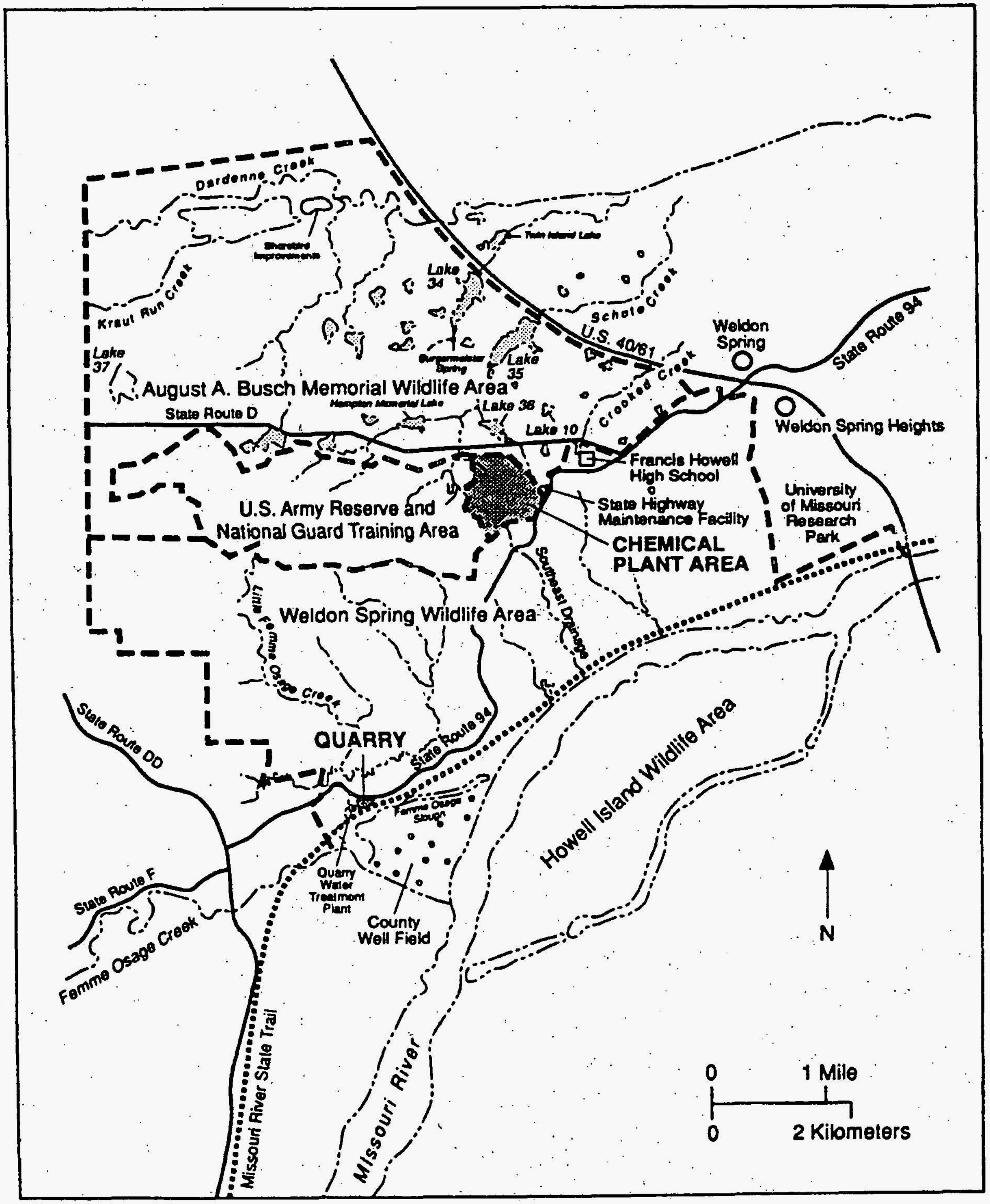


FIGURE 3 Surface Features near the Weldon Spring Site

low levels of radioactivity as a result of surface runoff from the chemical plant area. (Other nearby locations have also been contaminated as a result of such releases, including the Southeast Drainage that carries runoff from part of the chemical plant area to the Missouri River and vicinity properties near the quarry such as the Femme Osage Slough. However, decisions for these areas are not part of the current remedial action; they will be addressed in forthcoming documentation to be prepared within the next several years [see Chapter 3].)

The discussions in this proposed plan and in the companion documents for the current remedial action have used the term "on-site" to refer to the property located within the fence of the chemical plant area and the term "off-site" to refer to contaminated locations outside the fence. The formal definition of the term "site" in the context of this remedial action includes the chemical plant area, related soil vicinity properties, and other areas contaminated by the migration of a hazardous substance, pollutant, or contaminant from any of the properties under the custody and accountability of DOE. However, in these documents, the term site refers to the chemical plant area only; this approach was taken to reflect the more common use of the term and to simplify the presentation with regard to distinguishing between the chemical plant proper and the smaller areas of contamination nearby.

2.2 HISTORY

In April 1941, the U.S. Department of the Army acquired about 7,000 ha (17,000 acres) of land in St. Charles County, Missouri, to construct the Weldon Spring Ordnance Works — a production facility for trinitrotoluene (TNT) and dinitrotoluene (DNT) explosives. The facility began operations in 1941 and closed in 1946. By 1949, all but about 810 ha (2,000 acres) of the ordnance works property had been transferred to the state of Missouri and the University of Missouri for use as a wildlife area and for agriculture. Except for several small parcels transferred to St. Charles County, the remaining property became the chemical plant area of the Weldon Spring site and the adjacent U.S. Army Reserve and National Guard Training Area.

In May 1955, the AEC (a predecessor of DOE) acquired 83 ha (205 acres) of the property from the Army to construct a uranium feed materials plant. About 6 ha (15 acres) were later transferred to the AEC for expansion of waste storage capacity, i.e., to construct the fourth raffinate pit. Considerable explosives decontamination and regrading activities were conducted before the chemical plant was constructed. Uranium and thorium ore concentrates were processed at the plant from 1957 to 1966.

Plant operations generated several chemical and radioactive waste streams, including raffinates from the refinery operation and washed slag from the uranium recovery process. Waste slurries were piped to the raffinate pits, where the solids settled to the bottom and the supernatant liquids were decanted to the plant process sewer; this sewer drained off-site to the Missouri River via a 2.4-km (1.5-mi) natural drainage channel termed the Southeast Drainage. Some solid waste was also disposed of on-site during the plant's operational period. The Army disposed of chemically contaminated materials in the quarry beginning in the early 1940s. In July 1960, the quarry was transferred to the AEC, and the AEC used the quarry to dispose of radioactively contaminated materials such as uranium and thorium residues, building rubble, and process equipment through 1969.

The Army reacquired the chemical plant property in 1967 and began decontamination and dismantling operations to prepare the facility for herbicide production. Much of the resultant debris was placed in the quarry; a small amount was also placed in the fourth raffinate pit. The project was canceled in 1969 before any production was initiated, and the plant has remained essentially unused and in caretaker status since that time. The Army returned the raffinate pits portion of the chemical plant area to the AEC in 1971. In 1985, the Army transferred custody of the remainder of the property to DOE, having conducted some additional decontamination activities in the buildings during the previous year. The DOE established a project office at the site in 1986 to support cleanup activities, and several interim actions have been developed and implemented since that time.

The quarry was listed on the NPL in 1987, and the chemical plant area was added in 1989 (EPA 1989b). The balance of the former Weldon Spring Ordnance Works property, which is adjacent to the DOE portion of the property and for which the Army is responsible, was added to the NPL as a separate listing in 1990 (EPA 1990b).

2.3 SITE CONTAMINATION

Numerous characterization studies have been performed at the site over the last several years, and extensive data on the nature and extent of contamination are presented in the RI report (DOE 1992e). Radioactive contaminants at the site are radionuclides of the uranium-238, thorium-232, and uranium-235 decay series; chemical contaminants include metals and inorganic anions, as well as organic compounds such as polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and nitroaromatic compounds. Except for the organic compounds, these contaminants are naturally present in the environment but their concentrations at certain site areas exceed background levels. An overview of the concentrations of radioactive and chemical contaminants of concern in environmental media at the site and in off-site areas is presented in summary tables in Chapter 2 of the BA (DOE 1992c). General information on site contamination addressed by the proposed action can be summarized as follows:

- As a result of past discharge and disposal activities, the four raffinate pits and two ponds contain sludge and sediment contaminated with radionuclides such as uranium, thorium, and radium; metals such as lead and molybdenum; and inorganic anions such as fluoride, sulfate, and nitrate.

- As a result of past storage and disposal activities, dump areas contain soil contaminated with radionuclides such as uranium, thorium, and radium and some metals such as lead and arsenic.

- Material from site buildings and other structures includes asbestos-containing material used in construction, concrete and lighting components contaminated with PCBs, and metal and concrete contaminated with radionuclides such as uranium, thorium, and radium as a result of past processing activities and subsequent tracking.

- Containerized process wastes, both left over from past operations and wastes that will be generated by the project's recently constructed water treatment plants, include a variety of liquids and solids contaminated with both chemicals and radionuclides.

- Limited vegetation (e.g., from the quarry and from the borders of the ponds at the chemical plant area) contains low levels of radionuclides as a result of biouptake.

- On-site soil contains generally low levels of radionuclides (primarily uranium) as a result of airborne releases during the plant's operational period; as a result of past spills and handling activities at processing, storage, and disposal areas, the soil at scattered locations contains radionuclides such as uranium, thorium, and radium and some contamination with heavy metals, PCBs, PAHs, and inorganic anions such as sulfate and nitrate.

- Off-site soil and sediment at specific soil locations and three lakes in the adjacent wildlife area contain low levels of radionuclides (primarily uranium) that exceed background concentrations as a result of past spills and discharges and ongoing surface runoff.

The potential risks associated with this contamination are summarized in Chapter 4. The estimated volume of contaminated material addressed by this action is presented in Table 1. Included in this table for comprehensive planning purposes are estimates of material that could result from future response actions for the project, e.g., at the Southeast Drainage or Femme Osage Slough (see Chapter 3).

TABLE 1 Estimated Areas and Volumes of Contaminated Media

Contaminated Media and Locations	Area (acres)	Volume (yd^3)
Sludge		
Raffinate pits	25.8	220,000
Sediment		
Ash Pond	8.6	8,200
Frog Pond	1.9	7,000
Temporary storage area	1.0	4,100
Lakes 34, 35, and 36	113	20,000
Femme Osage Slough	3.5	80,500
Total sediment	**128**	**119,800**
Soil		
North Dump	1.9	7,600
South Dump	4.2	16,900
Other sitewide soil	20	85,400
Temporary storage area	2.0	52,000
Raffinate pits	25.8	153,500
Soil at subsurface piping	4.5	20,000
Off-site (vicinity properties)	1.2	3,600
Total soil	**59.6**	**339,000**
Structural material		
Concrete at temporary storage area	2.3	30,200
Steel at temporary storage area	0.8	10,500
Rubble/concrete at material staging area	2.5	59,000
Steel at material staging area	2.5	51,400
Debris at material staging area	0.5	3,700
Asbestos	0.5	9,800
Building 434	0.5	5,000
Total structural material	**9.6**	**169,600**
Process chemicals		
Treatment plant process waste	0.5	3,600
Consolidated chemicals	0.5	360
Total process chemicals	**1.0**	**3,960**
Vegetation		
From quarry	0.4	6,500
From building demolition	0.1	750
From sitewide areas	3.8	23,400
Total vegetation	**4.3**	**30,650**
Total volume	**-[a]**	**883,000**

[a] A value for total area would not be indicative of the total area impacted because some areas are counted more than once (e.g., sludge and soil are shown separately for the raffinate pits).

3. SCOPE AND ROLE OF THE REMEDIAL ACTION

The proposed remedial action is the major component of the phased site cleanup process (Figure 4). This action addresses comprehensive disposal decisions for the project, and its primary focus is the contaminated material at the chemical plant area; this includes material generated as a result of previous response actions, such as bulk waste removed from the quarry. The scope of these decisions also includes the disposition of material that might be generated by upcoming actions, e.g., at the Southeast Drainage and the quarry. That is, although the specific decisions for the later stages of site remediation are not included in the scope of this action, the contaminated material that could be generated by the actions that result from those decisions is being considered at this time to ensure an integrated disposal decision for the project. The types of material that could result from future actions are the same as those being addressed in this action, i.e., soil, sediment, vegetation, and containerized process waste from water treatment.

Decisions for several interim actions have already been made for both the chemical plant area and the quarry to respond to contaminant releases and to mitigate potential health and safety threats at the site; these actions are currently being implemented. The waste resulting from each of these actions will be stored on-site, pending the disposal decision determined from the RI/FS-EIS. The major interim actions include:

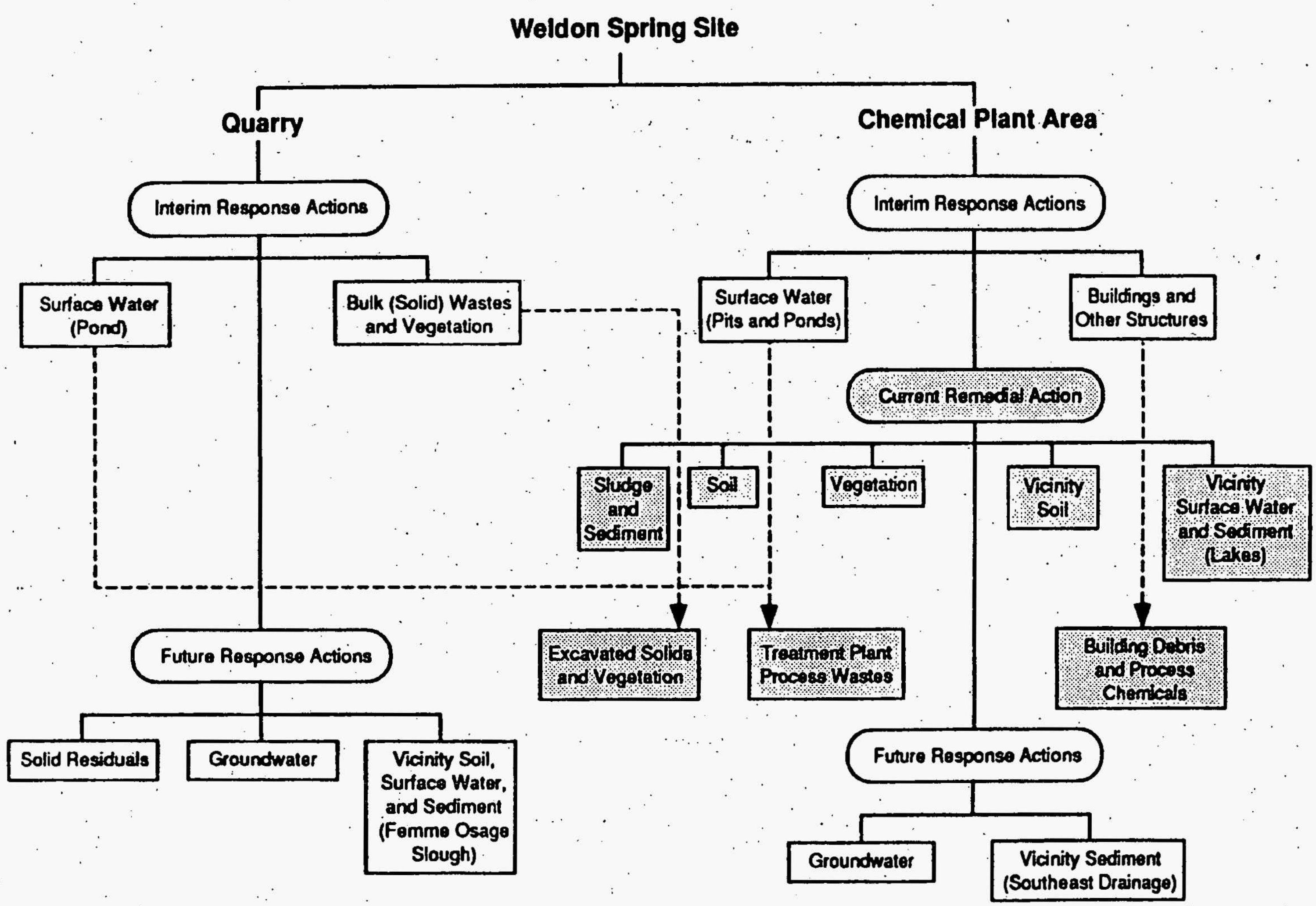
- Removal and treatment of contaminated surface water from the quarry, with transport of the treatment plant process wastes to the chemical plant area for short-term storage in a newly constructed temporary storage area (TSA) and possibly in a recently renovated storage building nearby (Building 434) — documented as a removal action (MacDonell et al. 1989);

- Excavation of bulk (solid) waste from the quarry, with transport to the chemical plant area for short-term storage at the TSA — documented as an interim remedial action (DOE 1990a, 1990b, 1990c);

- Removal and treatment of contaminated water from surface impoundments at the chemical plant area, with short-term storage of the treatment plant process wastes at the TSA (and possibly in Building 434) — documented as a removal action (MacDonell et al. 1990); and

- Decontamination and dismantlement of all chemical plant structures, with short-term storage in the material staging area (MSA) — documented as removal actions (MacDonell and Peterson 1989, 1990; Peterson and MacDonell 1991).

The purpose of the proposed remedial action is to establish appropriate responses for contaminated material at the chemical plant area, including cleanup standards for soil, and to identify an appropriate disposal decision for waste generated by all project cleanup activities.



Note: The boxes represent contaminated media addressed by the project's cleanup actions for the chemical plant area and the quarry, and they are connected by solid lines to the appropriate phase of site cleanup. Dashed lines identify waste stored at the chemical plant area as a result of the interim actions. The media for which specific treatment and disposal decisions will be made as part of the current remedial action are indicated by shading.

FIGURE 4 Components of Site Remediation

The purpose of this action is to minimize potential releases and human and environmental exposures to site contaminants by removing material from contaminated locations, treating it as appropriate, and disposing of it in an engineered facility with long-term controls. This material includes:

- Sludge and sediment from the raffinate pits and ponds, soil from scattered sitewide locations (e.g., at past dump and spill areas), and soil and sediment from localized off-site areas;

- Structural material — i.e., all debris associated with the site structures being dismantled (including building rubble, tanks, equipment, and asbestos) — in storage at the MSA;

- Solid material excavated from the quarry (including soil, sediment, rock, drums, building rubble and equipment, and vegetation) — in storage at the TSA; and

- Containerized process chemicals (including the wastes generated by the two water treatment plants) — in storage at the TSA and Building 434.

Specific cleanup decisions for the Southeast Drainage, groundwater at the chemical plant area, and residuals at the quarry (including groundwater, soil, and sediment in Femme Osage Slough) are not included in the scope of the current remedial action. Separate environmental documents will be prepared within the next several years to support decisions for those additional components of comprehensive site remediation. The various wastes that could be generated as a result of these future decisions are similar to those for which removal, treatment, and disposal decisions are being made as part of the current remedial action. Therefore, although the specific removal or treatment decision is outside the scope of this remedial action, contaminated material that could result from future cleanup actions has been included in the current disposal decision for planning purposes.

4 SUMMARY OF SITE RISKS AND PROPOSED CLEANUP CRITERIA

Potential impacts to humans, biota, and other environmental resources that might occur at the Weldon Spring site if it were not cleaned up were assessed as part of the evaluation process for determining an appropriate remedial action. For the human health assessment, risks were estimated to determine whether adverse health effects could result from repeated exposures to contaminants on-site or in nearby areas. For the ecological assessment, potential impacts to plants and animals that might result from biouptake were assessed by considering changes in parameters such as the types and numbers of species present, longevity, and biomass. For the other environmental resources, impacts that could occur to media such as groundwater and surface water in the absence of site cleanup were also assessed. The complete assessments for the site are presented in the BA (DOE 1992c) and the FS (DOE 1992d), and the key results are summarized in Sections 4.1 through 4.3.

The results of these assessments were used to achieve two main objectives: (1) to ensure that the major hazards remaining at the Weldon Spring site are factored into forthcoming cleanup decisions and (2) to develop cleanup levels for site soil, so risks from possible future exposures to residual contamination can be reduced to levels that are protective of human health and the environment. The soil cleanup levels proposed for the site are presented in Section 4.4; the process used to develop these criteria is discussed in detail in Chapter 2 of the FS. The final criteria will be selected after the public has had an opportunity to review and comment on the RI/FS-EIS, and these criteria will be documented in the ROD for this remedial action.

4.1 HUMAN HEALTH ASSESSMENT

Risks to human health that might result from various hypothetical exposures to site contaminants were estimated with standard methods that have been developed by the EPA and other agencies. Two types of health effects can result from exposures to radionuclides and chemicals: cancer and noncarcinogenic diseases, e.g., of the liver or kidney. To limit the likelihood of someone getting cancer from contamination at an NPL site, the EPA has established a range of from 1 in 1 million to 1 in 10,000 for the incremental lifetime risk of cancer associated with possible exposures (EPA 1990a). This range is referred to as the target range to provide a point of reference for the risk estimates presented in this section. It represents the increased probability (over the background cancer rate) that someone could get cancer during their lifetime if they were repeatedly exposed to contaminants at the Weldon Spring site.

To put this risk range in the context of the background cancer rate, it is estimated that about one in three Americans will develop cancer during their lifetime from all sources (American Cancer Society 1992) and that the risk from exposure to radiation naturally present in the environment is about 1 in 100, primarily from radon (EPA 1989a). Thus, the target range is a very small percentage of the cancer risk expected in the general U.S. population from everyday exposures. For example, the incremental risk targeted by the upper end of EPA's range means that if all persons in a population of 10,000 were assumed to be repeatedly exposed to site contaminants, one additional person might get cancer as a result of those exposures compared with the estimated 3,000 cancer cases expected from all other exposures; that is, the number of persons who would be expected to develop cancer in that population would be 3,001 instead of 3,000.

To address the possibility that someone could incur a disease other than cancer from contamination at an NPL site, the EPA has developed a measure called a hazard index. This index is determined by comparing the amount of a contaminant that someone might take in during exposures at a site with the dose that the scientific community considers safe or acceptable for that contaminant. If the hazard index exceeds 1, a noncarcinogenic health effect might result from the estimated exposure. This value is used as the point of reference for the results presented in this discussion.

For someone to be at risk for an adverse health effect from a contaminated site, the individual must be exposed to the waste at that site. To focus cleanup decisions for NPL sites, the EPA assumes that no institutional controls are in place and no cleanup action is taken. By this approach, the primary hazards can be identified and it can be determined whether someone who might enter the site could be at risk. Although these assumptions are very unrealistic for the Weldon Spring site, their sole intent is to ensure that the primary threats are identified and factored into the cleanup plans.

Several areas of the Weldon Spring site are highly contaminated — e.g., radioactive waste has been in the raffinate pits and the old process buildings since the plant was shut down 25 years ago — but DOE controls the site so people will not be exposed to the waste. For example, the site is fenced and guards patrol the gate so an individual cannot inadvertently walk into contaminated areas. In addition, DOE is making considerable progress with cleanup actions and will continue to maintain institutional controls such as access restrictions to ensure that the public is not at risk from exposure to site contaminants. Nevertheless, to provide a comprehensive analysis for the hypothetical no-action scenario, it was assumed that the site would not be cleaned up; and, for the analysis of hypothetical future conditions, it was assumed that no institutional controls would be in place to restrict access and subsequent exposures.

The site risk assessment was divided into several components to address possible exposures under different site conditions and over different time periods. The risk to an individual depends on the type of contamination to which that person is exposed and the total extent or length of exposure. Because several interim actions are under way at the site, the types of contamination to which someone could be exposed are changing. For example, the buildings are being dismantled and water will soon begin to be removed from the raffinate pits. Thus, although risks were estimated for these two major sources of potential health effects to satisfy the first objective of the assessment — i.e., to support remaining cleanup decisions (such as for sludge in the raffinate pits) — related threats are already known. Therefore, the major emphasis of the site risk assessment was to achieve the second objective — i.e., to support the development of cleanup levels for soil. To achieve this objective, various exposures were evaluated that concentrated on soil contaminants.

Different types of exposures could be associated with the site under the assumption of unrestricted access. For example, a hiker could regularly walk across the site and be exposed to soil and air for limited periods. On the other hand, if it were assumed that a person could live on-site in the future, that individual would have a greater extent of exposure and therefore a higher risk. These factors were addressed by considering different individuals with different types of exposures in the human health assessment.

In addition to contamination at the site, some locations outside the boundary of the chemical plant area are contaminated because of past spills or because contaminants have been carried into the adjacent wildlife areas over time (e.g., by water that drains from the site into nearby lakes after it rains). Possible health effects were also estimated for these localized areas to determine whether an individual might be impacted if that person were to repeatedly visit any one of the areas over time. These locations are referred to as off-site areas in this discussion to simplify the presentation and clarify the distinction between potential impacts estimated for the site proper and for the smaller areas nearby. Results were used to support cleanup decisions for those locations and to focus plans for collecting additional data (e.g., from the Southeast Drainage) in support of future decisions for areas not included in the current remedial action.

4.1.1 Baseline Site Configuration

Site conditions as of early 1992 were evaluated to identify potential health effects under the baseline configuration; this assessment is presented in the BA (DOE 1992c). Approximately 200 workers are currently at the Weldon Spring site, and public access is restricted. The public uses the surrounding wildlife areas for hiking, hunting, and fishing. Under these conditions, the individuals most likely to be exposed to contaminants at the site are a maintenance worker and a trespasser. The worker and trespasser would be exposed to contaminated soil and sitewide air. In addition, the trespasser could be exposed inside the buildings and at the raffinate pits if such a person were not aware of the hazards present at those areas. Exposures were also assessed for an individual who was assumed to swim in the raffinate pits.

In the future, if it were assumed that land use in the area remained the same but — for purposes of analysis — that DOE no longer controlled site access, the individual most likely to enter the site would be a recreational visitor. The possible exposures of a recreational visitor would be the same as those of a trespasser, except that the visitor would enter the area more frequently. Exposures were also assessed for a sportsman who was assumed to hunt on-site and ingest game animals from the site.

Some nearby areas have been contaminated by releases from the site, so the risk assessment also considered a recreational visitor at those areas. The areas are Lakes 34, 35, and 36 and Burgermeister Spring in the Busch Wildlife Area; the Southeast Drainage in the Weldon Spring Wildlife Area; and 10 other locations within the wildlife areas and on the adjacent Army property that contain contaminated soil and have been designated as soil vicinity properties. The recreational visitor was assumed to be exposed to contaminated surface water and soil or sediment at these areas. Exposures from fishing at the lakes were also assessed, assuming that the sportsman who hunts on-site could also fish at those lakes.

The results of the baseline assessment are presented in Table 2. When combined, the incremental radiological and chemical risks estimated for each of the hypothetical receptors from site exposures — the worker, trespasser, and future on-site recreational visitor — exceed the target range, i.e., the combined risks are greater than 1 in 10,000. For the worker, the estimated risk results primarily from inhalation of radon generated from radium in soil. However, it was assumed that the worker accessed all soil areas and a conservative estimate was used for the radium concentration in soil. A more realistic risk estimate for the worker would probably be lower because of the high bias in the data for radium in soil from which the radon concentrations were derived. In addition, a maintenance worker would not access highly contaminated areas because access to these areas is restricted. In fact, these results confirm the appropriateness of such access restrictions. The risks estimated for the trespasser and future on-site recreational visitor result almost entirely from exposures at the buildings and raffinate pits. (Because the buildings and raffinate pits represent contaminant sources that are not naturally present, all risks estimated for related exposures are considered incremental.) The hazard indexes for these two individuals are also greater than 1, indicating that such exposures could result in noncarcinogenic health effects. These results confirm the importance of restricting public access to these highly contaminated areas of the site.

The risks estimated for a recreational visitor at the off-site lakes and at Burgermeister Spring are within or below the target range for carcinogenic effects and the hazard indexes are less than 1 because the levels of contamination at these areas are generally very low. The incremental (and total) risks estimated for repeated exposures to radionuclides at one small vicinity property and at hot spots in the Southeast Drainage exceed the target range. These results confirm plans to (1) clean up that soil vicinity property (and others) as part of the current remedial action and (2) collect additional data from the Southeast Drainage to better characterize potential exposures in support of the cleanup decision that will be made for that location within the next several years. (The risk estimates for the Southeast Drainage in this assessment are preliminary because they were determined from data for the most highly contaminated areas and are therefore biased high. Potential risks will be reevaluated in an additional assessment that will use the expanded data from upcoming studies.) The health effects that could result from swimming in the off-site lakes or from ingesting fish and game are within or below the target range for carcinogenic effects, and the hazard indexes are less than 1.

The results of this baseline assessment indicate that the site does not currently pose a significant threat to human health as long as access to the contaminated areas is controlled. However, repeated uncontrolled exposures to certain areas associated with baseline conditions — such as the buildings and raffinate pits — could result in cancer risks or noncarcinogenic health effects that exceed EPA's target levels. Similarly, repeated exposures to localized hot spots at two off-site locations could result in risks above EPA's target range over time. This information was used to focus remaining decisions for site cleanup.

4.1.2 Interim Site Configuration

Several interim actions have already been approved for the project, and their completion will change the existing site conditions. These actions, which will be completed within the next

TABLE 2 Estimated Carcinogenic Risks and Hazard Indexes for the Baseline Site Configuration[a]

Receptor	Carcinogenic Risk: Radiological	Carcinogenic Risk: Chemical	Health Hazard Index for Noncarcinogenic Effects
Current On-Site Receptors			
Worker	Above target range	Within target range	Below 1
Trespasser	Within target range	Above target range	Above 1
Swimmer[b]	Above target range	Within target range	Below 1
Future On-Site Receptors			
Recreational visitor	Above target range	Above target range	Above 1
Sportsman	Within target range	Within target range	Below 1
Off-Site Receptors[c]			
Recreational visitor			
Lakes 34, 35, and 36	Within target range	Within target range	Below 1
Burgermeister Spring	Within target range	Below target range	Below 1
Southeast Drainage	Above target range	Within target range	Below 1
Soil vicinity property	Below to above target range[d]	NQ[e]	NQ
Swimmer	Below target range	Below target range	Below 1
Sportsman	Within target range	Within target range	Below 1

[a] Site conditions as of early 1992 were evaluated for the baseline configuration, assuming access restrictions were in place for current receptors and access was unrestricted for future receptors. Estimated risks are reported relative to EPA's range of 1 in 1 million to 1 in 10,000. When the total radiological or chemical risk (i.e., the risk including background) was within or below the target range, e.g., for the off-site lakes, no increment was determined; when the estimated total risk exceeded the range, e.g., for on-site exposures, the incremental risk was determined and is reflected in this table.

[b] The current on-site swimmer also represents a future swimmer, and it was assumed that the individual would swim over a period of 10 years in either case.

[c] Current conditions were assumed to represent future conditions for the off-site areas. For the recreational visitor, it was assumed that the entire exposure (i.e., 600 four-hour visits) would occur at each individual location.

[d] The radiological risks associated with exposures at each of the 10 vicinity properties are within or below the target range, except for one small (0.16-ha [0.4-acre]) property just south of the adjacent Army land.

[e] NQ means not quantified because chemical data were not available.

several years, include dismantling the chemical plant buildings and removing and treating the surface water from the raffinate pits. Therefore, an additional risk assessment was conducted to address new site conditions that will result from the interim actions. This transitional assessment is presented in Appendix E of the FS (DOE 1992d).

In general, risks estimated for the same individuals evaluated under the baseline configuration would be similar under the interim site configuration; an exception would be the trespasser, for whom the risks would be lower. (The risks associated with the buildings would no longer occur, and the presence of remedial action workers on-site for the interim actions would reduce the likelihood of trespassing at the new treatment and storage facilities.) For the future case under which site access is assumed to be unrestricted, exposures for a recreational visitor associated with the new facilities would generally offset exposures that would no longer occur. For example, the additional exposures to the waste excavated from the quarry and stored on-site (pending the forthcoming disposal decision) would be offset by the absence of exposures inside the buildings.

The results of this assessment indicate that the interim actions have improved site conditions, but if cleanup were halted now instead of continuing through completion, the future risks could be similar to those under baseline conditions. Therefore, this assessment emphasizes the need for remaining cleanup decisions to permanently address the material that will be stored on-site until the comprehensive disposal decision is made.

4.1.3 Modified Site Configuration

Risks were also estimated for the site under extended future conditions, e.g., after 100 years, to address the possibility that local land use could change and unrestricted access could result in additional types of exposures. For this assessment, both recreational and residential land uses were evaluated by estimating potential health effects for a recreational visitor, ranger, resident, and farmer. The primary objective of this evaluation was to support the development of cleanup criteria for site soil. Therefore, a modified site configuration was defined for this evaluation, which focused only on soil areas and did not include the raffinate pits, buildings, or temporary facilities associated with interim actions that are already under way. (Risks associated with these other areas were already evaluated as part of the assessments for the baseline and interim site conditions, and they would not be present as such under realistic assumptions for recreational or residential use in the long-term future.) This focused (rebaseline) assessment is presented in Appendix E of the FS (DOE 1992d).

Each of the four individuals evaluated for this assessment could be exposed to soil and air, but the conditions and durations of exposure would differ. The farmer could also eat homegrown food from the site. To address the possible exposures of a resident or farmer from ingestion of drinking water, a preliminary analysis was conducted for groundwater as part of this focused assessment. However, this analysis is preliminary because current groundwater data are limited; additional data will be collected over the next several years to support forthcoming decisions for the groundwater operable unit of the site, and a comprehensive assessment of related exposures will be developed at that time.

The results of the focused assessment are presented in Table 3. The carcinogenic risks from exposures of a recreational visitor to soil and air are within the target risk range, and the hazard index is less than 1. The incremental risks from exposures to radionuclides are greater than the target range for the ranger and farmer, as well as for the resident at many locations, and inhalation of radon generated from radium in soil is the major contributor. (The radiological risks estimated with the same assumptions for these receptors at a background location are 2×10^{-5} for the recreational visitor, 5×10^{-4} for the ranger, and 3×10^{-3} for the resident and farmer.) For the resident, the incremental risk from exposure to chemical contaminants is greater than the target range and the hazard index exceeds 1 at scattered locations across the site; at most locations, the incremental (and total) risk is within the target range and the hazard index is less than 1.

TABLE 3 Estimated Carcinogenic Risks and Hazard Indexes for the Modified Site Configuration[a]

Receptor	Carcinogenic Risk: Radiological	Carcinogenic Risk: Chemical	Health Hazard Index for Noncarcinogenic Effects
Recreational visitor[b]	Within target range	Within target range	Below 1
Ranger	Above target range[c]	Within target range	Below 1
Resident	From within to above target range[d]	From within to above target range[e]	From below 1 to above 1[f]
Farmer	Above target range	Within target range	Above 1

[a] The modified site configuration evaluated for the focused assessment included all soil areas but not other potential sources of exposure (such as the raffinate pits or new facilities) that had already been assessed as part of the baseline and interim (transitional) analyses. Estimated risks are reported relative to EPA's range of 1 in 1 million to 1 in 10,000. When the estimated total radiological or chemical risk (i.e., the risk including background) was within the target range, e.g., for the recreational visitor, no increment was determined; when the estimated total risk exceeded the range, e.g., for on-site exposures, the incremental risk was determined and is reflected in this table.

[b] The combined radiological and chemical risk estimated for the recreational visitor is also within the target range.

[c] The incremental (and total) risk estimated for the ranger from outdoor exposures exceeds the target range on the basis of a conservative estimate for sitewide radium in soil.

[d] The incremental risk estimated for the resident exceeds the target range at about 50% of the site soil areas.

[e] The incremental (and total) chemical risk estimated for the resident exceeds the target range at less than 5% of the site soil areas.

[f] The estimated hazard index exceeds 1 at less than 5% of the site soil areas.

At many areas of the site, the risks estimated for drinking water from a well in the shallow (Burlington-Keokuk Limestone) aquifer exceed the target range and the hazard index exceeds 1. However, no drinking water wells are currently completed in this aquifer either on-site or in the immediate vicinity. (The deeper aquifer, for which contamination is not indicated from current data, is the productive aquifer in this area.) This analysis is preliminary because current data are limited. The additional data being collected for groundwater at the site will be used to address potential exposures in more detail in documents to be prepared for the groundwater operable unit within the next several years.

Finally, the evaluation of potential health effects for a farmer from ingesting homegrown food indicates that the incremental radiological risk (but not the chemical risk) exceeds the target range and the hazard index exceeds 1. Considerable limitations and uncertainties exist in the data and methodologies available for estimating health effects from the ingestion of homegrown food, and the results for nonradiological exposures via this pathway are comparable to those estimated with the same assumptions for an off-site background location.

The results of the focused assessment, which addressed exposures related to soil and air under possible future recreational or residential use of the site, indicate that exposures of a hypothetical ranger, resident, or farmer at certain locations could result in carcinogenic risks or noncarcinogenic health effects that exceed EPA's target levels, whereas health effects estimated for a recreational visitor would be within or below the target levels. This information was incorporated into the development of cleanup criteria for site soil (Section 4.4).

4.2 ECOLOGICAL ASSESSMENT

The Weldon Spring site is adjacent to two state wildlife areas and near a third, and more than 200 species of plants and animals are expected to occur on-site. Several species listed by the state and/or federal government as threatened or endangered have been identified for the general area. These species have not been reported at the site from the studies conducted to date, although the pied-billed grebe, a state rare species, has been observed at the raffinate pits.

At scattered soil locations, elevated levels of naturally occurring metals such as arsenic, cadmium, copper, lead, mercury, uranium, and zinc could potentially impact certain biota (i.e., invertebrates). If exposure to the maximum measured on-site concentrations of these metals is assumed, possible ecological effects reported in the scientific literature include decreases in the diversity, density, and biomass of invertebrate species. This information was incorporated into the development of cleanup criteria for site soil. No adverse ecological impacts are associated with either the radionuclides or chemicals in soil at the cleanup levels developed for the site on the basis of the human health assessment (Section 4.4).

Under baseline conditions, certain contaminants present in surface water in the raffinate pits exceed either water quality criteria established by the EPA and/or the state of Missouri or concentrations reported in the scientific literature to adversely impact biota. For example, levels of arsenic, beryllium, cadmium, chromium, copper, lead, mercury, selenium, silver, uranium, fluoride, and nitrate could pose a threat to aquatic and semiaquatic biota. Selenium is present at concentrations exceeding those shown to adversely affect waterfowl. Furthermore, because selenium bioconcentrates, it could pose a hazard to wildlife species higher in the food chain. This information confirms the previous decision to remove and treat the contaminated surface water from the pits as an interim action; it also supports plans to address the remaining waste (raffinate pit sludge), which serves as the source of the water contamination, as part of the current remedial action.

For off-site surface water, the maximum concentrations measured for nitrate in the Southeast Drainage and Burgermeister Spring exceed the level that poses a potential for adverse impacts to aquatic biota, as indicated by the EPA. Similarly, the maximum concentrations measured for arsenic, lead, mercury, and silver exceed water quality criteria for protection of freshwater biota. Although the maximum measured concentration of uranium in the Southeast Drainage exceeds levels shown to be toxic to *Daphnia* (water fleas), estimates of related exposures do not exceed the 1 rad/d dose limit for protection of aquatic biota. However, uranium metal is also chemotoxic to animals, and the elevated concentrations reported for certain sediment locations and in water at certain locations during the periods of intermittent flow could potentially pose a threat to aquatic biota at the confluence of the drainage with the Missouri River if no mixing were to occur. The concentrations of other metals and radioactive contaminants are sufficiently low that no threats to biota are anticipated. (For the off-site surface water, only elevated levels of radionuclides are directly associated with the site. Site runoff contributes only a fraction of the flow in the drainage areas for the off-site lakes and streams. For example, these areas also receive runoff from the Army property adjacent to the site and from local agricultural land.)

Certain contaminant levels in the drainage have decreased from the maximum concentrations evaluated in this assessment; these decreases have resulted from natural attenuation and specific source control measures that have been implemented as part of interim actions at the site (including surface runoff controls). The information from this assessment confirms the plans to collect additional data from the Southeast Drainage to support final decisions for that location, which will be made within the next several years; these decisions will evaluate the potential adverse impacts associated with environmental disturbance in the drainage relative to the potential benefits associated with the cleanup measures being considered.

No obvious adverse ecological impacts have been observed to date at the site or surrounding areas, except for circumstantial evidence (the paucity of biota) at the raffinate pits. However, adverse ecological impacts might occur if the site were not cleaned up and contaminants remained in their current state, particularly at the raffinate pits. The results of this assessment were used to focus remaining decisions for site cleanup, e.g., for sludge in the raffinate pits.

4.3 OTHER ENVIRONMENTAL RESOURCES

In addition to the ecological assessment, potential impacts to other environmental resources in the absence of remedial action at the site were also assessed. On the basis of current site information, no significant adverse impacts to other environmental resources are expected to result from a continuation of current conditions, with the possible exception of groundwater. Additional studies to further characterize the nature and extent of groundwater contamination are under way and will be incorporated into documentation to be prepared within the next several years in support of the decision for site groundwater.

4.4 SOIL CLEANUP CRITERIA

Cleanup criteria for the key contaminants in soil at the Weldon Spring site were developed from available environmental standards and guidelines and results of the site-specific risk assessments. In addition, a preliminary site-specific analysis was conducted to assess the reduction of residual risks to levels as low as reasonably achievable (ALARA), as described in Chapter 2 of the FS. Final soil remediation levels will be identified in the ROD for this cleanup action. Those final levels will be determined from the remedy selected for the site, coupled with a consideration of future land uses. Land use will be affected by the disposal decision (i.e., on-site or off-site) and by the residual levels of soil contamination that can practicably be achieved. The ability to reduce these residual concentrations is limited by the natural occurrence of the key radionuclides and chemicals in soil, with related constraints for technology and cost.

4.4.1 Methodology for Developing the Criteria

A staged approach was used to develop cleanup criteria for soil at the Weldon Spring site. In the first stage, environmental regulations were reviewed to identify potentially applicable or relevant and appropriate requirements (ARARs), and additional (nonpromulgated) criteria were also reviewed to determine whether other sources of information may be pertinent to the development of soil remediation levels. The pertinent standards and guidelines that were identified from this review are described in Section 2.2 of the FS (DOE 1992d).

The cleanup targets for radionuclides were determined from EPA standards in combination with DOE Orders. The ALARA goals were determined in accordance with the DOE process from a site-specific analysis that evaluated the practicability of further reducing residual levels, considering background concentrations for the radionuclides in local soil. These goals represent the soil concentrations that excavation activities would aim to achieve in the field. A similar process was followed for the chemical contaminants, although fewer general environmental standards were available to use as the starting point for defining the cleanup targets. Therefore, the chemical criteria were developed primarily on the basis of the risk assessment results, with application of the ALARA process for further consideration in the field, in the context of the levels of naturally occurring chemicals in local soil that would be used as backfill for areas excavated on-site. The Missouri Department of Health (1992) recently proposed levels for chemicals in soil in residential areas, and these levels were also considered in developing the cleanup criteria for site soil.

In the second stage of the process, the results of the risk assessment were reviewed to incorporate site-specific information into the development of the criteria. Several hypothetical receptors were evaluated in the different risk assessments prepared for the site to address various scenarios of current and future use. A focused assessment was prepared to estimate potential health effects for several receptors from exposures to soil contaminants; the results of this assessment (presented in Appendix E of the FS) served as the primary source of information for this stage of criteria development.

Soil contamination at the Weldon Spring site is heterogeneous, i.e., different contaminants are present together at different locations; thus, the combined risks and the criteria applied for individual contaminants can differ by location. Similarly, the application of ALARA could potentially vary by location depending on the specific contaminants present. In areas where certain compounds are present but radionuclides are not elevated above background, the cleanup criteria for chemicals could be lower than at radioactively contaminated areas because reducing the concentrations of these chemicals in soil could reduce the incremental and total location-specific risk. In addition, where a contaminant may exert both a carcinogenic and a noncarcinogenic effect (e.g., for arsenic or uranium), the target level developed for one health effect may or may not be protective for the other. These considerations were factored into the development of soil cleanup criteria by considering the results of the risk assessments for both location-specific and sitewide exposures.

The cleanup criteria were developed separately for the radionuclides and chemicals, although some overlap did exist (e.g., for uranium). This approach — whereby chemical carcinogens are addressed separately to reduce risks to protective levels considering EPA's target range — is extremely conservative because radionuclides represent the limiting factor in risk reduction for the site. That is, reducing chemical risks will have no measurable effect on the combined risk at most site locations because this combined risk would be dominated by the radiological component in almost all cases (as indicated by the risks estimated for exposures to background levels of radionuclides). Nevertheless, this approach is expected to result in the lowest levels reasonably achievable for all site contaminants.

To provide some perspective for the following discussion, the process EPA follows to make risk management decisions for NPL sites is presented here. As part of cleanup at NPL Superfund sites, the EPA strives to manage possible incremental cancer risks within a target range of 1×10^{-6} to 1×10^{-4}, with the former generally serving as the point of departure. For sites where the estimated incremental risk is less than 1×10^{-4} and the hazard index is less than 1, action is usually not warranted. Furthermore, although the upper end of the target range is generally used to make a risk management decision to determine whether a remedial action is necessary or warranted, the EPA does not consider 1×10^{-4} a discrete limit; that is, risks above that level may be considered acceptable on the basis of site-specific conditions (EPA 1991). For example, the presence of radionuclides at the Weldon Spring site represents a somewhat unique condition compared with typical Superfund sites for which the target range was originally developed. In addition, factors other than the results of the site-specific risk assessment are used to make the final risk management decision — including the conservative assumptions applied to estimate risks from possible exposures at the site and other health-based guidance available for certain contaminants. These considerations were incorporated into the development of soil cleanup criteria for the Weldon Spring site. As an example, the proposed criteria for radium were developed from site-specific conditions regarding the background concentration in local soil and estimates of the radon levels that could be generated from residual radium under different scenarios, in combination with the health-based level EPA considers acceptable for radon.

4.4.2 Results

The cleanup criteria proposed for the Weldon Spring site consist of different values (alternatives) associated with each key contaminant, with cleanup levels ranging between a target and an ALARA goal. Results of the radiological and chemical assessments for various hypothetical receptors are presented in Tables 4 and 5, respectively. The cleanup targets listed in these tables represent the total concentrations (i.e., including background) above which site soil would be removed; the ALARA goals represent the concentrations that the remedial action would aim to achieve during field excavation activities. The concentrations of radioactive and chemical contaminants in soil that correspond to different target levels of risks and hazard indexes were also calculated as part of the development of cleanup criteria (see Chapter 2 of the FS). These combined analyses provide information from which the final remediation levels for soil contaminants will be selected and applied, in combination with ARARs, as indicated by the cleanup remedy for the site.

Excavating soil to meet the cleanup targets and ALARA goals for chemicals at the site would result in an incremental chemical risk at or below EPA's target range for all scenarios, and the hazard index would be well below the level of concern. However, this is not the case for the radiological cleanup criteria because incremental radiological risks exceed the target range at certain locations under a residential scenario. Therefore, an additional "post-cleanup" assessment was conducted for the radionuclides. For this assessment, areas with soil concentrations that exceed the ALARA goals were assumed to be excavated and backfilled with uncontaminated soil from a nearby background area. The results of this evaluation were also used to assess compliance with environmental standards and guidelines.

Results indicate that the incremental radiological risk for the resident following soil excavation and backfill would range from 0 (i.e., background) to 6×10^{-3}, with a median of 8×10^{-6} across the site. Locations at which the risk would exceed 1×10^{-4} are generally those areas at which the radium concentration in soil slightly exceeds the background concentration of 1.2 pCi/g; a small increment of 0.075 pCi/g corresponds to a risk of 1×10^{-4}. This indicates the difficulty associated with meeting EPA's target risk range for a residential scenario at the site. In addition, an annual dose of 25 mrem/yr above background could not be achieved for residential use at about 10% of the soil areas. The elevated risk estimates for those areas result almost entirely from exposures to the estimated levels of indoor radon, which would be generated by the residual radium in soil (entering through the basement or foundation slab). However, the target risk range was not specifically developed on the basis of exposures to radionuclides, and the EPA has separately identified an acceptable level for indoor radon of 4 pCi/L (EPA 1992). The indoor radon concentrations associated with the cleanup target and goal for radium is expected to be at or below this level at all site locations.

TABLE 4 Estimated Radiological Risks for the Recreational Visitor, Ranger, and Resident Associated with the Proposed Cleanup Criteria

Radionuclide/ Criterion[a]	Soil Concentration (pCi/g)[b]	Risk to Hypothetical Receptor: Recreational Visitor	Ranger	Resident
Radium-226				
Cleanup target	6.2	5×10^{-5}	8×10^{-4}	2×10^{-2}
ALARA goal	5	4×10^{-5}	6×10^{-4}	8×10^{-3}
Background	1.2	9×10^{-6}	2×10^{-4}	2×10^{-3}
Radium-228				
Cleanup target	6.2	2×10^{-5}	2×10^{-4}	1×10^{-3}
ALARA goal	5	1×10^{-5}	2×10^{-4}	8×10^{-4}
Background	1.2	3×10^{-6}	5×10^{-5}	2×10^{-4}
Thorium-230				
Cleanup target	6.2	3×10^{-7}	4×10^{-6}	8×10^{-6}
ALARA goal	5	2×10^{-7}	3×10^{-6}	6×10^{-6}
Background	1.2	6×10^{-8}	8×10^{-7}	2×10^{-6}
Thorium-232				
Cleanup target	6.2	2×10^{-6}	2×10^{-5}	4×10^{-5}
ALARA goal	5	1×10^{-6}	2×10^{-5}	3×10^{-5}
Background	1.2	3×10^{-7}	4×10^{-6}	7×10^{-6}
Uranium-238				
Cleanup target	120	2×10^{-5}	2×10^{-4}	5×10^{-4}
ALARA goal	30	4×10^{-6}	5×10^{-5}	1×10^{-4}
Background	1.2	2×10^{-7}	3×10^{-6}	8×10^{-6}

[a] The radiological risks associated with all radionuclides in the uranium-238, uranium-235, and thorium-232 decay series were included in the human health assessments. Cleanup criteria were developed for the five radionuclides listed in this table on the basis of a site-specific analysis of the relative concentrations of radionuclides present in site soil. The contributions of the other radionuclides in the three decay series are incorporated into the risk estimates reported for these five radionuclides, as described in Chapter 2 of the FS. Data for local background is presented for comparison; the background soil concentration of 1.2 pCi/g represents the average concentration measured for each of the listed radionuclides at off-site locations that have not been affected by site releases.

[b] The cleanup targets for radium and thorium represent the surface concentrations; the subsurface concentration is 16.2 pCi/g. The ALARA goal of 5 pCi/g for radium and thorium applies to both surface and subsurface contamination. The listed cleanup targets and ALARA goals include the background concentration of 1.2 pCi/g.

TABLE 5 Estimated Chemical Health Effects for the Recreational Visitor, Ranger, and Resident Associated with the Proposed Cleanup Criteria

Chemical/ Criterion[a]	Soil Concentration (mg/kg)	Risk			Hazard Quotient[b]		
		Recreational Visitor	Ranger	Resident	Recreational Visitor	Ranger	Resident
Metals[c]							
Arsenic							
Cleanup target	75	6×10^{-6}	7×10^{-5}	2×10^{-4}	0.02	0.3	0.9
ALARA goal	45	3×10^{-6}	3×10^{-5}	1×10^{-4}	0.01	0.2	0.5
Background	26	2×10^{-6}	2×10^{-5}	7×10^{-5}	0.008	0.1	0.3
Chromium (total)							
Cleanup target	110	NA[d]	NA	NA	0.03	0.6	1
ALARA goal	90	NA	NA	NA	0.02	0.4	0.8
Background	36	NA	NA	NA	0.01	0.1	0.3
Chromium (VI)							
Cleanup target	100	3×10^{-7}	6×10^{-6}	1×10^{-5}	0.03	0.6	1
ALARA goal	90	3×10^{-7}	5×10^{-6}	9×10^{-6}	0.02	0.4	0.8
Thallium							
Cleanup target	20	NA	NA	NA	0.03	0.3	1
ALARA goal	16	NA	NA	NA	0.02	0.3	0.8
Background	16	NA	NA	NA	0.02	0.3	0.8
PAHs[e]							
Cleanup target	5.6	3×10^{-6}	3×10^{-5}	1×10^{-4}	0.00002	0.0002	0.0007
ALARA goal	0.44	2×10^{-7}	2×10^{-6}	8×10^{-6}	0.000001	0.00002	0.00005
PCBs[f]							
Cleanup target	8	2×10^{-6}	3×10^{-5}	1×10^{-4}	0.008	0.09	0.3
ALARA goal	0.65	2×10^{-7}	2×10^{-6}	8×10^{-6}	0.0006	0.008	0.02

TABLE 5 (Cont.)

Chemical/ Criterion[a]	Soil Concentration (mg/kg)	Risk			Hazard Quotient[b]		
		Recreational Visitor	Ranger	Resident	Recreational Visitor	Ranger	Resident
Nitroaromatic compounds[g]							
DNB							
Cleanup target	25	NA	NA	NA	0.02	0.3	0.9
ALARA goal	5.6	NA	NA	NA	0.005	0.07	0.2
2,4-DNT							
Cleanup target	55	2×10^{-6}	2×10^{-5}	6×10^{-5}	0.03	0.3	1
ALARA goal	7.4	2×10^{-7}	3×10^{-6}	8×10^{-6}	0.003	0.04	0.1
2,6-DNT							
Cleanup target	94	3×10^{-6}	3×10^{-5}	1×10^{-4}	0.002	0.03	0.06
ALARA goal	7.4	2×10^{-7}	3×10^{-6}	8×10^{-6}	0.0002	0.002	0.007
NB							
Cleanup target	140	NA	NA	NA	0.03	0.3	1
ALARA goal	28	NA	NA	NA	0.005	0.06	0.2
TNB							
Cleanup target	14	NA	NA	NA	0.03	0.3	1
ALARA goal	10	NA	NA	NA	0.02	0.2	0.7
TNT							
Cleanup target	140	2×10^{-7}	2×10^{-6}	7×10^{-6}	0.03	0.3	1
ALARA goal	14	2×10^{-8}	2×10^{-7}	7×10^{-7}	0.003	0.03	0.1

See next page for footnotes.

TABLE 5 (Cont.)

[a] The listed criteria are for surface soil and include background; criteria for subsurface soil are 10 times the listed value. Data for local background are presented for comparison and to permit a determination of incremental risk for the listed criteria (for example, the incremental risk for the resident that corresponds to the arsenic cleanup target is 1×10^{-4}). For metals, the listed concentration represents the upper bound concentration (mean plus two standard deviations) measured at a nearby off-site area; no background concentration is listed for chromium (VI) because the soil samples were analyzed for total chromium (hexavalent chromium was assumed to be 10% of total chromium on the basis of limited site-specific data and general environmental data). No background concentration is listed for the organic compounds because they are not naturally present in soil. The cleanup targets were determined from the site-specific risk assessment. Most ALARA goals are the levels recently proposed for statewide consideration by the Missouri Department of Health (1992) for soil in residential settings; exceptions are chromium, arsenic, thallium, and trinitrobenzene (TNB) — for which the goals were determined from the site-specific risk assessment. For chromium, the concentrations in site soil are not expected to approach the state-proposed levels of 5,600 and 280 mg/kg for total and hexavalent chromium, respectively. The state-proposed levels for arsenic and thallium are 11 and 3.9 mg/kg, respectively, which are considerably below the local background concentrations; no level was proposed for TNB.

[b] The hazard quotient shown for each contaminant represents the sum of the contributions from the inhalation and ingestion pathways, where appropriate.

[c] Lead is not shown in this table because an EPA value is not available from which to quantify the risk or hazard quotient. The cleanup target is 450 mg/kg, as determined by applying site-specific input to EPA's model; the ALARA goal is 240 mg/kg, which is the general level proposed by the Missouri Department of Health (1992).

[d] NA indicates that the entry is not applicable because the contaminant is not a carcinogen.

[e] The carcinogenic PAHs detected at the Weldon Spring site are benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, and indeno(1,2,3-cd)pyrene. The listed concentration represents the objective for each individual compound; where present together, the individual concentrations would be adjusted accordingly.

[f] Aroclor 1248, Aroclor 1254, and Aroclor 1260.

[g] Notation: DNB, dinitrobenzene; 2,4-DNT, 2,4-dinitrotoluene; 2,6-DNT, 2,6-dinitrotoluene; NB, nitrobenzene; TNB, trinitrobenzene; TNT, trinitrotoluene.

For outdoor air, the incremental radon concentration is estimated to be less than 0.1 pCi/L, and the annual dose from inhalation of airborne particulates generated from site soil is estimated to be less 10 mrem/yr at all locations. Hence, standards for the radiological dose from exposure to outdoor air would be met by the cleanup targets for site soil. Potential leaching to groundwater for radionuclides from soil was also assessed for post-remedial action conditions to provide an initial indication of the potential impact to future receptors in the event that groundwater in the shallow aquifer at the site was used for drinking. The results indicate that the proposed cleanup targets for soil are expected to be protective of groundwater.

The incremental risk estimated for the ranger from sitewide exposures following remediation varies from 2×10^{-5} to 2×10^{-4}, with a median of 2×10^{-5} (the median and low end of the range are the same because outdoor exposures from sitewide activities dominate the combined risk from indoor and outdoor exposures for this hypothetical receptor at most locations). For the recreational visitor, the incremental risk is estimated to be 7×10^{-6}. Thus, incremental radiological risks associated with future recreational land use at the site are within the target range.

4.4.3 Conclusions

The cleanup levels proposed for soil at the Weldon Spring site would be protective of human health and the environment under a range of possible future uses. For all contaminants except radium, the cleanup levels would result in incremental risks at or below EPA's target range. For radium, the incremental risk would exceed the target range for those scenarios that include indoor exposures because of the risk from estimated concentrations of indoor radon that would be generated by the residual radium in soil. However, the target risk range was not specifically developed on the basis of exposures to radionuclides, and the EPA has separately identified an acceptable level for indoor radon of 4 pCi/L (EPA 1992). The radium cleanup level for the site is expected to result in an indoor radon concentration at or below this acceptable level at all locations.

The information presented in Chapter 2 of the FS provides the means for applying appropriate flexibility for individual contaminants at given locations while ensuring that overall protectiveness is maintained. One of the key objectives of the site-specific development of cleanup criteria was to address contaminant heterogeneity. That is, because the contaminants contributing significantly to health effects near or above target levels are not present together at all locations, the most restrictive combination of levels selected for individual contaminants need not be applied across the entire site to ensure protectiveness. Thus, adjustments can be made for specific locations at which several such contaminants are present together by combining the appropriate information from the tables in Chapter 2 of the FS.

It is possible that different land uses could be associated with different areas of the Weldon Spring site in the future under any of the final alternatives. For those final alternatives under which the waste would be disposed of on-site, neither recreational nor residential scenarios would apply to a determination of residual soil contaminant levels in the disposal area for two reasons. First, surface and subsurface soil would be excavated from this area to construct the cell, and the new surface soil to which someone could be exposed would be the uncontaminated soil of the cell cover. Second, contaminants in subsurface soil beneath the disposal cell would be isolated from possible future migration because the cell would serve as the equivalent of an engineered multilayer cap, with the liner and compacted subgrade components acting to limit the potential for leaching of any subsurface material to groundwater. However, the cleanup criteria for site soil outside the disposal area could be determined from an assumption of future recreational or residential use.

For the alternatives under which waste would be disposed of off-site, recreational or residential scenarios might be reasonable for any area of the site in the extended future. The potential for adverse impacts from the levels proposed for residual contamination at the Weldon Spring site, including consideration of migration to groundwater, is expected to be low for all scenarios. Thus, it is expected that the proposed remediation of this site could result in the release of property for other uses, as appropriate to the remedy selected.

5 SUMMARY OF ALTERNATIVES

Alternative remedial actions for the site were developed as part of the FS (DOE 1992d) by identifying remedial technologies and process options that are potentially applicable to the various contaminated media associated with the site. Potentially applicable technologies were incorporated into seven preliminary alternatives, and these alternatives were screened on the basis of effectiveness, implementability, and cost. From the screening analysis of the preliminary alternatives, the following final alternatives were retained for detailed evaluation:

- Alternative 1: No Action;
- Alternative 6a: Removal, Chemical Stabilization/Solidification, and Disposal On-Site;
- Alternative 7a: Removal, Vitrification, and Disposal On-Site,
- Alternative 7b: Removal, Vitrification, and Disposal at the Envirocare Facility; and
- Alternative 7c: Removal, Vitrification, and Disposal at the Hanford Facility.

These alternatives are described in Sections 5.1 through 5.5 on the basis of preliminary conceptual engineering information. The no-action alternative was retained for this evaluation in accordance with the CERCLA and NEPA processes to provide a baseline for comparison with the final action alternatives.

The technology process options discussed herein (e.g., for chemical stabilization/ solidification and vitrification) are considered representative of the general technologies that define the alternatives. The actual processes that would be applied for site cleanup activities would be determined as part of the detailed design stage for this remedial action, after the remedy is selected. Similarly, other representative components that have been evaluated for this analysis, such as the types of equipment and material and the treatment rates, would be specified as part of detailed design. The major regulatory requirements associated with each of these alternatives are discussed in Section 6.2.2.

5.1 ALTERNATIVE 1: NO ACTION

Under Alternative 1, no further action would be taken at the site. Certain interim response actions for which decisions have already been finalized were assumed to be in effect, as follows: (1) the bulk waste excavated from the quarry would be in short-term storage at the TSA, (2) the water treatment plants at the quarry and the chemical plant area would be operational, (3) the buildings and other structures would be dismantled and the resulting material would be in short-term storage at the MSA debris staging area and asbestos container staging area, and (4) the containerized chemicals would remain in storage at Building 434.

Contaminated soil, sludge, and sediment would remain as for current conditions, with continued potential for off-site releases during the short term and into the future. Site ownership, access restrictions, and monitoring would continue into the foreseeable future. Annual costs to maintain the site under this alternative are estimated to be about $1.2 million, with increases likely to address contamination that might be released in the absence of further source control or migration control measures.

5.2 ALTERNATIVE 6a: REMOVAL, CHEMICAL STABILIZATION/ SOLIDIFICATION, AND DISPOSAL ON-SITE

Under Alternative 6a, about 675,000 m^3 (883,000 yd^3) of contaminated sludge, soil, sediment, structural material, vegetation, and process waste from the water treatment plants would be removed from the source areas and on-site storage areas; approximately 342,000 m^3 (447,000 yd^3) of that material would be treated by chemical stabilization/solidification or volume reduction, as appropriate; and about 772,000 m^3 (1,010,000 yd^3) of treated and untreated material would be placed in an engineered disposal facility on-site.

It is expected that the remedial action activities could be completed within about 10 years after the ROD for this action. About 1 year would be required for pilot-scale testing; 3.5 to 4.5 years for design, construction, and start-up; and 4.5 years for operating the chemical stabilization/solidification facility. Construction and operation of the disposal cell would require about 6.5 years. (Some of these activities would overlap.) Releases would be controlled with engineering and mitigative measures; and groundwater, surface water, and air would be monitored at the site and at specific off-site areas throughout the cleanup and maintenance period to address protectiveness of the general public and the environment. Because waste would remain on-site under this alternative (in the disposal cell), DOE would review the effectiveness of the remedy every 5 years in accordance with CERCLA, as amended.

Treatment would be used as a principal element of the response, primarily to reduce (1) the mobility of contaminants in raffinate pit sludge, process waste, and certain soil and (2) the volume of contaminated debris, e.g., by chipping and composting wooden debris. The addition of chemical stabilizing and solidifying agents to the material being treated would increase its final volume. The toxicity of radiation from the site waste would not be affected by chemical stabilization/solidification (or any other treatment method). Standard equipment and readily available resources would be used to implement Alternative 6a, and the total cost is estimated to be about $157 million. The representative technical components of this alternative are described in the following paragraphs.

Standard construction equipment and procedures would be used to remove contaminated sludge and soil from the raffinate pits; sediment from ponds and lakes; solid material (including structural material and debris, process equipment, rock, vegetation, and soil) from the MSA and TSA; underground pipes; and soil from dump areas, scattered locations across the site, and vicinity properties. Good engineering practices and other mitigative measures would be applied to minimize potential releases; for example, the size of the area being disturbed would be minimized and erodible material would be misted with water during excavation and transport.

Sludge would be removed from the raffinate pits with a dredge suspended on the ponded water and then pumped as a slurry to an adjacent treatment facility. (Although much of the surface water in these pits would have previously been removed and treated under a separate action, a small amount of water would be left in the pits to cover the raffinate pit sludge to prevent radon and particulate emissions.) After the sludge had been removed, the more highly contaminated soil forming the berms and pit bottoms would be removed with conventional earth-moving equipment (such as bulldozers and front-end loaders) and transported by truck to the treatment facility. Similar equipment would be used to excavate sediment from other surface water impoundments, after the water was removed, and to excavate soil from across the site and vicinity properties. The excavated material not targeted for treatment would be transported by truck directly to the disposal cell.

Structural material, debris, and soil from the MSA and TSA would be removed and transported to the appropriate treatment facility or the disposal cell. In addition, a mobile chipper would be used intermittently to reduce the volume of woody material at the site; the resultant chips would be composted on-site to reduce the waste volume. Containerized process chemicals stored in Building 434 would be either transported off-site to a permitted incinerator (e.g., the liquids) or treated in the on-site sludge processing facility with a designated "best demonstrated available technology," such as chemical neutralization or stabilization.

Excavated areas would be backfilled with clean soil material, regraded to natural contours matching the surrounding topography, and vegetated to support final site restoration. Much of the backfill could be obtained nearby, e.g., from a 61-ha (150-acre) parcel of land owned by the Missouri Department of Conservation that is located across State Route 94 from Francis Howell High School. Additional fill such as gravel, sand, and topsoil would be obtained from local vendors.

Two new facilities would be constructed on-site to support this alternative, one for chemical stabilization/solidification (the sludge processing facility) and another for physical treatment (the volume reduction facility). Each facility would be equipped with emission control systems to limit potential releases, e.g., a baghouse or high-efficiency particulate air filter system. A mulch pile would also be constructed on-site to enhance the biodegradation of wooden debris and vegetation.

The following material would be treated by chemical stabilization/solidification: sludge dredged from the raffinate pits, the more highly contaminated soil from on-site areas or in storage (e.g., radioactively contaminated clay underlying the raffinate pits and quarry soil at the TSA that is contaminated with radionuclides and/or nitroaromatic compounds), and containerized process waste from the project's two water treatment plants. Material treated by chemical stabilization/solidification would increase in volume by about 32%, and the overall volume for combined waste disposal would increase by about 12%. To minimize emissions during material transport to the sludge processing facility, the sludge would be pumped directly to the treatment facility as a slurry and loose soil material would be wetted during transport over the short distances from the staging areas or pits.

The treatment facility would contain mixing equipment such as a pug mill blender in which waste feed would be combined with stabilizing/solidifying reagents, e.g., a blend of Portland cement and fly ash. The treated raffinate pit sludge would be a grout-like material that would be discharged wet to minimize potential releases; it would be transported by truck to the disposal cell, where it would be placed in the cell and allowed to set into a cement-like form. Soil would be treated separately or mixed with the sludge in the processing facility, which would result in a drier treated product that could be placed and compacted in the same manner as other soil-like material.

Volume reduction operations would include the use of material-sizing equipment such as a shear, an impact crusher, a rotary shear shredder, and an in-drum compactor to treat structural material and rock as well as containerized debris such as used personal protective equipment. The volume of material processed by these methods would be reduced from 10 to 50%, depending on the specific material type. A decontamination unit would also be provided to treat selected structural materials for which release and reuse is practicable. Such material could be treated with a wet or dry abrasive blast process; the equipment and facility would contain emission control systems. Any structural material determined to be unreleasable would be transported to the disposal cell.

Other facilities already present on-site for interim actions would continue to be used for this remedial action, including the MSA, water treatment plant, and decontamination pad. Support facilities would also be maintained on-site to provide electrical power, potable water, showers, portable sanitary facilities, offices for the construction management staff, and staging for excavation and construction activities. Most of these facilities are already in place, and they could be expanded to address incremental requirements associated with increased activity on-site. Additional staging facilities would be constructed to support the heavy equipment needed for cleanup activities and to provide for stockpiling of material.

The various treatment and support facilities would be dismantled at the end of the remedial action period and either decontaminated for reuse (e.g., at another DOE facility) or treated by volume reduction and placed in the disposal cell. Following closure of the water treatment plant, a mobile water treatment unit could be brought on-site, if needed, to support final site closure activities.

An engineered disposal cell would be constructed at the chemical plant area within a specifically designated portion of the site that has undergone numerous subsurface investigations to confirm the suitability of the area for disposal of site waste. The waste containment capacity for this cell would be about 960,000 m^3 (1,250,000 yd^3). For planning purposes, a cell having a disposal capacity of about 1,100,000 m^3 (1,500,000 yd^3) was considered in the FS (Figure 5.5). This capacity is 20% over that expected to be required. The total area covered by the disposal cell would be about 17 ha (42 acres). A buffer zone would be maintained between the edge of the disposal facility and the property boundary, with a design goal of 90 m (300 ft).

The disposal cell base would consist of a double liner/leachate collection and removal system. The lower leachate collection and removal system would also serve as a leachate detection system and would facilitate the monitoring of cell performance during operation of the cell and the active leachate management period. The liners would be designed to minimize the transport of any leachate from the contaminated material that would be contained in the cell, considering both content and form. The multilayer cell cover would include an infiltration/radon attenuation barrier, a flexible membrane liner, a filter-protected drain layer, a frost protection layer, and an erosion protection layer; this cover would serve as a barrier to radon release and would protect against the potential effects of freeze-thaw cycles, intrusion by plant roots or burrowing animals, and erosion (including that associated with extreme precipitation events). The cell would be seismically engineered to withstand potential damage from earthquakes, and it would be designed to last for at least 200 to 1,000 years.

The cell would be constructed in stages to provide timely receiving capacity for waste generated by various cleanup activities being conducted concurrently (e.g., building dismantlement and volume reduction). This staged construction would minimize both the need for temporary storage and the potential for construction impacts by limiting the active work area. The cell would be maintained and its performance monitored for the long term, and its effectiveness would be reviewed every 5 years. The monitoring program would include visual inspection of the cell and regular testing of air, surface water, and groundwater. This monitoring would be frequent (e.g., quarterly to annually) during the near term, and it would be reduced to within the 5-year schedule after the site entered long-term caretaker status.

Site-specific operational and contingency plans would be prepared to support the remedial action. These plans would specify (1) safe work practices, engineering controls, and worker protective equipment to reduce occupational exposures and/or contaminant releases; (2) monitoring techniques and frequencies; and (3) contingencies for a variety of possible occurrences — e.g., to provide a response plan in the event that an accident occurred, that increased contaminant levels were measured by the monitoring systems, or that an environmental disturbance occurred such as a heavy rainstorm, tornado, or earthquake.

Under Alternative 6a, DOE would continue to maintain custody of and accountability for the disposal area, but the remainder of the site could be released for other use. For example, that portion of the property outside the disposal location could be transferred back to the Army for incorporation into the adjacent Army Reserve and Training Area, or it could be released for incorporation into the adjacent wildlife areas. Planning discussions would be held with parties who indicate an interest in the future use of this property after the remedy is selected for the current remedial action. However, the final disposition of the site will not be determined until after the final remedy is selected for the chemical plant area, i.e., until after the decision is made for the groundwater operable unit within the next several years. Any institutional controls that would be pertinent to the future use of this property, such as restrictions on the use of land or groundwater, would be identified at that time.

5.3 ALTERNATIVE 7a: REMOVAL, VITRIFICATION, AND DISPOSAL ON-SITE

Alternative 7a is similar to Alternative 6a except that vitrification would be the treatment method for the sludge, the more highly contaminated soil and sediment, and the containerized process waste. Under Alternative 7a, about 675,000 m^3 (883,000 yd^3) of contaminated sludge, soil, sediment, structural material, and water treatment plant process wastes would be removed from the source areas and on-site storage areas. About 342,000 m^3 (447,000 yd^3) of that material would be treated by vitrification or volume reduction, as appropriate, and about 522,000 m^3 (683,000 yd^3) of treated and untreated material would be placed in an engineered disposal facility on-site.

It is projected that remedial action activities could be completed within about 10 years following the ROD if no difficulties were encountered during testing, start-up, or operation. About 2.5 to 3 years are estimated to be required for bench-scale and pilot-scale testing; 5 to 7 years for design, construction, and start-up; and 4 years for operating the vitrification facility. (Construction and operation of the disposal cells would require about 6.5 years; some of these activities could overlap.) However, the total time required for these activities could be longer because of the innovative nature of this technology. As for Alternative 6a, releases would be controlled with good engineering practices and mitigative measures, and monitoring would be conducted throughout the cleanup and maintenance period to address protectiveness of the general public and the environment. Similarly, DOE would review the effectiveness of the remedy every 5 years.

Treatment would be a principal element of Alternative 7a, and vitrification would reduce the toxicity of certain contaminants (e.g., nitrate and nitroaromatic compounds); the toxicity of radiation from the site waste would not be affected by vitrification (or any other treatment method). Vitrification would also reduce the mobility of contaminants in soil and sludge and the disposal volumes of these media; this treatment method would result in a volume reduction of about 68% for the treated material and an overall volume reduction of 24% for the combined waste. The volume of other material such as structural debris and vegetation would be reduced as described for Alternative 6a.

Standard equipment and readily available resources would be used for the excavation and nonthermal treatment operations. However, equipment and resources are not readily available for vitrification. Use of the vitrification technology for large-scale operations is innovative and would require engineering scale-up and further bench-scale and pilot-scale testing before implementation at the Weldon Spring site. The total cost of implementing Alternative 7a is estimated to be about $182 million. The representative technical components of removal and much of the treatment and disposal components are the same as described for Alternative 6a. Those components of Alternative 7a that differ from Alternative 6a are described in the following paragraphs.

The vitrification unit within the sludge processing facility would be expected to consist of two melters operated in parallel to provide system flexibility. The contaminated material that would be treated in these melters is the same material that would be chemically treated under Alternative 6a. Feed preparation (sludge dewatering and material sizing) would be required before vitrification. In addition, the sludge and soil would need to be mixed in an optimized blend ratio to produce a glassy product. The vitrification process would operate continuously, i.e., 24 hours per day throughout the year, and would consume a considerable amount of energy.

The vitrified product would be irregularly shaped, 0.32- to 0.64-cm (1/8- to 1/4-in.) pieces of glass-like fitted material; it would be collected in a hopper and transferred to bins for truck transport to an adjacent staging area or directly to the disposal facility. Emissions from the vitrification process would be treated before release to the atmosphere. The specific off-gas treatment system would be developed following bench-scale and pilot-scale testing and optimization, but it would likely consist of a heat removal system, a primary quench scrubber, a submicron aerosol scrubber, a nitrogen oxide gas removal system, and a final filtration system, as required. Off-gas treatment requirements under this alternative would result in additional technical complexity, and delays could occur if inadequate controls were achieved during testing.

The location of the disposal area would be similar to that identified for Alternative 6a. However, for Alternative 7a, it was assumed that two cells could be constructed over the same general surface area. The first would be the same as that described for Alternative 6a (only smaller) and would receive all but the vitrified material. The design volume for nonvitrified material is about 591,000 m^3 (773,000 yd^3), with contingency. This disposal cell would cover about 12 ha (30 acres). A second cell could be constructed for the vitrified material, and it could have less stringent engineering controls if pilot testing demonstrated that the product would resist leaching. That is, although this cell would contain a cap similar to that described for Alternative 6a and a compacted natural clay liner, it would not include a leachate collection system because the material is expected to withstand leaching into the long term. The design volume of this cell is about 86,400 m^3 (113,000 yd^3), with contingency, and it would cover an area of about 5 ha (12 acres). The vitrified material would be cohesionless and would be placed in the cell in alternate layers with a binder such as clay to promote waste compaction and increase cell stability. The cell would be maintained and its performance monitored for the long term. As described for Alternative 6a, site-specific operational and contingency plans would be prepared to support the remedial action phase of this project, and institutional controls would be maintained for the long term.

On the basis of continuing engineering evaluations and pending further analyses to be developed during the detailed design phase, this approach might be modified to parallel the scenario described under Alternative 6a. The result would be a single disposal cell designed to contain both the vitrified and untreated waste, which would incorporate the same features described under Alternative 6a. The major difference would be the smaller size of the cell because of volume reduction achieved during vitrification. The analyses for the representative case in the FS are expected to bound potential impacts that would be associated with cell operations (including construction, waste placement, and closure) under the modified approach if Alternative 7a were selected.

5.4 ALTERNATIVE 7b: REMOVAL, VITRIFICATION, AND DISPOSAL AT THE ENVIROCARE FACILITY

Alternative 7b is similar to Alternative 7a except that the treated and untreated material would be transported to the Envirocare facility near Clive, Utah, for disposal. It is expected that the removal and treatment activities at the Weldon Spring site could be completed within the same time frame as for Alternative 7a (although the environmental compliance process associated with obtaining the necessary license to dispose of the large volume of by-product material at the Envirocare facility could delay implementation of this alternative); release controls and monitoring would also be the same as previously described. Under this alternative, the same material targeted for treatment under Alternative 7a would be vitrified at the Weldon Spring site before off-site transport for disposal. The total cost of implementing Alternative 7b is estimated to be about $351 million.

The Weldon Spring waste is classified as 11e(2) by-product material as defined in the Atomic Energy Act, as amended. The DOE can transfer this type of material only to organizations licensed to receive it by the U.S. Nuclear Regulatory Commission (NRC). (Certain states have been authorized to manage such material pursuant to Section 274 of the Atomic Energy Act, as amended. The state of Utah does not have this authority.) This requirement would apply to the disposal of waste from the Weldon Spring site at the Envirocare site. The Envirocare site has been permitted by the state of Utah to accept mixed hazardous waste and naturally occurring radioactive material. However, a disposal facility is not currently available at the site to receive material from the Weldon Spring site, i.e., 11e(2) by-product material. Envirocare of Utah, Inc., has submitted an application to the NRC for a license to allow for disposal of 11e(2) by-product material, and the NRC is currently preparing an EIS to support the license application. The environmental review process for this EIS is currently projected to be completed in July 1993. Because of the nature of the regulatory compliance process associated with the proposed Envirocare facility, cleanup of the Weldon Spring site might be delayed for several years under this alternative, depending on the length of time it takes the NRC and the Envirocare owners to complete the environmental review process.

The technologies and activities that would be used to construct, operate, and maintain a disposal cell for the Weldon Spring waste at the Envirocare site would likely be similar to those identified for Alternative 7a. Implementation of Alternative 7b would allow for release of the entire Weldon Spring site for future uses; the site would not be evaluated every 5 years to review the effectiveness of the cleanup because all waste would have been transported to the Envirocare facility. The long-term institutional controls appropriate for the Weldon Spring site would be determined on the basis of final site conditions, which will depend on the remedy selected for the groundwater operable unit, as described for Alternative 6a.

To support off-site disposal, the treatment facilities planned for the Weldon Spring site would need to be modified to include a staging area for loading the waste product into containers and onto trucks for off-site transport. These trucks would then transport contaminated material from the Weldon Spring site to a rail siding transfer station in Wentzville, Missouri, that would be either leased or newly constructed to support this action. About 38,600 trips would be required to transport the material to the siding over a combined one-way haul distance of 932,000 truck-km (579,000 truck-mi). The material would then be transferred to railcars for subsequent shipment along a commercial rail line to Clive, Utah. The transportation component of this alternative would probably extend over 7 years. On the basis of an estimated 515 required train trips, Alternative 7b would involve transportation over about 1,240,000 rail-km (773,000 rail-mi).

Transport of waste for off-site disposal at the Envirocare facility would result in an increased risk of transportation accidents, with the potential for exposing workers and the general public to radioactive and chemically hazardous substances. On the basis of current statistics for highway and rail accident rates and the distance that would be traveled by transport vehicles, a total of about six transportation accidents would be expected to occur. About half of these would be truck accidents, largely as a result of truck transport of the waste to the rail siding transfer station in Wentzville. The remaining three transportation accidents would involve railcars transporting the waste to Clive. Although several injuries could occur as a result of these accidents, no fatalities would be expected.

5.5 ALTERNATIVE 7c: REMOVAL, VITRIFICATION, AND DISPOSAL AT THE HANFORD FACILITY

Alternative 7c is similar to Alternative 7b except that the contaminated material would be transported to the Hanford facility near Richland, Washington, for disposal. Removal and treatment considerations would be the same as described for Alternative 7b, and the basic components of off-site disposal would be similar.

Under Alternative 7c, cleanup activities at the Weldon Spring site could be delayed many years because an appropriate disposal facility is not currently available at the Hanford facility to receive site waste and no such facility is planned. The technologies and activities that would be used to construct, operate, and maintain a disposal facility at the Hanford site would likely be similar to those identified for Alternative 7a. The total cost of implementing Alternative 7c is estimated to be about $304 million. This cost is based on an estimate of $\$130/m^3$ ($\$100/yd^3$) to dispose of the large volume of waste from the Weldon Spring site. The cost estimate for this alternative assumes that long-term monitoring and maintenance at the Hanford site would cost the same as at the Weldon Spring site. A detailed cost analysis would be performed to develop a firm price for disposal at the Hanford site if this were a component of the remedy selected for the Weldon Spring site.

Transport of contaminated material to the Hanford site for disposal would involve the same considerations identified for Alternative 7b, but Alternative 7c would require transport of the material along a commercial rail line to Richland, Washington, and then transfer to a dedicated rail line for transport to the Hanford site. On the basis of an estimated 515 train trips, Alternative 7c would involve transportation over about 1.7 million rail-km (1.1 million rail-mi) during an estimated 7-year period. A total of about eight transportation accidents would be expected, three involving trucks and five involving railcars. (More railcar accidents are expected for Alternative 7c than 7b because of the longer transport distance.) Although several injuries could occur as a result of these accidents, no fatalities would be expected.

6 EVALUATION OF FINAL ALTERNATIVES

The final alternatives for the proposed remedial action were evaluated according to EPA's standard criteria, which are defined in Section 6.1. A summary of the comparative evaluation of final alternatives is presented in Section 6.2. The alternative currently preferred by DOE and the rationale for its preference are identified in Section 6.3.

6.1 EVALUATION CRITERIA

The EPA has identified nine evaluation criteria against which final remedial action alternatives are to be evaluated. The purpose of these criteria is to focus the evaluation of alternatives to address statutory mandates identified in Section 121 of CERCLA, as amended, in order to determine the most appropriate solution for the specific problems at an NPL site. These mandates include protection of human health and the environment, compliance with ARARs, preference for permanent solutions with treatment as a principal element (to the maximum extent practicable), and cost-effectiveness. Least preferred is off-site disposal without treatment. The EPA's nine evaluation criteria are:

1. *Overall protection of human health and the environment* addresses protection from unacceptable risks in both the short term and the long term by minimizing exposures.

2. *Compliance with ARARs* addresses the attainment of federal and state environmental requirements and state facility siting requirements, unless a waiver condition is appropriate.

3. *Long-term effectiveness and permanence* addresses residual risks, focusing on the magnitude and nature of those risks associated with untreated waste and/or treatment residuals; this criterion includes consideration of the adequacy and reliability of any associated institutional or engineering controls, such as monitoring and maintenance requirements.

4. *Reduction of contaminant toxicity, mobility, or volume through treatment* addresses the degree to which treatment is used to address the principal threat(s) of the site; the amount of material treated; the magnitude, significance, and irreversibility of specific reductions; and the nature and quantity of treatment residuals.

5. *Short-term effectiveness* addresses the effect of implementing the alternative relative to potential risks to the general public during the action period, potential impacts to workers and the environment during the action period, the effectiveness and reliability of mitigative measures, and the time required to achieve protectiveness.

6. *Implementability* addresses technical feasibility, including the availability and reliability of required resources (such as demonstrated technologies, specific material and equipment, facility capacities, and availability of skilled workers), the ease of implementation, and the ability to monitor effectiveness; this criterion also addresses administrative feasibility, e.g., the coordination with other agencies and the need for approvals or permits for off-site actions, as appropriate to the alternative.

7. *Cost* addresses both capital costs and operation and maintenance costs, as well as the combined net present worth.

8. *State acceptance* addresses formal comments made by the state of Missouri about the consideration of alternatives and identification of the preferred alternative.

9. *Community acceptance* addresses the formal comments made by the community on the alternatives under consideration.

The first two criteria are the threshold criteria that must be met by the final remedial action alternatives for a site, unless a waiver condition is appropriate for the second criterion. The next five criteria are the primary balancing criteria and are evaluated together to identify significant trade-offs among the alternatives with respect to these criteria. The last two are the modifying criteria and will be evaluated after the RI/FS-EIS has been issued for public review and comment.

Application of the first seven criteria to the evaluation of final alternatives for remedial action at the Weldon Spring site is discussed in Section 6.2. For the remaining two criteria, responses to public comments and formal state comments will be provided in a Responsiveness Summary and will be used to develop the ROD for this action. Thus, the evaluation of state and community acceptance will be documented in the ROD. The RI, BA, FS, and this proposed plan for remedial action at the chemical plant area of the Weldon Spring site have been reviewed by the EPA Region VII, and EPA concurs with DOE's preferred alternative.

6.2 SUMMARY OF THE COMPARATIVE ANALYSIS OF FINAL ALTERNATIVES

The comparative evaluation of the final alternatives for remedial action against the threshold and balancing criteria is summarized in Sections 6.2.1 through 6.2.7 and in Table 6. Much more detailed information on the analysis of each alternative against these criteria is presented in Chapters 6 and 7 of the FS and in supporting appendixes.

6.2.1 Overall Protection of Human Health and the Environment

All of the final alternatives except no action (Alternative 1) would provide overall protection for human health and the environment. This protection could not be ensured for the

TABLE 6 Comparative Analysis of Alternatives

Alternative 1: No Action	Alternative 6a: Removal, Chemical Treatment, and Disposal On-Site	Alternative 7a: Removal, Vitrification, and Disposal On-Site	Alternative 7b: Removal, Vitrification, and Disposal at Envirocare	Alternative 7c: Removal, Vitrification, and Disposal at Hanford
Overall Protection of Human Health and the Environment				
Could not ensure protection of human health and the environment in the long term.	Engineering and mitigative measures would be applied during the remedial action period such that no significant adverse impacts would occur to the general public or the environment. Worker exposures would be similarly controlled to levels within health-protective limits. Long-term exposures would be minimized by removing contaminated material from source areas to reduce residual sitewide risks toward levels comparable to background. The highly contaminated material would be chemically treated, and all waste would be placed in an engineered disposal cell to provide permanent containment. If the cell were to fail and no corrective actions were taken, potential health and environmental impacts would be much lower than under Alternative 1 because contaminants in the treated waste would be much less mobile than under existing conditions.	Generally similar to Alternative 6a, except as follows. Short-term impacts could be slightly higher because contaminants would be released from the stack of the vitrification facility during the remedial action period and the potential for accidents and worker injuries would increase as a result of the larger work force required, the high operating temperatures, and the lack of experience with such a large-scale application of this process to waste treatment. Long-term impacts could be somewhat lower if the cell were to fail and no corrective actions were taken, because certain contaminants would be destroyed by vitrification and the vitrified portion of the waste is expected to be less susceptible to leaching.	Similar to Alternative 7a, except long-term impacts that could occur if the cell were to fail over time would occur at the Envirocare facility instead of at the Weldon Spring site. Temporary impacts to air quality from the dispersal of untreated material might be higher than Alternative 6a or 7a, impacts to groundwater could be comparable to Alternative 7a, and impacts to surface water would be lower than Alternative 6a or 7a. Incremental radiological exposures would be incurred by workers and, to a lesser extent, by the general public during off-site waste transport, including transfer activities at the Wentzville rail siding. In addition, the likelihood of accidents and worker injuries would increase; the public could also be injured and/or exposed to contaminants from an accident. Radiological exposures associated only with waste transportation would be significantly lower than those resulting from waste removal, treatment, and disposal activities — which are also associated with Alternatives 6a and 7a.	Similar to Alternative 7a, except long-term impacts that could occur if the cell were to fail over time would occur at the Hanford facility. In the event of such a failure, overall impacts would probably be higher than Alternative 6a, 7a, or 7b. Impacts to air quality from the dispersal of untreated material might be higher than for Alternative 6a or 7a and comparable to Alternative 7b; groundwater could be contaminated sooner than Alternative 7a or 7b; impacts to surface water might be comparable to Alternative 6a or 7a and higher than Alternative 7b; and ecological impacts could be higher than Alternative 6a, 7a, or 7b. Impacts of off-site transportation would be similar to Alternative 7b.

TABLE 6 (Cont.)

Alternative 1: No Action	Alternative 6a: Removal, Chemical Treatment, and Disposal On-Site	Alternative 7a: Removal, Vitrification, and Disposal On-Site	Alternative 7b: Removal, Vitrification, and Disposal at Envirocare	Alternative 7c: Removal, Vitrification, and Disposal at Hanford
Compliance with ARARs				
Would not meet all ARARs, including EPA time limits for storing certain waste prior to disposal. If institutional controls were lost in the future and access was unrestricted, EPA and DOE standards for radiological exposures and for residual levels of radium and thorium in soil would not be met; if the raffinate pits refilled, certain water quality criteria for the protection of aquatic life would not be met.	Would meet all pertinent ARARs, including those for radiological exposures and residual soil concentrations. Appropriate health-based ARARs would be met for both workers and the general public during and following cleanup. A waiver from the state limit of 1 pCi/L above background for radon-222 might be pertinent during a limited period of TSA activities. The disposal cell would incorporate design features that would ensure compliance with performance objectives, considering relevant and appropriate standards from regulations such as the Uranium Mill Tailings Radiation Control Act, Toxic Substances Control Act, Resource Conservation and Recovery Act (RCRA), and Missouri Hazardous Waste Management Law and Regulations. A 5-year review of the effectiveness and protectiveness of the response would be conducted because waste would remain on-site.	Same as Alternative 6a, with additional requirements for the vitrification facility that would be met, including emission standards given in the Missouri Air Pollution Control Regulations and possibly incineration standards given in RCRA.	Same as Alternative 7a, with additional requirements for off-site transportation that would be met. Disposal requirements would be addressed by the Envirocare facility.	Same as Alternative 7b, except disposal requirements would be addressed by the Hanford facility.

TABLE 6 (Cont.)

Alternative 1: No Action	Alternative 6a: Removal, Chemical Treatment, and Disposal On-Site	Alternative 7a: Removal, Vitrification, and Disposal On-Site	Alternative 7b: Removal, Vitrification, and Disposal at Envirocare	Alternative 7c: Removal, Vitrification, and Disposal at Hanford
Long-Term Effectiveness and Permanence				
Current exposures and impacts would continue and could increase over time because of continued contaminant migration and the possible failure of existing containment systems. Over a 30-year period, monitoring and maintenance activities associated with no further action would result in an estimated 9 cases of occupational injury and no occupational fatalities. If institutional controls were lost in the future and access was unrestricted, the lifetime risk of cancer induction to an individual from exposures to radioactive and chemical contaminants, respectively, are estimated to be 6×10^{-5} for a recreational visitor and would range from 4×10^{-6} to 9×10^{-2} for a resident; noncarcinogenic effects would be indicated for the resident at less than 5% of the soil areas. Adverse impacts to biota could occur at highly contaminated areas such as the raffinate pits, and contaminants could migrate from the surface to groundwater.	More protective than Alternative 1 because the current sources of potential hazards would be removed to provide a permanent solution for those areas. Residual sitewide risks could be reduced toward levels comparable to background, and environmental conditions would improve. The ranges developed for soil cleanup criteria would be applied as appropriate to the long-term use of the site, in accordance with DOE's "as low as reasonably achievable" (ALARA) process. By this process, contaminant concentrations would be reduced to the most protective levels practicable, so residual levels for each alternative could be similar. For the waste, the highly contaminated material would be treated to limit the potential for future releases, prior to isolation in an engineered cell. If the cell were to fail at some time in the future, releases from that material would be slow because the lifetime of the treated product is expected to be hundreds to thousands of years (beyond the time of cell failure, assuming no corrective actions are taken). The disposal cell (continued on next page)	Similar to Alternative 6a, but could be somewhat more protective if the disposal cell were to fail in the long term and no corrective actions were taken because certain contaminants in a portion of the waste would be destroyed during vitrification (e.g., organic compounds in soil from the quarry, but not radionuclides). An effectively vitrified waste form is expected to be able to withstand environmental degradation for thousands of years. If the cell were to fail in the future, that portion of waste that is successfully vitrified could be relatively less susceptible to leaching than if it were chemically stabilized/solidified. Thus, contaminant concentrations in the leachate of that material could be lower, and the incremental contribution to overall groundwater impacts could be lower. Overall health and environmental impacts associated with maintenance activities and with cell failure in the absence of maintenance activities would be generally similar to Alternative 6a.	Generally similar to Alternative 6a or 7a, except soil within the cell area for that alternative would be selectively remediated under Alternative 7b and potential impacts would occur at the off-site location instead of on-site if the disposal cell were to fail in the future. If the waste were exposed, air quality impacts from wind dispersal of untreated material would be higher than Alternative 7a because wind speeds are higher, the climate is dry, and the site is sparsely vegetated. Related health impacts would depend on whether land use changed over the extended future; the nearest residence is currently about 40 km (25 mi) away so public exposures would be lower than Alternative 6a or 7a under current land use conditions (the nearest residence and town are 2 to 3 km [1 to 2 mi] from the Weldon Spring site). Potential groundwater contamination could be similar to Alternative 7a because, although annual precipitation is lower, the depth to groundwater is comparable and the overburden permeability is higher than the Weldon Spring site. No surface water impacts would be (continued on next page)	Similar to Alternative 7b, except impacts would generally be higher at the Hanford facility than at the Envirocare facility or the Weldon Spring site if the disposal cell were to fail in the future. Air quality impacts associated with the untreated material would be similar to Alternative 7b and higher than Alternative 6a or 7a because the terrain and meteorological conditions are similar to the Envirocare facility and much more conducive to wind dispersal than at the Weldon Spring site. Impacts to the general public would depend on future land use; if the relative population densities at the alternate sites remain the same, impacts would be higher than Alternative 7b and lower than Alternative 6a or 7a (the distance from the disposal location to the nearest town is about 30 km [19 mi]). If homes were built closer to the cell in the future, impacts might be similar to Alternative 6a or 7a (high winds and sparse vegetation might offset the additional distance). Assuming that the waste becomes saturated, (continued on next page)

TABLE 6 (Cont.)

Alternative 1: No Action	Alternative 6a: Removal, Chemical Treatment, and Disposal On-Site	Alternative 7a: Removal, Vitrification, and Disposal On-Site	Alternative 7b: Removal, Vitrification, and Disposal at Envirocare	Alternative 7c: Removal, Vitrification, and Disposal at Hanford
Long-Term Effectiveness and Permanence (Cont.)				
	would be designed to last for at least 200 to 1,000 years, and monitoring and maintenance would continue into the long term. In the 30 years immediately following implementation, about 9 cases of occupational injuries and no occupational fatalities are estimated to occur during site maintenance activities. If the cell were to fail and no corrective actions were taken, potential impacts to human health and the environment would be much lower than under Alternative 1 because the highly contaminated material would have been treated and would be much less susceptible to leaching and dispersal. In addition, the compaction of natural clay in the subgrade would limit transport. No adverse ecological impacts would be expected because the highly contaminated material would have been treated to reduce contaminant mobility and availability.		expected because the Envirocare facility is 45 km (28 mi) from the nearest surface water body. No adverse ecological impacts would be expected (as for Alternative 6a or 7a) because the highly contaminated material would have been treated to reduce contaminant mobility and availability.	groundwater impacts might occur sooner than Alternative 7a or 7b because, although the overburden is 3 or more times thicker, its higher permeability would more than offset the increased depth to groundwater. Surface water impacts could be higher than Alternative 7b and comparable to Alternative 6a or 7a because an ephemeral stream is within 3 km (2 mi) of the disposal location and two rivers are within 8 and 24 km (5 and 15 mi), respectively. Ecological impacts would be higher than Alternative 7b and somewhat similar to Alternative 6a or 7a, except potential impacts to threatened and endangered species could be higher under Alternative 7c.

TABLE 6 (Cont.)

Alternative 1: No Action	Alternative 6a: Removal, Chemical Treatment, and Disposal On-Site	Alternative 7a: Removal, Vitrification, and Disposal On-Site	Alternative 7b: Removal, Vitrification, and Disposal at Envirocare	Alternative 7c: Removal, Vitrification, and Disposal at Hanford
Reduction of Toxicity, Mobility, or Volume through Treatment				
Toxicity, mobility, and volume of contaminated material would not change.	The disposal volume of 772,000 m^3 (1,010,000 yd^3) would be larger than the volumes for the other action alternatives because chemical stabilization/solidification would result in a 32% increase in waste volume, or about 327,000 m^3 (428,000 yd^3) of treated product; this corresponds to an increase of 12% for the combined waste volume. The incorporation of contaminants into the treated product would significantly reduce contaminant mobility. The volume of certain structural material (primarily metal debris) could be reduced by 10 to 50%, depending on its type and physical configuration. The volume of wooden debris and vegetation could be reduced by at least 50% and up to 80 to 90% by shredding and composting, depending on process enhancement. The volume of rock and concrete would not be reduced.	The disposal volume of 522,000 m^3 (683,000 yd^3) would be smaller than that for Alternative 6a because vitrification would result in a 68% decrease in volume, or about 78,800 m^3 (103,000 yd^3) of treated product; this corresponds to a decrease of 24% for the combined waste volume. The reduction in contaminant mobility would be greater than Alternative 6a because the vitrified product would be incorporated into a glass-like matrix instead of a cement-like matrix. In addition, the toxicity of certain waste types would be reduced because organic contaminants in the portion of waste that would be treated (e.g., nitroaromatic compounds in the quarry soil) would be destroyed and some inorganic contaminants (e.g., nitrate) would be altered. For the other waste material, expected volume reductions would be the same as Alternative 6a. The off-gas system would generate treatment residuals consisting of spent filters and about 2,200 t (2,400 tons) of scrubber residuals (for the expected case over 4 years of operation).	Same as Alternative 7a.	Same as Alternative 7a.

TABLE 6 (Cont.)

Alternative 1: No Action	Alternative 6a: Removal, Chemical Treatment, and Disposal On-Site	Alternative 7a: Removal, Vitrification, and Disposal On-Site	Alternative 7b: Removal, Vitrification, and Disposal at Envirocare	Alternative 7c: Removal, Vitrification, and Disposal at Hanford
Short-Term Effectiveness				
Current exposures and impacts would continue. About 80 person-years of effort would be required for baseline activities over a 10-year period, and about 12 occupational injuries and 110 lost workdays are associated with these activities. Radiological and chemical carcinogenic risks estimated for an on-site maintenance worker under current conditions are 5×10^{-4} and 1×10^{-5}. The corresponding risks for a trespasser (member of the general public) are 9×10^{-5} and 1×10^{-4}, and noncarcinogenic effects are indicated.	Exposures would be higher than Alternative 1 because of particulate and gaseous (radon) emissions and external gamma irradiation associated with removal, treatment, and disposal activities. Mitigative measures would be implemented to minimize potential health and environmental impacts. Total worker effort is estimated to be 560 person-years. The risk of worker accidents would increase compared with Alternative 1; about 82 cases of occupational injuries are estimated to occur, with about 790 lost workdays. Worker protection would be used to control exposures. The risks of cancer induction from exposures to radioactive and chemical contaminants, respectively, are estimated to be about 1×10^{-3} and 8×10^{-5} for the maximally exposed remedial action worker and about 6×10^{-7} and 3×10^{-8} for the maximally exposed member of the general public. No adverse impacts to off-site individuals are expected from contaminant releases during implementation of this alternative; the radiological risk to the population within 5 km (3 mi) of the site is estimated (continued on next page)	Similar to Alternative 6a, except that the risk of worker accidents would increase (110 occupational injuries are expected to occur, with about 1,100 lost workdays) and emissions from the vitrification facility could result in increased airborne contaminant levels. These emissions are not expected to significantly affect human health or the environment because the facility would be equipped with an off-gas system to ensure protectiveness and additional mitigative measures would be applied. Additional worker protection against inhalation and ingestion of airborne contaminants would be required, as would increased protection against safety hazards associated with the treatment operations because high temperatures are used in the vitrification process. Total worker effort is estimated to be 780 person-years. The risks of cancer induction would not increase appreciably compared with Alternative 6a. The risks from exposures to radioactive and chemical contaminants, respectively, are estimated to be about 1×10^{-3} and 8×10^{-5} for the maximally exposed remedial (continued on next page)	Similar to Alternative 7a, except that the requirements for transportation of waste for off-site disposal would increase potential impacts to human health and the environment in the short term. Incremental radiological exposures would be incurred by workers and, to a lesser extent, by the general public during waste transport, including transfer activities at the Wentzville rail siding. Radiological exposures associated with transportation activities (including accidents) would be significantly lower than those resulting from removal, treatment, and on-site disposal activities for Alternatives 6a and 7a. The additional risks of cancer induction from transportation activities are estimated to be 2×10^{-4} for the maximally exposed worker and 7×10^{-8} for the maximally exposed member of the general public. In addition, the potential for accidents and the likelihood of worker injuries would increase; the estimated number of occupational injuries would increase to 160, with about 1,600 lost workdays; and six vehicular accidents would be expected, with no associated (continued on next page)	Similar to Alternative 7b, except that habitat used by a candidate species would be disturbed at the Hanford facility.

TABLE 6 (Cont.)

Alternative 1: No Action	Alternative 6a: Removal, Chemical Treatment, and Disposal On-Site	Alternative 7a: Removal, Vitrification, and Disposal On-Site	Alternative 7b: Removal, Vitrification, and Disposal at Envirocare	Alternative 7c: Removal, Vitrification, and Disposal at Hanford
Short-Term Effectiveness (Cont.)				
	to be 3×10^{-3}. Most impacts to biota would be temporary, but about 17 ha (42 acres) of habitat would be permanently altered at the cell location. Activities are not expected to impact threatened or endangered species. About 15 ha (38 acres) of on-site wetlands would be lost, but the excavation of these areas would remove a source of exposure and improve environmental conditions; related mitigation plans would be developed with the state of Missouri. Up to 0.6 ha (1.4 acres) of land within the 100-year floodplain of a nearby creek might also be excavated, but the area would be recontoured and revegetated so impacts would be temporary. Alternative 6a would be the most timely of all the action alternatives because it would use an established process and treatment could begin after standard engineering design and start-up activities. About 4 to 5 years would be required to treat the raffinate pit sludge and more highly contaminated soil. Approximately 895,000 m^3 (1,171,000 yd^3) of clay-rich soil would be required for borrow material; this soil could be obtained from a nearby source.	action worker and about 7×10^{-7} and 3×10^{-8} for the maximally exposed member of the general public. The radiological risk to the population within 5 km (3 mi) of the site is estimated to be 3×10^{-3}. The initiation of site cleanup under this alternative would be delayed compared with Alternative 6a because additional lead time would be needed to address engineering issues such as scale-up and optimization of the vitrification and off-gas treatment processes. About 4 years would be required to treat the raffinate pit sludge and more highly contaminated soil. The same amount of borrow material would be required as for Alternative 6a; this soil could be obtained from a nearby source.	fatalities. The public could also be exposed if contaminants were released during an accident. Additional mitigative measures would be implemented to reduce related impacts. Total worker effort is estimated to be 1,100 person-years. About 376,000 m^3 (492,000 yd^3) of soil would be required for borrow material; this soil could be obtained from a nearby source.	

TABLE 6 (Cont.)

Alternative 1: No Action	Alternative 6a: Removal, Chemical Treatment, and Disposal On-Site	Alternative 7a: Removal, Vitrification, and Disposal On-Site	Alternative 7b: Removal, Vitrification, and Disposal at Envirocare	Alternative 7c: Removal, Vitrification, and Disposal at Hanford
Implementability				
Minimum site operations would continue with the use of readily available resources.	Most straightforward to implement of the action alternatives. Chemical stabilization/solidification has been successfully applied at a number of contaminated sites and is an established technology. Pilot-scale testing, design, construction, and start-up would require less time than the vitrification technology of Alternatives 7a, 7b, and 7c; approximately 4 years would be required for these initial engineering activities. Chemical stabilization/solidification of the contaminated material would involve some special handling, but the equipment and process reagents are readily available from local suppliers. The process could be readily monitored in the short term, as could the effectiveness of the disposal cell in the short term and the long term (with the leachate collection/leak detection system and groundwater monitoring wells).	Less straightforward to implement than Alternative 6a because more extensive testing and optimization of the vitrification treatment system would be needed. Engineering scale-up, more highly trained personnel, and off-gas controls and monitoring would also be required. Vitrification is considered an innovative technology and has only been implemented for small waste quantities at the pilot-scale stage. Bench-scale and pilot-scale testing, design, construction, and start-up of the vitrification system at the Weldon Spring site would probably require at least 5 to 7 years. (Considerable uncertainty is associated with this estimate because of the innovative nature of the technology.) The off-gas treatment system would require extensive testing and optimization, and it would necessitate coordination and approvals with the state of Missouri for emissions (for substantive permitted conditions).	Same as Alternative 7a, except for off-site transport and disposal, which would be less straightforward to implement than on-site disposal because of the need for increased coordination among federal, state, and local agencies for the transportation route and in Utah. Handling and support facilities are available at the Envirocare facility. However, administrative procedures are not currently in place at the Envirocare facility for accepting the Weldon Spring waste, which is classified as 11(e)2 by-product material. Additional administrative difficulties could be associated with waste transport through the various states. About 515 train trips would be required over a projected 7-year period, for a total one-way haul distance of 1,240,000 rail-km (773,000 rail-mi).	Similar to Alternative 7b, but off-site disposal would be even less straightforward to implement because the Hanford facility currently accepts only small-quantity shipments of containerized waste from off-site sources, and administrative and handling procedures are not in place for accepting the large volume of waste from the Weldon Spring site. About 515 train trips would be required over a projected 7-year period, for a total of 1,740,000 rail-km (1,080,000 rail-mi).

TABLE 6 (Cont.)

Alternative 1: No Action	Alternative 6a: Removal, Chemical Treatment, and Disposal On-Site	Alternative 7a: Removal, Vitrification, and Disposal On-Site	Alternative 7b: Removal, Vitrification, and Disposal at Envirocare	Alternative 7c: Removal, Vitrification, and Disposal at Hanford
Cost				
The total cost would be the lowest in the short term (about $12 million over a 10-year period), but the comparative level of effectiveness would be low. In addition, the cost would be potentially higher than for the action alternatives over the long term because the scope of the required remediation effort could increase if cleanup actions were not implemented in the near term. That is, conditions could worsen considerably over time, necessitating an expensive emergency and/or expanded response in the future.	The total cost would be about $157 million, which is the lowest of the action alternatives for the same overall level of effectiveness. The estimated long-term maintenance cost is about $24 million, and the present-worth cost is about $79 million. The total cost is significantly lower than that for Alternative 7b or 7c because of the lower cost for on-site disposal.	The total cost would be about $182 million. The estimated long-term maintenance cost is about $24 million and the present-worth cost is about $97 million. A vitrification facility would cost about $24 million more to construct and operate than a chemical stabilization/solidification facility. However, the cost for on-site disposal of the vitrified waste would be about $45 million, which is $11 million less than for on-site disposal of the chemically stabilized/solidified waste, because of the smaller volume and less extensive design requirements for the vitrified product. The net cost difference from Alternative 6a is $25 million.	The total cost would be about $351 million, which is much higher than Alternative 7a. The total cost for off-site transport and disposal at the Envirocare facility, including construction of a rail siding in Wentzville, is estimated to be $214 million, of which $110 million is attributable to waste transportation. (The long-term maintenance cost is included in the estimate for waste disposal.) The present-worth cost is $197 million.	The total cost could be about $304 million, which is generally comparable to Alternative 7b. This value was determined from a preliminary estimate for waste disposal; a detailed cost analysis would be performed to develop a firm price if disposal at the Hanford facility were a component of the selected alternative. The total cost for off-site transport and disposal is estimated to be about $143 million, and the long-term maintenance cost is assumed to be the same as for Alternative 7a. The estimated cost for transporting the waste is about $16 million higher than for Alternative 7b because of the increased distance to the Hanford facility. The present-worth cost is $171 million.

extended future if no action were taken because contaminants could migrate to off-site receptors over time (e.g., via groundwater) resulting in possible impacts. For each of the action alternatives, human and environmental exposures would be reduced by removing the sources of contamination, treating the waste that contributes to the principal threats at the site, and permanently containing the treated and untreated materials in an engineered disposal cell designed to prevent the release of contaminants into the environment for at least 200 to 1,000 years.

The two basic differences among the final action alternatives are the treatment method and the disposal location (which includes a transportation component for the off-site disposal alternatives). Therefore, impacts to workers and the general public from removal activities during the remedial action period would be similar for each alternative because the same areas would be excavated or dredged. However, incremental impacts to workers and the public from treatment activities could result from differences between the chemical treatment and vitrification operations. Additional emissions are associated with Alternatives 7a, 7b, and 7c compared with Alternative 6a because contaminants would be released from the stack of the vitrification facility. However, these emissions are expected to be controlled by an extensive air pollution control system within the facility, so related impacts would be small.

Potential health impacts for members of the general public during the cleanup period would be below EPA's target limits for protecting human health for each of the action alternatives. Impacts would be relatively higher for Alternatives 7b and 7c than for Alternative 6a or 7a because of the increased likelihood of exposures and accidents during the waste handling and transportation activities for off-site disposal. Worker impacts would be higher under the vitrification alternatives because this process would require more workers and additional accidents could result from the hazards of high operating temperatures and limited field experience. If the cell were to fail in the future and no corrective actions were taken, long-term impacts could be somewhat lower for Alternative 7a than Alternative 6a because the vitrified portion of the waste could be less susceptible to leaching and the organic contaminants in that waste would have been destroyed.

Environmental impacts would result from excavating and dredging the contaminated material; constructing access roads, staging areas, and other support facilities; constructing and operating the disposal cell (either on-site or off-site); and excavating borrow soil from a location near the Weldon Spring site to provide backfill for the remediated areas on-site and to construct the cell under Alternatives 6a and 7a. Additional impacts would be associated with activities at the rail siding in Wentzville and other transportation operations under Alternatives 7b and 7c. Except for the permanent loss of habitat at the disposal cell area and possibly at the off-site borrow location (depending on the location selected during detailed design), all impacts would be short term and would be mitigated by various standard measures, including engineering controls to limit erosion and siltation.

6.2.2 Compliance with ARARs

The discussion of ARARs in this section is somewhat extensive because one of the purposes of the analysis is to inform the public of key requirements associated with the proposed remedial action. In addition, this plan will serve as a primary source of information for the discussion of final alternatives to be presented in the ROD. For these reasons, a detailed presentation of the ARARs evaluation provides the best means of soliciting input from the public on this topic, and public comments are important to the selection of an appropriate remedy for the site.

Section 121 of CERCLA, as amended, requires that remedial actions achieve a standard or level of control that is consistent with environmental laws or facility siting laws, which are termed applicable or relevant and appropriate requirements, or ARARs. The determination as to whether or not a requirement is applicable depends upon the jurisdictional prerequisites specified in the regulation. If a requirement is judged to be not applicable for the conditions at a site, it may still be considered relevant and appropriate on the basis of a number of factors, which include the purpose and intent of the requirement as well as site-specific circumstances associated with implementing the remedial action. The analysis of ARARs applies to all aspects of remedial action, including the establishment of cleanup criteria, the operation and performance of treatment systems, and the design of disposal facilities.

A comprehensive listing of potential location-specific, contaminant-specific, and action-specific requirements for the current remedial action and the conditions under which a waiver would be appropriate are provided in Appendix G of the FS. The following overview addresses key requirements for this action, including location-specific requirements for activities in floodplains and wetlands. The contaminant-specific requirements discussed are those for air emissions of radionuclides, including radon. The major action-specific requirements address the design of the disposal cell and the nature of waste placement.

Alternative 1 (no action) would not comply with certain ARARs, including time limits for the storage of some site waste. For example, under the Toxic Substances Control Act, material contaminated with PCBs is to be stored for no longer than 1 year prior to disposal; PCB-contaminated material (which also contains radioactive contaminants) is currently in storage on-site, so this requirement would apply. If no further action were taken, this requirement would not be met. Also, certain water quality criteria for the protection of aquatic life would be exceeded by contaminant concentrations in the raffinate pits because the pits might refill and reestablish current conditions following the interim action to remove and treat the water. In addition, if site access were unrestricted at some time in the future (e.g., under the scenario of a hypothetical loss of institutional controls), standards for general radiation exposure and levels of radium and thorium in soil given in DOE Orders and in the Uranium Mill Tailings Radiation Control Act would not be met. Therefore, the no-action alternative would not satisfy the threshold criteria under current and potential future scenarios.

Alternative 6a would comply with applicable location-specific and contaminant-specific requirements, unless a waiver is appropriate. Location-specific requirements that apply to the site include those for the protection of endangered species and habitats, floodplains, and wetlands. Limited site surveys have been conducted to identify the presence of state listed species. No federal listed, candidate, or category 2 species occur at or utilize the site (Appendix I of the FS). A small portion of the 100-year floodplain of the Schote Creek-Dardenne Creek drainage basin within the headwaters of Schote Creek is located on-site. Portions of this area and the adjoining drainage on the U.S. Army Reserve Training Area are contaminated and would require excavation and regrading during remedial action. Also, the raffinate pits, Ash Pond, and Frog Pond are designated as wetlands by the National Wetlands Inventory, and contaminated material would be removed from these impoundments under Alternative 6a. A separate floodplain/wetland assessment was prepared to address impacts to these areas (Appendix H of the FS). No practicable alternative exists for these areas but to remove the contaminated soil, sludge, and sediment. The small floodplain area would be returned to original conditions following completion of remedial activities, and possible mitigative measures for wetland disturbance from project activities (such as wetland replacement) are being coordinated with the state of Missouri.

Other location-specific requirements that apply to Alternative 6a are identified in environmental laws such as the Resource Conservation and Recovery Act (RCRA) and parallel state laws that govern the siting of treatment, storage, and disposal facilities for hazardous waste. Certain waste at the site meets the regulatory definition of characteristic hazardous waste under RCRA because leachate concentrations determined by EPA's toxicity characteristic leachate procedure (TCLP) test exceed the given limits. Therefore, RCRA siting requirements for new hazardous waste facilities would apply for certain facilities that would be constructed for that waste under Alternative 6a. Many of these requirements are incorporated by reference in the Missouri Hazardous Waste Management Law and Regulations. Because the specific nature of the action greatly affects the applicability or relevance and appropriateness of these requirements, they are reviewed with the requirements for treatment and disposal.

Several contaminant-specific requirements for air emissions would apply to Alternative 6a. The most significant of these are given in the National Emission Standards for Hazardous Air Pollutants (NESHAPs), which provide limits on the emission of contaminants such as radionuclides to the atmosphere from DOE facilities, including the Weldon Spring site. For example, the limit for radon-222 (given as a flux) is 20 pCi/m^2-s, as an average for the entire site. These requirements would be met during and following implementation. Similarly applicable requirements are listed in the Missouri Radiation Regulations; except for the limit of 1 pCi/L above background for radon-222 in uncontrolled areas, those requirements would be met during and following the implementation of this alternative. For radon-222, it is possible that activities at the TSA might result in temporary exceedances of the standard during the cleanup period, e.g., when the radium-contaminated quarry bulk waste was being uncovered and loaded for treatment. The most likely location for these exceedances is the fence line that separates the site from the Army property, and the potential for an exceedance would depend on meteorological conditions at the time of these activities (prevailing winds would tend to disperse the radon within the site boundary in most cases). Access to that property is controlled by the Army, and the levels would decrease with distance because of dispersion and transport, so no measurable impacts are expected. In addition, this standard would apply and would be met following remediation. If needed, the waiver condition that addresses intermediate actions for cases where the total remedial action will attain the given level would be appropriate (EPA 1990a). Contaminant-specific requirements for soil identified in the Toxic Substances Control Act, Uranium Mill Tailings Radiation Control Act, DOE Orders, and guidance and proposals from both EPA and the state of Missouri were considered in developing cleanup criteria for the site; these standards and criteria are described in Section 2.2 of the FS. The proposed cleanup levels that incorporate these standards and other criteria are presented in Section 4.4 of this proposed plan.

Action-specific requirements focus on waste treatment, storage, and disposal. Several requirements that apply to Alternative 6a are included in various provisions of RCRA and are incorporated by reference in the state regulations for solid and hazardous waste. For the storage component of this alternative, the 1-year time limit specified in the Toxic Substances Control Act for PCB-contaminated material would apply. However, a waiver from this limit would be pertinent for the cleanup period on the basis of technical impracticability. That is, the PCB-contaminated waste in storage at the site is also radioactively contaminated, and a disposal facility is not currently available for this type of waste. In addition, the storage of this material constitutes an intermediate measure in the context of the overall remedial action. The requirement would be attained upon completion of this action under Alternative 6a.

For the treatment component of Alternative 6a, the facility for treating the highly contaminated sludge from the raffinate pits and certain other site waste would be constructed and operated in accordance with several requirements in RCRA and the parallel state law, as described below. The characteristic hazardous waste would be chemically stabilized/solidified to meet the RCRA treatment standards (i.e., to pass the leachate test). Thus, following treatment, the waste would no longer meet the definition for hazardous waste so related requirements would not apply to the subsequent disposal action. However, certain of these requirements would be considered relevant and appropriate to the disposal of this waste.

For the disposal component of Alternative 6a, no environmental laws are available that specifically apply to the combined waste that would be placed in the disposal cell. However, a number of laws contain requirements that apply separately to hazardous waste, uranium and thorium mill tailings, and demolition waste. Certain requirements would be considered relevant and appropriate to specific design components of the disposal cell on the basis of sufficient similarity of the different waste types and the appropriateness of the purpose of the requirements to the overall purpose of this action, i.e., to dispose of site waste in a manner that will protect human health and the environment in both the short term and the long term. Therefore, the cell design would incorporate the protective components from each of the pertinent regulations, including requirements given in RCRA, the Toxic Substances Control Act, the Missouri Hazardous Waste Management Law and Regulations, and the Uranium Mill Tailings Radiation Control Act. These requirements include designing for an effective life of at least 200 to 1,000 years, incorporating a radon barrier cover to limit radon releases to 0.5 pCi/L above background at the facility boundary, and incorporating a double liner and leachate collection system to contain the waste and monitor cell performance. A 5-year review of the effectiveness of the remedy would be conducted at the Weldon Spring site in accordance with CERCLA, as amended, because waste would remain on-site under this alternative.

Additional requirements address the siting of a new hazardous waste facility. The RCRA requirements and similar requirements in the state law specify that a treatment, storage, or disposal facility should not be constructed within 61 m (200 ft) of a fault in which displacement has occurred in Holocene time and that any facility located in a 100-year floodplain should be constructed, operated, and maintained to prevent washout of any waste by a 100-year flood. These requirements apply to locating the chemical stabilization/solidification facility on-site under this alternative because the unit is expected to treat some characteristic hazardous waste. However, they would not apply to the disposal facility because the waste would have been rendered nonhazardous by the treatment process so the regulatory prerequisite (i.e., the waste definition) would no longer be met. Nevertheless, the requirements are considered relevant and appropriate to the construction of that facility on the basis of sufficient similarity of the waste type and the appropriateness of the purpose of the requirement for this action, i.e., to limit the potential for facility displacement by a nearby earthquake. In actuality, all facilities that would be constructed at the Weldon Spring site under Alternative 6a would meet these siting criteria.

More stringent siting requirements for hazardous waste landfills identified in the Missouri Hazardous Waste Management Law and Regulations also specify that a disposal landfill should not be located in an area of unstable soil deposits subject to landslides or catastrophic collapse. This requirement does not apply to the disposal action under Alternative 6a because the waste would have been treated such that it no longer met the regulatory definition for hazardous waste. However, the requirement is considered relevant and appropriate to the action on the basis of sufficient similarity of the waste type and the appropriateness of the purpose of the requirement for this action, i.e., to limit the potential for facility displacement from subsidence.

Additional state siting requirements specify that 9.1 m (30 ft) of soil or other material with a permeability of less than 1×10^{-7} cm/s should be present between the bottom of the cell and the uppermost regional aquifer, or an equivalent protection may be based on at least 6.1 m (20 ft) of naturally occurring material. Again, these requirements do not apply to the disposal action because the waste would have been treated such that it no longer met the regulatory definition for hazardous waste. These criteria are considered relevant on the basis of sufficiently similar waste type, but the specific circumstances at the site were reviewed to determine whether they were well suited and therefore appropriate for the action. From this review, the requirements for the thickness and permeability of naturally occurring material are not considered appropriate in the context of in-place material because of the circumstances at the chemical plant facility — i.e., much of the site overburden was significantly altered during the extensive excavation, backfilling, and regrading that occurred as part of plant construction more than 20 years ago, and a number of subsurface features such as building foundations and pipes are present. However, after those features are removed, naturally occurring material would be used in combination with compacted fill to engineer to an equivalent level of protection to achieve the purpose of these requirements, i.e., to limit the potential for contaminant leaching to groundwater. Thus, these specific requirements would be adopted as design criteria to ensure that the properties of the disposal cell foundation (a combination of in-place materials and engineered fill) would attain the indicated performance measures.

Similarly, the restriction on the placement of waste containing free liquids in a landfill that is specified in both RCRA and the similar state law does not apply to Alternative 6a. Although the requirement is considered relevant to disposal of the chemically stabilized/ solidified waste on the basis of sufficient similarity of the waste type, it is not appropriate because of the specific nature of the waste relative to its radionuclide content and the potential for emissions under the required method of waste placement. That is, the chemically treated waste should be maintained at an adequate moisture content during waste placement to control radon and particulate releases. Airborne contaminants that could be released if the waste were placed in the cell in accordance with this requirement, instead of in a wet form, could exceed DOE standards for occupational exposures (especially for thorium), thereby posing a health threat to workers nearby. Disposing of the cement-like material in a somewhat wet condition and allowing it to harden in the cell would also provide other benefits. For example, the overall density of the final waste form would increase because the material could move into small open spaces in the surrounding waste; this would improve the overall structural integrity of the cell for the long term and would result in a smaller total waste volume compared with the method identified in this requirement. Therefore, the restriction on placement of waste containing free liquids is not well suited to the specific circumstances of the remedial action under Alternative 6a. Its purpose of providing overall protection for human health and the environment would be better achieved by the wet placement method described for this alternative.

The RCRA land disposal restrictions would not apply to disposal under Alternative 6a because no listed waste would be disposed of on-site and any characteristic waste would be treated so that it no longer met the definition for hazardous waste. If any listed waste were identified as the remedial action progressed, these requirements would apply and the waste would be disposed of at an appropriate RCRA facility (e.g., off-site).

Compliance with ARARs under Alternative 7a would be similar to that identified for Alternative 6a except additional requirements that regulate emissions could be relevant and appropriate to the off gas from the vitrification facility. These requirements include the Missouri Air Pollution Control Regulations for maximum allowable emissions of particulate matter from fuel-burning equipment used for indirect heating, restrictions for emissions of visible air contaminants, and restrictions for emissions of particulate matter from industrial processes. State ambient air quality standards could also be considered relevant and appropriate for Alternative 7a, insofar as the vitrification process would have a potential to emit pollutants above specified de minimis emission levels specified in these regulations. Emission requirements for hazardous waste incineration under RCRA could also be relevant and appropriate for this alternative for treatment of characteristic waste, and emission requirements for burning of hazardous waste in boilers or industrial furnaces could be relevant and appropriate under Alternative 7a because vitrification might be considered similar to an industrial furnace (melting furnace). In this case, the pertinent requirements would be addressed. Compliance with disposal requirements under Alternative 7a would be similar to that described for Alternative 6a, except the restriction from placement of free-standing liquids in the disposal cell would be met for the vitrified material.

Compliance with location- and contaminant-specific requirements under Alternative 7b would be the same as for Alternative 7a. Compliance with action-specific requirements for activities that take place on-site under this alternative would also be the same as for Alternative 7a. Applying specific environmental regulations to activities being considered for an off-site facility, such as disposal of waste at the Envirocare facility, would be addressed by the owners/operators in the environmental compliance documents and activities for that facility. For example, the RCRA requirements for a manifest system, recordkeeping, reporting, and finances would apply to the owner/operator of the Envirocare facility under Alternative 7b if the waste to be disposed of at that facility met the prerequisites for definition as hazardous waste. The DOE would comply with applicable requirements for transportation of radioactive and chemically hazardous material to the Envirocare facility under Alternative 7b, e.g., with regard to the containers that would be used.

Compliance with ARARs under Alternative 7c would be similar to that described for Alternative 7b. The application of specific environmental regulations to activities being considered for the Hanford facility would be addressed by the owners/operators under the environmental compliance documents and activities for that facility. The DOE would comply with applicable requirements for transportation of radioactive and chemically hazardous material to the Hanford facility in the same manner as for Alternative 7b.

6.2.3 Long-Term Effectiveness and Permanence

Potential health and environmental impacts could be associated with no further action at the site (Alternative 1), as described in the BA (DOE 1992c) and in Appendix E and Chapter 6 of the FS (DOE 1992d). The long-term effectiveness of Alternative 6a (chemical stabilization/solidification) is expected to be generally comparable to the other action alternatives (vitrification), and residual risks at the site would be reduced toward background levels. Potential impacts associated with the action alternatives are discussed in Chapters 2 and 6 of the FS. Under the hypothetical scenario of disposal cell failure, e.g., after 200 to 1,000 years in the absence of corrective measures, the wastes would be exposed to the elements. In this case, the effectiveness of Alternative 6a might be slightly lower than Alternative 7a, 7b, or 7c. The portion of waste that is vitrified under these alternatives would be expected to resist leaching for a longer time (thousands of years) compared with the chemically treated form (hundreds to thousands of years). However, this possible difference could be offset by differences in the likelihood that institutional controls could be lost in the distant future. For example, continuation of institutional controls into the extended long term at a commercial facility (Alternative 7b) might be more difficult to ensure than at a federally owned facility (for the remaining alternatives, including Alternative 6a).

6.2.4 Reduction of Toxicity, Mobility, and Volume

The reduction in toxicity, mobility, or volume through treatment would be greater for Alternatives 7a, 7b, and 7c compared with Alternative 6a. The volume of structural material and vegetation and wooden debris would be similarly reduced under each alternative; however, for the sludge and soil that would be treated by vitrification, some contaminants would be destroyed (e.g., the limited organic compounds), the others would be immobilized in a glass-like matrix, and the overall disposal volume would decrease by about 24%. Alternative 6a would also significantly reduce contaminant mobility by incorporating contaminants into a cement-like matrix, but contaminant toxicity would not change and the overall waste disposal volume would increase by about 12%.

6.2.5 Short-Term Effectiveness

The short-term effectiveness of Alternatives 6a and 7a would be comparable. Remedial action workers would apply engineering controls, e.g., they would wear respiratory protective equipment in indicated work areas, to maintain occupational exposures below applicable standards. Risks estimated for people off-site during the cleanup period, including individuals at Francis Howell High School, would be below EPA's target risk range for protecting human health. Short-term impacts associated with implementing Alternative 7b or 7c would be greater than those for Alternative 6a or 7a because of increased handling of waste material and transportation of the waste to the off-site locations. Potential health impacts associated with the cleanup period for each of the action alternatives are presented in detail in Appendix F of the FS.

6.2.6 Implementability

Alternative 6a would be the most straightforward of the final action alternatives to implement. Chemical stabilization/solidification is a reliable technology that has been proven at other sites, and it can be implemented with readily available resources. Implementing chemical stabilization/solidification at the Weldon Spring site (testing, design, construction, and start-up) is estimated to require about 4 years. Implementing Alternative 7a, 7b, or 7c would require significant scale-up of existing vitrification systems and application of that innovative technology to large waste volumes. Although the results of bench-scale testing have indicated that certain components of the Weldon Spring waste could be successfully vitrified, they also indicated the need for further testing to evaluate treatment of waste materials representing the extremes in chemical variability and to test treatment equipment that would be similar in type and function to that required for full-scale operations. Implementing vitrification at the Weldon Spring site (testing, design, construction, and start-up) has been estimated to require up to 7 years; however, this estimate involves greater uncertainty because of the innovative nature of the technology, and it might take much longer to establish an effective system for the site waste. Alternative 7b or 7c would require coordination of transportation, licensing, and permitting issues with local, state, and federal agencies and the establishment of administrative procedures (as appropriate) to dispose of the Weldon Spring waste at either off-site facility.

6.2.7 Cost

Alternative 6a is expected to be the least costly of the final action alternatives. Alternative 7a is estimated to cost about $25 million more than Alternative 6a because of the higher costs associated with the more complex treatment technology. Off-site disposal contributes significantly to the costs of Alternatives 7b and 7c, which are more than $100 million higher than the cost of Alternative 7a.

6.3 PREFERRED ALTERNATIVE

From the evaluation of final alternatives, Alternative 6a is identified as DOE's preferred alternative for remedial action at the chemical plant area of the Weldon Spring site. Under this alternative, material would be removed from contaminated areas and treated as appropriate; raffinate pit sludge, certain soil (e.g., from the quarry and beneath the pits), and process waste from the water treatment plants would be treated by chemical stabilization/solidification; structural material would be compacted; and vegetation and wooden debris would be composted to enhance biodegradation. All site waste would be disposed of in an engineered disposal cell constructed on-site at a location where appropriate geologic conditions exist. This cell would be designed to withstand natural forces such as heavy rains and earthquakes, and it would be designed to last for at least 200 to 1,000 years. By removing contaminated material from the various source areas of the site, residual risks would be reduced toward background levels (Section 4.4). The cell would be maintained and its performance would be monitored for the long term.

On the basis of currently available information, the preferred alternative provides the best balance of trade-offs among the final alternatives with respect to the evaluation criteria. This alternative would achieve substantial risk reduction by removing the sources of contamination, treating the material for which exposures result in the highest risks, and placing all material in an engineered cell designed for permanent containment. The preferred alternative can achieve this reduction in risk and protection of human health and the environment most reliably, in the least amount of time, and for the lowest cost of the final action alternatives.

Under the preferred alternative, the highly contaminated material at the site would be chemically stabilized and solidified. The components of Alternative 7a are similar to those of the preferred alternative except this material would be physically treated by vitrification. Although a number of problems are associated with trying to implement vitrification, this process would better reduce the toxicity, mobility, and volume of that portion of the waste being treated. Vitrification would destroy certain contaminants, e.g., the nitroaromatic compounds in the quarry waste, but the toxicity of radiation from the site waste would not be affected by either treatment method. Both treatment methods would immobilize contaminants in a solid product, but vitrification would reduce the overall waste volume by 24% whereas this volume would increase by 12% under Alternative 6a. In addition, because vitrification is an innovative technology for waste treatment, it merits special consideration under CERCLA, as amended. Therefore, Alternative 7a is being carried forward with Alternative 6a into the conceptual design phase of this action as a contingency remedy.

Continued consideration of vitrification together with chemical stabilization/ solidification allows DOE is promote the evaluation of an alternative technology for waste treatment and to provide treatment flexibility for site waste. The effective application of the two different methods could offer comparable results according to the integrated evaluation of the five primary balancing criteria. More information on the applicability and effectiveness of these two treatment methods will be available after conceptual design and other testing is completed. If vitrification were found to be more appropriate for the site pursuant to this continued evaluation, the contingency remedy would be selected, an explanation of the reasons for its selection would be provided to the public, and public input would be solicited.

The potential benefit associated with retaining vitrification as a contingency response relative to the balancing criteria is reviewed as follows. Both the chemical and physical treatment methods would be expected to significantly reduce risks associated with the portion of site waste that would be treated because those contaminants would be immobilized in a dispersion-resistant and leach-resistant matrix. Thus, Alternatives 6a and 7a would both provide a permanent solution that would ensure protection of human health and the environment for a very long time, e.g., for at least 200 to 1,000 years. However, it is possible that Alternative 7a could provide an incremental benefit in the very long term if it were hypothetically assumed that institutional controls were lost in the future and the cell subsequently failed without maintenance activities being taken.

Under this unlikely scenario, the waste within the cell could be subject to dispersal and leaching. The related benefit that might be observed in the distant future, e.g., after thousands of years, would result from the destruction of organic contaminants in that portion of the waste that was treated and the expectation that the vitrified product would be more resistant to leaching. That is, the glass-like particles of the vitrified material are expected to resist leaching for thousands of years, compared with hundreds to thousands of years for the cement-like matrix of the chemically treated counterpart under the preferred alternative. However, the vitrified portion of the waste would comprise only 15% of the total disposal volume, which means that the rest of the material in the cell would contribute the same contaminants to the leachate or dispersed material for either alternative. Thus, the actual benefit might be relatively small.

In addition, the projected effectiveness of vitrification cannot be confirmed for the volume and type of material that would be treated at the site because of the innovative nature of this technology for waste treatment. Forthcoming tests with similar waste at other DOE facilities are expected to provide better information on its applicability for site waste. However, because the vitrification process is much more complex than the chemical treatment process, more time would probably be needed to conduct engineering scale-up, design, construction, and start-up activities; determine appropriate operating procedures for the variable site waste; and obtain and train the operators. Therefore, it would probably take considerably longer to complete site cleanup under Alternative 7a. In addition, because emissions would be released from the stack of the vitrification facility, possible concerns of the local community and state regulators might lead to administrative problems that could further delay implementation of the vitrification alternative.

Also, resource commitments would be much higher for the vitrification alternative because it would take a tremendous amount of energy to vitrify the large volume of site waste targeted for treatment. Potential worker impacts would also be higher because additional hazards are associated with this process compared with chemical treatment and a larger work force would be required. These incremental impacts associated with the remedial action period are expected to offset the benefit that might occur after hundreds to thousands of years if the cell were to fail in the extended long term. Therefore, if future studies indicate that both treatment processes could be applied successfully for site waste, Alternative 6a would remain the preferred alternative. Nevertheless, to provide treatment flexibility in the event that it is needed for certain waste and to promote an alternative technology, Alternative 7a is being retained as a contingency response.

On the basis of information available at this time, DOE believes that both the preferred alternative and the contingency remedy would protect human health and the environment. Both would comply with regulatory requirements, with waivers as appropriate (Section 6.2); be cost-effective; utilize permanent solutions to the maximum extent practicable; and utilize treatment as a principal element of the response.

7 COMMUNITY PARTICIPATION

Input from the public is an important element of the decision-making process for cleanup actions at the Weldon Spring site. Comments on the proposed remedial action at the chemical plant area will be received during the public review period following issuance of the RI/FS-EIS documents. Oral comments will be received at the public meeting to be held for this action. Written comments may be either submitted at the public meeting or mailed before the close of the comment period to:

Stephen H. McCracken, Project Manager
U.S. Department of Energy
Weldon Spring Site Remedial Action Project Office
7295 Highway 94 South
St. Charles, Missouri 63304

Information relevant to the proposed remedial action is located in the administrative record and public document room at the Weldon Spring Site Remedial Action Project Office. Additional information repositories have been established at the following four locations:

Kathryn M. Linneman Branch
St. Charles City/County Library
2323 Elm Street
St. Charles, Missouri 63301

Spencer Creek Branch
St. Charles City/County Library
425 Spencer Road
St. Peters, Missouri 63376

Kisker Road Branch
St. Charles City/County Library
1000 Kisker Road
St. Peters, Missouri 63376

Francis Howell High School
7001 Highway 94 South
St. Charles, Missouri 63304

Information on file at these repositories includes the RI, BA, FS, and this proposed plan for remedial action at the chemical plant area. Supporting technical reports are available in the public reading room located at the site. For additional information, the lead agency can be contacted at the Weldon Spring Site Remedial Action Project Office at the address provided above; the telephone number is (314) 441-8086. The remedial project manager for EPA who can supply additional information is:

Mr. Daniel Wall
U.S. Environmental Protection Agency
Region VII
726 Minnesota Avenue
Kansas City, Kansas 66101
(913) 551-7710

For further information on DOE's CERCLA and NEPA processes, respectively, the following individuals can be contacted:

Ms. Kathleen Taimi, Director
Office of Environmental Compliance, EH-22
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, DC 20585
(202) 586-2113

Ms. Carol Borgstrom, Director
Office of NEPA Oversight, EH-25
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, DC 20585
(202) 586-4600 or (800) 472-2756

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