DOE/OR/21548-033

Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the Weldon Spring Site, Weldon Spring, Missouri

August 1988

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

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prepared by

J.M. Peterson, M.M. MacDonell, L.A. Haroun, F.K. Nowadly,* W.C. Knight,* and G.F. Vajda†

Energy and Environmental Systems Division, Argonne National Laboratory

prepared for

U.S. Department of Energy, Oak Ridge Operations Office, Weldon Spring Site Remedial Action Project, under Contract W-31-109-Eng-38

**Affiliated with Jacobs Engineering Group, Inc., Weldon Spring, Missouri.*

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NOTATION

The following is a list of the acronyms, initialisms, and abbreviations (including units of measure) used in this document.

ACRONYMS, ABBREVIATIONS, AND INITIALISMS

AEC	U.S. Atomic Energy Commission
ALARA	as low as reasonably achievable
ANL	Argonne National Laboratory
ARAR	applicable or relevant and appropriate requirement
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
DNR	Department of Natural Resources
DNT	dinitrotoluene
DOE	U.S. Department of Energy
DOE-HQ	U.S. Department of Energy-Headquarters
DOE-OR	U.S. Department of Energy-Oak Ridge Operations
DOE-RL	U.S. Department of Energy-Richland Operations
DOE-WSS	U.S. Department of Energy-Weldon Spring Site Project Office
EA	environmental assessment
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ERA	expedited response action
FFA	Federal Facility Agreement
FONSI	finding of no significant impact
FS	feasibility study
ICRP	International Commission on Radiological Protection
IRA	interim response action
MKT	Missouri-Kansas-Texas (Railroad)
MSL	mean sea level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act
NLO	National Lead Company of Ohio
NPL	National Priorities List
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
QAPP	quality assurance project plan
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
ROD	record of decision
SARA	Superfund Amendments and Reauthorization Act
SCCAHW	St. Charles Countians Against Hazardous Waste

SFMP	Surplus Facilities Management Program
SLAPS	St. Louis Airport Site
TCL	Target Compound List
TNT	trinitrotoluene

UNITS OF MEASURE

°C	degree(s) Celsius
°F	degree(s) Fahrenheit
cfs	cubic feet per second
Ci	curie(s)
cm	centimeter(s)
cm^3	cubic centimeter(s)
ft	foot (feet)
ft^2	square foot (feet)
gal	gallon(s)
g	gram(s)
gpm	gallon(s) per minute
h	hour(s)
ha	hectare(s)
in.	inch(es)
km	kilometer(s)
km^2	square kilometer(s)
L	liter(s)
μg	microgram(s)
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
mg	milligram(s)
mi	mile(s)
mi^2	square mile(s)
mph	mile(s) per hour
pCi	picocurie(s)
ppb	part(s) per billion
ppm	part(s) per million
rem	Roentgen equivalent man
s	second(s)
t	metric ton(s)

1 INTRODUCTION

1.1 SUMMARY AND BRIEF HISTORY OF THE WELDON SPRING SITE REMEDIAL ACTION PROJECT

The Weldon Spring Site Remedial Action Project is being conducted as a Major System Acquisition under the Surplus Facilities Management Program (SFMP) of the U.S. Department of Energy (DOE). The major goals of the SFMP are to eliminate potential hazards to the public and the environment that are associated with contamination at SFMP sites and to make surplus real property available for other uses to the extent possible.

The Weldon Spring site is located near Weldon Spring, Missouri, about 48 km (30 mi) west of St. Louis (Figure 1). It is surrounded by large tracts of land owned by the federal government and the state of Missouri. The site consists of four raffinate pits, an inactive chemical plant, and a contaminated quarry. The raffinate pits and chemical plant are on adjoining land about 3.2 km (2 mi) southwest of the junction of Missouri (State) Route 94 and U.S. Route 40/61, with access from Route 94. The quarry is located in a comparatively remote area about 6.4 km (4 mi) south-southwest of the raffinate pits and chemical plant area; the quarry can also be accessed from Route 94. These areas are fenced and closed to the public.

From 1941 to 1944, the U.S. Department of the Army operated the Weldon Spring Ordnance Works, constructed on the land that is now the Weldon Spring site, for production of trinitrotoluene (TNT) and dinitrotoluene (DNT). The Army used the quarry for disposal of rubble contaminated with TNT. In the mid 1950s, 83 ha (205 acres) of the ordnance works property was transferred to the U.S. Atomic Energy Commission (AEC); this is now the raffinate pits and chemical plant area. An additional 6 ha (15 acres) was later transferred to the AEC for expansion of waste storage capacity. From 1957 to 1966, the AEC operated a uranium-processing facility at the Weldon Spring uranium feed materials plant, which subsequently became the Weldon Spring chemical plant. Ore concentrates and some scrap metal were processed at the plant, and products that included uranium metal were then shipped to other sites. Thorium-containing materials were processed on an intermittent basis. Radioactive raffinates from the processing were placed in four on-site pits. Other radioactive wastes were disposed of in the quarry.

After closure by the AEC, the chemical plant was reacquired by the Army in 1967. The Army partially decontaminated several buildings, dismantled some of the equipment, and began converting the facilities to produce herbicides. In 1969, prior to becoming operational, the herbicide project was canceled. In 1971, the Army returned the 21-ha (51-acre) portion of the site containing the raffinate pits to the AEC. As successor to the AEC, DOE assumed responsibility for the raffinate pits. In 1984, the Army repaired several of the buildings at the chemical plant; decontaminated some of the floors, walls, and ceilings; and isolated some contaminated equipment.

Several areas in the vicinity of the raffinate pits and chemical plant area and the quarry, but outside of current fenced boundaries, are radioactively and chemically

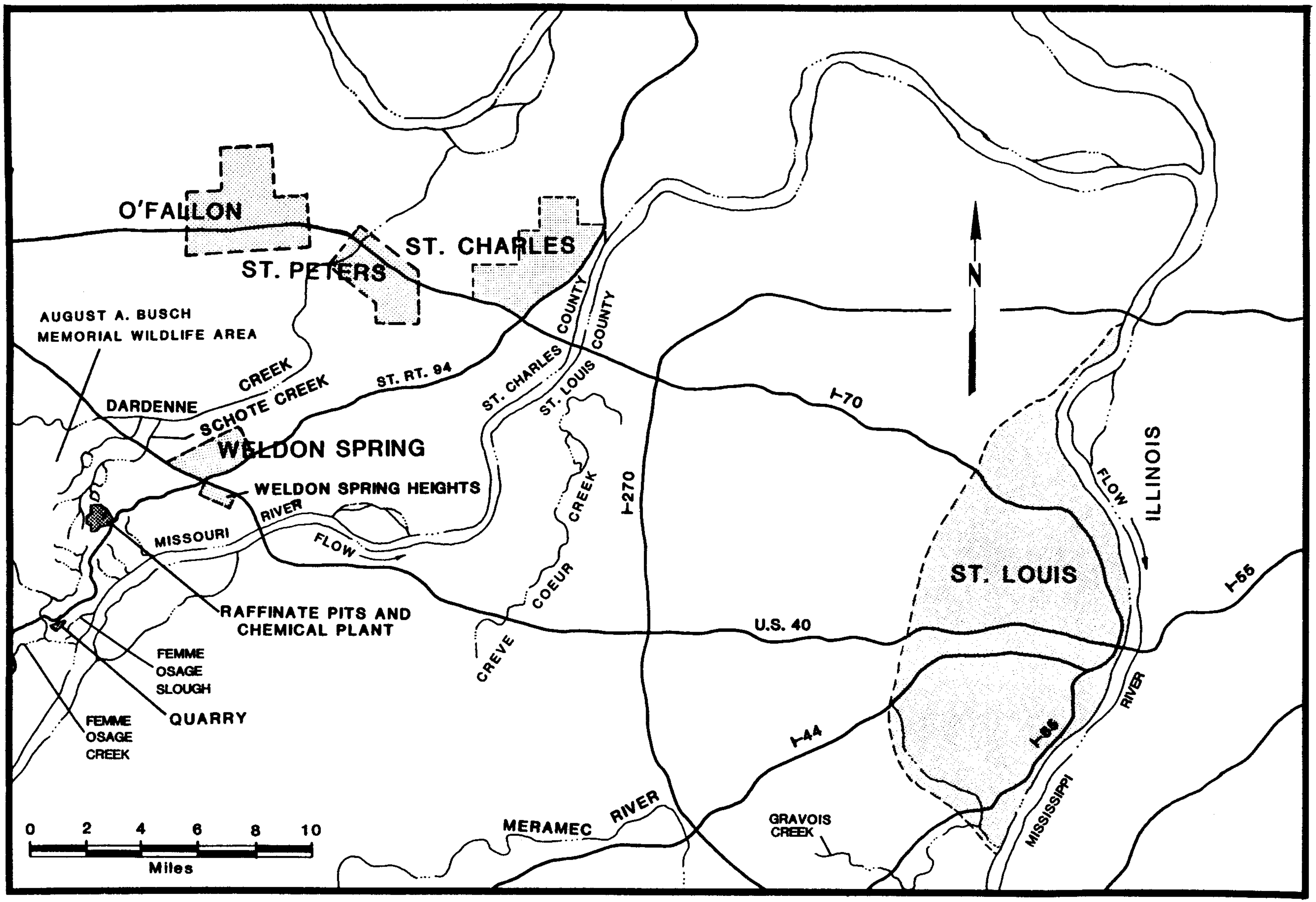


FIGURE 1 Area and Vicinity Map of the Weldon Spring Site, Weldon Spring, Missouri

contaminated as a result of activities previously carried out at the Weldon Spring site. These contaminated areas are termed vicinity properties. The DOE is responsible for the contaminated vicinity properties associated with previous uranium-processing activities conducted at the site. This contamination consists of radioactive constituents (i.e., uranium, thorium, and radium) and any chemicals associated with the processing of these materials. The DOE is also responsible for any chemical contamination that is mixed with radioactive contamination. The U.S. Department of the Army is responsible for contamination on vicinity properties resulting from previous ordnance production activities. The DOE is continuing to work with the Army in identifying off-site areas contaminated as a result of Army activities. To minimize disturbance of the environment, DOE will coordinate the cleanup of vicinity properties with the Army.

In May 1985, DOE designated the control and decontamination of the Weldon Spring site as a Major Project (this project has since been designated as a Major System Acquisition). In October 1985, custody of the chemical plant was transferred to DOE. A project management contractor for the Weldon Spring Site Remedial Action Project was selected in February 1986, and a DOE project office was established on the site in July 1986. The project management contractor, MK-Ferguson Company, assumed control of the Weldon Spring site on October 1, 1986.

On October 15, 1985, the U.S. Environmental Protection Agency (EPA) proposed to include the quarry on the National Priorities List (NPL). This listing occurred on July 30, 1987. On June 24, 1988, EPA proposed to expand this designation to include the raffinate pits and chemical plant area.

1.2 OVERVIEW OF THE ENVIRONMENTAL COMPLIANCE PROCESS

In February 1987, DOE issued a draft environmental impact statement (EIS) to assess the environmental impacts of alternatives for long-term management of contaminated materials associated with remedial action at the Weldon Spring site (U.S. Dept. Energy 1987a). The draft EIS was prepared in accordance with the National Environmental Policy Act (NEPA), as implemented by regulations promulgated by the Council on Environmental Quality (CEQ) and DOE's implementing guidelines. A Notice of Intent to prepare this draft EIS was issued March 2, 1984, in the *Federal Register*, and a public scoping process was conducted. The draft EIS was prepared taking into account the comments received during the scoping process.

The response actions, i.e., removal actions and remedial actions, to be carried out by DOE at the Weldon Spring site are subject to EPA oversight under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA). For this project, the oversight function is being carried out by EPA Region VII. Because preparation of the draft EIS was already in progress when EPA's role in the project was identified, DOE and EPA entered into a Federal Facility Agreement (FFA) in August 1986 whereby the respective responsibilities of these two agencies were defined. By this agreement, DOE intended to meet EPA's remedial investigation/feasibility study (RI/FS) requirements under CERCLA with the EIS and supporting documentation.

Since publication of the draft EIS in February 1987, the Phase I water quality assessment (U.S. Dept. Energy 1987c) has provided significant new information relevant to environmental concerns at the Weldon Spring site. In response to this new information (i.e., high concentrations of nitrates and sulfates and significant quantities of nitroaromatics in the groundwater at the site), DOE announced in June 1987 its intent to issue for public comment a revised draft EIS on remedial action at the Weldon Spring site. Since that time, EPA Region VII has formally requested that DOE prepare an RI/FS for this project, pursuant to the requirements of CERCLA. The DOE and EPA have agreed that the appropriate environmental review required by an RI/FS and an EIS can be more expeditiously accomplished by incorporating those elements required by an EIS into the format of an RI/FS (herein referred to as an RI/FS-EIS). The purpose of this work plan is to describe the integrated process by which DOE intends to implement the Weldon Spring Site Remedial Action Project.

This document consists of three parts. The first part is an RI/FS-EIS work plan (essentially an RI/FS work plan prepared in accordance with EPA guidance), which (1) is typically prepared prior to detailed site characterization activities, (2) summarizes existing information regarding the site, and (3) serves to integrate the site characterization and analysis of alternatives phases of the remedial action process. The second part of this document (Appendix A) augments the information given in the body of the RI/FS-EIS work plan and contains information necessary to ensure compliance with DOE procedures for preparation of an EIS. This appendix was prepared in accordance with DOE guidance for an EIS implementation plan. The third part of the document (Appendix B) consists of responses to the major issues raised during public review of the draft EIS.

For purposes of investigation and evaluation relevant to the Weldon Spring Site Remedial Action Project, the Weldon Spring site has been divided into two separate areas: (1) the raffinate pits and chemical plant area and (2) the quarry. These two areas are considered to be one site for purposes of NEPA and CERCLA compliance. However, because the areas are geographically separate and have very distinct physical characteristics, it is reasonable to treat them separately for purposes of environmental analysis. The seven environmental compliance components associated with these two areas are shown in Figure 2. The relationship of these environmental compliance components to the RI/FS-EIS are shown in Figure 3.

Several distinct response actions may be needed at each of these two areas. The three major actions currently envisioned for the raffinate pits and chemical plant area are (1) management of the contaminated surface structures, raffinate pit wastes, surface water, and soils; (2) assessment of the need to restore contaminated groundwater; and (3) cleanup of contaminated vicinity properties. These three actions will be addressed in the RI/FS-EIS and supported by a single response decision. This decision will also include disposition of the bulk wastes currently in the quarry (Figure 3). It is possible that the groundwater restoration issue will be ready for a decision at a different time than the waste disposal issue. If this is the case, DOE may handle groundwater restoration as a separate operable unit to satisfy the requirements of NEPA and CERCLA for this decision.

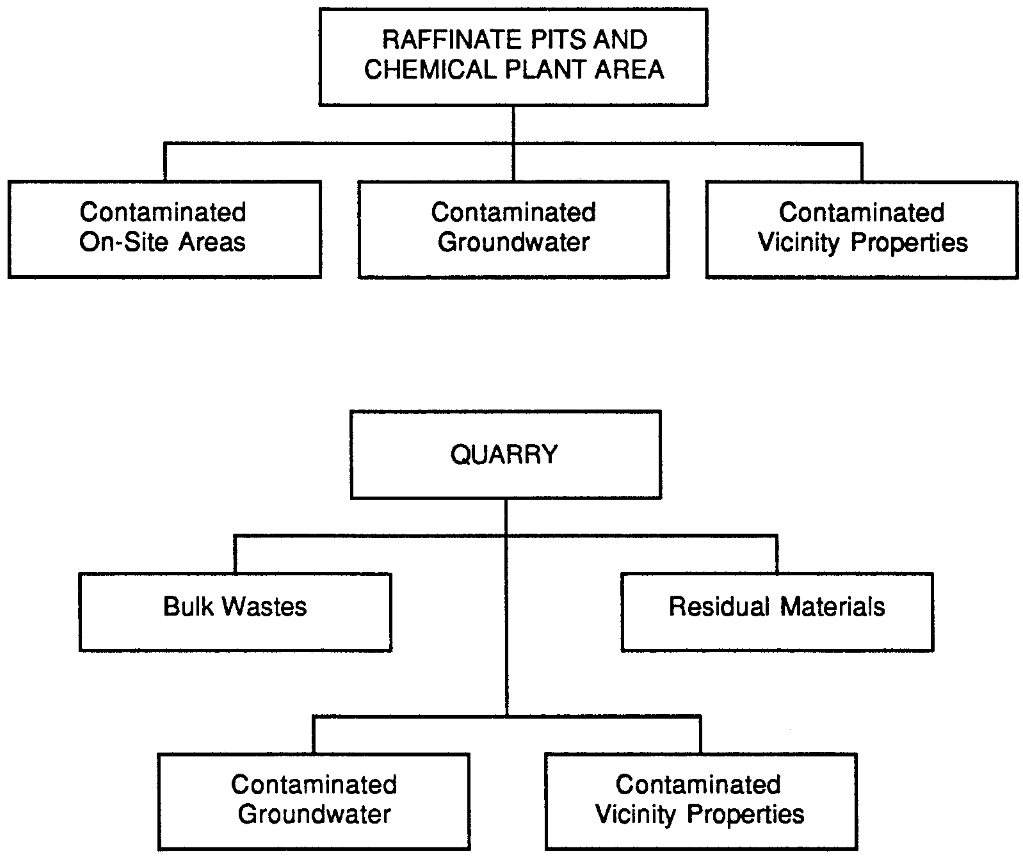


FIGURE 2 Environmental Compliance Components for the Weldon Spring Site Remedial Action Project

Four distinct response actions may be required at the quarry: bulk waste removal, removal of any residual materials following bulk waste removal, groundwater restoration, and cleanup of contaminated vicinity properties. The DOE is proposing to address bulk waste removal as a separate operable unit and will prepare a separate RI/FS and environmental assessment (EA) to support this decision (see additional discussion in Section 3.11 of this work plan). The need to remove any residual materials following bulk waste removal and the need to restore groundwater at the quarry cannot be determined until the bulk wastes have been removed and the remaining conditions evaluated. The DOE will address this issue following bulk waste removal and will involve EPA Region VII and the state of Missouri in its determination. Although removal of residual materials and groundwater restoration are shown as two separate compliance components (or operable units) in Figures 2 and 3, these may be addressed as one operable unit pending the results of environmental investigations at the quarry following bulk waste removal.

Of the vicinity properties for which it is responsible, DOE is planning to clean up those that pose an unacceptable risk to public health and the environment. Management

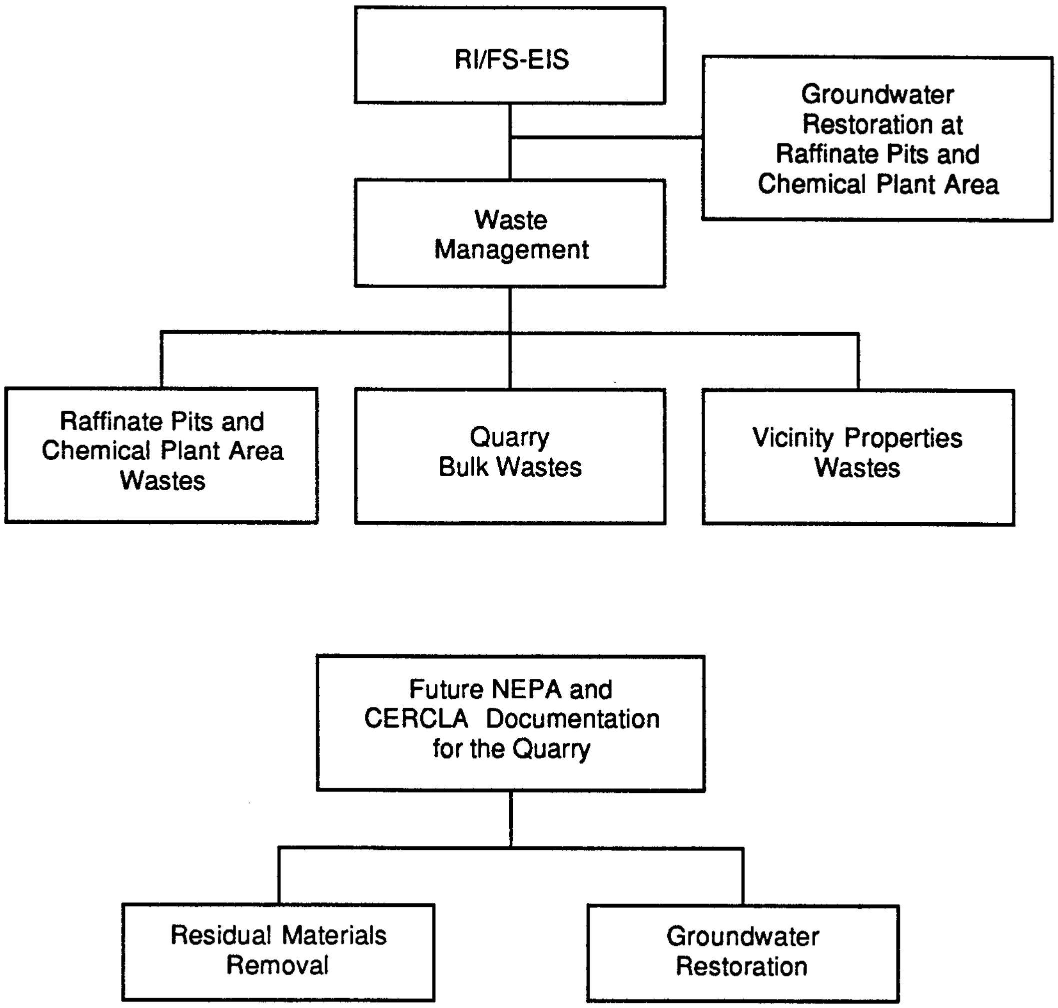


FIGURE 3 Environmental Compliance Documentation for the Weldon Spring Site Remedial Action Project

of the resulting contaminated materials will be included in the record of decision (ROD) for disposition of the raffinate pits and chemical plant area (including the bulk quarry wastes). Appropriate NEPA and CERCLA compliance documentation will be prepared prior to cleanup of the vicinity properties. Those vicinity properties cleaned up prior to the ROD will be addressed per the modified engineering evaluation/cost analysis (EE/CA) process discussed in Section 3.10.1. The cleanup of any remaining vicinity properties at the raffinate pits and chemical plant area will be included in the RI/FS-EIS. A thorough study of the need for additional cleanup of vicinity properties in the quarry area will be part of the NEPA and CERCLA processes for the residual materials and groundwater restoration operable units at the quarry.

1.3 SUMMARY OF PROPOSED APPROACH

The DOE proposes to implement a multifaceted approach at the Weldon Spring site, consisting of the following elements:

- A thorough site characterization program will be completed prior to issuance of the RI/FS-EIS for public review. The results of this characterization program will be documented in an RI report that will provide the level of environmental information required to support decisions under both NEPA and CERCLA.

- Concurrent with site characterization, a baseline risk assessment will be prepared to determine the potential threats to public health and the environment in the absence of any remedial action at the site. The results of this assessment will be included as the near-term impacts for the no-action alternative in the FS-EIS.

- The RI/FS-EIS will be prepared to analyze various alternatives for conducting remedial action at the Weldon Spring site consistent with the requirements of NEPA and CERCLA.

- Prior to issuance of the ROD for this project, various interim response actions (IRAs) will be performed to mitigate actual or potential uncontrolled releases of radioactively or chemically hazardous substances to the environment. The scope of the IRAs will be limited to those actions that can be performed under CERCLA and within the constraints of CEQ regulations for NEPA (i.e., actions will be limited to those that do not have adverse environmental impacts or limit the choice of reasonable alternatives for the ultimate disposition of the site).

- Also prior to issuance of this ROD, DOE is planning to remove the bulk wastes from the quarry and transport them to the raffinate pits and chemical plant area for temporary storage; this will be accomplished as a separate operable unit. This action will be documented in an RI/FS and EA and will be conducted within the same constraints of CEQ regulations for NEPA as the IRAs.

Several actions will occur prior to the ROD for waste disposal. The quarry bulk wastes are proposed to be removed and placed in temporary storage at the raffinate pits and chemical plant area. In addition, various IRAs will be performed, including decontamination of certain vicinity properties, as well as other actions that will alter the environmental conditions at the raffinate pits and chemical plant area. The baseline risk assessment will be prepared using current site conditions. If appropriate, this assessment will be updated at the time the RI/FS-EIS is issued to accurately reflect site conditions at that time.

This multifaceted approach has several advantages:

- Because the RI/FS-EIS will be in a format providing the level of detail required by both NEPA and CERCLA, separate documentation for NEPA and CERCLA will not be required. The DOE, in cooperation with EPA Region VII and the state of Missouri, will ensure that all NEPA and CERCLA requirements are contained within the RI/FS-EIS.

- This approach is intended to result in a single ROD by both DOE and EPA.

- This approach provides for the appropriate degree of public participation required under NEPA and CERCLA.

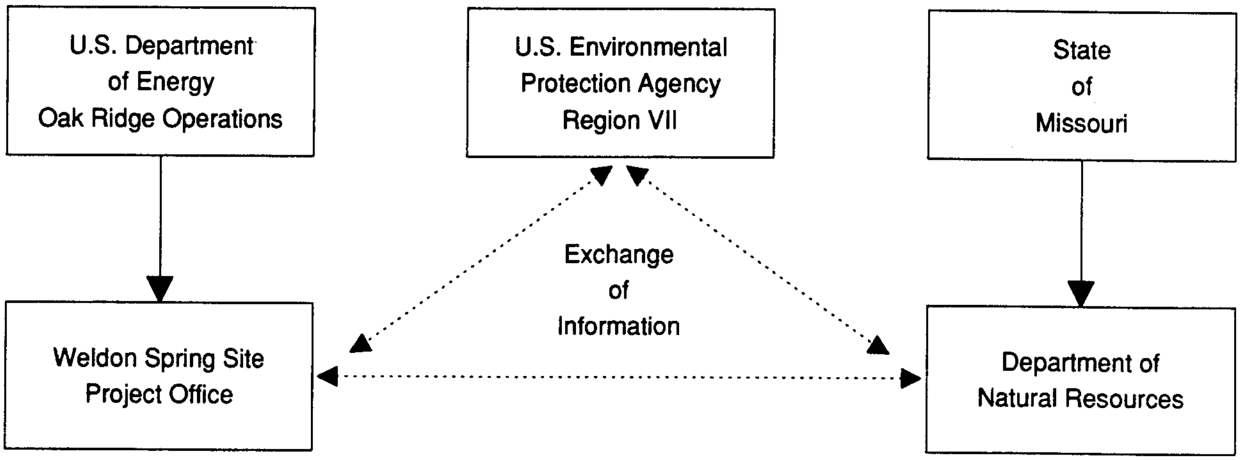
- Limited actions can be initiated via the IRAs to ensure the health and safety of on-site personnel and to minimize or preclude off-site releases of contamination.

- Removal of the bulk wastes from the quarry will reduce the risk to public health and the environment by eliminating the primary source of contamination in this area and reducing the potential for migration.

This approach will allow DOE to meet the requirements of NEPA and CERCLA and to initiate response action activities expeditiously.

The FFA signed in August 1986 provides for an exchange of information and expertise between EPA Region VII and DOE, and it establishes a basis for delisting the Weldon Spring site from the NPL upon completion of the Weldon Spring Site Remedial Action Project. This agreement, which was signed prior to the promulgation of SARA in October 1986, may need to be revised to incorporate new requirements mandated by SARA. The need for such revisions is being discussed with EPA. The DOE will also consult with the state of Missouri on this project. The DOE will interface directly with the Missouri Department of Natural Resources (DNR), the agency designated by the state of Missouri to coordinate state involvement. The relationship between DOE, EPA, and the Missouri DNR and the major responsibilities of each are shown in Figure 4. Through its community relations plan, DOE will also exchange information with the St. Charles County Commission, federal and state legislators from Missouri, local citizens, and public interest groups.

Two additional agencies that are directly involved in this project are the U.S. Geological Survey (USGS) and the University of Missouri. These agencies are funded by DOE and perform specific geological and hydrological studies based on their expertise and experience in these areas.



U.S. Department of Energy	U.S. Environmental Protection Agency	Missouri Department of Natural Resources
Perform environmental analyses and prepare NEPA and CERCLA documentation in accordance with existing requirements and guidance.	Ensure compliance with NEPA and CERCLA requirements.	Ensure compliance with state environmental review requirements. Coordinate review and response of other appropriate state agencies.
Prepare engineering and characterization plans and reports.	Review engineering and characterization plans and reports.	Review engineering and characterization plans and reports.
Monitor the environment before, during, and after response action activities to ensure a safe environment for the nearby population.	Ensure a safe environment for the workers and nearby population.	Ensure a safe environment for the workers and nearby population. Conduct independent environmental monitoring, as appropriate.
Perform response action activities.	Oversee response action activities.	Oversee response action activities. Perform special studies, as appropriate.

FIGURE 4 Relationship between the U.S. Department of Energy, U.S. Environmental Protection Agency Region VII, and State of Missouri for the Weldon Spring Site Remedial Action Project

This work plan presents a description of the Weldon Spring site, its history, and the existing environmental setting. In addition, the document includes an initial evaluation of site contamination, environmental transport mechanisms, and potentially exposed individuals. It also presents the procedures that will be followed to obtain data that, with evaluation, will allow the RI/FS-EIS process to be completed and documented. As a component of the overall program of project management, quality assurance, and quality control, this work plan also includes a description of the organization, project controls, and task schedules that will be employed to fulfill the requirements of the proposed studies.

2 SITE BACKGROUND AND SETTING

2.1 SITE DESCRIPTION

The 21-ha (51-acre) raffinate pits area at the Weldon Spring site contains four surface impoundments (raffinate pits) covering approximately 11 ha (26 acres). These pits were constructed by excavating the existing clay formation and using the removed clay to construct the dikes. The raffinate pits contain the residues from uranium and thorium processing operations previously conducted at the chemical plant (U.S. Dept. Energy 1987a). These residues are generally covered with water during the entire year. Ash Pond and Frog Pond are two additional surface water bodies in the chemical plant area. The 67-ha (166-acre) chemical plant consists of 13 major buildings and approximately 30 support structures, as shown in Figure 5 (U.S. Dept. Energy 1987c).

The quarry is located in limestone and covers about 3.6 ha (9 acres). The deepest part is filled with water covering about 0.2 ha (0.5 acres) and is the only surface water body within this controlled area. The layout of the quarry is shown in Figure 6. The quarry was used for disposal of a variety of wastes at different times during the Weldon Spring site's operational period. A major source of potable groundwater in this area is the county well field located about 1.6 km (1 mi) southeast of the quarry in the Missouri River alluvium (U.S. Dept. Energy 1987a). The nearest well is located about 0.8 km (0.5 mi) from the quarry.

The Weldon Spring site is located within the St. Louis metropolitan area in St. Charles County. The St. Louis metropolitan area has a population in excess of 2.5 million. The communities of Weldon Spring and Weldon Spring Heights are located approximately 3.2 km (2 mi) from the chemical plant and raffinate pits area and have a combined population of about 800. The Francis Howell High School is located about 1 km (0.6 mi) east of the raffinate pits and chemical plant area on State Route 94. An estimated 2,300 persons are on campus daily during the school year (U.S. Dept. Energy 1987a). The largest city in St. Charles County is the city of St. Charles, which is located about 24 km (15 mi) northeast of the raffinate pits and chemical plant area and has a population of about 40,000. St. Charles County has been experiencing a rapid population growth in the last few decades. The 1980 population of 144,000 represented a 55% increase over the 1970 population.

2.2 SITE HISTORY

In 1941, the U.S. Department of the Army acquired about 7,000 ha (17,000 acres) of land in St. Charles County, Missouri. The Weldon Spring Ordnance Works was constructed on this land and was operated for the Army as a TNT and DNT explosives production facility from November 1941 through January 1944 by Atlas Powder Company. The ordnance works was closed and declared surplus to Army needs in April 1946. By 1949, all but about 810 ha (2,000 acres) had been transferred to the state of Missouri (August A. Busch Memorial Wildlife Area) and the University of Missouri (agricultural research land). A large portion of the land transferred to the University of Missouri is now included in the Weldon Spring Wildlife Area. Except for several small parcels

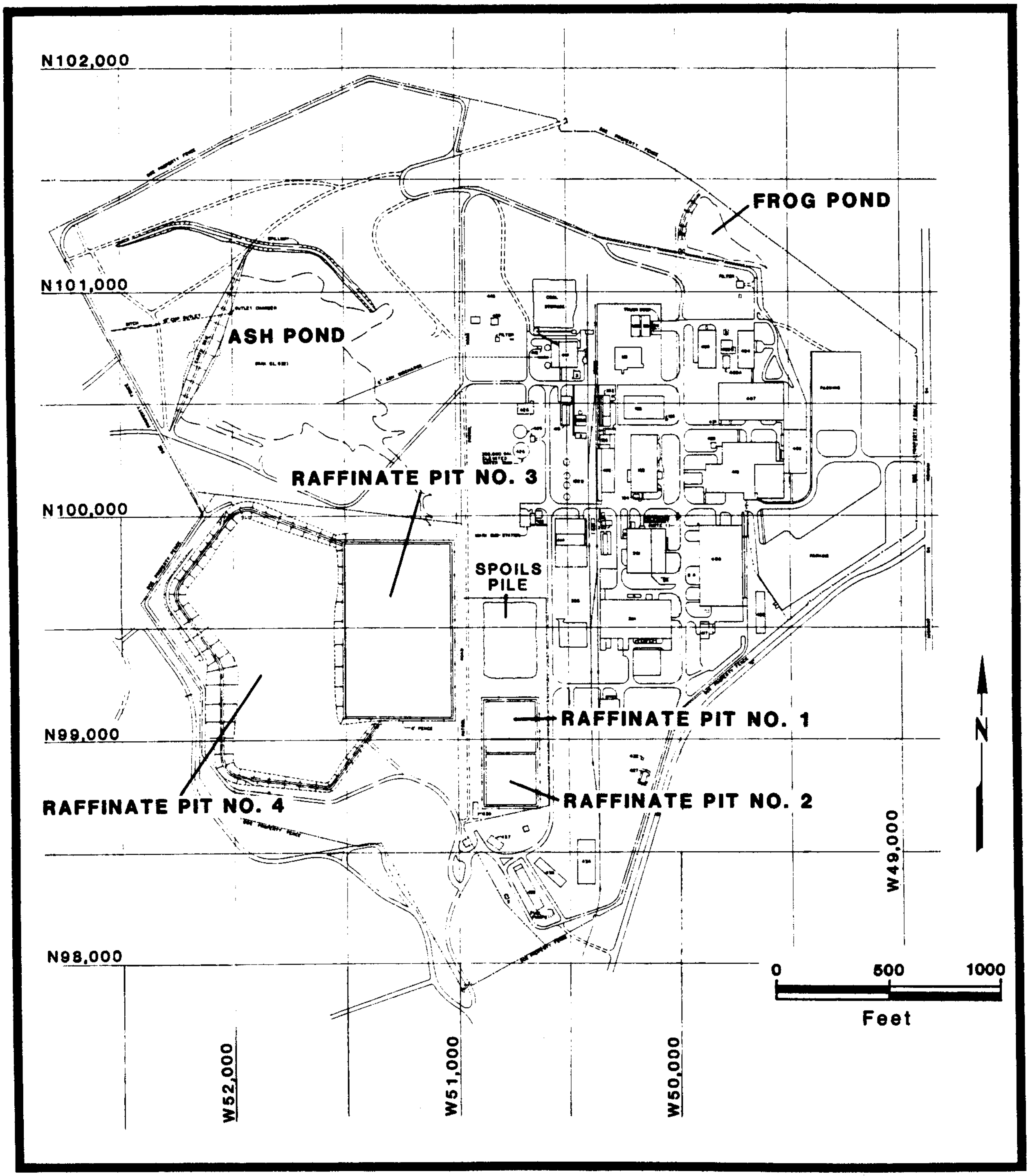


FIGURE 5 Layout of the Weldon Spring Raffinate Pits and Chemical Plant Area

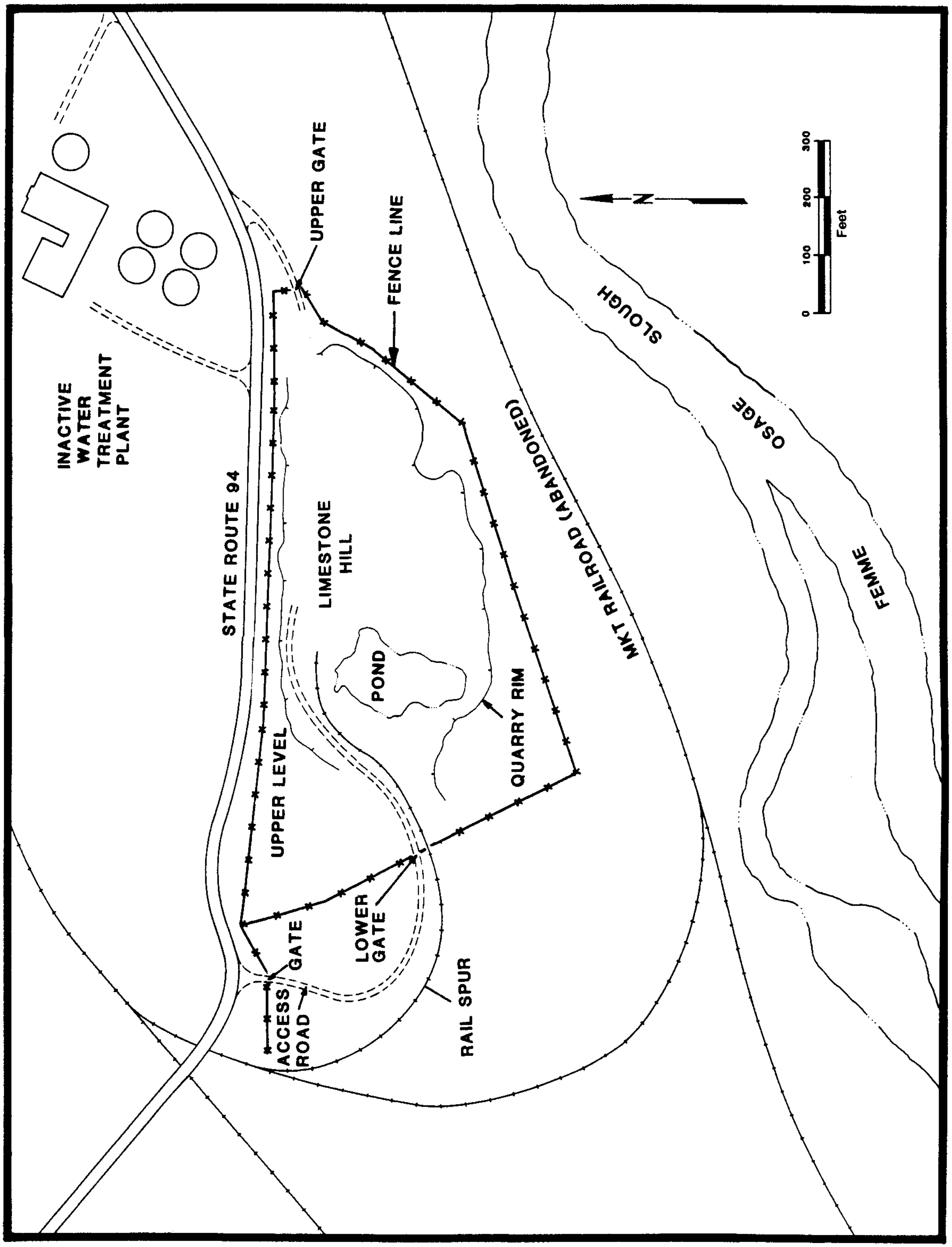


FIGURE 6 Layout of the Weldon Spring Quarry

transferred to St. Charles County, the remaining property became the current Weldon Spring site and the adjacent U.S. Army Reserve and National Guard Training Area.

Through a memorandum of understanding between the Secretary of the Army and the General Manager for the AEC in May 1955, 83 ha (205 acres) of the former ordnance works was transferred to the AEC for construction and operation of the Weldon Spring Uranium Feed Materials Plant. Considerable explosives decontamination was performed prior to construction of the plant. The feed materials plant processed uranium and thorium ore concentrates from 1957 to 1966, with the Uranium Division of Mallinckrodt Chemical Works acting as the AEC operating contractor.

During plant operations, uranium ore concentrates and recycled scrap were processed to produce uranium trioxide, uranium tetrafluoride, and uranium metal; an average of 14,000 t (16,000 tons) of uranium materials was processed per year. In addition, a limited amount of thorium ore concentrates was processed at the plant. These processes generated several chemical and radioactive waste streams, including raffinates from the refinery operation and magnesium fluoride slurry (washed slag) from the uranium recovery process. These streams were slurried to the raffinate pits where the solids settled out and the supernatant liquids were decanted to the plant process sewer; this sewer drained off-site to the Missouri River. The solids remaining in the pits consist of silica and other insoluble metals and oxides associated with the uranium ore feed materials, hydroxides and other precipitates formed from lime neutralization of the raffinates, and washed slag residues from uranium metal production.

The AEC closed the feed materials plant in December 1966; however, in August 1967, the plant was selected as the site for an herbicide production facility. The AEC granted a license to the Army for the radioactive source material that was present as contamination throughout the site. On December 31, 1967, the feed materials plant was transferred to the Kansas City District of the U.S. Army Corps of Engineers for the design and construction of the herbicide facility. Excluded from the transfer were custody and control of the source and special nuclear material stored in the four raffinate pits. Because the AEC did not elect to remove the source and special nuclear material, the 21 ha (51 acres) on which the raffinate pits are located was transferred back to the AEC in December 1971.

Decontamination and dismantling operations at the feed materials plant, now referred to as the chemical plant, were initiated for the Army in January 1968 by Thompson-Stearns-Roger Corporation to allow for construction of the herbicide facility. However, the extensive decontamination effort and associated costs required to meet radiological contamination limits imposed on the facility, combined with a reduction in the military's requirements for herbicides, resulted in cancellation of the project on February 4, 1969. The cancellation occurred before any processing activities were initiated. The Army retained responsibility for the land and facilities at the chemical plant.

The National Lead Company of Ohio (NLO) was contracted by the AEC to perform environmental monitoring and maintenance of the raffinate pits and quarry. Bechtel National, Inc. -- under contract to DOE -- assumed management responsibility for the raffinate pits and quarry from NLO in October 1981. In November 1984, DOE was directed by the Office of Management and Budget to assume custody and accountability for the chemical plant from the Army. This transfer occurred on October 1, 1985. The site is currently under control of DOE and its project management contractor, MK-Ferguson Company.

2.3 ENVIRONMENTAL SETTING

2.3.1 Physical Setting

The Weldon Spring site is located in two distinct physiographic regions. The raffinate pits and chemical plant area is situated at the southern edge of the dissected till plains of the Central Lowlands Physiographic Province. The quarry is located about 6.4 km (4 mi) south-southwest of the raffinate pits and chemical plant area on the northern flank of the Salem Plateau of the Ozark Plateaus Physiographic Province. Parts of the raffinate pits and chemical plant area are covered with buildings and ponds, and the remainder is covered with vegetation (predominately grasses, shrubs, and small trees), gravel, or paved surfaces. The August A. Busch Memorial Wildlife Area is located 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 of the raffinate pits and chemical plant area. At the quarry, which is surrounded by the Weldon Spring Wildlife Area, vegetation consists largely of grasses, shrubs, and small trees. The deepest portion of the quarry is filled with water.

The Missouri River is located approximately 2.4 km (1.5 mi) southeast of the raffinate pits and chemical plant area and 1.6 km (1 mi) east of the quarry. At its closest point to the Weldon Spring site, the Mississippi River lies about 23 km (14 mi) north of the raffinate pits and chemical plant area and about 29 km (18 mi) north of the quarry. Surface hydrological features in the vicinity of the Weldon Spring site are shown in Figure 7.

2.3.2 Topography and Site Drainage

The Weldon Spring site is located in the southwest portion of St. Charles County. The county, roughly triangular in shape, is bounded by the Mississippi River on the north and east and the Missouri River on the south. Approximately half of the county land is floodplain and half is uplands characterized by gently rolling topography. The southwest uplands, which contain the site, are dissected by small stream valleys.

The raffinate pits and chemical plant area straddles the watershed divide that separates the Mississippi and Missouri river valleys. Gently rolling topography characterizes areas to the north and west whereas the terrain to the south and east is heavily wooded, rugged, and ravined (Figure 8). Elevations range from approximately 190 m (610 ft) mean sea level (MSL) near the northern edge of the raffinate pits and chemical plant area to approximately 200 m (670 ft) MSL near the southern edge.

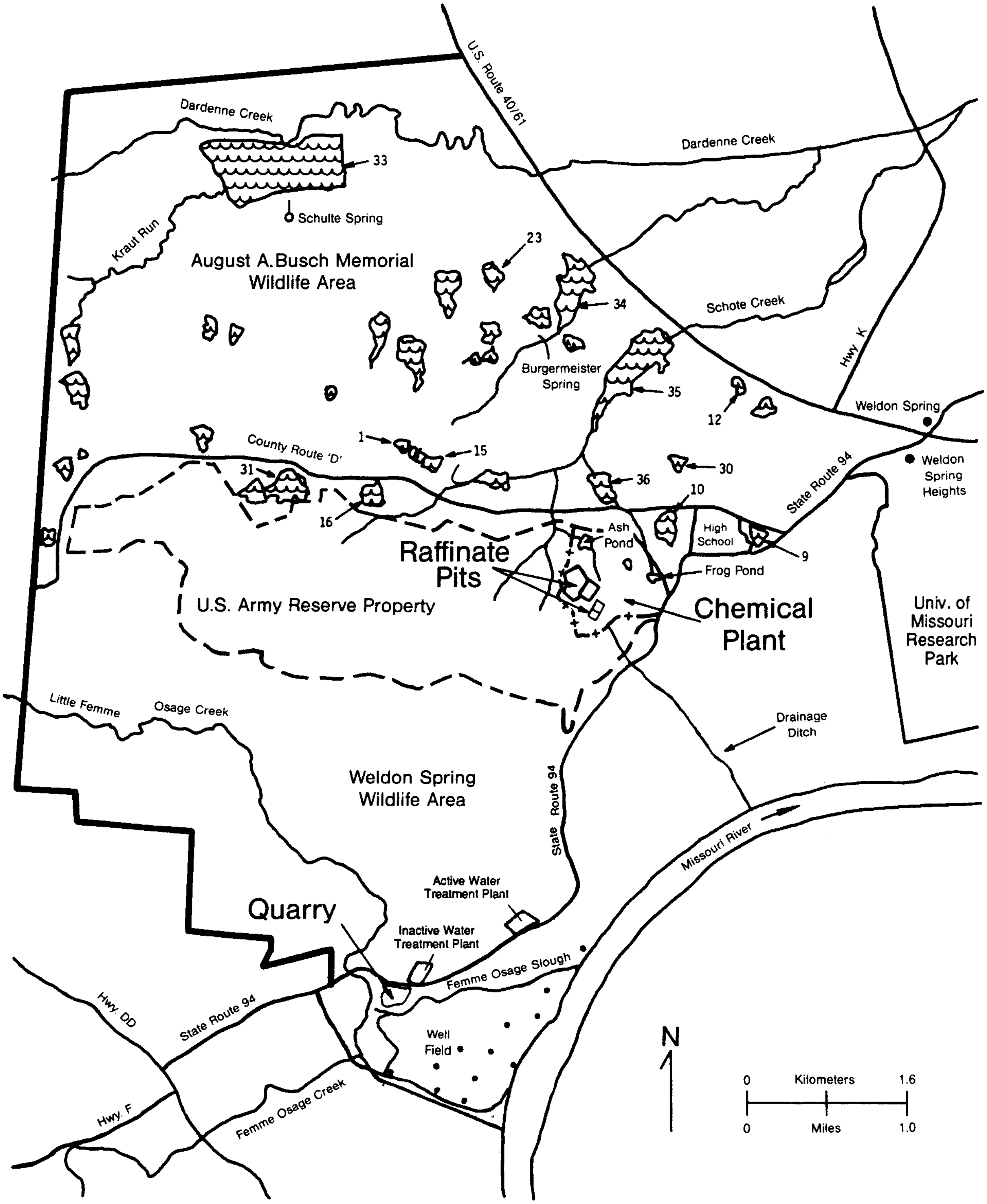


FIGURE 7 Surface Hydrological Features in the Vicinity of the Weldon Spring Site (the numbers refer to lakes in the Busch Wildlife Area) (Source: Modified from U.S. Department of Energy 1987a)

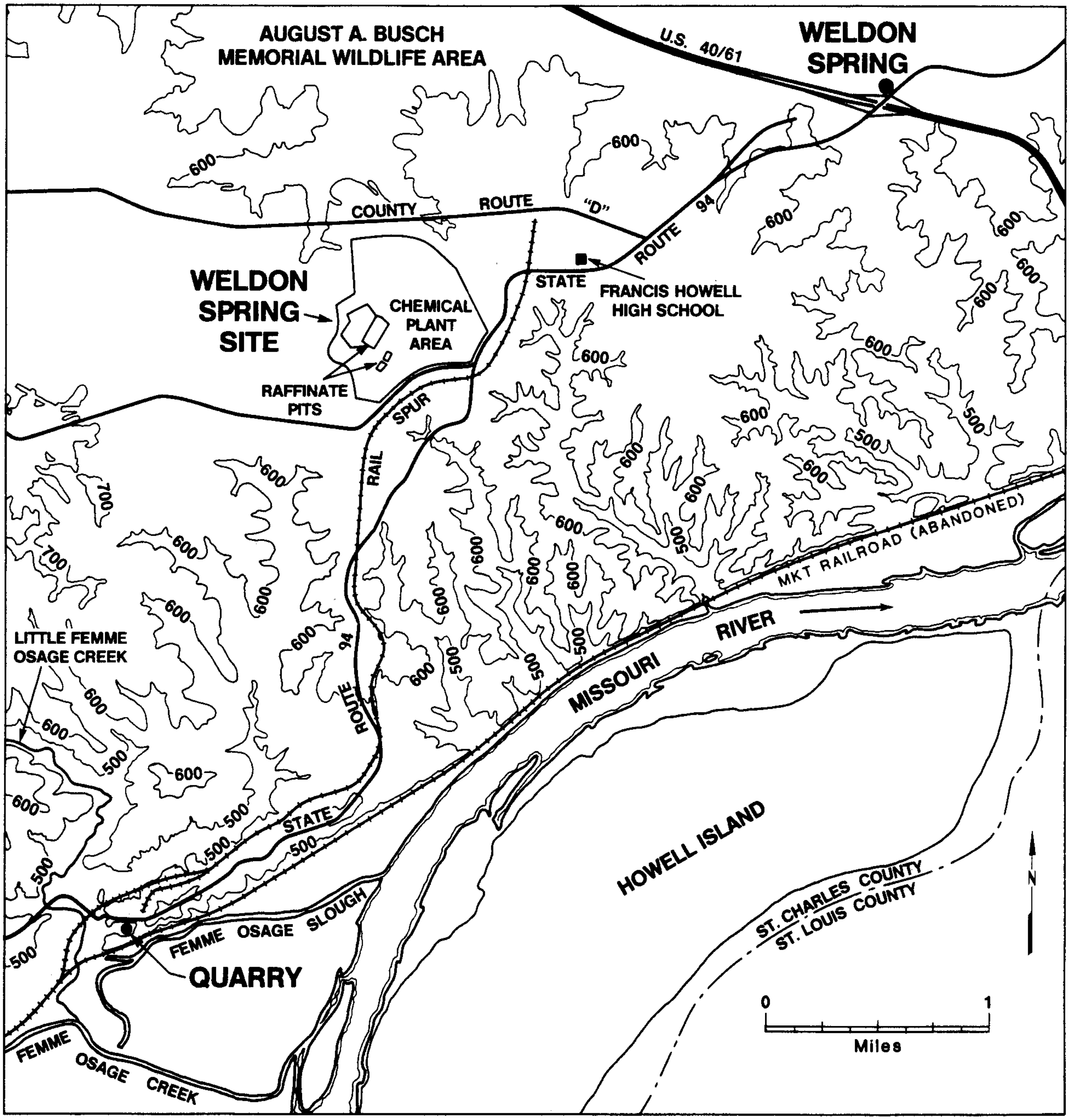


FIGURE 8 Topographic Map of the Weldon Spring Area (Elevations in Feet above MSL) (Source: Modified from U.S. Department of Energy 1987a)

Drainage and the migration of contaminants are influenced by pits, buildings, drainage ditches, and other man-made features -- as well as by ponds and other surface features, including remnants of a channel through the Ash Pond area. Surface hydrological features near the raffinate pits and chemical plant area are shown in Figure 9.

Most surface drainage from the raffinate pits area discharges either via intermittent streams in the Army Reserve training area to the west or into Ash Pond on the chemical plant area. Discharges from the intermittent streams and Ash Pond combine near County Route "D" and flow northward into Schote Creek; from there they enter Dardenne Creek, which discharges into the Mississippi River. An additional surface drainage system reaching the Mississippi River exits the chemical plant area from Frog Pond. Frog Pond drains stormwater events from most of the chemical plant area (via the stormwater sewer). Surface water flow from the northeastern edge of the chemical plant also drains to Frog Pond.

Drainage from the southern portion of the chemical plant area flows southeast to the Missouri River. As flows occur, a portion enters the subsurface; this flow reemerges farther downstream in springs or the stream channel. The drainage originates from two sources. The first is the sanitary sewer system for the chemical plant. Although this system was taken out of service in 1986, it does receive some flow from the stormwater runoff system. The sanitary system drain pipe merges with the chemical plant process sewer, which is also unused. The second source of southeast drainage flow is the overland flow from the southern portion of the chemical plant area during precipitation events.

The limestone quarry is southwest of the raffinate pits and chemical plant area and borders the Missouri River alluvial floodplain. The surrounding topography, except the floodplain area to the south, is rugged and heavily wooded and is characterized by deep ravines. The quarry floor and rim are at an elevation of about 140 and 170 m (450 and 550 ft) MSL, respectively.

Drainage in the quarry area occurs primarily through the subsurface, with limited surface drainage on the southern rim. The quarry drainage flows to the Missouri River, 1.6 km (1 mi) to the east, through Femme Osage Creek and Little Femme Osage Creek. About 210 m (700 ft) south of the quarry is a 2.4-km (1.5-mi) section of the original Femme Osage Creek that was dammed at both ends by the University of Missouri between 1960 and 1963. This section is now called the Femme Osage Slough. The water level of the slough is affected by the levels of the Missouri River and the groundwater, and the average water level is about 140 m (450 ft) MSL (U.S. Dept. Energy 1988a). The St. Charles County well field is located between the Femme Osage Slough and the Missouri River. The location of production wells in the well field is shown in Figure 10.

2.3.3 Geology

The following general description of the geology of the raffinate pits and chemical plant area highlights the major geologic characteristics of the area. More detail is provided in a recently completed hydrogeological characterization report for the chemical plant (Bechtel Natl. 1987).

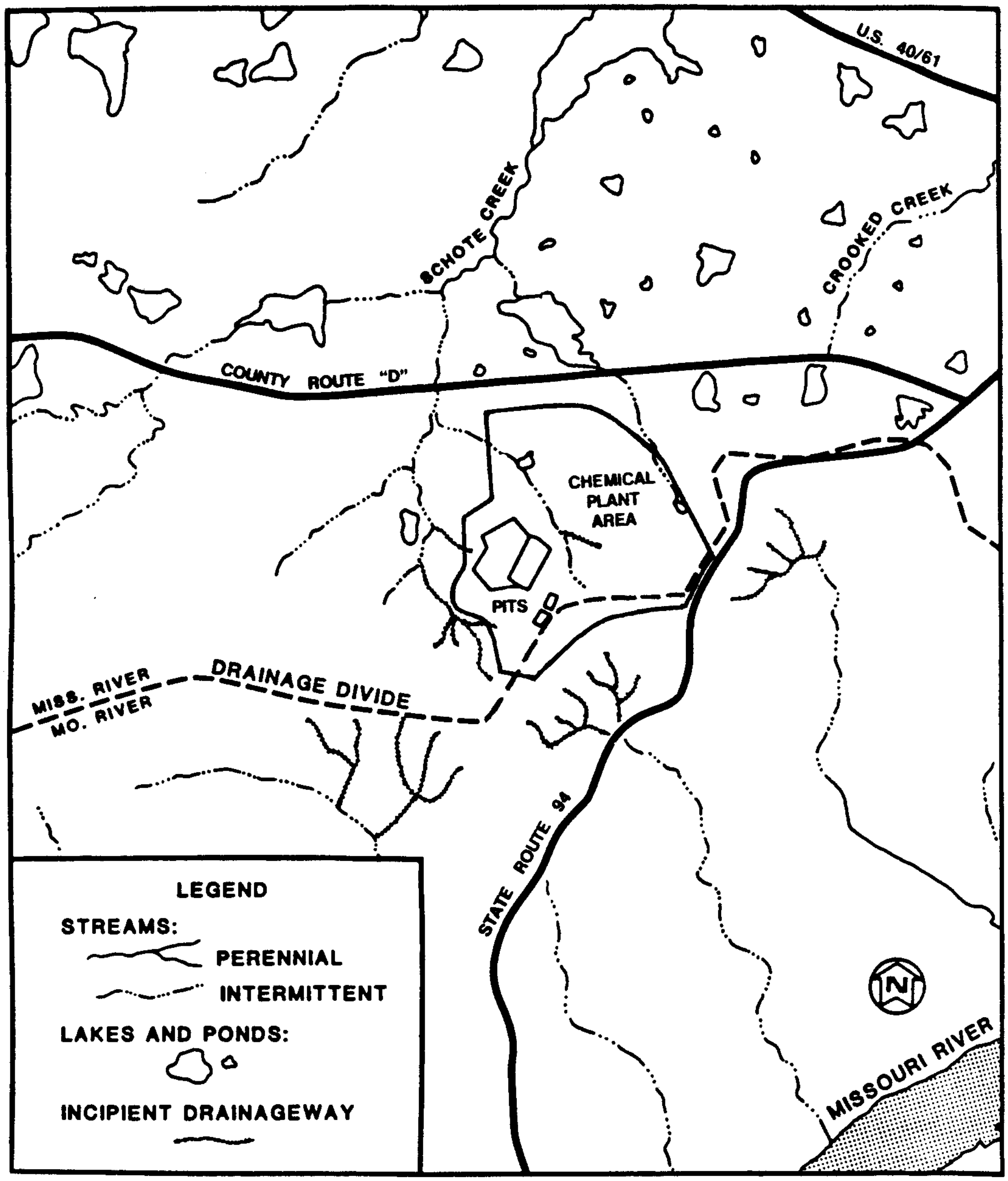


FIGURE 9 Surface Hydrological Features in the Vicinity of the Raffinate Pits and Chemical Plant Area (Source: Modified from U.S. Department of Energy 1987a)

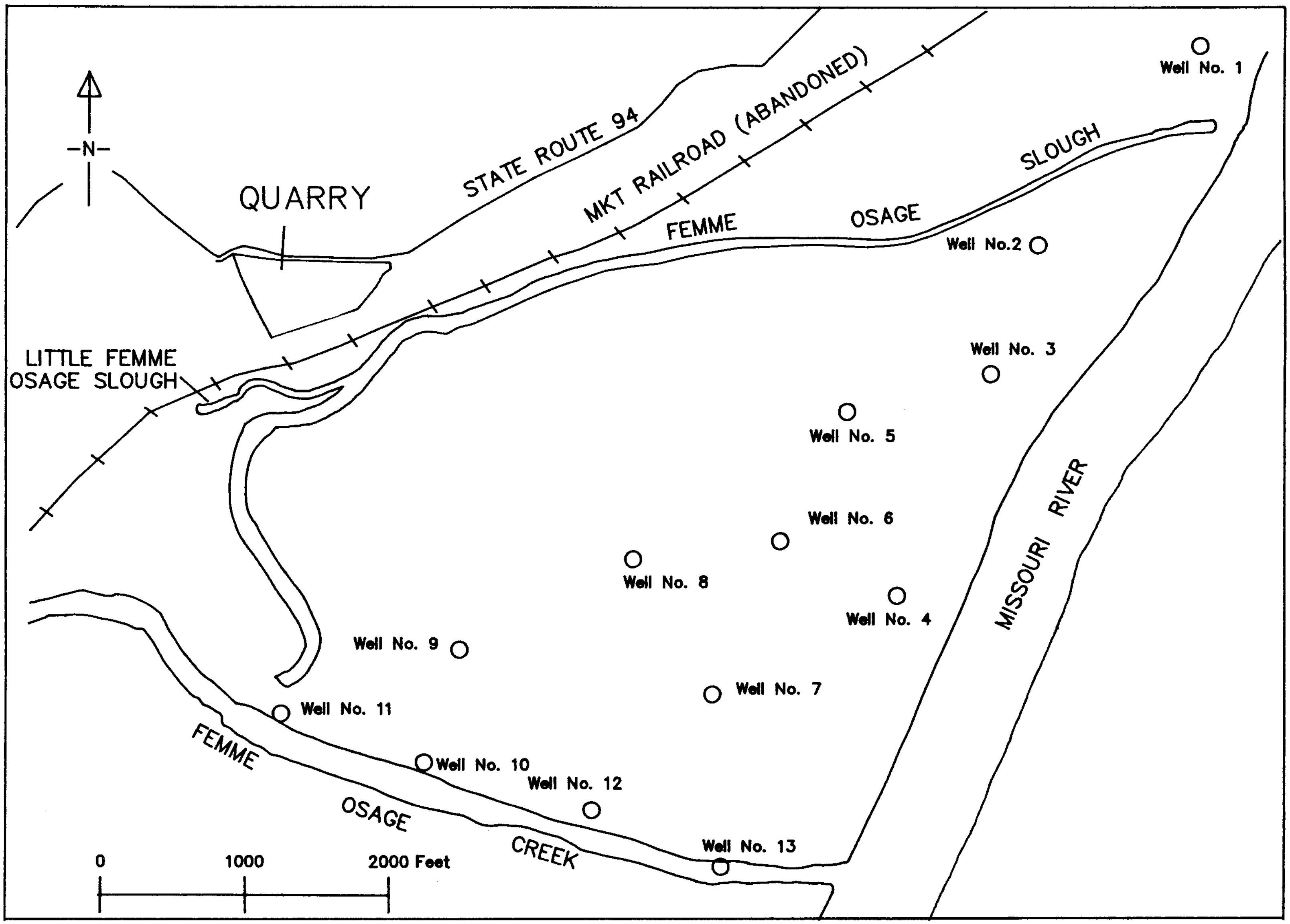


FIGURE 10 Surface Hydrological Features in the Vicinity of the Quarry and Location of Production Wells in the St. Charles County Well Field

The raffinate pits and chemical plant area is underlain by Quaternary age unconsolidated sediments and Paleozoic age bedrock formations. The unconsolidated materials in this area can be categorized into six units (see Table 1). The predominant soil type belongs to the Harvest-Urban land complex group and has a low permeability. More than 20 m (64 ft) of alluvial deposits overlie the bedrock in the Missouri River valley. Underlying the unconsolidated deposits is a thick sequence of limestones and sandstone bedrock formations of Paleozoic age. The uppermost limestone bedrock formation is fractured and contains many karst features, such as solution-enlarged cavities and voids that developed along bedding planes and northeast-trending joints. Other karst features that occur in St. Charles County include springs, losing streams, caves, and sinkholes (U.S. Dept. Energy 1987a).

TABLE 1 Unconsolidated Overburden Units in the Raffinate Pits and Chemical Plant Area

Unit	Characteristics	Thickness (m)
Topsoil	Sandy clay, blackish-brown, organic-rich.	0.15-1.5
Modified loess	Clayey silt, mottled gray-dark yellowish-orange, becomes dense and plastic with depth, manganese stained (the loess is modified in the sense that it contains higher than average clay content for loess).	0.3-4.6
Clay (Ferrelview Formation)	Clay, mottled gray-dark yellowish-orange, plastic, dense, manganese stained, contains weathered iron nodules.	0-4.6
Clay till	Clay, yellowish-brown, plastic, dense, manganese stained, blocky fractures, contains sand- to pebble-sized quartz, granitic rock, and chert dispersed throughout the clay matrix.	0.3-11.3
Basal till	Sandy, clayey silt, yellowish-brown, abundant in broken chert nodules, loosely bound by matrix.	0.3-2.4
Cherty clay	Multicolored brown, red, orange, and yellow, very dense, clay matrix with tightly bound abundant granular- to cobble-sized chert.	0-4.6

Source: U.S. Department of Energy (1987a).

The uppermost stratum at the quarry is Kimmswick limestone, and the quarry floor is Decorah shale. Limestone bedrock exposed on the quarry walls and on the steep bluffs along the Missouri River is predominantly Ordovician limestone, shale, dolomite, and sandstone.

A generalized stratigraphic column of geologic formations that are typically encountered in the vicinity of the Weldon Spring site is presented in Table 2. Also included are data on water-yielding capabilities of the different formations or formation groups. Primarily as a result of Paleozoic structural activity, the bedrock formations of the region have been formed into arches, basins, and other structures. The Weldon Spring site is located on the gently dipping east flank of the northwest-trending House Springs-Eureka anticline.

2.3.4 Hydrology

The Mississippi River is north and the Missouri River south of the Weldon Spring site. All runoff from land surfaces in the area eventually reaches the Mississippi or Missouri River. The combined flow of these two rivers at St. Louis averages about 5,100 m^3/s (180,000 cfs) (U.S. Dept. Energy 1987a).

Most of the raffinate pits and chemical plant area is located on the Mississippi River (northern) side of the drainage divide in the headwater of Schote Creek (Figure 9). Surface runoff from this area flows into nearby intermittent streams, Ash Pond, or Frog Pond on the chemical plant area (Figure 7). Surface discharges from the streams and Ash Pond combine near County Route "D" and flow northward to Lake 35 in the Busch Wildlife Area just southwest of U.S. Route 40/61; surface discharges from Frog Pond flow into Lake 36 in the Busch Wildlife Area (Figure 7). Schote Creek enters Dardenne Creek about 6 km (3.7 mi) northeast of the raffinate pits and chemical plant area and has a drainage area of about 13 km^2 (5 mi^2). Water in Dardenne Creek eventually reaches the Mississippi River near Seeburger, Missouri, about 32 km (20 mi) northwest of St. Louis (U.S. Dept. Energy 1987a).

Rainwater and snowmelt runoff and percolation enter various drains at the chemical plant area. The drains collect the water into the chemical plant process sewer, which exits on the southern slope of the drainage divide. Effluent from this exit flows to the Missouri River through a drainage ditch (Figure 7).

Preliminary estimates of flood peak discharges have been prepared by the U.S. Army Corps of Engineers, St. Louis District, for Schote Creek at several reaches and for different recurrence intervals. At the raffinate pits and chemical plant area, the 100-year and 500-year flood peak discharges at the main stem of Schote Creek are expected to be about 60 and 76 m^3/s (2,100 and 2,700 cfs). The 500-year flood elevation near the raffinate pits and chemical plant area would be about 160 m (530 ft) MSL. Thus, the area would not be affected by either a 100-year or a 500-year flood occurring in the main stem of Schote Creek (U.S. Dept. Energy 1987a).

TABLE 2 Generalized Stratigraphic Column in the Vicinity of the Weldon Spring Site

System	Series	Stratigraphic Units	Depth from Ground Level to Top of Formation (ft)	Thickness (ft)	Typical Thickness[a] (ft)	Physical Characteristics	Remarks
Quaternary	Holocene	Alluvium	0	0-65	10-30	Gravelly, silty loam over occasionally gravelly, silty clay loam.	Deposits underlie tributaries to the Missouri and Mississippi rivers.
				65-120	100-110	Silty loam, clay, and sand over sand and gravelly sand.	Deposits underlying the Missouri and Mississippi river floodplains generally yield large quantities of water to wells (600-2,600 gal/min).
	Pleistocene	Loess and glacial drift	0	0-150	5-30 30-60	Silty clay, silty loam, clay, or loam over residuum and bedrock, or both.	Yields little water to wells (<5 gal/min).
Pennsylvanian		Undifferentiated	0-120	0-75	b	Partly silty red shale with purplish-red to light gray clay.	Limited occurrence. Yields small quantities of water to wells (<1-10 gal/min).
Mississippian	Meramecian	St. Louis Limestone	0-120	0-105	70-75	Limestone: white to light gray, lithographic to finely crystalline, medium- to thick-bedded. Contains some shale.	Individually, the rock units yield small to moderate quantities of water to wells (5-50 gal/min). Collectively, these units yield sufficient water to supply most domestic and stock needs.
		Salem Limestone	0-225	0-140	90-130	Limestone: light gray to white, fine to coarsely crystalline, cross-bedded. Some siltstone and shale in lower part.	
		Warsaw Formation	0-345	0-95	70-90	Calcareous shales and interbedded shaly limestone, grades downward to shaly dolomitic limestone.	
	Osagean	Keokuk and Burlington Limestone	0-405	0-220	160-200	Limestone: white to bluish-gray, medium to coarsely crystalline, thick-bedded. Cherty.	
		Fern Glen Limestone	0-500	0-85	50-70	Limestone: yellowish-brown, fine-grained, medium- to thick-bedded. Contains appreciable chert.	
	Kinderhookian	Chouteau Limestone	0-580	0-105	50-70	Dolomitic limestone: gray to yellowish-brown, fine-grained, thin- to medium-bedded.	

TABLE 2 (Cont'd)

System	Series	Stratigraphic Units	Depth from Ground Level to Top of Formation (ft)	Thickness (ft)	Typical Thickness[a] (ft)	Physical Characteristics	Remarks
Devonian	Upper	Bushberg Sandstone	0-625	0-20	5-15	Quartz sandstone, reddish-brown, fine- to medium-grained, friable.	Yields small to moderate quantities of water to wells (5-50 gal/min).
		Lower part of Sulphur Spring Group, undifferentiated	0-625	0-60	35-40	Calcareous siltstone, and sandstone with oolitic limestone with some dark, hard, carbonaceous shale.	Group also includes Glen Park and Grassy Creek formations.
Ordovician	Cincinnatian	Maquoketa Shale	0-650	0-75	30-50	Calcareous or dolomitic shale, typically thinly laminated, silty, with shaly limestone lenses.	Yields small quantities of water to wells.
	Champlanian	Kimmswick Limestone	0-710	0-140	90-100	Limestone: white to light gray, coarsely crystalline, medium- to thick-bedded. Cherty near base.	Yields small to moderate quantities of water to wells (10-50 gal/min).
		Decorah Formation	0-810	0-35	30	Interbedded green and yellow shale, with thin beds of limestone.	
		Plattin Limestone	0-840	0-195	100-125	Limestone: light to dark gray, finely crystalline. Thin-bedded, weathers with pitted surface.	
		Joachim Dolomite	0-950	0-135	90-110	Dolomite: yellowish-brown, silty, thin- to thick-bedded. Grades into siltstone; shales common.	
		St. Peter Sandstone	0-1070	0-250	120-150	Quartz sandstone: yellowish white to white, fine- to medium-grained, massive-bedded.	Yields moderate quantities of water to wells (10-40 gal/min).
		Everton Formation	0-850	0-65	0	Sandy dolomite.	Everton Formation discontinuous.
	Canadian	Powell Dolomite	0-950	0-65	50-60	Dolomite: medium to finely crystalline, often sandy, occasionally cherty or shaly.	Generally yields small quantities of water to wells (<10 gal/min).
		Cotter Dolomite	0-1250	75-275	200-250	Dolomite: light gray to light brown, medium to finely crystalline. Cherty.	Argillaceous, interbedded with green shale.

TABLE 2 (Cont'd)

System	Series	Stratigraphic Units	Depth from Ground Level to Top of Formation (ft)	Thickness (ft)	Typical Thickness[a] (ft)	Physical Characteristics	Remarks
Ordovician (Cont'd)	Canadian (Cont'd)	Jefferson City Dolomite	100-1500	145-225	160-180	Dolomite: light brown to brown, medium to finely crystalline.	
		Roubldoux Formation	350-1700	150-170	150-170	Dolomitic sandstone.	Yields moderate to large quantities of water to wells (10-300 gal/min).
		Gasconade Dolomite	500-1850	250	250	Cherty Dolomite-Gunter Member is arenaceous dolomite.	Gunter Member is about 30 ft thick.
Cambrian	Upper	Eminence Dolomite	750-2100	190	200	Dolomite: medium- to massive-bedded, light gray, medium- to coarse-grained.	Yields moderate to large quantities of water to wells (10-500 gal/min).
		Potosl Dolomite	950-2250	100	100	Dolomite: massive, thick-bedded, medium- to fine-grained. Abundant quartz druse.	Fresh water only in southwest part of St. Charles County; saline water elsewhere in county.
		Derby Dolomite and Doe Run Dolomite	1050-2350	140	150	Dolomite: thin- to medium-bedded, alternating with thin-bedded siltstone and shale.	Hydrologic characteristics unknown in St. Charles County; occurs as a confining bed elsewhere in the state.
		Davis Formation	1200-2500	170	170	Contains shale, siltstone, fine-grained sandstone, dolomite, and limestone conglomerate.	
		Bonneterre Dolomite	1350-2650	430	400	Dolomite: typically light gray, medium- to fine-grained, medium-bedded.	Yields unknown in St. Charles County; however, water is probably saline.
		Lamotte Sandstone	1800-3100	460	450	Predominantly quartzose sandstone.	
Precambrian					2200-3500		Igneous rock. Yields no water.

[a]Typical thickness refers to thickness of formation normally encountered while drilling.

[b]Insufficient data for estimate.

Source: Data from Kleeschulte and Emmett (1986).

The quarry is located on the Missouri River (southern) side of the drainage divide (Figures 7 and 9). Surface streams in the vicinity of the quarry area include Femme Osage Creek, Little Femme Osage Creek, an unnamed tributary to Little Femme Osage Creek, and Femme Osage Slough (Figure 7). The Missouri River bottom at the quarry (river mile 49 from the confluence with the Mississippi River) is at an elevation of about 129 m (422 ft) MSL. Although the floodplain area below the quarry is partially behind a levee, the area floods occasionally to a depth of about 1 m (3-4 ft) and takes 1 to 2 months to dry; it is drained by a 41-cm (16-in.) diameter pipe through the levee (U.S. Dept. Energy 1987a).

A large volume of surface water currently exists in the raffinate pits, in ponds on the chemical plant area, and in the quarry. Although the amount of water in these impoundments varies significantly according to season, the raffinate pits generally contain about 216,000 m^3 (57,000,000 gal) and the quarry pond about 11,000 m^3 (3,000,000 gal). Two major ponds on the chemical plant area are Ash Pond and Frog Pond. Although the volume of water in Frog Pond varies throughout the year, it typically is 2,000 m^3 (500,000 gal). Ash Pond contains water intermittently, depending on seasonal precipitation events.

2.3.5 Buildings, Structures, and Other Facilities

Numerous buildings and structures associated with former ordnance works activities have been demolished or removed from the chemical plant area. The remaining buildings, facilities, and structures were used to support the chemical plant operations. Additional demolition and decontamination activities were conducted after cessation of operations. There are currently 13 major buildings, approximately 30 support structures, and other miscellaneous facilities and equipment in the chemical plant area -- including sewage treatment facilities, power lines, transformers, construction vehicles, and several office trailers. The major buildings, structures, and other facilities are listed in Table 3.

2.3.6 Local Land Use

Urban areas occupy about 6% and nonurban areas about 90% of St. Charles County (based on 1983 information). The remaining area is dedicated to transportation and water uses. It has been estimated that approximately 4% of the county's nonurban land will be converted to urban uses during 1980 to 2000 (U.S. Dept. Energy 1987a). The two closest communities to the site are Weldon Spring and Weldon Spring Heights, which are located about 3.2 km (2 mi) northeast of the raffinate pits and chemical plant area (Figure 7). The combined population of these two communities is approximately 800.

Development in the county has been dynamic in the past, and strong residential and commercial/industrial demands are anticipated to continue. The cities of St. Charles, St. Peters, O'Fallon, Lake St. Louis, and Wentzville are located along I-70 where major development has occurred. The area south of I-70 from St. Charles City to Wentzville and bounded by U.S. 40/61 to the west and the recently abandoned Missouri-Kansas-Texas (MKT) Railroad to the south is locally referred to as the "Golden

TABLE 3 Major Buildings, Structures, and Facilities at the Chemical Plant

Building or Area	Name/Function
101	Sampling plant
102	Refinery tank farm
103	Digestion and denitration
104	Lime storage
105	Ether extraction
106	Refinery sewer sampler
108	Nitric acid plant
109	West drum storage
110	East drum storage
201	Green salt building
202 (A&B)	Green salt tank farm
301	Metals building; concrete pad storage area and drum packaging stations on south side of building
302	Magnesium building
303	Foundation (only remaining structure)
401	Steam plant; coal conveyor and coal yard north of Building 401; smokestacks west of Building 401
403	Chemical pilot plant and filter and substation north of Buildings 403 and 404
404	Metal pilot plant
405 (A&B)	Pilot plant maintenance building
406	Warehouse
407	Laboratory
408	Maintenance and stores
409	Administration building
410	Services building
412	Electrical substation
413	Cooling tower and pump house
414	Salvage building
415	Process incinerator
417	Paint shop
426	Water tower
427	Primary sewage treatment plant
428	Fuel gas plant
429	Reserve water facilities
430	Ambulance garage
431	Laboratory sewer sampler
432	Main sewer sampler
433-436	Storage buildings
437	Records retention building
438	Storage building
439	Fire training building
441	Cylinder storage
443	Fire training storage building

Triangle." This area is considered likely to experience the most growth in the coming decades. The Golden Triangle includes the cities of St. Charles, St. Peters, O'Fallon, Lake St. Louis, Wentzville, Weldon Spring, Cottleville, Harvester, Dardenne, and All Saints Village. In addition to development within the Golden Triangle, there is substantial development potential in other areas of the county.

The August A. Busch Memorial Wildlife Area is located to the north and the Weldon Spring Wildlife Area to the south and east of the raffinate pits and chemical plant area. Both of these wildlife areas are park-like tracts administered by the Missouri Department of Conservation and are dedicated to various kinds of recreational uses.

The University of Missouri operates the St. Charles County Extension Center and owns 300 ha (740 acres) of land to the east of the raffinate pits and chemical plant area. This land is currently used for pasture, but about 100 ha (250 acres) is being developed as a high-technology research park, which will remain under ownership of the University of Missouri. The purpose of the research park is to help stimulate the development of high-technology industries in the St. Louis area. A state of Missouri highway maintenance facility and Francis Howell High School are also located east of the raffinate pits and chemical plant area along State Route 94.

The St. Charles County water treatment plant is located on State Route 94 about 1.6 km (1 mi) northeast of the quarry. The design capacity of this treatment plant is 61,000 m^3/day (16 mgd), and it is currently processing about 76,000 m^3/day (20 mgd) from the county well field. Five workers operate three shifts over a 7-day period at the treatment plant, with three operators during the first shift and one operator during each of two subsequent shifts. During the summer months, two additional workers are hired to perform various jobs at both the water treatment plant and the nearby county well field. Subcontract personnel are utilized at the treatment plant on an as-needed basis.

The U.S. Army Reserve and National Guard Training Area is located immediately west of the raffinate pits and chemical plant area. No permanent personnel are currently assigned to the training area, although one individual may be assigned on an intermittent basis to perform such duties as answering the telephone and checking the grounds. Regular weekend training occurs at reduced levels compared to normal training operations at other facilities because certain activities (e.g., digging foxholes) are not permitted.

2.3.7 Ecology

The Weldon Spring site is located within the Bluestem Prairie, Oak-Hickory Forest Mosaic (northern) subsection of the Prairie Parkland province. The Oak-Hickory Forest (northern) subsection also occurs within the Weldon Spring area. Much of the land surrounding the Weldon Spring site is state-owned wildlife areas containing secondary growth forest (August A. Busch Memorial Wildlife Area, Weldon Spring Wildlife Area, and Howell Island Wildlife Area). Nonforested areas occur over much of St. Charles County and are largely used for crop production and pastures or are old-field habitat.

Habitat types within the vicinity of the Weldon Spring site include open fields and pastures, forests (upland, slope, and bottomland), and cultivated fields. Slope forests are similarly dominated by oak and hickory but also include sugar maple, American elm, and black walnut among the predominant species. Bottomland forests occur within the Missouri River floodplain and along stream and lake banks. Typical tree species can include willow, eastern cottonwood, silver maple, American elm, boxelder, red mulberry, pecan, oak (pin and bur), hackberry, and persimmon. Old-field habitat includes species such as Indian mallow, crabgrass, ragweed, aster, Canada thistle, mustard, fleabane, and goldenrod. Cultivated fields contain harvestable crops whereas pastures contain herbaceous plants for grazing. The raffinate pits and chemical plant area is essentially old-field habitat; however, mowing maintains much of the area in a pasture-like condition. The quarry consists of slope and bottomland forests, and eastern cottonwood is the predominant species.

Based on habitat preferences and ranges of Missouri mammals, over 30 species could be common to abundant in the area. These would include eastern cottontail rabbit, opossum, raccoon, white-tailed deer, and several species of mouse, vole, shrew, squirrel, bat, and fox. Several mammal species -- most notably the woodchuck, eastern mole, and plains pocket gopher -- dig burrows into habitat similar to that occurring at the raffinate pits and chemical plant area.

In the Busch Wildlife Area immediately north of the raffinate pits and chemical plant area, almost 300 species of birds have been observed. About one-third of these nest in the area whereas a smaller number are common to abundant throughout at least three seasons of the year. About 10 waterfowl species are common to abundant during the spring and fall migration, and a few species such as Canada goose, mallard, and wood duck nest and/or overwinter in the area. The ponds in the raffinate pits and chemical plant area and the quarry provide habitat suitable for waterfowl.

St. Charles County is within the range of more than 50 reptile and amphibian species. Some of these species occur at the Weldon Spring site due to the variety of terrestrial and aquatic habitats that are present.

Aquatic habitats in the vicinity of the Weldon Spring site include intermittent and permanent streams that drain the site, various-sized ponds and lakes, and the Mississippi and Missouri rivers that ultimately receive drainage from St. Charles County. The Busch Wildlife Area contains 32 lakes and ponds that support a warmwater fishery. Common species include carp, black bullhead, bluntnose minnow, fathead minnow, bluegill, black crappie, white crappie, gizzard shad, largemouth bass, and channel catfish (the channel catfish is regularly stocked). Lakes 34, 35, and 36 of the Busch Wildlife Area receive drainage from the raffinate pits and chemical plant area.

Based on habitats and distributions of Missouri fishes, the fish species that would most likely be abundant in streams in the site vicinity include carp, creek chub, redfin shiner, bigmouth shiner, fathead minnow, white sucker, green sunfish, orangespotted sunfish, johnny darter, and fantail darter. The major species in the Missouri and Mississippi rivers include gar, gizzard shad, carp, river carpsucker, buffalo, channel catfish, freshwater drum, white bass, sturgeon, paddlefish, blue catfish, and blue sucker. Largemouth bass, bluegill, and crappie are also abundant in backwaters and oxbows.

Three endangered species could be present in the Weldon Spring vicinity: bald eagle (*Haliaeetus leucocephalus*), fat pocketbook pearly mussel (*Potamilus capax*), and Higgins' eye pearly mussel (*Lampsilis higginsi*). No designated critical habitat currently exists in the project area. Although the specialized habitat requirements and/or preferences of these species are not generally met by the Weldon Spring site, it is possible that the more mobile species (such as the bald eagle) could intermittently occupy the site (U.S. Dept. Energy 1987a). The mussel species would not be found in any of the aquatic areas that may be designated for response action (e.g., ponds, lakes, ditches, and drainageways) because their habitat is limited to larger rivers.

2.3.8 Regional Climate

The climate in the Weldon Spring area is continental, with moderately cold winters and warm summers. Alternating warm/cold, wet/dry air masses converge and pass eastward through the area, almost daily. The variability of the climate is demonstrated by the record low and high temperatures for the state, i.e., -40°C (-40°F) and 48°C (118°F), recorded in 1905 and 1936, respectively. The monthly average temperature is 13°C (56°F), with the average daily minimum being 7°C (45°F) and the average daily maximum being 19°C (66°F).

Normal annual precipitation in the area is approximately 94 cm (37 in.), and the heaviest rainfalls occur in the spring and early summer. Summer rains frequently occur as thunderstorms, occasionally with hail and high winds. Locally, rainfalls can be very heavy; as much as 25 cm (10 in.) has been recorded in 24 hours. The three winter months are the driest, with an average precipitation totaling about 15 cm (6 in.); the three spring months are typically the wettest, with an average total near 30 cm (12 in.) (U.S. Dept. Energy 1987a).

Wind speeds and directions recorded at the Weldon Spring site during 1985 are illustrated in Figure 11. Prevailing winds in the vicinity of the Weldon Spring site are from the south during the summer and fall. Wind speeds during these months average 13.9 km/h (8.7 mph). Winds during the winter months are from the northwest and west-northwest, averaging 17.6 km/h (11 mph) (U.S. Dept. Energy 1987b). Tornadoes occur in the St. Louis area once or twice per year, most often in April and May.

2.4 RECENT ENVIRONMENTAL MONITORING AND SITE CHARACTERIZATION STUDIES

An environmental monitoring program is in place at the Weldon Spring site in accordance with DOE requirements. This program will continue for the duration of the project. During 1981 to 1985, DOE conducted environmental monitoring programs to identify changes (if any) in the radioactive contaminant levels in and around the raffinate pits and quarry. At that time, the raffinate pits and quarry were under caretaker status of the DOE, and the chemical plant was controlled by the Army. Following its assumption of responsibility for the chemical plant in 1985, DOE revised the overall environmental monitoring program to provide a more comprehensive determination of the levels of radioactive and chemical contamination in and around the chemical plant,

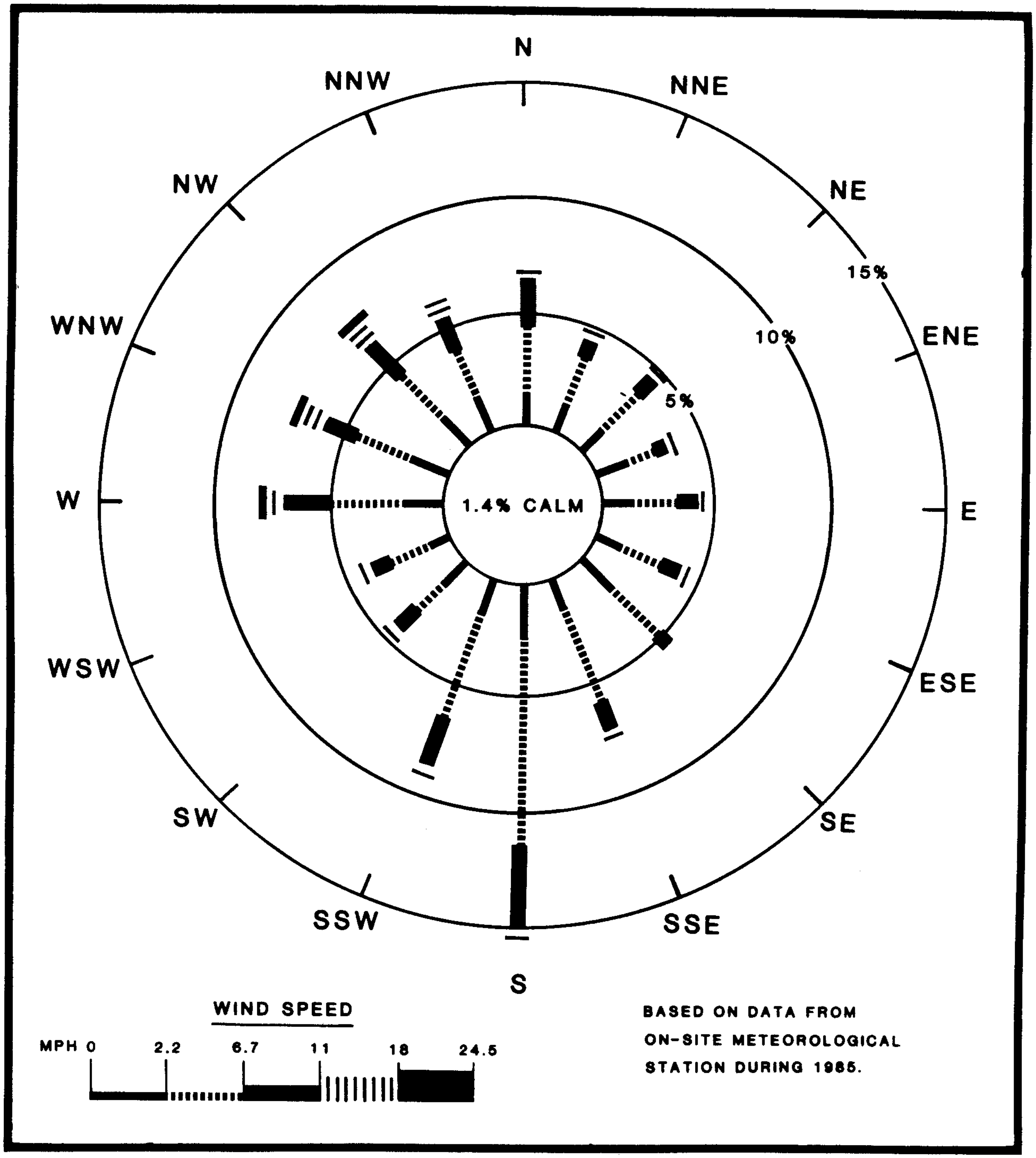


FIGURE 11 Annual Wind Rose for the Weldon Spring Site in 1985 (Source: Bechtel National 1986)

raffinate pits, and quarry. Six monitoring wells were installed in the quarry area, and 19 new wells were installed in and around the chemical plant where no monitoring wells had previously existed. These well installations were completed in late 1986. In addition, fugitive dust samplers were installed around the perimeter of the Weldon Spring site and at nearby locations (U.S. Dept. Energy 1987b).

In 1984, a radiological characterization of the quarry was completed. During this characterization effort, selected samples were analyzed for a variety of chemical species. These data became available in late 1985 and early 1986. The results led to a second, more comprehensive characterization of the quarry materials that emphasized chemical determinations. The results of the second study became available in March 1987. A sampling effort was also performed in 1986 to chemically characterize the sludge material in the raffinate pits (U.S. Dept. Energy 1987b).

Agencies other than DOE were also involved in sampling activities at the Weldon Spring site during 1986. Both the U.S. Geological Survey and the Missouri DNR collected samples from the quarry and the raffinate pits (U.S. Dept. Energy 1987b).

In 1987, DOE initiated the Phase I water quality assessment (U.S. Dept. Energy 1987c) to evaluate baseline water quality at the Weldon Spring site. Information gathered during this sampling program has been used to guide subsequent characterization activities. The Phase I program consisted of sampling 50 existing and new monitoring wells and 23 surface water locations. Groundwater samples were analyzed for nitroaromatics, select inorganic anions, various water quality indicators, radionuclides, and the complete Target Compound List (TCL) (U.S. Environ. Prot. Agency 1986a). Surface water samples were analyzed for radionuclides, select inorganic anions, various water quality indicators, and TCL metals at selected locations. Results from this monitoring program indicated the presence of high concentrations of nitrates and sulfates and significant quantities of nitroaromatics, particularly 2,6-DNT, in the groundwater at the Weldon Spring site (U.S. Dept. Energy 1987c).

An extensive field program was conducted by DOE from April to July 1987 to characterize the horizontal and vertical extent of radioactive contamination in the raffinate pits and chemical plant area (Marutzky, Colby, and Cahn 1988). This field program included exposure-rate measurements taken at the ground surface and at 1 m (3 ft) above the surface to delineate areas of elevated exposure rates. At locations exhibiting elevated exposure rates, in-situ measurements of uranium, radium, and thorium-232 were taken. If in-situ measurements showed elevated concentrations, soil samples were collected and analyzed for these elements. Randomly selected soil samples were also collected and analyzed.

Section 2.5 of this work plan summarizes the nature and extent of radioactive and chemical contamination at the Weldon Spring site, based upon currently available information. Section 4 of the work plan summarizes the rationale for developing the various field sampling and analysis plans that will be used to obtain the data needed to support detailed environmental analyses.

2.5 SUMMARY OF RECENT SITE CONTAMINATION DATA

The nature and extent of contamination at the Weldon Spring site will be further defined during the site characterization (RI) phase of this project. The following discussion is a brief summary of the known and suspected nature and extent of contamination at the raffinate pits and chemical plant area and the quarry, based upon studies that have been conducted since 1984. The individual sampling plans being developed (see Section 4.2) are designed to complete the characterization data base resulting from these studies. The discussion is generally organized by site area (i.e., raffinate pits and chemical plant area, quarry, and vicinity properties).

2.5.1 General

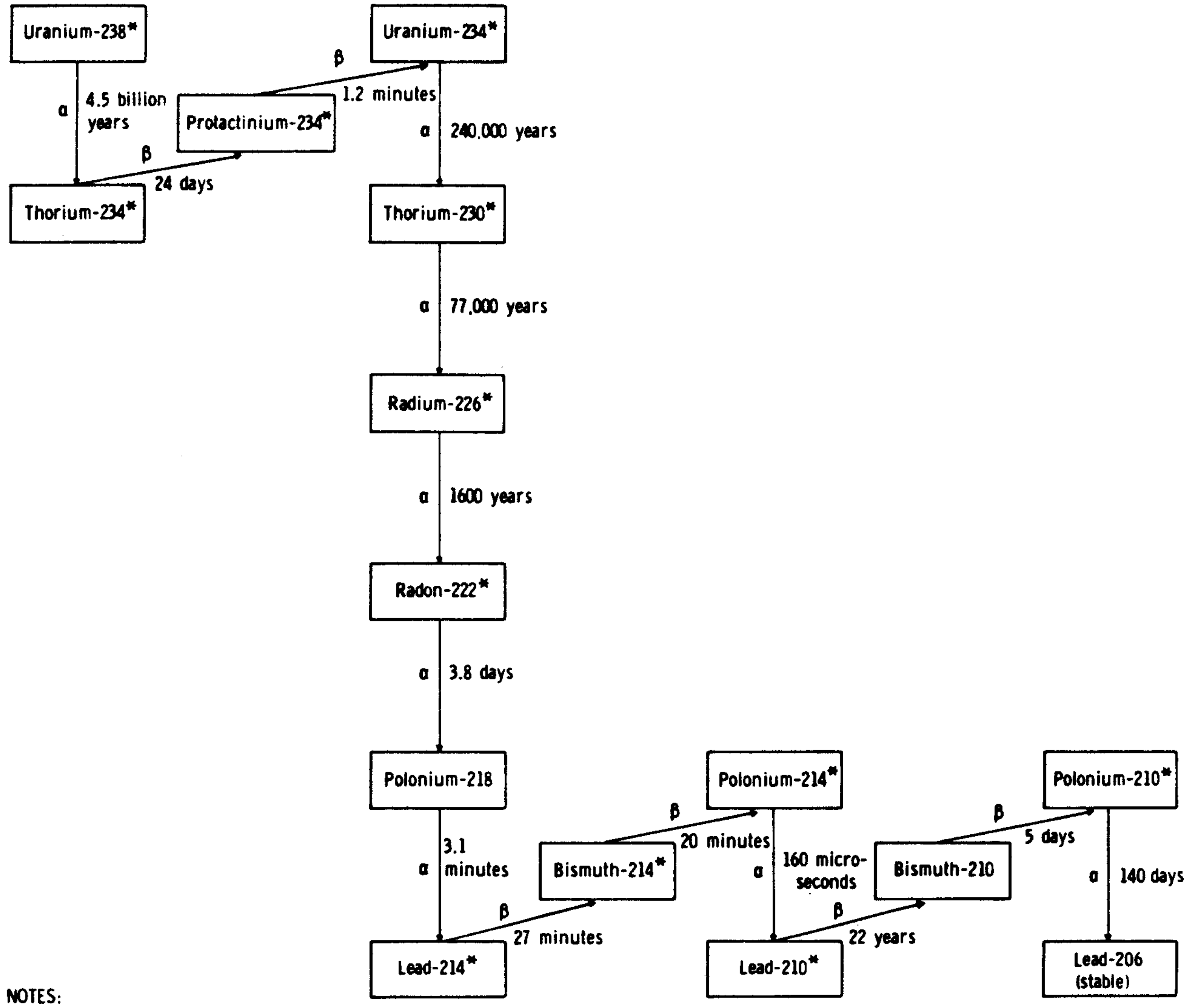
Radioactive and nonradioactive (i.e., chemical) contamination has been detected at the Weldon Spring site. In addition, some nearby vicinity properties are also contaminated with radioactive and chemical contaminants originating from the raffinate pits and chemical plant area and/or the quarry.

Uranium and thorium ore concentrates and some scrap metal were processed at the chemical plant during its operational period. An estimated 600,000 m^3 (780,000 yd^3) of radioactively contaminated materials resulted from these past operations, and these materials are currently located at the Weldon Spring site. Sludges in the raffinate pits and quarry, which comprise about one-third of the total volume of contaminated materials, contain most of the radioactive contaminants. About two-thirds of the total volume of contaminated materials consists of soil and rubble. These materials are contaminated with naturally occurring radionuclides of the uranium-238 and thorium-232 decay series (Figures 12 and 13). The estimated concentrations and inventories of the major radionuclides at the raffinate pits, chemical plant, and quarry are listed in Table 4.

Nonradioactive chemicals -- such as nitroaromatics, heavy metals, strong acid salts, and some other organics -- are present at the site due to TNT production and/or uranium-processing activities. In addition, contaminants such as polychlorinated biphenyls (PCBs) and asbestos are present because of previous uses of equipment and buildings at the site.

2.5.2 Raffinate Pits and Chemical Plant Area

Raffinate pits 1, 2, and 3 contain raffinate sludge and slag resulting from the refining of uranium ore concentrates and the recycling of scrap metal carried out at the chemical plant. Pit 4 contains similar slag and sludge as well as wastes from the processing of thorium-containing materials and drums and rubble from the partial decontamination of the chemical plant. The physical characteristics of these wastes and the volume of wastes in each pit are given in Table 5. It is estimated that the pits contain a total of about 170,000 m^3 (220,000 yd^3) of wastes.



NOTES:

Only the dominant decay mode is shown.
The times shown are half-lives.
The symbols α and β indicate alpha and beta decay.
An asterisk indicates that the isotope is also a gamma emitter.

FIGURE 12 Uranium-238 Radioactive Decay Series

The wastes in the pits are generally stratified and heterogeneous. The amount of surface water covering the wastes varies during the year. In summer, all surface water may evaporate from pits 1 and 2, but surface water is always present in pits 3 and 4. Pits 1 and 2 have not been dry since 1982. Pit 3 is designed to overflow into pit 4 through a pipe in the dike wall common to both pits. Pit 3 contains the largest volume of wastes.

Thorium-230 is the predominant radionuclide in the pit wastes. The average concentration of thorium-230 in the raffinate sludge is estimated to be 3,500 pCi/g (wet

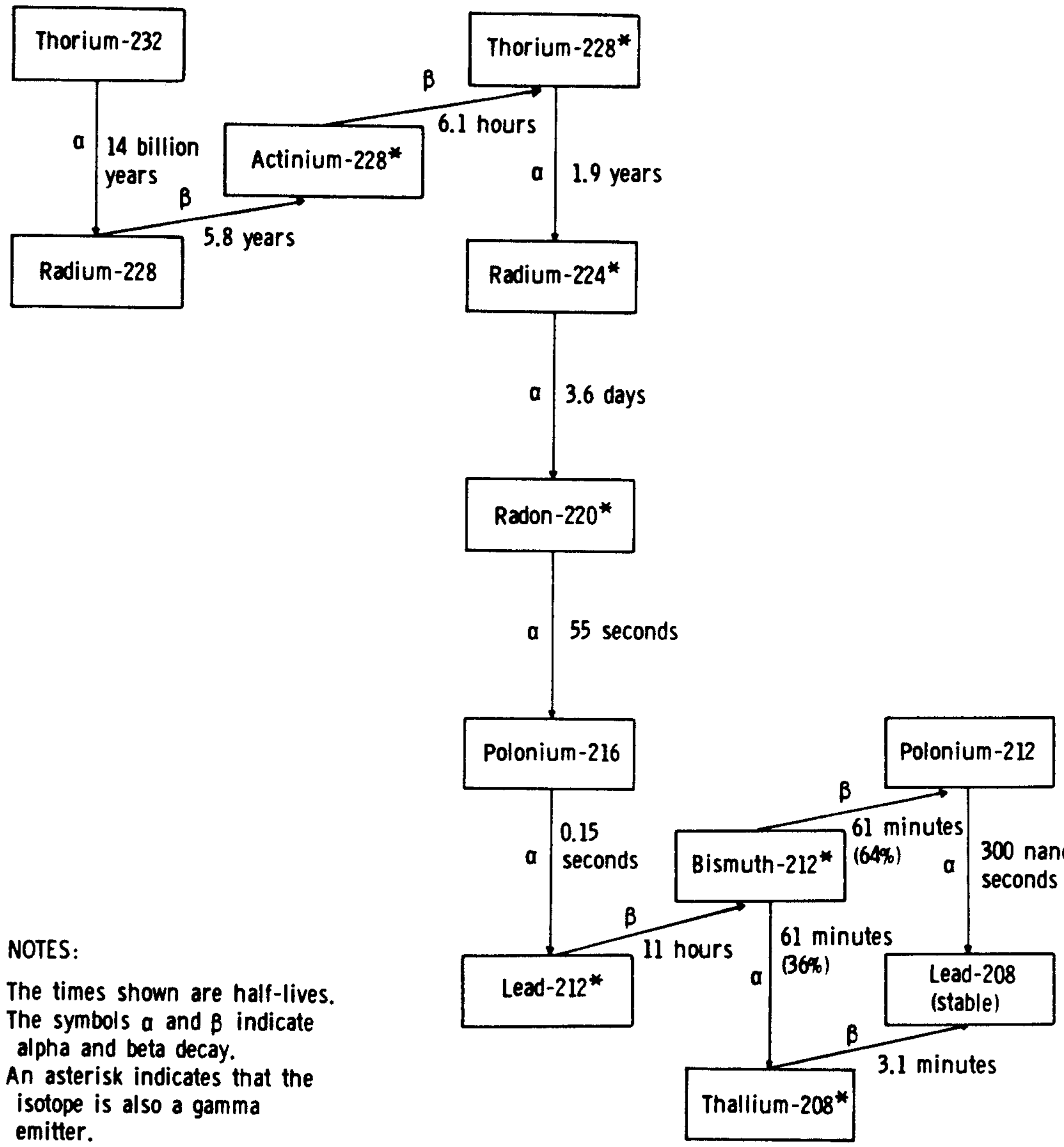


FIGURE 13 Thorium-232 Radioactive Decay Series

wt.), and the total inventory is estimated to be 700 Ci. For radium-226, the average concentration and total inventory in the wet sludge are 97 pCi/g and 20 Ci, respectively. Because of ingrowth of radium-226 from the radioactive decay of thorium-230 (which has a half-life of 77,000 years), the concentration of radium-226 in the raffinate sludge (averaged over the four pits) will increase to a peak concentration of 3,200 pCi/g (wet wt.) in about 9,000 years. After this, the radium-226 concentration will decrease at the same rate as the parent thorium-230.

The raffinate sludge has high concentrations of several metals, including iron, lead, magnesium, and molybdenum. The principal anions are nitrate, sulfate, and fluoride. In 1984, a composite sample of raffinate sludge was analyzed for 82 organic priority pollutants (19 pesticides, 7 PCBs, and 56 acid and base/neutral compounds) and

TABLE 4 Summary of Radioactive Concentrations and Inventories of the Weldon Spring Wastes

	Average Concentrations (pCi/g) and Inventories (Ci)[a]					
	Raffinate Pits[b]		Quarry		Chemical Plant	
Species	pCi/g	Ci	pCi/g	Ci	pCi/g	Ci
Uranium-238[c]	150	30	170	30	20	7
Thorium-232	32	6	16	3	3	1
Thorium-230	3,500	700	540	90	6	3
Radium-226	97	20	63	10	3	1

[a]Inventory values for all wastes and average concentrations for the chemical plant wastes are estimated to one significant figure.

[b]Concentrations are given in terms of the wet sludge.

[c]The amounts of uranium-238, uranium-235, and uranium-234 are assumed to be present in their natural activity ratio, 238:235:234 = 1:0.046:1.

Source: U.S. Department of Energy (1987a).

TABLE 5 Summary of the Physical Characteristics of Sludge in the Raffinate Pits

Pit Number	Construction Date	Pit Volume (m^3)	Percent Filled	Surface Water Volume (m^3)	Waste Volume (m^3)	Weight Percent Solids	Wet Bulk Density (g/cm^3)	Solids Weight (t)
1	1958	14,100	94.0	2,000	13,300	27.6	1.191	4,370
2	1958	14,100	94.0	2,000	13,300	29.4	1.219	4,770
3	1959	127,500	77.8	19,000	99,200	27.3	1.206	32,660
4	1964	339,800	12.5	57,000	42,500	25.3	1.184	12,730

Source: Modified from U.S. Department of Energy (1987a).

13 organic nonpriority pollutants. All concentrations were reported as being below detection limits, which varied from 0.1 to 1 ppm for the different individual compounds (U.S. Dept. Energy 1987a).

Water in the pits exists in two phases: free water above the sludge and water in intimate contact and bound to the raffinate material making a sludge or gel. The water in intimate contact with the raffinate material would be expected to have higher concentrations of dissolved solids than free water standing over the sludge.

Surface water sampling locations and groundwater monitoring well locations for the raffinate pits and chemical plant area are shown in Figures 14 and 15, respectively. The radiological results of the Phase I water quality assessment are presented in Table 6 (groundwater at the raffinate pits and chemical plant area), Table 7 (surface water in the raffinate pits), and Table 8 (surface water near the raffinate pits and chemical plant area). According to these results, elevated concentrations of uranium are present in surface water in the four raffinate pits and at off-site sampling locations.

The radioactive contamination on the chemical plant area occurred during the plant's operational period. From June 1957 to December 1966, the feed materials plant was used to process uranium concentrates in the form of sodium diuranate containing 70% uranium. Small amounts of materials containing depleted and slightly enriched uranium were also processed, and thorium concentrates were processed in 1965 and 1966. Uranium is the main radioactive contaminant at the chemical plant area. Estimated concentrations of uranium-238 range from 3.9 to 50,000 pCi/g, with a total estimated inventory of 7 Ci (U.S. Dept. Energy 1987a). Estimated concentrations and inventories of radium-226, thorium-230, and thorium-232 are much lower (see Table 4).

The presence of gamma-emitting radionuclides at the raffinate pits and chemical plant area results in elevated exposure rates. The areas having exposure rates above background levels are shown in Figure 16.

The primary nitroaromatic compounds associated with the Weldon Spring site are 2,4-DNT, 2,6-DNT, and TNT. Decomposition products of these compounds are also present in small quantities. Nitroaromatics have been detected in the soil, surface water, and groundwater at the Weldon Spring site. Figure 17 shows the groundwater monitoring wells in which detectable levels of nitroaromatics have been measured at the raffinate pits and chemical plant area. Traces of nitroaromatics have also been detected in the surface waters of Frog Pond, Ash Pond, and raffinate pit 2 (U.S. Dept. Energy 1987c). Potential nitroaromatic source areas at the raffinate pits and chemical plant area are shown in Figure 18.

Metal contamination is prevalent at the raffinate pits and chemical plant area. High concentrations of lead, iron, magnesium, and molybdenum have been reported in the raffinate pit sludge (U.S. Dept. Energy 1987a). In general, metal concentrations have been at or below normal background levels in recent analyses of groundwater and surface water samples. However, elevated levels of chromium, lithium, magnesium, nickel, and vanadium have been detected in samples of groundwater from monitoring wells 3007 and 3008 (see Figure 15).

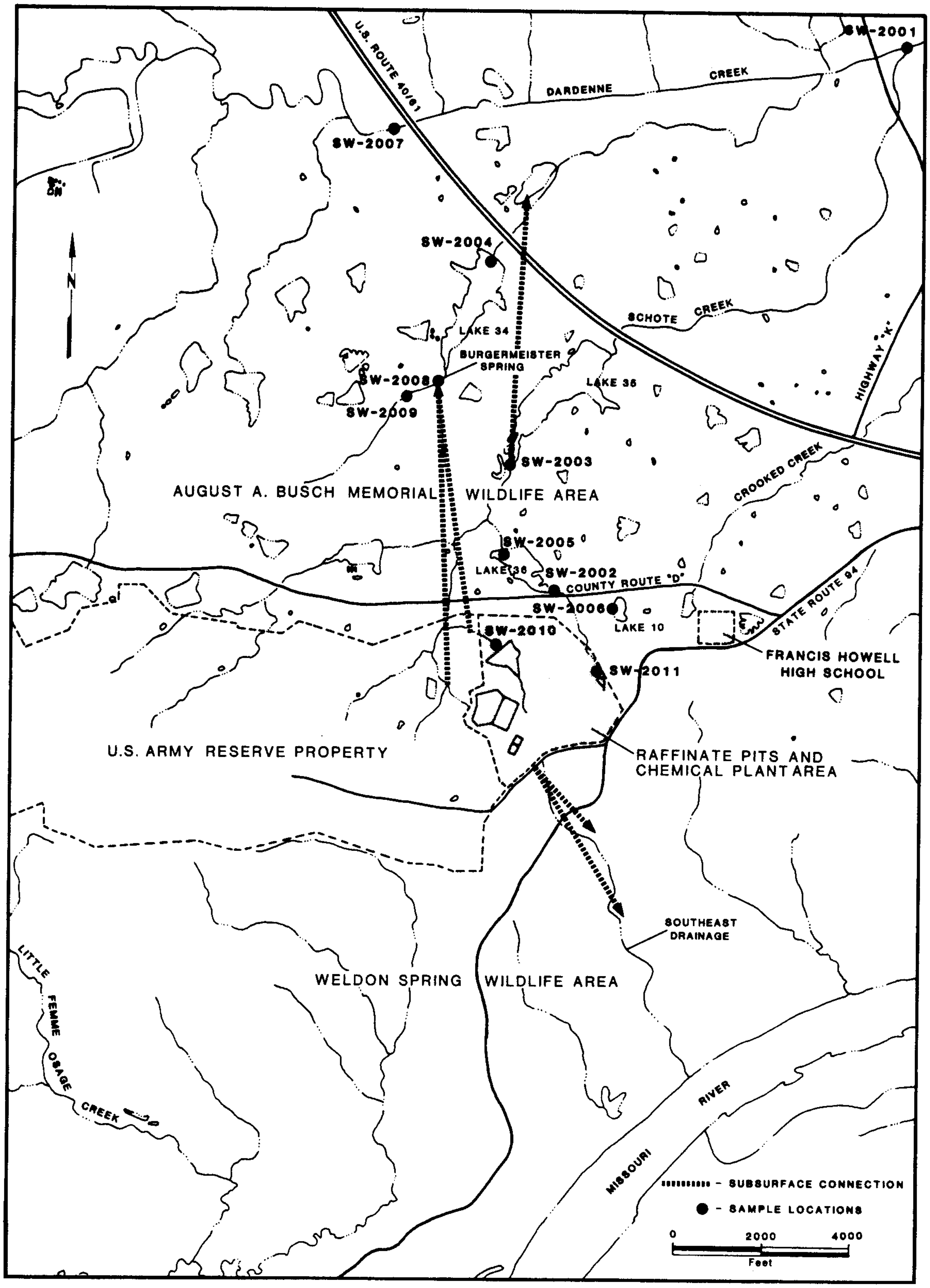


FIGURE 14 Surface Water Sampling Locations near the Raffinate Pits and Chemical Plant Area

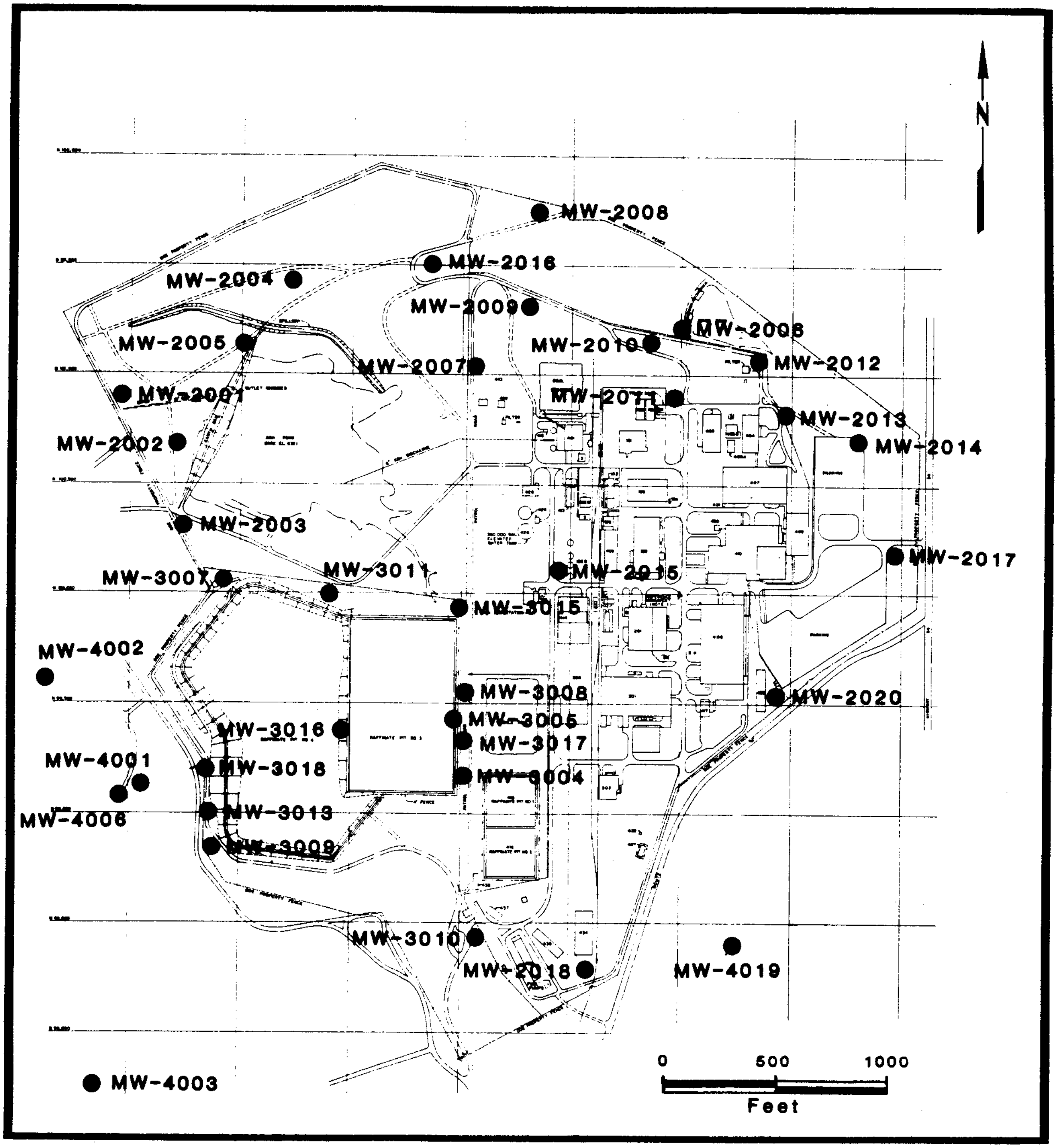


FIGURE 15 Monitoring Wells at the Raffinate Pits and Chemical Plant Area (Source: U.S. Department of Energy 1987c)

TABLE 6 Radiological Data from Groundwater Sampling at the Raffinate Pits and Chemical Plant Area

		Concentration ± Error[b] (pCi/L)						
Sampling Location[a]	Date Sampled	Gross Alpha	Gross Beta	Natural Uranium[c]	Radium -226	Radium -228	Thorium -230	Thorium -232
GW-2001	3/3/87	5.1 ± 3.9	8.7 ± 5.0	<2	<1	<3	<5	<5
GW-2002	3/4/87	I	I	5.3 ± 2	<1	<3	<4	<4
GW-2003	3/4/87	I	I	2.7 ± 1.3	<1	<4	<3	<3
GW-2003-D	3/4/87	I	I	<2	<1	<2	<2	<2
GW-2004	3/3/87	<5	<8	<2	<1	<2	<4	<4
GW-2005	3/5/87	I	2.2 ± 1.2	<1	<3	<2	<2	
GW-2006	3/2/87	<5	11 ± 5	1.9 ± 1.2	<1	<3	<3	<3
GW-2007	3/2/87	7.8 ± 4.3	<7	7.7 ± 6.5	<1	<4	<1	<1
GW-2008	3/4/87	<5	<8	2.7 ± 1.0	<1	<4	<3	<3
GW-2009	3/3/87	<5	<8	2.7 ± 1.3	<1	<5	<2	<2
GW-2010	3/3/87	6.4 ± 4.4	<8	<2	<1	<2	<4	<4
GW-2011	3/3/87	8.0 ± 4.2	10 ± 5.0	<2	<1	<4	<2	<2
GW-2012	3/3/87	<5	<8	<2	<1	<2	2.4 ± 0.6	<1
GW-2013	3/2/87	<6	<8	2.6 ± 1.3	<1	<6	<3	<3
GW-2014	3/2/87	5.6 ± 4.3	22 ± 6	3.9 ± 1.4	<1	<5	<1	<1
GW-2015	3/6/87	<5	<8	8.4 ± 1.8	<1	<4	<5	<5
GW-2015-D	3/6/87	<5	<8	4.6 ± 1.3	<1	<3	<3	<3
GW-2016	3/4/87	<5	<7	<2	<1	<2	<3	<3
GW-2017	3/2/87	<6	8.3 ± 5.4	3.7 ± 1.4	<1	<3	<2	<2
GW-2018	3/5/87	<5	<8	2.0 ± 1.0	<1	<7	<3	<3
GW-2020	3/6/87	<5	<8	4.1 ± 1.2	<1	<5	<2	<2
GW-3007	3/4/87	I	I	6.7 ± 1.4	<1	<3	<2	<2
GW-3008	3/10/87	I	80 ± 50	7.5 ± 1.5	<1	<3	I	I
GW-3009	3/5/87	<5	17 ± 6	14 ± 2	<1	I	<3	<3
GW-3010	3/5/87	<5	<8	2.4 ± 1.2	<1	<2	<3	<3
GW-3010-D	3/5/87	<5	<5	<8	2.1 ± 1.3	<1	<4	<3

TABLE 6 (Cont'd)

		Concentration ± Error[b] (pCi/L)						
Sampling Location[a]	Date Sampled	Gross Alpha	Gross Beta	Natural Uranium[c]	Radium -226	Radium -228	Thorium -230	Thorium -232
GW-3013	3/5/87	I	I	7.4 ± 1.7	<1	<2	<9	<9
GW-4001	3/5/87	<5	<8	<2	<1	<3	<3	<3
GW-4002	3/6/87	<5	<7	<2	<1	<4	<4	<4
GW-4003	3/6/87	<5	<7	<2	<1	I	<3	<3
GW-4006	3/5/87	<5	<7	<2	<1	<4	<3	<3
GW-4019	3/6/87	<5	<7	5.2 ± 1.3	<1	<3	<3	<3

[a]D refers to duplicate sample analysis.

[b]I = interference.

[c]Natural uranium is the sum of all uranium isotopes assumed to be present in their natural activity ratio.

Source: Data from U.S. Department of Energy (1987c).

TABLE 7 Radiological Data from Water Sampling in the Four Raffinate Pits

			Concentration ± Error[a] (pCi/L)						
Sampling Location	Pit No.	Date Sampled	Gross Alpha	Gross Beta	Natural Uranium[b]	Radium -226	Radium -228	Thorium -230	Thorium -232
SW-3001	1	4/24/87	200 ± 30	190 ± 70	45 ± 4	61 ± 7	<3	I[c]	I
SW-3002	2	4/24/87	180 ± 30	210 ± 30	300 ± 30	28 ± 8	6 ± 2.7	13 ± 2	<6
SW-3003	3	4/24/87	150 ± 50	290 ± 60	130 ± 20	42 ± 10	32 ± 4	16 ± 2	<6
SW-3004	4	4/24/87	980 ± 100	1200 ± 300	2400 ± 300	3.4 ± 0.4	13 ± 6	<5	<5

[a] I = interference.

[b] Natural uranium is the sum of all uranium isotopes assumed to be present in their natural activity ratio.

[c] Thorium levels in the sludges of pits 1 and 2 indicate that the water in pit 1 may contain about 13 pCi/L of thorium-230.

Source: Data from U.S. Department of Energy (1987c).

TABLE 8 Radiological Data from Surface Water Sampling near the Raffinate Pits and Chemical Plant Area

Sampling Location	Date Sampled	Concentration ± Error[a] (pCi/L)						
		Gross Alpha	Gross Beta	Natural Uranium[b]	Radium -226	Radium -228	Thorium -230	Thorium -232
SW-2001	3/11/87	<3	<7	2.8 ± 1.0	<1	<5	<7	<7
SW-2002	3/10/87	50 ± 9	35 ± 7	100 ± 10	<1	<8	<2	<2
SW-2003	3/11/87	20 ± 4	14 ± 8	21.08	<1	<1	<1	<1
SW-2004	3/11/87	33 ± 5	17 ± 3	33.32	<1	<1	<1	<1
SW-2005	3/11/87	54 ± 8	23 ± 3	53.72	<1	<1	<1	<1
SW-2006	3/12/87	0 ± 1	4 ± 2	2.72	<1	<1	<1	<1
SW-2007	3/11/87	<3	<7	<1	<1	<4	I	I
SW-2008	3/10/87	97 ± 11	54 ± 7	160 ± 20	<1	<5	8.0 ± 0.6	<2
SW-2010	3/12/87	2100 ± 300	1400 ± 200	2700 ± 300	<1	<4	<2	<2
SW-2011	3/12/87	I	I	2400 ± 30	<1	<3	<2	<2

[a] I = interference.

[b] Natural uranium is the sum of all uranium isotopes assumed to be present in their natural activity ratio.

Source: Data from U.S. Department of Energy (1987c).

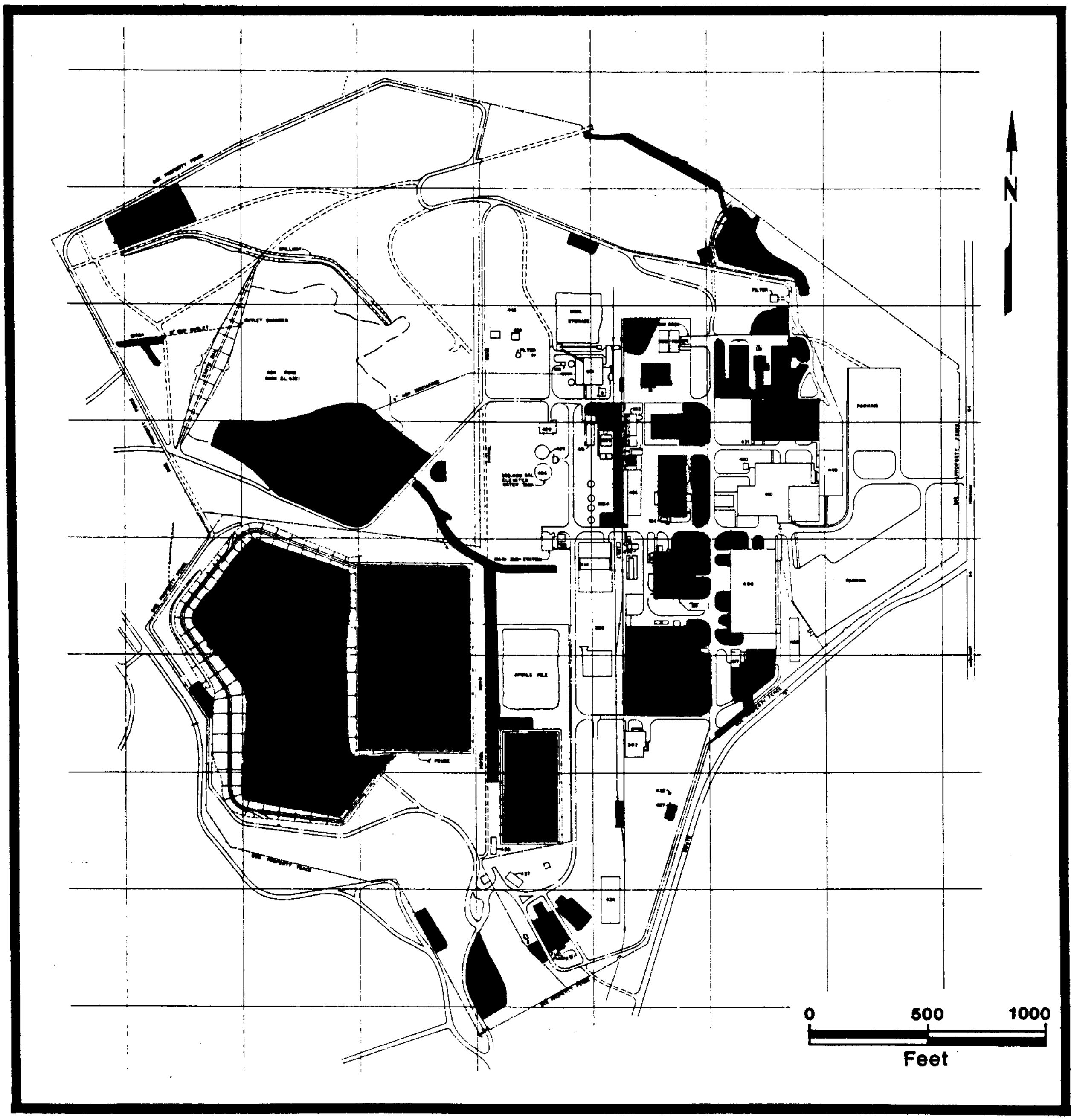


FIGURE 16 Areas in the Raffinate Pits and Chemical Plant Area that Have Exposure Rates above Background

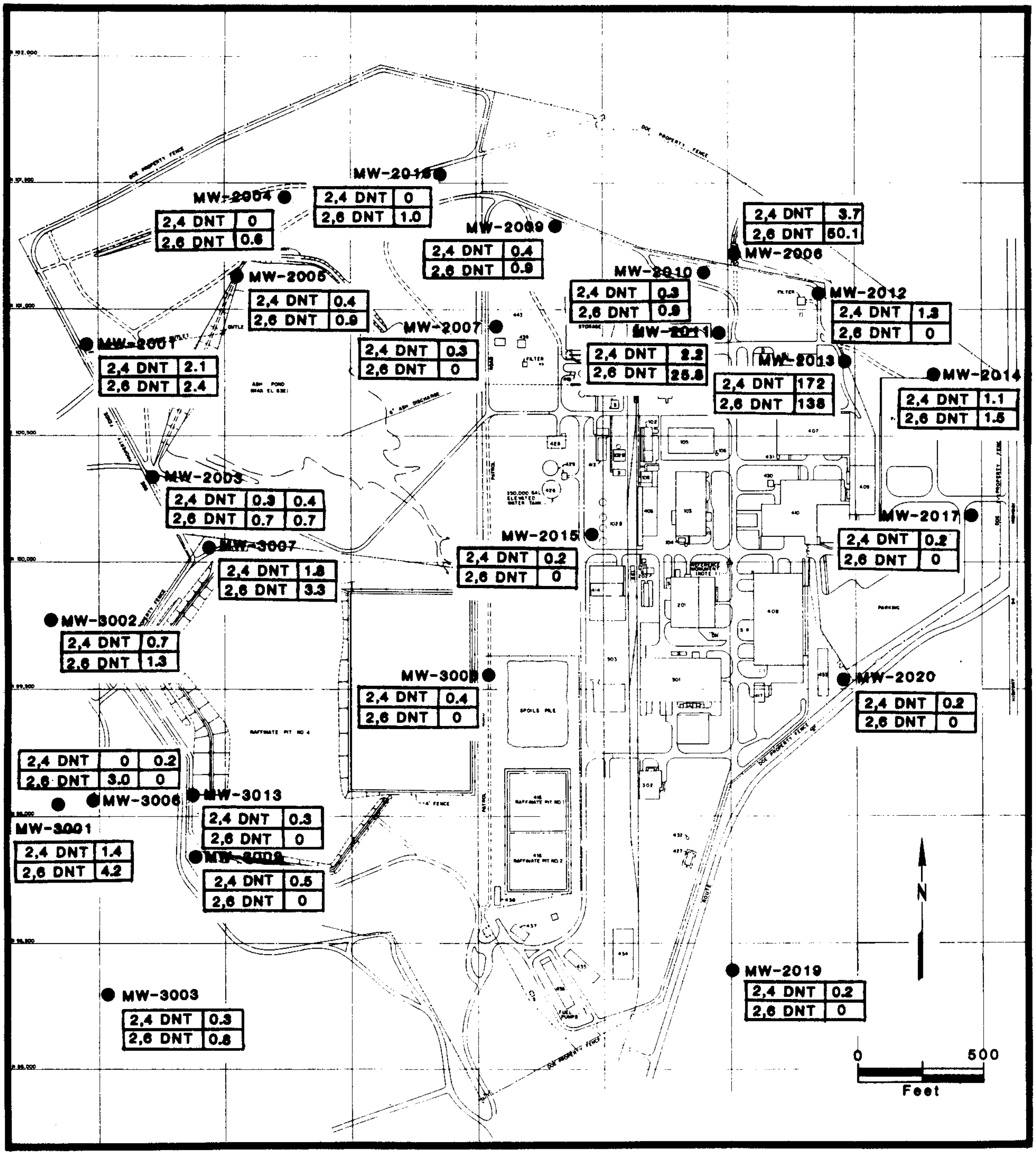


FIGURE 17 Monitoring Wells at the Raffinate Pits and Chemical Plant Area in Which Detectable Levels (µg/L) of Nitroaromatics Have Been Measured (Source: U.S. Department of Energy 1987c)

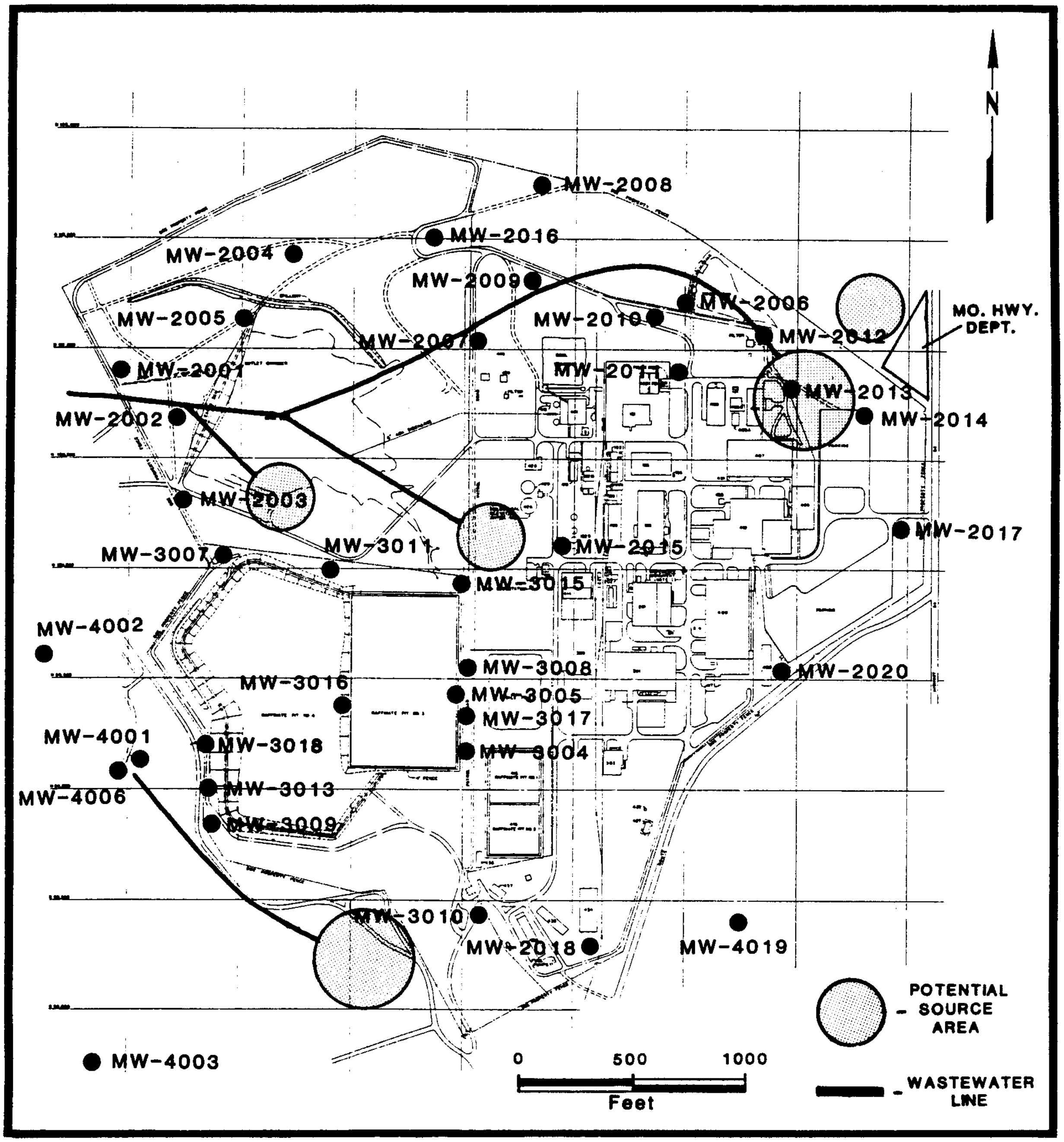


FIGURE 18 Potential Nitroaromatic Source Areas at the Raffinate Pits and Chemical Plant Area (Source: U.S. Department of Energy 1987c)

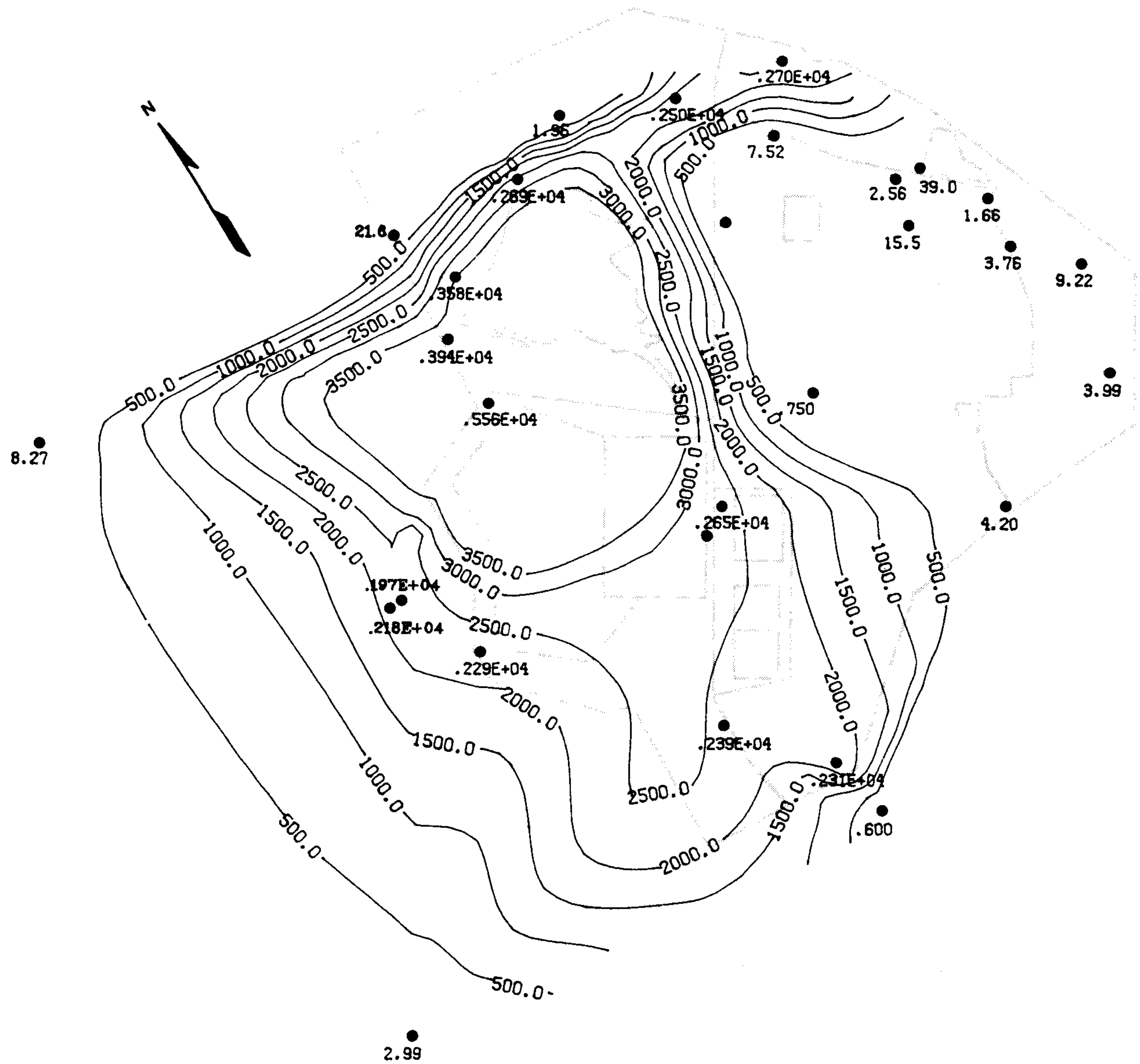


FIGURE 19 Nitrate Isopleth (mg/L as nitrate) in Groundwater at the Raffinate Pits and Chemical Plant Area (Source: Modified from U.S. Department of Energy 1987c)

Inorganic contaminants are present in the soil, groundwater, surface water, buildings, and wastes at the Weldon Spring site. Nitric acid and hydrofluoric acid were used extensively at the chemical plant. High levels of nitrates, sulfates, and fluorides are present in the raffinate pit sludge; high levels of nitrates and sulfates are present in the groundwater beneath the raffinate pits and chemical plant area (see Figures 19 and 20 for nitrate and sulfate isopleths). Inorganic anion and water quality data obtained in March and April 1987 from surface water (including raffinate pits water) and groundwater sampling are presented in Tables 9, 10, and 11.

Tributyl phosphate in hexane and other organics were used in uranium processing at the chemical plant. Two stainless steel tanks currently at the plant are partially filled

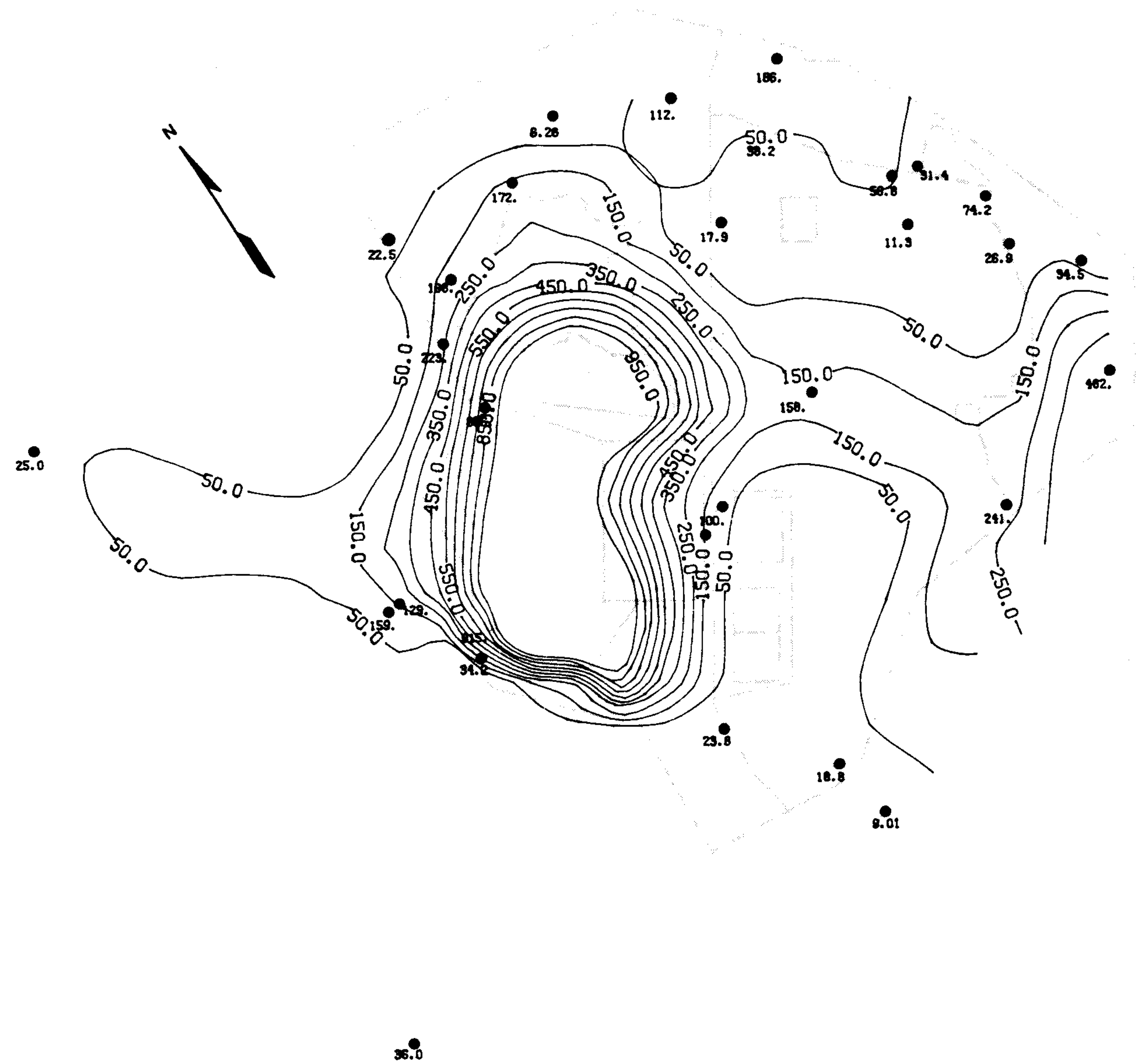


FIGURE 20 Sulfate Isopleth (mg/L) in Groundwater at the Raffinate Pits and Chemical Plant Area (Source: Modified from U.S. Department of Energy 1987c)

with solutions of tributyl phosphate/kerosene oil (a total volume of 30 m^3 [8,000 gal]), and these solutions have elevated concentrations of uranium. Samples from these tanks are currently being evaluated to assess potential reprocessing and disposal alternatives. Other tanks on-site appear empty but were previously used to store hydrofluoric acid, nitric acid, sulfuric acid, caustic soda solutions, propane, and hexane. All process tanks are located above ground; however, several underground tanks were previously used to store petroleum products.

At the chemical plant, 15 transformers contained PCB fluids in the range of 30-40% by volume. In addition, several electrical components -- including transformers, capacitors and switches -- contained PCB-contaminated fluids at PCB concentrations of

TABLE 9 Inorganic Anion and Water Quality Data from Surface Water Sampling at the Raffinate Pits and Chemical Plant Area

		Concentration[a] (mg/L)						
Sampling Location	Date Sampled	Nitrate (as N)	Sulfate	Chloride	Fluoride	Hardness	Total Dissolved Solids	Total Organic Carbon
SW-2001	3/11/87	562	130	8.45	1.12	192	334	4.86
SW-2002	3/10/87	0.2	72.1	198	<0.25	160	526	4.23
SW-2003	3/11/87	0.3	18.8	16.5	<0.25	NM	NM	NM
SW-2004	3/11/87	2.0	25.2	17.2	<0.25	NM	NM	NM
SW-2005	3/11/87	<0.1	23.4	17.1	<0.25	NM	NM	NM
SW-2006	3/12/87	<0.1	11.3	6.67	<0.25	NM	NM	NM
SW-2007	3/11/87	538	119	6.95	0.56	171	306	3.53
SW-2008	3/10/87	12.6	55.9	13.2	<0.25	199	292	2.78
SW-2010	3/12/87	10.9	66.3	5.63	0.42	226	288	1.42
SW-2011	3/12/87	0.2	71.6	817	1.47	226	2302	1.45
EPA standard[b]		10	250	250	2	c	500	c

[a]NM = not measured.

[b]Primary/secondary drinking water standard.

[c]No drinking water standard has been promulgated for these parameters.

Source: Data from U.S. Department of Energy (1987c).

TABLE 10 Inorganic Anion and Water Quality Data from Sampling of the Raffinate Pits Water

Sampling Location	Pit No.	Date Sampled	Concentration (mg/L)								
			Nitrate (as N)	Sulfate	Chloride	Fluoride	Hardness	Total Dissolved Solids	Total Organic Carbon	Cyanide	Phenol
SW-3001	1	4/24/87	422	231	1.50	1.90	872	3160	12	0.032	<0.005
SW-3002	2	4/24/87	10.1	493	2.34	1.57	422	818	8	0.025	<0.005
SW-3003	3	4/24/87	947	704	3.37	4.84	2107	6390	6	0.027	<0.005
SW-3004	4	4/24/87	46.6	136	5.69	4.69	252	694	8	0.032	<0.005
EPA standard[a]			10	250	250	2	b	500	b	b	0.001[c]

[a]Primary/secondary drinking water standard.

[b]No drinking water standard has been promulgated for these parameters.

[c]Missouri drinking water standard.

Source: Data from U.S. Department of Energy (1987c).

TABLE 11 Inorganic Anion Data from Groundwater Sampling at the Raffinate Pits and Chemical Plant Area

		Concentration[b] (mg/L)								
Sampling Location[a]	Date Sampled	Nitrate (as N)	Sulfate	Chloride	Fluoride	Hardness	Total Dissolved Solids	Total Organic Carbon	Cyanide	Phenol
GW-2001	3/3/87	4.8	22.5	5.12	<0.25	307	362	<1	U	U
GW-2002	3/4/87	806	198	23.2	14.9	664	1360	1	U	U
GW-2003	3/4/87	886	223	33.2	14.7	985	2724	16	U	U
GW-2003-D	3/4/87	945	232	32.8	14.6	1331	2520	<1	U	U
GW-2004	3/3/87	0.4	6.26	1.14	<0.25	305	374	63	U	U
GW-2005	3/5/87	605	172	4.43	1.01	419	1562	2.12	U	U
GW-2006	3/2/87	8.8	31.4	87.1	<0.25	411	570	7	U	0.016
GW-2007	3/2/87	<0.1	17.9	1.34	<0.25	312	320	<1	U	U
GW-2008	3/4/87	608	166	64.2	17.0	375	622	1	U	0.013
GW-2009	3/3/87	1.7	38.2	8.04	<0.25	448	596	2	U	U
GW-2010	3/3/87	0.6	56.8	32.2	<0.25	374	590	2	U	U
GW-2011	3/3/87	3.5	11.3	4.44	<0.25	279	314	1	U	U
GW-2012	3/3/87	0.4	74.2	32.2	<0.25	352	546	57	U	U
GW-2013	3/2/87	0.9	26.9	8.62	0.40	415	688	6	U	U
GW-2014	3/2/87	2.2	34.5	2.83	0.28	460	570	3	U	U
GW-2015	3/6/87	0.2	158	2.46	<0.25	502	570	3.26	U	0.011
GW-2015-D	3/6/87	<0.1	158	2.12	0.25	514	568	2.96	U	U
GW-2016	3/4/87	562	112	18.1	15.3	328	656	2	U	U
GW-2017	3/2/87	0.9	462	10.8	0.62	735	1000	1	U	U
GW-2018	3/5/87	519	18.8	2.45	0.54	352	642	0.98	U	U
GW-2020	3/6/87	0.9	241	38.4	<0.25	434	680	8.21	U	U
GW-3007	3/4/87	1251	866	52.2	12.4	2594	5260	10	U	U
GW-3008	3/10/87	597	100	31.7	1.51	3482	6028	2.06	U	0.014
GW-3009	3/5/87	515	34.2	1.64	0.58	478	728	2.20	U	0.020
GW-3010	3/5/87	296	23.8	2.21	0.38	322	500	1.85	U	U
GW-3010-D	3/5/87	537	23.0	2.34	0.55	333	506	1.55	U	U
GW-3013	3/5/87	468	915	2.30	1.09	997	1436	3.51	U	U

TABLE 11 (Cont'd)

Sampling Location[a]	Date Sampled	Concentration[b] (mg/L)								
		Nitrate (as N)	Sulfate	Chloride	Fluoride	Hardness	Total Dissolved Solids	Total Organic Carbon	Cyanide	Phenol
GW-4001	3/5/87	491	159	1.48	0.55	367	652	14.1	0.018	0.011
GW-4002	3/6/87	1.9	25.0	2.16	<0.25	219	232	24.8	U	U
GW-4003	3/6/87	0.7	36.0	7.40	<0.25	294	308	8.78	U	U
GW-4006	3/5/87	444	129	0.78	0.44	226	402	17.7	U	0.011
GW-4019	3/6/87	0.1	9.01	0.91	<0.25	280	278	3.77	U	0.026
EPA standard[c]		10	250	250	2	d	500	d	d	0.001[e]

[a]D refers to duplicate sample analysis.

[b]U means undetected at the contract-required detection limits.

[c]Primary/secondary drinking water standard.

[d]No drinking water standard has been promulgated for these parameters.

[e]Missouri drinking water standard.

Source: Data from U.S. Department of Energy (1987c).

less than 500 ppm (see Figure 21 and Table 12). These fluids and electric equipment have recently been removed from the site (see Section 3.10.2.1). Also, PCB contamination has been found in storage areas, on concrete pads and some building floors, and in localized areas of soil. No PCBs have been detected in groundwater or surface water samples.

Asbestos is present in many areas of the chemical plant, including overhead pipelines inside and outside of buildings, and cement-asbestos siding and internal insulation of some buildings. Asbestos pipeline insulation is typically secured to pipelines with an outer cover of nonasbestos material; this cover has deteriorated in many areas, particularly on outside lines that are exposed to the elements, and asbestos has fallen to the ground or floor. Some pipes have been dismantled and stored in spoil piles, and asbestos remnants are visible in many areas. Asbestos contamination is likely to be present at the following locations:

- Chemical plant buildings and associated indoor and outdoor pipes,
- Pipes adjacent to raffinate pits 1 and 3,
- Soils and sediments, including those from Ash Pond, Frog Pond, and areas northwest and south of Ash Pond,
- Other on-site surface impoundments, including the raffinate pits,
- Soils in localized areas traversed by outdoor pipes, and
- Spoils piles.

Known locations of asbestos at outdoor locations of the chemical plant are shown in Figure 22.

2.5.3 Quarry

The quarry was used for the disposal of chemically and radioactively contaminated materials intermittently from the early 1940s to 1968. The chemically contaminated materials are largely TNT-contaminated rubble and soil. The radioactive materials are those associated with uranium- and thorium-processing activities previously carried out at the chemical plant and at other sites in the St. Louis area. Some of these wastes may be classified as *mixed wastes*, i.e., radioactive wastes that also meet the criteria for classification as hazardous wastes under the Resource Conservation and Recovery Act (RCRA).

The concentrations of radioactive species in boreholes drilled into the quarry wastes vary greatly, as a function of both depth within a borehole and borehole location. It has been estimated that there are 73,000 m^3 (95,000 yd^3) of contaminated wastes in the quarry (U.S. Dept. Energy 1987a). Compared with the raffinate sludge, the concentration and inventory of thorium-230 are lower in the quarry wastes, but the uranium-238 concentration and inventory are similar (Table 4). In addition to uranium,

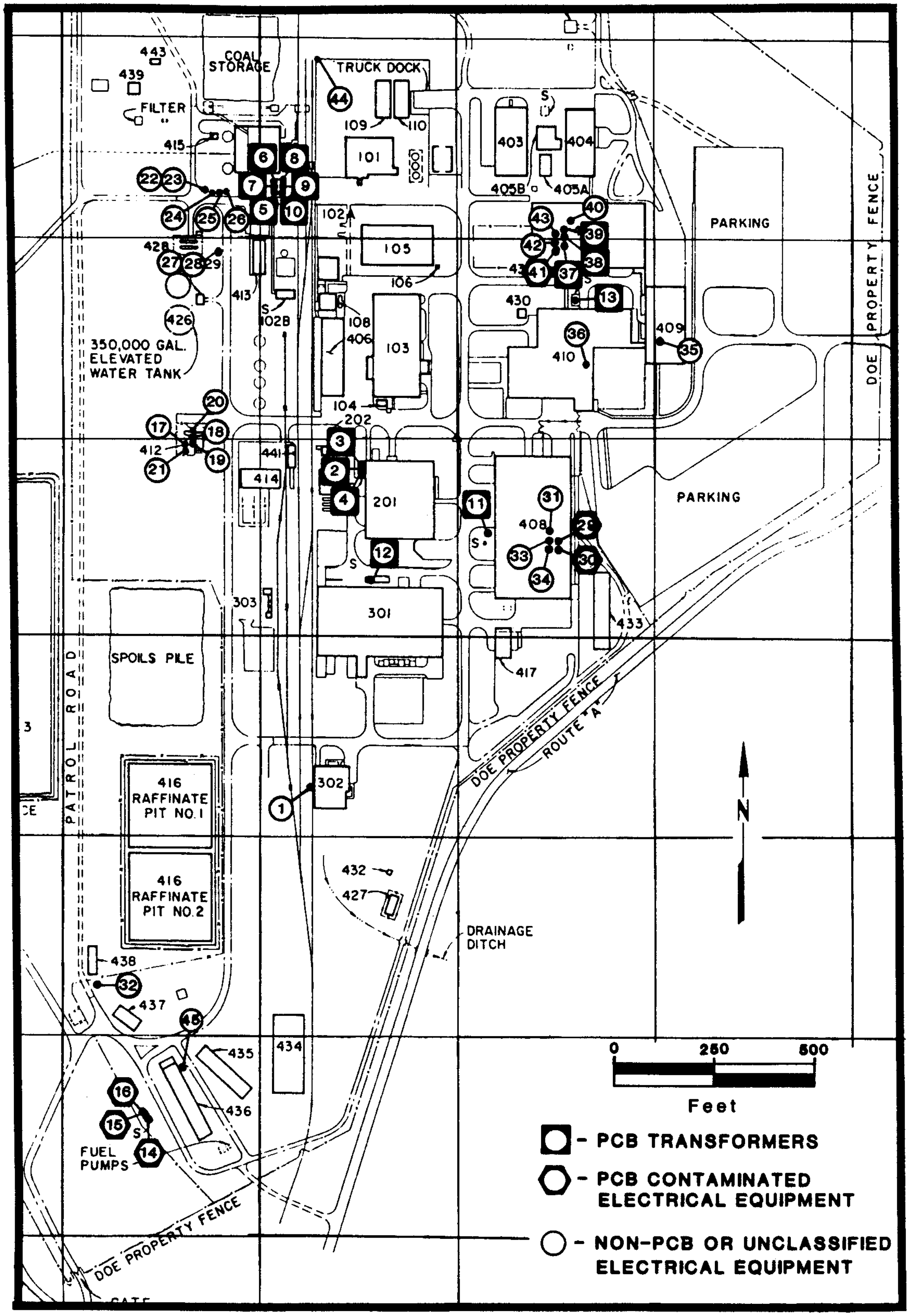


FIGURE 21 PCB-Contaminated Transformers, Capacitors, and Switches at the Chemical Plant

TABLE 12 PCB Contents of Transformers at the Weldon Spring Site

No.[a]	PCB Concentration[b] (ppm)	Capacity (gal)	Location	40 CFR Part 761 Classification
1	NA	-	Pad mounted	No PCBs
2	340,000	423	Pad mounted	PCB transformer
3	410,000	430	Pad mounted	PCB transformer
4	390,000	423	Pad mounted	PCB transformer
5	370,000	475	Pad mounted	PCB transformer
6	360,000	430	Pad mounted	PCB transformer
7	380,000	430	Pad mounted	PCB transformer
8	380,000	475	Pad mounted	PCB transformer
9	370,000	475	Pad mounted	PCB transformer
10	370,000	475	Pad mounted	PCB transformer
11	380,000	430	Pad mounted	PCB transformer
12	350,000	430	Pad mounted	PCB transformer
13	370,000	475	Pad mounted	PCB transformer
14	142	48	Pad mounted	PCB-contaminated electrical equipment
15	211	48	Pad mounted	PCB-contaminated electrical equipment
16	290	48	Pad mounted	PCB-contaminated electrical equipment
17	<0.5	330	Pad mounted	No PCBs
18	<0.5	2160	Pad mounted	No PCBs
19	<0.5	2160	Pad mounted	No PCBs
20	25	2450	Pad mounted	No PCBs
21	<0.5	45	Pad mounted	No PCBs
22	NS	≈15	Pole mounted	Not classified
23	NS	≈15	Pole mounted	Not classified
24	3.5	98	Pole mounted	No PCBs
25	1.0	71	Pole mounted	No PCBs
26	1.0	17	Pole mounted	No PCBs
27	1.5	≈75	Pole mounted	No PCBs
28	5.5	≈15	Pole mounted	No PCBs
29	223	≈50	Pole mounted	PCB-contaminated electrical equipment
30	208	≈50	Pole mounted	PCB-contaminated electrical equipment
31	2.5	≈75	Pole mounted	No PCBs
32	NS	≈50	Pole mounted	Not classified
33	NA	-	Pole mounted	No PCBs
34	NA	-	Pole mounted	No PCBs
35	NA	-	Pole mounted	No PCBs
36	NA	-	Pole mounted	No PCBs

TABLE 12 (Cont'd)

No.[a]	PCB Concentration[b] (ppm)	Capacity (gal)	Location	40 CFR Part 761 Classification
37	380,000	≈200	Roof mounted	PCB transformer
38	400,000	≈250	Roof mounted	PCB transformer
39	420,000	≈350	Roof mounted	PCB transformer
40	NA	-	Roof mounted	No PCBs
41	68	≈90	Wall mounted	PCB-contaminated electrical equipment
42	3.5	≈90	Wall mounted	No PCBs
43	2.5	≈90	Wall mounted	No PCBs
44	NA	-	Pole mounted	No PCBs
45	NS	≈15	On ground	Not classified

[a]Number refers to sampling location (see Figure 21).

[b]NA = not applicable, transformer is air-cooled and contains no dielectric fluids; NS = not sampled.

elevated concentrations of several metals -- including arsenic, copper, lead, and nickel -- have been detected. The presence of gamma-emitting radionuclides in the quarry results in elevated exposure rates. Areas at the quarry having exposure rates above background levels are shown in Figure 23.

Organic volatile and semivolatile compounds, nitroaromatic compounds, PCBs, and pesticides were detected in samples of soils, sludges, and sediments collected from 17 borings. Volatile organics detected in one or more boreholes included methylene chloride, xylene, and ethyl benzene at concentrations ranging from 1 to 50 ppm. (Volatile compounds were probably introduced into field samples during collection or analysis, based on their presence in test and sample blanks.) Semivolatile organic compounds detected in one or more boreholes included the polycyclic aromatic hydrocarbons (PAHs) phenanthrene, fluoranthene, and benzo(b)fluoranthene at maximum concentrations of 150, 190, and 110 ppm, respectively. The maximum value detected for subsurface nitroaromatic compounds was 1,600 ppm for TNT, and the maximum value for PCBs was 120 ppm for Aroclor 1254 (Kaye and Davis 1987). Surficial discoloration of soils in the eastern portion of the quarry (Figure 24) indicates the presence of nitroaromatic compounds that were subsequently determined to be at levels of 1 to 2%.

Groundwater monitoring locations near the quarry are shown in Figure 25. Results obtained during the Phase I water quality assessment and from routine environmental monitoring are presented in Table 13 (radiological parameters), Table 14 (nitroaromatics), Table 15 (metals), and Table 16 (inorganic anion species and water

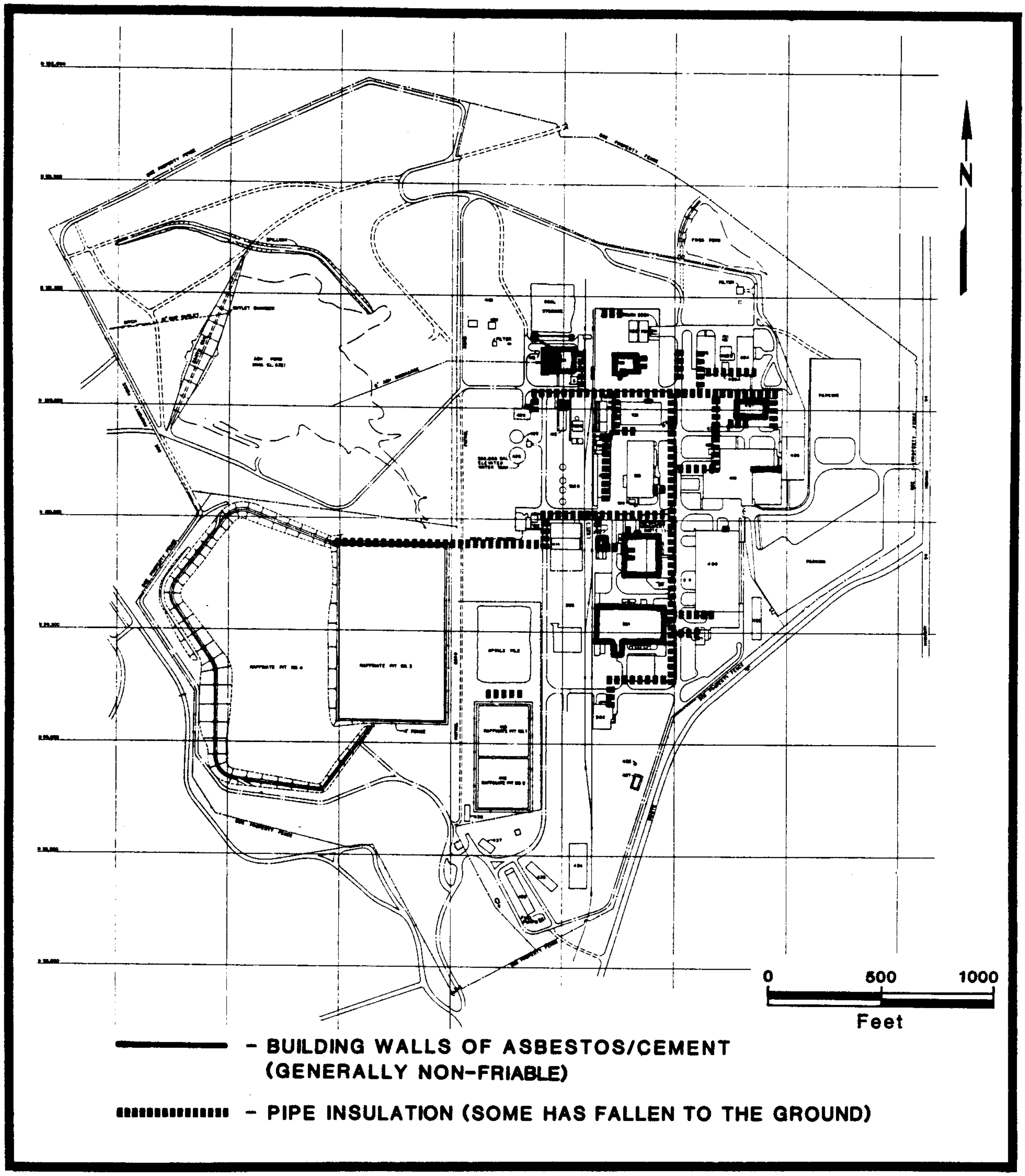


FIGURE 22 Known Locations of Asbestos at Outdoor Locations at the Raffinate Pits and Chemical Plant Area

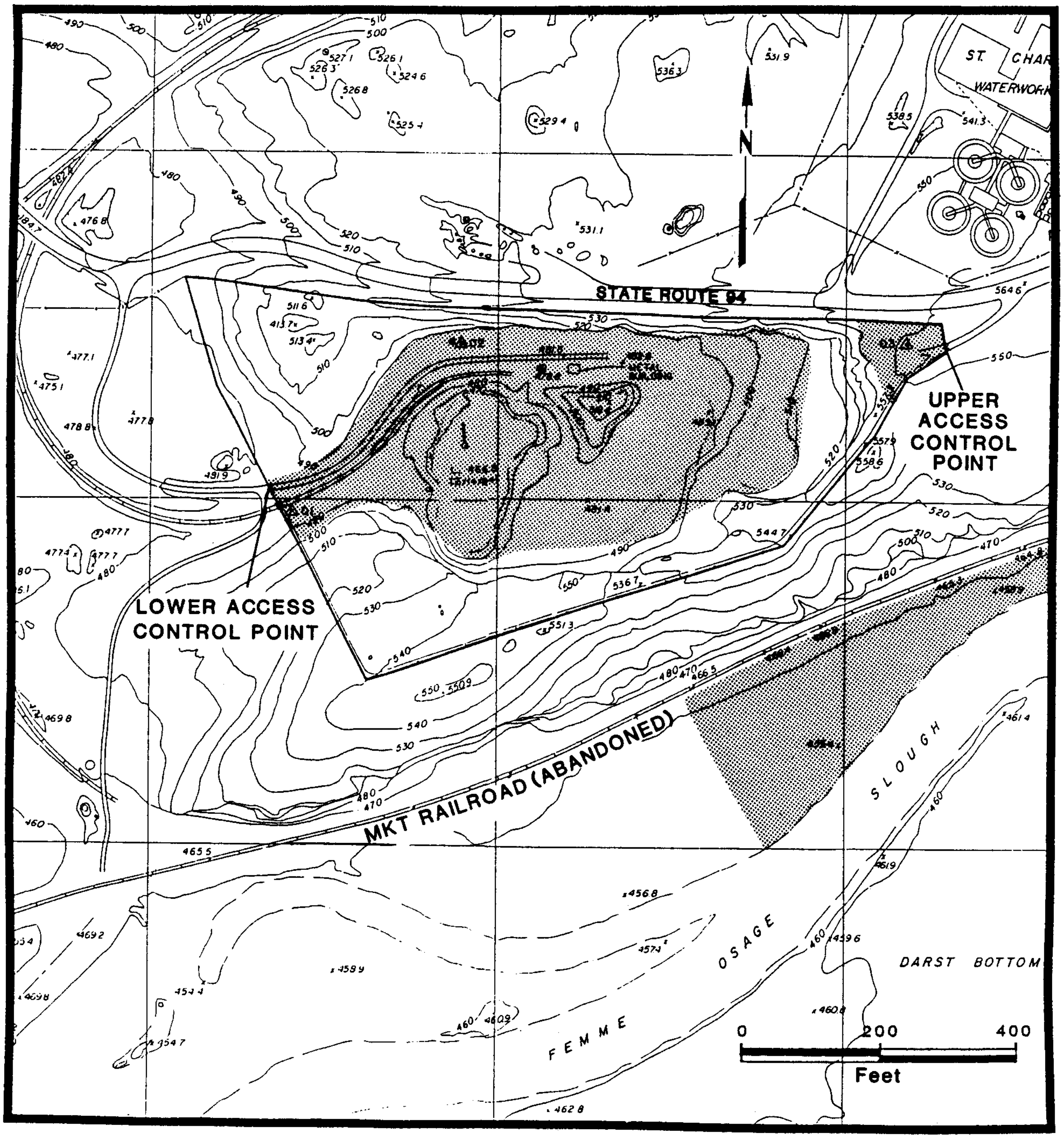


FIGURE 23 Areas at the Quarry that Have Exposure Rates above Background

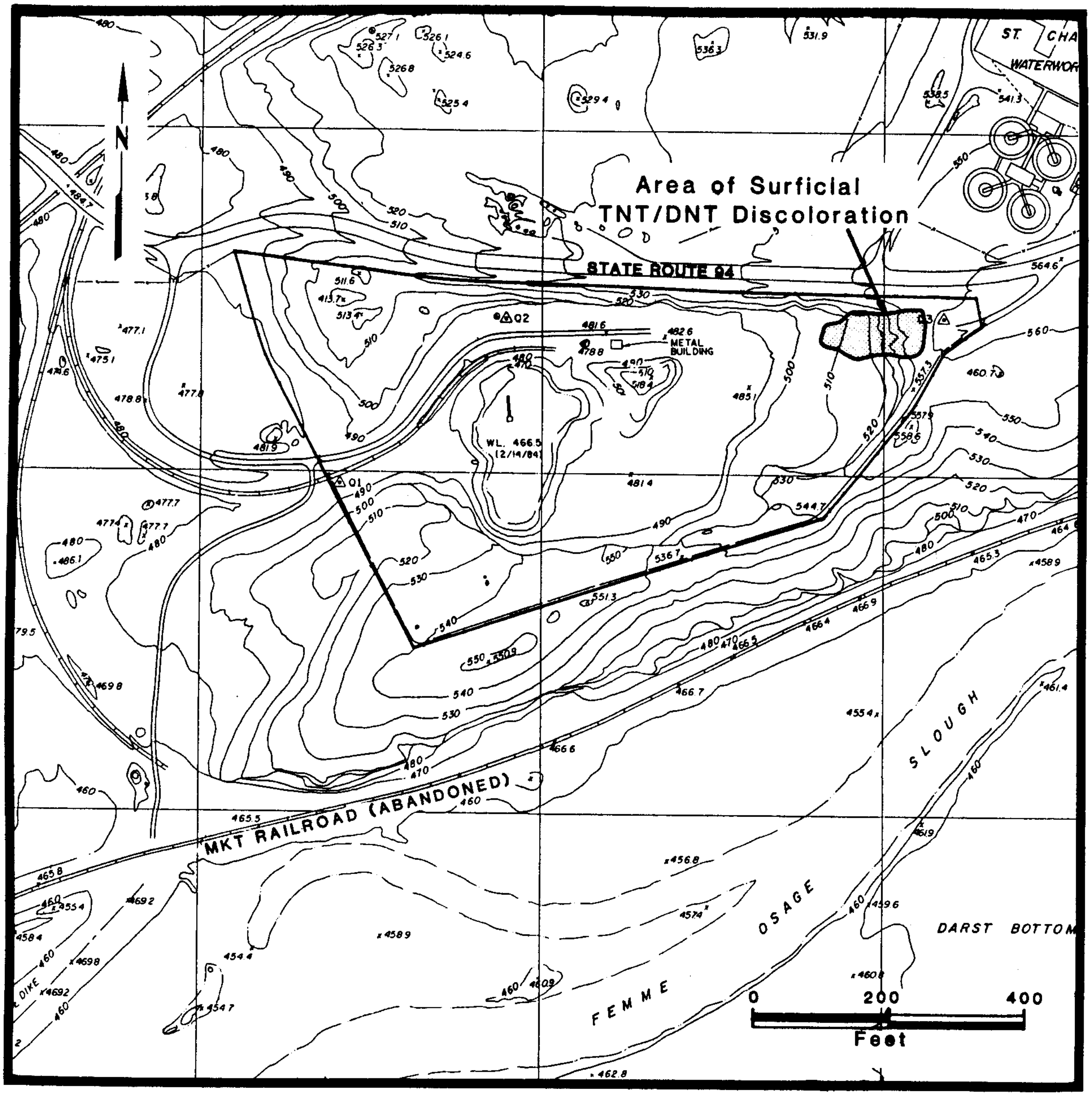


FIGURE 24 Area of Surficial TNT/DNT Discoloration at the Weldon Spring Quarry

quality parameters). The results indicate the presence of nitroaromatic compounds in wells completed in Decorah limestone and in certain alluvial wells north of the Femme Osage Slough. Three volatile organic compounds -- ethyl benzene, toluene, and xylene -- were detected in two alluvial wells (MW-1008 and MW-1009) at concentrations ranging from 8 to 20 ppb. These are the same volatile organic compounds detected in the quarry waste materials. Although subsequent quarterly sampling of these and other alluvial wells failed to detect these compounds, sampling and analysis for volatile organic compounds will continue. Semivolatile organic compounds, PCBs, and pesticides have not been detected in any of the quarry monitoring wells. The metal concentrations in both

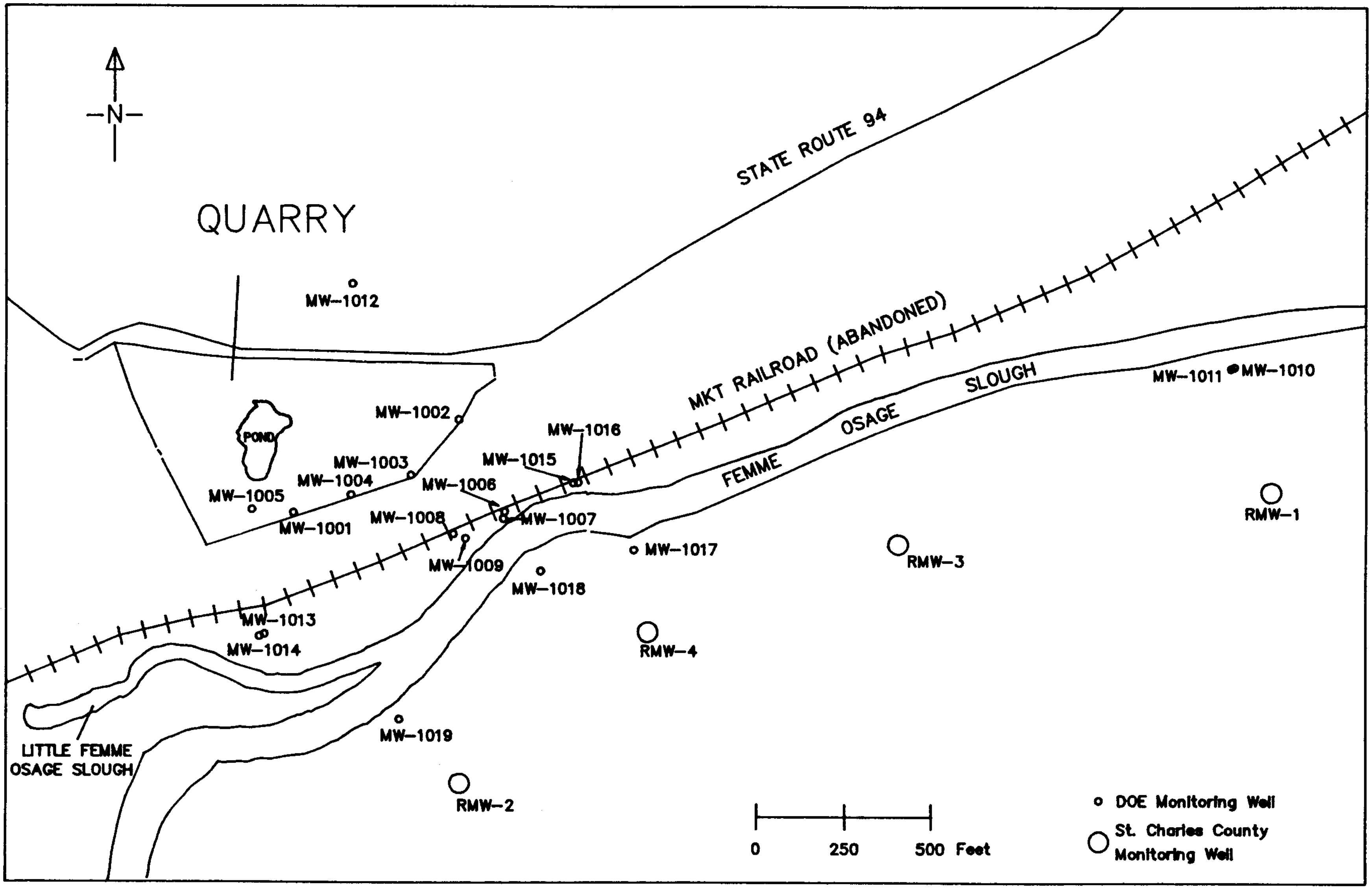


FIGURE 25 Groundwater Monitoring Locations near the Quarry

TABLE 13 Radiological Data from Groundwater Sampling at the Quarry

		Concentration ± Error (pCi/L)						
Sampling Location[a]	Date Sampled	Gross Alpha	Gross Beta	Natural Uranium[b]	Radium -226	Radium -228	Thorium -230	Thorium -232
GW-1002	3/12/87	<4	<8	3.8 ± 1.1	<1	<3	<2	<2
GW-1004	3/11/87	2600 ± 300	2500 ± 300	3900 ± 400	<1	32 ± 6	<1	<1
GW-1005	3/11/87	460 ± 50	490 ± 50	420 ± 50	<1	<2	<1	<1
GW-1006	3/13/87	640 ± 50	850 ± 90	1300 ± 200	1.0 ± 0.1	<5	<2	<2
GW-1007	3/13/87	78 ± 9	120 ± 20	360 ± 40	1.8 ± 0.2	<3	<2	<2
GW-1008	3/13/87	500 ± 50	280 ± 30	770 ± 80	3.7 ± 0.1	<4	<2	<2
GW-1009	3/13/87	<8	<15	12 ± 2.0	<1	<3	<1	<1
GW-1010	3/10/87	<3	<8	<1	<1	<2	<2	<2
GW-1011	3/10/87	<3	<8	<1	<1	<2	<2	<2
GW-1012	3/2/87	<9	28 ± 9	2.9 ± 1.0	<1	<10	12 ± 1	<4
GW-1013	9/28/87	300 ± 30	290 ± 30	1200 ± 200	<1	<8	<1	<1
GW-1014	9/28/87	650 ± 70	490 ± 50	1200 ± 200	<1	<5	<1	<1
GW-1015	9/24/87	310 ± 40	180 ± 20	470 ± 50	<1	<1	<1	<1
GW-1015-D	9/24/87	320 ± 40	170 ± 20	470 ± 50	<1	3.5 ± 1.2	<1	<1
GW-1016	9/24/87	26 ± 6	<6	32 ± 4	<1	<1	<1	<1
GW-1017	9/22/87	<5	<8	1.2 ± 0.6	<1	<4	<1	<1
GW-1018	9/23/87	<3	<7	<1	<1	<1	<1	<1
GW-1019	9/23/87	<3	<6	<1	<1	<1	<1	<1

[a]D refers to duplicate sample analysis.

[b]Natural uranium is the sum of all uranium isotopes assumed to be present in their natural activity ratio.

TABLE 14 Nitroaromatics Data from Groundwater Sampling at the Quarry

Sampling Location	Date Sampled	Concentration (µg/L)					
		2,4,6-TNT	2,4-DNT	2,6-DNT	Nitro-benzene	1,3,5-Trinitro-benzene	1,3-Dinitro-benzene
GW-1001	10/2/87	<0.5	<0.2	<0.6	<0.6	<0.03	<0.4
GW-1002	10/1/87	<0.5	<0.2	<0.6	2.2	0.48	<0.4
GW-1004	10/2/87	<0.5	0.33	<0.6	<0.6	0.16	<0.4
GW-1005	10/1/87	<0.5	0.61	<0.6	1.7	0.52	<0.4
GW-1006	9/28/87	7.6	<0.2	1.0	8.5	1.5	<0.4
GW-1007	9/29/87	<0.5	<0.2	<0.6	<0.6	<0.03	<0.4
GW-1008	9/29/87	<0.5	<0.2	<0.6	<0.6	<0.03	<0.4
GW-1009	9/22/87	<0.5	<0.2	<0.6	<0.6	<0.03	<0.4
GW-1010	9/22/87	<0.5	<0.2	<0.6	<0.6	<0.03	<0.4
GW-1011	9/22/87	<0.5	<0.2	<0.6	<0.6	<0.03	<0.4
GW-1012	9/30/87	<0.5	<0.2	<0.6	<0.6	<0.03	<0.4
GW-1013	9/28/87	<0.5	0.56	<0.6	0.95	0.23	<0.4
GW-1014	9/28/87	<0.5	0.33	<0.6	1.6	0.25	<0.4
GW-1015	9/24/87	28.9	<0.2	<0.6	44.0	8.3	<0.4
GW-1016	9/24/87	<0.5	<0.2	<0.6	<0.6	<0.03	<0.4
GW-1017	9/22/87	<0.5	<0.2	<0.6	<0.6	<0.03	<0.4
GW-1018	9/23/87	<0.5	0.33	<0.6	<0.6	<0.03	<0.4
GW-1019	9/23/87	<0.5	<0.2	<0.6	<0.6	<0.03	<0.4

TABLE 15 Metals Data from Groundwater Sampling at the Quarry

Sampling Location	Date Sampled	Concentration[a] (μg/L)											
		Al	Sb	As	Ba	Be	Cd	Ca	Cr	Co	Cu	Fe	Pb
GW-1002	3/12/87	132	U	U	150	U	U	120,000	38	U	7	40	U
GW-1004	3/11/87	370	97	U	95	U	U	103,900	76	U	20	220	U
GW-1005	3/11/87	132	U	U	74	U	U	103,900	47	U	10	23	U
GW-1006	3/13/87	260	77	U	103	U	U	224,400	75	U	20	24	U
GW-1007	3/13/87	203	82	U	512	U	U	208,200	67	U	14	5,130	U
GW-1008	3/13/87	224	79	U	191	U	U	177,700	66	U	14	296	U
GW-1009	3/13/87	186	78	U	328	U	U	198,100	70	U	15	4,570	U
GW-1010	3/10/87	U	U	27	533	U	U	57,200	28	U	9	883	U
GW-1011	3/10/87	U	U	U	170	U	U	69,000	32	U	9	2,250	U
GW-1012	3/2/87	219	86	10	171	U	U	145,600	54	U	18	80	U
GW-1013	9/28/87	121	44	U	159	1	U	126,000	49	10	15	1,860	U
GW-1014	9/28/87	132	47	U	158	1	U	130,000	49	10	15	2,360	U
GW-1015	9/24/87	103	40	U	92	1	U	137,000	45	7	17	118	U
GW-1016	9/24/87	122	-	U	138	U	U	139,000	45	7	15	104	U
GW-1017	9/22/87	110	46	32	962	1	11	139,000	46	18	15	20,190	U
GW-1018	9/23/87	100	60	32	890	1	12	137,000	47	18	14	26,400	U
GW-1019	9/23/87	149	41	48	852	1	U	100,000	33	12	12	9,600	U
EPA standard[b]		c	c	50	1,000	c	10	c	50	c	1,000	300	50
RDL[b]		200	60	10	200	5	5	5,000	10	50	25	100	5

TABLE 15 (Cont'd)

Sampling Location	Date Sampled	Concentration[a] (μg/L)											
		Li	Mg	Mn	Hg	Ni	K	Se	Ag	Na	Tl	V	Zn
GW-1002	3/12/87	U	20,800	620	U	36	6,350	U	U	27,600	U	U	12
GW-1004	3/11/87	U	46,700	840	U	52	8,660	U	23	27,700	U	28	29
GW-1005	3/11/87	U	24,200	64	U	37	7,680	U	U	25,800	U	U	7
GW-1006	3/13/87	U	33,150	3,690	U	39	3,400	U	26	79,370	U	33	30
GW-1007	3/13/87	U	34,100	7,170	U	38	3,290	U	19	67,740	U	30	12
GW-1008	3/13/87	U	32,600	6,180	U	41	3,640	U	19	39,000	U	29	23
GW-1009	3/13/87	U	34,600	4,330	U	39	2,850	U	18	50,800	U	31	17
GW-1010	3/10/87	U	12,800	5,915	U	U	3,310	U	U	15,500	U	U	21
GW-1011	3/10/87	U	15,800	4,240	U	U	2,060	U	U	21,700	U	U	38
GW-1012	3/2/87	U	41,000	380	U	43	8,340	U	22	187,600	U	25	21
GW-1013	9/28/87	U	31,000	633	U	20	3,990	U	U	19,900	U	35	8
GW-1014	9/28/87	U	30,500	786	U	21	4,760	U	U	21,400	U	36	21
GW-1015	9/24/87	U	30,700	39	U	14	2,370	U	U	26,200	U	34	37
GW-1016	9/24/87	U	27,400	206	0.2	26	1,030	U	U	17,900	U	33	16
GW-1017	9/22/87	U	38,500	690	U	24	5,800	U	U	23,900	U	35	U
GW-1018	9/23/87	U	40,400	1,230	U	25	6,550	U	U	24,900	U	36	34
GW-1019	9/23/87	U	31,000	503	U	10	4,490	U	U	11,400	U	27	7
EPA standard[b]		c	c	50	2	c	c	10	50	c	c	c	5,000
RDL[b]		-	5,000	15	0.2	40	5,000	5	10	5,000	10	50	20

[a]U means undetected at the contract-required detection limit; a hyphen indicates that data are not available.

[b]EPA standard = EPA primary/secondary drinking water standard; RDL = contract laboratory program required detection limit.

[c]No drinking water standard has been promulgated for these parameters.

TABLE 16 Inorganic Anion and Water Quality Data from Groundwater Sampling at the Quarry

Sampling Location[a]	Date Sampled	Concentration[b] (mg/L)								
		Nitrate (as N)	Sulfate	Chloride	Fluoride	Hardness	Total Dissolved Solids	Total Organic Carbon	Cyanide	Phenol
GW-1002	3/12/87	0.4	62.7	9.06	<0.25	313	404	3	U	U
GW-1004	3/11/87	537	329	7.0	0.97	530	872	3.48	U	U
GW-1005	3/11/87	579	379	125	0.62	372	600	11.2	U	U
GW-1006	3/13/87	2.2	377	50.9	<0.25	777	1,108	6.28	0.014	U
GW-1007	3/13/87	3.2	132	71.0	<0.25	784	968	8.63	0.013	U
GW-1008	3/13/87	<0.1	238	24.3	<0.25	784	816	6.06	U	U
GW-1009	3/13/87	<0.1	160	28.5	<0.25	740	870	5.01	U	U
GW-1010	3/10/87	<0.25	4.40	7.91	<0.25	215	278	4.17	U	U
GW-1011	3/10/87	<0.25	20	9.64	<0.25	267	318	4.00	U	U
GW-1012	3/2/87	0.8	479	11.4	0.76	528	1,156	13	U	U
GW-1013	9/28/87	<0.1	112	24.5	0.9	444	1,002	3.8	0.008	<0.005
GW-1014	9/28/87	25.2	106	21.5	1.0	524	720	2.3	0.012	<0.005
GW-1015	9/24/87	1.3	160	31.4	1.0	568	727	2.55	<0.005	<0.005
GW-1015-D	9/24/87	1.5	156	30.6	1.0	556	599	6.58	<0.005	<0.005
GW-1016	9/24/87	<0.1	154	14.6	0.9	544	670	2.63	<0.005	<0.005
GW-1017	9/22/87	<0.1	1.3	24.4	1.0	630	715	15	<0.005	<0.005
GW-1018	9/23/87	<0.1	51.4	33.4	0.9	614	701	6	<0.005	<0.005
GW-1019	9/23/87	<0.1	1.05	8.5	0.8	440	483	12	<0.005	<0.005
EPA standard[c]		10	250	250	2	d	500	d	d	0.001[e]

[a]D refers to duplicate sample analysis.

[b]U means undetected at the contract-required detection limits.

[c]Primary/secondary drinking water standard.

[d]No drinking water standard has been promulgated for these parameters.

[e]Missouri drinking water standard.

limestone and alluvial groundwater appear consistent with background levels for the respective aquifers.

Surface water monitoring locations are shown in Figure 26, and the measured radiological parameters are presented in Table 17. The main contaminant in the quarry pond (SW-1008) is uranium, which was recently measured at an average concentration of 2,100 pCi/L. Analysis of water samples from wells in the limestone bluff and in the alluvium between the quarry and the slough indicate that uranium has migrated from the quarry (Kleeschulte and Emmet 1987).

Contaminant migration from the quarry into the alluvium and Femme Osage Slough was investigated in 1987 using uranium as an indicator (Marutzky, Colby, and Cahn 1988). Samples were collected in 0.3-m (1-ft) increments along two geologic cross sections, as shown in Figure 27. The results of the analysis are shown in Figure 28. Because the water table in the area is 0.6 to 1.5 m (2 to 5 ft) below the ground surface, most of the soil samples collected were saturated. Thus, the uranium results reflect both soil and groundwater contributions. Based on typical dissolved groundwater concentrations of uranium in the quarry, ranging from 1,000 to 8,000 pCi/L, the overall groundwater contribution of dissolved uranium ranges from 5 to 20% of the alluvial uranium concentrations present. Because no samples were collected directly beneath the slough, little can be inferred about the presence of uranium in this area; however, samples collected from boreholes immediately south of the slough identified no elevated levels of uranium. Therefore, the isopleths for cross section A-A' in Figure 28 have been dashed to indicate that the uranium distribution in close proximity to the slough is only estimated.

Radiological surveys along the southern quarry wall and adjacent to the right-of-way of the recently abandoned MKT railroad failed to locate any surface contamination that could contribute to the contamination located between the slough and quarry via surface runoff. Rather, the uranium contamination present in the slough area appears to have resulted from transport via groundwater migration. Groundwater migration has deposited uranium along preferential flow pathways. Groundwater elevations fluctuate in response to changing river stages. During higher stages, the groundwater elevation has been observed at the ground surface; as the water table falls, uranium appears to remain in the upper alluvial soils.

The uranium contamination appears to be restricted to an area between the quarry and Femme Osage Slough. The slough may act as a hydrogeologic boundary for groundwater migration north of the slough. Groundwater north of the slough probably discharges into Femme Osage Slough. Seepage into the slough becomes subject to natural dilutional effects.

2.5.4 Vicinity Properties

The vicinity properties are areas near the raffinate pits and chemical plant area and the quarry -- but outside of the current fenced boundaries -- that are contaminated as a result of previous activities conducted at the site. Contamination in the vicinity properties is located mainly along ditches, drainageways, roads, and railroads; some

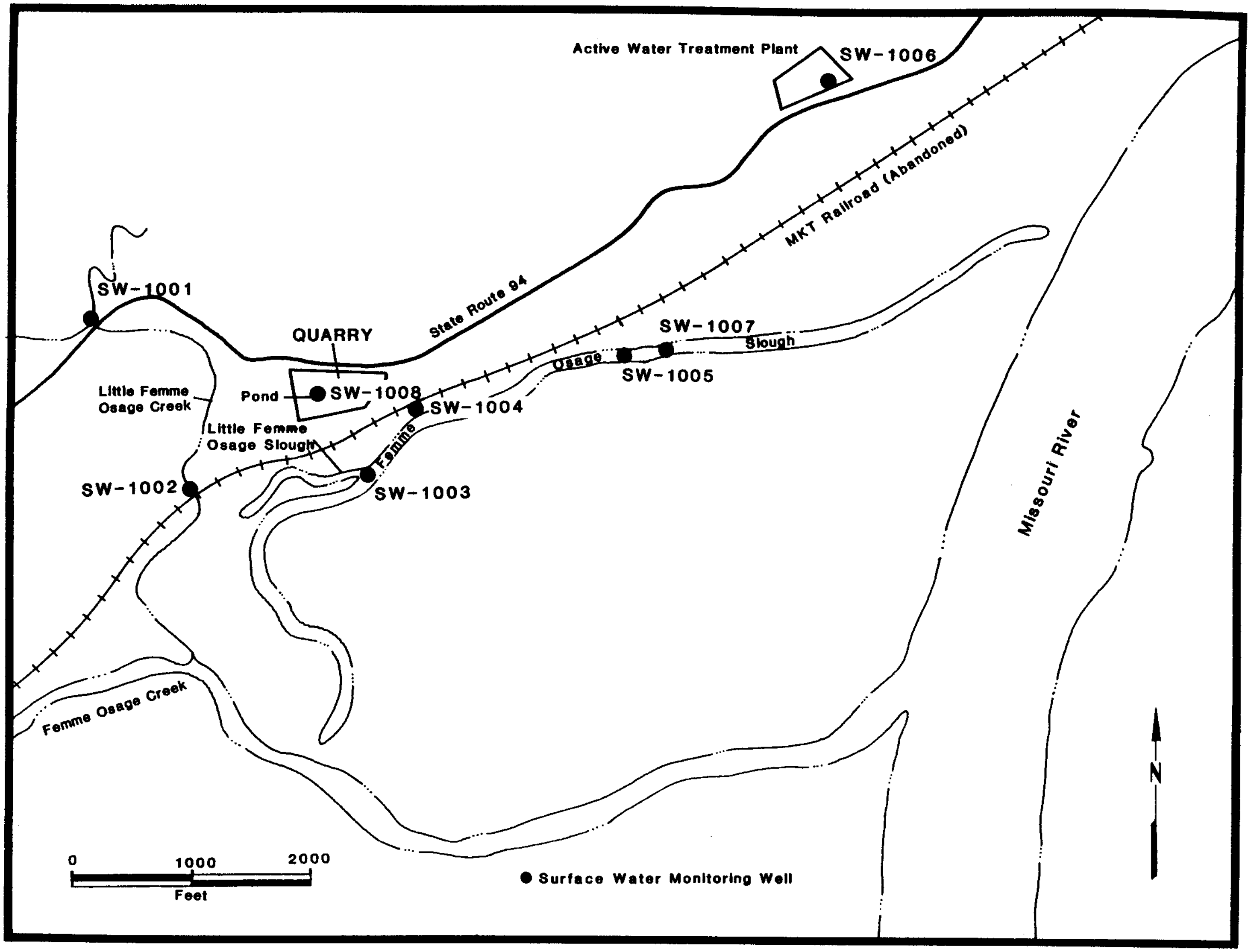


FIGURE 26 Surface Water Sampling Locations near the Quarry (Source: U.S. Department of Energy 1987c)

TABLE 17 Radiological Data from Surface Water Sampling at the Quarry

		Concentration ± Error[a] (pCi/L)						
Sampling Location	Date Sampled	Gross Alpha	Gross Beta	Natural Uranium[b]	Radium -226	Radium -228	Thorium -230	Thorium -232
SW-1001	3/12/87	<4	<8	3.7 ± 1.1	<1	I	<2	<2
SW-1002	3/12/87	<4	<8	<1	<1	<2	<3	<3
SW-1003	3/23/87	26 ± 5	26 ± 4	45 ± 7	<1	<2	<4	<4
SW-1004	3/13/87	26 ± 5	56 ± 7	47 ± 7	<1	<3	<2	<2
SW-1005	3/10/87	19 ± 5	19 ± 5	39 ± 4	<1	<4	<2	<2
SW-1006	3/9/87	<5	<8	<1	<1	<5	<2	<2
SW-1007	3/11/87	<3	<6	25 ± 3	<1	<10	<2	<2
SW-1008	3/11/87	1100 ± 200	1200 ± 200	2100 ± 200	3.9 ± 0.4	<3	<2	<2

[a]I = interference.

[b]Natural uranium is the sum of all uranium isotopes assumed to be present in their natural activity ratio.

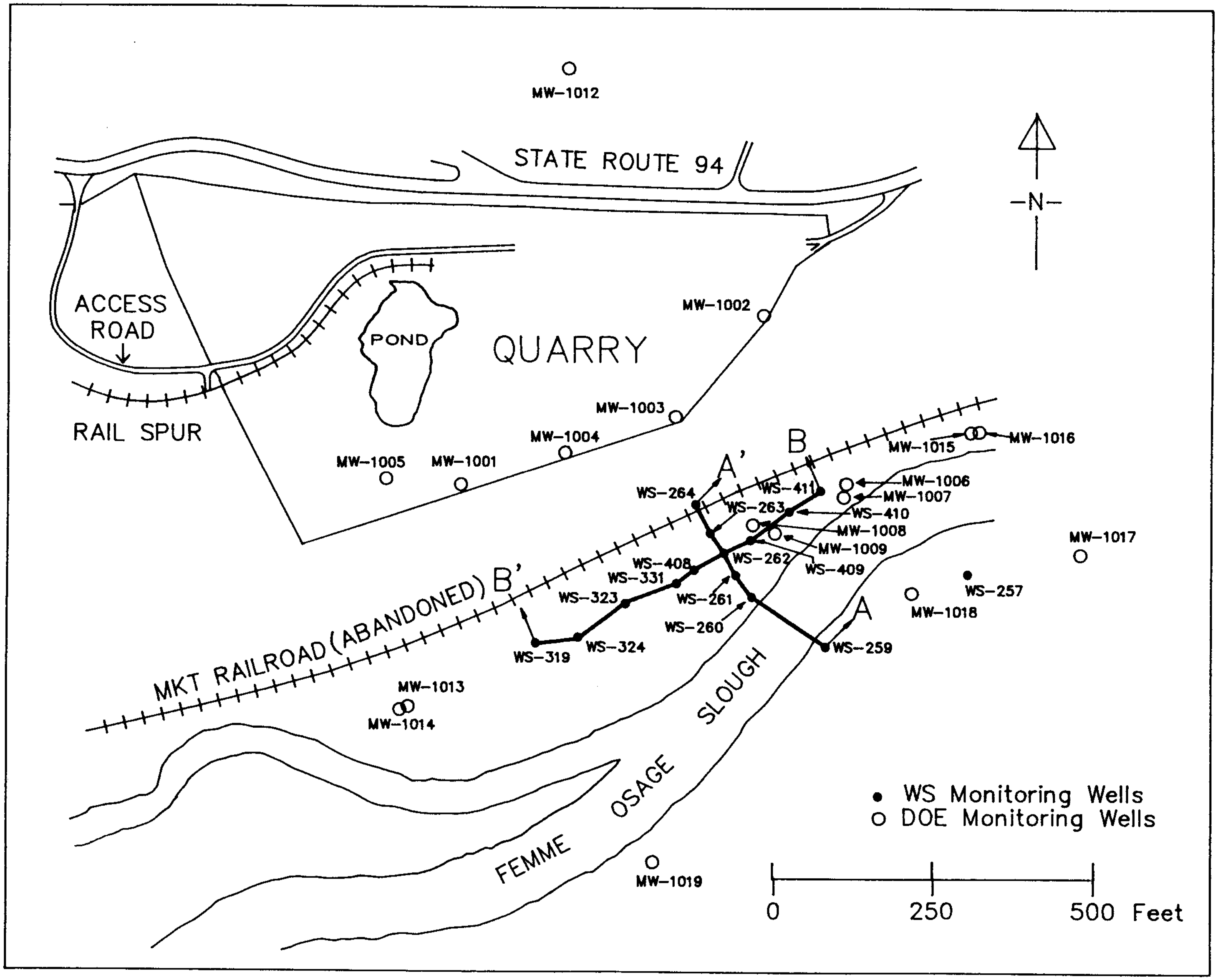


FIGURE 27 Locations Sampled in the Alluvium near the Quarry to Assess Contaminant Migration (Source: Modified from U.S. Department of Energy 1988a)

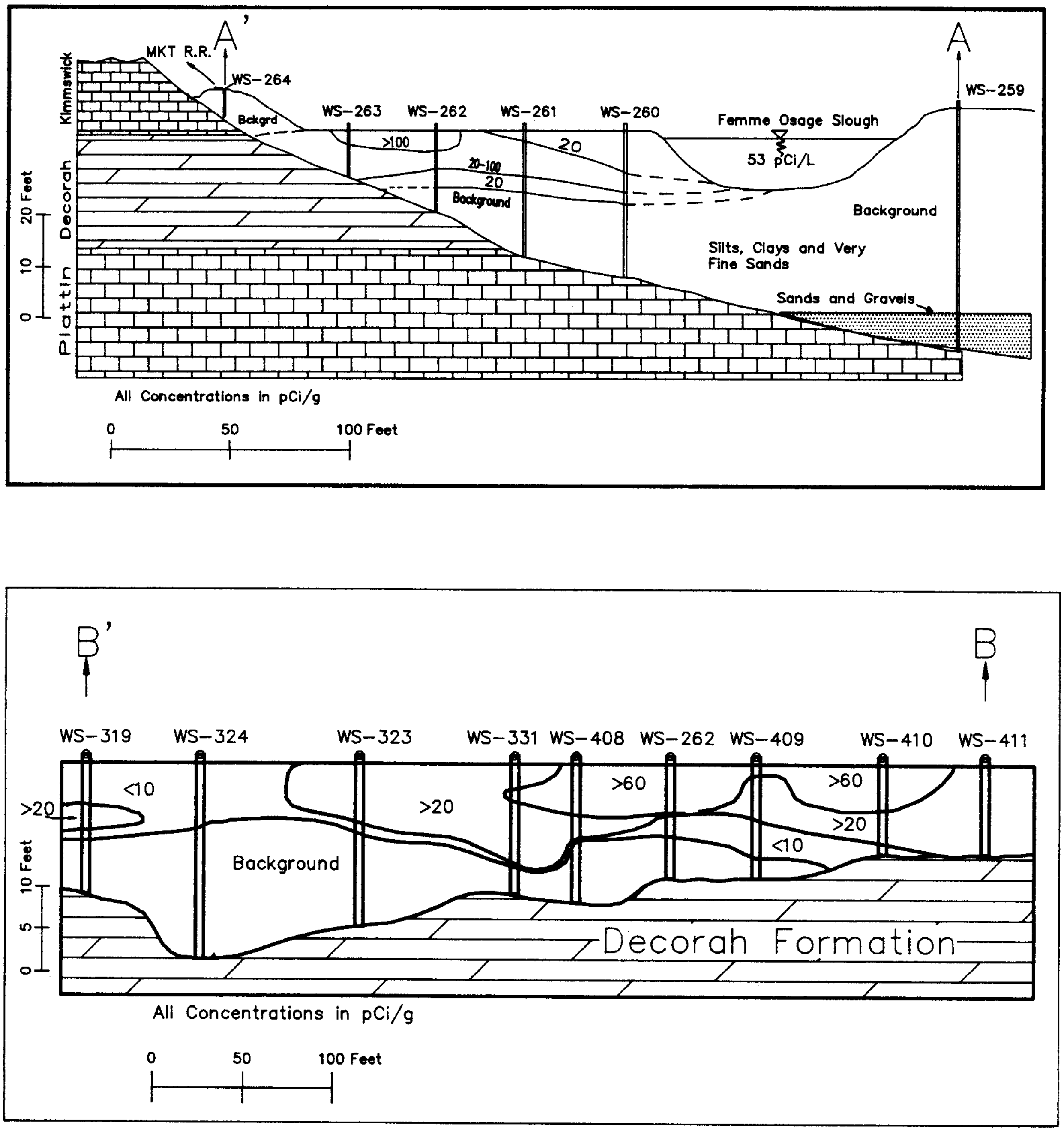


FIGURE 28 Uranium Concentrations (pCi/g) in the Alluvium near the Quarry, Cross Sections A-A' and B-B' (Source: Modified from U.S. Department of Energy 1988a)

nearby ponds and lakes are also contaminated. The contaminated off-site areas that need response action will be identified as a result of the ongoing characterization activities and assessment of potential risks to public health and the environment.

Seventeen contaminated land areas were identified in the vicinity of the Weldon Spring site during a radiological survey performed in 1986 by Oak Ridge Associated Universities at the request of DOE (Boerner 1986; Deming 1986). Seven contaminated areas are located on the U.S. Army Reserve property and ten are located on property owned by the Missouri Department of Conservation. The locations of these contaminated land areas are shown in Figure 29. (Vicinity property A7 was cleaned up in early 1988 [see Section 3.10.2.4].) In addition, some water bodies in the vicinity of the site are contaminated (e.g., Lakes 34, 35, and 36 in the Busch Wildlife Area). The contaminated areas can be grouped into two categories: (1) areas that became contaminated as a result of surface water or groundwater discharges from the raffinate pits and chemical plant area or the quarry and (2) areas that became contaminated by disposal of contaminated materials off-site or by spills from railcars carrying radioactive materials to or from the chemical plant or quarry. The characterization activities for vicinity properties are limited to those in the second category until the discharge of contaminated water from the Weldon Spring site can be stopped.

The potential for adverse human health impacts from exposure to contaminated materials on the 13 nondrainageway areas is extremely low, primarily due to the fact that these properties are uninhabited and access to them is difficult. The four contaminated areas associated with drainage of surface water from the chemical plant area are the southeast drainage (A4/B7), the Ash Pond drainage (A6), and the raffinate pits drainage (A5). The Ash Pond and raffinate pits drainageways discharge into Lakes 34 and 35 in the Busch Wildlife Area. Average annual natural uranium concentrations measured in these waters in 1987 were 25 and 15 pCi/L, respectively. However, these lakes are not used as drinking water sources and, therefore, no significant human exposure is believed to occur via this pathway. The potential doses to visitors to the area from ingesting lake water, eating fish caught in these lakes, or using the lakes for recreational purposes will be evaluated in the RI/FS-EIS.

Response actions on vicinity properties could impact several areas that are located within the Missouri River floodplain, e.g., the lower portion of the southeast drainage (B7) and a small area of land located between the quarry and Femme Osage Slough (B9). Wetlands may also exist on various vicinity properties. A floodplain/wetlands assessment will be prepared and included as a part of the RI/FS-EIS process. This assessment will describe the proposed response actions, discuss the effects of the proposed actions on the floodplain and wetlands, and discuss alternatives -- including mitigative measures. The assessment will be prepared in accordance with the requirements of Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands). It is DOE's policy to avoid adverse impacts on wetlands and floodplains to the extent possible and to minimize any unavoidable adverse impacts (10 CFR Part 1022).

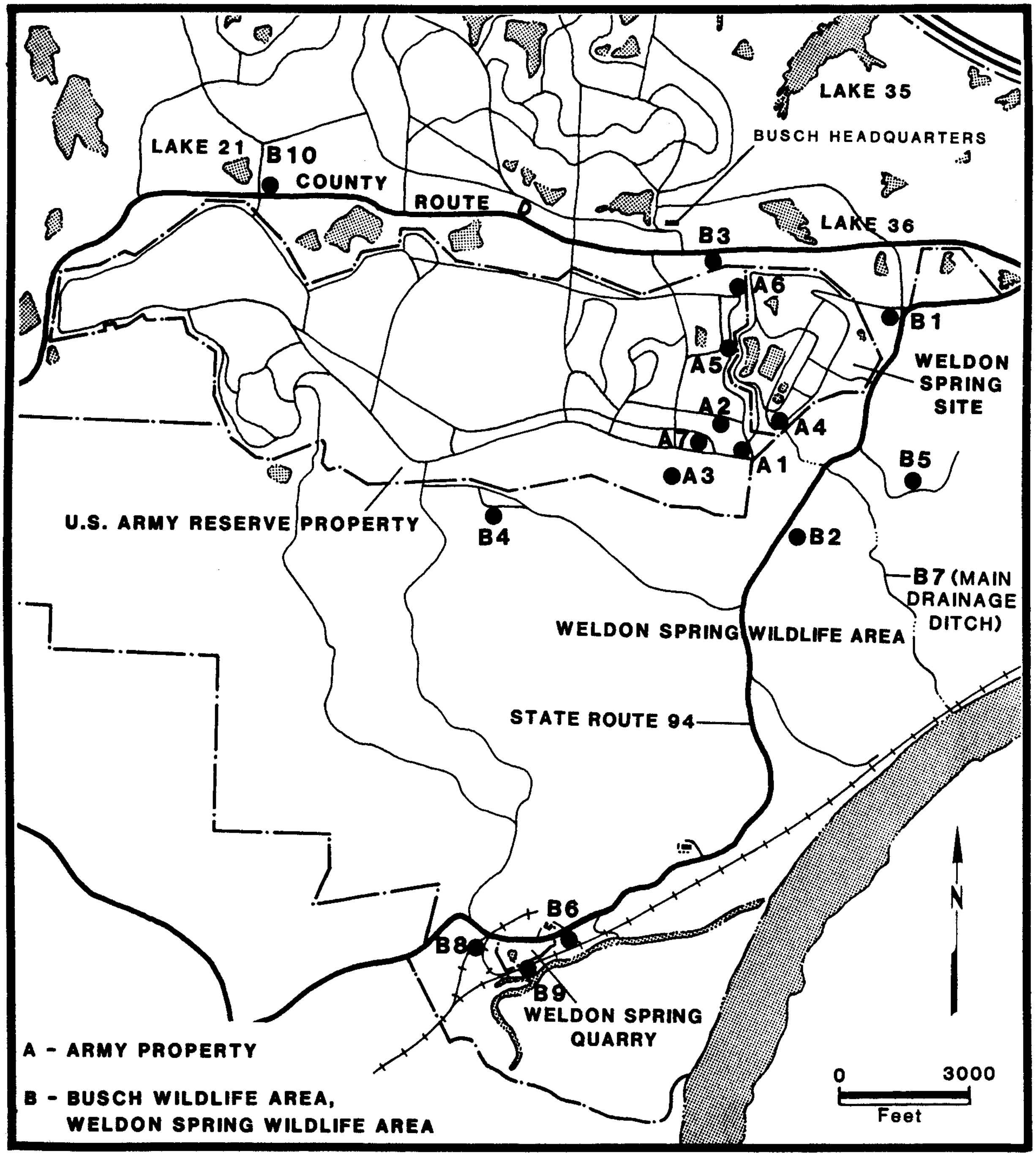


FIGURE 29 Location of Contaminated Vicinity Properties in the Area of the Weldon Spring Site (Source: Modified from U.S. Department of Energy 1988a)

3 INITIAL EVALUATION

3.1 PRELIMINARY IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Remedial actions at the Weldon Spring site will be undertaken in accordance with all applicable or relevant and appropriate requirements (ARARs). The identification of ARARs is an iterative process. As the remedial action planning process moves from data gathering in the RI phase to selection of a remedial action alternative in the FS-EIS phase, the list of ARARs will be finalized to those required for implementation of the selected alternative.

Any regulation, standard, requirement, criterion, or limitation under any federal or state environmental law may be either *applicable* or *relevant and appropriate* to a remedial action, but not both. A regulation, standard, requirement, criterion, or limitation is *applicable* if it legally applies to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance. A regulation, standard, requirement, criterion, or limitation is *relevant and appropriate* if it addresses problems or situations sufficiently similar to those encountered at the site such that its use is well suited to the particular site. A requirement that is determined to be relevant and appropriate must be complied with to the same extent as an applicable requirement. However, a determination of relevance and appropriateness may be applied only to portions of a requirement, whereas applicability can be determined only for the requirement as a whole. Only those state laws that are more stringent than federal laws may become ARARs.

The ARARs may be classified into three general categories:

- Contaminant-specific -- related to the level of contamination allowed for a specific pollutant in various environmental media (i.e., soil, water, and air),

- Location-specific -- related to the presence of a special geographical (e.g., floodplain or wetland) or archeological area at or near the site, and

- Action-specific -- related to a method of remedial action identified as an alternative for the site (e.g., disposal requirements or incineration standards).

The ARARs are identified on a project-specific basis -- i.e., site-specific contamination, proposed remedial action alternatives, and site characteristics influence the selection of ARARs. The selection of ARARs will be addressed at various stages in the RI/FS-EIS process as additional information becomes available:

- RI/FS-EIS work plan -- potential ARARs identified (contaminant- and location-specific).

- Completion of RI phase -- ARARs used to identify cleanup goals (contaminant- and location-specific).

- Development of alternatives -- alternatives evaluated with respect to ARARs (action-, contaminant- and location-specific).

For an alternative to be selected, it must meet the associated ARARs -- unless waiver conditions identified in SARA, Section 121(d)(4), are met.

Potential ARARs for the Weldon Spring Site Remedial Action Project are listed in Table 18. Additional federal and state requirements may also be ARARs, depending upon the alternatives identified during the RI/FS-EIS process or as a result of changes in federal or state laws. A complete list of ARARs identified for the various remedial action alternatives will be provided in the FS-EIS.

3.2 CONCEPTUAL EXPOSURE MODEL

The conceptual exposure model consists of the release mechanisms, potential receptors, and potential risks associated with the radioactive and chemical contaminants at the Weldon Spring site. This conceptual model is not intended to be an all-inclusive description of the various components associated with the evaluation of risks at the site. Rather, it is intended to indicate the nature of the evaluation that will be performed in the RI/FS-EIS. The various pathways of exposure cannot be fully determined before site characterization is complete. The conceptual exposure model presented here will be revised, as needed, to reflect the findings of the site characterization program.

3.2.1 Release Mechanisms

The migration of radionuclides and chemicals is related to the physical and chemical characteristics of the contaminants, the chemistry of the local environment, and the nature of the groundwater and surface water movement. A contaminated area can affect the quality of soil, groundwater, surface water, and air. Possible release mechanisms are:

- Dissolution, runoff, leaks, or spills that contaminate surface water;

- Contact of sediments/soils with the contaminated surface water;

- Leaching of contaminated surface and/or subsurface materials to the groundwater;

- Internal gas generation (e.g., radon) and emission to the atmosphere;

TABLE 18 Laws and Orders Potentially Applicable or Relevant and Appropriate to the Weldon Spring Site Remedial Action Project

Federal Laws

- Archeological and Historic Preservation Act of 1974
- Archeological Resources Protection Act of 1979
- Atomic Energy Act of 1954, as amended
- Clean Air Act of 1963, as amended
- Clean Water Act, as amended (also referred to as Federal Water Pollution Control Act of 1972, as amended)
- Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended
- Department of Energy Organization Act of 1977
- Endangered Species Act of 1973, as amended
- Fish and Wildlife Coordination Act of 1934, as amended
- Hazardous Materials Transportation Act of 1974, as amended
- National Environmental Policy Act of 1969, as amended
- National Historic Preservation Act of 1966, as amended
- Noise Control Act of 1972
- Noise Pollution and Abatement Act of 1970
- Occupational Safety and Health Act of 1970
- Safe Drinking Water Act of 1974
- Soil and Water Resources Conservation Act of 1977
- Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, as amended by the Hazardous and Solid Waste Amendments of 1984
- Superfund Amendments and Reauthorization Act of 1986
- Toxic Substances Control Act of 1976
- Uranium Mill Tailings Radiation Control Act of 1978

Executive Orders

- Executive Order 11490, Assigning Emergency Preparedness Functions to Federal Departments and Agencies
- Executive Order 11514, Protection and Enhancement of Environmental Quality
- Executive Order 11738, Providing for Administration of the Clean Air Act and the Federal Water Pollution Control Act with Respect to Federal Contracts, Grants, or Loans
- Executive Order 11807, Occupational Safety and Health Programs for Federal Employees
- Executive Order 11988, Floodplain Management
- Executive Order 11990, Protection of Wetlands
- Executive Order 11991, Relating to the Protection and Enhancement of Environmental Quality

TABLE 18 (Cont'd)

Executive Orders (Cont'd)

Executive Order 12088, Federal Compliance with Pollution Control Standards
Executive Order 12146, Management of Federal Legal Resources
Executive Order 12580, Superfund Implementation

Department of Energy Orders

Order 1540.1 Materials Transportation and Traffic Management
Order 4240.1H Designation of Major System Acquisition and Major Projects
Order 4320.1A Site Development and Facility Utilization Planning
Order 4700.1 Project Management System
Order 5440.1C Implementation of the National Environmental Policy Act
Order 5480.1B Environment, Safety, and Health Program for Department of Energy Operations -- Note: Chapter XI of Order 5480.1B has been amended (see Vaughan [1985] and subsequent updates of Derived Concentration Guides)
Order 5480.4 Environmental Protection, Safety, and Health Protection Standards
Order 5480.14 Comprehensive Environmental Response, Compensation, and Liability Act Program
Order 5481.1B Safety Analysis Review System
Order 5482.1B Environmental Protection, Safety, and Health Protection Appraisal Program
Order 5483.1A Occupational Safety and Health Program for Government-Owned Contractor-Operated Facilities
Order 5484.1 Environmental Protection, Safety, and Health Protection Information Reporting Requirements
Order 5000.3 Unusual Occurrence Reporting System
Order 5500.2 Emergency Planning, Preparedness, and Response for Operations
Order 5700.6B Quality Assurance
Order 5820.2 Radioactive Waste Management

Missouri State Environmental Laws

Missouri Clean Water Act
Missouri Clean Air Act
Missouri Hazardous Waste Management Law
Missouri Solid Waste Management Law
Missouri Land Reclamation Act
Governor's Executive Order 82-19 on Flood Plain Management
Missouri 401 Water Quality Certification

- Release of resuspended solids to the atmosphere; and

- Fugitive dust emissions from traffic, wind, and construction activities.

The RI/FS-EIS will address these release mechanisms and any others that are determined to be significant as a result of site characterization activities.

After a release has occurred, it is necessary to analyze the fate of the contaminants in the environment so that the exposure of all potential receptors can be determined. Exposure can be direct or indirect. Direct exposure can result from contact with contaminants due to work or recreational activities. Indirect exposure involves the transport of the contaminants through various media to the potentially affected receptors. The primary contaminant transport media are the atmosphere, surface water, and groundwater. The environmental fate of contaminants in these media are affected by the following factors:

- Atmospheric dispersion,

- Atmospheric transfer to surface water,

- Atmospheric deposition on soil,

- Surface water dilution,

- Groundwater transfer to surface water,

- Surface water transfer to groundwater,

- Groundwater dilution,

- Water transfer to soil, and

- Soil transfer to water.

3.2.2 Population Exposure

The assessment of population exposure consists of (1) developing scenarios of human activities that give rise to exposure, (2) assessing the transport of contaminants from the source through environmental media to potential receptors, and (3) assessing the biological uptake of these contaminants by all potential receptors. This assessment will evaluate the following means of exposure:

- Inhalation of contaminants,

- Ingestion of contaminated surface water and groundwater,

- Direct contact with contaminated soil and water,
- Ingestion of food grown in contaminated soil,
- Ingestion of contaminated meat and milk, and
- Ingestion of contaminated soil.

The assessment will include both radioactive and chemical contaminants.

3.2.3 Potential Risks

The evaluation of potential risks involves a determination of the likelihood that a given pathway of exposure will result in a deleterious health impact. The exposure pathways listed in Section 3.2.2 will be quantitatively evaluated for selected scenarios of human activity.

Exposure from the inhalation pathway will likely be quite minor for existing conditions at the Weldon Spring site. Most of the contamination at the Weldon Spring site is either below ground, below surface water, or covered with vegetation. The relationships of the receptor to the source and to the concentration of the source will be major factors in the level of exposure. The potential for inhalation of airborne particulates will increase if contaminated materials are disturbed, such as will likely occur during response action activities (e.g., demolition of buildings or excavation of contaminated soils).

Exposure through ingestion of contaminated surface water and/or groundwater is the most likely source of exposure. Elevated concentrations of uranium have been detected in the surface water runoff leaving portions of the site, and persons drinking this water could incur measurable radiation doses. On-site monitoring has also detected elevated levels of radionuclides and chemicals in the groundwater, and exposure by ingestion of this contaminated groundwater is also possible. The potential use of surface water and/or groundwater as a source of drinking water will be evaluated.

Direct contact with contaminated materials is a hazard only in areas where contamination is immediately accessible (e.g., in soil and water). Exposure by direct contact with soil is possible because radiation exposure levels in excess of background levels have been recorded at the site. Direct contact with contaminated water is also possible from such activities as swimming and fishing. Such contact could result in potential health hazards because some water bodies in the vicinity of the Weldon Spring site are currently contaminated (e.g., Lakes 34, 35, and 36 in the Busch Wildlife Area).

Exposure through ingestion of food could occur if individuals in the area grow a significant fraction of plant foods for their own consumption or if they collect and eat contaminated wild foods (e.g., mushrooms, berries, and nuts) from the surrounding wildlife areas. Exposure could also occur if there are livestock (e.g., cows) that graze in areas of contaminated soil. Contamination in the soil can be taken up by plants, and consumption of such plants by humans or animals can result in radioactive and chemical contaminants entering the human food chain. The potential exposure from consumption of food grown in contaminated soil or from consumption of meat and milk derived from livestock feeding in contaminated areas is expected to be minimal because the contaminants have not migrated significantly from the site. Similarly, consumption of fish that live in contaminated lakes in the Busch Wildlife Area and consumption of game animals that feed on plants grown in contaminated soil are also expected to be minimal sources of human exposure.

Ingestion of contaminated soil can occur intentionally (e.g., by a small child) or inadvertently (e.g., by consuming vegetables grown in contaminated soil). There is some potential for this exposure pathway because radioactive and chemical contaminants have been detected in soil at and in the vicinity of the site.

3.3 CONTAMINANTS OF CONCERN

3.3.1 Radioactive Contaminants

Uranium and thorium ore concentrates and some scrap metal were processed at the chemical plant during its operational period. These were the only radioactive materials processed at the plant. Various waste materials associated with uranium and thorium processing at the chemical plant and at other facilities were disposed of in the quarry. Thus, the radioactive contaminants of concern for the Weldon Spring site are those associated with the uranium-238 and thorium-232 decay series (see Figures 12 and 13).

In nature, the radionuclides in a decay series are in a state of secular equilibrium in which the activities of all radionuclides are equal. However, the processing of uranium and thorium ores alters this natural state, and deviation from secular equilibrium is expected. The rate at which secular equilibrium is reestablished depends on the half-lives of the decay products. Because of their relatively short half-lives and the length of time since closure of the chemical plant (about 20 years), all radioactive decay products in the thorium-232 decay series can be assumed to be in secular equilibrium with thorium-232.

By contrast, the activities of the radionuclides in the uranium-238 decay series will change with time at a rate that depends on their original activities and half-lives and on the activities of their parent radionuclides (ingrowth effect). For example, the amount of radium-226 and its decay products in the raffinate pit sludge is estimated to increase 30 fold (from an average concentration of 97 pCi/g to 3,200 pCi/g in about 9,000 years) as a result of a gradual reestablishment of secular equilibrium (U.S. Dept. Energy 1987a). The activities of the various radionuclides in the uranium-238 decay series can be determined from the activities of uranium-238, thorium-230, and radium-226; the activities of the radionuclides from uranium-238 through uranium-234 can be assumed to be equal to that of uranium-238 (because the activities of uranium-238 and uranium-234 are equal in nature and thorium-234 and protactinium-234 have short half-lives), and the activities of the radionuclides from radium-226 through polonium-210 can be assumed to be equal to that of radium-226. The latter assumption will overestimate the short-term concentration of lead-210, bismuth-210, and polonium-210 due to the relatively long half-life of lead-210 (22 years) in comparison to the length of time since these materials were processed (approximately 20 to 30 years). This will result in an overestimate of the short-term hazard from radium-226 and its decay products.

The radioactive contaminants of concern are, therefore, uranium-238, thorium-232, thorium-230 and radium-226. The activities of all other radionuclides at the Weldon Spring site can be determined from these four species.

3.3.2 Chemical Contaminants

The following assessment of chemicals found at the Weldon Spring site is based on results of the Phase I water quality assessment (U.S. Dept. Energy 1987c), Phase I chemical soil investigation (U.S. Dept. Energy 1988b), chemical characterization of the quarry (Kaye and Davis 1987), and earlier studies summarized in the draft EIS (U.S. Dept. Energy 1987a). Investigations to date have been carried out to provide baseline information on water quality and soil contamination and to begin characterization of the wastes; however, further studies are planned to fully characterize the extent of chemical contamination.

3.3.2.1 Organic Contaminants

Nitroaromatics. Results of the Phase I water quality assessment indicate that high concentrations of nitroaromatics (mainly 2,4-DNT, 2,6-DNT, and TNT) are present in the groundwater under the northeast corner of the chemical plant and that generally low-level contamination is present throughout the raffinate pits and chemical plant area (potential source areas of nitroaromatics are shown in Figure 18). Nitroaromatics are also present in the groundwater at the quarry and in alluvial wells north of Femme Osage Slough. Surficial discoloration of soils in the eastern portion of the quarry (see Figure 24) indicates the presence of nitroaromatic compounds that were subsequently determined to be at levels of 1 to 2%. These compounds have also been detected in the surface water, sludges, sediments, and wastes at the quarry.

Volatile and Semivolatile Compounds. Volatile and semivolatile organic compounds have not been detected in the groundwater at the raffinate pits and chemical plant area. Volatile compounds detected in soil and sediment samples from the quarry are believed to be due to contamination introduced during field collection or laboratory extraction. Although three volatile organic compounds (ethylbenzene, toluene, and xylene) were detected in two alluvial wells during the Phase I water quality assessment, subsequent quarterly sampling of these and other wells failed to detect these compounds. The PAHs detected at the quarry were in borings clustered in an area adjacent to the pond.

PCBs and Pesticides. The PCB contamination is present in fluids associated with electrical equipment at the raffinate pits and chemical plant area, which have recently been removed (see Section 3.10.2.1), and in surface structures and localized areas of soil at both the raffinate pits and chemical plant area and the quarry. No PCBs or pesticides have been detected in groundwater or surface water.

3.3.2.2 Inorganic Contaminants

Inorganic Ions. Nitrate, sulfate, and fluoride concentrations have been measured in groundwater from several wells at the raffinate pits and chemical plant area at above drinking water standards (10 [as N], 250, and 2 mg/L, respectively). Elevated nitrate levels were also detected in Ash Pond and Burgermeister Spring. Soil samples collected during the Phase I soil investigation had elevated nitrates and sulfates at numerous locations, most commonly in surficial samples; some slightly elevated fluoride levels were also present. High concentrations of nitrate and fluoride were detected in the raffinate pit solids, and elevated levels of nitrate and sulfate were detected in groundwater at the quarry. Elevated levels of sulfate have also been detected in the quarry pond and in alluvial wells north of Femme Osage Slough (see Table 16 and Figure 27).

Metals. Concentrations of metals have been below background levels in most groundwater samples from the raffinate pits and chemical plant area; however, two wells had elevated levels of chromium, lithium, magnesium, nickel, and vanadium. Results of the Phase I soil investigation indicate that the soils at the raffinate pits and chemical plant area may be contaminated with low levels of metals; isolated areas also had elevated concentrations of barium, lead, and zinc. Additional investigations are required to determine actual background levels and to assess the extent of contamination. High concentrations of several metals -- including iron, lead, magnesium, and molybdenum -- are present in the raffinate pit solids. Elevated levels of iron, manganese, and arsenic have been detected in the quarry pond, but metals were not above background levels in groundwater samples from the quarry area.

Asbestos. Although asbestos is present in many areas of the chemical plant, selected surface soil samples did not have elevated levels. Asbestos levels at perimeter locations of the raffinate pits and chemical plant area were the same as background levels, and those detected in the quarry pond were below the recommended guidelines of the U.S. Environmental Protection Agency (1985).

3.4 POTENTIAL HEALTH EFFECTS

3.4.1 Radioactive Contaminants

The cause-and-effect relationships between radiation exposure and adverse health effects are quite complex, but these relationships have been more extensively studied than have the cause-and-effect relationships for other environmental contaminants. Physiological effects to an individual are clinically detectable only from radiation exposure resulting in a dose greater than about 10 rem (to the whole body) for a few persons and about 25 rem for nearly all persons over a short period of time (hours). Doses about 10 to 20 times higher, also received over a relatively short period of time (hours to a few days), can be expected to result in some fatalities.

Lower levels of exposures also constitute a health risk, but a direct cause-and-effect relationship between a known exposure to radiation and any given health effect is difficult to define because of the many other possible reasons why a particular effect is observed in a specific individual. For this reason, such effects -- including an increased incidence of cancer in the exposed population and genetic changes in future generations after exposure of a prospective parent -- must be assessed on a statistical basis. Occurrences of cancer in the exposed population may begin to develop only after a lapse of 2 to 20 years from the time of exposure (latent period) and may then continue over a period of about 30 years (plateau period). However, in the case of exposure of fetuses (in utero), occurrences of cancer may begin to develop at birth (no latent period) and end at age 10 (i.e., the plateau period is 10 years). The occurrence of cancer itself does not necessarily result in fatality.

Most authorities agree that a reasonable -- and probably conservative -- estimate of the randomly occurring number of health effects from low levels of radiation exposure to a large number of people is within the range of about 10 to 500 potential cancer deaths per million person-rem. The radiological impacts for the Weldon Spring Site Remedial Action Project will be calculated as 50-year committed effective dose equivalents based on the methodology recommended by the International Commission on Radiological Protection (ICRP). The ICRP gives a risk estimator of 1.65×10^{-4} per person-rem for the induction of fatal cancers and serious genetic effects in the first two generations following radiation exposure (Int. Comm. Radiat. Prot. 1977). This risk estimator will be used to estimate potential health effects from radiation exposure to site-originated radioactive contaminants.

3.4.2 Chemical Contaminants

For most of the chemicals identified at the Weldon Spring site, there appears to be little potential for significant human exposure under current site conditions. An assessment of potential risks to public health from current site conditions will be carried out in the baseline risk assessment. A brief summary of the major toxic effects of selected chemical contaminants is given in Sections 3.4.2.1 and 3.4.2.2.

3.4.2.1 Organic Contaminants

Nitroaromatics. The nitroaromatics 2,4-DNT and 2,6-DNT are classified by the EPA as Group B2 (i.e., probably carcinogenic to humans) and Group C (i.e., possibly carcinogenic to humans) carcinogens. Laboratory studies have shown that TNT can induce cancer in experimental animals (Furedi et al. 1984). Nitroaromatics can induce methemoglobinemia, a reduction in the oxygen-carrying capacity of the blood, especially in infants. Other effects include toxicity to the liver, kidney, and nervous system. Nitroaromatics can be absorbed following exposure by inhalation, ingestion, or dermal contact, although the extent of absorption depends on the specific compound.

PAHs. The PAHs are classified by the EPA as Group B2 and Group C human carcinogens, depending on the specific compound (U.S. Environ. Prot. Agency 1986b). In experimental animals, PAHs have been shown to induce tumors both at the site of application and systemically. They can also cause skin disorders, immunosuppression, and liver and kidney damage. The limited data available regarding oral absorption of PAHs indicate that some compounds are readily absorbed. Inhaled compounds can be readily absorbed. Dermal absorption can also occur, but the rate and extent are dependent on the specific compound and its concentration.

PCBs. The PCBs have been shown to induce cancer of the liver in experimental animals and are classified as Group B2 human carcinogens (U.S. Environ. Prot. Agency 1986b). In experimental animals, chronic exposure to PCBs has induced such effects as severe weight loss, liver damage, toxicity to the immune system, adverse reproductive effects, and malformations in offspring. In humans exposed to these compounds, the skin and liver are the primary sites affected, but the gastrointestinal and neuromuscular systems can also be affected. The only significant adverse health effects that have been observed in PCB-exposed workers are occasional skin irritations, usually acne-like lesions and rashes, and liver damage. Following oral exposure, gastrointestinal absorption of most isomers is greater than 90%; limited data indicate that PCBs can also be absorbed following exposure by inhalation or dermal contact.

3.4.2.2 Inorganic Contaminants

Inorganic Anions. The health hazards that are associated with nitrate result primarily from the bacterial conversion of ingested nitrate to nitrite. Nitrites alone can induce methemoglobinemia, and they can also react with other compounds, such as amines, to form N-nitroso compounds. Although most N-nitroso compounds are carcinogenic in experimental animals, the contribution of nitrate to a potential carcinogenic hazard for humans and the magnitude of the associated risk is unclear. Low levels of fluorides in drinking water are generally considered to have a beneficial effect on the rate and occurrence of dental caries. Ingestion of higher levels of fluorides can induce dental and skeletal fluoroses whereas inhalation of flourides can irritate the respiratory system.

Metals. Uranium is the most widespread of the metal contaminants at the Weldon Spring site. The two main hazards associated with exposure to uranium compounds are (1) kidney damage caused by the chemical toxicity of soluble ingested uranium compounds and (2) injury caused by the ionizing radiation resulting from radioactive decay of ingested or inhaled uranium isotopes. The main effect depends on a number of factors, including the solubility of the compound, the route of exposure, and the relative composition of the isotopes. In addition to the adverse effects on the kidney, the chemical toxicity of uranium can also affect the cardiovascular, endocrine, hematopoietic, and immunological systems. The extent of metal contamination at the Weldon Spring site has not yet been well characterized. Of the other metals present at elevated levels, certain compounds of arsenic, chromium, lead, and nickel are carcinogenic and may induce teratogenic and other adverse reproductive effects. Metals that may be present at levels of potential significance will be identified during the baseline risk assessment.

Asbestos. Inhalation of asbestos can induce cancer of the lung and mesothelium (lining of the chest and abdomen). Exposure by inhalation may also cause asbestosis -- a progressive, irreversible lung disease. Ingestion of high concentrations of asbestos may result in damage to the gastrointestinal tract.

3.5 ENVIRONMENTAL FATE

The release, transport, and fate of contaminants in the environment depends on both the properties of the contaminant and the environmental medium in which it occurs. The primary transport media are air, surface water, and groundwater, although transport by air is of minor importance at the Weldon Spring site. The baseline risk assessment will include a comprehensive evaluation of the environmental fate of the contaminants identified at the Weldon Spring site and the potential exposure resulting from these contaminants. A brief summary of the potential transport pathways and fate of selected contaminants is given in Sections 3.5.1 and 3.5.2.

3.5.1 Organic Contaminants

3.5.1.1 Nitroaromatics

Experimental and field data suggest that nitroaromatics are not strongly adsorbed to soil or sediment and may therefore migrate to groundwater. Their residence time in soil depends on the pH and the oxygen and organic carbon content of the soil. Biotransformation can occur in the soil, and both photolysis and biotransformation may be significant fate processes in the aquatic environment (Rickert 1985).

3.5.1.2 PAHs

The PAHs are fairly persistent in the environment. They adsorb strongly to soil and sediment, particularly those with a high organic content. Atmospheric transport generally occurs by adsorption to airborne particulate matter, although PAHs with low molecular weights are typically volatile. Airborne PAHs can be returned to the aquatic and terrestrial ecosystems by atmospheric fallout and precipitation. They can also reach groundwater and surface waters by leaching from contaminated soil. The PAHs are relatively insoluble in water, but the fraction that is dissolved may undergo rapid, direct photolysis. Although PAHs can be rapidly bioaccumulated, they are also rapidly metabolized and eliminated from most organisms (Clements Assoc. 1985).

3.5.1.3 PCBs

The PCBs are very persistent in the environment. They are relatively inert and have low vapor pressures and low water solubilities. Despite their low vapor pressures, they have high activity coefficients in water, which results in a higher rate of volatilization than would otherwise be expected. The PCBs adsorb strongly to organic soil and sediment. Adsorption to organic material in soil or sediment is considered to be the primary fate of the more heavily chlorinated PCBs. Once bound, the PCBs may persist for years, with slow desorption to the surrounding media. Bioaccumulation and biomagnification of PCBs are common, and some biodegradation can also occur.

3.5.2 Inorganic Contaminants

3.5.2.1 Inorganic Anions

Inorganic anions such as fluoride, nitrate, and sulfate are highly water soluble and therefore very mobile in the environment. This mobility can result in significant leaching from soil and diffusion in soil and water. The extent of migration to groundwater depends primarily on the type of soil affected.

3.5.2.2 Metals

Metal compounds can undergo a wide range of transformation processes, forming complexes with inorganic species or organic ligands that are present in the environment. These processes, collectively referred to as speciation, can occur in all environmental media. The speciation of a metal in a given environment affects it bioavailability, solubility, volatility, and sorptive properties. In addition to speciation, the fate of metals is affected by the properties of the environmental media; for example, the mobility of a metal compound in soil depends on the cation-exchange capacity of the soil whereas its solubility in water depends on the presence of other chemical species and on the pH.

3.5.2.3 Asbestos

Asbestos is quite stable in the environment and may be transported by water or wind dispersion. It is not prone to significant degradation in the aquatic environment. In surface waters, it remains in suspension until it physically degrades or settles by chemical coagulation into the sediment layer (Clements Assoc. 1985).

3.6 MIGRATION PATHWAYS AND POTENTIAL RECEPTORS

The extent of contaminant migration into the nearby environment is dependent, in part, upon the physical and chemical characteristics of the specific contaminants. Certain species that are relatively immobile will migrate little; other, more mobile species will migrate to a greater extent. The three general pathways by which contaminants may migrate are air transport, surface water transport, and subsurface water transport.

In general, air transport is not a significant pathway for contaminant migration at the Weldon Spring site because there is currently no processing of materials at the site. Most of the radioactive and chemical contaminants on the site are in water, in areas covered by water, or in soil, and many of the soil-contaminated areas are overgrown with vegetation. The remaining contaminants are in buildings or process equipment. Air monitoring operations by DOE have sampled for asbestos, organic vapors, and airborne radioactive particles and gases. Measurements of external gamma exposure rates have also been performed as a part of the monitoring program. Except for the quarry, measurements of both on-site (outdoor locations at the raffinate pits and chemical plant area) and off-site values of these constituents have generally been at background levels. Elevated levels of radon gas and elevated external gamma exposure rates have been measured at the quarry. However, because these levels decrease rapidly with distance, background levels are generally reached within a relatively short distance (i.e., within about 0.4 km [0.25 mi]).

The transport of contaminants via the surface water pathway is likely an important mechanism for contaminant migration from the site. Surface water runoff from the raffinate pits and chemical plant area can mobilize contaminants. Migration of these contaminants will generally follow the slope of the land surface to lower elevations. Because of the generally gentle slopes at the raffinate pits and chemical plant area, movement of contaminants for appreciable distances over unpaved surfaces or areas without defined channels is unlikely. Although transport over appreciable distances via surface channels is possible, no natural or artificial surface channels currently traverse the site except for a channel remnant that crosses through the Ash Pond area. However, there are a number of relatively short drainage channels, with and without pipe segments, that could result in the spread of contaminants from their source. Other surface drainage features that may affect contaminant migration include the Ash Pond spillway, the Ash Pond discharge line, the drainage channels to the southeast drainage easement, and the drainage channels from Frog Pond.

Potential subsurface migration pathways include (1) buried sewer and process pipelines, particularly those that have deteriorated; (2) natural subsurface features that tend to impede the downward movement of water and therefore result in lateral spreading, such as low-permeability layers or zones; (3) permeable pathways that are relatively isolated but continuous laterally or vertically, such as solution channels, caverns, or joint-sets; and (4) permeable media of a relatively continuous nature, such as permeable limestone with a combination of fractures, joints, and solution-enlarged features. All of these subsurface pathways may exist at the raffinate pits and chemical plant area to some degree.

Potential receptors of the radioactive and chemical contaminants migrating from the Weldon Spring site include:

- Students and staff of the Francis Howell High School, located east of the raffinate pits and chemical plant area on State Route 94; an estimated 2,300 persons are on campus daily during the school year (U.S. Dept. Energy 1987a).

- Visitors and staff at the St. Charles County Extension Center, located to the east of the raffinate pits and chemical plant area on State Route 94.

- Personnel at the state of Missouri highway maintenance facility, located to the east of the raffinate pits and chemical plant area.

- Personnel at the U.S. Army Reserve and National Guard Training Area, located to the west of the raffinate pits and chemical plant area.

- Other persons who live near the site, drink water from local surface water and groundwater supplies, consume locally grown plant or animal food products, and/or consume fish and game animals that inhabit the surrounding area.

- Visitors and staff at the August A. Busch Memorial Wildlife Area, the Weldon Spring Wildlife Area, and the Howell Island Wildlife Area; attendance at the Busch Wildlife Area alone has averaged 710,000 persons per year over the last 10 years (U.S. Dept. Energy 1987a).

- Trespassers who gain entry to the site in spite of existing access restrictions.

- Persons who fish or swim in nearby surface waters.

- Terrestrial and aquatic organisms.

3.7 DATA GAPS

Although much is currently known about the nature of the contaminants and their environmental fate and transport at the Weldon Spring site, several data gaps exist that must be filled before a final remedy can be selected for disposition of the contaminated materials. The field sampling plans summarized in Section 4.2 have been prepared to obtain the data necessary to fill these gaps so that, when the RI phase is completed, sufficient data will exist to allow for detailed assessment of remedial action alternatives in the FS-EIS. A summary of the current data gaps and the data collection activities being performed to obtain the necessary data is presented in Sections 3.7.1 through 3.7.3.

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- Other persons who live near the site, drink water from local surface water and groundwater supplies, consume locally grown plant or animal food products, and/or consume fish and game animals that inhabit the surrounding area.

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3.7.1 Extent and Magnitude of Contamination

The extent and magnitude of the radiological contaminants in the soils at the raffinate pits and chemical plant area are understood, based on the history of site activities and the recently completed sampling program (Marutzky, Colby, and Cahn 1988). However, a detailed characterization of chemical contaminants in these soils is not currently available. Therefore, the soil investigation sampling plan for chemical contaminants (Section 4.2.1) will be implemented to provide a complete inventory of chemical contaminants in the soils within this area.

Although the contaminants in the raffinate pits are reasonably well defined, the waste assessment sampling plan for the raffinate pits (Section 4.2.3) will be implemented to provide a complete inventory of these contaminants. Similarly, the waste assessment sampling plan for the process buildings (Section 4.2.3) will provide a detailed inventory of contaminants in the process buildings of the chemical plant.

Results of the recent water quality assessment program have identified the chemical and radiological species present in surface water and groundwater at the Weldon Spring site (U.S. Dept. Energy 1987c). The lake and stream sediment characterization plan (Section 4.2.5) is being implemented to provide information on the nature and extent of contamination of sediments in off-site lakes and streams that have received surface and subsurface discharges from the raffinate pits and chemical plant area.

It is essentially impossible to fully characterize the quarry bulk wastes in situ because of the nature of these wastes, i.e., a heterogeneous conglomerate of steel, rubble, process equipment, and drummed and uncontained process residues intermixed in a soil matrix. It is proposed that these bulk wastes be removed from the quarry in order to minimize the potential for contaminant migration (see Section 3.11). A detailed characterization of the bulk wastes will be performed following their removal from the quarry; hence, this data gap will be filled as a part of the quarry bulk waste removal action. The nature and extent of contamination in the quarry fracture joints and cracks, and the need for groundwater restoration in this area, will be evaluated following bulk waste removal.

3.7.2 Environmental Transport Pathways

The surface pathways of environmental transport at the raffinate pits and chemical plant area (e.g., air and surface water runoff) have been identified and are currently being monitored. Although many subsurface pathways have also been identified and all known springs and seeps have been inventoried and sampled, it is possible that other, unidentified pathways exist. Implementation of the hydrogeological investigation sampling plan (Section 4.2.2) will characterize the hydrogeological conditions at the raffinate pits and chemical plant area. Data from this sampling effort will also assist in determining the need to perform groundwater restoration in this area. A biouptake study (Section 4.2.5) is currently being implemented to assess the extent to which contaminants originating from the Weldon Spring site have been incorporated into local wildlife.

3.7.3 Waste Disposition

Additional data are needed regarding the amenability of various waste materials to treatment and the suitability of the site to isolate the wastes from the public and the environment (i.e., if on-site disposal were selected as a result of the RI/FS-EIS process). The different waste forms associated with the Weldon Spring project will be studied to evaluate the feasibility of various methods of treatment and volume reduction (see Section 3.9). The results of these studies will be incorporated in the RI/FS-EIS to support the screening and evaluation of potential technologies and alternatives. The geophysical/geotechnical investigation sampling plan (Section 4.2.4) will be used to evaluate the suitability of the raffinate pits and chemical plant area for waste disposal.

3.8 RESPONSE OBJECTIVES AND CONCEPTUAL REMEDIAL ACTION ALTERNATIVES

3.8.1 Response Objectives

The objective of response action at the Weldon Spring site -- consisting of the raffinate pits and chemical plant area and the quarry -- is to decontaminate or stabilize radioactively and chemically contaminated materials to protect human health and the environment and bring the site into compliance with ARARs. The selected alternative will implement permanent solutions to the extent practicable. Vicinity properties contaminated in excess of acceptable criteria will be decontaminated and the resultant wastes will be disposed of along with wastes from the raffinate pits and chemical plant area and the quarry. Consistent with the goals of DOE's SFMP, real property will be released for unrestricted use to the extent practicable.

3.8.2 Technology Identification

Section 121 of SARA identifies a strong statutory preference for remedies that are highly reliable and provide long-term protection. In addition to the principal requirements that a selected remedy be protective of human health and the environment and be cost-effective, other selection criteria include the following:

- Preferred remedial actions are those in which the principal element is treatment to permanently or significantly reduce the volume, toxicity, or mobility of hazardous substances, pollutants, and contaminants.

- Where practical treatment technologies are available, off-site transport and disposal without treatment is the least favored alternative.

- Permanent solutions and alternative treatment technologies or resource recovery technologies should be assessed and used to the maximum extent practicable.

The following discussion provides a general overview of the technologies that could be used to protect public health and the environment, based on the current understanding of the Weldon Spring wastes and on the potential for population exposure; during implementation of the RI/FS-EIS process, additional technologies may be identified and evaluated. The discussion is divided into two general categories as prescribed in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP): source control response actions and migration control response actions.

3.8.2.1 Source Control Response Actions

Source control response actions are aimed at protecting public health and the environment by altering the nature of the source (i.e., the radioactively and chemically hazardous constituents in the waste) to reduce the toxicity, mobility, and/or volume of its constituents, thereby limiting the potential for exposure to contaminants via the pathways described in Section 3.6. Potential source control response actions include access restrictions, removal, reprocessing/treatment, temporary storage, and disposal.

Access Restrictions. Access restrictions involve the use of physical barriers (e.g., fences) and/or institutional controls (e.g., deed restrictions and condemnation of property) to reduce the potential for public exposure to contaminated materials. These restrictions, in and of themselves, are not typically effective in terms of protecting public health and the environment. Therefore, access restrictions are usually implemented in conjunction with other source control response actions.

Removal. Removal of contaminated materials may involve decontamination, demolition, and/or excavation. Decontamination of structural surfaces can be accomplished using various methods of washing and/or abrading. Demolition consists of decontaminating and/or dismantling contaminated structures and disposing of the resultant rubble in a designated area. Excavation involves removing contaminated soil and hauling it to a designated area for disposal. Both the demolition and excavation technologies are reliable, can easily be implemented with common construction equipment, and can be extremely effective means of removing contaminated materials. Removal of contaminated liquids, e.g., surface water or groundwater, by mechanical means such as pumping is more difficult to implement but is technically feasible. Removed materials can then be treated and/or disposed of.

Reprocessing/Treatment. Reprocessing/treatment includes a wide range of treatment technologies. Although a number of these technologies can be implemented for contaminated liquids, sludges, and soils, they are not typically suitable for the decontamination of structural surfaces. (This decontamination would be carried out as described above, under source control actions.) In addition, only a limited number of technologies are effective where radioactive contamination is present. Treatment technologies for radioactive wastes can be divided into two general categories:

- Those that remove radioactive constituents from the waste matrix, and

- Those that change the form of the waste, thereby reducing its toxicity, mobility, and/or volume.

Hazardous waste treatment can be accomplished by chemical, physical, and/or biological technologies.

Chemical treatment technologies are used to alter the nature of the hazardous chemical constituents and can affect waste toxicity, mobility, and/or volume. When radioactive contaminants are also present, a chemical extraction or leaching process can be used to remove the radioactive components from the waste matrix to reduce the volume and/or mobility of contaminants. The liquid leachate can then be reprocessed to recover the radioactive components. Chemical treatment of liquid wastes can involve precipitation, coagulation, adsorption, ion-exchange, or oxidation/reduction techniques.

Physical treatment technologies are used to alter the structure of the waste constituents to facilitate stabilization and management. Physical treatment can reduce toxicity, mobility, and/or volume of contaminated liquids, sludges, or soils. Contaminated liquids at the site could be treated by sedimentation, granular media filtration, microscreening, or vapor recompression/distillation. Contaminated sludges (e.g., in the raffinate pits) could be treated by dewatering technologies such as centrifugation, pressure or vacuum filtration, horizontal belt filtration, screening, drying beds, or gravity thickening. Three classes of physical treatment technologies that could be considered for contaminated soils and dewatered sludges are vitrification, stabilization, and separation.

In the vitrification process, contaminated soil and sludge are immobilized by passing an electrical current through the material, creating temperatures high enough to melt the soil. When power to the system is turned off, the molten volume cools, and a block of glass-like material resembling natural obsidian is produced. This mobility-reducing technology is developmental and has not yet been used on a large-scale project. Stabilization would involve the addition of chemical and cementitious materials to contaminated soil and sludge to produce a solid monolith. This technique would reduce waste mobility. Several separation techniques have been identified for reducing the volume of contaminated material by separating the radioactive constituents from the soil matrix. These techniques are also developmental and include sand sifting, paramagnetic separation, soil sorting, and selective mineral separation.

Biological treatment technologies can be used to alter the nature of a waste and to remove contaminants from a waste matrix. Biological processes are typically employed in conventional wastewater treatment systems and can affect waste toxicity, mobility, and/or volume. Biological treatment processes include activated sludge treatment, trickling filters, and surface impoundments.

Temporary Storage. Temporary storage is the isolation of contaminated material in a manner designed to protect public health and the environment until a permanent disposal option becomes available. Temporary storage can involve the placement of contaminated material on an engineered pad and covering the material with a synthetic membrane, clay cap, or other protective layer. Temporary storage can also be achieved by placing the contaminated material in an existing engineered structure or in a structure newly constructed for containment purposes.

Disposal. Disposal involves the placement of contaminated material in a confined environment for permanent disposition. This can be an extremely effective means of reducing waste mobility and the associated potential for population exposure. Disposal of the large volume of low-specific-activity wastes resulting from implementation of the Weldon Spring Site Remedial Action Project can potentially be on-site, off-site (land-based), or in the ocean.

On-site disposal would entail disposing of the Weldon Spring wastes in a facility designed in accordance with all ARARs. This appears to be a technically feasible source control response action. Off-site (land-based) disposal is also technically feasible; however, a disposal facility would have to be sited and constructed because none currently exists. Ocean disposal could be considered a viable alternative for disposal of some of the Weldon Spring wastes because the degree of radioactivity associated with these wastes is essentially the same as that naturally present on the ocean floor. The suitability of the disposal site (i.e., the ocean floor) would be based on such factors as levels and volumes of radioactive and chemical contamination, water depth, and ocean currents. However, the ocean disposal option has not been approved by the EPA, and it is anticipated that several years of study and a fundamental change in terms of public acceptance would be required prior to its implementation.

3.8.2.2 Migration Control Response Actions

Migration control response actions are designed to mitigate exposure of the population to contaminants that are transported via any of the pathways described in Section 3.6. An additional objective of migration control measures is to limit activities that could disturb and result in the migration of contaminated materials present at the Weldon Spring site. Potential migration control response actions include access restrictions and containment/treatment.

Access Restrictions. Access restrictions involve the use of physical barriers (e.g., fences) and/or the implementation of institutional controls (e.g., deed restrictions and condemnation of property). These methods could be used to reduce contaminant migration by human or animal activities and to limit exposure to off-site areas where contamination has already migrated. Access restrictions are not effective in reducing the impact of environmental factors (e.g., wind and precipitation) on contaminant migration. In general, access restrictions would not serve as a reliable means of protecting public health and the environment in the absence of other supporting response actions.

Containment/Treatment. Containment/treatment involves the use of media-specific technologies for migration control. The purpose of containment, which can involve containment of contaminated material within an engineered structure or in situ, is to reduce contaminant migration and, therefore, the potential exposure of the population. Containment technologies, in and of themselves, do not typically reduce waste toxicity or volume.

Media-specific containment technologies for migration control include:

- Air -- pipe and trench vents, with containment of vented air;

- Soil -- excavation/containment, liners, isolation (e.g., in situ), and stabilization via vegetation;

- Surface water -- dikes, terraces, channels, downpipes, grading, and surface seals (with containment of runoff); and

- Groundwater -- slurry/cutoff walls, grout curtains, subsurface drains/other leachate containment systems, and groundwater pumping.

When used in conjunction with containment technologies, treatment technologies for migration control may reduce waste volume as well as toxicity and mobility. Media-specific treatment technologies for migration control include:

- Air -- filtration of vented air;

- Soil -- excavation/dewatering and encapsulation (e.g., vitrification, stabilization);

- Surface water -- runoff collection (e.g., with dikes or channels) in conjunction with physical/chemical/biological treatment systems; and

- Groundwater -- groundwater pumping/leachate collection in conjunction with physical/chemical/biological treatment systems.

3.8.2.3 Summary of Potential Response Action Technologies

The potential response action technologies described in Sections 3.8.2.1 and 3.8.2.2 are summarized in Table 19 for source control and Table 20 for migration control. Additional technologies that may be appropriate for the proposed action will be identified and evaluated during the FS-EIS process.

TABLE 19 **Summary of Response Action Technologies: Source Control**

Response Action	Source Control Technology	Type of Contamination	Comments
Access restrictions	Physical barriers	Soils, sludges, structures, surface water, groundwater	Temporarily limits exposure to radioactive and chemical contaminants.
	Institutional controls		
	Deed restrictions	Soils, sludges, structures, surface water, groundwater	Temporarily limits exposure to radioactive and chemical contaminants.
	Condemnation	Property	Temporarily limits exposure to radioactive and chemical contaminants.
Removal	Excavation	Soils, bulk wastes	Reduces exposure to radioactive and chemical contaminants; allows unrestricted use of area. Requires storage or disposal facility and access restrictions during excavation.
	Decontamination	Structural surfaces	Reduces exposure to radioactive and chemical contaminants; allows unrestricted use of area. Requires storage or disposal facility and access restrictions during decontamination.
	Demolition	Structures	Reduces exposure to radioactive and chemical contaminants; allows unrestricted use of area. Requires storage or disposal facility and access restrictions during demolition.

TABLE 19 (Cont'd)

Response Action	Source Control Technology	Type of Contamination	Comments
Removal (Cont'd)	Pumping	Surface water, groundwater	Reduces exposure to radioactive and chemical contaminants; allows subsequent treatment. Requires containment/treatment facility and access restrictions during treatment.
Reprocessing/ treatment	Chemical treatment		
	Leaching/extraction	Soils, bulk wastes, sludges	Reduces exposure to radioactive and chemical contaminants; may reduce toxicity, mobility, or volume of waste constituents; allows unrestricted use of treated area. May require bench-scale testing; requires treatment facility and access restrictions during treatment.
	Precipitation, coagulation, adsorption, ion exchange, lime softening, etc.	Surface water, groundwater	May reduce waste toxicity, mobility, or volume; allows unrestricted use of treated area. May require bench-scale testing; requires treatment facility and access restrictions during treatment.
	Physical treatment		
	Sedimentation, filtration, vapor recompression/distillation, etc.	Surface water, groundwater	May reduce waste toxicity, mobility, or volume. May require bench-scale testing; requires treatment facility and access restrictions during treatment.
	Dewatering	Sludges	May reduce waste mobility or volume; allows unrestricted use of treated area. Requires treatment facility and access restrictions during treatment.

TABLE 19 (Cont'd)

Response Action	Source Control Technology	Type of Contamination	Comments
Reprocessing/ treatment (cont'd)	Physical treatment (cont'd)		
	Vitrification	Soils, sludges	Reduces waste mobility and possibly toxicity. Requires further testing and development; limits future land use; requires access restrictions during treatment.
	Stabilization	Soils, sludges	May reduce waste mobility. Limits future land use; requires treatment facility and access restrictions during treatment.
	Sand sifting	Soils, bulk wastes	Reduces waste volume. Suitability of process for alluvial materials is unknown. Requires further testing and development; requires access restrictions during treatment.
	Paramagnetic separation, soil sorting, selective mineral separation	Soils, bulk wastes, dewatered sludges	Reduces waste volume; may allow unrestricted unrestricted use of treated area. Requires further testing and development; requires access restrictions during treatment.
	Biological treatment		
	Activated sludge, trickling filters, surface impoundments, etc.	Surface water, groundwater,	May reduce waste toxicity, mobility, or volume. Requires treatment facility and/or area; may require bench-scale testing and access restrictions during treatment.

TABLE 19 (Cont'd)

Response Action	Source Control Technology	Type of Contamination	Comments
Temporary storage	On-site	Soils, sludges, bulk wastes, liquids	Reduces waste mobility and exposure to radioactive and chemical contaminants while a more permanent remedy is being developed. Limits future land use; requires storage facility (outdoor area or engineered structure) and access restrictions during storage.
	Off-site	Soils, sludges, bulk wastes, liquids	An off-site temporary storage facility would probably not be available for several years.
Disposal	Land-based facility		
	On-site	Soils, sludges, bulk wastes, liquids	Reduces waste mobility and exposure to radioactive and chemical contaminants. Limits future land use; requires specific siting and construction of disposal facility and access restrictions during the long term.
	Off-site	Soils, sludges, bulk wastes, liquids	Reduces waste mobility and exposure to radioactive and chemical contaminants; allows unrestricted use of decontaminated area. Requires siting and construction of a disposal facility and access restrictions at the facility for the long term. (Disposal site not currently available.)
	Ocean disposal	Soils, sludges, bulk wastes, liquids	Not currently available and may not be available within a reasonable time. Transportation to the ocean port would be expensive.

TABLE 20 Summary of Response Action Technologies: Migration Control

Response Action	Migration Control Technology	Type of Contamination	Comments
Access restrictions	Physical barriers	Soils, sludges, bulk wastes, surface water, groundwater	Temporarily limits exposure to migrated contaminants. Limits land use.
	Institutional controls: Deed restrictions	Soils, sludges, bulk wastes, surface water, groundwater	Temporarily limits exposure to migrated contaminants. Limits land use.
	Condemnation	Property	Temporarily limits exposure to migrated contaminants. Limits land use.
Containment/ treatment	Engineered system or in situ	Soils, sludges, bulk wastes, surface water, groundwater	Reduces waste mobility and, in conjunction with treatment, may also reduce waste toxicity or volume. Requires containment/treatment system(s); may require access restrictions during containment/treatment period.

3.8.3 Remedial Action Alternatives

Remedial action alternatives will be developed and assessed according to the following five categories, as recommended by the current NCP:

1. No action,

2. Alternatives for treatment or disposal at an off-site facility, as appropriate,

3. Alternatives that attain applicable or relevant and appropriate federal public health and environmental requirements,

4. Alternatives that exceed applicable or relevant and appropriate federal public health and environmental requirements, and

5. Alternatives that do not attain applicable or relevant and appropriate public health and environmental requirements but will reduce the likelihood of present or future threat from the hazardous substances and that will provide significant protection to public health and welfare and the environment. This must include an alternative that closely approaches the level of protection provided by the applicable or relevant and appropriate requirements.

Section 105 of SARA requires the President (who subsequently delegated this responsibility to the EPA) to propose amendments to the NCP by April 17, 1988. The EPA is currently drafting revisions to the NCP in response to this requirement. The revised NCP has not yet been issued in final form. Nonetheless, the identification of categories for remedial action alternatives that are recommended by the EPA in its proposed revisions will also be considered in the current evaluation, in the interest of addressing those requirements that may be promulgated before the proposed remedial actions are complete. These categories are:

- No action;

- Containment (migration control) or institutional controls -- involving little or no treatment, but protective of human health and the environment by causing a reduction in waste mobility and related exposure risks; and

- Treatment (source control) with disposal of the remaining wastes either on-site or off-site -- ranging from (a) treatment as the principal element of the alternative, to reduce the principal threat(s) posed by a site (i.e., may not involve the highest degree of treatment or treatment of all wastes) to (b) treatment that will minimize the need for long-term management of the wastes (including monitoring).

On the basis of the technologies identified to date (see Section 3.8.2), a limited number of general remedial action alternatives have been identified:

- No action,
- On-site disposal,
- Off-site disposal,
- On-site treatment with on-site disposal,
- On-site treatment with off-site disposal, and
- Off-site treatment with off-site disposal.

These alternatives address the radioactively and chemically contaminated materials -- including structures, equipment, soils, sludges, and water -- present at the Weldon Spring site and its vicinity properties. They represent a wide range of remedial actions, from no action to treatment and disposal. The following descriptions of the general remedial action alternatives include a variety of engineering options that could be implemented, either singly or in various combinations.

3.8.3.1 No Action

The no-action alternative provides a baseline for comparison to other alternatives. If this option were selected, there would be no reduction in the toxicity, mobility, or volume of the contaminated materials. The potential for human exposure to radioactive and chemical contaminants would probably continue for the short term at the levels presented in the baseline risk assessment. However, as off-site migration continued, long-term exposure would likely increase -- in terms of both levels of exposure and size of the potentially affected population. These exposures could become quite large if changes in land use near the Weldon Spring site were to occur. Redevelopment of the site could also result in the uncontrolled release of contaminated materials.

3.8.3.2 On-site Disposal

On-site disposal would reduce waste mobility. Implementation of this alternative would involve a determination of site suitability and the construction of an on-site disposal facility. After closure of the facility, monitoring and maintenance activities would be performed as needed. These activities would include periodic inspection of the cover, environmental monitoring, and security precautions. Permanent access restrictions and other institutional controls would be required to protect public health. A buffer zone would be created between the disposal facility and surrounding areas.

3.8.3.3 Off-site Disposal

Off-site disposal would reduce waste mobility. Implementation of this alternative would involve the siting and construction of an off-site disposal facility for the Weldon Spring wastes. Once an off-site disposal facility became available, the removal, transport, and disposal of the wastes from the Weldon Spring site could be implemented. Other considerations applicable to on-site disposal (see Section 3.8.3.2) would also apply to off-site disposal.

3.8.3.4 On-site Treatment with On-site Disposal

On-site treatment with on-site disposal would reduce the mobility and could reduce the toxicity and/or volume of the contaminated materials. This alternative would involve many of the same issues related to the on-site disposal alternative (see Section 3.8.3.2). In addition, treatment systems for the various forms of contaminated materials would have to be constructed and operated on-site, and access restrictions would be required during treatment operations. If this alternative were selected, contaminated surface water, groundwater, soils, and sludges would be treated and subsequently disposed of -- with all activities occurring on-site.

3.8.3.5 On-site Treatment with Off-site Disposal

On-site treatment with off-site disposal would reduce the mobility and could reduce the toxicity and/or volume of the contaminated materials. This alternative would involve the same issues related to on-site treatment that are addressed for the previous alternative (Section 3.8.3.4) and the same issues related to off-site disposal that are addressed for the off-site disposal alternative (Section 3.8.3.3).

3.8.3.6 Off-site Treatment with Off-site Disposal

Off-site treatment with off-site disposal would reduce the mobility and could reduce the toxicity and/or volume of the contaminated materials. This alternative would involve the same issues related to the off-site disposal alternative (see Section 3.8.3.3) and the identification of an off-site location for the construction and operation of the treatment facilities.

3.9 FEASIBILITY TESTING

The DOE will perform various studies to support the RI/FS-EIS process. The results of these studies will be used to screen the various technologies and define the alternatives to be assessed in the FS-EIS. The studies listed here are those currently planned. Additional studies may be performed in the future as part of the post-screening investigations that bridge Phases II and III of the FS-EIS process (see Figure 32 for a definition of the various phases of the RI/FS process).

3.9.1 Volume Reduction

The applicability of various volume-reduction techniques for solid waste will be examined relative to the wastes expected to be produced during implementation of the Weldon Spring Site Remedial Action Project. This study will include contaminated soils and sludges, metallic wastes such as equipment and siding, and other building components.

3.9.2 Sludge Stabilization

The feasibility of stabilizing the sludge in the raffinate pits with chemical and cementitious materials to reduce waste mobility will be assessed. Earlier studies conducted by Oak Ridge National Laboratory have demonstrated the technical feasibility of stabilization. Although these tests used a fairly wide range of mixtures with varying results, there is no assurance that the samples used were representative of the raffinate pit sludge at the Weldon Spring site. Additional tests will be performed to better define the quantity and quality of the additives to be used, the mixing techniques to be employed, and the chemical (e.g., leachability) and geotechnical (e.g., strength) characteristics of the resultant mixture using samples that better represent the raffinate pit sludge.

3.9.3 Waste Vitrification

The feasibility of vitrifying the raffinate pit sludge, and possibly the materials in the quarry, will be evaluated. Battelle Pacific Northwest Laboratories (PNL) has recently been testing the feasibility of treating hazardous waste by vitrification. If costs are not prohibitive, vitrification could prove to be an applicable technique for management of the raffinate pit sludge. Based on preliminary data, vitrification appears to be a feasible technology that could result in significant volume reduction. Vitrification could also dramatically reduce the leachability of hazardous substances in the sludge and decrease the rate of radon emissions, thereby reducing waste mobility and toxicity. Preliminary discussions with PNL indicate that vitrification of the raffinate pit sludge might require the addition of some siliceous material (if the current level is insufficient). If so, wastes from the quarry could be a candidate source for the additive. Thus, some of the quarry wastes might also be considered for vitrification.

3.9.4 Waste Reprocessing

The feasibility of reprocessing the raffinate pit sludge will be evaluated relative to recovering resources and reducing the toxicity, mobility, and volume of the sludge. In addition to small quantities of uranium, thorium, and radium, the sludge contains other elements -- including a significant quantity of magnesium fluoride. A preliminary review of the data indicates that removal of all of the uranium, thorium, and radium would not significantly reduce the waste volume; in fact, reprocessing is expected to involve the addition of significant quantities of reprocessing reagents to the sludge, which would increase the final waste volume. Even if the magnesium fluoride were recovered from the sludge, it is possible that its level of radioactive contamination would render it commercially unusable. Therefore, it appears that the waste-reprocessing method used to reduce the sludge volume would have to reduce the contamination to a level at which the sludge would no longer be considered radioactively contaminated. The same processes considered for the raffinate pit sludge will also be examined for applicability to contaminated soils and sediments.

3.9.5 Lake Silt Removal

Preliminary data indicate that silt in Lakes 34, 35, and 36 in the Busch Wildlife Area is contaminated and may require response action; additional sampling will be performed to evaluate the need for such action. Although these lakes are currently filled with water, existing data indicate that only the silt is contaminated to an extent that might require remediation. If tests confirm the need for cleanup of these lakes, various methods will be evaluated for removing and treating the contaminated silt.

3.9.6 Liner Compatibility

Flexible membrane liners may be used in the construction of any required leachate collection system and/or leak detection system in the disposal facility. Such liners could be adversely affected by the wastes or leachates produced by the wastes placed in the disposal facility. In addition, underlying clays could be detrimentally affected by leachates produced during construction of the disposal facility, during operation of the leachate collection system, and especially after cessation of leachate collection. The compatibility of these potential leachates with flexible membrane liners and engineered sublayers will be evaluated.

3.9.7 Thermal Waste Destruction

The toxicity, mobility, and volume of some of the chemical wastes present at the raffinate pits and chemical plant area and the quarry could be reduced by thermal destruction. The thermal properties and off-gas treatment requirements for the various wastes will be studied. Thermal waste destruction would probably require the use of a mobile incinerator and thus would be applicable to either on-site or off-site treatment.

3.9.8 Land Treatment

The toxicity, mobility, and volume of certain liquid wastes might be reduced by applying the liquids to the ground and allowing natural processes to break down the contaminants. The soil, meteorological, and vegetative conditions at and in the vicinity of the Weldon Spring site will be assessed for compatibility with land treatment. Although the mix of constituents present in contaminated site waters probably precludes use of this method, land treatment could be appropriate when used in conjunction with other treatment methods.

3.9.9 Waste Drying/Dewatering

The volume and mobility of contaminated sludges and sediments could be reduced by drying or dewatering. Methods of drying/dewatering will be evaluated relative to specific site wastes. This technology could be used to support on-site or off-site disposal and would reduce transportation costs for off-site disposal.

3.9.10 In-Situ Leaching

The toxicity, mobility, and volume of certain contaminated soils and sludges could be reduced by in-situ leaching. In this process, a solution is pumped into or sprinkled onto a contaminated zone and allowed to dissolve the desired contaminant. The contaminant-bearing solution is then removed and treated. The appropriateness of this method for various waste types will be evaluated.

3.9.11 Groundwater Treatment

Contaminants associated with the Weldon Spring site have been identified in various samples taken from on-site and near-site monitoring wells. With the exception of nitroaromatics, these contaminants have also been identified in surface waters at the raffinate pits. If, as a result of the RI/FS-EIS process, DOE determines that groundwater at the raffinate pits and chemical plant area must be remediated, a groundwater restoration program will be implemented. Current knowledge of the local aquifer and types of contaminants suggest that groundwater pumping and treatment could be a feasible response. However, other response alternatives will also be evaluated prior to the selection of a final remedy.

3.10 EVALUATION OF POTENTIAL INTERIM RESPONSE ACTIONS

The DOE is proposing to perform various expedited response actions (ERAs) -- synonymous for this project with the term interim response actions (IRAs) -- prior to issuance of the ROD, in order to mitigate actual or potential uncontrolled releases of radioactively or chemically hazardous substances to the environment and to minimize potential health and safety risks to on-site personnel and local human and biotic populations. The scope of the IRAs will be limited to those actions that can be performed within the guidelines for removal actions of CERCLA and the NCP, and remain within the constraints of CEQ regulations for NEPA (i.e., actions will be limited to those that do not have adverse environmental impacts or limit the choice of reasonable alternatives for the ultimate disposition of the site).

Under the July 1982 version of the NCP, removal actions were divided into two categories: (1) immediate, for emergencies, and (2) planned, for near emergencies. The February 1986 revisions of the NCP expanded the definition of removal to combine three previously separate activities -- immediate removals, planned removals, and initial remedial measures -- into one general activity category of removals. The use of ERAs (i.e., IRAs) was designed to address those situations that were previously performed as initial remedial measures. The primary purpose of conducting a removal action is to expedite response activities at those sites where cleanup solutions are straightforward. In addition, the NCP revisions extended removal authority to permit actions to be taken in response to a threat (rather than to an immediate and significant threat). Thus, removal actions can now be implemented on a non-time-critical basis, i.e., when the action does not need to be initiated within hours or days (classic emergency removal) or within six months (time-critical removal) after the preliminary assessment of a site. By definition, the IRAs proposed for the Weldon Spring site are of a non-time-critical nature.

The EPA lists the following major factors for implementing an ERA (i.e., IRA):

- The action must meet criteria for removal actions as stated in the NCP,
- The action must be implemented within the statutory limits of 1 year and $2 million, for Superfund-financed actions only (waivers of these limits are possible), and
- The action must be consistent with and contribute to the performance of the long-term remedial action for the site.

The IRAs at the Weldon Spring site will be conducted in accordance with relevant guidelines primarily to:

- Reduce the potential for off-site migration of contaminated ground-water and surface water,
- Reduce the potential for extended soil contamination,
- Reduce the potential for air contamination, and
- Protect the health and welfare of on-site personnel and nearby individuals and the environment.

A secondary objective of the IRAs will be to facilitate adequate site characterization.

3.10.1 EE/CA Documentation Process

The decision-making process DOE will follow to document the evaluation of IRA alternatives is shown in Table 21 and Figure 30. The major document prepared to analyze alternatives for implementing the various IRAs is the engineering evaluation/cost analysis (EE/CA) report. A flow chart of the EE/CA process is shown in Figure 31. The decision-making process is intended to be flexible to the specific needs of the various IRAs; not all components of the process will be needed for all IRAs. Specific documentation will be prepared for each IRA to ensure that the environmental review

TABLE 21 Summary of the NEPA and CERCLA Decision-Making Processes for IRAs

Step	Action
I	Notification (DOE Action)
II	Characterization Data (DOE Preparation -- EPA and State Review/Comment)[a]
	Evaluation of Existing Data
	Collection of New Data (As Necessary)
III	Engineering Evaluation/Cost Analysis Report (DOE Preparation -- EPA, State, and Public Review/Comment)[b]
	Site Characterization
	Site Description
	Site Background
	Analytical Data
	Site Conditions That Justify a Removal Action
	Removal Action Objectives
	Statutory Limits
	Scope and Purpose
	Schedule
	Compliance with ARARs (Contaminant- and Location-Specific)
	Removal Action Alternatives
	Screening of Removal Action Alternatives
	Public Health and Environmental Effectiveness
	Timeliness
	Technical Feasibility
	Institutional Considerations
	Analysis of Removal Action Alternatives
	Action-Specific ARARs
	Technical Feasibility
	Cost/Benefit Analysis
	Institutional Considerations
	Environmental Impacts
	Summary
	Comparative Analysis of Removal Action Alternatives
	Technical Feasibility
	Cost
	Institutional Considerations
	Environmental Impacts
	Recommended Removal Action Alternative
IV	NEPA Documentation (DOE Preparation -- EPA and State Review/Comment)
	Memorandum-to-File[c] or Finding of No Significant Impact (FONSI) (As Appropriate)

TABLE 21 (Cont'd)

Step	Action
V	CERCLA Documentation (EPA and State Preparation -- DOE Review/Comment)
	Action Memorandum
VI	Implementation (DOE Performance -- EPA and State Oversight)
	Planning and Design of Removal Action Issuance of Notice to Proceed Initiation of Work Description of Oversight and Monitoring Completion of Work Inspections Acceptance of Completed Work Work Completion Report

[a]EPA refers to EPA Region VII and state refers to the state of Missouri.

[b]The scope of this analysis may be expanded for certain IRAs to include the level of environmental analysis required in an EA under NEPA.

[c]A memorandum-to-file is a unique DOE mechanism that was established when DOE's NEPA guidelines (U.S. Dept. Energy 1987d) were first issued in 1980. It was developed to avoid the need to prepare EAs for a large number of DOE actions that, because of limited agency experience, had not yet been added to the list of categorical exclusions.

requirements of both NEPA and CERCLA are satisfied. The DOE will consult with EPA Region VII and the state of Missouri in this regard.

3.10.2 Proposed IRAs

The IRAs proposed for the Weldon Spring Site Remedial Action Project are described in this section. The objectives of these IRAs are to (1) expedite cleanup of the site, (2) reduce threats of releases of chemical and radioactive contaminants into the nearby environment, (3) minimize for on-site personnel and local populations the health and safety risks that are associated with site conditions, and (4) contribute to the long-term, overall remedial action for the site (e.g., by reducing on-site waste volume and facilitating waste disposal activities). Additional IRAs may be proposed as the project proceeds. The selection of those actions will continue to involve coordination with EPA Region VII and the state of Missouri and will follow the guidelines described in Section 3.10 and the general process shown in Table 21.

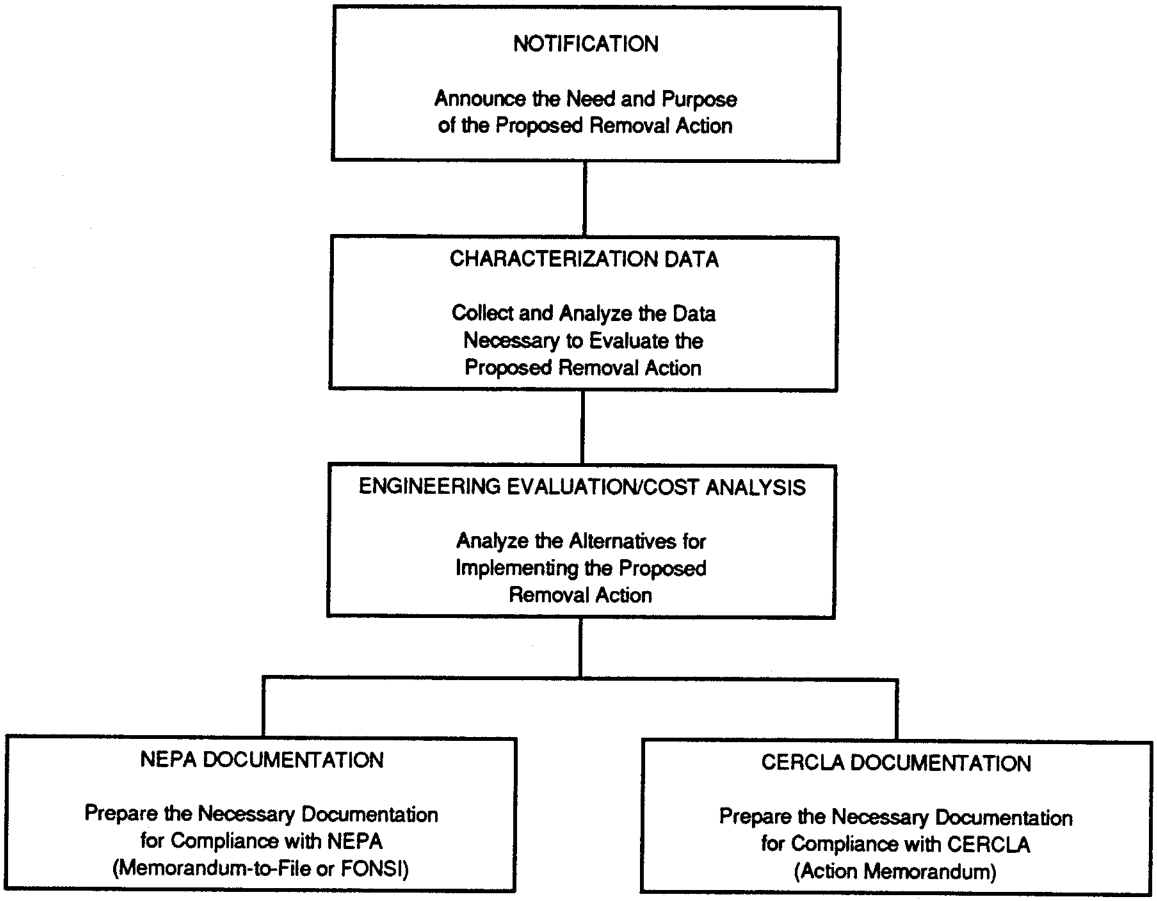


FIGURE 30 Decision-Making Process for Evaluation of IRA Alternatives

3.10.2.1 Removal of PCB Transformers

Fifteen on-site transformers and several additional electrical components on-site held an estimated 25,000 L (6,500 gal) of PCB-containing fluids. Approximately 49,000 L (13,000 gal) of PCB fluids and flushing solutions were removed and transported to an off-site licensed incineration facility; the flushed units were then transported off-site to a licensed disposal facility. Eleven non-PCB transformers were removed as well. Removal of these radioactively clean, out-of-service transformers from the site was carried out in compliance with existing regulations and will prevent leakage of the PCBs during subsequent response action activities at the raffinate pits and chemical plant area. Thus, this action has reduced the volume of on-site materials requiring disposal and has decreased the potential health threats to workers during subsequent on-site activities that would have been associated with PCB contamination.

Status: EPA and state concurrence received in November 1987.
Removal action completed in August 1988.

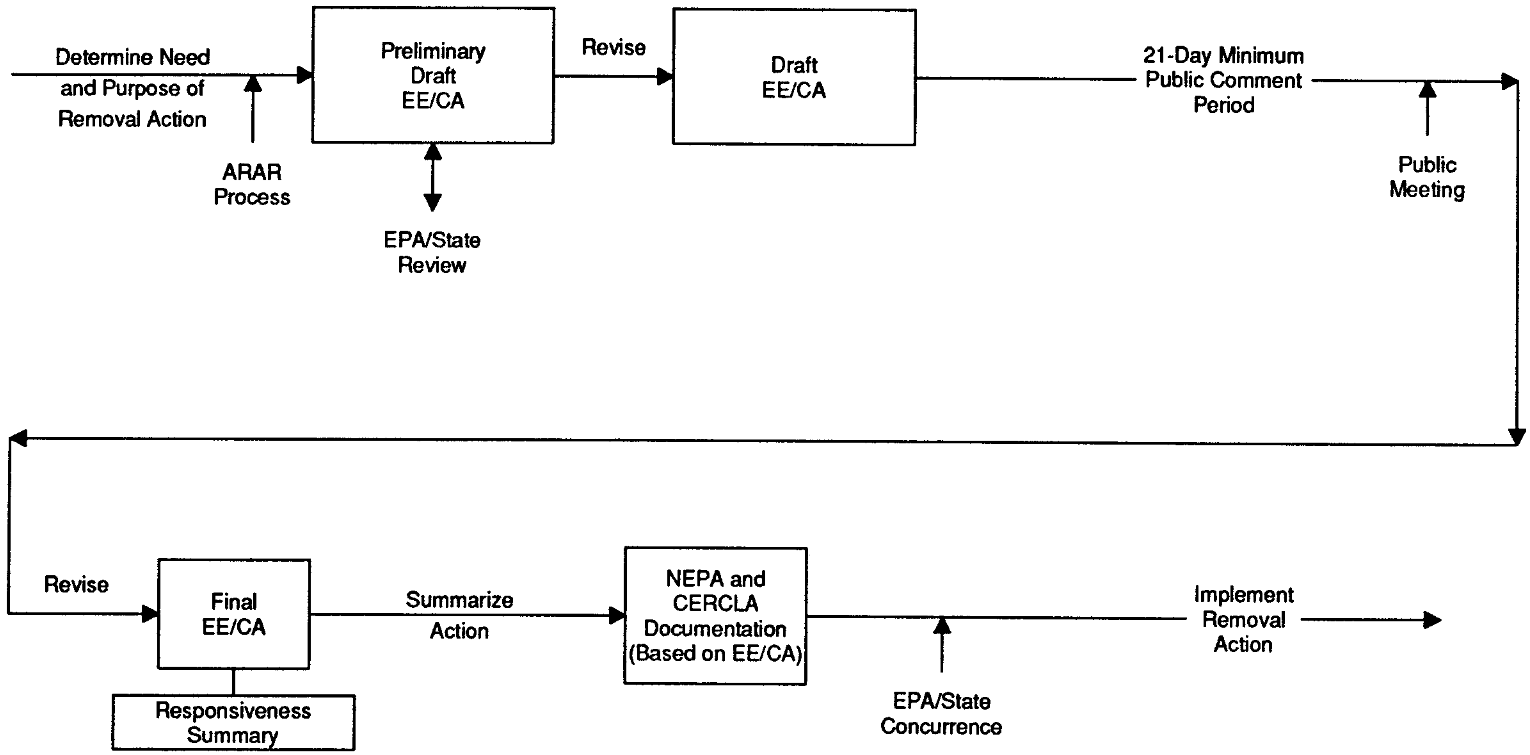


FIGURE 31 Flow Chart of the EE/CA Process

3.10.2.2 Construction of an Ash Pond Isolation Dike

Surface water runoff flowing from the east into Ash Pond, the lowest elevation on the site, is contaminated with uranium measured at levels up to 440 pCi/L. Water runoff from the south flows across a former dump area and into Ash Pond, such that the pond outflow into the Busch Wildlife Area is contaminated with uranium measured at levels up to 3,500 pCi/L. Construction of a dike and channels to divert surface runoff around the dump area and Ash Pond will minimize surface water intrusion and help control erosion. This action will reduce the levels of radioactive contamination leaving the site via surface water runoff.

Status: EPA and Missouri DNR comments received in December 1987.
Additional data were collected to address EPA and Missouri DNR concerns.
Revised documentation transmitted to EPA and state in June 1988.
Construction to begin October 1988; projected completion by November 1988.

3.10.2.3 Construction of Material Staging Area

A material staging area is needed to store, on a temporary basis, contaminated materials resulting from IRA activities at the chemical plant and vicinity properties. In addition to storage, the staging area will be used to classify and segregate materials for future disposal. This staging area will consist of approximately 1.2 ha (3 acres) of cleared ground. A low-permeability liner will be installed and a surface water diversion system and a leachate collection system will be provided. This action will facilitate the consolidation and screening of contaminated materials and will minimize potential threats to workers and the environment related to both the scattered materials and the temporary storage of the materials.

Status: To be developed.

3.10.2.4 Cleanup of Army Reserve Property A7

About 1.2 m^3 (1.5 yd^3) of radioactively contaminated soil was removed from Army Reserve vicinity property A7, which is located about 1 m (1 yd) north of Army Road No. 1 and 300 m (330 yd) west of a road intersection. The soil was placed in eight 55-gal drums, loaded onto a pickup truck, transported to the raffinate pits and chemical plant area, and then placed in storage in an on-site building. Vicinity property A7 was radiologically surveyed by an independent contractor to confirm that cleanup was effective in removing the radioactive material, thereby minimizing the potential threat to public health and the environment associated with this contaminated soil.

Status: EPA and state concurrence received in November 1987.
Removal action completed in January 1988.

3.10.2.5 Cleanup of Selected Locations on Department of Conservation Property

Radioactively contaminated soil will be removed from four isolated locations on Missouri Department of Conservation property (see Figure 29): one on the Busch Wildlife Area, north of the raffinate pits and chemical plant area (B3); and three on the Weldon Spring Wildlife Area, south of the raffinate pits and chemical plant area (B4, B5, and B8). The excavated soil will be stored in a designated, controlled-access area at the Weldon Spring site until final disposition. The current estimated volume to be removed is 400 m^3 (520 yd^3). This action will reduce potential threats to public health and the environment associated with this contaminated soil.

Status: To be developed.

3.10.2.6 Removal of Overhead Piping/Asbestos

Ten thousand linear meters (33,000 linear feet) of overhead piping and 500 structural supports, which hold 4,000 linear meters (13,000 linear feet) of asbestos-containing material, will be removed from the chemical plant area. The asbestos-containing material will be wrapped and dismantled, and soil contaminated with asbestos will be cleaned up. All materials will be surveyed and classified. Nonradioactive asbestos-containing material will be transported to an off-site licensed disposal facility; radioactive asbestos-containing material will be stored on-site. Reusable materials may be salvaged. This action will reduce potential off-site airborne releases of asbestos, reduce potential threats to the health and safety of on-site workers, reduce the volume of on-site materials requiring disposal, and facilitate future cleanup efforts.

Status: EPA and state concurrence received in November 1987.
Removal action to begin September 1988; projected completion by April 1989.

3.10.2.7 Disposal of Containerized Chemicals

There are 4,000 individual containers on-site in which 300 different types of chemicals are stored. The estimated volumes are 19,000 L (5,000 gal) of containerized liquids and 71 m^3 (93 yd^3) of containerized solids. The types of containers include laboratory vials and bottles, bags, cylinders, and drums. Although some of the containers are intact, others have deteriorated and are leaking. Radioactively contaminated materials will be stabilized and consolidated for future disposition. Nonradioactive materials will be sampled and tested for chemical compatibility, then stabilized, consolidated, and transported off-site by a licensed hauler to a licensed disposal facility. This removal will reduce the potential for future exposure of on-site workers to these chemicals and the potential for leakage of chemical containers during future cleanup activities, as well as reduce the volume of on-site materials requiring disposal.

Status: EPA and state concurrence received in November 1987.
Removal action to begin August 1988; projected completion by November 1988.

3.10.2.8 Removal of Electric Lines and Poles

All deenergized exterior power and telephone lines (an estimated 46,000 linear meters [150,000 linear feet] of cable and wire) and 300 timber poles, their cross beams, and supports have been removed from the chemical plant area. These inactive lines and poles were deteriorating, and many had fallen or were in danger of falling to the ground. All materials were radiologically surveyed and classified. Nonradioactive material was transported off-site for salvage; radioactive material is being stored on-site. Removal of these items has improved the safety conditions for on-site workers and reduced the volume of on-site materials requiring disposal; it also facilitates future cleanup activities (e.g., dismantling of area buildings).

Status: EPA and state concurrence received in November 1987.
Removal action completed in March 1988.

3.10.2.9 Consolidation of Debris

Following the inventory and characterization of containerized chemicals and the scanning of major items for radioactive contamination, action will be taken to consolidate debris (e.g., pipe, steel, and rubble) randomly scattered throughout the site. Placing this debris in one controlled area will improve environmental and safety conditions on the site. It will also facilitate groundskeeping and future dismantling and construction activities.

Status: EPA and state concurrence received in November 1987.
Awaiting construction of material staging area.

3.10.2.10 Dismantling of Building 409 (Administration)

The two-story, 3,500-m^2 (38,000-ft^2) former administration building (409) is badly deteriorated. Characterization of this building has identified the presence of asbestos pipe insulation, PCB contamination on floor surfaces, and radioactive contamination in the roofing material. The asbestos insulation and the PCB-contaminated material will be removed and transported off-site to appropriately licensed disposal facilities. The radioactively contaminated material will be containerized and stored on-site until final disposition. Internal equipment, walls, and the superstructure will then be dismantled and transported to an off-site licensed disposal facility or salvaged where feasible. This action will facilitate future cleanup activities, reduce the volume of on-site materials requiring disposal, and reduce the potential health and safety hazards to on-site workers associated with the deteriorating structure.

Status: EPA and state concurrence received in November 1987.
Removal action to begin August 1988; projected completion by April 1989.

3.10.2.11 Dismantling of Building 401 (Steam Plant)

The steam plant (Building 401) is a 1,600-m^2 (17,000-ft^2) building that contains asbestos and small radioactively contaminated areas. Asbestos from the building will be removed and transported to an off-site licensed disposal facility. The radioactively contaminated material will be containerized and stored on-site until final disposition. The equipment and building will then be dismantled and transported to an off-site licensed disposal facility or salvaged where feasible. This action will facilitate future cleanup activities, reduce the volume of on-site materials requiring disposal, and reduce the potential health and safety hazards to on-site workers associated with the structure.

Status: EPA and state concurrence received in November 1987.
Removal action to begin October 1988; projected completion by June 1989.

3.10.2.12 Construction of Southeast Drainage Dike

A dike will be constructed to isolate contaminated portions of the southeast drainage watershed from surface water intrusion. This dike, which will also provide erosion control, will be about 3.0 m (10 ft) high at its maximum elevation and about 300 m (1,000 ft) long. The southeast drainage watershed, which receives surface water as well as infiltration and inflow from the chemical plant sanitary and process sewers, flows to the Missouri River. Construction of the dike, and subsequent water management, will reduce the potential threat to public health and the environment associated with off-site discharges of contaminated surface water from this area.

Status: To be developed.

3.10.2.13 Cleanup of Army Reserve Properties A1, A2, and A3

More than 1,000 m^3 (1,400 yd^3) of radioactively contaminated soil material (up to approximately 280 pCi/g of uranium and 38 pCi/g of radium) is present on the Army Reserve property. This proposed cleanup consists of removing the contaminated soil material from vicinity properties A1, A2, and A3 (see Figure 29), hauling it to an on-site staging area at the raffinate pits and chemical plant area, verifying and certifying that the affected properties meet cleanup criteria, and then backfilling, regrading, and reseeding the disturbed areas. This action will consolidate the radioactive material in a controlled-access area at the Weldon Spring site, pending its final disposition, and will reduce potential threats to public health and the environment associated with this contaminated soil.

Status: To be developed.

3.10.2.14 Dismantling and Removal of Nonprocess Buildings, Structures, and Equipment

This action involves the dismantling and/or removal of nonprocess buildings, structures, and equipment that were not directly involved in the processing of materials and are therefore not expected to be heavily contaminated. However, many of these buildings, structures, and equipment are likely to be slightly contaminated with radioactive and chemical contaminants (including asbestos and some RCRA-hazardous materials) due to their former use to support activities at the plant and/or their close proximity to processing areas. Nonradioactive, chemically contaminated material will be transported to off-site licensed disposal facilities; radioactive material will be stored on-site. The following buildings, structures, and equipment will be addressed in this action:

Building or Area	Name/Function
104	Lime storage
109	West drum storage
110	East drum storage
202	Green salt tank farm
302	Magnesium building
406	Warehouse
407	Laboratory
408	Maintenance and stores
410	Services building
412	Electrical substation
413	Cooling tower and pump house
414	Salvage building
415	Process incinerator
417	Paint shop
426	Water tower
427	Primary sewage treatment plant
428	Fuel gas plant
430	Ambulance garage
431	Laboratory sewer sampler
432	Main sewer sampler
433-436	Storage buildings
437	Records retention building
438	Storage building
439	Fire training building
443	Fire training storage building
None	Rail and rail ties
None	Fuel tanks
None	Sewers in area

This action may be divided into several smaller actions to expedite the cleanup process. The action will facilitate future cleanup activities, reduce the volume of on-site materials requiring disposal, and reduce the potential health and safety threat to on-site workers associated with deteriorating, contaminated facilities.

Status: To be developed.

3.10.2.15 Construction and Operation of Water Treatment System for the Quarry

Results of site characterization activities have indicated that the water currently contained in the quarry pond may be leaking from the quarry into local groundwater. It is proposed that this water be collected, treated, and then discharged after verifying that the effluent meets release limits that will be established in conjunction with EPA Region VII and the Missouri DNR. The water treatment system will be designed to continuously treat 0.0050 m^3/s (80 gpm). The initial volume of ponded water to be treated is estimated to be 11,000 m^3 (3,000,000 gal). This action will reduce the risk of contaminant migration to the nearby county well field, thereby reducing the potential threat to public health and the environment and will facilitate future remedial action at the quarry.

Status: An EE/CA for this action is currently being prepared.

3.10.2.16 Construction and Operation of Water Treatment System for the Raffinate Pits and Chemical Plant Area

Results of site characterization activities have indicated that the water currently contained in the raffinate pits is leaking from the pits into local groundwater. It is proposed that this water be collected, treated, and then discharged after verifying that the effluent meets release limits that will be established in conjunction with EPA Region VII and the Missouri DNR. The water treatment system will be designed to continuously treat 0.0063 m^3/s (100 gpm). The initial water volume to be treated is estimated to be 216,000 m^3 (57,000,000 gal). These pits contain the bulk of the surface water at the raffinate pits and chemical plant area. Additional contaminated water at the area, e.g., resulting from other IRA activities, will be treated in this plant on an as-needed basis. This action will reduce the risk of further contaminant migration to surrounding areas and groundwater, thereby reducing the potential threat to public health and the environment associated with contaminated soil and groundwater, and will facilitate future remedial action at the raffinate pits and chemical plant area.

Status: An EE/CA for this action is currently being prepared.

3.10.2.17 Decontamination of Area to Support Construction/Staging Activities at the Weldon Spring Site

Radioactively contaminated soil will be removed from an area of less than 0.4 ha (1 acre) at the quarry location currently planned for construction or staging activities. The contaminated soil will be stored in a designated on-site area until a final decision regarding waste disposal is reached. This action will permit planned activities to go forward and will reduce the potential threat to on-site personnel that is associated with this contaminated soil.

Status: To be developed.

3.11 REMOVAL OF BULK WASTES FROM THE QUARRY

3.11.1 Proposed Action

The bulk wastes that are present in the quarry may pose a risk to both the health of the local population and the environment. Bulk wastes, as defined here, are wastes that can be removed using technologies such as excavation by standard construction equipment (e.g., backhoe and bulldozer), hydroblasting, and laser scarfing. Bulk wastes include structural debris, drums, sludges, and other solid materials. The DOE is proposing to remove these bulk wastes from the quarry and transport them to the raffinate pits and chemical plant area for temporary storage prior to the ROD for the project. The decision on the ultimate disposal of these bulk wastes will be included as part of the decision for management of the waste materials resulting from remedial action activities at the raffinate pits and chemical plant area.

Although the extent, pathways, and mechanisms of contaminant transport are not fully understood at this time, it can reasonably be concluded that the quarry wastes are the source of the contamination that has been detected in the quarry area. In addition, this contamination is of concern with respect to potential future adverse impacts to surface water and groundwater, which could subsequently represent a risk to public health and the environment. Expedited removal of the bulk wastes would mitigate these risks by eliminating the primary source of contamination and reducing the potential for migration.

Before a long-term remedial plan for the quarry can be developed, the geology, hydrogeology, and extent of residual contamination in and around the quarry must be adequately assessed. In order to accomplish this in a safe and effective manner, it is necessary to first remove the bulk wastes. Because of the nature of the quarry wastes (e.g., steel, rubble, and process equipment), conventional investigative techniques such as drilling or geophysics are infeasible. Additionally, there is a potential risk to the environment resulting from the investigation activities themselves. For example, even if boring through the wastes could be conducted successfully, the wastes could potentially migrate from the quarry via this pathway. All of these issues would be minimized or avoided if the bulk wastes were first excavated and detailed evaluation of the quarry residual materials were conducted as a follow-on activity.

Another reason for the removal and transport of these bulk wastes to the raffinate pits and chemical plant area is that such action would allow consolidation of wastes associated with the Weldon Spring site in one location, rather than their current location in two noncontiguous areas. This would enable DOE to better control access, prevent accidental releases, and provide for environmental monitoring. Finally, the removal of the bulk wastes would accomplish one step in the overall remediation of the

Weldon Spring site and would expedite the development and implementation of a long-term response action strategy at the quarry.

The public has expressed a concern that disturbing the wastes unnecessarily could result in the unintentional release of contaminants. The major mechanism for such release would be contaminant migration from the quarry via groundwater. The potential for this release would be reduced by lowering the water level in the quarry pond through pumping, treating, and discharging the effluent prior to excavation of the bulk wastes. The lowered water table would effectively turn the quarry into a sump, i.e., by reversing the gradient for groundwater movement, thereby greatly reducing the potential for contaminant migration. Treatment of this ponded water is being addressed as an IRA (see Section 3.10.2.15).

3.11.2 Documentation Requirements

Environmental compliance documentation must be prepared for the Weldon Spring site in accordance with the requirements of NEPA and CERCLA. The raffinate pits and chemical plant area and the quarry, although noncontiguous, are considered to be one site for the purpose of this remedial action project. A single, comprehensive analysis is usually prepared for each NPL site; however, it is possible to subdivide a large and/or complicated site into separate operable units to expedite the documentation and remediation processes. An operable unit is a discrete part of the entire site (or of a response action), whose management (or performance) decreases a release or threat of release, or limits a pathway of exposure. Implementation of response action at a separate operable unit must be consistent with the permanent remedy for the entire site, even though the action may be implemented prior to selection of the final remedy. By defining the quarry bulk wastes as a separate operable unit, it becomes possible to expedite this remedial action. The residual wastes (i.e., within bedrock fractures) and the groundwater will be managed as additional separate operable units after sufficient data have been obtained to define and evaluate appropriate remedial action alternatives. This can only be accomplished after the bulk wastes have been excavated and removed from the quarry.

3.11.2.1 RI/FS-EA Process

The proposed response action for this separate operable unit could be considered either a remedial action or a removal action. For CERCLA, a remedial action is supported by an RI/FS whereas a removal action is supported by an EE/CA. For this project, these two processes have been modified to allow for NEPA and CERCLA compliance with one set of documentation (see Sections 1.2 and 3.10.1). The RI/FS is a formal process that has specific data and documentation requirements. The EE/CA is a less formal process that generally focuses on one or two alternative actions and has somewhat flexible documentation requirements. Both processes consider all federal and state ARARs and stress the use of permanent solutions to the extent practicable.

A focused RI/FS is an administrative compromise between the full-scale RI/FS and EE/CA approaches for CERCLA compliance; it encompasses many of the procedural advantages of an EE/CA while maintaining the formal nature of an RI/FS. The focused RI/FS is generally applicable to separate operable units that have limited alternatives and that subsequently allow a more simplified selection process and require only limited data gathering. When the action involves a separate operable unit rather than an entire site, EPA concurrence is in the form of an action memorandum. Otherwise, the process and format of a focused RI/FS generally comply with those of the conventional RI/FS.

The DOE is planning to use the concept of a focused RI/FS to document the removal and transport of the quarry bulk wastes to the raffinate pits and chemical plant area for temporary storage. This focused RI/FS process will be modified to include an assessment of environmental impacts associated with this action. The level of environmental review associated with an action of this nature would typically be included in an EA. The DOE is planning to use this hybrid documentation process, termed the RI/FS-EA process, for this action. Procedures for implementing this process are described in Section 3.11.7.

The two major alternatives to be evaluated in the RI/FS-EA process for quarry bulk waste removal are:

- Removing and transporting the bulk wastes to the raffinate pits and chemical plant area for temporary storage, and
- Leaving the bulk wastes in place, pending the ROD for the project.

Other alternatives will be considered, as appropriate; if detailed analyses of these alternatives are not included in the RI/FS-EA process, the reasons for not doing so will be documented. Within the removal alternative, a number of different technologies for each element of this alternative will be considered. The decision on ultimate disposition of the quarry bulk wastes will be included in the overall RI/FS-EIS process for the project.

3.11.2.2 Risk Evaluation

One of the key components of the RI/FS process is the risk assessment. This assessment is conducted for the baseline (no-action) case to determine the potential impacts to human health and the environment and to assist in the determination of the appropriate cleanup criteria. In addition, it provides a basis for evaluating the effectiveness of proposed remedial action alternatives. However, preparation of a comprehensive baseline risk assessment is not possible with the bulk wastes in place. Significant data gaps currently exist with respect to the extent, pathways, and mechanisms for contaminant migration from the quarry. These data gaps preclude the preparation of a comprehensive risk assessment for the proposed removal. Furthermore, much of this information cannot be obtained until after the wastes have been removed. To meet the risk assessment requirement for this process, DOE will prepare a limited baseline risk evaluation -- to the extent possible with existing information -- using as guidance the EPA risk assessment methodology provided in the *Superfund Public Health Evaluation Manual* (U.S. Environ. Prot. Agency 1986b). Current data are sufficient to justify the need for this action and to allow for an assessment of environmental impacts associated with implementing the action. The need for additional cleanup at the quarry will be addressed after removal of the bulk wastes, at which time a comprehensive risk assessment will be prepared to assess potential impacts from residual materials on human health and the environment and to help establish cleanup criteria.

3.11.3 Additional Characterization

Collection of additional characterization data for the quarry would probably not significantly increase current knowledge concerning the quarry wastes. Also, the type and placement of buried materials make representative sampling difficult. Obtaining samples of the wastes, without altering their chemical properties during collection, is virtually impossible. In addition to the basic difficulty of drilling through the types of materials present and obtaining representative samples, the lubricating fluid required for drilling tends to wash and dilute the resultant samples. To conduct trenching studies of the nonhomogeneous materials would not permit characterization of the entire depth of the waste materials and would be of limited value. Therefore, it is proposed to remove the bulk wastes from the quarry on the basis of existing data regarding both the characteristics of the quarry wastes and the potential transport mechanisms and pathways.

A substantial amount of historical data currently exists on past disposal practices at the quarry, including analytical data regarding the heterogeneity of the wastes. Several characterization studies of the quarry wastes have confirmed the presence of radioactive and chemical contaminants consistent with the types of materials placed in the quarry. Radiological surveys of the quarry wastes have detected naturally occurring radionuclides of the uranium-238 and thorium-232 radioactive decay series, as well as metals associated with uranium-processing activities. The organic compounds that have been identified are those expected from past disposal activities, i.e., PCBs, PAHs, and nitroaromatic compounds. The chemical and radiological species in the quarry are not found in discrete, homogeneous areas; rather they are intermixed in a soil/rubble matrix at varying concentrations.

Additional characterization data regarding groundwater transport of hazardous contaminants from the quarry into the surrounding environment are needed to complete remedial action at the quarry. The groundwater transport is believed to occur through two distinct hydrological regimes: the bedrock and the alluvial aquifer. The bedrock regime involves the limestone walls and floor of the quarry. It is suspected that contaminated leachate migrates from the quarry through solution-enlarged joints and cracks. After passing through this first medium, contaminants are transported into an alluvial aquifer system. The mechanisms and pathways of transport at the interface between the bedrock and alluvial systems are not yet clearly defined. These pathways will be investigated in detail following removal of the bulk wastes.

In contrast, the alluvial aquifer system is fairly well understood. Past characterization and monitoring efforts have involved the drilling of a number of wells throughout the alluvial system. This has resulted in a well-documented subsurface lithology, and the aquifer transport characteristics have been modeled with a reasonable degree of confidence. Although contaminant transport through the quarry bedrock into the alluvium has not yet been defined, the movement of the contaminants once they reach the alluvial system is well understood.

Detailed evaluation of the transport of contaminants from the quarry into the surrounding environment is not an essential part of this proposed response action. However, the RI/FS-EA process will include an assessment of the potential migration of contaminants into the limestone quarry, to the extent possible, during both the action period and the time period following bulk waste removal. A good understanding of the nature and extent of fracture joints and cracks can be developed only after the bulk wastes have been removed from the quarry and the limestone walls and floors have been exposed for study. The residual contamination in joints and cracks of the quarry -- and in the groundwater -- will be treated as separate operable units following the currently proposed waste removal effort.

3.11.4 Temporary Storage Requirements

Temporary storage of the quarry wastes at the raffinate pits and chemical plant area is a necessary component of the bulk waste removal action. Storage of the wastes will be temporary until the ultimate disposition of all Weldon Spring wastes is determined. The response action will be evaluated on the basis of compliance with potential ARARs, such as RCRA storage requirements given in 40 CFR Part 264, Subparts I and L. These regulations, which are discussed in greater detail in Sections 3.11.4.1 and 3.11.4.2, pertain to container storage and waste piles, respectively. Other requirements, e.g., those of 40 CFR Part 192 -- which provide groundwater and atmospheric protection standards with regard to the release of radioactive materials from uranium mill tailings sites -- will be considered in the determination of potential ARARs for this action.

3.11.4.1 Container Storage

In consideration of the container storage requirements of 40 CFR Part 264, Subpart I, container storage areas will be designed and operated on a base that will contain leaks, spills, and precipitation until the accumulated liquids can be analyzed and removed. The base will be sloped or the containers elevated to prevent contact of the containers with the accumulated liquids. The storage area will have sufficient volume to contain any anticipated surface water accumulation in addition to 10% of the volume of all containers that store wastes with free liquids. Accumulated liquids will be removed from the collection area in as timely a manner as is necessary to prevent overflow of the collection system.

3.11.4.2 Waste Piles

Regulations concerning waste piles (40 CFR Part 264, Subpart L) state that such a pile must be designed, constructed, and installed to prevent the migration of contaminants out of the pile at any time during its active life. Thus, the storage pile will have a containment structure composed of materials that are capable of preventing failure due to pressure gradients, stress of installation or operation, climatic conditions, or contact with the wastes or waste leachate. It will be installed to cover all surrounding soil likely to be in contact with the wastes or leachate. If not enclosed, the waste pile will also have a leachate collection system that is designed, constructed, maintained, and operated to collect and remove leachate from the pile. To maintain the capacity of the containment system, a surface water runon/runoff control and management system will be developed, and the associated collection and holding facilities will be emptied expeditiously after storms. The pile will be covered or otherwise managed to control wind dispersal and will be inspected regularly for deterioration or malfunction.

3.11.5 Cleanup Criteria

The RI/FS process evaluates potential remedial alternatives with respect to their ability to meet cleanup criteria that have been established for each separate operable unit. These criteria are typically in the form of specific analytical parameters. Due to the sequence of events planned for the quarry, DOE proposes that the cleanup criteria be technology based rather than analytically based. The reason for this approach is recognition that the response action for this separate operable unit is only the first step in the overall remediation of the quarry. Immediately following excavation of the bulk wastes, the next phase will involve a comprehensive investigation of any residues remaining in the quarry and of the hydrogeological characteristics of the bedrock. Data gathered during this phase will support the evaluation and selection of a final remedial action for the quarry. Therefore, the establishment of temporary cleanup criteria that could change would result in no benefit and would also require the additional time and expense of a confirmatory sampling program. It is recommended instead that the final cleanup criteria for the quarry be defined pursuant to completion of the characterization efforts that will follow removal of the bulk wastes.

3.11.6 Water Treatment

Approximately 11,000 m^3 (3,000,000 gal) of ponded water is currently in the quarry. This water must be removed and treated prior to removal of the bulk wastes. Treatment of this water is being addressed as an IRA (see Section 3.10.2.15).

3.11.7 Compliance with NEPA and CERCLA

The DOE is proposing to address quarry bulk waste removal as a separate operable unit and will use the RI/FS-EA process to support this decision (see Section 3.11.2.1). This action is scheduled to occur prior to the ROD for the project. Implementation of the RI/FS-EA process will be as follows. The first two phases of the FS process will be completed concurrent with preparation of the RI and baseline risk evaluation. At this point, an assessment of environmental impacts will be performed consistent with the requirements of an EA in support of a finding of no significant impact (FONSI), if appropriate. If DOE determines that this action requires preparation of an EIS, the action will be included within the overall RI/FS-EIS process for the project, and removal of the quarry bulk wastes will not be undertaken prior to issuance of the ROD.

Because the EA is scheduled to be completed prior to issuance of the FS, the RI/FS process for the quarry bulk waste removal action will be completed only if a FONSI is issued. If an RI/FS for bulk waste removal is completed, DOE and EPA will issue decision documents under CERCLA to document the decision-making process.

4 SAMPLING AND ANALYSIS PLAN RATIONALE

The assessment of remedial action alternatives for the Weldon Spring Site Remedial Action Project involves two major phases: the RI and the FS-EIS. The RI phase consists of all activities necessary to collect data to assess the hazards at the site and to analyze various remedial action alternatives during the FS-EIS phase. In order to conduct the RI in an acceptable manner and to allow adequate oversight, review, and participation by EPA Region VII and the Missouri DNR, DOE is preparing a detailed sampling and analysis plan to define the procedures to be used in site characterization activities. The sampling and analysis plan consists of two parts: (1) a quality assurance project plan that describes the policy, organization, functional activities, and quality assurance and quality control protocols necessary to ensure that the collected data are valid for their intended use, and (2) field sampling plans that provide guidance for all field work by defining in detail the sampling and data-collecting methods to be used for the project.

4.1 QUALITY ASSURANCE PROJECT PLAN

The purpose of the quality assurance project plan (QAPP) is to focus on the programmatic steps employed during the RI phase to ensure precision and accuracy of data. The QAPP will consist of the following 16 elements:

1. Title page
2. Table of contents
3. Project description
4. Project organization and responsibilities
5. Quality assurance objectives for measurement
6. Sampling procedures
7. Sample custody
8. Calibration procedures
9. Analytical procedures
10. Data reduction, validation, and reporting
11. Internal quality control
12. Performance and systems audits

13. Preventive maintenance

14. Data assessment procedures (precision, accuracy, and completeness)

15. Corrective actions

16. Quality assurance reports

The title page will include the usual information. In addition, at the bottom of the title page, provision will be made for the signatures of approving personnel, as follows:

- Project director,
- Project manager,
- Project quality assurance manager,
- DOE project manager, and
- DOE quality assurance officer.

The table of contents will include an introduction, a serial listing of the QAPP elements, and a listing of any appendixes that are required to augment the QAPP. The end of the table of contents will include a list of the recipients of official copies of the QAPP.

The project description will consist of an introductory discussion of the proposed work and general objectives of the investigation. The location, size, and important physical features of the site will also be described. A chronological site history, including descriptions of site use, will be provided along with a brief summary of previous sampling efforts and an overview of the results. Finally, specific project objectives for this phase of data collecting will be listed, and the means by which the data will be used to address each of the objectives will be identified.

Project organization and responsibilities will be described in terms of identifying key personnel and/or organizations that are necessary for each data-collecting study. An organizational table or chart will be included.

The quality assurance objectives for measurement will be based on the intended use of the data, available laboratory procedures, and available resources. The field blanks and duplicate field sample aliquots to be collected for quality assurance purposes will be itemized for the contaminants identified in the project description. The selection of analytical methods requires a familiarity with regulatory requirements concerning data usage. Any regulations that mandate the use of certain methods for any of the sample matrices and parameters listed in the project description will be specified. The detection limits needed for the project will be reviewed against the detection limits of the laboratory used. Quantitative limits will be established for the following quality assurance objectives:

1. Level of quality assurance effort,

2. Accuracy of spikes and reference compounds,

3. Precision, and

4. Method detection limits.

Completeness, representativeness, and comparability are quality characteristics that will be considered.

Sampling procedures will be submitted with the field sampling plans. For each major measurement, including pollutant measurement systems, a description of the sampling procedures to be used will be provided. Where applicable, the following will be included:

- Description of techniques or guidelines used to select sampling sites;

- Description of the specific sampling procedures to be used;

- Charts, flow diagrams, or tables delineating sampling program operations;

- Description of containers, procedures, and reagents used for sample collection, preservation, transport, and storage;

- Discussion of special conditions for the preparation of sampling equipment and containers to avoid sample contamination;

- Description of sample preservation methods;

- Discussion of the time considerations for shipping samples promptly to the laboratory;

- Examples of the custody or chain-of-custody procedures and forms; and

- Description of the forms, notebooks, and procedures to be used to record sample history, sampling conditions, and analyses to be performed.

Sample custody, which is an integral part of any good laboratory or field operation, is divided into three parts: (1) sample collection, (2) laboratory analyses, and (3) final evidence files. The QAPP will address all three areas of custody. In addition, the QAPP will provide examples of chain-of-custody records or forms used to record the chain-of-custody for samples, laboratories, and evidence files.

Calibration procedures will be identified for each parameter measured and will include field and laboratory testing. The appropriate standard operating procedure will be referenced, or a written description of the calibration procedures to be used will be provided.

Analytical procedures will be developed using approved EPA procedures or their equivalent. For each measurement, either the applicable standard operating procedure will be referenced or a written description of the analytical procedures to be used will be provided.

The data reduction, validation, and reporting procedures to be used for all collected data will be described. These procedures will include a description of the equations used to calculate the concentration or value of a given parameter, based upon the collected data.

All specific internal quality control methods to be used will be identified. These methods include the use of replicates, spike samples, split samples, blanks, standards, and quality control samples. Ways in which the quality control information will be used to qualify the field data will be identified.

The internal and external performance and systems audits that will be used to monitor the capability and performance of the total measurement system will be described. The systems audits consist of evaluating the components of the measurement systems to determine their proper selection and use. These audits include a careful evaluation of both field and laboratory quality control procedures and are normally performed before or shortly after systems are operational. However, such audits should be performed on a regularly scheduled basis during the lifetime of the project.

A preventive maintenance schedule will be provided for the major preventive maintenance tasks that will be carried out to minimize the down time of field and laboratory instruments.

The precision and accuracy of data must be routinely assessed for all environmental monitoring and measurement data. The QAPP will describe specific procedures to accomplish this assessment. If enough data are generated, statistical procedures may be used to assess the precision, accuracy, and completeness. If statistical procedures are used, they will be documented.

Corrective actions, in the context of quality assurance, are procedures that might be implemented with respect to samples that do not meet quality assurance specifications. Corrective actions will be addressed on a case-by-case basis. The need for corrective actions is based on predetermined limits for acceptability. Corrective actions may include resampling or reanalysis of samples and recommending an audit of laboratory procedures. The QAPP will identify persons responsible for initiating these actions, procedures for identifying and documenting corrective actions, and reporting and follow-up procedures.

Quality assurance reports include results of performance audits, results of systems audits, and significant quality assurance problems encountered, along with recommended solutions. The QAPP will identify the method to be used to report the performance of measurement systems and data quality. The final report for the project will include a separate quality assurance section that summarizes the data quality information contained in the periodic reports.

4.2 FIELD SAMPLING PLANS

The purpose of the field sampling plans is to obtain data to confirm the presence or absence of contaminants, the contaminant sources, modes of transport, direction of contaminant migration, and the effect of the contaminants on public health and the environment. The field sampling plans include a description of objectives, work tasks, specific quality assurance procedures, and level of effort required for site characterization. It is the intent of the field sampling plans to provide a detailed sampling rationale -- including the sampling locations and the types and number of samples -- which, coupled with standard operating procedures and analytical methods/detection limits, will offer a well-defined approach. These plans are designed to permit detailed characterization of the wastes, soil, groundwater, surface water, and facilities at the Weldon Spring site. From these investigations, remedial measures can be identified, evaluated, and selected.

Five categories of field sampling plans will be prepared for the Weldon Spring Site Remedial Action Project:

- Soil investigation,
- Hydrogeologic investigation,
- Waste assessment,
- Geophysical/geotechnical investigation, and
- Other investigations.

4.2.1 Soil Investigation

The soil investigation sampling plan is designed to determine the extent and magnitude of chemically contaminated soil, evaluate contaminant migration pathways, document uncontaminated areas, establish background concentrations, and provide identification of soil contaminant concentrations in both qualitative and quantitative terms for the 88-ha (217-acre) raffinate pits and chemical plant area. The sampling plan delineates a review of historical information, identifies data needs and uses, and outlines sampling and analytical procedures, quality assurance procedures, data documentation requirements, and data reporting requirements for the soil investigation at the raffinate pits and chemical plant area. Specific soil sampling locations have been selected based on association with the operation of either the ordnance works (explosives production) or the chemical plant (uranium processing). In addition, unbiased sampling over the raffinate pits and chemical plant area will be conducted in order to provide a statistically valid data base for soils characterization and to provide documentation for uncontaminated areas. The soil investigation will provide a data base sufficient to support consideration of remedial action options and preparation of the risk assessment. The subcontract for the soil investigation will be awarded in August 1988; sampling activities will commence immediately thereafter. Laboratory analysis and report preparation are expected to be completed by December 1988.

The radiological contamination investigation of the Weldon Spring site has already been completed. Preliminary radiological characterizations of the site have been conducted by Oak Ridge National Laboratory, Bechtel National, EG&G, and others. An extensive field program was also conducted by UNC-Geotech from April to July 1987 to characterize the horizontal and vertical extent of radioactive contamination in the raffinate pits and chemical plant area (Marutzky, Colby, and Cahn 1988). The UNC-Geotech field program included exposure-rate measurements taken at the ground surface and at one meter above the land surface to delineate areas of elevated exposure rates. At locations exhibiting elevated exposure rates, in-situ measurements of uranium, radium, and thorium-232 were taken. If in-situ measurements showed elevated concentrations, soil samples were collected and analyzed for these radionuclides. Samples were collected with a bucket auger at 15-cm (6-in.) intervals; additional boreholes were drilled where elevated concentrations extended below 45 cm (18 in.).

The UNC-Geotech field activities also included drilling 317 boreholes in the raffinate pits and chemical plant area. Samples collected from each borehole were scanned with a gamma-ray spectrometer. Selected samples were then analyzed for either total uranium, thorium-230, or both. Those samples for which the spectrometric results indicated no elevated activities were archived for possible future analysis.

4.2.2 Hydrogeologic Investigation

The purpose of the hydrogeologic investigation sampling plan is to characterize the groundwater and surface water conditions at the raffinate pits and chemical plant area. The sampling plan has been divided into subtasks that include groundwater monitoring, aquifer testing, analysis of karst hydrogeology, unsaturated zone characterization, assessment of surface water hydrology and quality, studies of regional hydrogeology and water balance, and computer modeling of the hydrologic regime.

Although substantial hydrogeologic data have been collected during past site characterization activities, a number of data deficiencies remain for the raffinate pits and chemical plant area that relate to the areal and vertical distribution of the data, the detail of the data, and the frequency of the data collection. To address these deficiencies, it is the intent of the sampling plan to accomplish the following objectives:

- Extend the monitoring well network in order to determine the vertical and horizontal extent of groundwater contamination, levels of contamination, and hydrogeologic conditions.

- Test the aquifer to (1) provide area and depth data on aquifer characteristics, such as hydraulic conductivity, transmissivity, and storativity; (2) provide information for prediction of long-term contaminant migration; and (3) assess contaminant migration effects that could result from pumping the upper limestone aquifer.

- Study the karst hydrogeology by conducting dye-tracing and streamflow studies to determine groundwater/surface water interactions and improve understanding of migration pathways and rates.

- Study the surface water hydrology and water quality to (1) define potential surface migration pathways; (2) determine the possible extent of migration; (3) define the concentration levels of contaminants in surface water; and (4) define the hydrologic characteristics associated with the surface water features.

- Characterize the unsaturated zone to (1) define chemical and physical characteristics in order to classify types and levels of contaminants; (2) estimate recharge to the groundwater system; and (3) define perched zones that may influence contaminant migration.

- Perform hydrogeologic and water balance studies to define (1) regional groundwater levels; (2) fluctuation features that influence groundwater movement and surface water/groundwater interaction; and (3) groundwater geochemistry relationships.

- Define the groundwater system through reasonably detailed and accurate computer models of groundwater flow and contaminant transport in order to predict future contaminant migration and to develop and evaluate the effectiveness of possible mitigative measures.

- Perform data evaluation analyses for the above tasks and previous studies in order to accomplish the field sampling plan objectives.

Field activities to meet the stated objectives of the hydrogeologic investigation are in various stages of completion, as described below.

- Thirty-three additional monitoring wells have been drilled on-site and nine additional wells are being drilled at various off-site locations. Well development is proceeding and is expected to be completed by September 1988. Sampling of these new wells will begin two weeks after their development is complete.

- The pumping and observation wells to test the local aquifer were completed in August 1988. The procurement activity to perform the actual testing is under way, and the pump tests are expected to be performed in September and October 1988.

- The Missouri DNR has injected dye into four area wells and is continuing its observation of known springs and seeps for dye emergence.

- Drought conditions have generally precluded the study of surface water hydrology. Results of the Missouri DNR dye-tracing studies will be used to support the surface water hydrology investigation.

- The sampling plan to characterize the unsaturated zone has been prepared and is currently undergoing review.

- The USGS is continuing its routine monitoring of water levels in area wells and creeks. Additional monitoring equipment will be installed by the USGS in August and September 1988.

4.2.3 Waste Assessment

The purpose of the waste assessment sampling plan is to characterize the wastes, sludge, and sediment contained in the raffinate pits; and the wastes resulting from decontamination and decommissioning of the buildings and associated equipment at the chemical plant area.

The characterization of materials in the raffinate pits will include a radiological, chemical, and physical analysis of the following:

- Neutralized raffinates from uranium-refining operations, washed slag residues from uranium metal production operations, raffinate solids from the processing of thorium recycle materials, and contaminated rubble;

- Contaminated water ponded in each raffinate pit; and

- Contaminated clay and soil on the inner surfaces of the dikes surrounding the pits and underlying the pits.

Characterization of the sludge from the raffinate pits is necessary in order to define and evaluate treatment and disposal alternatives. Representative samples of the sludge will be collected and evaluated for chemical, radiological, and physical parameters. The data will then be used to support technical decisions for remedial action alternatives. The sampling of sludge in the raffinate pits began in July 1988. Subcontracts for sludge analysis are currently in place, and analytical results are expected to be available by October 1988.

A radiological characterization of the nonprocess buildings and the equipment inside the buildings will be conducted to determine what buildings and equipment can be released for unrestricted use or disposal. An asbestos and a chemical characterization of all buildings, pipelines, and equipment in the chemical plant area will also be performed. Procurement of the required radiological characterization subcontracts for the nonprocess buildings is currently in the bid cycle. Field activities to support this characterization effort are expected to begin in October 1988. Initial samples to support the asbestos and chemical characterization activities for the nonprocess buildings have been collected by the project management contractor. Full-scale characterization activities will be conducted concurrent with the radiological characterization efforts, i.e., beginning in October 1988.

4.2.4 Geophysical/Geotechnical Investigation

The purpose of the geophysical/geotechnical investigation sampling plan is to physically characterize the site soil, substrata, and bedrock; delineate the tests necessary to support the risk assessment; and evaluate on-site earthen materials proposed for suitability as a containment liner for the disposal cell. In addition, results of the sampling plan will be used to predict, from available data, the worst-case composition of a leachate that might contact the earthen liner upon failure of a primary flexible membrane liner if such a flexible membrane liner were used in the disposal cell. The inherent variability of soil and rock requires a quantitative standard for acceptability. A statistical sampling and testing plan will be developed to address the adequacy and representativeness of the sampling and testing effort. This activity is currently being performed under three separate subcontracts: geotechnical drilling and trenching, geotechnical laboratory testing, and geophysical surveying. These subcontracts are in various stages of implementation. Field activities associated with the investigation are scheduled to be completed in August 1988, and follow-up reports are expected to be available in October 1988.

4.2.5 Other Investigations

Other investigations include a lake and stream sediment characterization and a biouptake study. Additional investigations may be identified during a later stage of the RI/FS-EIS process if a specific need is determined. The purpose of the lake and stream sediment characterization is to determine the extent and magnitude of potential chemically and radioactively contaminated sediments in off-site streams and surface water bodies. The sampling effort will determine the concentrations of uranium, nitroaromatic compounds, PCBs, semivolatile compounds, and metals in lake and stream sediments affected by drainage from the raffinate pits and chemical plant area. A statistically significant number of samples will be collected and analyzed to limit uncertainty and achieve the level of confidence required to evaluate the baseline (no-action) condition and various remedial action alternatives. Areas receiving direct runoff or subsurface recharge will be the focus of this study. Samples collected for this activity are currently undergoing laboratory analysis. The analysis is expected to be completed in October 1988, and a characterization report is expected to be issued in November 1988.

The purpose of the biouptake study is to determine and characterize the level of potential human exposure to radionuclides, organic compounds (e.g., nitroaromatics and PCBs), and metals from food pathways in the vicinity of the Weldon Spring site. This is accomplished by sampling biota available for human consumption from various locations around and within the site. The biouptake study is expected to provide data on potential human exposure to contaminants via ingestion. The field collection activities and sample analysis for this study have been completed, and the report is currently in preparation.

4.3 HEALTH AND SAFETY PLANS

Health and safety plans have been developed to ensure the health and safety of on-site personnel during the performance of site characterization and response action activities. The plans include the safety standards that must be met by all personnel and subcontractors during the conduct of their assignments. Addressing the health and safety of on-site personnel will also serve to minimize any potential impacts to the general public and the nearby environment. Key elements of these plans are the use of appropriate protective equipment and safeguards and the performance of specific tasks under the supervision of trained technicians and safety specialists. On-site personnel are trained to be cognizant of all appropriate safety equipment and procedures, locations and types of on-site hazards, standard operating procedures, and procedures to be followed in emergency situations. Health and safety training and medical surveillance of all potentially exposed personnel are required elements of these plans. A copy of the health and safety plans will be appended to the QAPP.

4.4 COMMUNITY RELATIONS PLAN

The community relations plan describes the policy and procedures for the interaction of personnel responsible for implementing the Weldon Spring Site Remedial Action Project with the general public. The purpose of the community relations program is to ensure meaningful exchanges of information on such matters as potential health impacts, environmental issues, response action construction plans, project costs, and specific site activities. A copy of this plan will be appended to the QAPP.

4.5 EMERGENCY PREPAREDNESS PLAN

An emergency preparedness plan has been developed to provide on-site personnel with appropriate procedures for notification/reporting and organization of personnel in the event of an on-site emergency. This plan also includes the procedures for responding to potential credible emergencies that could result in the off-site release of hazardous materials. Such emergencies include fire, tornado, failure of a raffinate pits dike, and spills of hazardous materials. This plan fulfills the requirements of DOE Order 5500.2 and the applicable sections of CERCLA and the Toxic Substances Control Act. A copy of this plan will be appended to the QAPP.

4.6 SPILL PREVENTION, CONTROL, AND COUNTERMEASURES PLAN

A spill prevention, control, and countermeasures plan has been developed for the project. The plan is intended to protect navigable waterways (including groundwater and downstream habitats) from harmful oil spills and to ensure that operations at the Weldon Spring site comply with 40 CFR Part 112. A secondary goal of this plan is to minimize potential damage to the environment by identifying containment and control procedures that can be implemented rapidly. A major element of the plan is procedures for mobilizing on-site personnel to respond to a spill and for notifying appropriate federal, state, and local authorities of the spill. A copy of this plan will be appended to the QAPP.

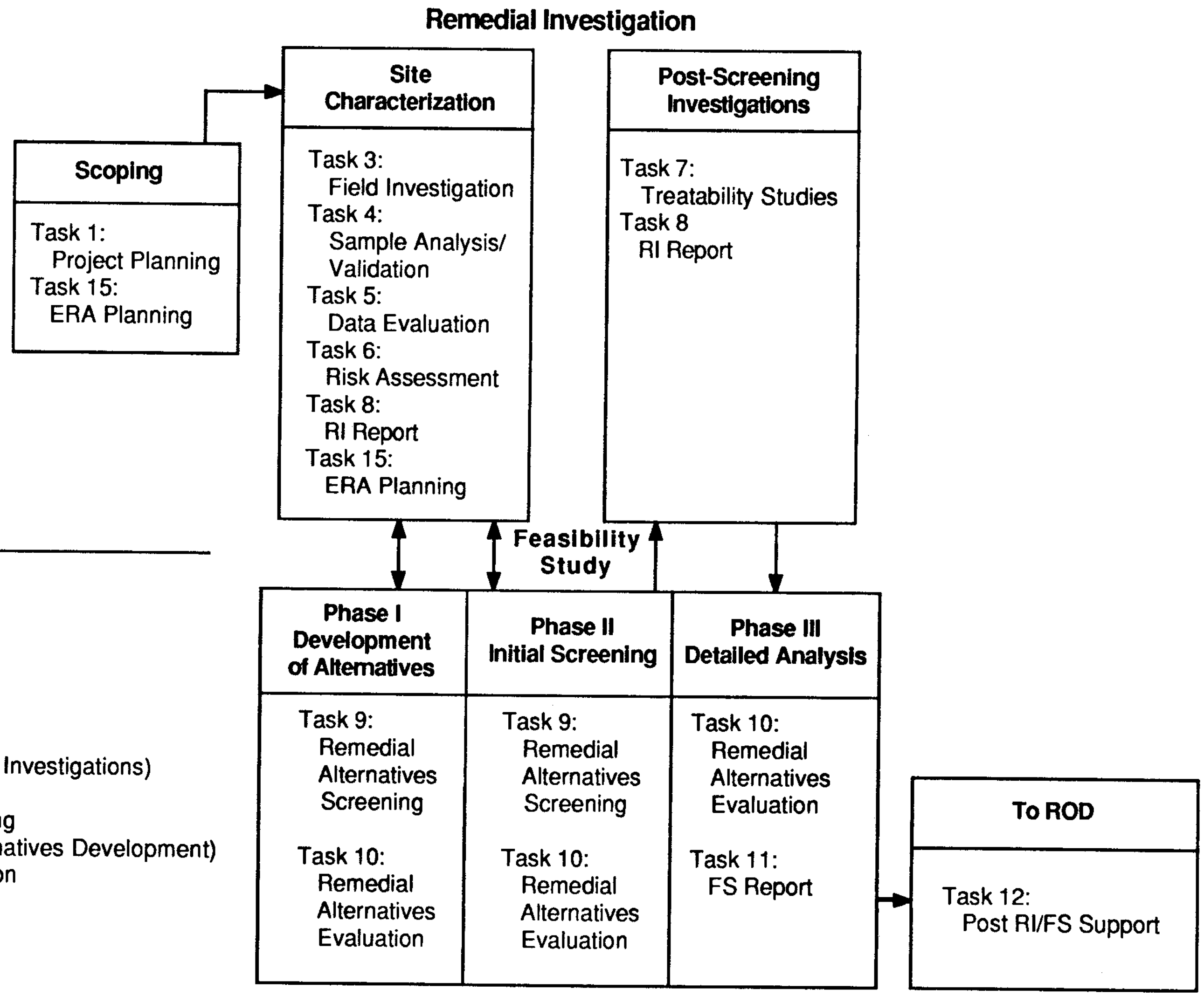
5 REMEDIAL INVESTIGATION/FEASIBILITY STUDY TASKS

Fifteen standard tasks have been defined by EPA as comprising the RI/FS process. This task structure will be used in implementing the RI/FS-EIS process for the Weldon Spring Site Remedial Action Project. This process should enhance coordination with and review by EPA Region VII, the state of Missouri, and local citizens and officials. The RI/FS tasks and the generic phased approach suggested by EPA are shown in Figure 32 and are briefly described in Sections 5.1 through 5.15. Reference is included to other sections of this work plan or other project documents to explain the means by which these 15 tasks are being implemented for this project.

5.1 TASK 1: PROJECT PLANNING

The project planning task initiates the RI/FS-EIS process and establishes the project basis by:

- Collecting and documenting scoping information (Sections 1 and 2),
- Collecting and evaluating existing data (Section 2.5),
- Compiling a list of potential ARARs (Section 3.1),
- Evaluating a conceptual exposure model (Section 3.2),
- Performing preliminary assessments of contaminant status (Sections 3.3 through 3.7),
- Developing conceptual response alternatives (Section 3.8),
- Identifying various feasibility studies to support the RI/FS-EIS process (Section 3.9),
- Identifying operable units and potential expedited (interim) response alternatives (Sections 1.2, 3.10, and 3.11),
- Establishing data quality objectives (Section 4.1),
- Identifying major project plans, including the field sampling plans (Sections 4.2 through 4.6),
- Documenting RI/FS-EIS tasks (remainder of Section 5),
- Developing schedules for completion of major project elements (Section 6), and
- Identifying project organization and project management (Section 7).



RI/FS Work Plan Standard Tasks

Task	Title
1	Project Planning
2	Community Relations*
3	Field Investigation
4	Sample Analysis Validation
5	Data Evaluation
6	Risk Assessment
7	Treatability Study/ Pilot Testing (Post-Screening Investigations)
8	Remedial Investigation Report
9	Remedial Alternatives Screening (Technology Screening/Alternatives Development)
10	Remedial Alternatives Evaluation
11	Feasibility Study Report
12	Post RI/FS Support
13	Enforcement Support*
14	Miscellaneous Support*
15	ERA Planning

* Tasks that can occur in any phase of the RI/FS

FIGURE 32 Relationship of RI/FS Tasks to the Phased RI/FS Approach

All of these elements are included in this work plan. Many elements are summaries of more comprehensive documents. Each of the summaries contained in this work plan reflects the current status of the respective task. This work plan will be updated in the future, as appropriate.

5.2 TASK 2: COMMUNITY RELATIONS

Task 2 incorporates all efforts related to the preparation and implementation of the community relations plan. Community relations are initiated at the beginning of the RI/FS-EIS process and will be completed when all community relations activities under Task 12 are complete. Task 2 does not include preparation of the responsiveness summary, which is part of Task 12. The following are typical components of Task 2:

- Community relations plan,
- Fact sheets,
- Public meeting support,
- Technical support for community relations, and
- Community relations implementation.

The DOE has already established a community relations plan for the Weldon Spring Site Remedial Action Project (see Section 4.4).

5.3 TASK 3: FIELD INVESTIGATION

Task 3 includes all efforts related to field work performed to conduct the RI phase of the RI/FS-EIS process so that adequate technical data will be available to support the development and evaluation of alternatives during the FS-EIS phase. The task begins with the procurement of subcontractors and is complete when all contractors and subcontractors performing portions of the site investigation task are demobilized from the field. The following activities are typically included in this task:

- Mobilization of field activities,
- Media sampling,
- Source testing,
- Geological/hydrological investigations,
- Geophysical investigations,
- Site surveys/topographic mapping,

- Field measurements/analyses,
- Procurement of subcontractor services, and
- RI waste disposal.

Plans for field investigations are documented in field sampling plans. Five categories of field sampling plans are being developed for the Weldon Spring site that cover the full range of contaminated and/or potentially contaminated areas at the site (see Section 4.2).

5.4 TASK 4: SAMPLE ANALYSIS/VALIDATION

Analyses of samples collected during the field investigation will be performed in accordance with the data quality objectives established for this project. The analyses will be performed by laboratories that participate in the EPA Contract Laboratory Program (CLP), using CLP analysis protocol where appropriate. Procedures to ensure quality control during sample analyses are described in EPA's CLP guidance document (U.S. Environ. Prot. Agency 1986a). Sample management and data validation will be performed using EPA-approved procedures and specifications.

Validation of measurements is a systematic process of reviewing a body of data to provide assurance that the data are adequate for their intended use. The validation process includes the following activities:

- Auditing measurement system calibration and calibration verification,
- Auditing quality control activities,
- Monitoring sample management,
- Monitoring non-CLP analyses and use of mobile laboratories (if appropriate),
- Screening data sets for outliers,
- Reviewing data for technical credibility,
- Reviewing chain-of-custody procedures, and
- Checking intermediate calculations.

Procedures that will be used to provide quality assurance for this project will be described in detail in the QAPP (see Section 4.1).

5.5 TASK 5: DATA EVALUATION

Task 5 includes efforts related to the analysis of data once the data have been verified, under Task 4, to be of acceptable accuracy and precision. Task 5 begins on the date that the first set of validated data is received and ends during preparation of the RI report when it is determined that no additional data are required. The following are typical Task 5 activities:

- Literature surveys (e.g., for relevant information on geology, hydrology, and remedial technology),
- Data evaluation,
- Data reduction and tabulation, and
- Environmental fate and transport modeling/evaluation.

These activities will lead directly to the development of the baseline risk assessment and the screening of remedial action alternatives in the FS-EIS. All calculations will be documented in calculation logs and checked by an independent reviewer prior to sign-off. Where computations are performed with computer programs, either validated software will be used or the calculation methods will be hand-verified.

5.6 TASK 6: ASSESSMENT OF RISKS

After the site information and characterization data have been validated and evaluated, a baseline risk assessment will be performed to determine the potential threats to public health and the environment in the absence of any remedial actions at the site. To determine the hazards posed by current site conditions, the assessment will analyze the environmental transport pathways to potential receptors from areas where radioactive and chemical contaminants are currently located. The risk assessment will also be used to assist in the screening of alternatives and to assist in determining acceptable levels of residual contamination (i.e., cleanup limits) for radioactive and chemical species. An overview of the risk assessment process is shown in Figure 33.

The first step in the risk assessment process is the selection of indicator chemicals and radionuclides that pose potential risks to public health and the environment. These indicator chemicals and radionuclides are those that represent the most toxic, mobile, and persistent species at the site, as well as those that are present in the largest amounts. These "highest risk" species are used to assess risks at the site. This list of indicator chemicals and radionuclides will be based on data obtained during field investigations and on usable data previously gathered. A quantitative risk analysis will be performed for all indicator species identified in this step.

The second step in the risk assessment process is the characterization of potential exposure pathways and the determination of exposure concentrations. Potential exposure pathways are described in Section 3.6. Possible pathways that will be

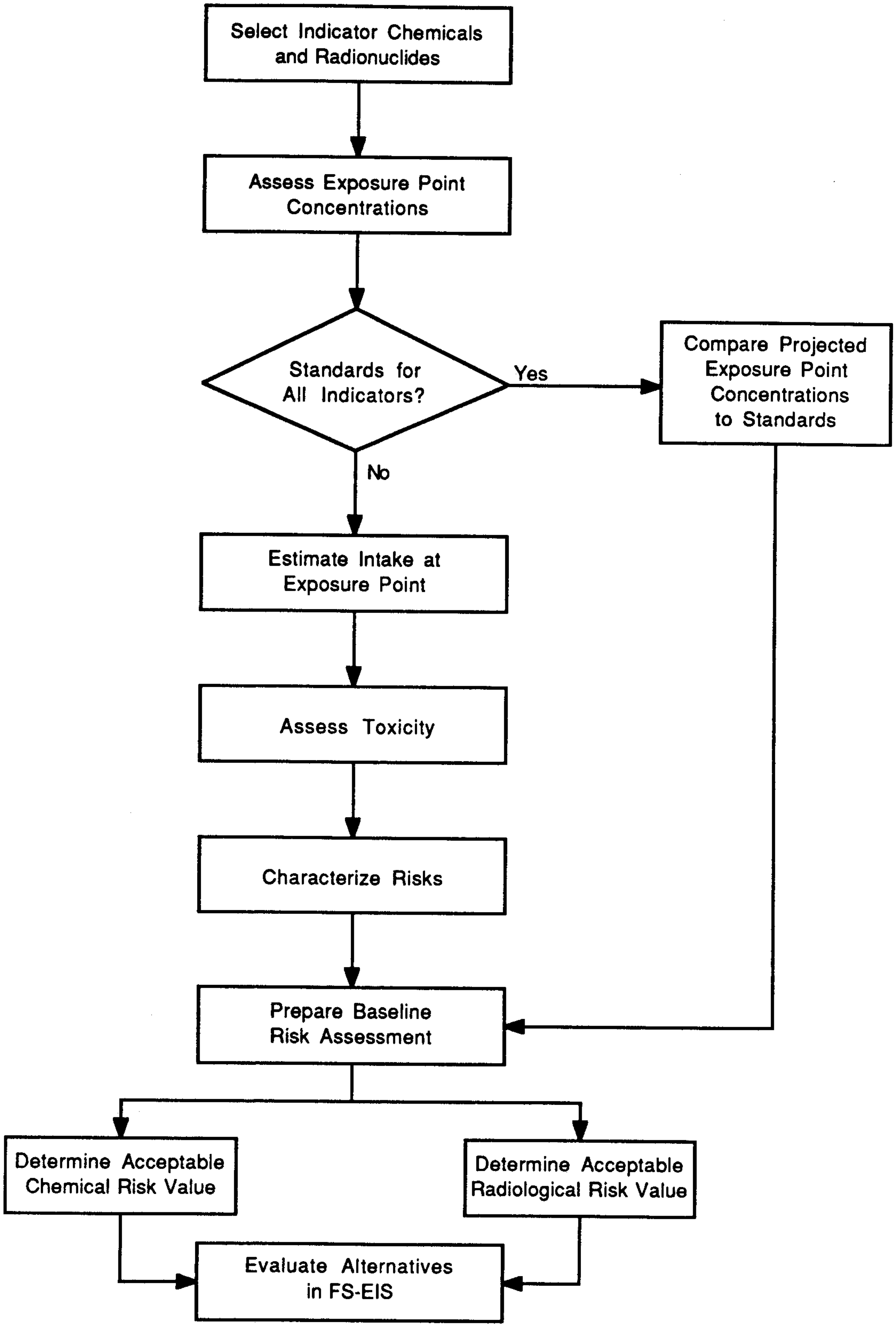


FIGURE 33 Overview of the Risk Assessment Process

evaluated include air, soil, sediment, groundwater, surface water, and biota. Site-specific exposure routes for the study area will be addressed in the evaluation. Initially, these exposure pathways will be the principal areas of focus; however, subsequent data collected during field investigations may warrant the inclusion of additional exposure pathways.

The concentrations of the indicator chemicals and radionuclides in environmental media at exposure points will be estimated using characterization and monitoring data and appropriate environmental fate and transport models. Several models are available for use. The models and input parameters to be used will be developed in cooperation with EPA Region VII and the state of Missouri. Information from the literature and prior studies regarding environmental chemistry and contaminant fates will be considered and incorporated, where valid and applicable, in all estimates of chemical and radionuclide concentrations. The estimated concentrations will then be compared to the potential ARARs. If health-based ARARs are available for all indicator chemicals and radionuclides, no further quantitative analysis of risk will be performed as part of the baseline risk assessment. The baseline risk assessment will evaluate existing data to confirm that the pollutant transport models adequately reflect conditions at the site and to determine where additional data are needed to properly characterize risks.

If health-based ARARs are not available for all indicator chemicals and radionuclides, quantitative analyses will be performed following the general procedures outlined in EPA's *Superfund Public Health Evaluation Manual* (U.S. Environ. Prot. Agency 1986b). The identification of sensitive receptors near the site will be based on demographic records and standard demographic statistical techniques. A population activity profile will be developed, based on area land use and population structure, to delineate exposure coefficients required for quantitative evaluation of exposure. The baseline risk assessment ends with the characterization of risks to human health and the environment in the absence of any remedial action at the site. The risk assessment process continues with an evaluation of risks associated with various remedial action alternatives.

The Weldon Spring site is contaminated with both radioactive and chemically hazardous substances. This situation is somewhat different than usual because most sites remediated under CERCLA are contaminated only with hazardous chemicals. Determining the significance of risks differs markedly for radiological and chemical contaminants because the radionuclides associated with the Weldon Spring site occur naturally in the environment whereas chemical carcinogens generally do not. For this reason, combining the two risks during the risk assessment process could mask distinct, relevant information. Therefore, the chemical and radiological risks associated with the various remedial action alternatives will be evaluated in parallel during the risk assessment process. This assessment will provide a mechanism for determining the range and extent of remedial action activities based upon comparison to acceptable levels of risk. The resultant risk from radioactive contaminants following remedial action activities will be evaluated as an incremental risk over that resulting from background sources of radiation whereas the residual risk from exposure to chemical carcinogens can be evaluated as an absolute risk because exposure to these chemical substances does not generally occur in our everyday environment.

The dose to any individual from background sources of radiation averages about 200 mrem/yr, which corresponds to a 70-year lifetime cancer risk of about 2×10^{-3} (this value exceeds the upper limit of the EPA acceptable risk range of 10^{-4} to 10^{-7}). This risk from background radiation sources may be contrasted to the hazards from exposure to chemical carcinogens that are not naturally present in our environment (e.g., PCBs and nitroaromatics). Using the EPA-recommended target risk value of 10^{-6}, with a range of 10^{-4} to 10^{-7}, is indeed appropriate for those types of contaminants.

Because the residual radiological risk can be interpreted only as an increment to the risk from background radiation, it is necessary to determine what an appropriate increment should be. Determination of the acceptable level of radiological risk can be developed using the "as low as reasonably achievable" (ALARA) philosophy for reducing radiation doses below acceptable limits. The point at which further reduction in radiation exposure (and hence risk) cannot reasonably be achieved is the increment in radiological risk (above the risk from background sources of radiation) that should be used to assess the scope of remedial action activities. The acceptable level of residual chemical risk will be determined consistent with EPA guidance. Hence, during the evaluation of various alternatives in the FS-EIS, radiological doses will be compared to a radiological risk value and chemical risks will be compared to a chemical risk value. The cumulative risk to potential receptors, i.e., the sum of the radiological and chemical risks, will be assessed in the FS-EIS.

5.7 TASK 7: TREATABILITY STUDIES

Task 7 is performed after alternatives have been screened in the FS-EIS phase. This task includes any efforts related to the performance of pilot and bench-scale treatability studies as well as associated procurement efforts. Such studies may be necessary to test volume reduction or treatment technologies for the waste materials at the Weldon Spring site that have not yet been proven reliable or effective in full-scale operation or on similar materials and to develop sufficient conceptual design information on which to base analyses in the FS-EIS. Several post-screening investigations have already been identified (see Section 3.9). Additional studies will be developed, as necessary, to support the screening of potential technologies with respect to availability and technical and administrative feasibility (see Section 5.9).

5.8 TASK 8: RI REPORT

Task 8 covers all efforts related to the reporting of RI findings once the data have been evaluated under Tasks 5 and 6. Task 8 covers all draft and final RI reports, and includes the following typical activities:

- Formatting data for reporting purposes,
- Writing the report,
- Preparing associated graphics,

- Providing and reviewing quality control efforts,
- Printing and distributing the report,
- Holding review meetings, and
- Revising the report based on reviewer comments.

5.9 TASK 9: SCREENING OF REMEDIAL ACTION ALTERNATIVES

Task 9 involves the screening of remedial action alternatives for the Weldon Spring Site Remedial Action Project. This evaluation is conducted subsequent to the screening of technologies and development of alternatives that is completed during the first phase of the FS-EIS process.

The objective of the Task 9 screening process is to narrow the range of alternatives that will undergo detailed evaluation. This process begins with the identification of remedial action objectives, proceeds through a screening of technologies based on implementability, and ends with the assembly of screened technologies into a set of remedial action alternatives (a preliminary set of alternatives for management of the contaminated materials at the Weldon Spring site is given in Section 3.8). Each of these alternatives may involve the application of a single technology or the combination of multiple technologies.

Task 9 consists of the following activities:

- Identifying remedial action objectives,
- Listing potential technologies,
- Screening technologies based on site-specific criteria,
- Assembling potential remedial action alternatives from the screened technologies, and
- Screening the candidate remedial action alternatives for detailed evaluation in Task 10 (Section 5.10).

5.10 TASK 10: EVALUATION OF REMEDIAL ACTION ALTERNATIVES

The candidate remedial action alternatives that pass the screening process will be evaluated in detail in Task 10. Three criteria will be used to evaluate the candidate alternatives: effectiveness, implementability, and cost.

In the effectiveness evaluation, two factors will be used for detailed analysis of candidate remedial action alternatives: (1) degree of protectiveness and (2) ability to reduce the toxicity, mobility, and/or volume of the contamination. The first factor, protectiveness, involves the following set of subfactors, which are essentially short-term factors:

- Ability to reduce existing risks,
- Compliance with criteria, advisories, and guidelines that are pertinent to the site and have been identified during the ARAR process,
- Compliance with potential ARARs,
- Protection of the community and on-site workers during remedial action, and
- Time required until protection is achieved.

For the longer term, protectiveness involves:

- Magnitude of residual risk,
- Long-term reliability,
- Compliance with ARARs,
- Prevention of future exposure to residual contamination, and
- Potential need for future maintenance.

The second factor in the effectiveness evaluation deals with the long-term ability to bring about a permanent and significant reduction of toxicity, mobility, and/or volume of the contamination.

In the implementability evaluation, three factors will be used in the detailed analysis of candidate alternatives: (1) technical feasibility, (2) administrative feasibility, and (3) availability. Technical feasibility relates to the following, essentially short-term, subfactors:

- Ability to use the technology,
- Short-term reliability of the technology,
- Compliance with potential action-specific ARARs, and
- Status of the technology, i.e., whether or not proven.

For the longer term, technical feasibility relates to:

- Ease of undertaking additional remedial action, if necessary,

- Ability to monitor the effectiveness of the remedy, and

- Ability to perform maintenance activities.

Two subfactors will be considered in evaluating candidate alternatives with respect to administrative feasibility:

- Likelihood of favorable community response, and

- Compliance with specific ARARs.

Two subfactors will be considered in evaluating candidate alternatives with respect to availability.

- Availability and capacity of required treatment, storage, and disposal services, and

- Availability of necessary equipment and specialists.

These subfactors are expected to be reflected largely in the technology screening performed in Task 9 and generally will not be expected to be decisive in evaluating candidate alternatives.

The cost evaluation of each alternative will include capital and annual operating/maintenance costs, sensitivity of cost estimates, and present worth analyses. The total capital costs include both direct and indirect capital costs. The major direct capital cost components are based on the major functional facilities, equipment, and construction features. Operating costs for implementing temporary remedial actions and other capital costs incurred until the remedial action is completed will also be considered as part of the capital cost. Material quantities, labor, equipment, and installation costs are estimated on the basis of available sources and local wage rates. The indirect capital costs include overhead, legal fees, administrative costs, and contingency allowances.

Operating costs will be determined from estimates of labor and material requirements. Maintenance costs will be calculated as a percentage of the direct construction costs, based on standard costs and experience, but will reflect perpetual care considerations, costs of periodic reviews such as would be associated with nontreatment alternatives, and the potential for future remedial action costs.

The annual cost will be converted to a present worth capital expenditure. Inflation, discount, and interest rates will be estimated in accordance with current market values. Finally, a sensitivity analysis will be prepared of financial factors that could affect the overall costs of the various alternatives. The key financial factor to be considered is a change in the discount rate.

A summary for each alternative, including the no-action alternative, will be prepared using the criteria outlined in the preceding sections. The relative advantages and disadvantages will then be used to compare and evaluate the remedial action alternatives.

5.11 TASK 11: DRAFT RI/FS-EIS REPORT

The draft RI/FS-EIS report will contain descriptions of the activities, results, and associated conclusions for the entire RI/FS-EIS process. The report will also address those NEPA-related topics not typically addressed in an RI/FS, e.g., environmental consequences of taking each of the remedial action alternatives under consideration, long-term impacts, cumulative impacts, mitigative measures, unavoidable adverse impacts, potential impacts from loss of institutional controls, irreversible and irretrievable commitment of resources, and short-term uses and long-term productivity. The report will include a description of the screening process and a detailed evaluation of remedial action alternatives. The task is complete when the draft RI/FS-EIS is released to the public. The following are typical Task 11 activities:

- Formatting data for reporting purposes,
- Preparing associated graphics,
- Writing the report,
- Printing and distributing the report,
- Holding review meetings, and
- Revising the report based on reviewer comments.

5.12 TASK 12: FINAL RI/FS-EIS REPORT AND SUPPORTING ACTIVITIES

Task 12 includes efforts to prepare the responsiveness summary, revise the RI/FS-EIS report as necessary in response to public comments, support preparation of the ROD, and perform design engineering activities. All activities occurring after release of the draft RI/FS-EIS to the public, and prior to issuance of the ROD, should be covered under this task. The following are typical Task 12 activities:

- Attending public meetings,
- Writing/reviewing the responsiveness summary,
- Revising the RI/FS-EIS in response to public comments,
- Printing and distributing the final RI/FS-EIS,
- Supporting ROD preparation/briefings,
- Providing and reviewing task management and quality control efforts,

- Preparing the predesign report, and
- Completing the conceptual design.

5.13 TASK 13: ENFORCEMENT SUPPORT

Task 13 includes the activities associated with enforcement aspects of the project in terms of potentially responsible parties. Because DOE accepts responsibility for the waste materials that fall within the scope of this document, Task 13 is not applicable.

5.14 TASK 14: MISCELLANEOUS SUPPORT

Task 14 is used to report on work that is associated with the project but does not fall under any of the other established RI/FS-EIS tasks. Task 14 activities will vary, but may include the following:

- Specific support for review of activities of the Agency for Toxic Substances and Disease Registry,
- Special efforts related to public health assessments, and
- Support for review of special state or local projects.

5.15 TASK 15: EXPEDITED (INTERIM) RESPONSE ACTION PLANNING

Task 15 relates specifically to planning expedited response actions (ERAs), which are synonymous for this project with the term interim response actions (IRAs). The proposed IRAs for the Weldon Spring Site Remedial Action Project are discussed in Section 3.10.2 of this document.

6 SCHEDULE

6.1 RI/FS-EIS

The overall schedule for preparation of the RI/FS-EIS is shown in Figure 34. The RI/FS-EIS will address management of contaminated materials resulting from response action activities at the Weldon Spring site, including wastes from the raffinate pits and chemical plant area, bulk wastes from the quarry, and wastes from cleanup of contaminated vicinity properties. The RI/FS-EIS will also address groundwater restoration at the raffinate pits and chemical plant area. The project plan consists of the following:

- Completion of site characterization activities. Site characterization is currently being performed and is scheduled to be completed in early 1989.

- Completion of the RI/FS-EIS process consisting of an RI report, a baseline risk assessment, and an FS-EIS report. The RI/FS-EIS will be prepared with data obtained from the site characterization activities. A more detailed schedule for the baseline risk assessment is given in Figure 35. The first two phases of the FS-EIS will screen technologies and develop and screen alternatives to be evaluated in the third phase of the FS-EIS. Comments on the completed draft RI/FS-EIS will be addressed in the final RI/FS-EIS, which includes the responsiveness summary, following public review. The ROD for the RI/FS-EIS is projected to be issued in April 1991.

- Completion of the quarry bulk waste environmental process. This is described in more detail in Section 6.2.

- Development of design criteria and conceptual design information for remedial action activities at the raffinate pits and chemical plant area. The conceptual design will address location, size, layout, effluent controls, and general concepts of remediation to provide feasibility and comparative information. Remedial action activities at the raffinate pits and chemical plant area will begin in 1991, following issuance of the ROD.

- Treatment of surface water from the raffinate pits and other sources in the raffinate pits and chemical plant area. This treatment will be handled as an IRA and documented through the modified EE/CA process. Support facilities -- including utilities, decontamination station(s), and staging/parking areas -- will be designed and constructed as needed. These activities will be performed concurrently with the RI/FS-EIS process.

- Removal of the quarry bulk wastes. This action will be initiated in 1990 and should be completed by the end of 1992.

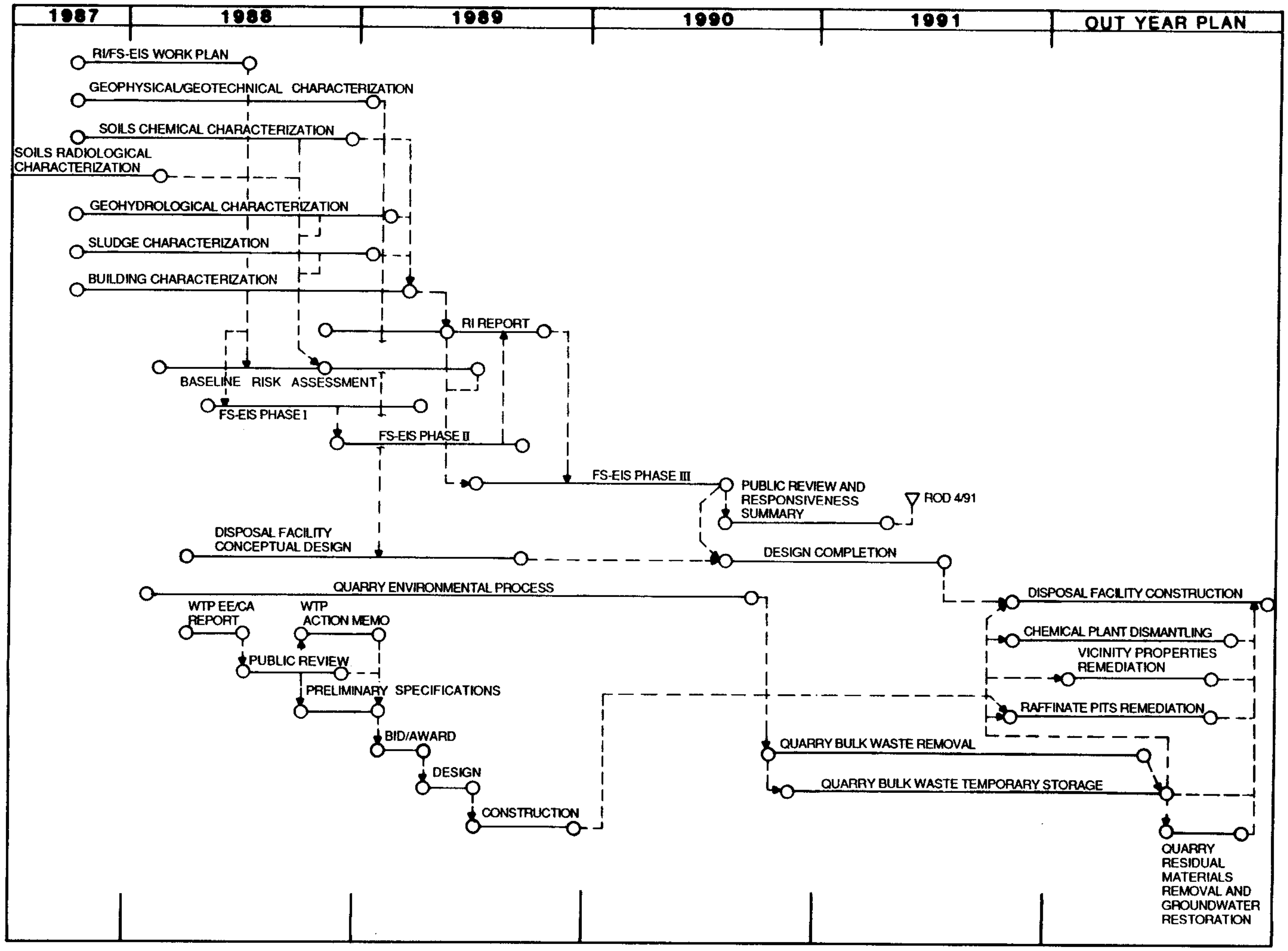


FIGURE 34 Overall Schedule for Completion of the RI/FS-EIS

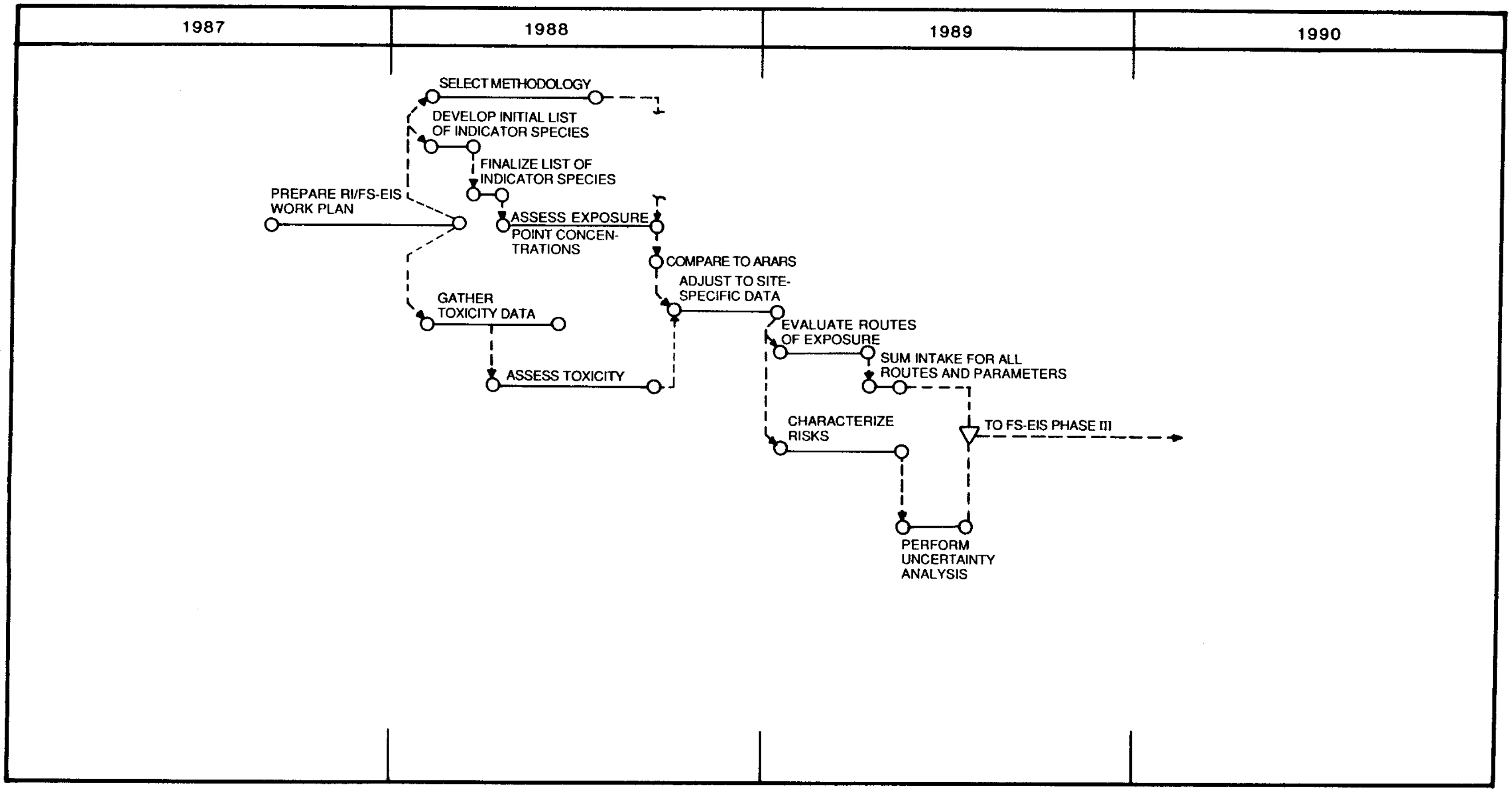


FIGURE 35 Schedule for Completion of the Baseline Risk Assessment

6.2 QUARRY

Removal of the bulk wastes from the quarry is planned to be undertaken as a separate operable unit within this project and to be documented using the RI/FS-EA process (see Section 3.11.2.1). The overall plan for implementation of activities in the quarry is shown in Figure 36. This plan consists of the following elements:

- Completion of an RI/FS for the bulk waste removal action consisting of an RI report, a risk evaluation, and an FS report. The RI/FS process will be completed using existing information on the quarry bulk wastes. Comments on the draft RI/FS will be addressed in the final RI/FS, which includes the responsiveness summary, following public review. The decision document for the RI/FS is projected to be issued in May 1990.

- Completion of an EA for the bulk waste removal action. The first two phases of the FS process will develop and screen alternatives that will be addressed in the EA. This EA, which will address environmental impacts associated with the proposed alternatives, will be issued prior to completion of the FS process.

- Development of the conceptual design for bulk waste removal activities concurrently with preparation of the RI/FS and EA. The conceptual design will include an excavation plan providing for operator controls to minimize the possibility of contaminant release during the excavation process.

- Development of design criteria and conceptual design information for the temporary storage area. The conceptual design will address location, size, layout, water runon/runoff management, and general concepts of the liner and/or cover systems.

- Treatment of the ponded water in the quarry. This treatment will be handled as an IRA and documented through the modified EE/CA process. Support facilities -- including roads/utilities, decontamination station(s), and water retention basins -- will be designed and constructed as needed.

This plan should allow for expedited removal of the bulk quarry wastes beginning in 1990.

It has not yet been determined if any residual material will have to be removed from the quarry following bulk waste removal or if groundwater restoration will be required at the quarry. Therefore, no schedules have been developed for these activities.

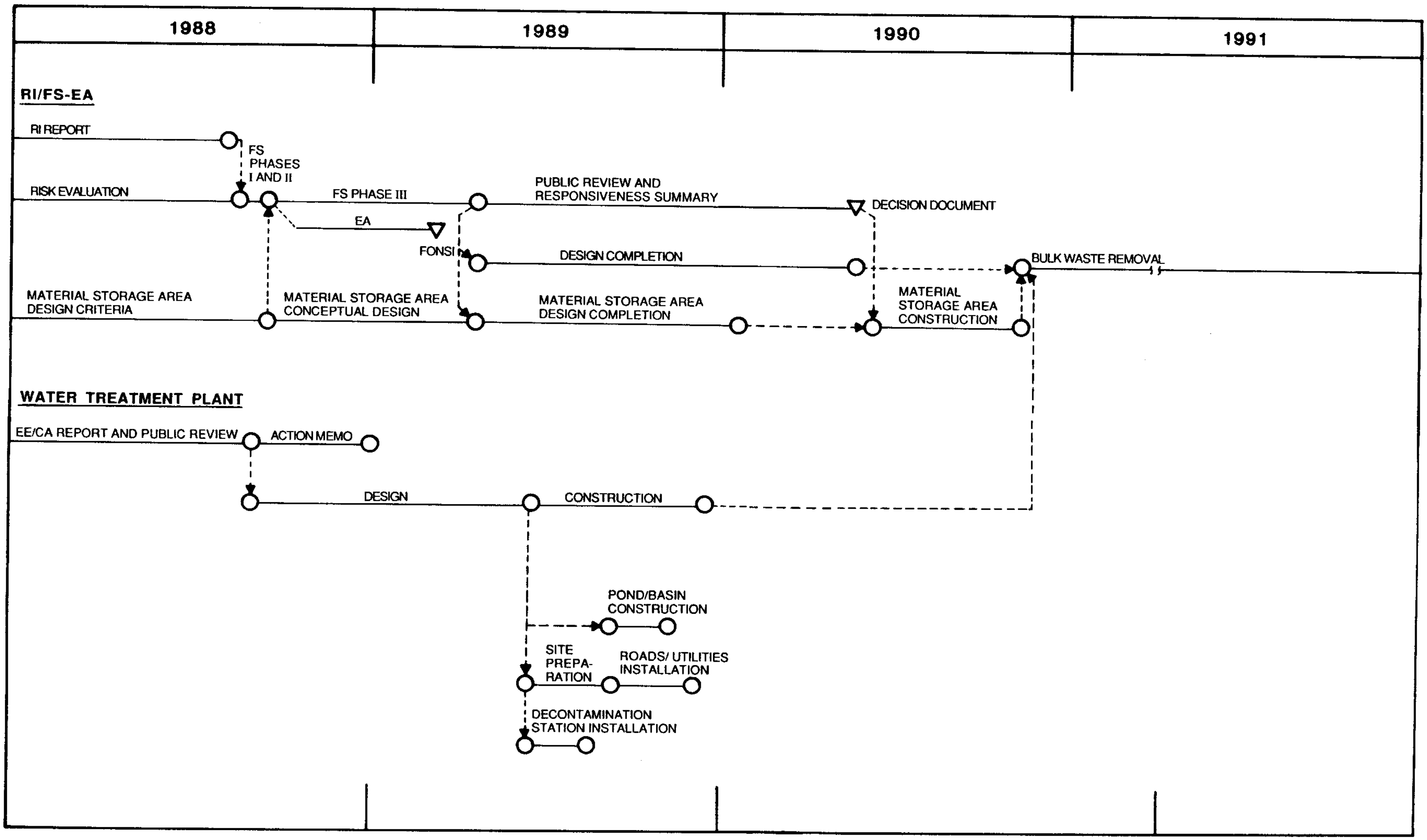


FIGURE 36 Schedule for Completion of the RI/FS-EA Process for Quarry Bulk Waste Removal

7 PROJECT MANAGEMENT

7.1 PROJECT ORGANIZATION

The Weldon Spring Site Remedial Action Project is being conducted by DOE under the SFMP, which is administered by the Division of Facility and Site Decommissioning Projects within the Office of Nuclear Energy (Figure 37). This division is responsible for policy decisions that impact the project and for coordination with the U.S. Department of the Army, which is sharing the cost of this project. The responsibility for management and technical direction of the response action activities has been delegated to the DOE Oak Ridge Operations Office, which has established a project office at the Weldon Spring site. This project office has responsibility for directing the conduct of response actions at the site.

Four separate organizations are under contract to DOE to support implementation of this project:

- MK-Ferguson Company is the project management contractor, assisting DOE in the planning and management of response action activities, and Jacobs Engineering Group, Inc., is under contract to MK-Ferguson to provide technical support for the project.

- Argonne National Laboratory, Energy and Environmental Systems Division, is the NEPA and CERCLA process management contractor and is responsible for directing preparation of appropriate environmental compliance documentation to support specific activities.

- Oak Ridge Associated Universities provides technical support, specifically for independent verification of completed response actions.

- PEER Consultants, Inc., provides administrative support to the DOE project office, and Dames & Moore has been retained by PEER to assist in this capacity.

7.2 PROJECT COORDINATION AND RESPONSIBILITIES

The response actions to be carried out by DOE at the Weldon Spring site are subject to EPA oversight under CERCLA. The oversight function is being carried out by EPA Region VII. The responsibilities of DOE and EPA are defined in the FFA signed in August 1986. This agreement, which was signed prior to the enactment of SARA in October 1986, may need to be revised to incorporate new requirements mandated by SARA. The need for such revisions is being discussed with EPA.

The state of Missouri has designated the Missouri DNR to coordinate state involvement in this project. The DNR is responsible for ensuring that the appropriate

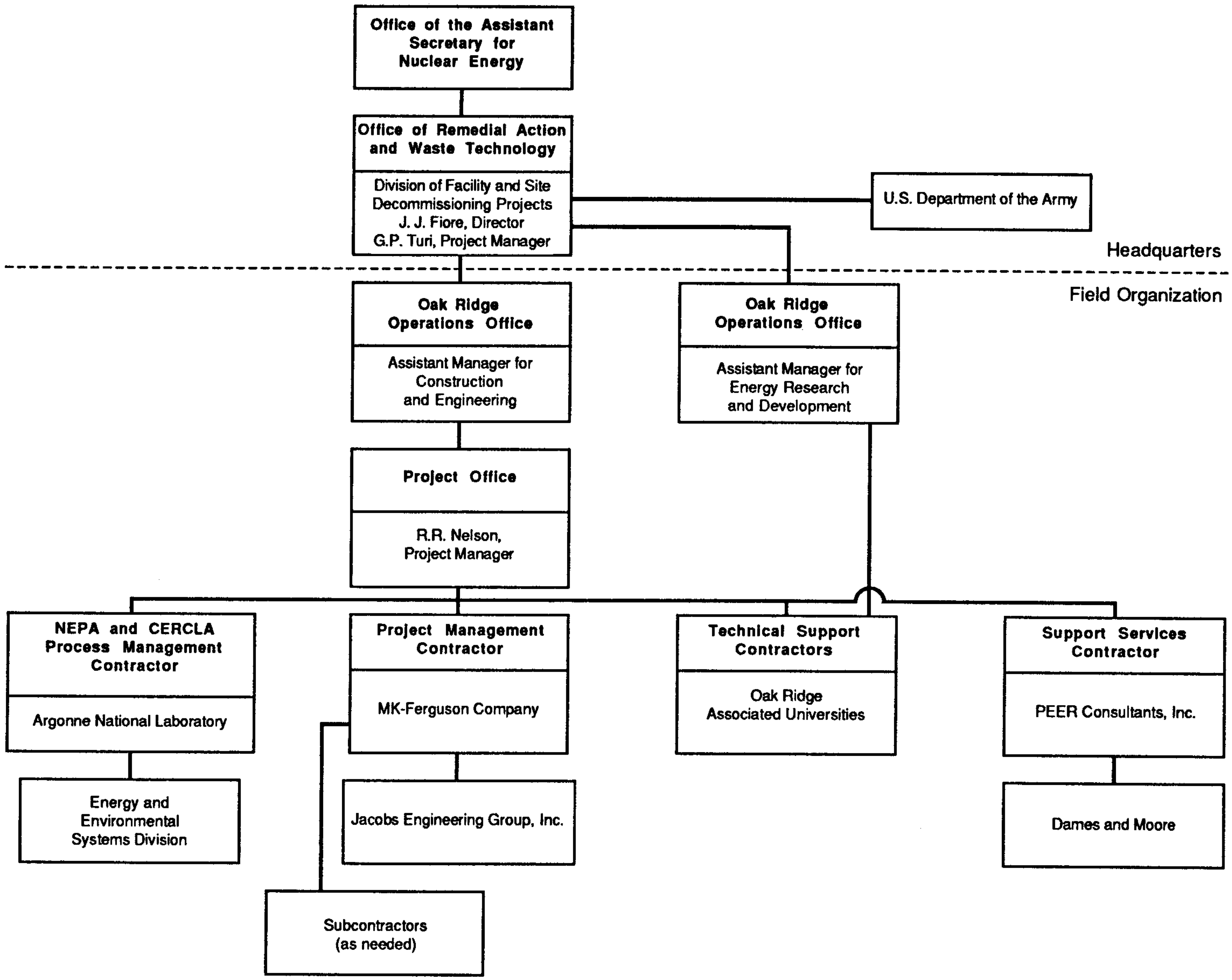


FIGURE 37 Organizational Chart for the Weldon Spring Site Remedial Action Project

state agencies are kept informed regarding project activities and that state concerns are properly reflected in project plans and actions. The relationship between DOE, EPA, and the Missouri DNR -- and the major responsibilities of each -- are shown in Figure 4 (Section 1.3).

The responsibilities of each of the major organizations under contract to DOE at the Weldon Spring site are identified as follows:

- MK-Ferguson Company (including Jacobs Engineering Group, Inc., as a subcontractor)

    - Provide overall project management support to DOE for the Weldon Spring Site Remedial Action Project.

    - Administer procurement and quality assurance functions.

    - Perform general administrative functions.

    - Administer all environmental, safety, and health programs at the site.

    - Direct all engineering activities.

    - Provide technical input to the preparation of environmental documents.

    - Perform community relations duties.

- Argonne National Laboratory, Energy and Environmental Systems Division

    - Perform environmental analyses for the RI/FS-EIS process.

    - Provide an independent analysis of environmental studies, engineering feasibility, and cost-effectiveness of response action alternatives performed by other DOE contractors.

    - Prepare additional environmental compliance documentation as needed.

- Oak Ridge Associated Universities

    - Conduct radiological surveys to identify and designate vicinity properties that require response action.

    - Conduct post-response action radiological surveys to provide an independent verification of the adequacy of cleanup and prepare associated verification reports.

- PEER Consultants, Inc. (including Dames & Moore as a subcontractor)

  - Provide technical and administrative support to the DOE project office.

  - Review environmental documents and advise the DOE project office on regulatory requirements.

  - Review and analyze resources as changes in funding and priorities occur.

  - Assist the DOE Project Office with the preparation and/or analysis of documents and reports for the annual budget process.

7.3 PROJECT CONTROLS

Project controls are implemented to provide detailed planning regarding cost, schedule, and technical performance. In this way, efforts towards achievement of project goals are maximized. A work breakdown structure is used to divide the total project into discrete work packages, thereby establishing the formal work organization and the planning and scheduling structure to permit identification of critical relationships and interdependencies among project tasks. The work breakdown structure also provides the framework for integrating budget requirements with schedule and technical performance. Finally, it establishes the management analysis and reporting structure to permit presentation of data to various levels of management.

Project controls are implemented in accordance with DOE cost and schedule control requirements. This provides a basis for assessing the quality of the cost and schedule controls used by the project participants; aids in ensuring effective planning, management, and control of project work; and provides a quick and effective means of measuring cost, schedule, and technical performance.

A project document control center is maintained at the Weldon Spring site to collect, register, distribute, and retain all documents associated with the project. This includes aerial photographs, topographic maps, reports on features of the site and its surrounding area, correspondence involving the site, findings of previous surveys, and analytical data obtained during site characterization. The types of characterization data that are on file include environmental contaminant data based on analysis of soil, groundwater, and surface water; borehole logging data; air sampling data; and information about geological and soil properties. Well construction data, field notebooks, and other documentation (e.g., chain-of-custody forms) are also on file in the document control center.

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APPENDIX A:

WORK PLAN SUPPLEMENT

APPENDIX A:

WORK PLAN SUPPLEMENT

A.1 BACKGROUND

As part of its Surplus Facilities Management Program (SFMP), the U.S. Department of Energy (DOE) issued a draft environmental impact statement (EIS) in February 1987 to assess the environmental impacts of alternatives for long-term management of contaminated materials associated with remedial action activities at the Weldon Spring site in Weldon Spring, Missouri (U.S. Dept. Energy 1987a). Based on public and technical scoping input, DOE decided to take the "tiered" approach recommended by the Council on Environmental Quality (CEQ) under its regulations for implementing the National Environmental Policy Act (NEPA). The EIS was intended to support the major decisions on cleanup and long-term management of the contaminated materials at the Weldon Spring site, which consists of the raffinate pits and chemical plant area and the quarry, and at contaminated vicinity properties. However, because many of the issues associated with decontamination and decommissioning of the chemical plant were not yet ready for a decision at the time the draft EIS was prepared, cleanup of the chemical plant was to be covered in a separate NEPA document tiered to the EIS.

Ongoing well monitoring at the Weldon Spring site has provided significant new information relevant to environmental concerns at the site that was not available in February 1987 when the draft EIS was published. Results from the Phase I water quality assessment program (U.S. Dept. Energy 1987b) show significant quantities of nitroaromatics, particularly 2,6-dinitrotoluene (2,6-DNT), and high nitrate and sulfate concentrations in the groundwater at the raffinate pits and chemical plant area. In response to these new findings, DOE announced in June 1987 its intent to issue for public comment a revised draft EIS on remedial action at the Weldon Spring site. Since that time, the U.S. Environmental Protection Agency (EPA) Region VII has formally requested that DOE prepare a remedial investigation/feasibility study (RI/FS) for this project, under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA). The DOE and EPA have agreed that the appropriate environmental review required by an RI/FS and an EIS can be accomplished by incorporating those elements required by an EIS into the format of an RI/FS; this integrated document is termed an RI/FS-EIS. This is the process DOE intends to carry out for the Weldon Spring Site Remedial Action Project. This appendix has been written to illustrate the process by which the RI/FS-EIS will be prepared in compliance with DOE regulations for preparation of an EIS, which is necessary because DOE must comply with NEPA regulations for this project.

The DOE has specific procedures for ensuring compliance with NEPA. An EIS implementation plan must be prepared prior to preparation of an EIS to state the procedures DOE intends to use to complete the EIS process. Guidance on the content of an EIS implementation plan is given in the DOE procedures for compliance with NEPA (U.S. Dept. Energy 1987c). Many elements of an EIS implementation plan are similar to those of an RI/FS work plan. This appendix was written to supplement the information given in the main text of the work plan to demonstrate that all of the DOE requirements for an EIS will be met by the proposed environmental compliance process for this project.

A.2 PROPOSED ACTION AND DECISION TO BE MADE

In order for DOE to determine how to manage the contaminated materials at the Weldon Spring site, environmental impacts -- in addition to engineering, cost, and other considerations -- must be factored into the decision. Therefore, in accordance with NEPA and CERCLA, DOE is preparing an RI/FS-EIS to assess and compare the potential environmental impacts of various alternatives for management of the radioactively and chemically contaminated materials at the site and for remediation of contaminated groundwater at the raffinate pits and chemical plant area.

A.3 SUMMARY OF NEPA SCOPING PROCESS

The DOE issued a Notice of Intent in the *Federal Register* on March 2, 1984, announcing its intention to prepare an EIS to assess the environmental impacts of alternatives for disposal of existing radioactively and chemically contaminated materials at the Weldon Spring raffinate pits, chemical plant, vicinity properties, and quarry. In accordance with CEQ regulations and DOE guidelines for implementing NEPA, a scoping process was conducted to determine the alternatives to be analyzed in the EIS, the significant issues to be analyzed in depth, and the issues to be eliminated from further detailed study.

Public input to this scoping process included:

- Presentations at a public meeting held in the Francis Howell High School gymnasium, St. Charles, Missouri, on March 20, 1984, and

- Letters received by DOE regarding the scope of the EIS.

The persons and organizations who provided input during this public scoping process are listed in Table A.1. Considerable input was received from private citizens; organized citizen action groups (particularly the St. Charles Countians Against Hazardous Waste); local, state, and national political representatives; and state government agencies.

Technical input to the scoping process included:

- Preliminary engineering evaluations by Bechtel National, Inc., of several alternatives for disposition of the wastes at the Weldon Spring site;

- Meetings and correspondence between Argonne National Laboratory (ANL) and DOE Oak Ridge Operations Office (DOE-OR) regarding location and conceptual designs for long-term management of the wastes;

TABLE A.1 Participants in the Scoping Process

Oral Comments, Weldon Spring Public Scoping Meeting, March 20, 1984

Kenneth Rothman, Lt. Gov., State of Missouri
Joseph R. Ortwerth, State Representative, 18th District
Richard Roehl, State Representative, 21st District
Fred Lafser, Missouri Department of Natural Resources
Gary Elmestad, Staff Assistant to Congressman Robert A. Young, 2nd District
Fred Dyer, State Senator, 2nd District
John R. Crellin, Missouri Department of Health
Leann Stevens, St. Charles Countians Against Hazardous Waste
Mary A. Halliday, Defiance
Richard M. Green, St. Charles County Administrative Court
Peggy Coppage, St. Charles County Administrative Court
Thomas Glosier, St. Charles County Administrative Court
Meredith Bollmeier, St. Charles Countians Against Hazardous Waste
James Whitley, Missouri Department of Conservation
Dan Bolef, Washington University, St. Louis
Wallace Howe, Missouri Department of Natural Resources, Division of Geology and Land Survey
Pamela Armstrong, League of Women Voters of the St. Charles Area
Bobbie Judge, St. Charles Countians Against Hazardous Waste
Robert M. Wester, R.M. Wester & Associates
Thomas J. Aley, Ozark Underground Laboratory
William T. Rebore, Francis Howell School District
Dominick Ferranto, Jr., St. Peters
Kenneth F. Gronewald, St. Peters
Sandy Tabaka, St. Charles County
Sharon Rogers, Missourians Against Hazardous Waste, Warren County
Kay Drey, University City
Bernard Iffrig, St. Peters Old Town Association

Written Comments

Tom Nash, Columbia Field Office, U.S. Fish and Wildlife Service
Mary A. Halliday, Defiance
Kay Drey, University City
Charles Hajninian, U.S. Environmental Protection Agency, Region VII
Ann Hood, St. Charles Countians Against Hazardous Waste
Aimee Judge, St. Charles
Richard C. Rice, Missouri Emergency Management Agency
Al and Linda Hoenig, St. Peters
Bernard J. Iffrig, St. Peters
Robert A. Young, U.S. Congressman, 2nd District
Fred Dyer, State Senator, 2nd District
Richard O. Olson, Jr., St. Charles Clinic, Inc.
William T. Rebore, Francis Howell School District
Michael V. Garvey, St. Charles

- Meetings, correspondence, and review of alternatives and issues by SFMP program managers at DOE Headquarters (DOE-HQ) and DOE Operations Offices at Oak Ridge, Tennessee (DOE-OR), and Richland, Washington (DOE-RL);

- Preliminary evaluation by ANL and -- in consultation with Missouri state agencies, local government representatives, and members of the St. Charles Countians Against Hazardous Waste -- development of a conceptual design for an additional alternative of a new, above-grade disposal cell at the Weldon Spring site;

- Meetings with Missouri state agencies (e.g., Department of Natural Resources [DNR]) and elected officials; and

- Meetings with EPA Region VII.

The draft EIS was issued in February 1987 based, in part, on the input received during the NEPA scoping process. Many comments were received by DOE regarding the draft EIS, both by letter and at a public hearing held on April 10, 1987, at Hollenbeck Junior High School in Harvester, Missouri. The persons and organizations who provided comments on the draft EIS are listed in Table A.2. Responses to the major issues raised on the draft EIS are given in Appendix B of this work plan. All comments on the draft EIS are being treated as scoping input for the RI/FS-EIS.

A.4 ISSUES TO BE ADDRESSED IN THE RI/FS-EIS

The issues to be addressed in the RI/FS-EIS were developed based upon public and technical input. Some issues deal with potential environmental impacts, whereas others are factors that may influence or be influenced by remedial action activities. The issues have been separated into two categories: (1) primary issues to be analyzed in depth in the RI/FS-EIS and (2) secondary issues to be discussed in less detail.

A.4.1 Primary Issues

The primary issues will be analyzed more extensively than other issues. They are issues that were raised both during the initial scoping process in 1984 and during the public comment period on the draft EIS. Additional data that are being gathered on the radioactive and chemical contamination at the Weldon Spring site will be incorporated in the RI/FS-EIS. The primary issues to be analyzed in the RI/FS-EIS are as follows.

1. Potential radiological impacts

   - On people -- including workers and the general public, individuals and the total population, present and future generations.

TABLE A.2 Commenters on the Draft EIS

Oral Comments, Public Hearing on the Draft EIS, April 10, 1987

Fred Dyer, State Senator, 2nd District
Joseph Ortwerth, State Representative, 18th District
Craig Kilby, State Representative, 21st District
George Dames, State Representative, 17th District
Jane Schmidt, Western District Commissioner, St. Charles County
Nancy Becker, Eastern District Commissioner, St. Charles County
Tom Owens, Alderman, City of St. Peters
Thomas W. Brown, Mayor, City of St. Peters
Fred Brunner (for John Ashcroft, Governor)
Fred Brunner, Missouri Department of Natural Resources
Fred Bronson, St. Charles
John Crellin, Missouri Department of Health
William H. Dieffenbach, Missouri Department of Conservation
Leon Heath, Soil Consultants, Inc.
William Rebore, Francis Howell School District
Carl Johnson, Pierre, S.D.
John Shocklee, Human Rights Office, Archdiocese of St. Louis
Marty Hayden, Eastern Missouri Group, Sierra Club
Ann Hood, Wentzville
Leann Starr, O'Fallon
Bruce Thomas, St. Peters
George A. Behrens, Glendale
Roger Pryor, Coalition for the Environment
Stephen Kauffman, Coalition for the Environment
Michael Garvey, St. Charles
John C. Soucy, Jr., St. Charles
Evalena Wood, St. Charles County
Rao Ayyagari, Lindenwood College, St. Charles
Jack Sanford, St. Charles
Tom Aley, Ozark Underground Laboratory, Protem
Lisa Gruenloh, Francis Howell High School
Stan Pogue, St. Charles (for John Gofman)
Michael Hrdlicka, Francis Howell High School
Terry Mangan, New Melle
Meredith Bollmeier, St. Charles Countians Against Hazardous Waste
Lily Trimble, Coalition for the Environment
George Oliver, Chesterfield
Arlene Sandler, University City
Kay Drey, University City
Rebecca Selove, Community Mental Health Center, St. Charles
Mary Halliday, St. Charles Countians Against Hazardous Waste
Bobbie Judge, St. Charles
Beatrice Buder, Clayton
Byron Clemens, Academy of Mathematics and Science
Katherine McDaniel, St. Louis (for Rex Couture)
Dan Vornberg, Doe Run Company
Martin Pultman, Chesterfield

TABLE A.2 (Cont'd)

Oral Comments, Public Hearing on the Draft EIS, April 10, 1987 (Cont'd)

Lee Swendsen, St. Charles County
Katherine Swendsen, St. Charles County
Lucy P. Clements
Tom Henkey, Francis Howell High School
John Gestrich, St. Louis
David Lobbig, University City (for Lou P. Kimmell)
Marcus Jackman, Francis Howell High School
Daniel Romano, St. Louis

Written Comments

Frederick A. Brunner, Missouri Department of Natural Resources, Jefferson City
Allen W. Hatheway, Department of Geological Engineering, University of Missouri-Rolla
R. Roger Pryor and Stephen E. Kauffman, Coalition for the Environment, St. Louis
Virginia D. VandenBroek, St. Charles
Paul F. Larson, Soil Conservation Service, Columbia
Virgil Aubuchon
Mark and Sharon Cherry, Weldon Spring
Marcia L. Allmon, Marthasville
Cynthia Fels, Defiance
Michael V. Garvey, St. Charles
George A. Behrens, Glendale
Richard O. Olson and Gary J. Meltz, St. Joseph Health Center, St. Charles
Joan Beauchamp, Wentzville
Donna Owens, Harvester
Richard Christensen, St. Louis
Wayne Muri, Missouri Highway and Transportation Commission, Jefferson City
Charles L. Cronin, St. Peters
John C. Villforth, Food and Drug Administration, Rockville, Md.
Robert S. Wilkerson, Federal Emergency Management Agency, Washington, D.C.
John C. Soucy, Jr., St. Joseph Health Center-Hospital West, St. Charles
Harold L. Volkmer, House of Representatives, Washington, D.C.
Stephan G. Heitkamp, Clerk, Board of Trustees, Town of Weldon Spring Heights, St. Charles
Barbara J. Ritchie, Washington Department of Ecology, Olympia
Diane Warmann, St. Charles
Pat Allison, St. Charles
Sydney S. Koegler, Richland, Wash.
Robert G. Harmon, Missouri Department of Health, Jefferson City
Larry R. Gale, Missouri Department of Conservation, Jefferson City
Dean Olson, New Mexico Department of Finance and Administration, Santa Fe
Leann M. Starr, O'Fallon
Dennis Kehoe, Marthasville
Ruby E. Quarterman, St. Charles
Catherine Bell, St. Louis

TABLE A.2 (Cont'd)

Written Comments (Cont'd)

Thomas B. Reth, Department of the Army, Fort Leonard Wood
Ann Hood, Wentzville
Robert J. Toomey, Overland
David M. Cochran, Texas Department of Health, Austin
Margaret C. Burwell, St. Charles
Craig Kilby, Missouri House of Representatives, Jefferson City
Pat Allison, St. Charles
Rao Ayyagari, Lindenwood College, St. Charles
Evalena Wood, St. Charles
Sue Jerman, St. Peters
Robert P. Wuertenberg
Gary T. and Mary A. Callier, St. Charles
Terry M. Millard
Betty Ackermann, St. Charles
Shirley S. Foster, St. Charles County Extension Center, St. Charles
Carole Leriche, St. Charles County Extension Center, St. Charles
Lillie C. Trimble, Parkville
John C. Danforth, U.S. Senate, Washington, D.C.
Steven P. Adams, St. Charles
Mary A. Halliday, St. Charles Countians Against Hazardous Waste, Defiance
Jack C. Sanford, St. Charles
Leon W. Heath, Soil Consultants, Inc., St. Peters
Bobbie Judge, St. Charles
George A. Farhner, St. Charles
Meredith A. Bollmeier, St. Charles
Morris Kay, U.S. Environmental Protection Agency, Kansas City, Kans.
Bruce Blanchard, U.S. Department of the Interior, Washington, D.C.
Pamela J. Fish, St. Peters
Terry Sova, St. Charles
St. Charles County Commission, St. Charles

- On students and staff at nearby Francis Howell High School.
- In terms of both radiation doses and resulting health risks.
- Associated with various pathways to humans -- including soil; surface water and groundwater; gases, dust, and particulates; and the food chain.
- In the vicinity of the Weldon Spring site, along transportation routes, and near any alternative disposal site.
- Associated with both routine operations and accidents, including transportation accidents (using conservative assumptions with regard to potential accidents).
- Associated with off-site migration of radioactive materials.
- Of radionuclide releases due to natural forces such as erosion or seismic activity.
- Associated with human intrusion into the contaminated materials.
- On wildlife in the area.

2. Potential chemical impacts

   - Associated with the same categories as potential radiological impacts, consistent with the state of scientific knowledge regarding the toxicological effects of various chemical species.

3. Potential socioeconomic impacts

   - Associated with current and future uses of land and the St. Charles County well field located southeast of the quarry.
   - On patterns of development and population distribution.

4. Potential engineering and technical issues

   - Reasonable engineering technologies for management of the contaminated materials at the Weldon Spring site. The technologies will be systematically screened to obtain reasonable alternatives for remedial action.
   - Probable duration of isolation of the contaminated materials, and rate and magnitude of loss of containment -- including the ability to monitor and control seepage and contaminant

releases from the containment facility and the ability to repair weaknesses or failures in containment. This analysis will be performed in the context of time frames described in Section A.7.

- Site geology as related to engineering requirements.

- Characterization of the amounts and types of contaminated materials.

- Procedures to remediate contaminated groundwater at the raffinate pits and chemical plant area.

5. Potential geological and hydrological issues

   - Characterization of site-specific geological and hydrological conditions.

   - History of seismic activity in the area and discussion of potential future activity.

   - Potential contamination of groundwater from waste disposal activities and possible mitigative measures. Procedures to clean up current groundwater contamination at the raffinate pits and chemical plant area will also be assessed in the RI/FS-EIS.

6. Potential institutional issues

   - Project-specific criteria for decontamination, effluents, environmental concentrations, and release of a site for unrestricted or restricted uses. Cleanup criteria for radionuclides (e.g., uranium) and for chemical contaminants will be developed in cooperation with EPA Region VII and the state of Missouri, based on an assessment of risks to human health and the environment.

   - Compliance requirements for state and local laws and regulations.

   - Future institutional requirements related to monitoring and maintenance activities.

   - Institutional factors that need to be resolved before an alternative can be implemented.

   - Potential post-action uses of the Weldon Spring site.

7. Potential loss of institutional control

   The list of ARARs to be included in the RI/FS-EIS will detail the institutional framework within which the project will be performed. Although EPA's standards and DOE's proposed remedial activities are based on continued federal ownership and control of the site, uncertainties regarding this issue increase significantly in the long term; it is reasonable to assume that federal control, including maintenance and monitoring, will be lost during the time that these wastes are hazardous. To address the impacts of loss of control (albeit unplanned and distant in time), the RI/FS-EIS will provide a systematic, but essentially qualitative, discussion of the longevity of the various containment systems and the potential failure modes that could lead to dispersal of the wastes and to human exposure following loss of institutional control at the site (including access control, monitoring, and maintenance). These include such possibilities as:

   - Groundwater intrusion and leaching of wastes.
   - Cap failure through cracking or differential settling.
   - Erosion of cover (including gully erosion).
   - Biotic intrusion (e.g., animal burrows and plant roots).
   - Waste saturation and resulting releases.

   The relative importance of these possibilities will be discussed to the extent possible. The estimated impacts to a resident intruder (an individual constructing a residence on the site following loss of access control, eating food from an on-site garden, and drinking water from an on-site well) will be analyzed using an appropriate pathway model. To place this in context, the likelihood of such a scenario will be addressed (qualitatively) in light of factors such as suitability for agriculture. Engineering and institutional measures to reduce the likelihood of loss of containment will be described. These generic descriptions will include a discussion of any differences that might be expected among the various alternatives.

8. Potential issues relative to mitigative measures and monitoring

   - Measures to control dispersion of contaminants to the environment.
   - Long-term monitoring and maintenance needs.
   - Measures that could be taken to reduce impacts under each alternative.

A.4.2 Secondary Issues

Secondary issues are those that were deemed through scoping to be important, but to a lesser degree than primary issues. Secondary issues, which are analyzed in less depth than primary issues, include the following.

1. Potential socioeconomic impacts

   - On current and future local employment and industrial and commercial operations.
   - On local transportation systems.
   - On long-term use of site areas.
   - On local, municipal, and community services and organizations such as schools, government, and citizen action groups.

2. Potential engineering and technical issues

   - Specific maintenance needs.
   - Specific transportation routes, modes, and packaging.
   - Recovery of potentially valuable materials.
   - Effects of catastrophic natural events such as tornadoes, intense rains, droughts, and floods.
   - Methods for controlling surface water runoff from the site during construction.

3. Potential institutional issues

   - Costs of implementing and funding the various alternatives.
   - On-site enforcement of safety standards during remedial action.

4. Miscellaneous issues

   - Commitment or loss of resources (e.g., uranium, thorium, and energy).
   - Worker safety.
   - Site-specific meteorological conditions.
   - Mitigative measures to protect potential cultural resources.

A.5 ISSUES BEYOND THE SCOPE OF THE RI/FS-EIS

The DOE has determined that the following issues are beyond the scope of the RI/FS-EIS.

1. Psychological impacts -- In light of a U.S. Supreme Court case involving the proposed restart of one of the Three Mile Island reactors (Metropolitan Edison Company v. People Against Nuclear Energy [PANE] 103 S. Ct. 1556 [1983]), DOE considers only psychological impacts that bear a close causal relationship to the physical environment in an EIS. Psychological impacts raised to date relative to the Weldon Spring site do not bear such a relationship.

2. Impacts of past operations at the site -- The impacts of the various alternatives on the existing environment will be assessed in the RI/FS-EIS. In the above-mentioned Supreme Court decision, it was stated that "NEPA is not directed at the effects of past accidents and does not create a remedial scheme for past federal actions." Therefore, a detailed analysis of past operations, beyond that necessary to characterize the existing environment, is considered to be beyond the scope of the RI/FS-EIS.

3. Monitoring of health of students and staff at Francis Howell High School -- An ongoing environmental monitoring program is being conducted by DOE in the vicinity of the Weldon Spring site. This program includes the Francis Howell High School area. No additional monitoring studies of students and staff at the Francis Howell High School will be performed as part of the RI/FS-EIS process because the existing environmental monitoring program demonstrates that individuals at the high school are not being exposed to measurable levels of radioactive or chemical contaminants originating from the Weldon Spring site. However, potential health impacts on students and staff will be addressed in the RI/FS-EIS.

4. Excavation, transport, and temporary storage of quarry bulk wastes -- The DOE is proposing to address the removal of the quarry bulk wastes as a separate operable unit and will use the RI/FS-EA process to support this decision (see Section 3.11 of this work plan). This action will include excavation, transport, and temporary storage of the quarry bulk wastes at the raffinate pits and chemical plant area. Implementation of the RI/FS-EA process will be as follows. The first two phases of the FS process will be completed concurrent with preparation of the RI and baseline risk evaluation. At this point, an assessment of environmental impacts will be performed consistent with the requirements of an EA in support of a finding of no significant impact (FONSI), if appropriate. If DOE determines that this action requires preparation of

an EIS, the action will be included within the overall RI/FS-EIS process for the project, and removal of the quarry bulk wastes will not be undertaken prior to issuance of the ROD. Because the EA is scheduled to be completed prior to issuance of the FS, the RI/FS process for this action will be completed only if a FONSI is issued. If an RI/FS for bulk waste removal is completed, DOE and EPA will issue decision documents under CERCLA to document the decision-making process.

5. Removal of residual contamination from the quarry -- After the bulk wastes have been removed from the quarry, the quarry will be inspected to determine if additional remedial action is required. The need for any additional remedial action at the quarry cannot be determined prior to bulk waste removal and inspection of the resultant conditions in the quarry. This issue is therefore beyond the scope of the RI/FS-EIS.

6. Remediation of contaminated groundwater at the quarry -- A decision to remediate contaminated groundwater at the quarry is beyond the scope of the RI/FS-EIS. The DOE is proposing to address the issue of contaminated groundwater remediation following removal of the bulk wastes from the quarry.

7. Other radioactively contaminated sites in the St. Louis area -- EPA Region VII proposed in 1984 that DOE also consider the possibility of cumulative disposal at the Weldon Spring site of the radioactive wastes currently stored at various locations in Missouri. These wastes and their locations are as follows:

   - St. Louis Airport Site (SLAPS) and SLAPS vicinity properties -- previously used for storing ore residues, scrap, and equipment from uranium-processing operations.

   - Latty Avenue Site -- previously used for storing ore residues and wastes from uranium-processing operations.

   - St. Louis Downtown Site -- previously used to process uranium ore or concentrates to produce uranium dioxide, uranium trioxide, uranium tetrafluoride, and uranium metal; the site was also previously used for other activities associated with uranium metal and for extraction and concentration of thorium-230 from pitchblende raffinates.

   - West Lake Landfill -- previously used for disposing of soil from the Latty Avenue site.

The SLAPS, Latty Avenue, and St. Louis Downtown sites are already included in the DOE Formerly Utilized Sites Remedial Action Program; the West Lake Landfill is under cognizance of the U.S. Nuclear Regulatory Commission. In the Congressional conference report that accompanied U.S. Public Law 98-360, DOE was directed to take the necessary steps to consolidate and dispose of the waste materials from the Latty Avenue and SLAPS vicinity properties. The report directed that the materials be disposed of locally by reacquiring, stabilizing, and using SLAPS in a manner acceptable to the city of St. Louis. Plans for disposal of wastes from the St. Louis Downtown site have not yet been formulated. The DOE has no plans to dispose of these wastes at the Weldon Spring site. Therefore, the cumulative impacts from disposal of the wastes from other sites in the St. Louis area at the Weldon Spring site will not be addressed in the RI/FS-EIS.

A.6 RELATED FEDERAL PROJECTS

The DOE has recently prepared EISs for other programs and other sites under its Remedial Action Program, including:

- U.S. Department of Energy, 1983, *Final Environmental Impact Statement, Remedial Actions at the Former Vitro Rare Metals Plant Site, Canonsburg, Washington County, Pennsylvania*, DOE/EIS-0096-F, 2 vol. (July).

- U.S. Department of Energy, 1984, *Final Environmental Impact Statement, Remedial Actions at the Former Vitro Chemical Company Site, South Salt Lake, Salt Lake County, Utah*, DOE/EIS-0099-F, 2 vol. (July).

- U.S. Department of Energy, 1985, *Final Environmental Impact Statement, Remedial Actions at the Former Vanadium Corporation of America Uranium Mill Site, Durango, La Plata County, Colorado*, DOE/EIS-0111F, 2 vol. (Oct.).

- U.S. Department of Energy, 1986, *Final Environmental Impact Statement, Remedial Actions at the Former Climax Uranium Company Uranium Mill Site, Grand Junction, Mesa County, Colorado*, DOE/EIS-0126-F, 2 vol. (Dec.).

- U.S. Department of Energy, 1986, *Final Environmental Impact Statement, Long-Term Management of the Existing Radioactive Wastes and Residues at the Niagara Falls Storage Site*, DOE/EIS-0109F (April).

In addition, the U.S. Nuclear Regulatory Commission and U.S. Environmental Protection Agency have prepared EISs on various related programs, proposed standards, and specific sites, including:

- U.S. Environmental Protection Agency, 1982, *Final Environmental Impact Statement for Remedial Action Standards for Inactive*

Uranium Processing Sites (40 CFR 192), Vols. 1 and 2; EPA 520/4/82-013-1, -2 (Oct.).

- U.S. Nuclear Regulatory Commission, 1983, *Final Environmental Statement Related to the Decommissioning of the Rare Earths Facility, West Chicago, Illinois, Docket No. 40-2061, Kerr-McGee Chemical Corporation*, NUREG-0904 (May).

- U.S. Environmental Protection Agency, 1986, *Final Environmental Impact Statement, Proposed Wastewater Treatment Facilities for Eastern St. Charles County, Missouri, Including: Duckett Creek Sewer District, St. Peters Sewer District, St. Charles Sewer District, Portage de Sioux Sewer District*, EPA 907/9-86-003 (May).

- U.S. Nuclear Regulatory Commission, 1987, *Draft Supplement to the Final Environmental Statement Related to the Decommissioning of the Rare Earths Facility, West Chicago, Illinois, Docket No. 40-2061, Kerr-McGee Chemical Corporation*, NUREG-0904, Supplement No. 1 (June).

A.7 TIME FRAME FOR COMPARATIVE ANALYSIS OF ENVIRONMENTAL IMPACTS

The potential environmental impacts will be analyzed over the following time periods:

- Action period (approximately 10 years) -- the period during which physical actions such as excavation, transportation, and stabilization will take place.

- Long-term period -- the time following the action period during which the disposal site will continue to be controlled. Human access to the disposal area will be limited, and the federal government will continue to own the area and use it solely for waste-disposal purposes. Containment structures will be maintained, any releases to the environment will be monitored, and corrective remedial actions will be taken as necessary. The cumulative impacts over 1,000 years will be assessed in the RI/FS-EIS. In addition, the RI/FS-EIS will describe the impacts that might peak after 1,000 years with continued site control and maintenance. Although the federal government intends to control the site, impacts that might occur if there was loss of institutional control will also be discussed.

The 1,000-year time frame is selected to be consistent with the time frames identified in EPA regulations for management of inactive uranium mill tailings (40 CFR Part 192). In these regulations, EPA identifies "the single most important goal of control to be effective isolation and stabilization of tailings for as long a time period as is reasonably feasible, because tailings will remain hazardous for hundreds of thousands of years." Furthermore, "the longevity of control is governed by the possibility of intrusion by man and erosion by natural forces." After considering several time periods for control, EPA required that "control measures be carried out in a manner that provides reasonable assurance they will last, to the extent reasonably achievable, up to 1,000 years, and, in any case, for a minimum of 200 years." Uncertainties increase significantly beyond 1,000 years and it would not be reasonable to require assurances of control for longer time periods.

The naturally occurring radionuclides found in uranium mill tailings (principally the uranium-238 decay series) constitute the bulk of radioactivity in the Weldon Spring wastes. Because the 1,000-year time period has been deemed to be a reasonable basis for EPA's decisions regarding inactive uranium mill tailings and because it should also be adequate for addressing potential chemical impacts, DOE considers this time period to be a reasonable reference point for analyzing environmental impacts in the RI/FS-EIS to support DOE's decision on management of the contaminated materials at the Weldon Spring site.

A.8 COORDINATION OF NEPA AND CERCLA REQUIREMENTS

The response actions to be carried out by DOE at the Weldon Spring site are subject to EPA oversight under CERCLA. For this project, the oversight function is being carried out by EPA Region VII. The Weldon Spring Site Remedial Action Project can be described as consisting of seven separate environmental compliance components (see Section 1.2). The three major actions currently envisioned for the raffinate pits and chemical plant area are (1) management of the contaminated surface structures, raffinate pit wastes, surface water, and soils; (2) assessment of the need to restore contaminated groundwater; and (3) cleanup of contaminated vicinity properties. These three actions will be addressed in the RI/FS-EIS and supported by a single response decision. This decision will also include disposition of the bulk wastes currently in the quarry. The RI/FS-EIS to support the decision will be prepared in a format that provides the level of detail required by both NEPA and CERCLA, so that separate documentation for each act will not be required. This approach is intended to result in a single ROD by DOE and EPA. It is possible that the groundwater restoration issue will be ready for a decision at a different time than the waste disposal issue. If this is the case, DOE may handle groundwater restoration as a separate operable unit to satisfy the requirements of NEPA and CERCLA for this decision.

Four distinct response actions may be required at the quarry: bulk waste removal, removal of any residual materials following bulk waste removal, groundwater restoration, and cleanup of contaminated vicinity properties. The DOE is proposing to address removal of the quarry bulk wastes as a separate operable unit and will use the RI/FS-EA process to support this decision. This action is scheduled to occur prior to the ROD for the project. The procedure for implementation of the RI/FS-EA process is given in Item 4 of Section A.5.

The other two environmental compliance areas for the Weldon Spring project (i.e., residual material removal and groundwater restoration at the quarry) are not ready for assessment at this time. The appropriate level of environmental review will be determined as sufficient data become available to reach an informed decision. The DOE will involve EPA Region VII and the Missouri DNR in its determination regarding the need for response actions in these areas.

Prior to issuance of the ROD for the waste disposal action, various expedited response actions, i.e., interim response actions (IRAs), will be performed to mitigate actual or potential uncontrolled releases of radioactively or chemically hazardous substances to the environment. The scope of the IRAs will be limited to those actions that can be performed under CERCLA and within the constraints of CEQ regulations for NEPA (i.e., actions will be limited to those that do not have adverse environmental impacts or limit the choice of reasonable alternative for the ultimate disposition of the site). The environmental compliance process for the IRAs, developed to ensure compliance with NEPA and CERCLA, is described in Section 3.10.1 of this work plan.

A.9 TENTATIVE OUTLINE OF THE FS-EIS COMPONENT OF THE RI/FS-EIS

A tentative outline of the FS-EIS component of the RI/FS-EIS is given in Table A.3. This outline was developed by integrating those elements required by an EIS into the format recommended for an FS.

A.10 CONTRACTOR RELATIONSHIPS IN PREPARATION OF THE RI/FS-EIS

The DOE-OR has been delegated responsibility and authority for field management of the Weldon Spring Site Remedial Action Project; DOE-OR has established a project office at the Weldon Spring site (DOE-WSS). The DOE-WSS has responsibility for implementing the conduct of response action activities and also has functional responsibility for preparation of the RI/FS-EIS. The DOE-HQ will approve publication of the RI/FS-EIS.

MK-Ferguson Company is the project management contractor for response action activities at the Weldon Spring site. Jacobs Engineering Group, Inc., is under contract to MK-Ferguson Company to provide technical support for the project. The project management contractor will collect all necessary environmental data and perform requisite engineering and monetary cost studies to support the analyses given in the RI/FS-EIS. The project management contractor will oversee preparation of the RI.

The Energy and Environmental Systems Division of ANL will perform environmental analyses for the RI/FS-EIS process under contract to DOE-WSS and will oversee preparation of the FS-EIS phase of the RI/FS-EIS process. As part of this process, ANL will provide an independent analysis of the environmental studies, engineering feasibility, and cost-effectiveness of alternatives for remedial action at the Weldon Spring site performed by other DOE contractors. These environmental analyses will be performed using information supplied by the project management contractor and supplementing such information, as necessary, by site visits, meetings and consultations with other agencies, and review of existing documents.

TABLE A.3 Tentative Outline for the FS-EIS for Remedial Action at t e Weldon Spring Site

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Executive Summary

1 Introduction

   1.1 Site Background
   1.2 Nature and Extent of Problems
   1.3 Justification of Need for Proposed Action
   1.4 Objectives of Remedial Action
   1.5 Scoping
   1.6 Related Federal Projects
   1.7 Consultation with Other Agencies

2 Development of Remedial Action Alternatives

   2.1 Definition of Remedial Action Objectives
   2.2 Identification of Potential Technologies
   2.3 Definition of Technical Evaluation Criteria
   2.4 Identification of ARARs and Acceptable Exposure Levels
   2.5 Technologies Screening
   2.6 Assembly of Technologies into Remedial Action Alternatives
      2.6.1 No Action
      2.6.2 Alternative 2
      • •
      • •
      • •
      2.6.n Alternative n

3 Initial Evaluation and Screening of Alternatives

   3.1 Definition of Screening Criteria (effectiveness, implementability, and cost)
   3.2 Screening of Alternatives

4 Detailed Analysis of Screened Alternatives (short- and long-term impacts)

   4.1 Effectiveness
      4.1.1 Protectiveness of Human Health and the Environment (including reliability and compliance with ARARs)
      4.1.2 Reduction of Waste Toxicity, Mobility, and/or Volume
   4.2 Implementability
      4.2.1 Resource Availability (including services and capacities, equipment, and personnel)
      4.2.2 Technical and Administrative Feasibility (including performance; ability to operate, monitor, and maintain; reliability; and compliance with ARARs)
      4.2.3 Institutional Issues (including compliance with ARARs and impacts of potential loss of institutional control)

TABLE A.3 (Cont'd)

- 4.3 Cost
  - 4.3.1 Estimation of Operation and Maintenance Costs and Capital Costs (direct/indirect)
  - 4.3.2 Present Worth Analysis
- 4.4 Sensitivity Analysis (effectiveness, implementability, and cost)
- 4.5 Comparative Analysis (relative performance of each alternative)
- 4.6 Environmental Consequences
  - 4.6.1 Radiological Impacts
  - 4.6.2 Chemical Impacts
  - 4.6.3 Soils and Geology
  - 4.6.4 Water Resources
  - 4.6.5 Ecology
  - 4.6.6 Air Quality
  - 4.6.7 Socioeconomics
  - 4.6.8 Historical and Archeological Issues
  - 4.6.9 Institutional Issues
- 4.7 Potential Loss of Institutional Control
- 4.8 Cumulative Impacts
- 4.9 Mitigative Measures
- 4.10 Unavoidable Adverse Impacts
- 4.11 Irreversible and Irretrievable Commitment of Resources
- 4.12 Short-Term Uses and Long-Term Productivity

5 Summary of Alternatives

6 Recommended Remedial Action (optional)

7 Responsiveness Summary (final only)

8 References

Appendixes

A.11 PAGE LIMIT TARGETS

Because the RI/FS-EIS will address several complex alternatives and issues, it is anticipated that it will be longer than the CEQ-recommended page limit of 150 pages for an EIS but less than the recommended maximum of 300 pages. Supporting information will be included in appendixes and stand-alone documents to minimize the length of the RI/FS-EIS to that necessary to support the ROD. A preliminary outline for the FS-EIS component of the RI/FS-EIS is given in Table A.3.

A.12 TARGET DATES FOR FS-EIS PREPARATION

A schedule for preparation of the RI/FS-EIS is given in Section 6 of this work plan. The target dates for the RI/FS-EIS given below are extracted from the more detailed schedule shown in Figure 34.

Activity	Date
RI/FS-EIS work plan issued	August 1988
Draft RI/FS-EIS issued	July 1990
End of public comment period	September 1990
Final RI/FS-EIS issued	March 1991
Record of decision issued	April 1991

A.13 REFERENCES

U.S. Department of Energy, 1987a, *Draft Environmental Impact Statement, Remedial Action at the Weldon Spring Site*, DOE/EIS-0117D, Office of Remedial Action and Waste Technology (Feb.).

U.S. Department of Energy, 1987b, *Water Quality Phase I Assessment*, DOE/OR/21548-003, prepared by MK-Ferguson Company, St. Charles, Mo., for Oak Ridge Operations, Weldon Spring Site Remedial Action Project Office, St. Charles, Mo. (Dec.).

U.S. Department of Energy, 1987c, *Compliance with the National Environmental Policy Act (NEPA); Amendments to the DOE NEPA Guidelines*, Federal Register, *52*(240):47662-47669 (Tuesday, Dec. 15).

APPENDIX B:

RESPONSES TO MAJOR ISSUES RAISED IN COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

APPENDIX B

RESPONSES TO MAJOR ISSUES RAISED IN PUBLIC COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

The draft environmental impact statement (EIS) for remedial action at the Weldon Spring site, Weldon Spring, Missouri, was issued by the U.S. Department of Energy (DOE) in February 1987. A public comment period followed issuance, as mandated by the Council on Environmental Quality regulations for implementing the procedural provisions of the National Environmental Policy Act (NEPA) (40 CFR Part 1503.1). As part of the public review process, a public hearing was held on April 10, 1987, at Hollenbeck Junior High School in Harvester, Missouri. Comments on the draft EIS were provided orally at the public hearing, in written material provided to DOE at the public hearing, and in individual letters sent to the DOE Weldon Spring Site Project Office. The names of individuals who provided comments on the draft EIS are listed in Appendix A, Table A.2. These comments are available for inspection at the project office during normal business hours.

The Weldon Spring quarry was listed on the National Priorities List of the U.S. Environmental Protection Agency (EPA) on July 30, 1987. On June 24, 1988, EPA proposed to expand the designation to include the raffinate pits and chemical plant area. This designation, along with promulgation of the Superfund Amendments and Reauthorization Act (SARA) in October 1986, has significantly altered the environmental compliance documentation process required to support the Weldon Spring Site Remedial Action Project. In conjunction with the EPA Region VII and the Missouri Department of Natural Resources (DNR), DOE has agreed that the appropriate environmental review for this project can be most expeditiously performed by incorporating those elements required by an EIS into the framework of the remedial investigation/feasibility study (RI/FS) process for remedial actions conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). This integrated process is termed the RI/FS-EIS process.

This appendix has been prepared to address the major issues identified in comments on the draft EIS. These issues have been summarized from the various oral and written comments received during the comment period. The intent of the responses to these major issues is to illustrate the manner in which the issues will be addressed in the RI/FS-EIS process. A draft RI/FS-EIS will be issued for public review, and any significant issues concerning the draft RI/FS-EIS will be addressed in a responsiveness summary. A final RI/FS-EIS, including the responsiveness summary, will be prepared prior to issuance of the record of decision (ROD) for this project.

The major issues identified in comments on the draft EIS have been divided into five categories as follows:

1. Compliance with NEPA and CERCLA,

2. Engineering considerations,

3. Site characterization and suitability,

4. Environmental impacts, and

5. Scope and conduct of remedial action activities.

The comments and responses for these issues are presented in Sections B.1 through B.5, respectively. The issues are numbered consecutively through the five sections.

B.1 COMPLIANCE WITH NEPA AND CERCLA

B.1.1 Issue 1

Comment: The draft EIS does not have sufficient detail to allow for meaningful comment by the public. A supplement to the draft EIS should be issued for public comment. Additionally, the draft EIS does not adequately incorporate the RI/FS process under CERCLA as required by the Federal Facility Agreement (FFA) for this project.

Response: Since issuance of the draft EIS, EPA Region VII has formally requested that DOE prepare an RI/FS for this project. The DOE has committed to comply with this request. The RI/FS will be modified to include those elements of an EIS not typically contained in an RI/FS. A tentative outline for the FS-EIS component of the RI/FS-EIS is given in Appendix A, Table A.3. The RI/FS-EIS will not be issued for public comment until all site characterization activities have been completed. Hence, much more detail will be included in the RI/FS-EIS when issued for public comment than was included in the draft EIS.

B.1.2 Issue 2

Comment: The information contained in the draft EIS is too general to allow for meaningful estimation of the environmental impacts that may occur. Estimation of environmental impacts should be based on site-specific information and not national figures or hypothetical computations. The draft EIS, therefore, does not comply with NEPA regulations.

Response: Estimation of environmental impacts in the draft EIS was based on available information at the time the document was prepared. Assumptions were made for information that was not available. Because DOE will now be preparing an RI/FS-EIS, sufficient site-specific information will be available to allow for detailed estimation of environmental impacts. (See also Response to Issue 1, Section B.1.1.)

B.1.3 Issue 3

Comment: The draft EIS does not present sufficient details on the various alternatives. The draft EIS should analyze the impact of all significant and reasonable alternatives, including combinations of design features. The alternatives presented in the draft EIS do not allow for assessment of all reasonable combinations.

Response: The procedure for developing alternatives in the RI/FS process will be used in the RI/FS-EIS. In this process, remedial action objectives are determined on the basis of existing site information regarding the nature and extent of contamination, along with potentially applicable or relevant and appropriate requirements (ARARs) and risk factors. Technologies are then screened to identify those that would be effective for the contaminants present at the site, taking into account the environmental setting of the site. Information developed for these two activities will be used to develop alternatives for assessment in the RI/FS-EIS. This approach will allow a systematic evaluation of various design features, and combinations of design features, in developing the alternatives.

B.1.4 Issue 4

Comment: The draft EIS ignored many issues brought up at the 1984 EIS scoping meeting. All of the issues brought up at that meeting, as well as those identified in comments on the draft EIS, should be addressed prior to the ROD.

Response: Issues raised at a public scoping meeting are one source of input considered in determining the scope of an EIS. Other sources of input include engineering feasibility; consultation with local, state, and federal officials; consultation with other federal agencies; and DOE policies and procedures. All issues raised at a public scoping meeting are considered in determining the scope of an EIS. However, if it is determined that an issue raised during scoping is not significant relative to the decision to be made, its inclusion in the EIS is not warranted. The DOE will reexamine all issues raised during the 1984 scoping process, as well as those raised on the draft EIS, to ensure that all significant issues are evaluated in the RI/FS-EIS.

B.1.5 Issue 5

Comment: Additional details should be provided on the "Nearby Site" as presented in the draft EIS. Potential use of the Callaway Nuclear Power Plant site should be addressed in this regard because this site will be contaminated into perpetuity. Without detailed information on the specific site to be addressed, it is impossible for an accurate comparative analysis to be performed.

Response: Under Alternative 3b in the draft EIS, the wastes are assumed to be transported to a "Nearby Site" in Missouri, within 160 km (100 mi) of the Weldon Spring site. The "Nearby Site" would be chosen to have more favorable conditions (e.g., thicker clay, lower hydraulic conductivity, deeper groundwater table, and/or higher sorption capacity) than the Weldon Spring site. This assessment was included to provide information on the feasibility of developing such a disposal site for the Weldon Spring wastes. The DOE did not undertake a detailed site-selection process to identify alternative disposal sites for wastes resulting from the Weldon Spring project in support of the draft

EIS, nor is such a detailed evaluation planned for the RI/FS-EIS. The DOE will consider the feasibility of a generic site within 160 km (100 mi) of the Weldon Spring site in the RI/FS-EIS. The use of this generic site will be analyzed according to the three screening criteria, i.e., effectiveness, implementability, and cost. Only if use of this generic site survives the screening evaluation and/or if the on-site disposal alternative is determined to be infeasible will DOE initiate off-site characterization studies as part of the post-screening investigations. It is incorrect to conclude that the Callaway Nuclear Power Plant site will be radioactively contaminated into perpetuity. Techniques for decontamination of equipment, structures, and soil are available to allow for this site to be returned to nonnuclear uses following its active lifetime.

B.1.6 Issue 6

Comment: The DOE is currently conducting geological studies at the Weldon Spring site to evaluate its suitability for waste disposal. Similar studies are not being conducted at other potential disposal sites. Not conducting such studies at alternative disposal sites could bias the decision-making process in favor of on-site disposal.

Response: A rather significant data base is needed for meaningful assessment of environmental impacts to support the RI/FS-EIS process. Data are currently being collected at the Weldon Spring site to support this process. This data-collecting process is necessary to allow for an informed assessment of current, and possibly future, environmental conditions (e.g., contaminant migration pathways). The DOE does not believe that it is necessary to perform such geological studies at other potential disposal sites at this time. (See also Response to Issue 5, Section B.1.5.)

B.1.7 Issue 7

Comment: The draft EIS should address all aspects of this project so that the full magnitude of environmental impacts is presented. Specific plans for decontaminating the buildings at the chemical plant area and the associated environmental impacts should be included in the EIS. It is not appropriate, under NEPA, to address this issue in a tiered document.

Response: When work was initiated on the draft EIS, the chemical plant area was under jurisdiction of the U.S. Department of the Army, and there was no indication at that time regarding the manner in which the Army intended to deal with this facility. Custody of the chemical plant area was transferred to DOE in October 1985. Because DOE was already in the process of preparing the draft EIS for long-term management of the contaminated materials located at the raffinate pits, quarry, and vicinity properties, DOE decided to include the impacts of disposing of the chemical plant wastes in the draft EIS. However, because characterization data to allow for assessment of the environmental impacts associated with decontamination and decommissioning of the chemical plant area were not available, inclusion of such data in the draft EIS would have unduly delayed issuance of the document. Therefore, DOE decided to implement the tiering concept for NEPA compliance. This is an acceptable use of tiering because the main issue discussed in the draft EIS is waste disposal and the means by which the wastes are obtained from site-specific actions is a comparatively minor issue. It should be noted that decontamination and decommissioning of nonprocess buildings will be addressed as interim response actions (IRAs) for this project, as discussed in Section 3.10.2.14 of this work plan. Documentation of the proposed IRAs will be made available to the public prior to initiation of such actions. Decontamination and decommissioning of process buildings will be included in the RI/FS-EIS.

B.1.8 Issue 8

Comment: The draft EIS excluded issues from discussion that are essential to an informed decision. Additionally, not all pertinent information is included in the draft EIS, but only that information that supports DOE's preferred alternative. Therefore, the draft EIS does not comply with NEPA.

Response: The issues addressed in the draft EIS were those determined to be relevant to the decision to be made. All available information was reviewed for appropriateness relative to the analyses provided in the draft EIS. The DOE will reconsider all available information in preparation of the RI/FS-EIS, including those specific references cited in comments on the draft EIS. The DOE is currently in the process of conducting a thorough site characterization program. The results of this program will be included in the RI report and will allow for detailed estimation of environmental impacts.

B.2 ENGINEERING CONSIDERATIONS

B.2.1 Issue 9

Comment: The location of the disposal facility for the on-site alternative should be shown. The geology of the raffinate pits and chemical plant area is complex and variable. An assessment of the feasibility of on-site disposal cannot be made without knowing the exact location of the proposed containment cell.

Response: Existing borings and surface geophysical investigations have adequately characterized the unconsolidated and upper bedrock strata. Geotechnical and geophysical investigations to be conducted in the immediate future will extend our knowledge of the unconsolidated geology and the upper 60 m (200 ft) of the bedrock. These investigations will characterize the on-site areas capable of supporting a disposal facility. Results of these investigations will be discussed in the draft RI/FS-EIS issued for public comment.

B.2.2 Issue 10

Comment: The disposal facility must be designed to withstand natural forces (e.g., freeze-thaw cycles, differential settling and slumping, cracking of the cover in dry weather, burrowing animals, and vegetative root systems). The disposal facility must also be designed to maintain its integrity against severe natural phenomena (e.g., seismic events, floods, tornadoes, heavy precipitation, water and wind erosion, and drought). A suitably designed leachate collection and monitoring system should be an integral component of cell design. A passive leachate collection system should be considered. The long-term stability of this facility must be guaranteed.

Response: The DOE is currently developing generic criteria for containment cell design. These criteria will include provisions to prevent contaminant migration as a result of natural forces and severe natural phenomena. The DOE is also evaluating the use of a leachate collection and monitoring system at this time. Such a system, if deemed appropriate, must be properly designed to ensure that it does not become a mechanism for contaminant release in the future. The DOE concurs with the need to guarantee the long-term stability of a disposal facility, wherever it is located. It should be noted that DOE is committed to monitor and maintain the disposal site for the foreseeable future.

B.2.3 Issue 11

Comment: Treatment of the wastes to reduce the potential for off-site migration should be addressed in greater detail. Special emphasis should be placed on those treatments that reduce the volume of wastes, result in recovery of usable materials, significantly reduce contaminant mobility, or result in permanent solutions.

Response: One of the first steps in the RI/FS-EIS process will be to evaluate treatment technologies for applicability to the Weldon Spring wastes (see also Response to Issue 3, Section B.1.3). These technologies will be evaluated for the parameters suggested in this comment. The DOE is currently planning numerous feasibility studies for this project (see Section 3.9 of this work plan). Additional studies may be performed as the project proceeds, pending the results of the RI phase, the development of new technologies, and the results of studies currently planned.

B.2.4 Issue 12

Comment: Various chemical species from the waste materials will be present in leachate, such as acids, organic solvents, and hexane. The effects of these chemicals on the underlying clay layer should be investigated to ensure adequate containment over long periods of time. Certain chemical species can greatly reduce the ion-exchange capabilities of clay liners. The feasibility of using synthetic geomembrane liners should be considered.

Response: The ion-exchange capabilities of clay can be greatly degraded by chemical species such as organic solvents. Tests will be performed on the wastes to determine the chemical characteristics of any leachate that may form. The feasibility of synthetic liners will also be assessed. Any containment cell would be designed to ensure that leachate would not degrade the selected liner to the extent that the liner could not adequately confine radioactive and chemical contaminants. Substances that are contaminated only with hazardous chemicals -- with no associated radiological hazard -- will not be disposed of on-site. All such wastes will be sent for treatment or disposal to a hazardous waste facility (licensed according to requirements of the Resource Conservation and Recovery Act [RCRA]).

B.2.5 Issue 13

Comment: The draft EIS should describe in detail how contaminated water will be treated prior to disposal.

Response: The DOE is currently evaluating methods for treating the contaminated water at the raffinate pits and chemical plant area and the quarry prior to discharge. Treatment of the water is essential to the implementation of any remedial action alternative. These actions are currently being planned as IRAs (see Sections 3.10.2.15 and 3.10.2.16 of this work plan). The methods for treating the water will be detailed in engineering evaluation/cost analysis (EE/CA) reports that will be prepared to support these actions. These EE/CA reports will include an assessment of potential environmental impacts associated with water treatment alternatives. The EE/CA reports will be expanded and additional documents will be prepared, as necessary, to meet the requirements of NEPA. The DOE has consulted, and will continue to consult, EPA Region VII and the Missouri DNR regarding this issue. The public will also have the opportunity provide input on this topic.

B.2.6 Issue 14

Comment: Long-term protection of groundwater can best be guaranteed by above-grade disposal in which a synthetic membrane liner is used at the bottom of the containment cell. The 25- to 30-year lifetime of such a liner, as stated in the draft EIS, may be too short. A leachate collection and monitoring system is essential to preventing contaminant migration to groundwater.

Response: The DOE concurs that groundwater protection is an essential component of any waste disposal system. There are several means by which this goal could be accomplished. An alternative to collecting infiltrate and leachate from the wastes (such as the use of a bottom liner and leachate collection system) would be to dispose of the wastes in a manner that water is prevented from reaching the contained wastes (e.g., by use of a very impermeable cap) so that leachate is not generated. Even though the lifetime of a synthetic membrane can be longer than 25 to 30 years when not exposed to ultraviolet radiation from the sun (up to 100 to 200 years), its lifetime is very short compared to the half-lives of the radionuclides controlling the hazard of the Weldon Spring wastes. The DOE is currently evaluating various disposal system designs that would provide groundwater protection.

B.2.7 Issue 15

Comment: The disposal cell cap should be thick enough to prevent the migration of radon-222 gas into the environment. In addition, although using a lead sheet in the cover may be technically feasible, there seem to be more disadvantages than advantages with regard to this design. The draft EIS indicates that the edge of the cover will have a slope of 20%. This slope seems excessive and could lead to slumping and increased erosion.

Response: The DOE is currently in the process of developing generic criteria for containment cell design. These criteria will lay the foundation from which various disposal cell designs could be developed and evaluated. The concerns raised in this issue will be addressed in the design criteria document. Adequate confinement of radon-222 gas is obviously required because the inventory of radium-226 (the immediate precursor of radon-222) will continue to increase for several thousand years. The use of a lead sheet in the cover, which was included in the draft EIS as a result of input obtained during the scoping process, will be reevaluated in the RI/FS-EIS. The 20% slope at the edge of the cover has been used at other sites with no apparent difficulties (e.g., the Niagara Falls Storage Site). The design of a containment cell has not yet been completed. Conceptual design information will be included in the draft RI/FS-EIS issued for public comment.

B.2.8 Issue 16

Comment: Performance standards and goals for waste confinement should be identified prior to the initiation of remedial action (i.e., regarding restricted versus unrestricted future use of the site and the potential for subsequent remedial action). It is not possible to evaluate the acceptability of the various alternatives without such performance standards.

Response: Performance standards will be developed as part of the ARAR process for the RI/FS-EIS (see Section 3.1 of this work plan). Any containment facility, whether on-site or off-site, would be designed to ensure conformance to these standards. The development and operation of an area as a disposal site would preclude its unrestricted use but not the implementation of subsequent remedial action.

B.2.9 Issue 17

Comment: The draft EIS refers to monitoring and inspecting the containment system following completion of remedial action. This is an important component of ensuring that the containment cell is performing as planned. The frequency and length of time DOE is planning to conduct monitoring, inspection, and corrective activities (as needed) must be defined. The parameters to be monitored and the party responsible for monitoring should also be identified.

Response: The DOE is committed to monitoring and maintaining the disposal site for the foreseeable future. It is premature to precisely define the parameters and the frequency with which monitoring and inspection should occur because a location for the disposal cell has not yet been identified and the disposal cell design has not been completed. Some systems may require more frequent inspections than others. At a minimum, inspections would occur annually. More frequent inspections (e.g., quarterly) would be expected in the near term to verify the adequacy of the containment system performance.

B.2.10 Issue 18

Comment: The disposal cell should not be located in an area overlying contaminated groundwater. Otherwise, it will be impossible to monitor the performance of the disposal facility because there are no means to differentiate between current contamination and that resulting from migration of contaminants from the disposal cell.

Response: The DOE is currently evaluating the effect of groundwater contamination at the raffinate pits and chemical plant area on the ability to dispose of wastes in that area. A decision to dispose of wastes above contaminated groundwater in that area will not be made unless it can be demonstrated that either (1) remediation of the groundwater is not needed or (2) groundwater remediation can be performed without impairing the integrity of an on-site disposal facility. Disposal cell performance could be monitored by means other than environmental sampling of the contaminants currently in the groundwater. For example, different indicator species could be monitored or a leachate collection and monitoring system could be used.

B.2.11 Issue 19

Comment: The draft EIS should discuss the need for restoration of the contaminated groundwater at the Weldon Spring site. At a minimum, it should discuss mitigative measures that will be used to reduce or prevent further migration of chemical or radioactive contamination in groundwater.

Response: Insufficient data were available at the time the draft EIS was prepared to address the need for restoration of contaminated groundwater. The baseline risk assessment to be performed as part of the RI/FS-EIS process for this project will evaluate the current hazards posed by the contaminated groundwater at the raffinate pits and chemical plant area. This information will be used in assessing the need for groundwater restoration. The DOE is currently evaluating the mechanisms responsible for groundwater contamination at the raffinate pits and chemical plant area and is developing plans to ensure the safety of nearby potable water supplies. The need for groundwater restoration at the quarry will be addressed following removal of the bulk wastes.

B.2.12 Issue 20

Comment: The technology to isolate the wastes from the environment for the length of time that the wastes will be hazardous does not exist. Considering the half-lives of the radionuclides in the Weldon Spring wastes, the design life of 200 to 1,000 years is very short.

Response: Isolation of the wastes from the human environment can only be ensured through implementation of a properly designed and managed waste disposal program consisting of good engineering design, periodic monitoring and maintenance, and institutional controls. Use of a passive containment system (i.e., one not reliant on active maintenance), along with a planned monitoring and maintenance program and controls to site access, should provide for effective isolation of these wastes from the nearby environment. The 200- to 1,000-year design life for the containment system was selected to be consistent with the time frames identified by the EPA for management of inactive uranium mill tailings, which also consist of low concentrations of very long-lived naturally occurring radionuclides.

B.3 SITE CHARACTERIZATION AND SUITABILITY

B.3.1 Issue 21

Comment: The geology of the raffinate pits and chemical plant area is very complex and has not been thoroughly characterized. In addition, the geology of this area is such that long-term containment of wastes is not possible. Developing a disposal facility in an area of karst geology is not appropriate because this type of geology consists of numerous voids. The area is prone to sinkholes, solution channels, and geological instabilities.

Response: The DOE is in the process of conducting a thorough geological study of the raffinate pits and chemical plant area, the results of which will be provided in the RI report. The environmental assessment given in the RI/FS-EIS will be based upon information obtained from the detailed site characterization activities currently being conducted. No large voids have been observed in the bedrock as a result of characterization activities conducted to date. (See also Response to Issue 9, Section B.2.1.)

B.3.2 Issue 22

Comment: The raffinate pits and chemical plant area is not suitable for waste disposal because this area has numerous test wells, boreholes, and trenches that will provide additional pathways for contaminants to reach the groundwater.

Response: The geology of this area is the subject of a comprehensive, ongoing investigation (see Response to Issue 21, Section B.3.1). The raffinate pits and chemical plant area will not be used for waste disposal unless its suitability can be demonstrated. Although it is possible for test wells, boreholes, and trenches to provide pathways for contaminants, rigid protocols and procedures have been and will continue to be used to effectively eliminate this possibility (e.g., double casing of deeper wells and grouting of abandoned boreholes).

B.3.3 Issue 23

Comment: All characterization activities should be completed prior to engineering design. It is not possible to properly design a containment cell for a site that may have significant geological flaws. The containment cell must accommodate site-specific geological and hydrological characteristics.

Response: Evaluation of remedial action alternatives will utilize the RI/FS process developed by EPA for CERCLA. This is an iterative process in which site characterization (RI) activities are conducted parallel to, and have input into, the evaluation of alternatives (FS) phase. Conceptual engineering design, which occurs during the FS phase, feeds back into the RI phase as data gaps are identified for a specific technology or alternative. Conceptual design activities must therefore be initiated prior to completion of site characterization activities as required for the RI/FS-EIS. The design of any containment cell would accommodate site geological and hydrological characteristics that will be defined during the RI phase.

B.3.4 Issue 24

Comment: The raffinate pits and chemical plant area should be thoroughly characterized prior to modeling studies because the area hydrogeology is complex, consisting of features such as losing streams and springs. The on-site saturated layer may actually be a naturally occurring perched water table. Modeling studies conducted to date have not been in agreement with measured levels of contamination in groundwater at the raffinate pits and chemical plant area, indicating that there may be additional migration pathways. Local springs should be identified and analyzed for chemical contaminants. All surface water/groundwater connections at the Weldon Spring site should be identified.

Response: The DOE is currently characterizing the local hydrogeology and is working with the Missouri DNR to accurately identify the losing streams and springs in the area. The Missouri DNR expertise in conducting dye studies should be very helpful in identifying surface to subsurface water connections. The baseline risk assessment, an integral component of the RI/FS-EIS process, will address the risks associated with the contamination currently at the site and the various pathways to the potential receptors. The RI/FS-EIS will not be issued until all site characterization activities have been completed. Modeling studies to support the RI/FS-EIS process will be calibrated against current contamination conditions at the site.

B.3.5 Issue 25

Comment: The volumes and concentrations of contaminants in the waste materials must be thoroughly characterized for both radioactive and chemical species. The data presented in the draft EIS do not present sufficient detail to justify the calculations performed.

Response: The waste materials will be characterized for both radioactive and chemical species as part of the RI phase. This information will be used to determine the volumes, physical properties, specific contaminants, and hazards of the waste materials currently located at the Weldon Spring site. This information will be included in the draft RI/FS-EIS issued for public comment.

B.3.6 Issue 26

Comment: Site-specific data are needed regarding soil engineering (physical) and ion-exchange (chemical) properties and the depths of clay layers.

Response: The DOE agrees that additional site-specific data are needed to understand migration potential and to ensure that, if a containment cell is located on-site, it would be properly designed and constructed. The DOE is planning to obtain these data as part of the RI process. This information will be obtained, in part, from ongoing characterization activities. Additional data will be collected as needed.

B.3.7 Issue 27

Comment: Statements made in the draft EIS that the Weldon Spring site is located in a tectonically quiet region are incorrect. It is very likely that a significant earthquake will occur in this area in the near future.

Response: The DOE is reevaluating current data regarding the potential for seismic events that could affect the Weldon Spring area. This information will be given in the RI report. A design-basis seismic event will be defined for the Weldon Spring site. Alternatives for on-site disposal will be assessed for their ability to withstand such an earthquake without compromising the integrity of the containment cell.

B.4 ENVIRONMENTAL IMPACTS

B.4.1 Issue 28

Comment: The draft EIS should include worst-case scenarios in which either mitigative measures or engineered structures fail.

Response: The RI/FS-EIS will include an assessment of the environmental impacts associated with scenarios in which either mitigative measures or engineered structures fail. However, judgment will be used to ensure that this assessment is reasonable, i.e, only reasonably foreseeable scenarios will be evaluated.

B.4.2 Issue 29

Comment: Use of meteorological data from Lambert Airport in St. Louis to assess impacts at the Weldon Spring site may be inappropriate because the airport is about 48 km (30 mi) from the site. Data should be used that can be obtained from closer sources, such as the National Weather Service station in St. Peters. Additionally, the draft EIS should include the wind rose used in these calculations.

Response: Meteorological data will be obtained from a source closer to the Weldon Spring site than Lambert Airport. In addition to the National Weather Service station at St. Peters, data could be obtained from other points closer to the site. Current plans are to construct an on-site meteorological station, projected to be operational in late 1988. As the meteorological information provided by this station becomes available, it will be used in the RI/FS-EIS process. A 1985 annual wind rose for the Weldon Spring site is included as Figure 11 of this work plan.

B.4.3 Issue 30

Comment: The draft EIS must include the health impacts of all radioactively and chemically hazardous substances at the site. These impacts should not be limited to humans only, but should consider all living organisms. This is especially true because certain organisms, which may be eaten by humans, are known to concentrate certain radionuclides. Biouptake studies on local wildlife -- such as wild turkeys, geese, deer, largemouth bass, and algae -- should be performed as part of this project.

Response: One of the first steps in the baseline risk assessment is to identify the significant chemical and radioactive species at the Weldon Spring site with regard to potential health risks to nearby individuals. These indicator compounds -- which are selected on the basis of their abundance at the site, their toxicity to human health, and their mobility in the environment -- will be included in the analyses given in the RI/FS-EIS. The means by which these indicator compounds can move through the environment to potential human receptors, including their uptake by plants and animals in the human food chain, will be assessed in the RI/FS-EIS. The environmental impact analysis presented in the RI/FS-EIS will address the effects of radioactive and chemical contaminants on the local ecosystem. Biouptake studies are currently being performed on local wildlife (e.g., fish, squirrels, and rabbits), and the results will be reported as they become available. Biouptake studies on other wildlife -- such as wild turkeys, geese, and deer -- will not be performed unless studies of indicator animals determine such a need.

B.4.4 Issue 31

Comment: The DOE should reexamine its calculations of radiation doses because the projected doses are too low to be believable. Specific considerations include (1) the respirable fraction of dust, (2) the doses to internal organs from inhalation of radioactive particulates and radon gas, as well as the doses due to external exposure, and (3) the effect of alpha emitters being 20 times more hazardous than beta radiation. Specific concern should be given to exposure from radon gases (i.e., radon-219, radon-220, and radon-222) because radon is estimated to cause 20,000 to 30,000 lung cancer deaths per year.

Response: The radiation doses in the draft EIS take into account all of the issues presented in this comment. However, DOE is intending to thoroughly reevaluate the estimation of radiation doses based upon the detailed site characterization activities currently being performed. Radon-219 is not a significant contributor to radiation exposure relative to radon-220 and radon-222 at the Weldon Spring site because of the low abundance of radionuclides that give rise to radon-219 and its very short half-life (approximately four seconds).

B.4.5 Issue 32

Comment: Because children are much more susceptible to radiation-induced illnesses than adults, the draft EIS should specifically address the potential doses and resultant health effects relative to children. Exposure to toxic substances should be addressed in a similar fashion. Both short-term and long-term health effects on children must be evaluated.

Response: The RI/FS-EIS will consider the toxicity of radionuclides and chemically hazardous substances on children. Data on age-specific effects will be used to the extent that they are available. Both short-term and long-term health effects on children will be assessed.

B.4.6 Issue 33

Comment: There is no safe level of radiation exposure. All exposures must be regarded as deleterious. Impacts include decreased life expectancy, genetic defects, and cancer. It should be noted that radionuclides can concentrate in certain organs, resulting in long-term radiation exposure. The people most susceptible to radiation-induced cancer are children and the elderly. The latency period for cancer induction can vary greatly in the general population.

Response: It is the policy of DOE to maintain all exposure to radiation at levels that are "as low as reasonably achievable" (ALARA). The DOE considers all radiation exposure above background to be hazardous and intends to minimize the doses incurred by both workers and the general public. The major health impacts to be addressed are cancer and genetic defects. Other impacts such as decreased life expectancy are very difficult to quantify but will be addressed to the extent possible. The calculation of radiation doses will consider organ uptakes, latency periods, and the greater susceptibility of children and the elderly.

B.4.7 Issue 34

Comment: The incidence of cancer in St. Charles County is greater than that expected in the general population. Although these data have not been substantiated by the scientific community, they do represent a reason for concern. Specific forms of cancer that have been documented in this area include leukemia and testicular cancer. Releases from the Weldon Spring site could be responsible for these cancers. Even if the site is not responsible for past cancers, it is imperative that the site be remediated so that it is not responsible for any new cases of cancer.

Response: The incidence of cancer in St. Charles County is not greater than that in other parts of the United States. The Missouri Department of Health recently completed a retrospective study of childhood leukemia in the vicinity of the Weldon Spring site. Although this study indicated an increased level of childhood leukemia cases during the period 1975-1979, the incidence rate over the entire period of the study (i.e., 1970-1983) was not statistically different from that to be expected in the general population. The Department of Health was not able to establish a link between these leukemia cases and any specific causes. The DOE is committed to conducting the Weldon Spring Site Remedial Action Project in a manner that will minimize the likelihood for any deleterious health impacts. (See also Response to Issue 52, Section B.5.10.)

B.4.8 Issue 35

Comment: The draft EIS must explicitly evaluate the potential health impacts of response action activities on students and staff at Francis Howell High School, staff and visitors at the St. Charles County Extension Center, and residents in nearby communities such as Weldon Spring Heights. The DOE should relocate these facilities at government expense if it cannot be shown, with absolute assurance, that people using these facilities and nearby residents will be safe during conduct of response action activities at the Weldon Spring site.

Response: The impacts on nearby residents, the students and staff at Francis Howell High School, and the staff and visitors at the St. Charles County Extension Center will be explicitly evaluated in the RI/FS-EIS. All data and calculations to date show a very low risk to nearby individuals from proposed response action activities at the Weldon Spring site. (See also Responses to Issues 52 and 53 in Sections B.5.10 and B.5.11, respectively.)

B.4.9 Issue 36

Comment: The draft EIS does not accurately describe local groundwater users in the vicinity of the site. The St. Charles Countians Against Hazardous Waste (SCCAHW) has completed a survey of private wells in this area. This information, which indicates that many private wells in the area are drawing water from the shallow Burlington-Keokuk aquifer, was not incorporated in the draft EIS. Instead, the draft EIS lists only municipal and water district supply facilities. St. Charles County also contains subdivisions, mobile home parks, and institutions that are classified as users of public water supplies. Failing to use this information greatly underestimates the impact of this project on local groundwater supplies. The EIS should address actual water users.

Response: The DOE greatly appreciates the information supplied by the SCCAHW and the state of Missouri on nearby users of groundwater. This information has been very helpful to DOE in assessing the hazards associated with the groundwater contamination discovered in 1987 in the vicinity of the raffinate pits and chemical plant area. The data supplied by the SCCAHW and the state of Missouri will be used in the RI/FS-EIS to assess the environmental impacts of alternatives developed for detailed study.

B.4.10 Issue 37

Comment: The groundwater modeling results at the raffinate pits and chemical plant area are incorrect. The model used is too simple to adequately address the complex hydrogeology of this area. Nonuniform geology, possible barrier degradation, and flow through fractures and solution-enlarged cavities are factors that cannot be accurately or adequately considered using current modeling techniques. The modeling results performed to date do not agree with field-observed data.

Response: The DOE intends to conduct additional detailed groundwater modeling studies at the raffinate pits and chemical plant area following collection of relevant data. These results will be included in the RI/FS-EIS, as appropriate. Prior to performing these studies, the site geology will be thoroughly characterized. The modeling results will be calibrated to current measurements of radioactive and chemical contamination of the groundwater in the raffinate pits and chemical plant area. This should ensure that the modeling results are a reasonable representation of current conditions and can provide a meaningful estimation of future conditions.

B.4.11 Issue 38

Comment: The draft EIS underestimates the potential impact of increased use of nearby roads during response action activities on nearby facilities such as Francis Howell High School. There is a lot more traffic at the school than the draft EIS implies. In addition, contingency measures should be in place to respond to traffic accidents (such as an overturned truck transporting contaminated materials) and resultant releases of contaminants to the environment.

Response: The intersection of Missouri (State) Route 94 and U.S. Route 40/61 is very busy, especially during the morning and evening rush hours. There is also a lot of traffic at Francis Howell High School during the periods when students arrive for classes in the morning and depart in the afternoon. The DOE will coordinate all traffic associated with response action activities to minimize impacts on nearby facilities. The DOE will also require all subcontractors to develop contingency measures to deal with potential traffic accidents involving trucks transporting contaminated materials. (See also Response to Issue 51, Section B.5.9.)

B.4.12 Issue 39

Comment: The draft EIS states that the nonradioactive hazardous wastes will be transported to and disposed of at a RCRA-licensed hazardous waste facility. However, the draft EIS does not address the environmental impacts of handling and transporting the wastes.

Response: The DOE intends to dispose of all nonradioactive hazardous wastes off-site at a RCRA-licensed hazardous waste facility. The location of the facility cannot be identified until the characteristics of the wastes have been determined by the detailed waste characterization activities currently being performed by DOE. Also, because DOE is planning to perform various IRAs prior to the ROD, it is likely that much of the nonradioactive hazardous waste will be disposed of prior to the completion of the RI/FS-EIS. The environmental impacts associated with the handling and transportation of chemically hazardous wastes will be addressed in EE/CA reports or in the RI/FS-EIS, as appropriate.

B.4.13 Issue 40

Comment: The draft EIS understates the impacts of population growth in St. Charles County because most of this growth is in the direction of the Weldon Spring site. As population growth in this area continues, waste storage may prove to be a poor choice of land use. The draft EIS should include projected population estimates and a population distribution chart showing the population by sector and distance from the site.

Response: The RI/FS-EIS will include a population distribution chart showing the population by sector and distance from the site. The impact of population growth and local land use will be included for the various alternatives in the RI/FS-EIS. Projections of population growth are difficult to quantify beyond the near term because such growth is influenced by factors that cannot be estimated with any degree of precision (e.g., local economic growth and changes in land use patterns). The impacts of population growth will be assessed to the extent feasible.

B.4.14 Issue 41

Comment: The draft EIS does not adequately address the impact of the Weldon Spring site on current and long-term real estate values.

Response: The DOE is not planning to study the impact of the Weldon Spring site on local real estate values because such values can be affected by numerous factors. It is not possible to quantify the impact of the Weldon Spring site independently of other factors, such as population growth and local employment opportunities. Hence, it does not seem reasonable to address this issue in the RI/FS-EIS.

B.4.15 Issue 42

Comment: The DOE should consider the interim impacts of response action activities at the Weldon Spring site on adjacent lands owned by the Missouri Department of Conservation and should ensure that these activities will accommodate future public uses of surrounding lands and waters (including Lakes 34, 35, and 36 in the Busch Wildlife Area).

Response: The DOE will address interim impacts of response action activities in either EE/CA reports for IRAs (see Section 3.10 of this work plan) or in the RI/FS-EIS for the project. The DOE is committed to implementing response actions at the Weldon Spring site in a manner that will permit future public use of surrounding lands and waters.

B.5 SCOPE AND CONDUCT OF REMEDIAL ACTION ACTIVITIES

B.5.1 Issue 43

Comment: All areas in the vicinity of the Weldon Spring site that are contaminated with radioactive and chemical substances originating from the Weldon Spring site should be cleaned up. This includes soils, drainageways, Femme Osage Slough, and lakes and springs in the Busch Wildlife Area. At a minimum, all such areas should be clearly marked to warn people of these hazards.

Response: The DOE intends to clean up all areas in the vicinity of the Weldon Spring site for which it has responsibility that pose an unacceptable risk to public health and the environment. The DOE is continuing to work with the U.S. Department of the Army to identify off-site areas contaminated as a result of Army activities. The responsibility for cleanup of these areas rests with the Army. The DOE will inform the Missouri Department of Conservation of all contamination originating from the site that is detected in the wildlife areas administered by that department.

B.5.2 Issue 44

Comment: All of the wastes should be removed from the Weldon Spring site. This was done at the Vitro site in Salt Lake City, under similar circumstances. Under no conditions should additional wastes be brought to this site for disposal.

Response: The preference for total removal of the wastes from the Weldon Spring site is noted. The basis for the DOE decision relative to the Vitro site is provided in the ROD for remedial action at that site (U.S. Dept. Energy 1984). The DOE has no plans to move additional wastes to the Weldon Spring site for disposal.

B.5.3 Issue 45

Comment: The Weldon Spring site is responsible for current groundwater contamination. Of major concern is the quarry, which is located in very close proximity to the St. Charles County well field that supplies potable water for much of St. Charles County. Radioactive and chemical contaminants have been detected in monitoring wells between the quarry and the county wells. The groundwater in the raffinate pits and chemical plant area is also contaminated with nitrates, trinitrotoluene (TNT), and dinitrotoluene (DNT). The federal government should test all local water supplies in the vicinity of the Weldon Spring site to ensure the safety of local citizens.

Response: The DOE concurs that the Weldon Spring site is responsible for local groundwater contamination. The environmental monitoring program at the raffinate pits and chemical plant area and at the quarry includes many wells to monitor the status of groundwater contamination. One of the major components of the RI/FS-EIS will be an evaluation of the hazards posed by this contamination at the raffinate pits and chemical plant area. The DOE is planning to remove the bulk wastes from the quarry prior to the ROD to minimize the potential for increased groundwater contamination at the quarry (see Section 3.11 of this work plan). Removal of the source of this contamination should be an effective means of lowering the rate at which radioactively and chemically hazardous substances enter the groundwater in the area. The possible need to remediate the groundwater at the quarry will be addressed in the future (see Response to Issue 47, Section B.5.5). The DOE has tested several private wells in the proximity of the raffinate pits and chemical plant area and has found no contamination. The state of Missouri is responsible for ensuring that the water supplies in the vicinity of the Weldon Spring site are safe and has been carrying out this responsibility.

B.5.4 Issue 46

Comment: The draft EIS should provide specific details on how contaminated water will be treated prior to disposal. Of specific concern is the discharge of any contaminated water into the Missouri River because this is upstream of the water intakes for St. Louis City and St. Louis County. In addition, the state of Missouri has specific requirements for wastewater discharges that must be met.

Response: The DOE is addressing the treatment of contaminated water at the raffinate pits and chemical plant area and at the quarry as IRAs (see Sections 3.10.2.15 and 3.10.2.16 of this work plan). The treatment techniques to be used will be addressed in EE/CA reports prepared to support these actions. A major component of the EE/CA process will be determination of effluent limits and conditions of discharge. The DOE is working with the EPA Region VII and the Missouri DNR in developing these actions.

B.5.5 Issue 47

Comment: The DOE should commit to restoration of contaminated groundwater at both the raffinate pits and chemical plant area and the quarry.

Response: The need for groundwater restoration at the raffinate pits and chemical plant area will be addressed as part of the RI/FS-EIS process. Analysis of the groundwater contamination issue at the quarry will be addressed in a separate, but similar, process in the future. The DOE intends to address this issue for the quarry following removal of the bulk wastes and collection of sufficient data to allow for an objective decision to be made.

B.5.6 Issue 48

Comment: It is important to minimize the airborne release of radioactive particulates during response action activities. Use of water sprays during soil excavation may not be sufficient. All sources of dust should be addressed, e.g., from construction activities, building demolition, and/or truck traffic. Plans for detecting and minimizing dust releases should be developed prior to initiation of response action activities. In addition, all pertinent plans (i.e., those that address monitoring, response action, and waste storage) should be provided to the public.

Response: Use of water sprays has been shown to be an effective means of minimizing the amount of airborne particulates released during response action activities at similar sites. An aggressive environmental monitoring program will be implemented during construction-related activities to ensure a safe environment for workers and the nearby population. This program will rely primarily on air particulate monitors. All activities having the potential to generate airborne particulates will be reviewed to ensure that mitigative measures are in place prior to the initiation of field activities. The DOE intends to present its plans for conducting response action activities to the public. Included in these plans will be measures to minimize airborne particulate releases.

B.5.7 Issue 49

Comment: An important component of a remedial action plan is a determination of the mitigative measures that will be used to reduce environmental impacts. All potential exposure pathways must be identified and mitigative measures evaluated. Such mitigative measures should be detailed early in the process to allow for public review and comment.

Response: The DOE agrees that a comprehensive plan of mitigative measures is important to ensure that environmental impacts are minimized. Mitigative measures will be identified as specific actions are defined. These mitigative measures will address all potential exposure pathways. The public will have an opportunity to comment on these mitigative measures via the EE/CA and RI/FS-EIS processes.

B.5.8 Issue 50

Comment: The environmental monitoring program to be used must be defined at this time. This monitoring program should not only be in effect during the action period but should also be maintained long after remedial action has been completed. Results of the monitoring program should be provided to local citizens upon request.

Response: The DOE currently has in place an environmental monitoring program consistent with DOE requirements. The results of this program are available to the public upon request. The DOE publishes an annual environmental monitoring report for the Weldon Spring site in May of each year. The environmental monitoring program for the project will be reevaluated annually to ensure that monitoring activities are commensurate with ongoing and planned activities. The monitoring program to be used during remedial action activities will be defined in the RI/FS-EIS process and will address both the action period and the period following completion of remedial action (see also Response to Issue 17, Section B.2.9).

B.5.9 Issue 51

Comment: Contingency plans must be developed to allow for quick enactment of emergency response measures in the event of an accidental release either on-site or during transportation off-site.

Response: The DOE has an emergency preparedness plan in place that is consistent with DOE requirements. This plan details the procedures to be used in case accidental conditions occur that could impact nearby individuals. The major thrust of the plan is immediate response and timely notification of local authorities responsible for protecting the health and welfare of the nearby population.

B.5.10 Issue 52

Comment: The DOE should establish a trust fund for an insurance program to pay medical expenses of local residents for treatment of diseases and illnesses that might be caused by exposure to radioactively and chemically hazardous substances at the Weldon Spring site. In addition, DOE should finance periodic medical monitoring of the students, faculty, and staff at Francis Howell High School.

Response: The DOE has in place an environmental monitoring program to assess the concentrations of radioactive and chemical contaminants in the nearby environment. The results to date do not indicate that releases from the Weldon Spring site could be responsible for any deleterious health effects. The monitoring program will continue for the duration of the project. The Missouri Department of Health recently completed a retrospective study of childhood leukemia in the vicinity of the Weldon Spring site and was unable to establish a link between these leukemia cases and any specific cause (see Response to Issue 34, Section B.4.7). Based on this information, there is no basis to perform periodic medical monitoring of the students, faculty, and staff at Francis Howell High School or to establish an insurance trust fund.

B.5.11 Issue 53

Comment: The DOE should conduct a comprehensive health study of individuals who live in the vicinity of the Weldon Spring site.

Response: The DOE does not believe that it is necessary to conduct a comprehensive health study of nearby residents. An environmental monitoring program is in place to measure the concentrations of radioactive and chemical contaminants in the local environment. Results of this monitoring program can be used to identify potential impacts of the project on the local environment. Additionally, the retrospective health study conducted by the Missouri Department of Health did not uncover any reasons to suspect that the Weldon Spring site has been responsible for an increased incidence of cancer in this area. The health impacts of remedial action activities will be included in the RI/FS-EIS. In addition, the Agency for Toxic Substances and Disease Registry will perform a public health assessment for this project. (See also Response to Issue 52, Section B.5.10.)

B.5.12 Issue 54

Comment: The citizens of St. Charles County deserve to have the Weldon Spring site cleaned up by the best available technology, regardless of cost. Cost should not be the overriding factor in decisions regarding the conduct of the remedial action project.

Response: The DOE is accountable to the taxpayers of this country. Therefore, DOE must consider costs in its decision. The cost of the project will be a factor, but not the overriding factor, in selecting an alternative. The most important factors to be considered will be the health and safety of persons potentially impacted by the project.

B.5.13 Issue 55

Comment: The DOE should do everything possible to maintain the viability of the rail transportation option. The impact of abandonment of the Missouri-Kansas-Texas (MKT) rail line between Machens and Sedalia, Missouri, should be addressed. The DOE should try to ensure the usability of this abandoned line.

Response: The issue of abandonment of the MKT rail line between Machens and Sedalia is beyond the scope of DOE's responsibility. The abandonment was approved by the Interstate Commerce Commission.

B.5.14 Issue 56

Comment: Alternative 3a in the draft EIS (disposal of the Weldon Spring wastes at the Hanford site in the state of Washington) should not be considered a viable alternative because the Hanford site leaks and it would not accept the wastes.

Response: The DOE agrees that disposal of the Weldon Spring wastes at the Hanford site is currently not a viable option based on all factors that affect the implementability of this alternative. These factors include the likelihood that the Weldon Spring wastes would not be accepted for disposal at the Hanford site, the distance of the Hanford site from the Weldon Spring site, the volume of wastes that would be transported, and the increased health and safety risks associated with the transportation effort.

B.5.15 Issue 57

Comment: Alternative 3c in the draft EIS (transporting the raffinate pit and quarry sludges to an existing uranium-processing facility in the southwestern United States) should not be considered viable because it is unlikely that any uranium mill would accept these materials, no economic benefit would accrue, and significant transportation impacts would result.

Response: The DOE concurs that, as evaluated in the draft EIS, the negative aspects of this alternative associated with transportation impacts outweigh any positive benefits that might accrue. However, DOE is evaluating the potential for reprocessing the raffinate pit and quarry sludges at either an on-site facility or an off-site facility to recover potentially usable materials and to reduce the toxicity, mobility, and/or volume of the contaminated materials as required by CERCLA.

B.5.16 Issue 58

Comment: All DOE actions should be subject to independent oversight and inspection by an unbiased, qualified organization because DOE's record on environmental protection, health, and safety is very poor. The DOE should also consider establishing a citizens' advisory board to monitor progress on this project.

Response: The EPA Region VII is providing independent oversight of the entire project, as mandated by CERCLA. The DOE is also working with the Missouri DNR to ensure that all state concerns are addressed. The DOE has an active community relations program to ensure that local citizens are kept informed of ongoing activities.

B.5.17 Issue 59

Comment: The draft EIS is vague regarding the standards and guidelines that will be used to direct the remedial action. It is not clear if DOE will use EPA, DOE, or state of Missouri regulations, some combination of these regulations, or the most restrictive regulations where duplication occurs. The draft EIS should discuss how each alternative implements the ALARA policy of minimizing radiation exposure.

Response: Determination of ARARs is a key element of both the EE/CA and RI/FS-EIS processes. The ARARs will define the specific requirements to be followed in conducting response action activities. The DOE will conduct the ARAR process in cooperation with EPA Region VII and the Missouri DNR to ensure that all ARARs are determined. The DOE intends to develop an ALARA dose limit (see Response to Issue 60, Section B.5.18). The alternatives in the RI/FS-EIS will be assessed relative to this ALARA value.

B.5.18 Issue 60

Comment: The limits that DOE is using to allow release of facilities and equipment for unrestricted use will result in unacceptably high doses. Additionally, the DOE limit of 100 mrem/yr committed effective dose equivalent is too high. The International Commission on Radiological Protection (ICRP) recommended this limit for exposure from all sites and sources. This value is too high for exposure of individuals from a single site that is no longer providing any benefits to the public.

Response: The criteria DOE is using to determine release limits of facilities and equipment are based on published standards of the U.S. Nuclear Regulatory Commission and the EPA. These criteria have been used previously in similar circumstances by DOE and private industry. The DOE believes that the use of previously established criteria for this project is relevant and appropriate. The DOE dose limit for the general public is 100 mrem/yr committed effective dose equivalent for prolonged exposure; in addition, the dose must be ALARA. The DOE is intending to develop an ALARA value for the Weldon Spring Site Remedial Action Project. This value will include considerations of cost, implementability, and other relevant factors. This ALARA value will likely be much lower than 100 mrem/yr. (See also Response to Issue 59, Section B.5.17.)

B.6 REFERENCE

U.S. Department of Energy, 1984, *Compliance with the National Environmental Policy Act: Record of Decision for Remedial Actions at the Former Vitro Chemical Company Site, South Salt Lake, UT*, Federal Register, *49*(201):40436-40439 (Oct. 16).

APPENDIX C:

ENGLISH/METRIC - METRIC/ENGLISH EQUIVALENTS

TABLE C.1 English/Metric Equivalents

Multiply	By	To obtain
Acres	0.4047	Hectares (ha)
Cubic feet (ft^3)	0.02832	Cubic meters (m^3)
Cubic yards (yd^3)	0.7646	Cubic meters (m^3)
Degrees Fahrenheit (°F) - 32	0.5555	Degrees Celsius (°C)
Feet (ft)	0.3048	Meters (m)
Gallons (gal)	3.785	Liters (L)
Gallons (gal)	0.003785	Cubic meters (m^3)
Inches (in.)	2.540	Centimeters (cm)
Miles (mi)	1.609	Kilometers (km)
Pounds (lb)	0.4536	Kilograms (kg)
Square feet (ft^2)	0.09290	Square meters (m^2)
Square yards (yd^2)	0.8361	Square meters (m^2)
Square miles (mi^2)	2.590	Square kilometers (km^2)
Tons, short (tons)	907.2	Kilograms (kg)
Tons, short (tons)	0.9072	Tons, metric (t)

TABLE C.2 Metric/English Equivalents

Multiply	By	To obtain
Centimeters (cm)	0.3937	Inches (in.)
Cubic meters (m^3)	35.31	Cubic feet (ft^3)
Cubic meters (m^3)	1.308	Cubic yards (yd^3)
Cubic meters (m^3)	264.2	Gallons (gal)
Degrees Celsius (°C) + 17.78	1.8	Degrees Fahrenheit (°F)
Hectares (ha)	2.471	Acres
Kilograms (kg)	2.205	Pounds (lb)
Kilograms (kg)	0.001102	Tons, short (tons)
Kilometers (km)	0.6214	Miles (mi)
Liters (L)	0.2642	Gallons (gal)
Meters (m)	3.281	Feet (ft)
Square kilometers (km^2)	0.3861	Square miles (mi^2)
Square meters (m^2)	10.76	Square feet (ft^2)
Square meters (m^2)	1.196	Square yards (yd^2)
Tons, metric (t)	1.102	Tons, short (tons)