# Memphis Depot

## Main Installation



# Record of Decision

Memphis Depot Caretaker

February 2001 — Rev. 2

CH2MHILL

U.S. Army Engineering
and Support Center, Huntsville

U.S. Army Engineering and Support Center, Huntsville
Contract No. DACA87-94-D-0009
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**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY**
**REGION 4**
ATLANTA FEDERAL CENTER
61 FORSYTH STREET, SW
ATLANTA, GEORGIA 30303-3104


4WD

C.R. McKelvey
Captain, SC, USN
Commander
Defense Distribution Depot, Susquehanna Pennsylvania
2001 Mission Drive, Suite 100
New Cumberland, Pennsylvania 17070-5000

Re: Transmittal of Signed CERCLA Record of Decision for the Main Installation at Defense Depot, Memphis Tennessee

Dear Captain McKelvey:

The United States Environmental Protection Agency (EPA), Region 4, is pleased to enclose a fully executed original copy of the Record of Decision (ROD) which documents the selected remedy for the Main Installation at the Defense Depot, Memphis Tennessee (DDMT). This document was developed through a team effort by representatives from Defense Logistics Agency (DLA), Tennessee Department of Environment and Conservation (TDEC), and EPA, as parties to the Federal Facilities Agreement (FFA) dated March 6, 1995.

The remedy is selected under the authority of Section 121 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments Re-authorization Act of 1986 (SARA). The selected remedy requires treatment of contaminated ground water using enhanced bioremediation. In addition, the remedy requires implementation of certain specified institutional controls. The institutional controls include measures to prevent residential use of the majority of the property, as well as ground water use restrictions that will be imposed until such time as the ground water contamination is treated to achieve standards which are protective of human health.

All of the components of the selected remedy have been determined by the FFA partner agencies to be necessary in order to protect human health and the environment, while allowing for the safe and expeditious reuse of this property through the Base Re-alignment and Closure (BRAC) process. EPA is pleased to participate in returning this property to productive use for the benefit of the surrounding community. I wish to add personally that I am pleased with the professionalism shown by our front line staff, the members of the DDMT BRAC Cleanup Team

(BCT) and its support personnel, throughout the cleanup process. As lead agency, DLA staff have been cooperative and open-minded to requirements and suggestions by its regulatory partners on site management strategies, technical and administrative needs, and schedules; in short, a pleasure to work with. Conversely, EPA and TDEC staff have worked hard to bring to the table their professional experience and all the flexibility our regulations allow in the effort to move the Depot toward the ultimate goal of deletion from the National Priorities List (NPL).

I am especially pleased with the clarity of this decision document. It brings together all of our efforts into a single, easily accessible and transparent explanation of the process by which we reached the decision. This is a particularly important achievement at DDMT because of the high degree of community involvement and concern over the years. I commend all those involved, both principals and contractors, who worked long and hard to reach this milestone.

Sincerely yours,

Richard D. Green, Director
Waste Management Division

Enclosure

cc: (w/enclosure)
James W. Haynes, Director
Division of Superfund
Tennessee Department of Environment and Conservation (TDEC)

# Main Installation Record of Decision
# Administrative Record Index

| Document | Year | Author |
|---|---|---|
| Installation Assessment of Defense Depot Memphis, Tennessee Report No. 191 | 1982 | Chemical Systems Laboratory/U.S. Army Toxic and Hazardous Materials Agency |
| Geohydrologic Study No. 38-26-0195-83 | 1982 | U.S. Army Environmental Hygiene Agency |
| Summary Report: On-Site Remedial Activities at the Defense Depot Memphis, Tennessee | 1986 | O.H. Materials Company |
| Remedial Investigation Final Report and Appendices | 1990 | Law Environmental, Inc. |
| Feasibility Study Final Report | 1990 | Law Environmental, Inc. |
| Lake Danielson Water Samples Analytical Results | 1986 | Pickering Environmental |
| Engineering Report Removal Action for Groundwater | 1994 | Engineering-Science, Inc. |
| Groundwater Monitoring Results Report for Defense Depot Memphis, Tennessee, Volumes 1 through 9 | 1994 | Environmental Science & Engineering Inc. |
| Public Health Assessment for USA Defense Depot Memphis | 1995 | Agency for Toxic Substances and Disease Registry |
| Final Generic Remedial Investigation/Feasibility Study Work Plan | 1995 | CH2M Hill |
| Operable Unit 2 Field Sampling Plan | 1995 | CH2M Hill |
| Operable Unit 3 Field Sampling Plan | 1995 | CH2M Hill |
| Operable Unit 4 Field Sampling Plan | 1995 | CH2M Hill |
| Screening Sites Field Sampling Plan | 1995 | CH2M Hill |
| Memphis Depot Redevelopment Plan | 1997 | Pathfinders for Depot Redevelopment Corp. |
| Final Groundwater Characterization Data Report | 1997 | CH2M Hill |
| Historical Environmental Aerial Photographic Analysis of the Main Depot area South of Dunn Avenue | 1998 | U.S. Army Topographical Engineering Center |
| Final Background Sampling Program Report | 1998 | CH2M Hill |

# Main Installation Proposed Plan Administrative Record Index

| Document | Year | Author |
|---|---|---|
| Final Preliminary Risk Evaluation | 1998 | CH2M Hill |
| Basis for No Further Action Recommendations Report | 1998 | CH2M Hill |
| OUs 2, 3 and 4 and Screening Sites Field Sampling Plan Addendums | 1998 | CH2M Hill |
| Final Screening Sites Letter Reports | 1998 | CH2M Hill |
| BRAC Cleanup Plan Version 2 | 1998 | Memphis Depot Caretaker |
| Final Baseline Risk Assessment for Golf Course Impoundments | 1999 | Radian International |
| Preliminary Final Report Laboratory Evaluation of Bioremediation Techniques | 1999 | Venture Capital Associates |
| Final Streamlined Risk Assessment Parcel 3 Technical Memorandum | 1999 | CH2M Hill |
| Post Removal Report, Family Housing Area, Memphis Depot, Tennessee, Volumes I and II | 1999 | OHM/IT Remediation Services Inc., |
| Post Removal Report, Cafeteria Building, Memphis Depot, Tennessee | 1999 | OHM/IT Remediation Services Inc., |
| Action Memorandum for Removal Action at Parcels 35 and 28 | 1999 | Defense Distribution Center |
| Sampling and Analysis Plan for Evaluation of Biodegradation of VOCs in Groundwater at the Memphis Depot | 2000 | CH2M Hill |
| Final Main Installation Remedial Investigation | 2000 | CH2M Hill |
| Final Main Installation Feasibility Study for Soils | 2000 | CH2M Hill |
| Final Main Installation Feasibility Study for Groundwater | 2000 | CH2M Hill |
| Base Realignment and Closure Cleanup Team meeting minutes | 1998 -2000 | Memphis Depot Caretaker |
| Memorandum: Evaluation of less than lifetime risk for scheduling of land use control monitoring at Functional Unit 1 (FU-1)..... | 2001 | USEPA Region 4 Office of Technical Services |

# Main Installation Record of Decision
## Administrative Record Index

| EPA Guidance Documents |
|---|
| RAGS: Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A), December 1989 |
| RAGS: Risk Assessment Guidance for Superfund Volume I – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals), December 1991 |
| RAGS: Risk Assessment Guidance for Superfund Volume I – Human Health Evaluation Manual (Part C, Risk Evaluation Remedial Alternatives), December 1991 |
| RAGS: Risk Assessment Guidance for Superfund Volume I – Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments), January 1998 |
| Institutional Controls and Transfer of Real Property Under CERCLA Section 120(h)(3)(A), (B), or (C), February 2000 |
| Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, October 1988 |

# Contents

Tables



Figures

## Figures

| | |
|---|---|
| HHRA | Human Health Risk Assessment |
| HI | Hazard index |
| HQ | Hazard quotient |
| hr | hour |
| IA | Installation Assessment |
| ID | Identification number |
| IRA | Interim remedial action |
| IRP | Installation Restoration Program |
| LDR | Land disposal restriction |
| LUCAP | Land Use Control Assurance Plan |
| LUCIP | Land Use Control Implementation Plan |
| $m^3$ | Cubic meters |
| MCL | Maximum contaminant level |
| MCLG | Maximum contaminant level goal |
| MI | Main Installation |
| μg/L | Micrograms per liter |
| mg/kg | Milligrams per kilogram |
| MNA | Monitored natural attenuation |
| MOA | Memorandum of Agreement |
| MSCHD | Memphis-Shelby County Health Department |
| msl | Mean sea level |
| NA | Natural attenuation |
| NAPL | Non-aqueous phase liquid |
| NCP | National Oil and Hazardous Substances Pollution Contingency Plan |
| NOAA | National Oceanic and Atmospheric Administration |
| NPDES | National Pollutant Discharge Elimination System |
| NPS | National Park Service |
| O&M | Operation and maintenance |
| OSHA | Occupational Safety and Health Administration |
| OU | Operable unit |
| PAH | Polynuclear aromatic hydrocarbon |
| PCB | Polychlorinated biphenyl |
| PCA | 1,1,2,2-Tetrachloroethane |
| PCE | Tetrachloroethene |
| PCP | Pentachlorophenol |
| POTW | Publicly owned treatment works |
| ppm | Parts per million |
| PRE | Preliminary risk evaluation |
| PW | Present worth |
| RA | Remedial action |
| RAB | Restoration Advisory Board |
| RAO | Remedial action objective |
| RBC | Risk-based concentration |
| RCRA | Resource Conservation and Recovery Act |
| RD | Remedial design |
| RfD | Reference dose |
| RFI | RCRA Facility Investigation |

| | |
|---|---|
| RGO | Remedial goal option |
| RI/FS | Remedial investigation/feasibility study |
| ROD | Record of Decision |
| SARA | Superfund Amendments and Reauthorization Act |
| SDWA | Safe Drinking Water Act |
| SWDA | Solid Waste Disposal Act |
| SWMU | Solid waste management unit |
| TCDD | Tetrachlorodibenzo-p-dioxin |
| TCDF | Tetrachlorodibenzofuran |
| TCE | Trichloroethene |
| TCL/TAL | Target compound list/target analyte list |
| TCLP | Toxicity characteristic leaching procedure |
| TDEC | Tennessee Department of Environment and Conservation |
| TEC | Topographic Engineering Center |
| TMV | Toxicity, mobility, or volume |
| UCL | Upper confidence level |
| UIC | Underground injection control |
| VOC | Volatile organic compound |
| yr | Year |

# 1.0 Declaration

## 1.1 Site Name and Location

Memphis Depot
Main Installation, Functional Units (FUs) 1 through 7
2163 Airways Boulevard
Memphis, Shelby County, Tennessee
U.S. Environmental Protection Agency (EPA) Identification Number (ID): TN4210020570

## 1.2 Statement of Basis and Purpose

This decision document presents the selected remedy for the Main Installation (MI) of the Memphis Depot, in Memphis, Tennessee. This action was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and, to the extent applicable, the National Oil and Hazardous Pollution Contingency Plan (NCP). This decision is based upon the Administrative Record for the MI, including EPA Policy, *Land Use in the CERCLA Remedy Selection Process (OSWER Directive No. 9355.7-04)*. This policy provides for consideration of the likely future land use of the Memphis Depot when selecting the remedy.

The State of Tennessee Department of Environment and Conservation (TDEC) and EPA concur with the selected remedy.

## 1.3 Assessment of the Site

The response action selected in this Record of Decision (ROD) is necessary to protect human health and welfare, and the environment. The selected action will prevent imminent or substantial danger from actual or threatened releases from the MI of pollutants, contaminants, or hazardous substances.

## 1.4 Description of the Selected Remedy

The selected groundwater and surface soil remedy addresses the remediation of surface soil and groundwater contamination, which will allow the transfer or lease of the MI property for its intended land use (industrial and recreational). The selected surface soil remedy consists of land use controls for FUs 1 through 6, coupled with excavation, transport, and off-site disposal of an estimated 7,200-$ft^2$ area of surface soil in FU4. The selected groundwater remedy for FU7 is enhanced bioremediation, which includes land use controls and long-term monitoring. The selected remedy applies to the MI portion of the Memphis Depot and does not include Dunn Field (Operable Unit 1), located to the north of the MI.

The remedial investigation (RI) and feasibility study (FS) for Dunn Field are scheduled to be completed in 2001 and the final ROD in 2002.

The major components of the selected remedy include:

- Excavation, transportation, and off-site disposal at a permitted landfill of an estimated 7,200 $ft^2$ of surface soil containing lead concentrations equal to or greater than 1,536 milligrams per kilogram (mg/kg) near the southeast corner of Building 949 in FU4.
- Deed restrictions and site controls, which include the following:
  - Prevention of residential land use on the MI (except at the existing Housing Area).
  - Daycare restriction controls.
  - Production/consumptive use groundwater controls for the fluvial aquifer and for drilling into aquifers below the fluvial aquifer on the MI.
  - Elimination of casual access by adjacent off-site residents through maintenance of a boundary fence surrounding FU2.
- Enhanced bioremediation of chlorinated volatile organic compounds (CVOCs) in the most contaminated part of the groundwater plume.
- Long-term groundwater monitoring to document changes in plume concentrations and to detect potential plume migration to off-site areas or into deeper aquifers.
- 5-year reviews of the selected alternatives.

The land use controls (deed restrictions and site controls) that are included as part of the selected remedy provide additional layers of protection above the existing land use and groundwater controls as established by the: (1) City of Memphis and Shelby County zoning regulations; (2) Federal Property Management Regulations; and (3) Ground Water Quality Control Board for the City of Memphis and Shelby County.

No source materials on the MI are "principal threat wastes" as defined by EPA guidance. Surface and subsurface soils across the MI are not considered to be principal threats. No evidence of non-aqueous phase liquids (NAPL) has been discovered on the MI. Although contaminated groundwater poses a risk, it is not considered a principal threat.

## 1.5 Statutory Determinations

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable. The selected remedy allows the entire MI to be available for the anticipated future land use.

The selected remedy for groundwater contamination at the MI satisfies the statutory preference for treatment. The selected remedy for surface soil contamination at the MI does not satisfy the statutory preference for treatment as a principal element of the remedy. However, the remedy for surface soil was chosen for the following reasons:

- Deed restrictions and site controls can be implemented quickly.
- Deed restrictions and site controls provide additional layers of protectiveness above existing land use restrictions and controls.
- Excavation and off-site disposal provides permanent risk reduction at the MI through removal.
- The remedy will allow the property to be used for industrial and recreational land use, and does not preclude future response actions, if warranted.
- The remedy is cost-effective at achieving anticipated industrial (and recreational) land use criteria.

The remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure; therefore, in accordance with Section 121(c) of CERCLA and NCP §300.430(f)(5)(iii)(c), a statutory review will be conducted within 5 years of initiation of remedial action, and every 5 years thereafter, to ensure that the remedy continues to be protective of human health and the environment.

Hazardous substances above health-based levels will remain in groundwater beneath the Memphis Depot after implementation of this remedy. Because hazardous substances are to remain, the Defense Logistics Agency (DLA), TDEC, and EPA recognize that Natural Resource Damage Assessment (NRDA) claims, in accordance with CERCLA, may be applicable. This document does not address restoration or rehabilitation of any natural resource injuries that may have occurred or whether such injuries have occurred. In the interim, neither DLA nor TDEC waives any rights or defenses each may have under CERCLA, Sect. 107(a)4(c).

## 1.6 ROD Data Certification Checklist

The following information is included in the *Decision Summary* section (Section 2) of this ROD. Additional information can be found in the Administrative Record for the MI.

- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD (page 2-15).
- Chemicals of concern (COCs) and their respective concentrations (page 2-17).
- Baseline risk represented by the COCs (page 2-21).
- Clean-up levels established for COCs and the basis for these levels (page 2-24).
- Key factor(s) that led to the selection of the remedy (page 2-40).
- Estimated capital costs, annual operation and maintenance (O&M) costs, total present worth costs, discount rate, and number of years over which the remedial cost estimates are projected (pages 2-46 to 2-47).

- Potential land and groundwater use that will be available at the MI as a result of the selected remedy (page 2-48).

There are no source materials constituting principal threats on the MI; therefore, this topic will not be addressed.

## 1.7 Authorizing Signatures

For this document, DLA is the prime signatory while EPA and TDEC concur with the findings of the ROD.

| | |
|---|---|
| C.R. McKelvey<br>Captain, SC, USN<br>Commander | 22 FEB 2001<br>Date |
| Richard D. Green, Director<br>Waste Management Division<br>U.S. Environmental Protection Agency,<br>Region 4 | 6 SEP 01<br>Date |
| James W. Haynes, Director<br>Division of Superfund<br>Tennessee Department of Environment and Conservation | March 1, 2001<br>Date |

# 2.0 Decision Summary

## 2.1 Site Name, Location, and Description

The Memphis Depot (Depot) is a former military supply facility that closed in September 1997 under the Base Realignment and Closure (BRAC) Act. The Depot is located in southeastern Memphis, Tennessee (Figure 2-1), approximately 5 miles east of the Mississippi River and just northeast of Interstate 240. The Depot includes two components: the MI, which is the focus of this report, and Dunn Field. Airways Boulevard borders the Depot on the east and provides primary access to the installation. Dunn Avenue, Ball Road, and Perry Road serve as the northern, southern, and western boundaries of the MI, respectively.

For the purposes of completing the RI and FS, while complying with BRAC requirements, the term "Functional Unit" (FU) was established to identify groups of sites on the MI based on operational history, expected use, location, and where the human health exposure is generally uniform. The FUs are a refinement of the "Operable Unit" (OU) designation and are based on common past and anticipated future use of the land on the MI. The MI is divided into six FUs. A seventh FU is the groundwater beneath the MI. They are defined in Table 2-1 and shown graphically on Figure 2-2. This ROD addresses FUs 1 through 7 at the MI. At the time of closure, the Depot included approximately 118 buildings, 26 miles of railroad track, and 28 miles of paved streets, the majority of which lie within the MI. The facility includes approximately 5.5 million square feet ($ft^2$) of covered storage space and approximately 6 million $ft^2$ of open space.

The lead agency for site activities at the Depot is the DLA. The regulatory oversight agencies are EPA and TDEC. DLA will implement the selected response actions and will incur all associated costs. The Depot has an EPA Identification Number listed as TN4210020570.

## 2.2 Site History and Enforcement Activities

Starting in the 1940s, the Depot received, warehoused, and distributed supplies common to all U.S. military services and some civil agencies. Activities at the MI included storing and shipping various materials (e.g., food, clothing, medical supplies) and industrial supplies (e.g., hazardous materials). Several commonly used hazardous materials were also used for facility maintenance. Hazardous materials which were used or stored at the Depot during its operational period include: flammables, solvents, petroleum/oil/lubricants (POL), paints, pesticides, herbicides, wood treating products, oxidizers, corrosives, and reactives.

Types of past activities that led to the presence of hazardous materials in the environmental media at the facility include pesticide application, painting and sandblasting, vehicle maintenance, and hazardous material handling/storage. Other historical activities in open and enclosed storage areas included storing transformers with polychlorinated biphenyls (PCBs), storing and using pesticides/herbicides, and treating wood products with pentachlorophenol (PCP). These industrial activities (e.g., sandblasting of lead based paints, application of pesticides, use of hazardous materials) resulted in the presence of metals, pesticides, and other less frequently detected chemicals in surface soil, surface water, and sediment above background concentrations.

Important dates for the Depot as part of the clean-up process for these chemicals are as follows:

- From **1989 through 1990**, Law Environmental through a contract with the U.S. Army Engineering and Support Center (USAESCH) conducted an RI at the Depot.
- In **January 1990**, EPA Region 4 conducted a Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) at the facility through a contract with A.T. Kearney, Inc. (EPA, 1990).
- On **September 28, 1990**, the Depot was issued a RCRA Part B permit (No. TN4 210-020-570) by EPA Region 4 and TDEC. Subsequently, in accordance with Section 120(d)(2) of CERCLA, Title 42, Section 9620(d)(2) of CERCLA, and Title 42, Section 9620(d) (2) of the United States Code (USC), EPA prepared a final Hazard Ranking System (HRS) Scoring Package for the facility. On the basis of the final HRS score of 58.06, EPA added the Depot to the National Priorities List (NPL) by publication in the *Federal Register* (FR), 57 FR 47180 No. 199, on **October 14, 1992**.
- On **March 6, 1995**, a Federal Facilities Agreement (FFA) under CERCLA, Section 120, and RCRA, Sections 3008(h), and 3004(u) and (v), was reached by EPA, TDEC, and the Depot. The FFA identified a list of sites for investigation (Table 2-2). The FFA also outlined the terms by which the investigation and clean-up will be conducted. The selected remedy addresses all concerns related to these sites.
- In **July 1995**, the Depot was identified for closure under the BRAC process, which requires environmental restoration at the Depot to comply with requirements for property transfer under Public Law 101-510 of Title XXIX, Defense Base Closure and Realignment. After the Depot was placed on the BRAC closure list, the City of Memphis and County of Shelby established the Memphis Depot Redevelopment Agency, now the Depot Redevelopment Corporation (DRC), to plan and coordinate the reuse of the Depot. The DRC conducted several public meetings during the preparation of its *Memphis Depot Redevelopment Plan* to obtain community feedback on future land use plans. The *Memphis Depot Redevelopment Plan* was approved in 1997.
- From **1995 through 2000**, the Depot conducted an RI/FS under EPA, TDEC, and DLA oversight. The RI work plans were prepared in 1995 (and amended in 1998) and the RI report was finalized in January 2000. Separate FS reports were prepared for the soils and groundwater on the MI. Both FS reports were finalized in July 2000. The Proposed Plan for the MI was finalized in August 2000.

In addition, a number of interim remedial actions (IRAs) were conducted at the MI. These IRAs are detailed in Section 2.4.1 of this ROD.

## 2.3 Community Participation

The Depot has performed public participation activities throughout the CERCLA site clean-up process. This includes monthly Restoration Advisory Board (RAB) meetings since 1994, numerous Community Involvement Sessions and public meetings, production of a bi-monthly newsletter, and the establishment of information repositories and a Depot Community Outreach Room. The importance of Environmental Justice issues has been addressed through the Depot's community outreach programs, which consider the needs, interests, and concerns of those most directly impacted by the site clean-up activities. One of the more frequently raised Environmental Justice issues relates to anecdotal evidence from former Depot workers that past exposure, associated with their job duties, to hazardous substances, pollutants, or contaminants has resulted in occupation-related health problems. This issue is a common topic in meetings with community members, but it is not within the scope of the Superfund program to address, except to remediate any release to the extent that future site workers do not experience an undue risk related to past releases of these chemicals.

As part of the public participation activities, the Depot placed the final MI RI report in the Depot's four Information Repositories in January 2000 and announced the report's availability at the February 2000, March 2000, and April 2000 RAB meetings. The findings from the RI, including the baseline risk assessment (BRA), were presented to the public during the June and July 2000 RAB meetings.

Pursuant to CERCLA Sections 113(k)(2)(B)(i-v) and 117, the RI/FS reports and the Proposed Plan for the MI were released to the public for comment. The Depot released the RI report in January 2000 and released the Soils and Groundwater FS reports and the Proposed Plan in August 2000. These documents can be found at the following information repositories:

- Memphis Depot Community Outreach Room
- Memphis/Shelby County Health Department
- Cherokee Branch, Memphis/Shelby County Public Library System
- Hillview Village Neighborhood Network Systems

The notice of the availability of these documents was published in the *Commercial Appeal, Tri-State Defender*, and *Silver Star News*. A public comment period was held from August 14, 2000, to October 13, 2000. In addition, a public meeting was held on August 24, 2000, to explain the Proposed Plan and all the alternatives presented in the FSs. At this meeting, representatives from DLA accepted oral and written comments about issues at the MI and the remedial alternatives under consideration. The response to the comments received during this period is included in the Responsiveness Summary, in Section 3.1 of this ROD.

## 2.4 Scope and Role of Response Action

The overall strategy for remediation of the Depot is to select and implement the most effective response action to address soil and groundwater contamination that will protect public health and the environment while allowing for transfer or lease of the property for its intended land use.

As with many NPL sites, the problems at the Depot are complex. As a result, the Depot was divided into two components:

- Dunn Field (Operable Unit 1)
- MI (FUs 1 through 7)

A ROD for an IRA of the groundwater at Dunn Field was completed in January 1996 and was signed in April 1996. The Dunn Field interim ROD presents the selected IRA for hydraulic control of the contaminant plume in groundwater beneath Dunn Field via groundwater extraction and discharge to the publicly owned treatment works (POTW) or municipal sanitary sewer. Contaminants identified as those of potential concern include VOCs, such as solvents used for cleaning mechanical parts, and metals. The IRA is not intended as a permanent solution; however, it is intended to be compatible with the final remedy.

The final design for this IRA was completed in August 1997, and included the installation of seven groundwater extraction wells, one pre-cast concrete building, an underground conveyance system, flow measurement and control systems, and associated civil, electrical, and instrumentation/controls work. Construction began in January 1998 and was complete in October 1998. The interim groundwater extraction system began operation in November 1998 and continues to operate as of the date of this report. The groundwater extraction system was expanded to include four additional groundwater extraction wells to the south of the original seven wells. The expansion of the groundwater extraction system is scheduled to be operational in early 2001.

As noted previously, the RI and FS for Dunn Field are currently underway and are scheduled to be completed in 2001 and the final ROD in 2002.

This ROD addresses the soil contamination within the MI and groundwater contamination located only under the MI. Exposure to surface soil poses a current and potential risk to human health of residential users in FUs 1 through 6 and industrial users in FU4. Ingestion of groundwater (FU7) poses a current and potential risk to human health.

### 2.4.1 Past Response Actions at the MI

Interim actions have been taken to remove soils containing pesticides, PCBs and PCP surrounding the MI Housing Area, cafeteria (Building 274), and PCP dip vat area (Building 737), respectively (Figure 2-3a). The removal of surface soils containing elevated metals and polynuclear aromatic hydrocarbons (PAHs) near the southwest corner of the MI (FU3) was completed in August 2000. Interim actions that have been performed at the MI are detailed below.

- Approximately 602 $cy^3$ of surface and subsurface soil was removed from the PCP dip vat area in FU4 (Building 737) because of elevated levels of PCP (completed in 1985).

- Approximately 5,000 tons or 3,700 $cy^3$ of surface soil in the Housing Area of FU6 was removed because of the presence of dieldrin (began in June 1998; completed in October 1998). The soil was disposed at a RCRA-permitted Subtitle D landfill. The Housing Area is an exception to the overall industrial land use for MI and is acceptable for residential reuse.

- Approximately 530 tons or 400 $cy^3$ of surface soil surrounding the cafeteria (Building 274) in FU6 was removed because of elevated levels of PCBs (began in October 1998; completed in November 1998). The soil was disposed at a RCRA-permitted Subtitle D landfill.
- Approximately 980 $cy^3$ of surface and subsurface soil from near Buildings 1084, 1085, 1087, 1088, 1089 and 1090 was removed because of elevated levels of metals and PAHs (began in May 2000; completed in August 2000). The soil was disposed at a RCRA-permitted Subtitle D landfill.

### 2.4.2 Planned Response Actions at the MI

To achieve acceptable residual risk levels and allow for the planned industrial and recreational land use for the MI, the remedial actions listed below are planned for the MI:

- Restrict (1) future residential land use (except for the existing Housing Area in FU6) in FUs 1 through 6, (2) day care operations in FUs 1 through 6, and (3) casual access to FU2 from adjacent off-site residents through land use controls. It should be noted that FU6 consists of BRAC Parcels 1, 2, 4, and 5. In 1998, surface soil in the Housing Area of FU6, BRAC Parcel 2, was removed because of the presence of dieldrin (see Section 2.4.1). The Housing Area is the only area of the MI that may be used for future residential purposes, according to the DRC's *Memphis Depot Redevelopment Plan*. As such, it has been restored to meet the risk criteria for both industrial and residential use. Results of soil samples collected in the open land area around Building 144 and the north and south paved parking lots within BRAC Parcel 1 also indicated levels that are not inconsistent with unrestricted use. Parcel 1 was used in the past for administrative and employee parking purposes and does not contain any long-term operational areas. A hazardous substance release occurred as a result of pesticide application during routine grounds maintenance, but not at concentrations that require remedial action. Figure 2-3b depicts the areas of FU6 (Parcels 1 and 2) available for unrestricted reuse. The remainder of FU6 is safe for industrial use but not suitable for future residential use. Land use controls will be placed on these areas to prevent future residential use and day care operations.
- Attain soil concentrations of lead acceptable for industrial land use for FU4 (see Section 2.13 for Documentation of Significant Changes).
- Prevent future groundwater use on the MI while concentrations of the chemicals of concern (COCs) are above maximum contaminant levels (MCLs).
- Reduce concentrations of COCs in groundwater migrating away from the MI to MCLs.
- Conduct 5-year reviews of the remedial action according to Section 121(c) of CERCLA and NCP §300.430(f)(5)(iii)(C) if there are any hazardous substances, pollutants, or contaminants remaining at the site above levels that would allow for unlimited use and unrestricted exposure. The review will be conducted no less often than each 5 years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented.

# 2.5 Site Characteristics

## 2.5.1 Overview of Site

The Depot covers 642 acres of land. The MI comprises 574 acres of the Depot. Dunn Field, to the north of the MI, comprises the balance of the acreage. FU and parcel boundaries within the MI are presented on Figure 2-2.

### Geology

The principal geologic units beneath the Depot are (from oldest to youngest): Paleocene Old Breastworks Formation and Fort Pillow Sand, Eocene Flour Island Formation, Memphis Sand, and Claiborne Group-the Cockfield and Cook Mountain Formations; the Jackson Formation; the Pliocene/Pleistocene fluvial deposits, and the Pleistocene loess deposits. Monitoring wells drilled for the RI at the MI penetrate all formations down to and including the top of the Memphis Sand. The lithology of these units is described in the RI.

A clay-rich unit typically occurs near the base of the fluvial deposits beneath most of the MI. This upper clay of the Jackson Formation/Upper Claiborne Group does not appear to be present at the base of the fluvial deposits in the northwestern part of MI and in the southwestern part of Dunn Field. Hydrogeologic cross-sections based on boring logs are presented in the RI and Groundwater FS. The RI concluded that clay-rich units (clay or clayey sand) occur in the Jackson Formation/Upper Claiborne Group at variable elevations, and also are highly variable in thickness.

### Hydrology

There are only two surface water bodies on the Depot: Lake Danielson and the Golf Course Pond (Figure 2-2). No perennial streams, flood-prone areas, or wetlands occur within the Depot. The lake and pond are fed by drainage ditches conveying stormwater runoff. There is no groundwater inflow to these water bodies because both are too shallow to intercept the local water table.

The uppermost aquifer beneath the Depot appears to occur under water-table conditions in the fluvial deposits at an average depth of 87 feet below ground surface (CH2M HILL, July 2000a). Water levels in wells indicate the fluvial aquifer in the fluvial deposits ranges from approximately 5 to 25 feet (ft) in thickness.

Underlying the fluvial aquifer is a confined sand aquifer within the Jackson Formation/ Upper Claiborne Group (Cockfield and Cook Mountain Formations). In some places, ancient erosion or variations in thickness during deposition have removed or thinned the clay units in the Jackson Formation/Upper Claiborne Group deposits. In these areas, the sand within the Cockfield and Cook Mountain Formations is intermittently in hydraulic connection with the overlying fluvial deposits, and there is strong potential for downward movement of groundwater.

Beneath the confined sand aquifer in the Jackson Formation/Upper Claiborne Group is the Memphis Sand aquifer. Regional hydrogeologic reports state that a thick clay unit typically occurs between the confined sand aquifer in the Jackson Formation/Upper Claiborne Group and the Memphis Sand aquifer. The Memphis Sand is the source of water supply for the

City of Memphis. Due to extensive pumpage from the Memphis Sand for water supply, there are strong downward gradients from the shallow aquifers to the Memphis Sand beneath most of Memphis and Shelby County (Graham and Parks, 1986).

### 2.5.2 Groundwater Conceptual Model

A groundwater conceptual model was created for the RI and re-analyzed for the groundwater FS. Both models and findings are discussed below.

The initial conceptual model of the water-table aquifer relied on the presence of an underlying clay layer to sustain saturation of the fluvial aquifer. A potentiometric map displaying the water table surface of the fluvial aquifer (Figure 2-4) was developed for the RI report (CH2M HILL, January 2000). Water levels in wells that were screened above the uppermost clay in the Jackson Formation/Upper Claiborne Group were used to determine the potentiometric contours (water-level elevations) shown on Figure 2-4. A principal feature of the map on Figure 2-4 is a large depression in water levels centered at MW34 (in the southwestern corner of Dunn Field). If this feature is an accurate representation of the fluvial aquifer, then contaminants within the water-table aquifer under the northern part of the MI should migrate toward this depression.

Between completion of the RI and the FS, a revised conceptual model of the fluvial aquifer was developed. The revised model is based on the concept that the fluvial aquifer occurs within the fluvial deposits, regardless of the presence of an underlying clay layer. A new map of the water-table aquifer (Figure 2-5) was developed using only water levels from wells screened in the fluvial deposits. A significant difference between Figures 2-4 and 2-5 is the absence of the depression contours in the north-northwestern part of the MI, as the elevation of the water table is inferred in the area of MW34, MW38, and MW18. As indicated on Figure 2-5, groundwater in the fluvial deposits is expected to flow from the MI property boundaries toward the south-central part of the MI. Flow into this area is believed to be due to downward leakage from the water table to the underlying sand aquifer in the Jackson Formation/Upper Claiborne Group.

The differences between the two conceptual models of the water-table aquifer have significance for remedial actions. In particular, the model in the RI suggests monitoring wells are needed to detect potential plume migration toward the north and northwest of the MI. The revised model in the FS suggests monitoring is needed in the central and south-central part of the MI. Likewise, remedies that might be used to intercept and treat the leading edge of a contaminant plume may be located in different areas, depending on which model is confirmed.

Because of the uncertainty and the importance of deciding which conceptual model accurately represents water-table conditions beneath the MI, additional soil borings and monitoring wells will be installed at various depths in the northern part of the MI and southeastern part of Dunn Field. This additional hydrogeologic data collection effort will be conducted to continue refining the conceptual model and provide necessary information on the site hydrogeology. Evaluation of the results of this fieldwork will be conducted prior to the design/implementation of the preferred groundwater remedy. It is important to note that the additional data to be collected are intended to refine the specific locations where remediation will be implemented; the selection of the remedial action will be identical regardless of which conceptual model is ultimately proven correct.

Whichever conceptual model is used, water levels in April 2000 in the fluvial deposits ranged from about 195 to 240 ft mean sea level (msl) beneath the MI. At the same time, water levels in the sand aquifer within the Jackson Formation/Upper Claiborne Group were about 178-ft msl (at MW18), and in the Memphis Sand aquifer were at about 150 ft msl (in MW67). These data indicate a strong downward gradient between the fluvial aquifer, the confined sand aquifer in the Jackson Formation/Upper Claiborne Group, and the Memphis Sand aquifer at the Depot. For these gradients to be sustained, the confining clay layers within the Jackson Formation/Upper Claiborne Group must be horizontally extensive. The presence of these clay layers (except in the areas where the clay layer is thinned or absent) strongly retards the potential downward migration of contaminants from the fluvial deposits into the Memphis Sand.

### 2.5.3 RI Summary

#### Previous Investigations

In conformance with DLA environmental programs, several technical studies have been conducted at the Depot prior to the RI that began in 1995.

Installation Assessment - In 1981, the DLA and the U.S. Army Toxic and Hazardous Materials Agency (USATHMA) conducted an Installation Assessment (IA) to identify previously used waste disposal areas and waste management practices pursuant to the Installation Restoration Program (IRP). The IA indicated that some past waste management practices were not compatible with waste management practices in use at the time of the inquiry. This study identified areas where hazardous materials might have been used, stored, treated, or disposed at the site. Based on this assessment's findings, USATHMA recommended that DLA conduct a field survey (USATHMA, July 1982).

Geohydrologic Study - In 1982, the Army Environmental Hygiene Agency (AEHA) conducted a geohydrologic study to characterize the geohydrologic setting and to identify and monitor sources of potential groundwater contamination. The study identified two areas as having the potential for groundwater contamination: Dunn Field and the PCP Dip Vat Area (AEHA, 1982). More detailed information regarding groundwater investigations and investigations at the PCP Dip Vat Area is presented in Sections 1.4.8 and 1.4.9 of the MI RI, respectively.

Environmental Audit - In 1985, AEHA conducted an environmental audit of the Depot's waste management and disposal practices. The audit revealed the presence of damaged containers of acids, bases, solvents, and cleaners in the vicinity of Building 873 (the area designated as Site 27). In addition, spill areas and potentially contaminated soil areas were identified adjacent to this building (AEHA, 1985).

Water Quality Biological Study - In 1986, AEHA performed a water quality biological study at the Depot. This study was conducted to investigate possible metal, pesticide, and other inorganic and organic contamination of Lake Danielson and the Golf Course Pond waters, sediment, and associated fish species. The major finding from the water analysis was the presence of DDT in the stormwater influent to Lake Danielson.

Lake Danielson sediment analysis results indicated that several metals (cadmium, chromium, copper, lead, and zinc) and pesticides (chlordane and DDT) were effectively bound up in the sediments.

The following were the highest contaminant concentrations detected in the fish tissue samples:

- There were 23.64 milligrams per kilogram (mg/kg) of DDT, plus breakdown products in Lake Danielson fish tissue samples, compared to the U.S. Food and Drug Administration (FDA) action level of 5.0 mg/kg.
- Chlordane was detected at 2.13 mg/kg in the Lake Danielson fish tissue samples and 0.6 mg/kg in the pond fish tissue samples, compared to the FDA action level of 0.3 mg/kg.
- PCBs and chlorpyrifos (Dursban®) were detected in the fish tissue samples.

The result of this study was a recommendation to place these water bodies off-limits to fishing (AEHA, 1986).

RI/FS (1990) - In 1989 and 1990, the Depot initiated an RI/FS of several known and suspected sources of contamination. This study was performed by Law Environmental through a contract with the U.S. Army Engineering and Support Center (USAESCH). The final work plan for this effort was presented to EPA in April 1989. The study was performed in two phases, referred to as Phase I (primarily activities in 1989) and Phase II (primarily activities in 1990). The final 1990 RI report (Law Environmental, 1990a) was provided to EPA in August 1990 and the final FS report (Law Environmental, 1990b) was submitted in September 1990. The study indicated that the fluvial aquifer under Dunn Field was contaminated and that additional investigation was needed to fully identify contaminant source areas and to delineate the contaminant plume.

RFA - In January 1990, EPA Region 4 conducted an RFA at the facility through a contract with A.T. Kearney, Inc. (EPA, 1990). The RFA identified 49 solid waste management units (SWMUs) and 8 areas of concern (AOCs) at the site (a total of 57 sites). Of these, 12 SWMUs and 4 AOCs required no further action (NFA). Twenty-eight SWMUs and three AOCs required further investigation in the form of confirmatory sampling and analysis. Four SWMUs and one AOC were identified as needing RCRA Facility Investigation (RFI) characterization. On September 28, 1990, EPA and TDEC issued a RCRA Part B Permit to the Depot, No. TN4 210 020 570, under the Solid Waste Disposal Act (SWDA), as amended by RCRA of 1976.

Sediment Sampling - Sediment samples were collected from 18 off-site drainage pathway locations in October 1995 to assess the presence of contaminants in sediment from operations at the Depot (EDAW, January 1996). PAH compounds were detected at all sediment sampling locations, but exceedances of background and screening criteria were noted at only three sampling locations. Lead was the only metal detected above screening criteria throughout the sampling stations. DDD, DDT, and DDE were detected at numerous sampling locations at concentrations that exceeded background values or the National Oceanic and Atmospheric Administration (NOAA) sediment screening criteria.

In 1997, Radian International collected sediment samples from Lake Danielson and the Golf Course Pond for the baseline RA of surface impoundments at the golf course (Radian

International, May 1999). A total of 13 sediment samples and 1 duplicate were taken from the impoundments and analyzed for pesticides and PCBs. In late 1997, Radian International resampled both impoundments for sediments and Lake Danielson for fish tissue. Two composite samples of fish were collected from Lake Danielson: (1) whole body and (2) fillet. Both the whole body and fillet had pesticides–heptachlor epoxide, chlordane, dieldrin, DDE, and DDD. No fish were present in the Golf Course Pond. The sediment samples from the pond had the same pesticides as the fish samples, except dieldrin.

The Radian International report concluded that the presence of DDT, DDE, and DDD does not pose adverse health effects from direct exposure to pond sediments and surface water (risks ranging from $10^{-10}$ to $10^{-7}$ level) or indirect exposure through the ingestion of fish (risks at $10^{-6}$ level). All of the detected concentrations were below the ecological screening values. This report was finalized in May 1999.

Groundwater Monitoring Study - In 1993, Environmental Science & Engineering, Inc. (ESE), performed a groundwater monitoring study using existing monitoring wells at the Depot (ESE, 1994). The study was conducted to assess changes in groundwater quality since the RI/FS was completed in 1990. Groundwater samples were collected from 35 existing monitoring wells on- and off-site. The results indicated that all parameter concentrations above the federal and State of Tennessee MCLs were detected within the fluvial aquifer.

### RI Sampling Strategy

Field investigations as part of the RI were conducted from 1995 through 1999 to characterize the contamination in surface and subsurface soil, groundwater, surface water, and sediment at the MI and the surrounding areas in accordance with the existing work plans. Samples were collected by CH2M HILL during the following events: the RI/FS sampling events (three events total), the BRAC sampling event, and the groundwater sampling events in 1996, 1997 and 1998. In addition, a groundwater sampling event to evaluate the efficacy of natural attenuation as a remedy was conducted in 2000 as part of the FS.

A phased approach was used to implement observational methods of investigation at the MI. Soil, surface water, and sediment samples were collected from the first RI/FS sampling event for each site at locations and depths of most probable contamination based on available information. For example, if a sandblasting or painting operation (including storage of paints) occurred outside or within a building in a particular FU, the soil surrounding the operations and paint storage area was sampled for constituents that typically result from such activities.

Table 2-3 presents the number of samples collected in FUs 1 though 6 during the RI sampling events. Because of the wide variety of areas investigated, a complex array of analyses was conducted at a fixed-base laboratory. At least one sample from each FU was analyzed for the target compound list/target analyte list (TCL/TAL). Efforts were made to analyze for the TCL/TAL on samples from the area of known highest contamination from previous sampling events, or the areas of most probable contamination as discussed above, to increase the likelihood of detecting compounds not previously identified at the site.

After initial samples were collected, additional data were collected to meet the following needs:

- Provide sufficient data population to support a statistical estimate of the exposure concentration at each site to support a BRA.
- Assess the extent of contamination.
- Characterize the nature of contamination.
- Evaluate the potential for groundwater contamination. If present, then
- Provide data for FSs.

If, at any point, analytical results indicated either that contamination was not present or that the nature and extent of contamination had been defined based on comparison to the higher of either the background or risk-based concentration (RBC) of target compounds, no subsequent sampling was performed. However, if these criteria were not met, additional samples were collected and analyzed to more fully assess the nature and extent of contamination.

In 1998, in an effort to characterize the extent of both groundwater contamination beneath the MI and off-site, the Depot installed 12 groundwater monitoring wells, adding to the existing network of monitoring wells, obtained 7 groundwater quality samples with push methods, and installed 7 piezometers to monitor water levels. The groundwater samples collected during the RI were analyzed for a full spectrum of potential contaminants, including inorganics, trace metals, VOCs, semi-volatile organics, pesticides, herbicides, and PCBs (Table 2-4).

### Chemicals of Concern

### Known or Suspected Sources of Contamination

Types of past activities that led to the presence of hazardous materials in the environmental media at the facility include pesticide application, painting and sandblasting, vehicle maintenance, and hazardous material storage. Other historical activities in open and enclosed storage areas included storing transformers, storing and using pesticides and herbicides, and treating wood products.

Specific MI sources of the VOC plumes were not identified during the RI or previous studies (CH2M HILL, January 2000, Sec. 32; Law Environmental, 1990a). Considering the nature of the industrial operations at the MI, it is likely that the plumes resulted from multiple small-volume, undocumented releases, both on- and off-site. Extensive sampling during the RI did not identify any dense nonaqueous phase liquids (DNAPLs) (separate-phase solvents) in the soil at the MI (CH2M HILL, January 2000).

Tetrachloroethene (PCE) in the southwestern part of the MI appears to be migrating to on-site locations from off-site sources. Groundwater investigations have defined the boundary of the PCE plume in the upgradient direction but have not identified any off-site sources. A trichloroethene (TCE) plume in the southeastern corner of the MI also appears to result from unidentified off-site sources. Other data indicate that TCE and PCE plumes underlying the MI may have on-site origins. TDEC intends to conduct a site assessment of potential off-site sources of PCE and TCE. Remediation of off-site sources will be the responsibility of the off-site property owners and/or TDEC.

### Surface Soil

The soil COCs identified for consideration in the FS for surface soil included two metals (lead and arsenic) and the chlorinated pesticide dieldrin.

PAH compounds were not carried forward as COCs for several reasons. High PAH detentions are uniformly associated with transportation infrastructure (railroads, roadways, and associated runoff locations) and are assumed to be the results of auto, train, and airplane emissions. The current practice for the Depot is to remove railroad tracks as portions of the MI are developed for industrial land use. Therefore, they are not considered a CERCLA release at the Depot in accordance with the definition of a release under CERCLA §101(22).

Surface and subsurface soil across the MI are not considered to be principal threat wastes as defined by EPA guidance.

### Groundwater

The COCs identified for consideration in the groundwater FS were PCE and TCE.

Although contaminated groundwater poses an unacceptable risk through the ingestion pathway, it is not considered a principal threat as defined by EPA. None of the available RI or groundwater FS data suggest that DNAPLs occur in the groundwater under the MI; however, prior to the remedial design phase and implementation of the selected groundwater remedy, additional pre-design soil and groundwater sampling is planned to confirm that no DNAPLs are present at the top of the uppermost clay within the Jackson Formation/Upper Claiborne Group beneath the historic long-term operational areas on the MI that have been identified by TDEC (see Section 3.3 for additional information on the pre-design testing).

### Sediments and Surface Water

Results from the BRA presented in the RI indicated that direct exposures by human receptors to sediment and surface water in the ponds in FU2 did not present risks above the acceptable levels and thus no COCs were identified. Appendix M of the RI provides a list of all detected parameters in the surface water samples collected at FU2 and presents a comparison to screening and background values. In addition, a quantitative evaluation of chlordane, DDT, and metabolites, as well as dieldrin in fish and amphibian tissues, was conducted by Radian International (1999), and found that risk to piscivorous birds was unlikely. Therefore, it was concluded that the ecological risk at FU2 is negligible, and there is no need for remediation based on ecological risk.

## 2.5.4 Constituent Fate and Transport

Figure 2-6 presents a conceptual site model (CSM) of contaminant transport beneath the MI.

### Surface Soil

The fate and transport of each of the COCs in soil are briefly summarized below from Section 6 of the RI report (CH2M HILL, January 2000).

### Metals

Metals have been detected in all media at the MI and in general, are persistent in the environment. A direct relationship between the measured total metal concentration in soil and the extractable aqueous concentration cannot be assumed. The metal may be fixed in the interior of the soil and unavailable for exchange or release to water, or an exchangeable metal may be present at the surface of the particles. The potential release and migration of metals in the subsurface environment is a complex process.

Lead has a strong tendency to adsorb to the soil. A significant fraction of lead is insoluble and may be associated with colloidal particles. On the basis of the site data, lead is limited to the surface soil, indicating that it is tightly bound to the soil and paint material and is not leaching. The adsorption of arsenic onto clays, iron oxides, and organic (humic) matter reduces its mobility.

### Chlorinated Pesticides

Dieldrin was the most commonly detected chlorinated pesticide at the MI. This pesticide is not expected to volatilize significantly. Dieldrin-type pesticides (e.g., DDT, DDE, and DDD) are more likely to sorb to soil and are less mobile in aqueous phases. The most likely migration pathways for chlorinated pesticides are transport in airborne particulate emissions and transport of sorbed materials in surface runoff.

Dieldrin is extremely nonpolar and, therefore, has a strong affinity for organic matter in soil and sorbs tightly to soil particulates. It has low mobility through the soil column and migrates extremely slowly, even under saturated soil conditions. This low mobility is consistent with what was observed at the MI, where soils deeper than 2 ft are essentially free of dieldrin.

Use of these chlorinated pesticides has been discontinued in the U.S. for over a decade. The detection of high concentrations in the exposed soil after so many years since the last application indicates that the degradation rates of these pesticides are slower than the rates cited in the literature (Agency for Toxic Substances and Disease Registry [ATSDR], 1992).

Pesticide persistence is reduced by chemical or biological transformation processes and/or environmental sequestration. Sequestration of pesticides usually means natural burial in soils or sediments, where the compounds are tightly bound to organic carbon structures and there is little biological activity. Transformation processes, on the other hand, are variable and complex. A pesticide molecule that undergoes physical, chemical, or biological transformation in one environmental matrix might continue to be transformed/degraded in the same (or another) matrix by similar or different processes.

Pesticides are subject to three major transformation processes: biodegradation, abiotic oxidation and hydrolysis, and photolysis. The rate of these processes depends on environmental conditions such as temperature, oxygen content, and vapor pressure, as well as the chemical structure and properties of the substance (e.g., water solubility) and the distribution of the pesticides in various environmental matrices. However, while sufficient exposure to transformation processes will eventually transform all common pesticides to benign constituents, as a group, pesticides are very resistant to transformation (i.e., they have long environmental persistence).

## Groundwater

### Fluvial Aquifer

Recharge to the fluvial aquifer occurs through infiltration of rainfall. Dissolution of soil contaminants can occur as the water percolates through the soil and loess deposits. These dissolved contaminants may move downward to reach the aquifer. Within the unsaturated soil, multiple natural attenuation processes retard the migration of contaminants, including:

- Adsorption (sticking) to soil grains
- Volatilization (transfer from water to soil vapor phase)
- Dispersion (dilution)
- Biological transformation into different compounds, i.e., plants and soil bacteria can degrade many organic contaminants

As contaminants reach the water table, they may migrate within the groundwater flow system. Many of the same processes that attenuate contaminants in the soil horizon also are active in the aquifer.

Natural attenuation within an aquifer appears to be an important process controlling the TCE and PCE plumes at the MI. PCE levels in the fluvial aquifer at the southwestern MI boundary are greater than 50 micrograms per liter (μg/L), but these levels decrease to non-detectable within three-quarters of a mile northeast of this point. TCE concentrations are greater than 30 μg/L at the southwestern MI boundary, but decrease to non-detectable also within a half-mile northeast of this point.

Natural attenuation studies were performed during the RI and in March 2000 to measure the significance of biological degradation. The March 2000 results are detailed in Appendix A of the Groundwater FS (CH2M HILL, July 2000a). The initial studies were inconclusive, but the second measurements showed that biodegradation is occurring as a slow process. Regardless of the exact contribution of each factor that contributes to natural attenuation, historical monitoring results indicate generally declining VOC concentrations since 1996, and no migration of VOCs from the MI to off-site areas.

### Memphis Sand Aquifer

As noted above, the Memphis Sand aquifer is the sole source of potable water supply for the City of Memphis. Contaminants in groundwater are, therefore, a major concern for Memphis residents. Reports addressing the potential for contamination of the Memphis Sand aquifer (Graham and Parks, 1986; Parks, 1990; Kingsbury and Parks, 1993) emphasize that this hydrogeologic unit receives most of its recharge from the outcrop area, several miles east of Memphis. Some recharge is derived from overlying or hydraulically communicating units. In the northwest part of the MI, lower water level elevations in the fluvial aquifer suggest that this is an area of leakage into a confined sand aquifer at the top of the Jackson Formation/Upper Claiborne Group. Tritium (a radioactive component of water) analyses conducted for the RI also indicate that mixing of groundwater from the fluvial aquifer into the underlying confined sand aquifer of the Jackson Formation/Upper Claiborne Group occurs in the southern part of Dunn Field and the north-central to northwest portion of the MI (CH2M HILL, January 2000). The potential also exists for leakage from this confined sand aquifer into the Memphis Sand aquifer between the MI and the nearby Allen Well Field. Neither vertical gradients nor the degree of vertical migration have been determined yet but in order to evaluate potential impacts, it is assumed that once groundwater flows to the area of downward leakage from the fluvial aquifer, it will continue to flow vertically to the Memphis Sand aquifer. In the future, dissolved contaminants in plumes beneath the MI may begin to migrate downward. If contaminants reach the Memphis Sand beneath the MI, they may be drawn toward the Allen Well Field.

To address this concern, calculations of potential transport of VOCs in the Memphis Sand were performed for the Groundwater FS. The BIOSCREEN model (Air Force Center for Environmental Excellence [AFCEE], 1997) was chosen to estimate potential VOC transport within the Memphis Sand aquifer beneath the MI to the nearest pumping well at the Allen Well Field. The calculations were based on the following assumptions:

- The model assumes that PCE and TCE at concentrations of 10 µg/L each enter the Memphis Sand aquifer.
- The horizontal dimension of the breach area into the Memphis Sand aquifer was assumed to be 500 ft. It was also assumed that the concentration held constant at this level to a depth of 50 ft within the Memphis Sand aquifer.
- Due to the lack of data, VOC degradation rates within the Memphis Sand aquifer were assumed to be only one-fifth of the minimal rates calculated within the fluvial aquifer beneath the MI from the March 2000 natural attenuation study (CH2M HILL, July 2000a). The assumed PCE degradation rate was 0.017/year (yr), one-fifth of the 0.086 value calculated for the fluvial aquifer. The assumed TCE degradation rate was 0.012/yr, one-fifth of the 0.062/yr value calculated for the fluvial aquifer. This information can be found in Appendix A of the MI Groundwater FS.

The calculations show that the maximum PCE and TCE concentrations at the closest public-supply well will be below the MCL of 5 µg/L. The model calculations are based on very conservative assumptions and, in all likelihood, are gross overestimates of potential VOC concentrations that may reach the Memphis Sand aquifer beneath the MI. However, the results of the modeling indicate that it is prudent to monitor the confined sand aquifer in the Jackson Formation/Upper Claiborne Group to guard against the potential for VOCs from the fluvial aquifer which have migrated downward and could potentially migrate into the Memphis Sand aquifer.

## 2.6 Current and Potential Future Land and Groundwater Uses

### 2.6.1 Land Use

The DRC board of directors, the City of Memphis, and Shelby County approved the *Memphis Depot Redevelopment Plan* in 1997. The intended land use is industrial for FU1 and FU3 through FU6, and recreational for FU2. The Housing Area in FU6 has been identified for use as transitional housing for the homeless. The MI is zoned as Light Industrial (I-L). The principal uses permitted are manufacturing, wholesaling, and warehousing. According to Section 24 of the Memphis and Shelby County zoning regulation, single-family, or multi-family residential uses are prohibited at the MI. Under the Federal Property Management Regulations, FU2 is slated for transfer from the Department of Defense (DoD) (Army) to the Department of Interior (DOI)/National Park Service (NPS). It will then be transferred by public benefit conveyance to the City of Memphis for use as a park. According to 41 CFR 101-47.308-7, property for use as a public park or recreational area must be used and maintained for the purpose for which it was conveyed in perpetuity, or be returned to the United States (24 CFR 51D).

The installation is currently surrounded by residential, commercial, and industrial areas.

### 2.6.2 Groundwater Use

There are no known users of groundwater from the fluvial or confined sand aquifer within the Jackson Formation/Upper Claiborne Group at the Depot. A well survey conducted within a 3-mile radius of the Depot did not identify any residential or downgradient commercial wells pumping from the fluvial aquifer. However, groundwater from both the fluvial and confined sand aquifers within the Jackson Formation/Upper Claiborne Group meets the requirements of General Use Ground Water as defined by TDEC (1200-4-3-.07). This means that these aquifers could be used for water supply when the Depot is converted to commercial and recreational uses. It is important to note that groundwater use controls established by the Memphis-Shelby County Health Department (MSCHD), Water Quality Branch, prevent the installation of water wells within 0.5 mile of the designated boundaries of a listed federal CERCLA site. In order to drill a well within the Memphis-Shelby County boundaries, a permit must be obtained from MSCHD.

Approximately 1 mile west of the Depot is the Allen Well Field, where 13 water-supply wells pump from the Memphis Sand aquifer. This aquifer is the potable water source for the City of Memphis and most of Shelby County. Therefore, one factor in evaluating the effectiveness of a remedial alternative is the extent to which it controls the migration of contaminants that might affect the quality of water produced by these public supply wells.

## 2.7 Summary of Site Risks

The response action selected in this ROD is necessary to protect human health and welfare, and the environment. The selected action will prevent imminent or substantial danger from actual or threatened releases from the MI of pollutants, contaminants, or hazardous substances. The BRA estimates what risks the MI poses if no action were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the BRA for this MI.

A BRA was conducted for each of the FUs at the MI. Overall results indicate that, under current (limited) land use conditions at the MI, no threat to human health or ecological receptors exists above acceptable limits. Health risks to industrial workers are within acceptable levels for future industrial use of the property, except for lead in a limited surface soil area in FU3. A future residential risk scenario was performed for comparison purposes only. It is unlikely that this industrial facility will be used for future residential purposes (except for the Housing Area in FU6) for several reasons. For example:

- The MI is currently zoned light-industrial, which prohibits residential use.
- Depot redevelopment plans do not include future residential development.

- The large warehouses are still valuable for commercial uses.
- Industrial/commercial uses offer the potential for employment.

Future residential health risks due to exposure to chemicals in soil were addressed to support remedial management decisions.

## 2.7.1 Summary of Human Health Risk Assessment (HHRA)

### Identification of COCs

The HHRA compares site- and chemical-specific risk estimates with the acceptable health risks and hazard index (HI) levels. Acceptable risk levels (risks) for NPL sites range from 1 to 100 excess lifetime cancer risks (ELCRs) per 1 million population. The acceptable target HI for noncarcinogenic chemicals is 1.0. The chemicals that exceeded those criteria and require remedial action for the protection of human health are identified as COCs. Target risk criteria and calculations are discussed in more detail under the *Risk Characterization* subsection.

### Sediments and Surface Water

Direct exposures by human receptors to sediment and surface water in the ponds in FU2 did not present risks above the acceptable levels and, therefore, no COCs were identified.

### Surface Soil

One COC in the surface soil and two COCs in groundwater have been identified that pose unacceptably high potential risk to human health at this site under industrial and recreational land use scenarios, which are the reasonably anticipated future land uses for the MI. Two additional COCs for surface soil have been identified at the MI under a future residential land use scenario. Table 2-5 summarizes the ranges and frequency of detection (FOD) of COCs at each FU of the MI.

Lead is the only COC detected in surface soil on the MI that exceeds the industrial land use criteria. Figure 2-7 shows the distribution of detected lead concentrations across the MI (exclusive of areas previously remediated). Lead was detected in site soils at between 10 and 2,800 mg/kg.

The following summarizes the COCs found in each FU under the intended land uses: lead was found to be above industrial land use criteria only at FU4. No COCs were identified in FU's 1, 2, 3, 5, and 6 for the intended future land use (industrial and recreational).

COCs Under Evaluated Risk Scenarios Across the MI
*Memphis Depot Main Installation ROD*

| FU | Industrial Land Use | Recreational Land Use | Residential Land Use |
|---|---|---|---|
| **1** (Twenty Typical Warehouses) | None | NI | Dieldrin, Arsenic |
| **2** (SE Golf Course Area) | NI | None | Dieldrin, Arsenic |
| **3** (SW Open Area) | None | NI | Arsenic, Lead |
| **4** (Northern and Central Open Area) | Lead is the COC | NI | Dieldrin, Arsenic, Lead |
| **5** (Newer Warehouses) | None | NI | Dieldrin, Arsenic |
| **6** (Administrative and Residential Area) | None | NI | Arsenic |
| **7** (Groundwater) | PCE, TCE | NI | PCE, TCE |

None — No COCs for this land use. FU is acceptable for this land use without remediation.
NI — Land use scenario not intended for this FU.

As noted earlier, PAH compounds were not carried forward as COCs in surface soil for several reasons. High PAH detentions are uniformly associated with transportation infrastructure (railroads, roadways, and associated runoff locations) and are assumed to be the results of auto, train, and airplane emissions. The current practice for the Depot is to remove railroad tracks as portions of the MI are developed for industrial land use. Therefore, they are not considered a CERCLA release at the Depot in accordance with the definition of a release under CERCLA 101(22).

### Groundwater

The BRA in the RI report concluded that only three VOCs and one metal could pose a potential risk to future workers or residents at the MI. PCE, TCE, 1,1,2,2-tetrachloroethane (PCA), and arsenic were identified as chemicals of potential concern (COPCs) in groundwater. Arsenic and 1,1,2,2-PCA were carefully evaluated in the BRA and are not considered contaminants requiring remedial attention for the following reasons:

- Arsenic exceeded the existing federal drinking water standard (MCL) of 0.05 mg/L only once in 65 discrete unfiltered samples collected from monitoring wells at the MI (excluding QA samples) during the RI. The detection of arsenic above the MCL occurred in well MW20 in the third quarter of 1997 at a concentration of 0.091 mg/L. MW20 was also sampled in the first quarter of 1996, second quarter of 1997, first quarter of 1998, and fourth quarter of 1998. None of those samples exceeded the current MCL (the results were 0.0017U mg/L, 0.0069J mg/L, 0.0023J mg/L, and 0.0014U mg/L, respectively). However, since the RI was published in January 2000, the EPA has revised the MCL for arsenic, as required by the 1996 amendments to the SDWA, to 0.010 mg/L. Groundwater data were reviewed once again and one additional exceedance of the new arsenic MCL was detected. The detection of arsenic above the new MCL occurred in well MW22 in the fourth quarter of 1998 at a concentration of 0.021 mg/L. MW22 was also sampled in the first quarter of 1996, second quarter of 1997, third quarter of 1997, and first quarter of 1998. None of those samples exceeded the new MCL (the results were 0.00068U mg/L, 0.0024U mg/L, 0.0025J mg/L, and 0.0031U mg/L, respectively).
- The arithmetic mean of the 65 arsenic concentrations is 0.0038 mg/L and the geometric mean is 0.002 mg/L. Both of these mean concentrations are below the new MCL of 0.010 mg/L. In addition, the background value for arsenic at the MI is 0.010 mg/L, which is at the new MCL.
- PCA was detected in only 2 of 83 groundwater samples analyzed. The levels of PCA were estimated to be 2 and 4 µg/L. There is no MCL for PCA.

The COCs identified in FU7 are PCE and TCE. In the BRA for FU7, the groundwater analytical data from the RI sampling event were divided into three general groups, based on location of the monitoring wells. The areas were designated as "Plume A" (southwestern), "Plume B" (northwestern), and "Plume C" (eastern). According to the groundwater sampling data results in the RI (as presented in Section 34), the average PCE concentrations from the three organic contamination plumes ranged from 5.5 to 39 µg/L, and the average TCE concentrations ranged from 6.8 µg/L to 9.3 µg/L. The maximum PCE concentration was 120 µg/L, and the maximum TCE concentration was 58 µg/L. These data are summarized in Table 2-6.

Upon closer analysis of groundwater analytical data during the FS, two distinct VOC groundwater plumes were delineated in the southwestern and southeastern portions of the MI. These plumes appear to be nearing each other in the central portion of the MI. Figures 2-8 and 2-9 show the extent of PCE and TCE in the fluvial aquifer on the basis of the most recent analytical data available. The historical VOC plumes in the fluvial aquifer are shown on Figures 2-10 through 2-13.

### Exposure Point Concentrations

A risk assessment was not conducted at every site identified within the FFA for the MI (see Table 2-2). Instead, selected representative sites were included for risk estimations. The sites were selected to represent the high-end of the potential exposures. Depending on the type of exposure scenario(s) likely to occur, a surrogate site or a single highest concentration data point for worst-case exposure concentrations was used for risk estimations for a future hypothetical resident, although the most reasonably anticipated future land use is industrial. The surrogate site and FU-wide risk assessments are based on exposure units where the maintenance worker's exposure unit is the entire area within an FU, and an industrial worker exposure is assumed to be a smaller exposure unit represented by a surrogate site. An exposure unit for a resident is assumed be a 0.5-acre lot, represented by the highest preliminary risk evaluation (PRE) data point within the FU. Figures identifying the exposure units within each FU are included in the human health RA sections of the RI.

A risk assessment was conducted for each FU using the data collected within the physical unit, combining all of the data collected during the three sampling events from BRAC parcels and screening and RI sites. These FU-wide risk assessments evaluated the current and future industrial land use scenarios. Exposure point concentrations (EPCs) calculated for an FU include data combined from parcels within the FU combined with data from the screening and RI sites.

Potential chemical intakes by receptors were estimated, where possible, from direct chemical measurements in the soil and groundwater. For an industrial land use scenario, EPCs in soil were estimated for each FU as the upper confidence limit at the 95th percentile on the mean (upper confidence level 95 percent, or UCL95), calculated following EPA guidance. Upperbound estimates of the risks within an FU represented by a surrogate site and the EPC were also UCL95 estimates. Field duplicates were not included in these calculations, so results are for environmental samples only. Table 2-6 summarizes the EPCs used to estimate the risk for each COC at each FU.

The EPC value for a future residential receptor is the maximum detected concentration within an FU, regardless of the location of the sample (see Table 7-2 of the RI). For the selection of the maximum potential risk sample, a PRE was calculated for all the samples, and the sample location presenting the highest risk ratio was selected to assess the future residential risks. For an industrial land use scenario, on the other hand, samples from within an FU were used as a set for UCL95 estimates for the EPCs. Upperbound estimates of the risks within an FU represented by a surrogate site and the EPC were also UCL95 estimates. Again, a surrogate site was selected based on the PRE ratio estimates.

For organic COCs in groundwater, instead of a statistical estimate as the EPC value, average concentrations from the wells within a contaminant plume were selected as the EPCs. These wells are listed along with groundwater EPCs in Table 2-6.

### Exposure Assessment

To identify potentially complete exposure pathways at the MI, a conceptual exposure model was developed for each FU and the corresponding surrogate site. A CSM presents an overview of site conditions, potential contaminant migration pathways, and exposure pathways to potential receptors. The site conditions include both current and likely future conditions. The potential contaminant migration pathways are those by which a contaminant could migrate through various media. The exposure pathways represent the mechanism by which a contaminant could reach a potential receptor. The CSMs presented in each FU-specific risk assessment section were formulated using professional judgment, but relying heavily on site characterization data, including information on contaminant sources, release mechanisms, routes of migration, potential exposure points, potential routes of exposure, and potential receptor groups associated with the MI. These CSMs are described in detail in the RI. For this document, the CSMs for each FU have been combined and the result is presented as Figure 2-21.

Potential current exposures include on-site workers who may come into contact with surface media while performing routine occupational duties at the facility. Several categories of on-site workers were identified on the basis of their specific job responsibilities, the locations at which they may work, and the environmental media they may contact. No unusually sensitive subpopulations were identified within the receptor groups considered relevant for surface media exposures from the MI. Hypothetical future exposure scenarios that were considered in the analysis include continued industrial and commercial occupational activities, residential development, and recreational use of on-site constructed ponds (the Golf Course Pond and Lake Danielson). Such hypothetical future exposures also include evaluations of exposure of sensitive populations (e.g., pregnant women workers) to on-site lead, following EPA guidance (EPA, 1996).

Table 2-7 summarizes potentially exposed populations for each area of the MI.

The routes by which each population group could reasonably be exposed to site contaminants are ingestion, inhalation, and dermal contact. Ingestion exposures to the surface soil, sediment, surface water, and groundwater were evaluated for all of the receptors and media identified at each site. Skin surface area available for contact was estimated through best professional judgment using current practice from available guidance.

Inhalation of dust was estimated for both current and future workers, using the default inhalation rate of 20 cubic meters/8-hour workday ($m^3$/8-hr workday). For the smaller sites, the time spent within the site is expected to be shorter; thus, the resulting inhalation from the site was modified by the fraction of the workday spent in the contaminated area. Under the residential scenario, adult and child receptors were evaluated, although this scenario was considered hypothetical and was not used for site management decisions. Residential receptors could come into contact with COCs in surface soil via direct contact and inhalation of particulate emissions from surface soil. The risk assessment assumed that exposure to surface soil could occur 4 hours/day for 350 days/year, over 30- and 6-year residence times for adults and children, respectively. All residential adult exposure carcinogenic estimates were age-adjusted for 6 years as a child and 24 years as an adult. Potential exposure to potable groundwater was assumed to occur 350 days/year for 30 years and 6 years for adults and children, respectively, with ingestion rates of 2 and 1 liters/day, respectively. A 10-minute daily shower also was assumed, which is calculated to be 0.007 of a 24-hour day.

Other assumptions related to the exposure assessment are described in Section 7 of the RI (CH2M HILL, January 2000).

A separate risk assessment was performed for FU2 surface soils (see Appendix C of the Soil FS), assuming a recreational golfer exposure scenario. Alternative unlimited recreational land use scenarios for FU2 were also considered. This assessment evaluates risks at the golf course for additional recreational scenarios, such as jogging, playing soccer, and installation of playground equipment associated with use as a public park. The assessment evaluates the potential human health risks from using the golf course as a general recreational area such as a public park. This supplemental risk assessment is not included in the final RI since the alternative unrestricted land use scenario was established after completion of the final RI report. Several exposure scenarios were evaluated for the golf course using the upper confidence limit at 95 percent above the mean value (UCL95 ) the maximum detected concentrations as EPCs, as reported in the streamlined risk assessment. The assessment concluded that the golf course may be used as a golf course, baseball field, playground, and soccer field. It may not be used as a future residential area under the assumed exposure conditions evaluated in this risk assessment without access control or remediation.

### Toxicity Assessment

A toxicity assessment was performed to determine the relationship between the magnitude of exposure to a chemical at the MI and the likelihood of adverse health effects to potentially exposed populations.

Table 2-8 presents carcinogenic risk information that is relevant to the COCs in both soil and groundwater. The dose-response relationship for cancer effects is expressed as a cancer slope factor (CSF) that converts estimated exposures directly to incremental lifetime cancer risk. CSFs are presented in units of risk per level of exposure (or intake). Table 2-9 explains the EPA weight-of-evidence classification system for carcinogenicity.

Table 2-10 provides noncarcinogenic risk information that is relevant to the COCs in both soil and groundwater. For noncarcinogenic effects, toxicity values are derived based on the critical toxic endpoint (i. e., the most sensitive adverse effect following exposure). The toxicity value describing the dose-response relationship for noncancer effects is the reference dose (RfD). For most noncarcinogenic effects, the body's protective mechanisms must be overcome before an adverse effect is manifested. Once these protective mechanisms, or thresholds, are exceeded, adverse health effects may occur. Because no toxicity values specific to skin contact have been derived by EPA, oral RfDs were used for the dermal route.

### Risk Characterization

Table 2-11 summarizes the risks and HIs for future industrial and residential use, across the MI for surface soil and groundwater (FUs 1 through 7). This table also summarizes the risk calculations for COPCs considered in the RI and the selection of COCs using these risks.

### Carcinogenic Risk Calculation for Carcinogens

ELCR is defined as the unitless upperbound probability of the individual receptor developing cancer over a lifetime under the specified exposure conditions. This risk is above the background lifetime cancer risk of approximately 1 in 3. The ELCR is derived for each carcinogenic COPC as follows:

$$ELCR = CDI * CSF$$

where:

CDI = Route- and media-specific cumulative daily intake (dose) of a COPC (mg/kg/day)

CSF = Route-specific CSF $(mg/kg/day)^{-1}$ for the COPC

Summing all of the route- and media-specific ELCR estimates provides a total ELCR for a given COPC for each receptor. The summation of total ELCRs for all of the COPCs provides the total ELCR for the receptor at a site.

The ELCR levels due to intake of contaminated surface soil by a future receptor under industrial land use are within acceptable limits of 1 to 100 in a million. Exposure to average concentrations of groundwater organic COCs presents risks to future industrial workers and hypothetical future residents that are also within the acceptable risk range of 1 to 100 in a million.

### Hazard Index Calculation for Noncarcinogens

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period, e.g., lifetime, with an RfD derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). A HQ of less than 1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic noncarcinogenic effects from that chemical are unlikely. The HI is generated by adding the HQs for all COCs that affect the same target organ, e.g., liver, or that act through the same mechanism of action within a medium or across all media to which exposure by a given individual may reasonably be expected to occur. An HI of less than 1 indicates that, based on the sum of all HQs from the various contaminants and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI of greater that 1 indicates that site-related exposures may present a risk to human health.

The upperbound noncarcinogenic health hazard is estimated initially by calculating HQs on a route- and media-specific basis for each COPC for each receptor, as follows:

HQ = CDI/RfD

where:

CDI = Route- and media-specific cumulative daily intake (dose) of a COPC (mg/kg/day)

RfD = Route-specific reference dose (mg/kg/day) (daily intake considered unlikely to cause adverse effects over a lifetime of exposure) for the COPC

Summing the route- and media-specific HQs provides an estimate of a total HI for a given COPC for each receptor. The summation of HIs across COPCs provides a total HI for the receptor at the site. This procedure ignores toxicological endpoints and mechanisms of action as the basis for estimating the noncarcinogenic hazard from multi-contaminant exposure, thus providing a highly conservative estimate of potential effects.

Soil HQs for future industrial workers and recreational users in FU2 are below a target value of 1.0. Lead is above the industrial health protective level of 1,536 mg/kg in selected areas. The site has a predominantly industrial and recreational (golf course and playground areas in FU2) setting, which is the intended land use in the future.

Exposure to average concentrations of groundwater organic COC presents risks to future industrial workers and hypothetical future residents that are within the acceptable risk range of 1 to 100 in a million. HIs for a future industrial worker are within the acceptable level of 1.0, whereas HIs for a hypothetical future residential adult and child were at 1.0 and above 1.0, respectively. Exposure to maximum groundwater COC concentrations presents risks to future industrial workers that are within the acceptable range, but presents risks for the hypothetical future residential adult that are in the unacceptable range. HIs for a future industrial worker are within the acceptable level, whereas HIs for a future hypothetical residential child were above 1.0. Currently, there are no users of the shallow, fluvial aquifer beneath the Memphis Depot. Future concentrations of the VOCs are likely to decrease with time due to natural attenuation processes, although monitoring will be necessary to confirm this.

### Other Health-Based Risks

Health-based risks from lead are not calculated like cancer and HI risks; rather, they are addressed as a separate issue related to blood uptake models. Health-based protective target concentrations for lead in soil were calculated during the RI for an industrial worker (1,536 parts per million [ppm]) and for a hypothetical on-site resident (300 ppm).

### Uncertainty

Numerous sources of uncertainty are inherent in the risk assessment, due to the assumptions made. These generic uncertainty factors (and their relative effect on the risks and noncarcinogenic health hazards estimated for each site) are summarized in Table 2-12 and described qualitatively below. In the absence of measured data for exposures, risk calculations include conservative assumptions. Thus, when the actual situation is not known (uncertain), bias toward conservatism was used (e.g., future exposure scenarios and pathways, frequency of grass mowing, duration of time spent in a small area, exposure concentrations). The uncertainties associated with toxicity factors estimated by EPA include a bias to be conservative in RfD and CSF estimations.

### 2.7.2 Summary of Ecological Risk Assessment

The natural habitat in the MI area is very limited to non-existent. The golf course and the extensive industrialized areas do not provide natural habitat for wildlife. Ecological receptors, such as terrestrial or aquatic animals and plants in the ponds and streams, are not being exposed to the site groundwater, and are not likely to be exposed in the future. Occasional terrestrial animals visiting the facility or living nearby any of the six FUs are not subject to a significant threat from the site media.

A screening level Ecological Risk Assessment (ERA) conducted across the MI indicated little potential for significant ecological impacts or adverse effects to wildlife. The Screening Ecotoxicity Criteria for soil, sediment, surface water, and groundwater used in the ERA are listed in the RI. No ecological COCs were identified at the facility.

The land uses on the MI are expected to remain unchanged in the future; therefore, the potential for wildlife exposure is low. There are no unacceptable risks posed to ecological receptors at the MI.

## 2.8 Remedial Action Objectives

Remedial action objectives (RAOs) are medium-specific goals that the remedial actions are expected to accomplish to protect human health and the environment. They guide the formulation and evaluation of remedial alternatives. RAOs have been developed to reflect the anticipated future land use for the MI in accordance with EPA Policy, *Land Use in the CERCLA Remedy Selection Process (OSWER Directive No. 9355.7-04).*

The groundwater RAOs describe the goals that the remedial actions are expected to accomplish. The RAOs are expected to prevent ingestion of water contaminated with VOCs in excess of MCLs from potential future on-site wells; restore groundwater to levels at or less than MCLs; and prevent migration horizontally and vertically off-site of groundwater contaminants in excess of MCLs. The MCLs for TCE (5 μg/L) and PCE (5 μg/L) are the relevant and appropriate requirements for groundwater beneath the MI.

The surface soil RAO for protection of industrial workers is to prevent direct contact/ingestion of surface soils contaminated with lead in excess of industrial worker risk-based criteria (1,536 mg/kg).

The surface soil RAO for protection of future on-site residents is to prevent direct contact/ingestion of surface soils contaminated with dieldrin and arsenic in excess of HHRA criteria for residents; and prevent direct contact/ingestion of surface soils contaminated with lead in excess of risk-based criteria for protection of residential children.

The RAOs will reduce the excess cancer risk and HI associated with exposure to contaminated soil to acceptable levels to future workers and will prevent future residential development of the site. This will be achieved by reducing the exposure concentration of lead to the target clean-up level of 1,536 mg/kg (calculated using blood-lead uptake models) and by imposing land use restrictions.

Because there are no federal or state clean-up standards for soil contamination, these clean-up standards were established on the basis of the HHRA. Targets were selected that will both reduce the risk associated with exposure to soil contaminants to an acceptable level, and restrict the migration of contaminants into the groundwater.

## 2.9 Description of Alternatives

The remedial alternatives for the MI that are presented in the following text are numbered as shown below to correspond to the numbers in the MI FS reports.

| Medium | FS Alternative | Description |
|---|---|---|
| Soil | SS1 | No Action |
| | SS2 | Land Use Controls |
| | SS3 | Soil Containment |
| | SS4 | In-situ Soil Treatment |
| | SS7 | Excavation and Off-site Disposal |
| Ground-water | GW1 | No Action |
| | GW2 | Land Use Controls with Long-Term Monitoring |
| | GW3 | Enhanced Bioremediation |
| | GW4 | Air Sparging |
| | GW6 | Extraction and Discharge to POTW |

SS Surface soil
GW Groundwater

### 2.9.1 Description of Remedy Components

#### Surface Soil

Physical remedial action is required for approximately 7,200 $ft^2$ (or 270 $cy^3$) of lead-contaminated surface soil in FU4 (Figure 2-14). No other individual contaminant detected in surface soil at the MI is above an unacceptable risk level; however, measured as a group, contaminants may be above acceptable risk levels for future development scenarios for the MI. Specifically, cumulative risk from COCs in all other surface soils on the MI is within the acceptable risk range under the industrial and recreational reuse scenarios, but presents unacceptable risk under a residential reuse scenario.

EPA policy on land use allows reasonably likely future land uses to be considered in making risk management decisions, if properly documented. Through the BRAC process, the local redevelopment authority (DRC) produced the *Memphis Depot Redevelopment Plan*. This plan, in conjunction with current zoning for the MI (i.e., light industrial use), presents a compelling case that future residential use is unlikely (with the exception of the Housing Area in FU6, which is slated to be used for homeless veteran transitional housing). The only RAO required to address residential risk is, therefore, prevention of residential use.

Each of the alternatives described in this section would result in contaminants remaining at the site above levels that would typically allow for unlimited and unrestricted exposure. Therefore, as required by CERCLA and the NCP, a review of the selected remedial action will be necessary no less often than each 5 years after initiation of the remedial action to assure that human health and the environment are being protected.

### Alternative SS1: No Action
Regulations governing CERCLA require that the No Action alternative be evaluated to establish a baseline for comparison. Under this alternative, the Depot would take no action at the site to prevent exposure to soil contamination. The No-Action alternative would leave contaminated soil in place.

This alternative employs no technologies, land use controls, or operation and maintenance (O&M) activities.

### Alternative SS2: Land Use Controls
The land use controls alternative would leave contaminated surface soil in place, but would involve deed restrictions prohibiting the future use/sale of the property or portions of the property for residential use. These controls would be put in place through a land use controls implementation plan (LUCIP) that would be developed as part of the remedial design. The use restrictions would be included in Depot property transfer and leasing documents. The time to achieve RAOs would be approximately 6 months. Present worth (PW) costs use 30 years as a costing period, although the remedy may require monitoring, maintenance, and enforcement beyond this 30-year period.

The following land use controls would be implemented by the Depot (excluding the Housing Area [Parcel 2] and open land area around Building 144 and the associated north and south paved parking lots [Parcel 1] in FU6):

- Permanent deed restrictions prohibiting residential use (including day care operations) in FUs 1 through 6.
- Permanent deed restrictions precluding casual access by adjacent off-site residents through maintenance of a boundary fence surrounding FU2 (recreational area).
- Permanent deed restrictions prohibiting industrial land use at a 7,200-$ft^2$ area south of Building 949 in FU4 where lead-contaminated surface soil is greater than or equal to 1,536 mg/kg (Figure 2-14).
- Use of fencing and signage in FU4 (7,200-$ft^2$ area south of Building 949 in FU4 [Figure 2-14]) to regulate intrusive activities and potential exposure to contaminants.

The following O&M and monitoring activities would be required:

- Maintenance of access barriers and signage to limit entry into contaminated area in FU4.
- Periodic monitoring of the controlled area in FU4.
- An annual evaluation in accordance with the LUCIP, to verify that land use controls and deed restrictions are in effect and to ensure that land use changes that may pose an unacceptable risk to the users have not occurred.

### Alternative SS3: Soil Containment
This alternative would involve the placement of a protective soil cover over lead-contaminated surface soil to act as a physical barrier against direct contact under an industrial land use scenario. Surface controls would be necessary to prevent erosion damage or other disturbances to the protective cover. Under an industrial land use scenario, this alternative would also require the use of land use controls to prevent residential land use.

The time to achieve RAOs would be approximately less than 1 year. Present worth costs use 30 years as a costing period, although the remedy may require monitoring, maintenance, and enforcement beyond this 30-year period.

The following containment component would apply:

- A 1-ft-thick cover of soil or asphalt/concrete pavement would be installed over the contaminated surface soil.

The following additional land use controls would be implemented by the Depot:

- Regulation of intrusive activities into the protective cover in FU4 (7,200-$ft^2$ area south of Building 949 in FU4 [Figure 2-14]).
- Installation of access barriers and signage in FU4.

The following O&M and monitoring activities would be required:

- Maintenance of the cover.
- Periodic monitoring of the controlled area in FU4.
- An annual evaluation in accordance with the LUCIP, to verify that land use controls and deed restrictions are in effect and to ensure that land use changes that may pose an unacceptable risk to the users have not occurred.

### Alternative SS4: In-situ Soil Treatment

This alternative would include in-situ treatment for lead-contaminated surface soil. Under an industrial land use scenario, this alternative would also require land use controls to prevent residential land use. The time to achieve RAOs would be approximately 6 months for industrial land use.

The following treatment technology would be applied:

- In-situ treatment for lead-contaminated surface soils with a stabilizing chemical to fix, or immobilize, the contaminant (7,200-$ft^2$ area south of Building 949 in FU4 [Figure 2-14]).

The following O&M and monitoring activity would be required:

- Landscaping following treatment to restore the site to acceptable conditions.

### Alternative SS7: Excavation and Off-site Disposal

This alternative would include excavation of contaminated surface soil and permanent disposal in a RCRA-permitted landfill as a non-hazardous waste or hazardous waste depending on levels of contamination. Following excavation of the contaminated soil, clean backfill (laboratory-tested) would be placed in all areas excavated, and the site would be restored to its original condition. Under an industrial land use scenario, this alternative would also require land use controls to prevent residential land use. The time to achieve RAOs would be approximately less than 6 months.

The following excavation and off-site disposal components apply:

- Contaminated soil would be excavated to a depth of 1 ft and replaced with compacted clean (laboratory-tested) backfill. All disturbed areas would be reseeded with grass.

- Excavated lead-contaminated surface soil could require special handling and disposal at a RCRA Subtitle C hazardous waste landfill; however, disposal characterization samples would be analyzed prior to disposal. If the soil is determined to be non-hazardous, it could be disposed at a local Subtitle D landfill. Based on the concentrations of lead, it is conservatively assumed that all of the excavated lead-impacted soil would be hazardous and would be disposed at a hazardous waste RCRA Subtitle C landfill.

The following additional land use control would be implemented by the Depot:

- Temporary deed restrictions during excavation of contaminated soils to prevent possible use prior to and during the remedial action.

### Groundwater

PCE and TCE plumes have been delineated at the MI (see Figures 2-8 and 2-9). The concentrations of PCE and TCE in these plumes do not represent an unacceptable health threat under current conditions, wherein all potable water is provided by the municipal water supply. However, the concentrations of PCE and TCE do exceed applicable or relevant and appropriate requirements (ARARs). Thus, alternatives have been developed to achieve the RAOs.

Under each of these alternatives, contaminants would remain at the site above levels that would allow for unlimited and unrestricted exposure, until such time that the remedy attains the RAOs. Therefore, as required by CERCLA and the NCP, a review of the selected remedial action would be necessary no less often than each 5 years after initiation of the remedial action to assure that human health and the environment are being protected.

#### Alternative GW1: No Action

Regulations governing CERCLA require that the No Action alternative be evaluated to establish a baseline for comparison. This alternative would allow natural attenuation to reduce the contaminant plume in groundwater, but the lack of monitoring may allow undetected plume migration to off-site areas or into deeper aquifers. It would rely solely on existing groundwater use controls established by the MSCHD, Water Quality Branch, which prevent the installation of water wells within 0.5 mile of the designated boundaries of a listed federal CERCLA site.

This alternative would include no technologies, land use controls, or O&M activities.

#### Alternative GW2: Land Use Controls with Long-Term Monitoring

This alternative would rely on deed restrictions, coupled with existing groundwater use controls established by the MSCHD, Water Quality Branch. This alternative would also rely on dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials to reduce groundwater plume concentrations. The limited biodegradation processes would require between 15 and 50 years to reduce plume concentrations to MCLs, as indicated by calculations described in the Groundwater FS (CH2M HILL, July 2000a). The assumed duration of this alternative is 30 years.

The following land use controls would be implemented by the Depot:

- Deed restrictions would prohibit installation and use of production and consumptive use wells into the fluvial aquifer during the operational life of the remedy and drilling into aquifers below the fluvial aquifer. The deed restrictions would also guarantee access to all monitoring wells for the life of the remedy. These restrictions could be removed at the completion of the remedy.

- Contingency provisions would ensure that if groundwater contamination exceeds MCLs at the property boundary wells or interior sentinel wells, more active measures for plume control would be evaluated and implemented as needed to protect public health and the environment. The interior sentinel wells would be used to monitor the groundwater within the confined sand aquifer, which underlies the fluvial aquifer and the clay aquiclude beneath that. If, as noted above, samples obtained from these sentinel wells indicate that groundwater in this confined aquifer has become contaminated, additional active remedial measures would be necessary.

The following O&M and monitoring activities would be required:

- Monitoring of a network of groundwater wells, the frequency of which would be determined during the Remedial Design phase of the project.
- Monitoring well maintenance (cleaning, wellhead repairs, plugging, and abandonment) as needed.
- Annual summaries of monitoring data to document the site conditions and progress of the remedy. An annual evaluation in accordance with the LUCIP to verify that land use controls and deed restrictions are in effect and to ensure that land use changes that may pose an unacceptable risk to the users have not occurred.

### Alternative GW3: Enhanced Bioremediation

This alternative would use injection of nutrients/chemicals to enhance the natural biodegradation processes (Figure 2-15). It would also include land use controls and groundwater monitoring similar to Alternative GW2 (Land Use Controls with Long-Term Monitoring). In the absence of pilot test data, a conservative assumption was made that the nutrients/chemicals would triple the biodegradation rate within the fluvial aquifer, and that the duration of the remedial action would be approximately 10 years.

The following treatment technologies would be applied:

- Nutrient injection into the fluvial aquifer would be accomplished via borings or wells. Treatment zones would be established in the most contaminated parts of the plume within the MI (Figure 2-16).
- Untreated parts of the groundwater plume would degrade under natural attenuation processes (as described in Alternative GW2)
- Contingency provisions would ensure that if groundwater contamination exceeds MCLs at the property boundary wells or the interior sentinel wells, more active measures for plume control would be evaluated and implemented as needed to protect public health and the environment.

The following land use controls would be implemented by the Depot:

- Deed restrictions would prohibit the installation and use of production and consumptive use wells during the operational life of the remedy, and drilling into aquifers below the fluvial aquifer. The deed restrictions would also guarantee access to all contingency areas, monitoring, boundary, and sentinel wells for the life of the remedy. These restrictions can be removed at the completion of the remedy; however, any local controls separately in existence at the time would not be affected.

The following O&M and monitoring activities would be required:

- Monitoring of a network of groundwater wells, the frequency of which would be determined during the Remedial Design phase of the project.
- Monitoring well maintenance (cleaning, wellhead repairs, plugging, and abandonment) as needed.
- Annual summaries of monitoring data to document the site conditions and progress of the remedy. An annual evaluation in accordance with the LUCIP, to verify that land use controls and deed restrictions are in effect and to ensure that land use changes that may pose an unacceptable risk to the users have not occurred.

### Alternative GW4: Air Sparging

This alternative would treat groundwater through a network of air injection wells (Figure 2-17). in the absence of pilot test data, a conservative assumption was made that air sparging would remediate the plume in 10 years. Therefore, this alternative would include land use controls and groundwater monitoring similar to Alternative GW2 (Land Use Controls with Long-Term Monitoring).

The following treatment technologies would be applied:

- Air sparging of the fluvial aquifer would be conducted via a network of wells. Treatment zones would be established in the most contaminated parts of the plume within the MI (Figure 2-18).
- Untreated parts of the groundwater plume would degrade under natural attenuation processes.
- Contingency provisions would ensure that if groundwater contamination exceeds MCLs at the property boundary wells or the interior sentinel wells, more active measures for plume control would be evaluated and implemented as needed to protect public health and the environment.

The following land use controls would be implemented by the Depot:

- Deed restrictions would prohibit the installation and use of production and consumptive use wells during the operational life of the remedy, and drilling into aquifers below the fluvial aquifer. The deed restrictions would also guarantee access to all contingency areas, air sparging, boundary, sentinel, and monitoring wells for the life of the remedy. These restrictions could be removed at the completion of the remedy; however, any local controls separately in existence at the time would not be affected.

The following O&M and monitoring activities would be required:

- Monitoring of a network of groundwater wells, the frequency of which would be determined during the Remedial Design phase of the project.

- Air sparging and monitoring well maintenance (cleaning, repairs, replacement, plugging, and abandonment) as needed.
- Off-gas soil vapor collection and treatment to meet air emissions standards.
- Annual summaries of monitoring data to document the site conditions and progress of the remedy. An annual evaluation in accordance with the LUCIP to verify that land use controls and deed restrictions are in effect and to ensure that land use changes that may pose an unacceptable risk to the users have not occurred.

### Alternative GW6: Extraction and Discharge to POTW

This alternative would consist of pumping groundwater from extraction wells and discharging off-site (Figure 2-19). The estimated life of the remedial action was set at 10 years. Therefore, the alternative would include land use controls and groundwater monitoring similar to Alternative GW2 (Land Use Controls with Long-Term Monitoring).

The following extraction and treatment technologies would be applied:

- Pumping from the fluvial aquifer would be conducted with extraction wells (Figure 2-20) in the most contaminated parts of the plume. This extracted groundwater would be discharged off-site to the City of Memphis POTW.
- Untreated parts of the plume would degrade under natural attenuation processes.
- Contingency provisions would ensure that if groundwater contamination exceeds MCLs at the property boundary wells or the interior sentinel wells, more active measures for plume control would be evaluated and implemented as needed to protect public health and the environment.

The following land use controls would be implemented by the Depot:

- Deed restrictions would prohibit the installation and use of production and consumptive use wells during the operational life of the remedy, and drilling into aquifers below the fluvial aquifer. The deed restrictions would also guarantee access to contingency areas and all monitoring, extraction, boundary, and sentinel wells for the life of the remedy. These restrictions might be removed at the completion of the remedy; however, any local controls separately in existence at the time would not be affected.

The following O&M and monitoring activities would be required:

- Monitoring of a network of groundwater wells, the frequency of which would be determined during the Remedial Design phase of the project.
- Extraction well and monitoring well maintenance (cleaning, repairs, replacement, plugging, and abandonment) as needed.
- Effluent monitoring as required by the discharge permit from the City of Memphis.
- Annual summaries of monitoring data to document the site conditions and progress of the remedy. An annual evaluation in accordance with the LUCIP to verify that land use controls and deed restrictions are in effect and to ensure that land use changes that may pose an unacceptable risk to the users have not occurred.

## 2.9.2 Common Elements and Distinguishing Features

Many of the alternatives have common components as discussed herein. Some soil in the MI may be characterized as a hazardous waste by RCRA and is therefore subject to RCRA LDRs if the waste is excavated and treated or removed from the area of contamination. All remedies involving these activities would have to comply with the LDR (63 *Federal Register* 28555; May 26, 1998) and achieve 90 percent removal efficiency or 10 times the universal treatment standard for that contaminant in the material before disposal in a RCRA Subtitle C permitted landfill. The groundwater at the site does not contain RCRA hazardous waste; therefore, the LDR standards are not applicable.

As discussed in the Soils FS, no soil alternative was evaluated for the Housing Area (Parcel 2) in FU6. A previous surface soil removal action was conducted and the area is acceptable for residential reuse. This removal action was documented by OHM Remediation Services Corp. (March 1999a). In addition, the areas consisting of Building 144 and the adjacent north and south parking lots (Parcel 1) in FU6 were eliminated from further evaluation in the Soils FS because they do not require remedial action to facilitate the transfer of property or to meet requirements of CERCLA (see Figure 2-3b). No historical waste handling activities were conducted in Parcel 1.

All of the alternatives, except No Action, are consistent with CERCLA regulations, which stress that remedies should utilize active components to the maximum extent practicable and that land use controls should generally supplement active measures or engineering controls. Monitoring to ensure the effectiveness of the remedy, including deed restrictions, is part of each alternative, except for the No Action alternative. Natural attenuation is part of each groundwater alternative.

Several of the remedies would require land use controls, such as deed restrictions, to limit the use of parts of the property or to make sure that the groundwater is not used as drinking water. These resource-use restrictions, along with existing land use and groundwater use controls (such as zoning restrictions and Memphis-Shelby County groundwater use restrictions) provide protective layers of land use restrictions. They are discussed in each alternative where applicable. When a remedy employs land use controls to ensure protection of human health and the environment, it is necessary to specify the method or system that would be used to monitor, maintain, and enforce these controls. Therefore, a LUCIP would be developed as part the Remedial Design of any remedy that requires land use controls.

All soil and groundwater alternatives, except the No Action alternatives, would be expected to attain the RAOs.

## 2.9.3 Expected Outcomes of Each Alternative

All soil alternatives, except for SS1 (No Action), would enable an industrial land use for the MI.

All groundwater alternatives, except for GW1 (No Action), would reduce PCE and TCE concentrations to MCLs.

# 2.10 Summary of Comparative Analysis of Alternatives

## 2.10.1 Evaluation Criteria

The various remediation alternatives were evaluated individually against nine evaluation criteria in order to select a preferred remedy for the MI. The nine criteria, divided into threshold, balancing, and modifying criteria, are defined below.

### Threshold Criteria

The two threshold criteria must be met or complied with by the selected remedial action alternative. These include overall protection of human health and the environment, and compliance with ARARs.

**1. Overall Protection of Human Health and the Environment**
Addresses whether a remedy provides adequate protection of human health and the environment, and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled through treatment, engineering controls, or land use controls.

**2. Compliance with ARARs**
Addresses whether or not a remedy would meet the ARARs for federal and state environmental statues and/or provide grounds for invoking a waiver.

### Balancing Criteria

Balancing criteria are the five primary criteria on which analyses of remedial actions are based. These criteria provide decision-makers with a means to determine which alternative best achieves the RAOs.

**3. Long-Term Effectiveness and Permanence**
Refers to the expected magnitude of residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once clean-up goals have been met.

**4. Reduction of Toxicity, Mobility, or Volume through Treatment**
Refers to the anticipated performance of the treatment technologies that may be employed in a remedy.

**5. Short-Term Effectiveness**
Addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period until clean-up goals are achieved.

**6. Implementability**
Refers to the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.

**7. Cost**
Includes estimated capital and O&M costs, also expressed as net present worth costs. Per EPA Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, present worth costs do not exceed 30 years.

### Modifying Criteria

State and community acceptance of a proposed remedial action is an important element in the decision to select and to implement a given alternative. Concerns of state regulators and the local community must be addressed during the selection process and are generally termed "modifying criteria."

**8. State Acceptance**
Indicates whether, based on its review of the FS and Proposed Plan, the State concurs with, opposes, or has no comment on the preferred alternative.

**9. Community Acceptance**
Summarizes the general response to the alternative described in the FSs and Proposed Plan on public comments received. Each of the alternatives is evaluated by the nine criteria in the following subsections.

## 2.10.2 Surface Soil

FUs 1, 2, 3, 5, and 6 are suitable for an industrial land use scenario without any action. In addition, FU6 is suitable for residential use of the Housing Area and FU2 is suitable for recreational purposes.

### Overall Protection of Human Health and the Environment

All of the alternatives would protect human health and the environment except Alternative SS1 (No Action).

FU4 includes some lead in the surface soil (approximately 7,200 $ft^2$ south of Building 949 in FU4; see Figure 2-14) in excess of human health criteria, which would be remediated in preparation for industrial use. Alternative SS1 would not be protective of the industrial worker in FU4, but all other alternatives would provide adequate protection because they would protect the industrial worker from lead exposure.

Alternative SS2 (Land Use Controls) would achieve protection by establishing land use and site controls limiting access; Alternative SS3 (Soil Containment) would cover the lead-contaminated soil and provide deed restrictions preventing future disturbance of the cover; Alternative SS4 (In-situ Soil Treatment) would treat the soil to immobilize the lead; and Alternative SS7 (Excavation and Off-site Disposal) would remove the lead from the MI.

### Compliance with ARARs

All alternatives except Alternative SS1 (No Action) could be designed and implemented to meet all respective ARARs

### Long-term Effectiveness and Permanence

Alternatives SS4 (In-situ Soil Treatment) and SS7 (Excavation and Off-site Disposal) would afford the highest degree of long-term effectiveness and permanence. Alternative SS4 would include fixation of lead-contaminated surface soil, which would not reduce the level of contamination but would eliminate the exposure pathway. This would make the area acceptable for the intended land use. Alternative SS7 would provide for removal of all contaminants (specifically, lead) that were found to be above acceptable risk levels in the

BRA. Figure 2-14 presents the candidate area of the MI for surface soil remedial actions. Both alternatives would reduce risk to levels in accordance with RAOs and could be implemented in 6 months.

The long-term effectiveness and permanence of Alternative SS3 (Soil Containment) would be less reliable because contaminated soil would remain on-site and long-term controls would be necessary to prevent disturbance to the cover. The cover would require about the same amount of time to implement as land use controls, removal, or stabilization. Long-term maintenance of the cover would be required as long as hazardous substances, pollutants, or contaminants remain at the site; present worth costs use 30 years as a costing period. Alternative SS2 (Land Use Controls) would be less effective than the other active alternatives for the long term because there would be no physical barrier between potential receptors and contaminated soil, except fences and signs. Alternative SS2 would require long-term maintenance since hazardous substances, pollutants, or contaminants would remain at the site; present worth costs use 30 years as a costing period.

### Reduction of Toxicity, Mobility, or Volume (TMV) through Treatment

Alternative SS4 (In-situ Soil Treatment) is the only action that would include treatment of surface soil to reduce the risks posed by soil contamination. This alternative would use stabilization of lead-contaminated soil to reduce the mobility of metals in the soil to residual levels acceptable for residential and industrial land uses. Alternative SS4 would satisfy the statutory preference for treatment as a principal element. None of the other alternatives would include treatment technologies. Although Alternative SS3 (Soil Containment) and Alternative SS7 (Excavation and Off-site Disposal) would reduce the mobility of chemicals, the reduction would not be achieved through treatment.

### Short-Term Effectiveness

Alternative SS2 (Land Use Controls) would have the greatest short-term effectiveness because it would present the least risk to workers, the community, and the environment. Alternative SS2 would be the quickest way to achieve short-term protection (within 6 months). Alternative SS3 (Soil Containment) would present minimal risks to workers (dust) and the environment (stormwater) and could be implemented quickly (less than 1 year). Alternatives SS4 (In-situ Soil Treatment) and SS7 (Excavation and Off-site Disposal) would have the same short-term effectiveness.

Alternatives SS4 and SS7 would both present limited risk during implementation because of short-term exposure to dust during treatment, or excavation and transport within the area of elevated lead in FU4, respectively. Alternative SS7 could cause traffic impacts due to transportation of excavated material and backfill. Alternative SS4 could be implemented in the same timeframe as Alternative SS7 (within 6 months). Alternative SS1 (No Action) would have no short-term impacts because no action would be taken.

### Implementability

Alternative SS1 (No Action) would involve no implementability issues. Alternative SS2 (Land Use Controls) would be the simplest to implement because the site already has access controls and an active caretaker, and is already zoned industrial. Alternative SS3 (Soil Containment) would be easy to construct in FU4, requiring only pavement (or a soil cover)

over the lead-contaminated area (see Figure 2-14). Alternatives SS4 (In-situ Soil Treatment) and SS7 (Excavation and Off-site Disposal) both would require intrusive activities during implementation for lead-impacted soil, involving materials handling and disruption to other Depot activities. Also, specifically for Alternative SS4, depending upon the type of material used to stabilize lead-impacted soil in FU4, a monolith would be formed consisting of contaminated soil and stabilizer. Typically, such a monolith represents a volume increase, which could interfere with some industrial uses.

### Cost

No costs would be associated with Alternative SS1 (No Action). Alternative SS2 (Land Use Controls) is typically the least expensive of the active remediation alternatives because it involves a fixed cost for all FUs. Costs for this alternative at the MI would include implementation plans and deed (and lease) restrictions preventing unacceptable land use and fencing to protect industrial workers or transitional residents at the Housing Area in FU6.

The costs for controls are assumed the same whether for one or all FUs since the cost of establishing the land use restrictions is relatively independent of the anticipated number of parcels involved. If FU4 is not to be remediated, Alternative SS2 would be the least expensive to implement at FUs 1 through 6 for a present worth cost of $83,000. If FU4 is remediated by Alternatives SS3 (Soil Containment), SS4 (In-situ Soil Treatment), or SS7 (Excavation and Off-site Disposal), the present worth cost for land use controls in FUs 1 through 6 would be only $71,000 because fewer controls would be required in FU4 after remediation. With a present worth cost of $123,000, Alternative SS4 would be the least expensive alternative for making FU4 acceptable for industrial use. Alternative SS7, with a capital cost of $240,000, would be more expensive than Alternative SS4 due to the assumed hazardous waste disposal required. Containment of contaminated soil in FU4 would be the most expensive at $361,000 due to the long-term O&M cost associated with monitoring of the cover. Present worth costs are presented for each alternative in the *Summary* subsection below.

### State Acceptance

The State of Tennessee has issued a conditional concurrence letter regarding the MI FS and Proposed Plan, including conditional acceptance of the preferred alternative for surface soil that was presented in the Proposed Plan.

### Community Acceptance

The public comment period has been completed and no major reevaluations are required for the FS and the Proposed Plan. During the public comment period, the community expressed general support for the preferred remedial alternative for surface soil that was presented in the Proposed Plan. The community opposed remediation to the anticipated future industrial land use standards, citing inadequate protection for residents in the communities adjacent to the MI and preferring that soil at the MI be remediated to residential standards.

### Summary

The comparative analysis of alternatives is summarized as follows.

| Evaluation Criteria | SS1 No Action | SS2 Land Use Controls | SS3 Soil Containment | SS4 In-situ Soil Treatment | SS7 Excavation and Off-site Disposal |
|---|---|---|---|---|---|
| | **Surface Soil Remedial Alternative – Industrial/Recreational Use** | | | | |
| Protective of Human Health and Environ. | No | Yes | Yes | Yes | Yes |
| Complies with ARARs | No | Yes | Yes | Yes | Yes |
| Effective and Permanent | No | Yes | Yes | Yes | Yes |
| Reduces Toxicity, Mobility or Volume through Treatment | No | No | No | Yes | No |
| Short-term Effectiveness | Unacceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| Implementable | Yes | Yes | Yes | Yes | Yes |
| Cost | | | | | |
| *Capital Cost* | $0 | $19,000 | $51,000 | $51,000 | $183,000 |
| *Present Worth O&M* | $0 | $64,000 | $310,000 | $72,000 | $57,000 |
| *Total Present Worth Cost* | $0 | $83,000 | $361,000 | $123,000 | $240,000 |
| State Acceptance | Unlikely | Likely for FU1, 2, 3, 5, and 6<br>Unlikely for FU4 | Unlikely | Likely | Likely |
| Community Acceptance | Unlikely | Unlikely for FU4; Likely for FU1, 2, 3, 5, and 6 | Unlikely | Likely | Likely |

## 2.10.3 Groundwater

### Overall Protection of Human Health and the Environment

All alternatives, except Alternative GW1 (No Action), are considered protective of human health and the environment under current groundwater use.

Alternative GW1 would not be protective for future groundwater users, but all other alternatives would provide adequate protection because they prevent exposure to groundwater contaminants. Alternative GW2 (Land Use Controls with Long-Term Monitoring) would do this by limiting access to groundwater at the site and monitoring for contaminant migration. Alternatives GW3 (Enhanced Bioremediation) and GW4 (Air Sparging) would treat the groundwater in place until contamination is reduced to remedial goals. Alternative GW6 (Extraction and Discharge to POTW) would remove contaminated groundwater until groundwater contamination is reduced to remedial goals. Land use controls would be required for Alternatives GW2, GW3, GW4, and GW6 until remedial goals are met.

### Compliance with ARARs

All alternatives, except Alternative GW1 (No Action), are expected to meet ARARs at the completion of implementation.

### Long-term Effectiveness and Permanence

All alternatives, except Alternative GW1, are expected to be effective and permanent at the completion of implementation.

Alternatives GW3 (Enhanced Bioremediation), GW4 (Air Sparging), and GW6 (Extraction and Discharge to POTW) would be the most effective in that they would treat or remove contamination. Alternative GW6 would be somewhat more effective than GW3 or GW4 because it would capture contaminated groundwater through extraction. Alternative GW2 (Land Use Controls with Long-Term Monitoring) would be less effective than Alternatives GW3, GW4, and GW6 because it would leave the contamination in place and would rely on access controls to prevent exposure until natural degradation is complete.

### Reduction of TMV through Treatment

Alternatives GW3 (Enhanced Bioremediation), GW4 (Air Sparging), and GW6 (Extraction and Discharge to POTW) are expected to reduce TMV through treatment of contaminated groundwater. Alternative GW3 would treat the groundwater in-situ by injecting biodegradation amendments; Alternative GW4 would treat the groundwater in-situ via sparging; Alternative GW6 would provide for treatment at the POTW. Alternative GW6 would also reduce mobility of contaminants by capturing groundwater during extraction. No active contamination reduction would be associated with Alternatives GW1 (No Action) or GW2 (Land Use Controls with Long-Term Monitoring).

### Short-term Effectiveness

All alternatives, except Alternative GW1 (No Action), would be acceptable for short-term effectiveness.

Alternative GW1 would have no short-term effectiveness. Alternatives GW3 (Enhanced Bioremediation), GW4 (Air Sparging), and GW6 (Extraction and Discharge to POTW) would all begin to be effective upon start-up, but would require pilot testing prior to full-scale implementation. Alternative GW6 would present some limited risk to workers because of short-term exposure to VOCs during installation, testing, and calibration, as well as O&M of equipment for the extraction and treatment system, and discharge to the POTW. Alternatives GW3 and GW4 would present minimal risks to workers. Alternative GW2 (Land Use Controls with Long-Term Monitoring) could be implemented quickly and would present no implementation risk to workers.

### Implementability

All alternatives are considered technically feasible and could be implemented with available labor, materials, and equipment.

Alternative GW2 (Land Use Controls with Long-Term Monitoring) would be the simplest to implement since there are currently no fluvial aquifer wells supplying water to the MI and land use controls are already in place. Alternatives GW3 (Enhanced Bioremediation), GW4 (Air Sparging), and GW6 (Extraction and Discharge to POTW) would require pilot testing to determine an effective design for implementation. Alternatives GW3 and GW4 would be easier to implement than GW6 because no water would be extracted from the ground. Alternatives GW4, and GW6 would require intrusive activities during construction.

## Cost

No costs would be associated with Alternative GW1 (No Action). Alternative GW2 (Land Use Controls with Long-Term Monitoring) would be the least expensive of the treatment alternatives at approximately $0.84 million. Alternative GW3 (Enhanced Biodegradation) would be more expensive at $2.2 million. Costs for more aggressive remediation would be considerably higher: Alternative GW4 (Air Sparging) and Alternative GW6 (Extraction and Discharge to POTW) would cost approximately $4.3 million and $4.8 million, respectively. Present worth costs are presented for each alternative in the *Summary* subsection below.

## State Acceptance

The State of Tennessee has issued a conditional concurrence letter regarding the MI FS and Proposed Plan, including conditional acceptance of the preferred alternative for groundwater presented in the Proposed Plan.

## Community Acceptance

The public comment period has been completed and no major reevaluations are required for the FS and the Proposed Plan. During the public comment period, the community expressed general support for the preferred remedial alternative for groundwater at the MI that was presented in the Proposed Plan. Some comments made by the community expressed concern over remediation of groundwater to residential standards.

## Summary

The comparative analysis of alternatives is summarized as follows.

| | Groundwater Remedial Alternative – All Users | | | | |
|---|---|---|---|---|---|
| **Evaluation Criteria** | **GW1 No Action** | **GW2 Land Use Controls with Long-Term Monitoring** | **GW3 Enhanced Bioremediation** | **GW4 Air Sparging** | **GW6 Extraction and Discharge to POTW** |
| Protective of Human Health and Environment | No | Yes | Yes | Yes | Yes |
| Complies with ARARs | No | Yes | Yes | Yes | Yes |
| Effective and Permanent | No | Yes | Yes | Yes | Yes |
| Reduces Toxicity, Mobility, or Volume through Treatment | No | Yes | Yes | Yes | Yes |
| Short-term Effectiveness | Unacceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| Implementable | Yes | Yes | Yes | Yes | Yes |
| Cost | | | | | |
| *Capital Cost* | $0 | $162,000 | $1,019,000 | $3,429,000 | $2,228,000 |
| *Present Worth O&M* | $0 | $676,000 | $1,203,000 | $876,000 | $2,582,000 |
| *Total Present Worth Cost* | $0 | $838,000 | $2,222,000 | $4,305,000 | $4,810,000 |
| State Acceptance | Unlikely | Likely | Likely | Likely | Likely |
| Community Acceptance | Unlikely | Unlikely | Likely | Likely | Likely |

## 2.11 Selected Remedy

Based on a detailed analysis of all the feasible clean-up alternatives using the criteria described in the previous sections, the following clean-up plan to address surface soil and groundwater contamination at the MI of the Depot is proposed.

The selected soil alternative is:

*Alternatives SS2 and SS7,* **Land Use Controls, and Excavation and Off-site Disposal.**

The selected groundwater alternative is:

*Alternative GW3,* **Enhanced Bioremediation.**

### 2.11.1 Summary of the Rationale for the Selected Remedy

#### Surface Soil

The DRC board of directors, the City of Memphis, and Shelby County approved the *Memphis Depot Redevelopment Plan* in 1997. The intended land use is industrial for FU1 and FU3 through FU6. The selected remedies were chosen on the basis of anticipated industrial land use. The land use for FU2 will be recreational. Under the Federal Property Management Regulations, FU2 is slated for transfer from the DoD (Army) to the DOI/NPS. It will then be transferred by public benefit conveyance to the City of Memphis for use as a park. According to 41 CFR 101-47.308-7, property for use as a public park or recreational area must be used and maintained for the purpose for which it was conveyed in perpetuity, or be returned to the United States (24 CFR 51D).

With the exception of the lead-contaminated soil at FU4, the BRA determined that the risk in all other areas of the MI is acceptable under reasonably anticipated future uses. Therefore, the only actions needed to address the RAOs for surface soils in all other areas is to prevent residential use. However, due to removal of dieldrin from surface soils, the Housing Area in FU6 (Parcel 2) has been found suitable for the intended future land use as a transitional residence, and Parcel 1 in FU6 is available for unrestricted reuse.

Alternative SS7 (Excavation and Off-site Disposal) was chosen as the preferred alternative for remediation to industrial uses due to its expediency, permanency, and moderate cost.

Alternative SS2 (Land Use Controls) was chosen for each FU, but with slight variations. For FUs 1, 3, 4, 5, and 6, deed restrictions will be used to prevent residential land use, including day care operations. The same deed restrictions and site controls apply in FU2, but future unlimited recreational activities may occur. In addition, due to removal of dieldrin from surface soils, the Housing Area in FU6 (Parcel 2) has been found suitable for the intended future land use as a transitional residence, and Parcel 1 in FU6 is available for unrestricted reuse.

The preferred soil alternative was selected over other alternatives because deed restrictions and site controls can be implemented quickly, and they provide additional layers of protectiveness above existing land use restrictions and controls. Alternative SS7 provides permanent risk reduction through removal verses treatment as described in Alternative SS4. This alternative will allow the property to be used for the anticipated industrial land use, and does not preclude future removal actions if warranted. Since contaminants will remain on-site above levels that would allow for unrestricted and exposure criteria, the soil remedial action will be reviewed on a 5-year basis to ensure that the protectiveness is still effective.

### Groundwater

Alternative GW3 (Enhanced Bioremediation) has been selected as the preferred alternative for groundwater on the MI. This alternative will allow for effective contaminant reduction at lower cost than Alternatives GW4 (Air Sparging) and GW6 (Extraction and Discharge to POTW), which require more extensive construction of treatment systems. Although capital costs associated with this alternative are higher than those for Alternative GW2 (Land Use Controls with Long-Term Monitoring), the contaminant plume within the underlying aquifer will be reduced much more quickly through enhancement of natural biodegradation processes than through land use controls and long term monitoring alone. In addition, this alternative will result in faster reduction of the time required for monitoring of groundwater compared to that in Alternative GW2. Also, groundwater use restrictions are provided for, making acceptance of this alternative by local communities less of an issue.

The combination of Alternatives SS2 (Land Use Controls), SS7 (Excavation and Off-site Disposal), and GW3 (Enhanced Bioremediation), hereafter referred to as the selected remedies, will reduce the risk within a reasonable time frame and provide for long-term reliability of the remedy. The remedies will be reviewed on a 5-year basis to ensure that the protectiveness is still effective. In the case where groundwater data review indicates that PCE or TCE (or their degradation products) are migrating off-site or into underlying aquifers at levels greater than MCLs, a contingency plan will be developed for remediation of those constituents.

## 2.11.2 Description of the Selected Remedy

### Surface Soil

**Alternative SS2: Land Use Controls**

The land use controls alternative will leave contaminated surface soil in place, but will provide deed restrictions, in addition to the existing land use controls, thereby limiting exposure by defining the future use of the MI.

Deed (including lease) restrictions will restrict residential land use in FU1 through FU6 (exclusive of Parcels 1 and 2 in FU6) where dieldrin, arsenic, and/or lead in the surface soil pose an unacceptable risk for such use. Residential use controls will include preventing day care operations in all FUs. In addition, a boundary fence surrounding FU2 will be maintained to preclude casual access by adjacent off-site residents.

Restrictions and controls will be coordinated with the Depot reuse implementation plans, and will be included in all deeds and leases. The deed restrictions and site controls, in addition to the existing land use controls, to be applied under this alternative are as follows:

| FU | Deed Restrictions Preventing Residential Land Use[a] | Site Controls |
|---|---|---|
| 1 | X | |
| 2 | X | X[b] |
| 3 | X | |
| 4 | X | |
| 5 | X | |
| 6 | X[c] | |

[a] Includes day care restriction
[b] Maintaining a boundary fence surrounding FU2 to preclude casual access by adjacent off-site residents.
[c] Deed restrictions do not ably to Parcels 1 and 2 of FU6.

Land use controls contemplated for this alternative (excluding Parcels 1 and 2 of FU6) will:

- Prevent future residential land use in FUs 1 through 6, thus eliminating the risks associated with that land use scenario.
- Prevent casual access by adjacent off-site residents through maintenance of a boundary fence surrounding FU2.
- Prevent day care operations in FU1 through 6.

Applying land use controls will result in the following in each FU (excluding Parcels 1 and 2 of FU6):

- FUs 1, 3, 5, and 6 are acceptable for industrial use. With land use controls in place to prevent future residential development, these FUs can be used for industrial purposes with no further action.
- FU2 is acceptable for recreational use. With land use controls in place to prevent future residential development, and prevention of casual access by adjacent off-site residents through maintenance of a boundary fence, FU2 can be used for recreational purposes. In addition, according to Section 24 of the Memphis and Shelby County zoning regulations, single-family and multi-family residential uses are prohibited. Also, under the Federal Property Management Regulations, FU2 is slated for transfer from the DoD (Army) to the DOI/NPS. It will then be transferred by public benefit conveyance to the City of Memphis for use as a park. According to 41 CFR 101-47.308-7, property for use as a public park or recreational area must be used and maintained for the purpose for which it was conveyed in perpetuity, or be returned to the United States (24 CFR 51D).
- FU4 has 7,200 $ft^2$ of lead-contaminated surface soil that will require remedial action in order to be protective for industrial use. With land use controls in place to prevent residential development, coupled with the referenced surface soil remedial action for lead exceeding the industrial reuse criterion, FU4 can be used for industrial purposes.

Land use controls are part of the selected remedy for the Main Installation, and shall be implemented through a land use controls implementation plan (LUCIP). The LUCIP shall be developed as part of the remedial design. The timing and nature of the monitoring and reporting for the land use controls shall be specified in the LUCIP. However, to remain protective, land use controls depend on annual monitoring, and maintenance of fences and signs. The results of the annual evaluation shall be reported to TDEC and EPA. The deed restrictions will add a layer of protection against future residential use that will augment current zoning restrictions. There is no increase in risk to the community or to workers due to implementation of this alternative because there are no site activities that will affect exposure. Controls and restrictions will take an estimated 6 months to implement. Land use controls are easy to implement and require no special equipment or materials. The action could be enhanced by extending the areas of control and related fencing.

**Alternative SS7: Excavation and Off-site Disposal**

This alternative includes the excavation, transportation, and off-site disposal of lead-contaminated surface soil. One foot of contaminated surface soils will be removed from one 7,200-$ft^2$ area in FU4 where lead concentrations are equal to or greater than 1,536 mg/kg and disposed at an appropriate off-site landfill. Following excavation of the contaminated soil, 1 ft of clean (laboratory-tested) backfill will be placed in all areas excavated, and the entire area landscaping will be restored to its original condition.

Excavation, transportation, and off-site disposal will require temporary controls that will limit the use of those areas immediately adjacent to the excavation sites within the MI during implementation. These restrictions will be coordinated with the Depot reuse implementation plans. Under this alternative, excavation confirmation sampling and analyses will be required to confirm that RAOs are met. Figure 2-14 depicts the area to be addressed by this alternative (surface soils contaminated with lead in FU4 above the industrial use criterion).

Implementation of this alternative will be fully protective in FU4 for industrial use by eliminating risk of exposure to areas of surface soil with lead exceeding levels acceptable under an industrial land use scenario. This alternative will remain effective after completion because contaminated soil will have been removed. Removal is reliable and permanent. No monitoring or management beyond the implementation period will be required.

This alternative provides no reduction in toxicity, mobility, or volume of the contaminated soil through treatment. Disposal in an off-site landfill reduces the mobility of contaminants by physical containment.

Site engineering controls will be required to minimize fugitive dust and stormwater releases during periods of soil disturbance such as excavation and hauling. Site workers might be required to wear dermal and respiratory protective equipment to minimize the likelihood of exposure during intrusive activities in the lead-contaminated areas of FU4. This alternative will take about 6 months to complete.

This alternative is easily implemented and monitored. No special techniques, materials, equipment, or skills are required. Native soil is available locally for backfill. Off-site transportation may require special controls on trucking operations. The removal action could be enhanced by enlarging the excavated area if more contamination were discovered.

## Groundwater

### Alternative GW3 – Enhanced Bioremediation

This alternative employs nutrients/chemicals to accelerate natural biodegradation for treatment, thus reducing the TMV of the plume through treatment. The short-term effectiveness is considered acceptable because there will be no risk to workers, the community, or the environment during implementation. This alternative is technically feasible and could be implemented with readily available labor, materials, and equipment within a relatively short period of time.

Alternative GW3 uses injection of nutrients to enhance the natural biodegradation processes. The remedy will accelerate biodegradation in the most contaminated parts of the plume. Untreated parts of the plume will degrade under natural attenuation processes (as described in Alternative GW2, Land Use Controls with Long-Term Monitoring). In the absence of pilot test data, a conservative assumption was made that the nutrients will triple the biodegradation rate within the aquifer, and the duration of the remedial action was assumed to be 10 years. Therefore, enhanced bioremediation must also include land use controls and groundwater monitoring.

Preliminary design components will include the following:

- Nutrient injection into the fluvial aquifer will be conducted via borings or wells. Treatment zones will be established in the most contaminated parts of the plume within the MI (Figure 2-16). Pilot tests will be required to determine injection volumes, spacing, and depth. Nutrient re-injection will occur at intervals determined by pilot tests and monitoring results.
- Deed restrictions will prohibit the installation and use of production and consumptive use wells and drilling into aquifers below the fluvial aquifer until cleanup levels are achieved. The deed restrictions will also guarantee access to contingency areas, all injection, boundary, sentinel, and monitoring wells for the life of the remedy. These restrictions might be removed at the completion of the remedy. An annual evaluation will be conducted in accordance with the LUCIP to verify that land use controls and deed restrictions are in effect and to ensure that land use changes that may pose an unacceptable risk to the users have not occurred.
- A network of groundwater wells will be monitored at a frequency that will be determined during the Remedial Design phase of the project; however, monitoring will be no less than annual for the first 5 years. Well locations will be chosen during the Remedial Design phase with the following guidelines:
  - Wells inside the southwest and southeast plumes to measure the effect of enhanced bioremediation and natural attenuation. Water samples will be analyzed for VOCs as well as degradation products.
  - Boundary wells to detect potential migration of a plume to the MI boundary. Water samples will be analyzed for VOCs.
  - Sentinel wells to detect potential migration of a plume into the deeper confined sand aquifer. Water samples will be analyzed for VOCs.

- Monitoring well maintenance (cleaning, wellhead repairs) will be performed as needed.
- Annual summaries of monitoring data will be produced to document the site conditions and progress of the remedy.
- Groundwater concentrations will meet MCLs in all monitoring wells for four consecutive monitoring periods to demonstrate completion of the remedy. The sampling schedule will therefore be subject to change in response to observed trends and variability.
- Contingency provisions will ensure that if groundwater contamination exceeds MCLs at the boundary wells or the sentinel wells, more active measures for plume control will be implemented.

Without detailed information regarding the magnitude of MCL exceedances at boundary or sentinel wells in the future, development of a detailed contingency plan is not possible. Rather, should it be determined that the selected alternative is not achieving RAOs and an alternative remediation strategy is warranted, a detailed contingency plan would be completed at that time. The contingency plan would evaluate the existing site data and evaluate alternatives that could be implemented to achieve RAOs. The contingency plan would be reviewed by stakeholders, commented upon, and revised as necessary for the purpose of finalizing the revised remedy. Following this, the public notification and remedy modification phases of work would be completed to document the revised remedy. Finally, the revised remedy would be designed and then implemented. The time between identifying the need for an alternative remedy and implementation of the revised remediation strategy is estimated at 8 to 12 months, provided funding is available.

The costs of this alternative are split between capital cost (one-third) and present worth of O&M cost (two-thirds). These costs could increase if pilot tests indicate that more extensive injection of nutrients/chemicals is needed to achieve MCLs. Also, no cost estimates have been made for more extensive treatment, if required because of increased risk from plume migration.

Extensive subsurface sampling during the RI did not identify a significant on-site source of groundwater contamination. Should such a source be identified during future site activities, alternatives to remove the source will be evaluated and appropriate changes will be made to the remedy.

### 2.11.3 Summary of Estimated Remedy Costs

#### Surface Soil

The estimated costs for the selected soil remedy, Land Use Controls and Excavation and Off-site Disposal, are as follows:

| | |
|---|---|
| Capital Costs: | $183,000 |
| PW O&M Costs: | $57,000 |
| Total PW Costs: | $240,000 |

Table 2-13 presents a detailed description of the costs associated with this remedy. The assumptions used in developing the cost estimate for this alternative were as follows:

- Soils with contaminant levels identified as exceeding the RAOs will be removed and disposed as follows:
  - For industrial activities in a portion of FU4, soils with lead concentrations equal to or greater than 1,536 mg/kg.
- The extent of lead contamination in the surface soil is adequately defined (approximately 7,200 $ft^2$ south-southeast of Building 949 in FU4).
- Land use controls will be applied to the entire MI (excluding Parcels 1 and 2 of FU6). An annual evaluation will be conducted in accordance with the LUCIP to verify that land use controls and deed restrictions are in effect and to ensure that land use changes that may pose an unacceptable risk to the users have not occurred.
- Contaminated surface soil will be excavated to a depth of 1 ft and replaced with compacted clean (laboratory-tested) backfill. All disturbed sites will be restored to original conditions.
- Excavated lead-contaminated soil could require special handling and disposal at a RCRA Subtitle C hazardous waste landfill; however, disposal characterization samples will be analyzed prior to disposal. If the soil is determined to be non-hazardous, it could be disposed at a local Subtitle D landfill. Based on the concentrations of lead, it is conservatively assumed that all of the lead-excavated soil will be hazardous and will be disposed at a hazardous waste RCRA Subtitle C landfill.
- Periodic 5-year reviews by regulatory agencies will be required as long as hazardous substances, pollutants, or contaminants remain at the site above levels that will allow for unrestricted use and unrestricted exposure. Present worth costs use 30 years as a costing period.

The information used to create these cost estimate summaries was based on the best available data regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file, an Explanation of Significant Differences (ESD), or a ROD amendment. The order-of-magnitude engineering cost estimates presented are expected to be within +50 to −30 percent of the actual project cost.

## Groundwater

The estimated costs for the selected groundwater remedy, Enhanced Bioremediation, are as follows.

| | |
|---|---|
| Capital Costs: | $1,019,000 |
| PW O&M Costs: | $1,203,000 |
| Total PW Costs: | $2,222,000 |

Table 2-14 presents a detailed description of the costs associated with this remedy. The assumptions used in developing the cost estimate for this alternative were as follows:

- The remedy will require 10 years to achieve remedial goals.
- Deed restrictions will be the only land use controls to be imposed under this remedy to prevent the installation of wells for production or consumptive groundwater use. However, as discussed in Section 2.12 below, there are local ordinances, which would also prevent installation of wells on this site. An annual evaluation will be conducted in accordance with the LUCIP to verify that land use controls and deed restrictions are in effect and to ensure that land use changes that may pose an unacceptable risk to the users have not occurred. New monitoring wells will be installed, and a network of wells will be included in the monitoring program.
- A 6-month pilot study will be completed to determine design parameters, such as type of injection material, injection amounts, depth, and zone of influence. During this test, a suitable quantity of nutrients to enhance biodegradation will be injected into the fluvial aquifer at 10 locations. After injection, groundwater concentrations will be monitored eight times. Samples will be analyzed for VOCs, degradation products, and metabolic acids.
- 120 injection points will be installed by conventional drilling techniques.
- Re-injection will occur four times (years 2 through 5).
- Groundwater monitoring will occur at a frequency to be determined during the Remedial Design phase of the project; however, monitoring will be no less than annual for the first 5 years. Water samples will be analyzed for VOCs and degradation parameters. Field parameters (such as water level, pH, specific conductance, temperature, oxidation-reduction potential, and dissolved oxygen) will be measured during sample collection.
- Monitoring well maintenance will be performed every 5 years.
- All monitoring wells and injection points will be plugged and abandoned per Memphis-Shelby County requirements at the completion of the remedy.
- Annual monitoring reports will document the site status. These reports will include a potentiometric surface map, a plume map, summary tables of detected parameters, interpretative text, and an appendix that contains the laboratory data and field forms.
- Periodic 5-year reviews by regulatory agencies will be required as long as hazardous substances, pollutants, or contaminants remain at the site above levels that would allow for unrestricted use and unrestricted exposure

The principal uncertainties associated with the selected groundwater remedy are the rate of biodegradation that will be achieved using nutrients and the extent of the treatment zone of influence. More injection points or more frequent application of the nutrient compounds may be needed to treat the plume during the life of the action. The scope and cost of the actual application cannot be predicted without pilot test data. Information from the additional wells to be installed to confirm the conceptual model of the fluvial aquifer may change the number of long-term monitoring wells needed for implementation. The preliminary design and cost estimate assume application amounts and frequencies based on the experience of the queried vendor(s).

### 2.11.4 Expected Outcomes of the Selected Remedy

Based on the information available at this time, DLA, EPA, and TDEC believe the selected remedy will be protective of human health and the environment, will comply with ARARs, will be cost-effective, and will utilize permanent solutions and alternative treatment technologies to the maximum extent practicable.

Implementation of the selected remedy will facilitate the transfer of this closed base to the City of Memphis and Shelby County for redevelopment and reuse as commercial, light industrial, and recreational facilities, providing a strong economic base to anchor the low-income and disadvantaged neighborhoods of southeast Memphis.

The time required to implement the anticipated land use controls is estimated at approximately 6 months. Groundwater is not currently used for drinking water and will not be used for this purpose in the future. Groundwater concentrations of PCE and TCE (and their degradation products) above MCLs is expected to be reduced to MCLs before the groundwater migrates off-site.

As part of the Remedial Design, a LUCIP will be developed. This portion of the Remedial Design will detail how the land use controls in the selected remedy will be implemented, maintained, and monitored by the Army over time. As a planning document pursuant to a ROD, the LUCIP will be enforceable by any party under CERCLA.

## 2.12 Statutory Determinations

Under CERCLA and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with ARARs (unless a statutory waiver is justified), are cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes.

### 2.12.1 Protection of Human Health and the Environment

Land use controls are protective of human health since exposure to contamination is controlled. Deed restrictions, which will be instituted and controlled by the lead federal agency separate from the impact of local politics, provide an extra layer of prevention against residential use and the drilling of wells into or through the contaminated aquifer.

According to Section 24 of the Memphis and Shelby County zoning regulation, single-family or multi-family residential uses are prohibited on the MI. Also, under the Federal Property Management Regulations, FU2 is slated for transfer from the DoD (Army) to the DOI/NPS. It will then be transferred by public benefit conveyance to the City of Memphis for use as a park. According to 41 CFR 101-47.308-7, property for use as a public park or recreational area must be used and maintained for the purpose for which it was conveyed in perpetuity, or be returned to the United States (24 CFR 51D).

Excavation, transportation, and off-site disposal is protective of human health and the environment by removing contaminated soil. Removing contaminants reduces industrial worker exposure to levels that are acceptable for the intended land use; however, unacceptable levels for the residential scenario will remain at areas where no removal will occur.

Enhanced bioremediation of groundwater is considered protective of human health and the environment because groundwater will be treated in order to lower contamination levels to MCLs. During implementation, monitoring will warn if the plumes begin to migrate off-site or into deeper aquifers. The remedy will be reviewed on a 5-year basis to ensure that the protectiveness is still effective. If a groundwater data review indicates that PCE or TCE is migrating off-site or into an underlying aquifer at levels greater than MCLs, a contingency plan will be developed for remediation of those constituents.

## 2.12.2 Compliance with ARARs

ARARs are federal standards, requirements, criteria, or limitations that remedial actions must meet. Included in ARARs are state requirements if they are more stringent than federal requirements. There are three types of ARARs: chemical-specific, action-specific, and location-specific.

### Chemical-Specific

There are no chemical-specific ARARs for the soil. Therefore, chemical-specific remedial goal options (RGOs) developed in the risk analysis were used for the remedial alternatives analysis.

MCLs and maximum contaminant level goals (MCLGs) are relevant and appropriate as clean-up levels for groundwater that is a current or potential source of drinking water. The fluvial aquifer is a potential source of potable water at the Depot. Title 40 of the *Code of Federal Regulations* Section 300.430 (40 CFR 300.430, the NCP) states that MCLGs (established under the Safe Drinking Water Act [SDWA] at 40 CFR 141) above zero, shall be attained if relevant and appropriate to the circumstances of the release. Where the MCLG for a contaminant has been set at zero, the MCL for that contaminant shall be attained. TDEC's MCLGs and MCLs are listed at Tennessee Rule 1200-5-1-.06 and are identical to the federal MCLGs and MCLs.

### Action-Specific

Disposal characterization of the excavated soil will be conducted in accordance with 40 CFR 261. Disposal of contaminated soil will meet RCRA LDRs. The disposal characterization sampling and analysis may determine that the lead-contaminated soil is a hazardous waste (D008) per 40 CFR 261.24, and, therefore, will be required to be treated and disposed in a RCRA Subtitle C hazardous waste landfill.

Tennessee Rule 1200-3-1 on fugitive dust emissions during excavation, transportation, and backfilling operation will be complied with. The existing National Pollutant Discharge Elimination System (NPDES) requires compliance with regulations pertaining to stormwater in contact with contaminated soil during construction activities.

The following groundwater ARARs are applicable:

- State of Tennessee Rule 1200-4-6 —Applicable to underground injection control (UIC) permit with the Division of Water Supply, and injection well permits.
- *Rules and Regulations of Wells in Memphis-Shelby County Established by the Ground Water Quality Control Board for Memphis-Shelby County, Tennessee* — Applicable to the location, design, installation, use, modification, repair, and abandonment of all types of wells.
- RCRA for the disposal of the waste soil generated during well installation and groundwater monitoring.
- Clean Water Act — Applicable to local groundwater and wellhead protection requirements.
- Occupational Safety and Health Administration (OSHA)— Applicable to the protection of site workers during remedial action.

### Location-Specific

Currently, the MI is zoned as Light Industrial (I-L). The principal uses permitted are manufacturing, wholesaling, and warehousing. According to Section 24 of the Memphis and Shelby County zoning regulation, single-family, or multi-family residential uses are prohibited at the MI. Deed restrictions precluding future residential use across the MI reinforce and add a layer of protectiveness over and above the existing land use controls.

Under the Federal Property Management Regulations, FU2 is slated for transfer from the DoD (Army) to the DOI/NPS. It will then be transferred by public benefit conveyance to the City of Memphis for use as a park. According to 41 CFR 101-47.308-7, property for use as a public park or recreational area must be used and maintained for the purpose for which it was conveyed in perpetuity, or be returned to the United States (24 CFR 51D).

The Ground Water Quality Control Board for Shelby County, Tennessee, has promulgated *Rules and Regulations of Wells in Shelby County*. Under these rules, water wells are defined as wells developed for the primary purpose of producing a supply of water regardless of the intended use of the water supply. The rules prohibit water wells within a half-mile of the designated boundaries of a listed federal or state CERCLA site or RCRA corrective action site, unless the owner can demonstrate that movement of contaminated groundwater or materials into adjoining aquifers will not be enhanced by the well. Similar location restrictions are not specified for any other type of well (e.g., monitoring, injection, and recovery). In addition, these rules allow the Memphis - Shelby County Health Department to reject a permit application for a proposed well if the well will be harmful or potentially harmful to the water resources of Shelby County. Specific criteria for the determination of harm or potential harm are not identified in the rules.

Deed restrictions placed on the property at the MI will also prohibit groundwater use within the MI during implementation of the remedial action. These restrictions will not be removed until the remedial action is complete.

### Other Criteria and Guidance

By removing contaminated surface soil and disposing off-site, the site will meet surface soil RAOs for industrial use.

## 2.12.3 Cost-Effectiveness

The selected remedies are cost-effective and represent a reasonable value for the money to be spent. In making this determination, the following definition was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." (NCP 300.430(f)(1)(ii)(D)). This was accomplished by evaluating the overall effectiveness of those alternatives that satisfied the threshold criteria. Overall effectiveness was evaluated by assessing three of the five balancing criteria (long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness). Overall effectiveness was then compared to costs to determine cost-effectiveness. The relationship of the overall effectiveness of these remedial alternatives was determined to be proportional to its costs; hence, this selected remedy represents a reasonable value for the money to be spent.

The estimated present worth cost of the selected soil remedy is $240,000. The estimated present worth cost of the selected groundwater remedy is $2,222,000. By removing lead contamination equal to or greater than 1,536 mg/kg from the site, the selected remedy allows for unrestricted industrial land use. Enhanced bioremediation for groundwater was chosen over Alternative 2 because it is expected to achieve RAOs in a more reasonable timeframe and satisfies the statutory preference for treatment.

## 2.12.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Possible

Of those alternatives that are protective of human health and the environment and comply with ARARs, the selected remedies proved the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element and bias against off-site treatment and disposal and considering State and community acceptance.

The remedy will satisfy the criteria for long-term effectiveness by permanently removing lead-contaminated soil that exceeds the industrial-use criteria and reducing the concentrations of PCE and TCE (and their degradation products) in the groundwater to levels below MCLs. Enhanced bioremediation will reduce the volume and toxicity of contaminated groundwater through treatment. The selected remedies will not present short-term risks different from the other treatment alternatives.

## 2.12.5 Preference for Treatment as a Principal Element

By treating the contaminated groundwater through the innovative treatment technology, enhanced bioremediation, the selected groundwater alternative addresses potential exposure pathways posed by the MI. By utilizing treatment as a significant portion of the remedy, the statutory preference for remedies that employ treatment as a principal element is satisfied.

The selected remedy for surface soil contamination at the MI does not satisfy the statutory preference for treatment as a principal element of the remedy. However, the remedy for surface soil was chosen for the following reasons:

- Deed restrictions and site controls can be implemented quickly.
- Deed restrictions and site controls provide additional layers of protectiveness above existing land use restrictions and controls.
- Excavation and off-site disposal provides permanent risk reduction at the MI through removal.
- The remedy will allow the property to be used for industrial land use, and does not preclude future response actions, if warranted.
- The remedy is cost-effective at achieving anticipated industrial land use criteria.

Hazardous substances above health-based levels will remain in groundwater beneath the Memphis Depot after implementation of this remedy. Because hazardous substances are to remain, DLA, TDEC, and EPA recognize that Natural Resource Damage claims, in accordance with CERCLA, may be applicable. This document does not address restoration or rehabilitation of any natural resource injuries that may have occurred or whether such injuries have occurred. In the interim, neither DLA nor TDEC waives any rights or defenses each may have under CERCLA, Sect. 107(a)4(c).

### 2.12.6 Five-Year Review Requirements

Both selected soil and groundwater remedies will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure. Therefore, as required by Section 121(c) of CERCLA and NCP §300.430(f)(5)(iii)(C), a statutory review will be conducted every 5 years from initiation of remedial action to ensure that the remedy continues to be protective of human health and the environment.

## 2.13 Documentation of Significant Changes

CERCLA Section 117 (b) requires an explanation of significant change if actions selected in the final Record of Decision (ROD) differ significantly from the remedy presented in the Proposed Plan. There are two aspects of this ROD that differ from the Proposed Plan (CH2M HILL, August 2000), as presented below:

- The Proposed Plan for the MI was released for public comment in August 2000. The plan identified Alternative SS2, Land use Controls, as the preferred alternative for each FU as a measure to prevent a residential land use scenario. In addition, the plan called for deed restrictions, in conjunction with land use controls, as part of the land use controls. The land use controls and their effect on the MI will differ slightly among the FUs. Specifically for FU2, the Proposed Plan called for no fishing or swimming in the FU2 lake (Lake Danielson) and pond (Golf Course Pond) for safety reasons. During the public comment period, review of the Administrative Record indicated that human health risks from Lake Danielson and the Golf Course Pond do not materially increase the total risk at FU2. Absent such risk, there is no basis under CERCLA for a specific response action to address the two water bodies. Therefore, deed restrictions are not required for the prevention of fishing and swimming in Lake Danielson and the Golf Course Pond. For safety and liability reasons unrelated to exposure, the current owners may continue the ban on fishing and swimming through signage to be placed at the perimeter of these water bodies. Future owners of the property, enclosed within FU2, may also choose to enforce the ban for similar reasons.

- The small area of lead soil contamination located in FU 4 adjacent to building 949 is, coincidentally, located in a key area for BRAC re-use needs. A lessee is currently re-configuring a large portion of the western side of the Main Installation to accommodate the lessee's business needs, and its plans call for construction of an administrative building at this location. *Timing is critical for this lessee to move forward with its plans.* Therefore, in order to accommodate the economic redevelopment of this site, the Defense Logistics Agency exercised its removal authority under CERCLA Section 104, as delegated in Executive Order 12580, and removed the lead contaminated soil subsequent to development of, but prior to final execution of this ROD. This action has no effect on the protectiveness of the selected remedy because it merely moved forward the time in which the soil response action occurred. As part of the public comment period for the Proposed Plan, the public has had an opportunity under Section 117 of CERCLA to comment on the appropriateness of the soil response action, and there was no opposition to it. Both EPA and TDEC have agreed that the action is an appropriate part of a final, protective remedy, regardless of the timing of the action and the CERCLA authority under which it is performed. In addition, EPA and TDEC participated in oversight of the action to the same degree that they otherwise would have done if it had been conducted as part of the final remedy. However, because the early completion of this action effectively eliminates it as part of the remedy selected under Section 121 of CERCLA, this represents a significant difference from the remedy as originally proposed. Therefore, it is appropriate to document the change here.

  As stated above, the removal action occurred subsequent to development and lead agency approval of the ROD. Therefore, to the extent that this final, fully executed ROD contains forward-looking statements about response actions to address the lead-contaminated soil at Building 949, those actions have already been completed in full coordination with both EPA and TDEC.

**TABLE 2-1**
Functional Unit Titles and Descriptions
*Memphis Depot Main Installation ROD*

| FU No. | Name | Common Past Land Use | Description |
|---|---|---|---|
| 1 | Twenty Typical Warehouses | Transportation to and storage in closed warehouses | Located in the northeastern area of the MI, consisting of about 20 large warehouses, with interspersed roadways and railroad tracks. |
| 2 | Southeast Golf Course/ Recreational Area | Golf, other recreation | Located in the southeastern corner of the MI, consisting of golf course (Parcel 3). This FU also includes a baseball field and a small playground in the southeastern corner. This FU includes two constructed ponds and two concrete-lined drainage ditches from the ponds leading off-site. |
| 3 | Southwest Open Area | Transportation to and storage in open-sided warehouses, painting and sandblasting, open storage | Located in the southwestern corner of the MI, consisting of varied types of parcels and sites. |
| 4 | Northern and Central Open Area | Open storage, and transportation to and storage in closed warehouses | Located in the north-central to northwest area of the MI, covering a large area. |
| 5 | Newer Warehouses | Transportation to and storage in closed warehouses | Located in the south-central area of the MI and includes 10 large warehouse buildings. |
| 6 | Administrative and Residential Areas | Offices, equipment storage and maintenance, on-base housing | Located along the eastern property boundary of the Depot along Airways Boulevard. This FU includes the administrative building, former military Housing Area, parking lots, and other asphalt-paved areas. |
| 7 | MI Groundwater | | Groundwater beneath the MI (exclusive of Dunn Field) |

MI = Main Installation
FU = Functional Unit

**TABLE 2-2**
List of MI Sites from the FFA
*Memphis Depot Main Installation ROD*

| INSTALLATION RESTORATION SITE NUMBER | DSERTS SITE NUMBER[a] | DESCRIPTION |
|---|---|---|
| *Functional Unit 1 – Twenty Typicals Warehouses* | | |
| 57 | 57 | Building 629 Spill Area |
| 65 | 65 | XXCC-3 (Building 249) |
| 71 | 71 | Herbicide (All railroad tracks) (used to clear tracks) |
| 73 | 73 | 2,4-Dichlorophenoxyacetic Acid (all grassed areas) |
| *Functional Unit 2 – Southeast Golf Course Area* | | |
| 25 | 25 | Golf Course Pond |
| 26 | 26 | Lake Danielson |
| 51 | 51 | Lake Danielson Outlet Ditch |
| 52 | 52 | Golf Course Pond Outlet Ditch |
| 69 | 69 | 2,4-D, M2A1, and M4 Flamethrower Liquid Fuels (surface application) |
| 73 | 73 | 2,4-Dichlorophenoxyacetic Acid (all grassed areas) |
| *Functional Unit 3 – Southwest Open Area* | | |
| 27 | 27 | Former Recoupment Area (Building 873) |
| 29 | 29 | Former Underground Waste Oil Storage Tank |
| 30 | 30 | Paint Spray Booths (2 of 3 total; Buildings 770 and 1086) |
| 31 | 31 | Former Paint Spray Booth (Building 1087) |
| 32 | 32 | Sandblasting Waste Accumulation Area |
| 33 | 33 | Sandblasting Waste Drum Storage Area (metal shed south of Building 1088) |
| 34 | 34 | Building 770 Underground Oil Storage Tanks |
| 40 | 40 | Safety Kleen Units - 5 of 9 total (all located in Building 770) |
| 41 | 41 | Satellite Drum Accumulation Areas - 1 of 4 total (vicinity Building 770) |
| 71 | 71 | Herbicide (All railroad tracks) (used to clear tracks) |
| 73 | 73 | 2,4-Dichlorophenoxyacetic Acid (all grassed areas) |
| 82 | 82 | Flammables (Buildings 783 and 793) |
| 84 | 84 | Flammables, Solvents, Waste Oil, etc. (Building 972) |
| 87 | 87 | DDT, banned pesticides (Building 1084) |
| 88 | 88 | POL (Building 1085) |
| 89 | 89 | Acids (Building 1089) |
| *Functional Unit 4 – Northern and Central Open Area* | | |
| 28 | 28 | Recoupment Area (Building 865) |
| 35 | 35 | DRMO Building S308 - Hazardous Waste Storage |
| 36 | 36 | DRMO Hazardous Waste Concrete Storage Pad |
| 37 | 37 | DRMO Hazardous Waste Gravel Storage Pad |
| 38 | 38 | DRMO Damaged/Empty Hazardous Materials Drum Storage Area |
| 39 | 39 | DRMO Damaged/Empty Lubricant Container Area |
| 41 | 41 | Satellite Drum Accumulation Area (1 of 4 total - Building 210) |
| 54 | 54 | Main Installation - DRMO East Stormwater Runoff Canal |
| 55 | 55 | Main Installation - DRMO North Stormwater Runoff Canal |
| 42 | 42 | Former pentachlorophenol Dip Vat Area |
| 43 | 43 | Former Underground pentachlorophenol Tank Area |
| 44 | 44 | Former Wastewater Treatment Unit Area |
| 45 | 45 | Former Contaminated Soil Staging Area |
| 46 | 46 | Former pentachlorophenol Pallet Drying Area |
| 47 | 47 | Former Contaminated Soil Drum Storage Area (300 feet west of Building 689; removed 1988) |
| 53 | 53 | X-25 Flammable Solvents Storage Area (near Building 925) |
| 56 | 56 | Main Installation - West Stormwater Drainage Canal |
| 70 | 70 | POL, Various Chemical Leaks (railroad tracks 1, 2, 3, 4, 5, and 6) |
| 71 | 71 | Herbicide (all railroad tracks) (used to clear tracks) |

| TABLE 2-2 (cont'd)<br>List of MI Sites from the FFA<br>*Memphis Depot Main Installation ROD* | | |
|---|---|---|
| **INSTALLATION RESTORATION SITE NUMBER** | **DSERTS SITE NUMBER[a]** | **DESCRIPTION** |
| 72 | 72 | Waste Oil (DRMO yard) (surface application for dust control) |
| 73 | 73 | 2,4-Dichlorophenoxyacetic Acid (all grassed areas) |
| 74 | 74 | Flammables, Toxics (West End - Building 319) |
| 79 | 79 | Fuels, Miscellaneous Liquids, Wood, and Paper (Vicinity S702) |
| 80 | 80 | Fuel and Cleaners Dispensing (Building 720) |
| 81 | 81 | Fuel Oil AST (Building 765 – removed in 1994) |
| 83 | 83 | Disposal of Dried Paint Residues - South of Building 949 |
| *Functional Unit 5 – Newer Warehouses* | | |
| 75 | 75 | Unknown Wastes near Building 689 |
| 76 | 76 | Unknown Wastes near Building 690 |
| 77 | 77 | Unknown Wastes near Buildings 689 and 690 |
| 78 | 78 | Alcohol, Acetone, Toluene, Naphtha; Hydrofluoric Acid Spill |
| 49 | 49 | Medical Waste Storage Area |
| 40 | 40 | Safety Kleen Units - 4 of 9 total units (Buildings 253, 469, 490, and 689) |
| 41 | 41 | Satellite Drum Accumulation Areas - 2 of 4 total areas (Buildings 260 and 469) |
| 71 | 71 | Herbicide (all railroad tracks) (used to clear tracks) |
| 73 | 73 | 2,4-Dichlorophenoxyacetic Acid (all grassed areas) |
| *Functional Unit 6 – Administrative and Residential Areas* | | |
| 30 | 30 | Paint Spray Booths (1 of 3 total - Building 260) |
| 40 | 40 | Safety Kleen Units - 4 of 9 total units (Buildings 253, 469, 490, and 689) |
| 41 | 41 | Satellite Drum Accumulation Areas - 2 of 4 total areas (Buildings 260 and 469) |
| 58 | 58 | Pesticides, Herbicides (Pad 267) |
| 59 | 59 | Pesticides, Cleaners (Building 273) |
| 66 | 66 | POL (Building 253) |
| 67 | 67 | MOGAS (Building 257 |
| 68 | 68 | POL (Building 263) (20 by 40 feet) |
| 48 | 48 | Former PCB Transformer Storage Area |
| 71 | 71 | Herbicide (all railroad tracks) (used to clear tracks) |
| 73 | 73 | 2,4-Dichlorophenoxyacetic Acid (all grassed areas) |

**Notes:**

2,4-D 2,4-Dichlorophenoxyacetic acid
AST Aboveground storage tank
CWM: Chemical Warfare Materiel
DDT: 4,4'-Dichlorodiphenyltrichloroethane
DRMO: Defense Reutilization and Marketing Office
FFA Federal Facilities Agreement
MDRA: Memphis Depot Redevelopment Agency
MOGAS: Motor gasoline
PCB: Polychlorinated biphenyl
$PO_4$: Phosphate
POL: Petroleum, oil, and lubricants
a. Defense Site Environmental Restoration Tracking System (DoD Database)

MI = Main Installation
FU = Functional Unit

**TABLE 2-3**
Number of Soil, Sediment, and Surface Water Samples Collected in FUs 1 through 6 During CH2M HILL RI/FS Sampling Events
*Memphis Depot Main Installation ROD*

| Functional Unit | Sample Event | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BRAC[a] | | | DO4[b] | MAIN RI/FS[c] | | | | RI[d] | | | Screening Site[e] | | | |
| | SB | SE | SS | SB | SB | SE | SS | SW | SB | SS | SW | SB | SE | SS | SW |
| FU1 | | | 22 | 1 | | | 23 | | 12 | 5 | | 15 | | 8 | |
| FU2 | 6 | | 35 | | 1 | 9 | 5 | 9 | 6 | 11 | 34 | 14 | 15 | 20 | 10 |
| FU3 | 18 | 1 | 14 | | 30 | | 63 | | 27 | 34 | | 67 | | 48 | |
| FU4 | 35 | | 37 | 1 | 3 | | 48 | | 9 | 6 | | 138 | 11 | 101 | 16 |
| FU5 | 3 | | 8 | 1 | 1 | | 16 | | | | | 28 | | 14 | |
| FU6 | | 2 | 10 | | 8 | | 4 | | | 16 | | 26 | | 13 | |

[a]BRAC — BRAC samples were collected in October 1996 as part of the RI
[b]DO4 — Delivery Order 4 (DO4) is the groundwater sampling event that took place from March 1996 to October 1998 as part of the RI
[c]MAIN RIFS — Additional samples for RI, BRAC, and screening sites (and initial investigations for Topographic Engineering Center sites) collected in September and October 1998
[d]RI — RI sites sampled in December 1996 and January 1997
[e]Screening Site — Screening sites sampled in December 1996 and January 1997

SB - subsurface soil, SE – sediment, SS - surface soil, SW - surface water, FU – Functional Unit

**TABLE 2-4**
Analytes Investigated for FU7 (Groundwater)
*Memphis Depot Main Installation ROD*

| Station | Sample | Sample Type | Date Collected | General Chemistry | Natural Attenuation Protocol | Herbicides | Metals, Total | Organochlorine Pesticides/PCBs | Semivolatiles | Volatiles |
|---|---|---|---|---|---|---|---|---|---|---|
| HY01 | HY015B | N | 10/25/1998 | | | | | | | X |
| HY02 | HY025B | N | 10/26/1998 | | | | | | | X |
| HY03 | HY035B | N | 11/08/1998 | | | | | | | X |
| HY04 | HY045B2 | N | 11/07/1998 | | | | | | | X |
| HY04 | HY045B | N | 10/28/1998 | | | | | | | X |
| HY07 | HY075B | N | 11/03/1998 | | | | | | | X |
| HY09 | HY095B | N | 11/04/1998 | | | | | | | X |
| HY-83A | HY83A5 | N | 10/24/1998 | | | | X | | | |
| HY-83A | HY83A5FD | FD | 10/24/1998 | | | | X | | | |
| HY-89A | HY89A5 | N | 10/23/1998 | | | | X | | | |
| MW20 | MW20NA | | 03/22/2000 | | X | | | | | X |
| MW20 | MW205 | N | 10/17/1998 | | | | X | | X | X |
| MW20 | MW205FD | FD | 10/17/1998 | | | | | | X | |
| MW20 | MW204 | N | 03/25/1998 | | | | X | | X | X |
| MW20 | MW204D | FD | 03/25/1998 | | | | | | X | |
| MW20 | MW203 | N | 09/24/1997 | | | | X | | X | X |
| MW20 | MW203DUP | FD | 09/24/1997 | | | | | | X | |
| MW20 | MW202 | N | 06/18/1997 | | | | X | | X | X |
| MW20 | MW201 | N | 02/07/1996 | | | X | X | X | X | X |
| MW21 | MW21NA | | 03/24/2000 | | X | | | | | X |
| MW21 | MW215 | N | 10/19/1998 | X | | | X | | X | X |
| MW21 | MW214 | N | 03/27/1998 | X | | | X | | X | X |
| MW21 | MW213ADD | N | 09/28/1997 | X | | | X | | | |
| MW21 | MW213 | N | 09/27/1997 | | | | X | | X | X |
| MW21 | MW212 | N | 06/20/1997 | | | | X | | X | X |
| MW21 | MW211 | N | 02/10/1996 | | | X | X | X | X | X |
| MW22 | MW22NA | | 03/23/2000 | | X | | | | | X |
| MW22 | MW225 | N | 10/19/1998 | X | | | X | | X | X |
| MW22 | MW224 | N | 03/28/1998 | X | | | X | | X | X |
| MW22 | MW223 | N | 09/25/1997 | X | | | X | | X | X |
| MW22 | MW222 | N | 06/19/1997 | | | | X | | X | X |
| MW22 | MW221 | N | 02/10/1996 | | | X | X | X | X | X |
| MW23 | MW23NA | | 03/23/2000 | | X | | | | | X |
| MW23 | MW235 | N | 10/19/1998 | X | | | X | | X | X |
| MW23 | MW234 | N | 03/26/1998 | X | | | X | | X | X |
| MW23 | MW233 | N | 09/26/1997 | X | | | X | | X | X |
| MW23 | MW232 | N | 06/18/1997 | | | | X | | X | X |
| MW23 | MW231 | N | 02/10/1996 | | | X | X | X | X | X |
| MW24 | MW24NA | | 03/22/2000 | | X | | | | | X |
| MW24 | MW245 | N | 10/19/1998 | X | | | X | | X | X |
| MW24 | MW244 | N | 04/02/1998 | X | | | X | | X | X |
| MW24 | MW243 | N | 09/24/1997 | | | | X | | X | X |
| MW24 | MW24DUP | | 06/19/1997 | | | | X | | X | X |

**TABLE 2-4 (cont'd)**
Analytes Investigated for FU7 (Groundwater)
*Memphis Depot Main Installation ROD*

| Station | Sample | Sample Type | Date Collected | General Chemistry | Natural Attenuation Protocol | Herbicides | Metals, Total | Organochlorine Pesticides/PCBs | Semivolatiles | Volatiles |
|---|---|---|---|---|---|---|---|---|---|---|
| MW24 | MW242 | N | 06/19/1997 | | | | X | | X | X |
| MW24 | MW241 | N | 02/10/1996 | | | X | X | X | X | X |
| MW25 | MW255 | N | 10/16/1998 | | | | X | | X | X |
| MW25 | MW254 | N | 03/26/1998 | | | | X | | X | X |
| MW25 | MW253 | N | 09/25/1997 | | | | X | | X | X |
| MW25 | MW252 | N | 06/19/1997 | | | | X | | X | X |
| MW25 | MW251 | N | 02/09/1996 | | | X | X | X | X | X |
| MW26 | MW265 | N | 10/20/1998 | | | | X | | | X |
| MW26 | MW264 | N | 03/28/1998 | | | | X | | | X |
| MW26 | MW263 | N | 09/26/1997 | | | | X | | | X |
| MW26 | MW262 | N | 06/20/1997 | | | | X | | | X |
| MW26 | MW261 | N | 02/08/1996 | | | X | X | X | X | X |
| MW34 | MW344 | N | 03/27/1998 | X | | | X | | X | X |
| MW34 | MW344D | FD | 03/27/1998 | | | | | | | X |
| MW34 | MW343 | N | 09/26/1997 | X | | | X | | X | X |
| MW34 | MW343DUP | FD | 09/26/1997 | | | | | | | X |
| MW34 | MW342DUP | FD | 06/19/1997 | | | | | | | X |
| MW34 | MW342 | N | 06/19/1997 | X | | | X | | X | X |
| MW34 | MW341 | N | 02/09/1996 | X | | X | X | X | X | X |
| MW38 | MW385 | N | 10/17/1998 | | | | X | | X | X |
| MW38 | MW385FD | FD | 10/17/1998 | | | | X | | | |
| MW38 | MW384 | N | 03/26/1998 | | | | X | | X | X |
| MW38 | MW384D | FD | 03/26/1998 | | | | X | | | |
| MW38 | MW383 | N | 09/25/1997 | | | | X | | X | X |
| MW38 | MW383DUP | FD | 09/25/1997 | | | | X | | | |
| MW38 | MW382 | N | 06/19/1997 | X | | | X | | X | X |
| MW38 | MW382DUP | FD | 06/19/1997 | | | | X | | | |
| MW38 | MW381 | N | 02/11/1996 | X | | X | X | X | X | X |
| MW39 | MW39NA | | 03/23/2000 | | X | | | | | X |
| MW39 | MW395 | N | 10/19/1998 | | | | X | | X | X |
| MW39 | MW395FD | FD | 10/19/1998 | | | | X | | | |
| MW39 | MW394 | N | 03/27/1998 | | | | X | | X | X |
| MW39 | MW394D | FD | 03/27/1998 | | | | X | | | |
| MW39 | MW393 | N | 09/26/1997 | | | | X | | X | X |
| MW39 | MW393DUP | FD | 09/26/1997 | | | | X | | | |
| MW39 | MW392 | N | 06/20/1997 | | | | X | | X | X |
| MW39 | MW392DUP | FD | 06/20/1997 | | | | X | | | |
| MW39 | MW391 | N | 02/10/1996 | | | X | X | X | X | X |
| MW41 | MW415 | N | 10/16/1998 | | | | X | | | X |
| MW41 | MW414 | N | 03/25/1998 | | | | X | | | X |
| MW41 | MW413 | N | 09/27/1997 | | | | X | | | X |
| MW41 | MW412 | N | 06/17/1997 | | | | X | | | X |
| MW41 | MW41011796 | N | 01/17/1996 | | | | | | | X |
| MW43 | MW435U | N | 11/08/1998 | | | | X | | X | X |

**TABLE 2-4 (cont'd)**
Analytes Investigated for FU7 (Groundwater)
*Memphis Depot Main Installation ROD*

| Station | Sample | Sample Type | Date Collected | General Chemistry | Natural Attenuation Protocol | Herbicides | Metals, Total | Organochlorine Pesticides/PCBs | Semivolatiles | Volatiles |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| MW43 | MW435B | N | 10/24/1998 | | | | | | | X |
| MW43 | MW435 | N | 10/23/1998 | X | | | X | | | X |
| MW47 | MW475 | N | 10/19/1998 | X | | | X | | X | X |
| MW47 | MW474 | N | 03/28/1998 | X | | | X | | X | X |
| MW47 | MW473 | N | 09/26/1997 | X | | | X | | X | X |
| MW47 | MW472 | N | 06/22/1997 | | | | X | | X | X |
| MW47 | MW471 | N | 02/09/1996 | | | X | X | X | X | X |
| MW55 | MW555 | N | 10/16/1998 | X | | | X | | X | X |
| MW55 | MW554 | N | 03/25/1998 | X | | | X | | X | X |
| MW55 | MW553 | N | 09/26/1997 | X | | | X | | X | X |
| MW55 | MW552 | N | 06/18/1997 | X | | | X | | X | X |
| MW55 | MW551 | N | 02/10/1996 | | | | X | | | X |
| MW62 | MW62NADUP | | 03/23/2000 | | X | | | | | X |
| MW62 | MW62NA | | 03/23/2000 | | X | | | | | X |
| MW62 | MW625 | N | 10/26/1998 | X | | | X | | | X |
| MW63 | MW635 | N | 10/21/1998 | X | | | X | | X | X |
| MW64 | MW645 | N | 10/25/1998 | X | | | X | | X | X |
| MW66 | MW665 | N | 11/12/1998 | | | | X | | X | X |
| MW66 | MW665FD | FD | 11/12/1998 | | | | X | | X | X |
| MW72 | MW72NA | | 03/21/2000 | | X | | | | | X |
| MW72 | MW72 | | 10/07/1999 | | | | | | | X |
| PZ01 | HY065B | N | 10/27/1998 | | | | | | | X |
| PZ03 | HY78A5 | N | 10/29/1998 | | | | | | | X |
| PZ04 | HY085B | N | 11/03/1998 | | | | | | | X |
| PZ05 | HY055B | N | 11/05/1998 | | | | | | | X |
| PZ06 | HY36A5 | N | 11/08/1998 | | | | | | | X |
| PZ07 | HY67A5 | N | 11/09/1998 | | | | | | | X |
| PZ08 | HY115B | N | 11/11/1998 | | | | | | | X |

"X" - denotes that consituent was analyzed for in that particular sample.
N - Normal Sample
NA - Natural Attenuation Sample
DUP - duplicate
FD - field duplicate
FU - Functional Unit

**TABLE 2-5**
Concentration, Range, and Frequency of Detection of COCs
*Memphis Depot Main Installation ROD*

| Unit | Matrix | Units | Parameter Name | Number Analyzed | Number Detected | Minimum Detection Limit | Maximum Detection Limit | Minimum Detected Concentration | Maximum Detected Concentration | Arithmetic Mean Detected Concentration | Background Concentration |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FU1 | | | | | | | | | | | |
| | SS | mg/kg | Arsenic | 23 | 23 | 0.15 | 3.6 | 2.5 | 55 | 21 | 20 |
| | SS | mg/kg | Dieldrin | 44 | 33 | 0.0038 | 3.5 | 0.0049 | 4 | 0.78 | 0.086 |
| FU2 | | | | | | | | | | | |
| | SS | mg/kg | Arsenic | 27 | 27 | --- | --- | --- | 101 | 22 | --- |
| | SS | mg/kg | Dieldrin | 42 | 40 | --- | --- | --- | 10 | 0.7 | --- |
| FU3 | | | | | | | | | | | |
| | SS | mg/kg | Arsenic | 125 | 122 | 0.15 | 3.8 | 0.43 | 49 | 10 | 20 |
| | SS | mg/kg | Lead | 125 | 125 | 0.11 | 4.5 | 2.8 | 4150 | 244 | 30 |
| FU4 | | | | | | | | | | | |
| | SS | mg/kg | Arsenic | 150 | 147 | 0.14 | 3.3 | 1.1 | 66.3 | 13 | 20 |
| | SS | mg/kg | Dieldrin | 108 | 44 | 0.0034 | 1.5 | 0.0012 | 5.6 | 0.57 | 0.086 |
| | SS | mg/kg | Lead | 150 | 150 | 0.11 | 6.5 | 5 | 2800 | 153 | 30 |
| FU5 | | | | | | | | | | | |
| | SS | mg/kg | Arsenic | 21 | 21 | 0.16 | 2.6 | 5.05 | 29 | 13 | 20 |
| | SS | mg/kg | Dieldrin | 24 | 15 | 0.0037 | 1.9 | 0.0041 | 1.1 | 0.21 | 0.086 |
| FU6 | | | | | | | | | | | |
| | SS | mg/kg | Arsenic | 13 | 13 | 0.15 | 2.5 | 3.6 | 29 | 14 | 20 |
| FU7 | | | | | | | | | | | |
| | WG | mg/L | Tetrachloroethene | 83 | 33 | 0.005 | 0.01 | 0.001 | 0.12 | 0.021 | 0.001 |
| | WG | mg/L | Trichloroethene (TCE) | 83 | 31 | 0.005 | 0.01 | 0.001 | 0.058 | 0.009 | |

SS - surface soil, WG – groundwater

**TABLE 2-6**
Exposure Point Concentrations for Surface Soil and Groundwater
*Memphis Depot Main Installation ROD*

| Functional Unit | Matrix | Units | Parameter | Arithmetic Mean Value | Maximum Detected Concentration | UCL95 Normal | UCL95 Lognormal | EPC |
|---|---|---|---|---|---|---|---|---|
| FU1 | SS | mg/kg | Arsenic | 17 | 55 | 22 | 26 | 26 |
| | SS | mg/kg | Dieldrin | 0.58 | 4 | 0.81 | 10 | 0.81 |
| FU2 | SS | mg/kg | Arsenic | 22 | 101 | 28 | 2 | 29 |
| | SS | mg/kg | Dieldrin | 0.7 | 10 | 1 | 2.0 | 2 |
| FU3 | SS | mg/kg | Arsenic | 10 | 49 | 11 | 13 | 13 |
| | SS | mg/kg | Lead | 241 | 4150 | 326 | 311 | 311 |
| FU4 | SS | mg/kg | Arsenic | 13 | 66 | 14 | 17 | 17 |
| | SS | mg/kg | Dieldrin | 0.23 | 5.6 | 0.36 | 0.39 | 0.39 |
| | SS | mg/kg | Lead | 165 | 2800 | 227 | 162 | 162 |
| FU5 | SS | mg/kg | Arsenic | 12 | 29 | 14 | 15 | 15 |
| | SS | mg/kg | Dieldrin | 0.27 | 1.1 | 0.48 | 1.9 | 1.1 |
| FU6 | SS | mg/kg | Arsenic | 18 | 35 | 23 | 29 | 29 |
| FU7-Plume A | WG | mg/L | Tetrachloroethene Average | 0.039 | 0.12 | NA | NA | 0.039 |
| FU7-Plume A | WG | mg/L | Trichloroethene Average | 0.0079 | 0.031 | NA | NA | 0.0079 |
| FU7-Plume B | WG | mg/L | Tetrachloroethene Average | 0.0094 | 0.016 | NA | NA | 0.0094 |
| FU7-Plume B | WG | mg/L | Trichloroethene Average | 0.0093 | 0.058 | NA | NA | 0.0093 |
| FU7-Plume C | WG | mg/L | Tetrachloroethene Average | 0.0055 | 0.009 | NA | NA | 0.0055 |
| FU7-Plume C | WG | mg/L | Trichloroethene Average | 0.0068 | 0.037 | NA | NA | 0.0068 |

Data evaluated include normal samples only. Field duplicates have been dropped from risk evaluation
Organic constituents have been evaluated from plume-specific data, and arithmetic means have been used for exposure point concentration (EPC) values.
FU 7 was broken down into 3 subsets: Plume A, Plume B, and Plume C in order to perform risk calculations; however, only two plumes were delineated during the groundwater feasibility study.
Plume A consists of the following wells: HY02, MW21, MW22, MW23, MW47 & PZ04
Plume B consists of the following wells: HY03, HY04, MW25, MW26, MW64 & PZ05
Plume C consists of the following wells: MW34, MW43, MW38, MW39, MW62, MW63 & PZ03

NA Not applicable
SS surface soil
WG groundwater

**TABLE 2-7**
Potential Receptors
*Memphis Depot Main Installation ROD*

| | Current/Immediate Future Land Use | | Future Land Use | | | | | |
|---|---|---|---|---|---|---|---|---|
| **FU/(Surrogate Site)** | **Maintenance Worker** | **Lumberyard/ Factory Worker** | **Utility Worker** | **Landscaper** | **Industrial** | **Recreational** | **Transient Residents** | **Residential** |
| 1 | **X** | X | X | X | **X** | | | **X** |
| (57) | X | X | **X** | X | **X** | | X | X |
| 2 | **X** | | X | X | **X** | **X** | | **X** |
| (51) | X | X | **X** | X | **X** | | X | X |
| 3 | **X** | X | X | X | **X** | | | **X** |
| (34) | X | X | **X** | X | **X** | | X | X |
| 4 | **X** | | X | X | **X** | | | **X** |
| (46) | X | X | **X** | X | **X** | | X | X |
| 5 | **X** | X | X | X | **X** | | | **X** |
| (77) | X | X | **X** | X | **X** | | X | X |
| 6 | **X** | X | X | X | **X** | | X | **X** |
| (66) | X | X | **X** | X | **X** | | X | X |
| 7 | | | | | **X** | | X | **X** |

The surrogate site and FU-wide RAs are based on exposure units where the maintenance worker's exposure unit is the entire area within an FU, and an industrial worker's exposure is assumed to be a smaller exposure unit represented by a surrogate site.

FU Functional unit
**X** **Boldface** indicates pathways quantitated as conservative representatives of the other similar receptor populations

**TABLE 2-8**
Carcinogenic Toxicity Factors
*Memphis Depot Main Installation ROD*

| Name | Class | CAS Number | Oral SF kg-day/mg | Oral SF Source | Inhal SF kg-day/mg | Inhal SF Source | Weight-of-Evidence Basis | Weight-of-Evidence Class | Weight-of-Evidence Source |
|---|---|---|---|---|---|---|---|---|---|
| Arsenic | Inorganic | 7440-38-2 | 1.50E+00 | IRIS, 1999 | 1.51E+01 | IRIS, 1999 (calculated from unit risk) | Based on observation of increased lung cancer mortality in populations exposed primarily through inhalation and on increased skin cancer incidence in several populations consuming drinking water with high arsenic concentrations. | A | IRIS, 1999 |
| Dieldrin | Pest/ PCB | 60-57-1 | 1.60E+01 | IRIS, 1999 | 1.60E+01 | IRIS, 1999 (calculated from unit risk) | Carcinogenic in seven strains of mice when administered orally. Structurally related to compounds (aldrin, chlordane, heptachlor, heptachlor epoxide, and chorendic acid) which produce tumors in rodents. | B2 | IRIS, 1999 |
| Lead | Inorganic | 7439-92-1 | | | | | Sufficient animal evidence. Ten rat bioassays and one mouse bioassay have shown statistically significant increases in renal tumors with dietary and subcutaneous exposure to several soluble lead salts. | B2 | IRIS, 1999 |
| Tetrachloroethene | VOC | 127-18-4 | 5.20E-02 | Provisional SF Memo from H. Choudhury, STSC-NCEA to Ted Simon, Region 4 EPA, Feb 23, 1999 | 2.00E-03 | Provisional SF Memo from H. Choudhury, STSC-NCEA to Ted Simon, Region 4 EPA, Feb 23, 1999 | | C-B2 | Withdrawn from IRIS. Value listed in HEAST 1991 is used. |

**TABLE 2-8 (cont'd)**
Carcinogenic Toxicity Factors
*Memphis Depot Main Installation ROD*

| Name | Class | CAS Number | Oral SF kg-day/mg | Oral SF Source | Inhal SF kg-day/mg | Inhal SF Source | Weight-of-Evidence Basis | Weight-of-Evidence Class | Weight-of-Evidence Source |
|---|---|---|---|---|---|---|---|---|---|
| Trichloroethene | VOC | 79-01-6 | 1.10E-02 | Provisional SF Memo from H. Choudhury, STSC-NCEA to Ted Simon, Region 4 EPA, Feb 23, 1999 | 6.00E-03 | Provisional SF Memo from H. Choudhury, STSC-NCEA to Ted Simon, Region 4 EPA, Feb 23, 1999 | | B2 | Withdrawn from IRIS. Value listed in HEAST 1991 is used. |

Refer to Table 2-9 for explanation of the EPA Weight-of-Evidence Classification System for Carcinogenicity.

| | |
|---|---|
| CAS | Chemical Abstract System |
| EPA | Environmental Protection Agency |
| HEAST | Health Effects Assessment Summary Table |
| Inhal | Inhalation |
| IRIS | Integrated Risk Information System |
| kg-day/mg | kilogram per day per milligram |
| NCEA | National Center for Environmental Assessment |
| SF | Slope Factor |
| STSC | Superfund Technical Support Center |
| VOC | volatile organic compound |

**TABLE 2-9**
EPA Weight-of-Evidence Classification System for Carcinogenicity
*Memphis Depot Main Installation ROD*

| Group | Description |
|---|---|
| A | Human carcinogen, based on evidence from epidemiological studies |
| B1 or B2 | Probable human carcinogen<br>B1 indicates that limited human data are available<br>B2 indicates sufficient evidence in animals and inadequate or no evidence in humans |
| C | Possible human carcinogen, based on limited evidence in animals |
| D | Not classifiable as to human carcinogenicity |
| E | Evidence of noncarcinogenicity for humans |

Source: EPA, 1986

**TABLE 2-10**
Noncarcinogenic Toxicity Factors
*Memphis Depot Main Installation ROD*

| Parameter Name | Class | CAS Number | C Oral RfD mg/kg-day | C Oral RfD Critical Effect | C Oral RfD Uncert. Factor | C Oral RfD Modify Factor | C Oral RfD Source | C Inhal RfD mg/kg-day | C Inhal RfD Source |
|---|---|---|---|---|---|---|---|---|---|
| Arsenic | Inorganic | 7440-38-2 | 3.00E-04 | Hyperpigmentation, keratosis and possible vascular complications. | 3 | 1 | IRIS, 1999 | | |
| Dieldrin | Pest/PCB | 60-57-1 | 5.00E-05 | Liver lesions | 100 | 1 | IRIS, 1999 | | |
| Lead | Inorganic | 7439-92-1 | | | | | | | |
| Tetrachloroethene | VOC | 127-18-4 | 1.00E-02 | Hepatotoxicity in mice, weight gain in rats | 1000 | 1 | IRIS, 1999 | 1.71E-01 | Provisional RfD Memo from H. Choudhury, STSC-NCEA to Ted Simon, Region 4 EPA, Feb 23, 1999 |
| Trichloroethene | VOC | 79-01-6 | 6.00E-03 | Liver - Toxicity | 1000 | 3 | EPA-NCEA provisional value from EPA Region 3 Risk Based Concentrations Table, October 1998; not verified by Region 4 yet | | |

| | |
|---|---|
| C | Chronic |
| CAS | Chemical Abstract System |
| EPA | Environmental Protection Agency |
| HEAST | Health Effects Assessment Summary Table |
| Inhal | Inhalation |
| IRIS | Integrated Risk Information System |
| mg/kg-day | milligrams per kilograms per day |
| NCEA | National Center for Environmental Assessment |
| RfD | Reference Dose |
| STSC | Superfund Technical Support Center |
| TEF | toxicity equivalent factor |
| VOC | volatile organic compound |
| Uncert | uncertainty |
| Pest | Pesticide |
| PCB | Polychlorinated Biphenyl |

**TABLE 2-11 (cont'd)**
Risk Characterization Summary. Carinogenic Risk and Noncarcinogenic Hazards
*Memphis Depot Main Installation ROD*

**Scenario Time Frame: Future**
**Receptor Population: Worker**
**Receptor Age: Adult**

| FU/Surrogate Site | Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | NonCarcinogenic Hazard Quotient | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Dermal | Dust Inhalation | Exposure Routes Total | Ingestion | Dermal | Inhalation | Exposure Routes Total |
| FU1 | Soil | Soil on-site direct contact | PAHs, PCB, Dieldrin, and Arsenic | 4E-05 | 2E-05 | 3E-08 | 5E-05 | 0.060 | 0 009 | 4 0E-07 | 0 1 |
| FU1 - Site 65 | Soil | Soil on-site direct contact | PAHs | 4E-05 | 3E-05 | 6E-09 | 7E-05 | 0.01 | 0 004 | NA | 0 020 |
| | | | | FU1 Total Risk from all exposure media | | | 5E-05 | FU1 Total HI from all exposure media | | | 0.10 |
| FU2 | Soil | Soil on-site direct contact | PAHs, Dieldrin, and Arsenic | 1E-05 | 1E-05 | 8E-08 | 3E-05 | 0 09 | 0 04 | 0 006 | 0 100 |
| | Sediment | Sediment on-site direct contact | PAHs, and Arsenic | 1.30E-06 | 6 30E-07 | NA | 2E-06 | 0 006 | 0.001 | NA | 0 007 |
| | Surface water | Surface water on-site direct contact | Arsenic | 1 00E-06 | 6 00E-07 | NA | 2E-06 | 0.007 | 0 004 | NA | 0 01 |
| FU2 - Site 59 | Soil | Soil on-site direct contact | Dieldrin | 1 60E-06 | 5.00E-07 | 4 00E-09 | 2E-06 | 0 006 | 0.002 | NA | 0 008 |
| Plume B (Northeast plume) | Groundwater | Shallow Groundwater-Potable Use | PCE, 1122-PCA, Arsenic | 1.69E-05 | 2.99E-09 | 3.10E-06 | 2E-05 | 0 52 | 0 00034 | 0 002 | 0 53 |
| | | | | FU2 Total Risk from all exposure media | | | 5E-05 | FU2 Total HI from all exposure media | | | 0.65 |
| FU3 | Soil | Soil on-site direct contact | PAHs, Arsenic, and Lead | 6 60E-06 | 2.20E-06 | 1 80E-07 | 9E-06 | 0.04 * | 0 005 | 0 0004 | 0 05 |
| FU3 - Site 34 | Soil | Soil on-site direct contact | PAHs, Arsenic | 2.40E-05 | 1.20E-05 | 1 80E-07 | 4E-05 | 0 05 | 0 006 | 0 0004 | 0 06 |
| Plume A (Sothwest plume) | Groundwater | Shallow Groundwater-Potable Use | PCE, TCE, Arsenic | 1.95E-05 | 7 19E-09 | 4.40E-07 | 2E-05 | 0 55 | 0 00037 | 0 009 | 0 55 |
| | | | | FU3 Total Risk from all exposure media | | | 3E-05 | FU3 Total HI from all exposure media | | | 0.6 |
| FU4 | Soil | Soil on-site direct contact | PAHs, PCB, Dieldrin, TCDD, Arsenic and Lead | 2.00E-05 | 3 00E-06 | 2.00E-07 | 2E-05 | 0 08 | 0 007 | 0 01 | 0 1 |
| | Sediment | Sediment on-site direct contact | PAHs | 8.90E-06 | 3.50E-06 | NA | 1E-05 | 0 003 | 0.0003 | NA | 0 003 |
| FU4 - Site 36 | Soil | Soil on-site direct contact | Arsenic, Dieldrin | 6.70E-06 | 9.70E-07 | 2.30E-08 | 8E-06 | 0 05 | 0 006 | NA | 0 06 |
| | | | | FU4 Total Risk from all exposure media | | | 3E-05 | FU4 Total HI from all exposure media | | | 0.1 |
| FU5 | Soil | Soil on-site direct contact | PAHs | 2.00E-05 | 1.00E-05 | 1.00E-08 | 3E-05 | 0 04 | 0 007 | NA | 0 05 |
| FU5 - Site77 | Soil | Soil on-site direct contact | PAHs, Arsenic | 4.80E-05 | 2 80E-05 | 2 10E-08 | 8E-05 | 0 04 | 0 005 | NA | 0 05 |
| Plume C (Central Plum | Groundwater | Shallow Groundwater-Potable Use | PCE, 1122-PCA, Arsenic | 1.5E-05 | 1.8E-09 | 1 6E-06 | 2E-05 | 0 52 | 0 0003 | 0 0003 | 0 52 |
| | | | | FU5 Total Risk from all exposure media | | | 5E-05 | FU5 Total HI from all exposure media | | | 0.57 |
| FU6 | Soil | Soil on-site direct contact | PAHs, PCB, dieldrin, arsenic | 2.00E-05 | 7.00E-06 | 3 00E-08 | 3E-05 | 0 06 | 0.008 | NA | 0 06 |
| FU6 - Site 66 | Soil | Soil on-site direct contact | PAHs | 1 10E-05 | 6 70E-06 | 1.40E-09 | 2E-05 | NA | NA | NA | NA |
| | | | | FU5 Total Risk from all exposure media | | | 3E-05 | FU5 Total HI from all exposure media | | | 0.06 |

Note: There is no groundwater contamination underneath Functional Units (FU) 1, 4 and 6, and outer edges of the plume merge in the center underneath FU5 (Plume C) Plume A (Southwest plume) is underneath FU3, and Plume B (Southeast plume) is underneath FU2 (Golf Course).
Therefore, cumulative risks to future receptors are estimated by adding respective groundwater and other exposure media risks The estimated average groundwater concentration based risks were used for this cumulative risk estimation
Chemicals of potential concern are individual chemicals that contribute to cumulative risk at levels greater than $10^{-6}$. Other COPCs were identified and are discussed in the specific Functional Unit (FU)
risk assessment sections of RI Report (CH2M HILL, 2000). Lead is the only chemical of concern (COC) at FU4, surface soil. There are no other COCs for industrial land use.

**TABLE 2-11**
Risk Characterization Summary: Carinogenic Risk and Noncarcinogenic Hazards
*Memphis Depot Main Installation ROD*

**Scenario Time Frame: Current**
**Receptor Population: Worker**
**Receptor Age: Adult**

| FU | Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | NonCarcinogenic Hazard Quotient | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Dermal | Inhalation | Exposure Routes Total | Ingestion | Dermal | Inhalation | Exposure Routes Total |
| FU1 | Soil | Soil on-site direct contact | PAHs, PCB, Dieldrin, and Arsenic | 4E-06 | 3E-06 | 5E-09 | 7E-06 | 0.006 | 0.002 | 7.4E-08 | 0.008 |
| | | | | **FU1 Total Risk from all exposure media** | | | **7E-06** | **FU1 Total HI from all exposure media** | | | **0.008** |
| FU2 | Soil | Soil on-site direct contact | Dieldrin | 2E-06 | 2E-06 | 8E-09 | 4E-06 | 0.01 | 0.006 | 0.0006 | 0.020 |
| | Sediment | Sediment on-site direct contact | Arsenic | 3 1E-07 | 1.5E-07 | NA | 5E-07 | 0 001 | 0 0003 | NA | 0 002 |
| | Surface water | Surface water on-site direct contact | Arsenic | 2.0E-07 | 2.0E-07 | NA | 4E-07 | 0.002 | 0 0009 | NA | 0.003 |
| | | | | **FU2 Total Risk from all exposure media** | | | **5E-06** | **FU2 Total HI from all exposure media** | | | **0.025** |
| FU3 | Soil | Soil on-site direct contact | PAHs, Arsenic | 6.6E-07 | 4.4E-07 | 3.7E-08 | 1E-06 | 0 004 | 0.001 | 0 00007 | 0.005 |
| | | | | **FU3 Total Risk from all exposure media** | | | **1E-06** | **FU3 Total HI from all exposure media** | | | **0.005** |
| FU4 | Soil | Soil on-site direct contact | PAHs, PCB, Dieldrin, TCDD, Arsenic | 2.0E-06 | 6.0E-07 | 3.0E-08 | 3E-06 | 0.008 | 0.001 | 0.002 | 0.01 |
| | Sediment | Sediment on-site direct contact | PAHs | 2.0E-06 | 2.0E-06 | NA | 4E-06 | 0.0007 | 0.0002 | NA | 0 0008 |
| | | | | **FU4 Total Risk from all exposure media** | | | **7E-06** | **FU4 Total HI from all exposure media** | | | **0.011** |
| FU5 | Soil | Soil on-site direct contact | PAHs | 2.0E-06 | 2.0E-06 | 3.0E-09 | 4E-06 | 0.004 | 0 001 | NA | 0.006 |
| | | | | **FU5 Total Risk from all exposure media** | | | **2E-05** | **FU5 Total HI from all exposure media** | | | **0.018** |
| FU6 | Soil | Soil on-site direct contact | PAHs, PCB, Dieldrin, Arsenic | 2.0E-06 | 1.0E-06 | 5.0E-09 | 3E-06 | 0.006 | 0.002 | NA | 0 007 |
| | Sediment | Sediment on-site direct contact | PAHs | 5 0E-07 | 5.0E-07 | NA | 1E-06 | 0.09 | 0 01 | NA | 0 1 |
| | | | | **FU6 Total Risk from all exposure media** | | | **4E-06** | **FU6 Total HI from all exposure media** | | | **0.11** |

Chemicals of potential concern are individual chemicals that contribute to cumulative risk at levels greater than $10^{-6}$. Other COPCs were identified and are discussed in the specific Functional Unit (FU) risk assessment sections of RI Report (CH2M HILL, 2000). There are no chemicals of concern for a current worker at the site, as none present risk above upperbound acceptable risk limit of 1 in 10,000

**TABLE 2-11 (cont'd)**
Risk Characterization Summary: Carinogenic Risk and Noncarcinogenic Hazards
*Memphis Depot Main Installation ROD*

**Scenario Time Frame: Future**
**Rceptor Population: Resident**
**Receptor Age: Adult and Child***

| FU/Surrogate Site | Medium | Exposure Point | Chemical of Concern | Carcinogenic Risk (age-adjusted) | | | | NonCarcinogenic Hazard Quotient (Child) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Dermal | Inhalation | Exposure Routes Total | Ingestion | Dermal | Inhalation | Exposure Routes Total |
| FU1 | Soil | Soil on-site direct contact | PAHs, PCB, Dieldrin and Arsenic | 9E-04 | 4E-05 | 6E-09 | 1E-03 | 0.080 | 0.00060 | NA | 0.080 |
| | | | | **FU1 Total Risk from all exposure media** | | | **1E-03** | **FU1 Total HI from all exposure media** | | | **0.1** |
| FU2 | Soil | Soil on-site direct contact | PAHs, Dieldrin, and Arsenic | 1E-04 | 4E-05 | 1E-07 | 2E-04 | 2.4 | 0.2 | 0.03 | 2.7 |
| | Sediment** | Sediment on-site direct contact | PAHs, and arsenic | 3E-06 | 7E-07 | NA | 4E-06 | 0.1 | 0.002 | NA | 0.1 |
| | Surface water** | Surface water on-site direct contact | Arsenic | 1E-05 | 8E-06 | NA | 2E-05 | 0.2 | 0.06 | NA | 0.3 |
| Plume B (Northeast plume) | Groundwater | Shallow Groundwater-Potable Use | PCE, 1122-PCA, Arsenic | 7.30E-05 | 4.22E-08 | 1.30E-05 | 8.6E-05 | 3.2 | 0.004 | 0.01 | **3.2** |
| | | | | **FU2 Total Risk from all exposure media** | | | **3E-04** | **FU2 Total HI from all exposure media** | | | **6.3** |
| FU3 | Soil | Soil on-site direct contact | PAHs, and Lead | 5.40E-04 | 2.50E-05 | 3.30E-09 | 6E-04 | NA | NA | NA | NA |
| Plume A (Sothwest plume) | Groundwater | Shallow Groundwater-Potable Use | PCE, TCE, Arsenic | 8.40E-05 | 9.90E-08 | 1.90E-06 | 8.00E-05 | 3.3 | 0.005 | 0.06 | 3.4 |
| | | | | **FU3 Total Risk from all exposure media** | | | **7E-04** | **FU3 Total HI from all exposure media** | | | **3.4** |
| FU4 | Soil | Soil on-site direct contact | PAHs, and Lead | 3.2E-05 | 1.5E-06 | 1.90E-10 | 3E-05 | 0.00005 | 0.000003 | NA | 0.00005 |
| | | | | **FU4 Total Risk from all exposure media** | | | **3E-05** | **FU4 Total HI from all exposure media** | | | **0.00005** |
| FU5 | Soil | Soil on-site direct contact | PAHs | 3.8E-04 | 1.8E-05 | 2.30E-09 | 4E-04 | NA | NA | NA | NA |
| Plume C (Central Plume) | Groundwater | Shallow Groundwater-Potable Use | PCE, 1122-PCA, Arsenic | 6.6E-05 | 2.6E-08 | 7.00E-06 | 7E-05 | 3.1 | 0.0044 | 0.002 | 3.1 |
| | | | | **FU5 Total Risk from all exposure media** | | | **5E-04** | **FU5 Total HI from all exposure media** | | | **3.1** |
| FU6 | Soil | Soil on-site direct contact | PAHs | 9.5E-05 | 4.4E-06 | 5.70E-10 | 1E-04 | NA | NA | NA | NA |
| | | | | **FU6 Total Risk from all exposure media** | | | **1E-04** | **FU6 Total HI from all exposure media** | | | **NA** |

NA = A value not calculated

* - residential adult is age-adjusted, and conservatively represents risks to a child, and Hazard is based on a child scenario

** - recreational use of on-site ponds by future on-site hypothetical residents

Note: There is no groundwater contamination underneath Functional Units (FU) 1, 4 and 6, and outer edges of the plume merge in the center underneath FU5 (Plume C). Plume A (Southwest plume) is underneath FU3, and Plume B (Southeast plume) is underneath FU2 (Golf Course).

Therefore cumulative risks to future receptors are estimated by adding respective groundwater and other exposure media risks. The estimated average groundwater concentration based risks were used for this cumulative risk estimation.

Chemicals of potential concern are individual chemicals that contribute to cumulative risk at levels greater than $10^{-6}$. Other COPCs were identified and are discussed in the specific Functional Unit (FU)

risk assessment sections of RI Report (CH2M HILL, 2000). Lead (in FUs 3 and 4 only), PAHs and dieldrin are the chemicals of concern (COC) for soils for residential land use. Groundwater has chlorinated solvents as COCs for potable use of shallow groundwater.

**TABLE 2-12**
Sources of Uncertainty and their Contribution to Conservatism in Risk Assessment
*Memphis Depot Main Installation ROD*

| Sources of Uncertainty in Risk Assessment | Degree to which Factor May Result in Overestimated Risk | Degree to which Factor May Result in Underestimated Risk | Degree to which Factor May Result in Overestimated or Underestimated Risk |
|---|---|---|---|
| ***Hazard Identification*** | | | |
| Field sampling location bias | Moderate-High | | |
| Inclusion of soil data from depths outside realistic exposure intervals | | | Low-Moderate |
| Use of one-half reporting limit for nondetects | Moderate-High | | |
| Determination of background conditions | | | Moderate |
| Comparison criteria used in selecting COPCs | | | Moderate |
| ***Exposure Assessment*** | | | |
| Selection of site-specific exposure pathways | | | Low-moderate |
| Estimation of exposure to multiple substances | | | Moderate |
| Assumption that exposure scenarios and contact with affected media will occur | High | | |
| Assumption of frequent, routine exposure over prolonged durations | High | | |
| Assumption of equivalency of physiochemical characteristics of soil and sediment | Moderate-High | | |
| Selection of UCL95 or maximum concentration for EPC | Moderate-High | | |
| Use of default exposure values for physiologic parameters: | | | Low-high |
| - Skin surface area exposed | Moderate-High | | |
| - Inhalation rates | Moderate | | |
| - Sediment ingestion rates | High | | |
| - Soil ingestion rates | Moderate | | |
| ***Toxicity Assessment*** | | | |
| Factors used in derivation of toxicity values (e.g., inter-species extrapolation) | Moderate-High | | |
| Weight of evidence for human carcinogenicity | Moderate-High | | |
| Extrapolation of less than lifetime exposure to lifetime cancer risks | High | | |
| Interaction of multiple chemical substances | | Moderate | |
| Use of published RfDs and SFs derived by standard EPA methods | Moderate-High | | |
| Derivation of dermal SFs and RfDs using GI absorption factors | | | Moderate |
| Derivation of inhalation RfDs from published RfC values | | | Uncertain |
| Lack of toxicity values for some chemicals or exposure routes | | Low-Moderate | |
| Assumption of additivity of toxicological effects | Moderate-High | | |
| Use of default PEFs | | | Low-Moderate |

**TABLE 2-12 (cont'd)**
Sources of Uncertainty and their Contribution to Conservatism in Risk Assessment
*Memphis Depot Main Installation ROD*

| Sources of Uncertainty in Risk Assessment | Degree to which Factor May Result in Overestimated Risk | Degree to which Factor May Result in Underestimated Risk | Degree to which Factor May Result in Overestimated or Underestimated Risk |
|---|---|---|---|
| ***Risk Characterization*** | | | |
| Addition of risks across multiple exposure pathways | Moderate-High | | |
| Addition of risks from multiple chemical substances | | | Low-High |
| Lack of consideration of source depletion, natural degradation, or attenuation of COPCs over time | Moderate | | |

| | | | |
|---|---|---|---|
| UCL95 | 95% of the upper confidence limit | PEF | particulate emission factor |
| COPC | contaminant of potential concern | RfC | reference concentration |
| EPC | exposure point concentration | RfD | reference dose |
| GI | gastrointestinal | SF | slope factor |

**Table 2-13**

Cost Estimate Summary: Surface Soil Selected Remedy, Excavation and Off-site Disposal. Industrial Planned Us
Capital Costs
*Memphis Depot Main Installation ROD*

| Item | Activity/Component | Quantity | Unit | Unit Cost | Capital Cost[a] |
|---|---|---|---|---|---|
| 1 | Deed Restrictions | | | | |
| | 1.1 Attorney Fees | 32 | hr | $200 /hr | $6,400 |
| | 1.2 Recording of the Deed | 2 | ea | $500 /ea | $1,000 |
| 2 | Plans for Implementation | 96 | hr | $75 /hr | $7,200 |
| 3 | Excavation of Soils (Lead Hot Spot in FU4) | 267 | $yd^3$ | $3.69 /$yd^3$ | $1,000 |
| 4 | Surface Water Collection and Controls | 1 | ea | $10,000 /ea | $10,000 |
| 5 | Disposal of Contaminated Soils (Lead Hot Spot in FU4) | | | | |
| | 5.1 Laboratory Analysis - TCLP | 1 | ea | $1,500 /ea | $1,500 |
| | 5.2 Transportation-Emelle, AL | 373 [b] | tons | $33 /ton | $12,200 |
| | 5.3 Disposal Fee and Taxes- Haz. Waste Landfill | 373 [b] | tons | $308 /ton | $115,000 |
| | 5.4 Application Fees-Haz. Waste Landfill | 1 | ea | $250 /ea | $250 |
| 6 | Confirmation Sampling, 2 Events | | | | |
| | 6.1 Labor for Both Events | 40 | hr | $75 /hr | $3,000 |
| | 6.2 Laboratory Analysis - Lead | 8 | ea | $18 /ea | $200 |
| | 6.3 Rental Equipment | 2 | event | $360 /event | $800 |
| | 6.4 Mobilization/Demobilization | 32 | hr | $75 /hr | $2,400 |
| | 6.5 Supplies | 2 | event | $500 /event | $1,000 |
| 7 | Restoration of Site | | | | |
| | 7.1 Imported Backfill (material) | 267 | $yd^3$ | $10 /$yd^3$ | $2,600 |
| | 7.2 Transportation of Backfill On-site | 267 | $yd^3$ | $11.38 /$yd^3$ | $3,100 |
| | 7.3 Laboratory Analysis on Clean Soil | | | | |
| | 7.3.1 TCL Volatiles (8260) | 1 | ea | $198 /ea | $200 |
| | 7.3.2 TAL Metals (6010/700) | 1 | ea | $268 /ea | $270 |
| | 7.3.3 Pesticides (8081A) | 1 | ea | $141 /ea | $150 |
| | 7.3.4 PCBs (8082) | 1 | ea | $110 /ea | $110 |
| | 7.4 Soil Conditioning | 0.17 | acre | $885 /acre | $200 |
| | 7.5 Seeding | 0.17 | acre | $1,420 /acre | $300 |
| 8 | Maintenance of Site- Landscaping | 192 | hr | $75 /hr | $14,400 |

**Total Capital Costs** **$183,000**

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives. Planning and engineering costs are typically estimated to be a percentage of remedy cost and, therefore, do not factor in comparitive cost evaluations. The estimate is within plus 50 to minus 30 percent.

[b] Assumes soil bulk density of 1.4 tons/$yd^3$ based on historical surface soil removal actions conducted at the MI.

TCLP - Toxicity Characteristic Leaching Procedure

**Table 2-13 (cont'd)**
Cost Estimate Summary: Surface Soil Selected Remedy, Excavation and Off-site Disposal. Industrial Planned Use
O&M Costs
*Memphis Depot Main Installation ROD*

| Item | Activity/Component | Quantity | Unit | Unit Cost | Annual O&M Cost[c] | Present Worth O&M Cost[a,b] | Source/ Comments |
|---|---|---|---|---|---|---|---|
| 9 | Annual Evaluation (Year 2-30) | | | | | | |
| | 9.1 Inspection | 8 | hr/yr | $75 /hr | $600 | $9,100 | Assumes site conditions and use will be inspected annually to determine if institutional controls are currently acceptable. Evaluation would occur over 1 day. |
| | 9.2 Reporting | 32 | hr/yr | $75 /hr | $2,400 | $36,300 | Assume report will take 1 week to complete. |
| 10 | 5-Year Review (six over 30 years) | 40 | hr/yr | $100 /hr | $4000 ($800 averaged over 5 years) | $11,700 | Remedial alternative at site will need to be reviewed every 5 years to ensure that institutional controls are providing adequate protection |
| | **Total O&M Costs** | | | | **$3,800** | **$57,000** | |

[a] Estimates include remedial action, construction, and Operations and Maintenance (O&M) costs that are expected to differ between alternatives. Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations. The estimate is typically accurate within plus 50 to minus 30 percent.
[b] Present worth cost calculated using an interest rate of 5 percent over 30 years.
[c] The annual total O&M costs consist of cost for annual evaluation and an average of other costs over time period they occur. For example, the annual cost for 5-year review is total $4000 averaged over 5 years.
[d] O&M costs occur over a period of 30 years.
hr/yr - hours per year

**Table 2-13 (cont'd)**
Cost Estimate Summary: Surface Soil Selected Remedy, Excavation and Off-site Disposal, Industrial Planned Use
Cost Estimate Summary
*Memphis Depot Main Installation ROD*

| Item | Activity/Component | Capital Cost[a] | Annual O&M Cost[a] | Present Worth O&M Cost[a,b] | Total PW Cost[c] |
|---|---|---|---|---|---|
| 1 | Institutional Controls and Deed Restrictions | $7,400 | NA | NA | $7,400 |
| 2 | Plans for Implementation | $7,200 | NA | NA | $7,200 |
| 3 | Excavation of Soils | $1,000 | NA | NA | $1,000 |
| 4 | Surface Water Collection and Controls | $10,000 | NA | NA | $10,000 |
| 5 | Disposal of Contaminated Soils | $128,950 | NA | NA | $128,950 |
| 6 | Confirmation Sampling | $7,400 | NA | NA | $7,400 |
| 7 | Restoration of Site | $6,930 | NA | NA | $6,930 |
| 8 | Maintenance of Site- Landscaping | $14,400 | NA | NA | $14,400 |
| 9 | Annual Evaluation (Year 2-30) | NA | $3,000 | $45,400 | $45,400 |
| 10 | 5-Year Review (six over 30 years) | NA | $800 [d] | $11,700 | $11,700 |
| **Total Cost for Entire Main Installation** | | **$183,000** | **$3,800** | **$57,000** | **$240,000** |

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives. Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations. The estimate is typically accurate within plus 50 to minus 30 percent.

[b] Present worth (PW) cost calculated using an interest rate of 5 percent.

[c] Total PW cost includes capital plus PW O&M costs.

[d] The annual total O&M costs consist of cost for annual evaluation and an average of other costs over time period they occur. For example, the annual cost for 5-year review is total $4000 averaged over 5 years.

NA Not applicable

**Table 2-14**
Cost Estimate Summary: Groundwater Selected Remedy, Enhanced Bioremediation
Capital Costs
*Memphis Depot Main Installation ROD*

| Item | Activity/Component | Quantity | Unit | Unit Cost | Capital Cost[a] |
|---|---|---|---|---|---|
| 1 | Deed Restrictions | | | | |
| | 1.1 Attorney Fees | 32 | hr | $200 /hr | $6,400 |
| | 1.2 Recording of the Deed | 2 | ea | $500 /ea | $1,000 |
| 2 | Plans for Implementation | 88 | hr | $75 /hr | $6,600 |
| 3 | Installation of 6 Monitoring Wells | | | | |
| | 3.1 Mobilization | 1 | ea | $1,200 /ea | $1,200 |
| | 3.2 Drill Well - Rotasonic | 600 | ft | $100 /ft | $60,000 |
| | 3.3 2-inch PVC well casing | 540 | ft | $10 /ft | $5,400 |
| | 3.4 2-inch PVC well screen | 60 | ft | $12 /ft | $700 |
| | 3.5 Well Head | 6 | ea | $200 /ea | $1,200 |
| | 3.6 Develop well | 6 | ea | $500 /ea | $3,000 |
| | 3.7 Decontaminate Equipment | 6 | ea | $200 /ea | $1,200 |
| 4 | Enhanced Biotreatment | | | | |
| | 4.1 Pilot Study | | | | |
| | 4.1.1 Material | 900 | lbs | $6 /lb | $5,400 |
| | 4.1.2 Installation of HRC™ | 11 | day | $4,000 /day | $44,000 |
| | 4.1.3 Labor | 176 | hr | $75 /hr | $13,200 |
| | 4.1.4 Mobilization/ Demobilization | 1 | ea | $1,000 /ea | $1,000 |
| | 4.1.4 Pump | 11 | day | $150 /day | $1,700 |
| | Monitoring (8 Events) | | | | |
| | 4.1.5 Labor | 1120 | hr | $75 /hr | $84,000 |
| | 4.1.6 Laboratory Analyses (VOCs) | 184 | analysis | $198 /analysis | $36,400 |
| | 4.1.7 Laboratory Analyses (MNA Parameters) | 184 | analysis | $450 /analysis | $82,800 |
| | 4.1.8 Laboratory Analyses (Metabolic Acids) | 184 | analysis | $100 /analysis | $18,400 |
| | 4.1.7 Rental Equipment | 56 | day | $330 /day | $18,500 |
| | 4.1.8 Mobilization/ Demobilization | 256 | hr | $75 /hr | $19,200 |
| | 4.1.9 Supplies | 8 | event | $500 /event | $4,000 |
| | 4.1.10 Summary TM | 320 | hr | $75 /hr | $24,000 |
| | 4.2 Full Scale Remediation (Year 1) | | | | |
| | 4.2.1 Material | 10,400 | lbs | $6 /lb | $62,400 |
| | 4.2.2 Installation of HRC™ | 126 | day | $2,000 /day | $252,000 |
| | 4.2.3 Labor | 2000 | hr | $75 /hr | $150,000 |
| | 4.2.4 Mobilization/ Demobilization | 1 | ea | $1,000 /ea | $1,000 |
| | 4.2.4 Pump | 126 | day | $150 /day | $18,900 |
| 5 | Groundwater Monitoring (Year 1), 2 Events | | | | |
| | 5.1 Labor | 280 | hr | $75 /hr | $21,000 |
| | 5.2 Laboratory Analyses (VOCs) | 46 | analysis | $198 /analysis | $9,100 |
| | 5.3 Laboratory Analyses (MNA Parameters) | 46 | analysis | $450 /analysis | $20,700 |
| | 5.4 Laboratory Analyses (Metabolic Acids) | 46 | analysis | $100 /analysis | $4,600 |
| | 5.5 Rental Equipment | 14 | day | $330 /day | $4,600 |
| | 5.6 Mobilization/Demobilization | 64 | hr | $75 /hr | $4,800 |
| | 5.7 Supplies | 2 | event | $500 /event | $1,000 |
| 6 | Abandonment of Wells (Year 10) | | | | |
| | 6.1 Mobilization/Demobilization | 1 | ea | $1,200 /ea | $1,200 [PW $800] |
| | 6.2 Abandon Wells | 37 | ea | $1,000 /ea | $37,000 [PW $23900] |
| 7 | Annual Report (Year 1) | 64 | hr | $75 /hr | $4,800 |
| **Total Capital Costs** | | | | | **$1,018,900** |

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives. Planning and engineering costs are typically estimated to be a percentage of remedy cost and, therefore, do not factor in comparative cost evaluations. The estimate is typically accurate within plus 50 to minus 30 percent.

**Table 2-14 (cont'd)**
Cost Estimate Summary: Groundwater Selected Remedy. Enhanced Bioremediation
O&M Costs
*Memphis Depot Main Installation ROD*

| Item | Activity/Component | Quantity | Unit | Unit Cost | Annual O&M Cost[a] | Present Worth O&M Cost[a,b] |
|---|---|---|---|---|---|---|
| 8 | Continued Enhanced Biotreatment (Year 2-5) | | | | | |
| | 8.1 Material | 10,400 | lbs/yr | $6 /lb | $62,400 | $221,300 |
| | 8.2 Installation of HRC™ | 32 | day/yr | $2,000 /day | $63,000 | $223,400 |
| | 8.3 Labor | 512 | hr/yr | $75 /hr | $38,400 | $136,200 |
| | 8.4 Mobilization/Demobilization | 1 | ea/yr | $1,000 /ea | $1,000 | $3,500 |
| | 8.5 Pump | 32 | day/yr | $150 /day | $4,800 | $16,800 |
| 9 | Groundwater Monitoring (Year 2-5), 8 Events | | | | | |
| | 9.1 Labor | 280 | hr/yr | $75 /hr | $21,000 | $74,500 |
| | 9.2 Laboratory Analyses (VOCs) | 46 | analysis/yr | $200 /analysis | $9,200 | $32,600 |
| | 9.3 Laboratory Analyses (MNA Parameters) | 46 | analysis/yr | $1,500 /analysis | $69,000 | $244,700 |
| | 9.4 Laboratory Analyses (Metabolic Acids) | 46 | analysis | $100 /analysis | $4,600 | $16,300 |
| | 9.5 Rental Equipment | 14 | day/yr | $330 /day | $4,600 | $16,400 |
| | 9.6 Mobilization/Demobilization | 64 | hr/yr | $75 /hr | $4,800 | $17,000 |
| | 9.7 Supplies | 2 | event/yr | $500 /event | $1,000 | $3,500 |
| 10 | Groundwater Monitoring (Year 6-10), 5 Events | | | | | |
| | 10.1 Labor | 140 | hr/yr | $75 /hr | $10,500 | $37,200 |
| | 10.2 Laboratory Analyses (VOCs) | 23 | analysis/yr | $198 /analysis | $4,600 | $16,100 |
| | 10.3 Laboratory Analyses (MNA Parameters) | 23 | analysis/yr | $450 /analysis | $10,400 | $36,700 |
| | 10.4 Rental Equipment | 7 | day/yr | $330 /day | $2,300 | $8,200 |
| | 10.5 Mobilization/Demobilization | 32 | hr/yr | $75 /hr | $2,400 | $8,500 |
| | 10.6 Supplies | 1 | event/yr | $500 /event | $500 | $1,800 |
| 11 | Monitoring Well Maintenance (2 over 10 years) | | | | | |
| | 11.1 Cleaning | 20 | ea | $125 /ea | $2500 ($500 | $3,700 |
| | 11.2 Well head and miscellaneous repairs | 20 | ea | $200 /ea | $4000 ($800 averaged over 5 years) | $5,900 |
| 12 | Annual Report (Year 2-10) | 64 | hr/yr | $75 /hr | $4,800 | $72,700 |
| 13 | 5-Year Review (2 over 10 years) | 40 | hr | $100 /hr | $4000 ($800 averaged over 5 years) | $5,900 |
| **Total O&M Costs (1-10 years)[d, e]** | | | | | **$249,000** | **$1,202,900** |

[a] Estimates include remedial action, construction, and operation and maintenance (O&M) costs that are expected to differ between alternatives. Planning and engineering costs are typically estimated to be a percentage of remedy costfactor and therefore, do not comparitive cost evaluations. The estimate is typically accurate within plus 50 to minus 30 percent.

[b] Present worth cost is calculated by using an interest rate of 5 percent for all costs beyond year 1.

[c] The duration of O&M will be 10 years.

[d] The Total Annual O&M Costs are equal to an average of the annual cost for a year with semi-annual monitoring and a year with annual monitoring and includes cost for biotreatment.

[e] The annual O&M costs for monitoring well costs and 5 year review are an average of total cost over time period item occurs. For example, the annual cost for 5-year review is total $4000 averaged over 5 years ($800).

MNA - Monitored Natural Attenuation

**Table 2-14 (cont'd)**
Cost Estimate Summary: Groundwater Selected Remedy, Enhanced Bioremediation
Cost Estimate Summary
*Memphis Depot Main Installation ROD*

| Item | Activity/Component | Capital Cost[a] | Annual O&M Cost[a] | Present Worth O&M Cost[a,b] | Total PW Cost[c] |
|---|---|---|---|---|---|
| 1 | Institutional Controls and Deed Restrictions | $7,400 | NA | NA | $7,400 |
| 2 | Plans for Implementation | $6,600 | NA | NA | $6,600 |
| 3 | Installation of 6 Monitoring Wells | $72,700 | NA | NA | $72,700 |
| 4 | Enhanced Biotreatment | | | | $836,900 |
| | Pilot Study | $352,600 | NA | NA | |
| | Full Scale Remediation | $484,300 | NA | NA | |
| 5 | Groundwater Monitoring (Year 1) | $65,800 | NA | NA | $65,800 |
| 6 | Abandonment of Wells (Year 10) | $24,700 | NA | NA | $24,700 |
| 7 | Annual Report (Year 1) | $4,800 | NA | NA | $4,800 |
| 8 | Continued Enhanced Biotreatment (Year 2-5) | NA | $169,600 | $601,200 | $601,200 |
| 9 | Groundwater Monitoring (Year 2-5) | NA | $114,200 | $405,000 | $405,000 |
| 10 | Groundwater Monitoring (Year 6-10) | NA | $30,700 | $108,500 | $108,500 |
| 11 | Monitoring Well Maintenance (2 over 10 years) | NA | $1,300 [e] | $9,600 | $9,600 |
| 12 | Annual Report (Year 2-10) | NA | $4,800 | $72,700 | $72,700 |
| 13 | 5-Year Review (2 over 10 years) | NA | $800 [e] | $5,900 | $5,900 |
| **Total Costs for Entire MI** | | **$1,019,000** | **$249,000** [d] | **$1,203,000** | **$2,222,000** |

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives. Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations. The estimate is typically accurate within plus 50 to minus 30 percent.

[b] Present worth cost calculated using an interest rate of 5 percent over 10 years.

[c] Total PW cost includes capital plus PW O&M costs over 10 years.

[d] The Total Annual O&M Costs are equal to an average of the annual cost for a year with semi-annual monitoring and a year with annual monitoring.

[e] The annual O&M costs are an average of total cost over time period item occurs. For example, the annual cost for 5-year review is total $4000 averaged over 5 years ($800).

NA = Not applicable; PW - present worth

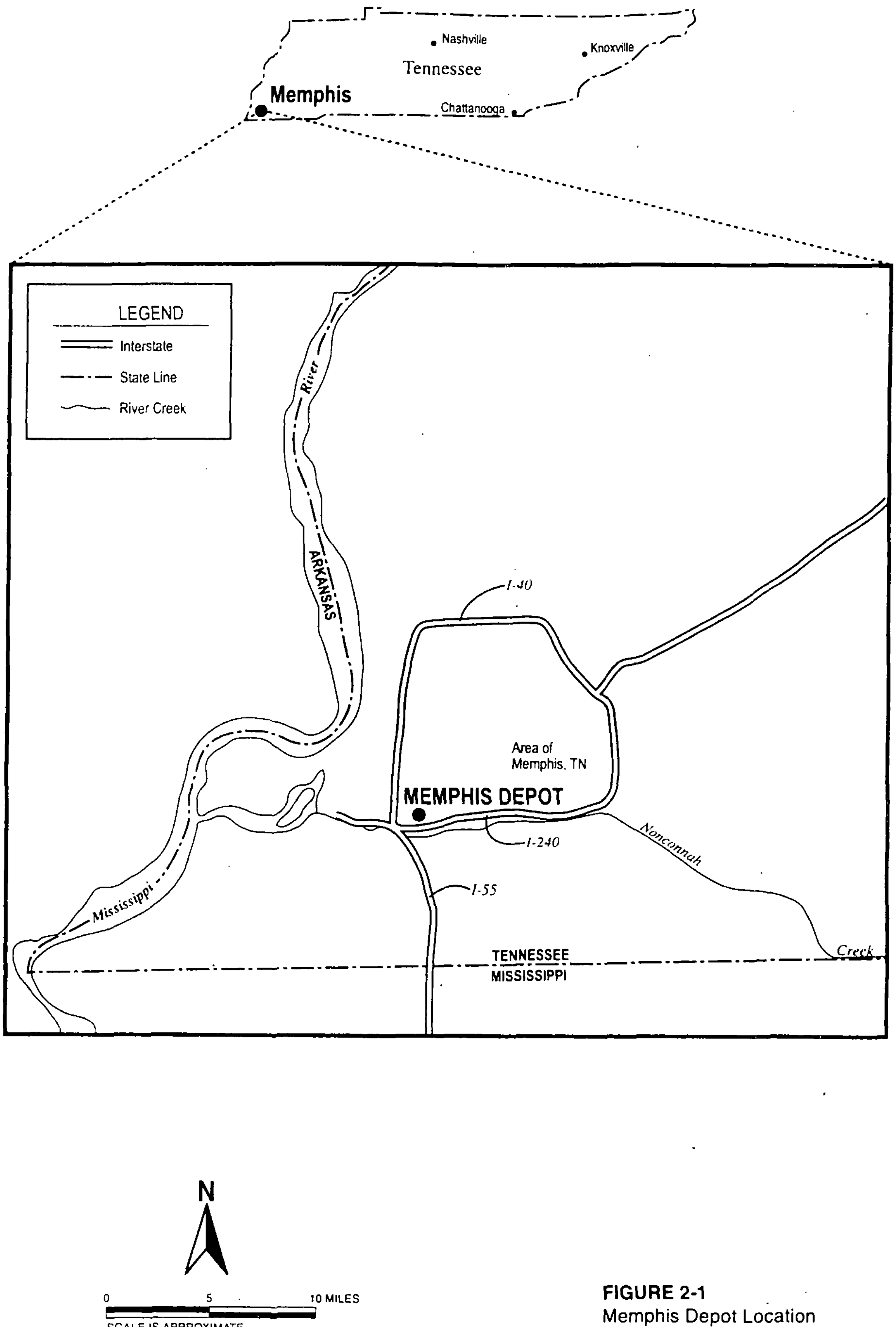


**FIGURE 2-1**
Memphis Depot Location
*Memphis Depot Main Installation ROD*

3126_02a (9/11/00)

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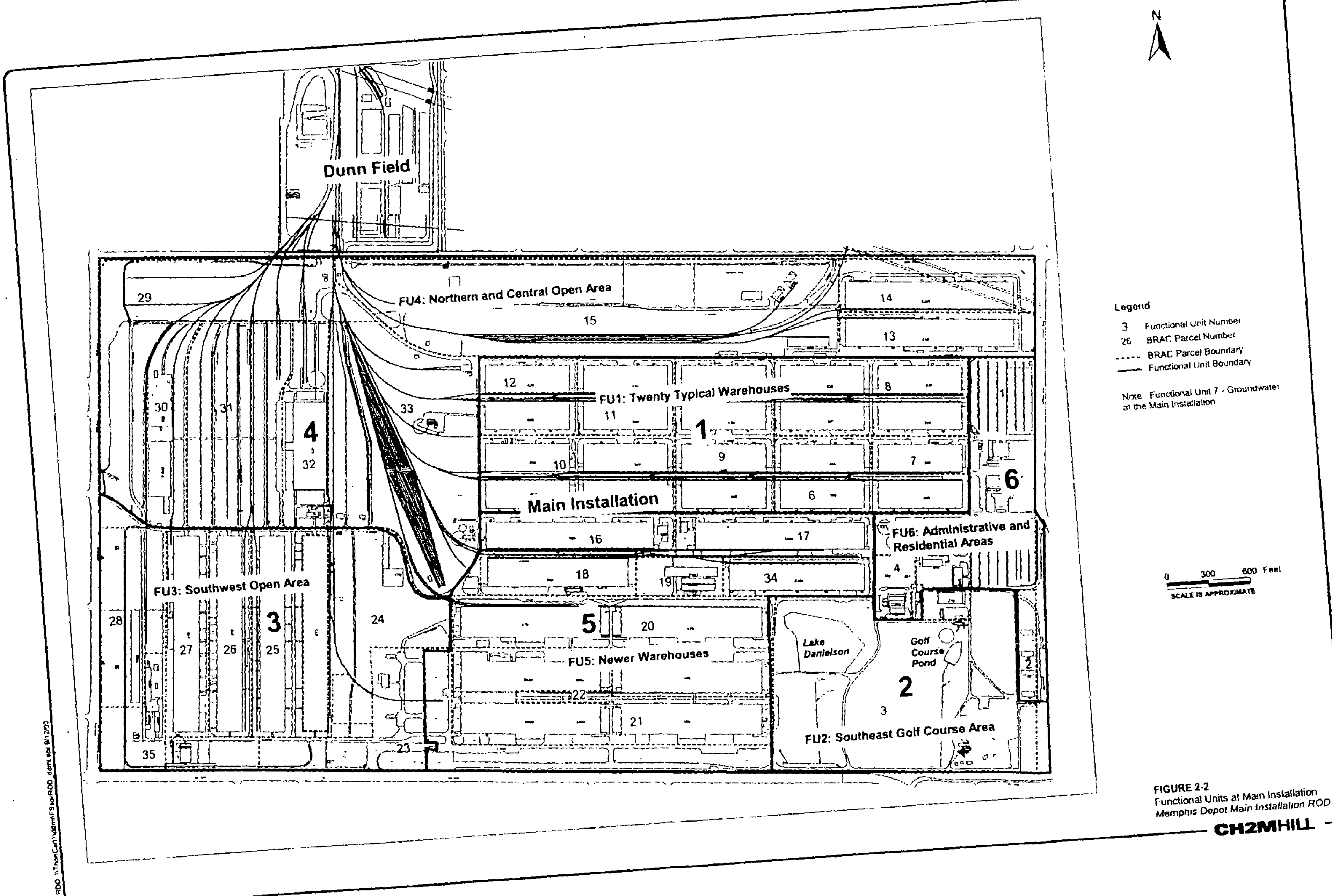


FIGURE 2-2
Functional Units at Main Installation
*Memphis Depot Main Installation ROD*

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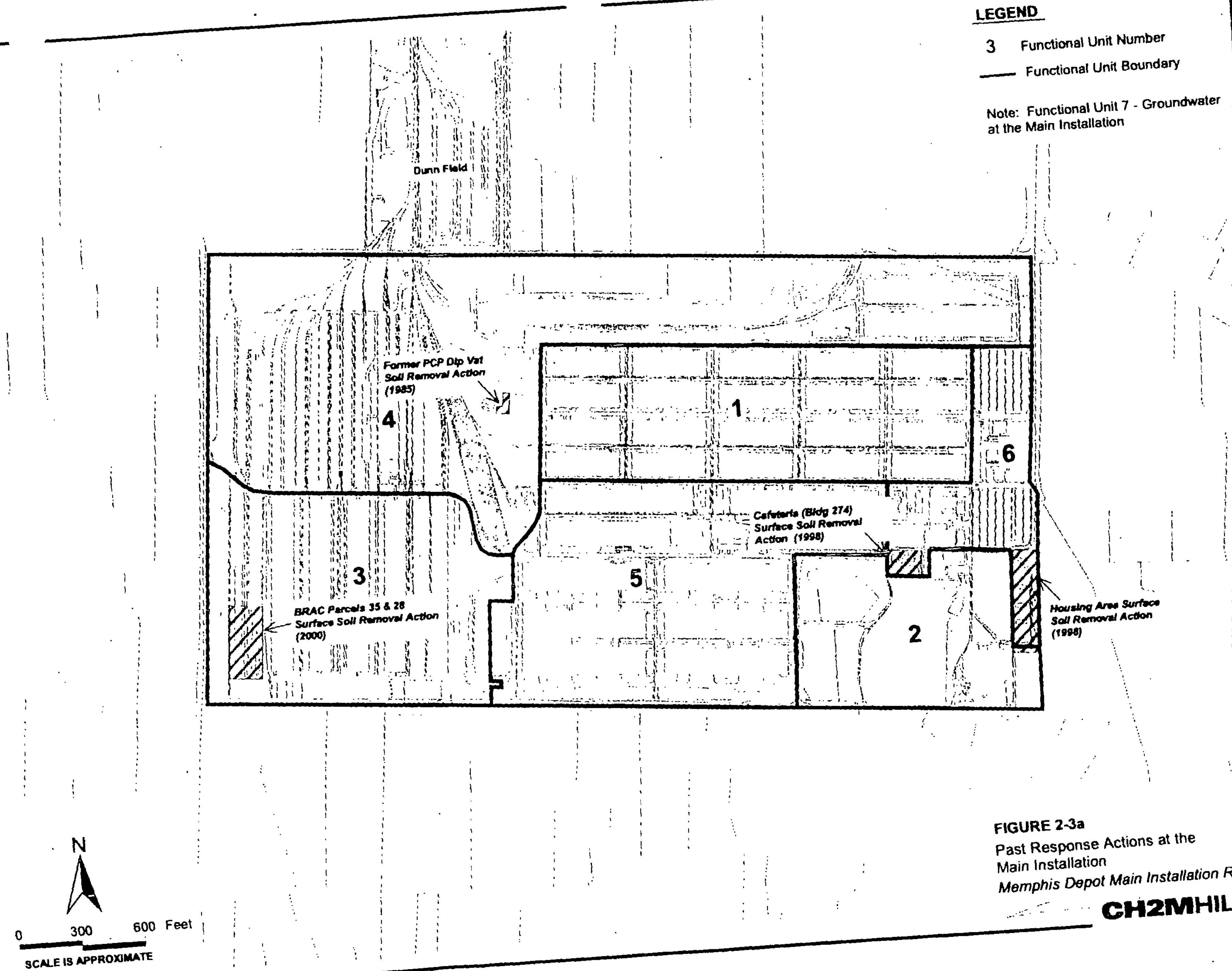


**FIGURE 2-3a**
Past Response Actions at the Main Installation
*Memphis Depot Main Installation ROD*

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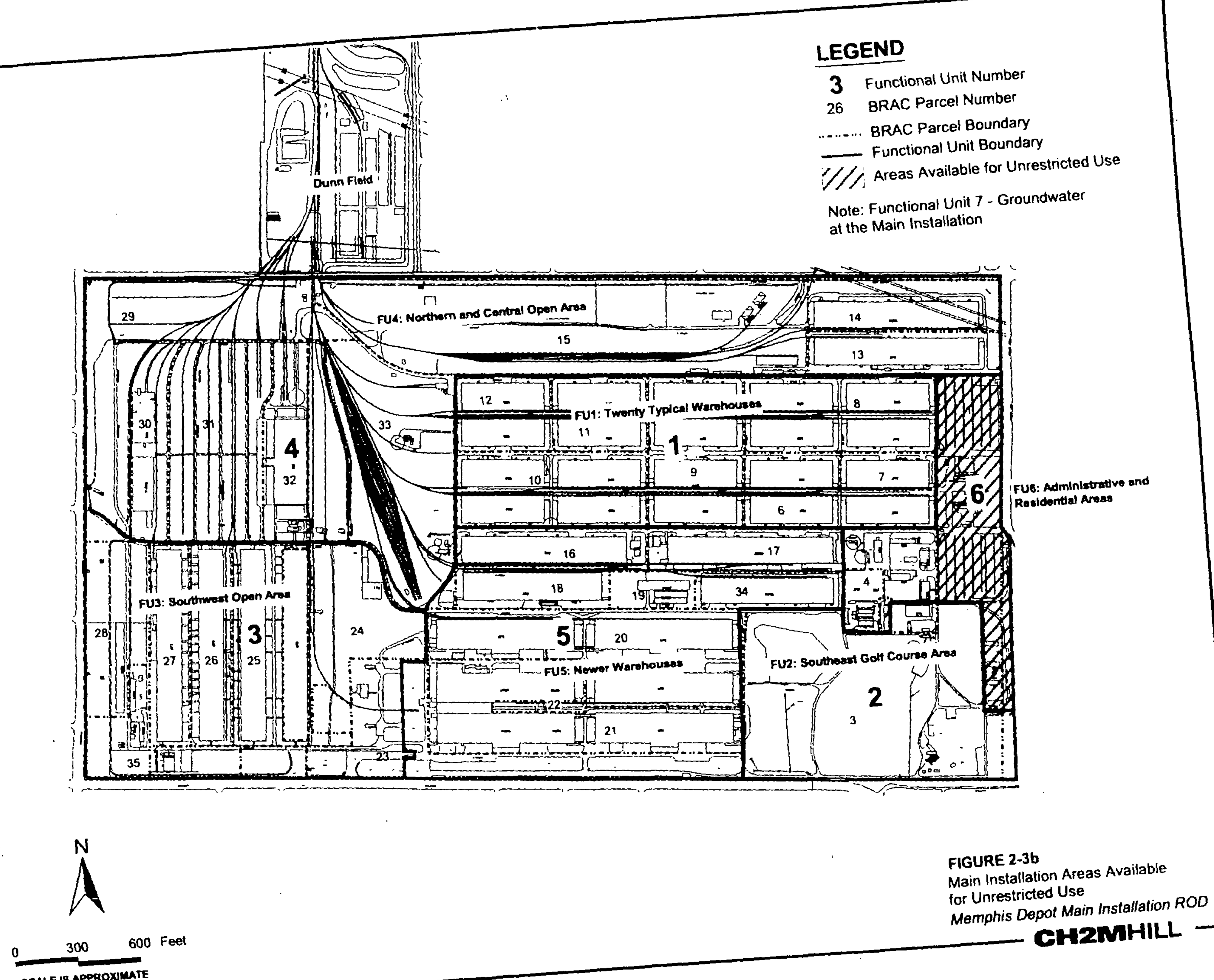


FIGURE 2-3b
Main Installation Areas Available for Unrestricted Use
*Memphis Depot Main Installation ROD*

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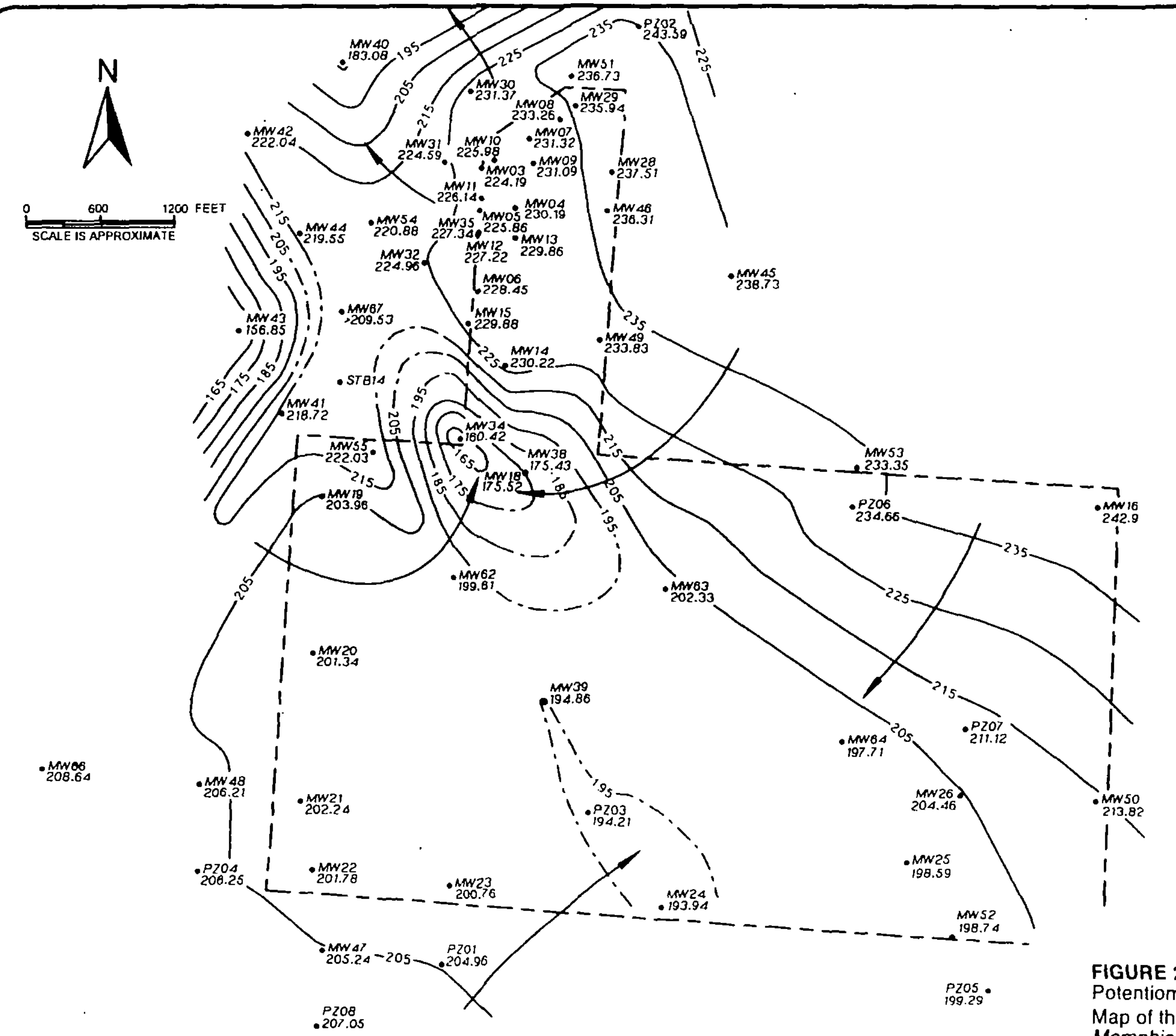
ROD \\Thor\Cart1\ddmt\FSsoilROD_ddmt.apr 2/16/01




## LEGEND

- Monitoring Well / Soil Boring Location
- MW16 Well Number
- Depot Boundary
- 225 Potentiometric Contour (Ft above msl)
- Tentative Potentiometric Contour (Ft above msl)
- Groundwater Flow Direction

Source: CH2M HILL Final RI Report, Jan-2000

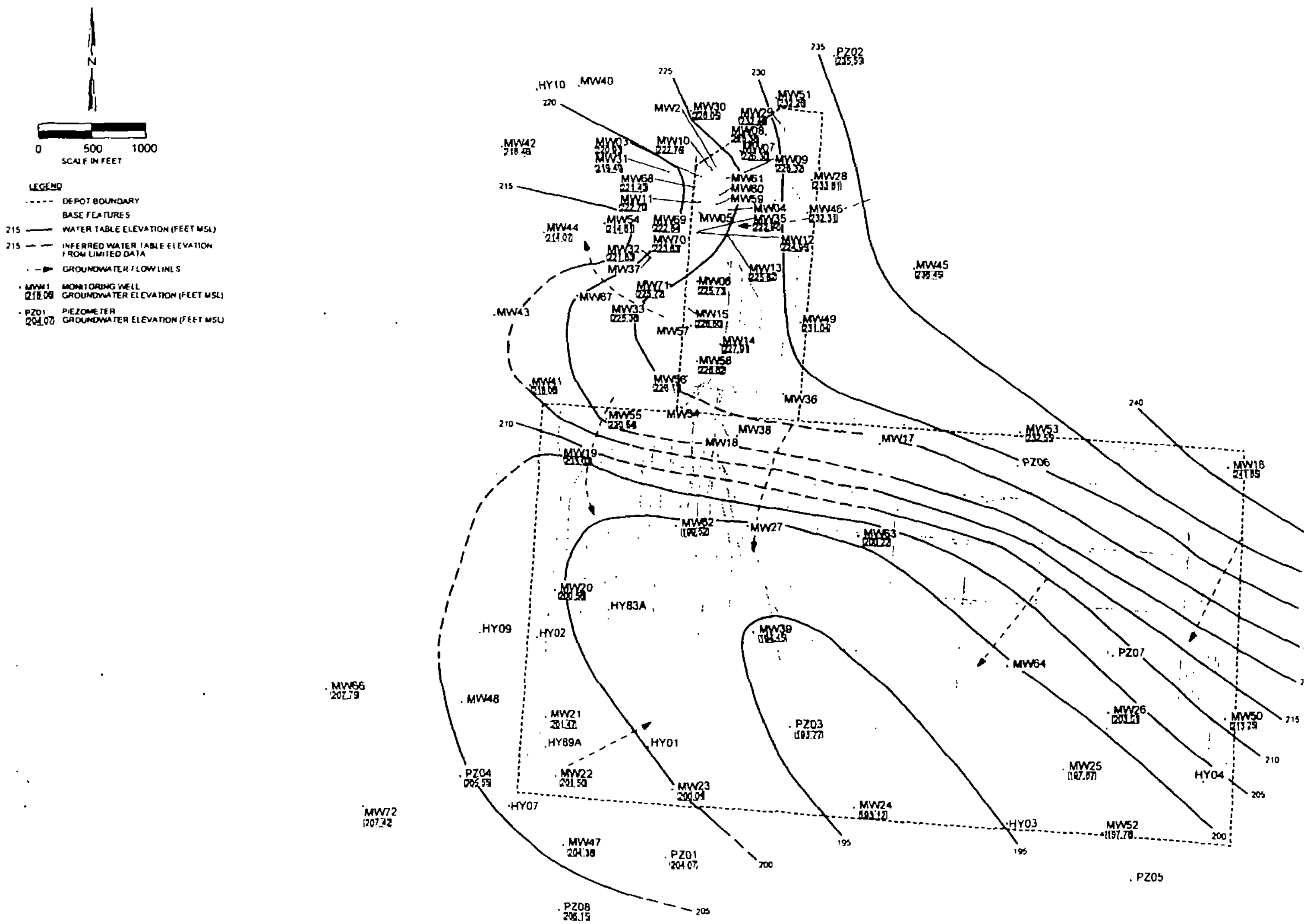
**FIGURE 2-4**
Potentiometric Surface
Map of the Fluvial Aquifer
*Memphis Depot Main Installation ROD*

**CH2MHILL**

Note: Date of Groundwater Level Measurements - November 1998

RDD \Thor\Cart1\ddmt\potsurf_fs.dgn 7/24/2000

3126.05 (9/11/00)




NOTES

- MONITORING WELLS 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 15, 18, 16, 27, 28, 29, 30, 31, 33, 35, 36, 38, 40, 41, 42, 43, 44, 45, 46, 49, 51, 53, 54, 55, 56, 57, 58, 62, 63, 67, 68, 69, 71, & PZ02 WERE MEASURED BY IT CORP. ON APRIL 17, 2000
- MONITORING WELLS 16, 17, 19, 20, 21, 22, 23, 24, 25, 26, 27, 38, 39, 41, 47, 50, 52, 53, 56, 62, 63, 66, 72, & PZ01, 03, 04, 08 WERE MEASURED BY CH2M HILL ON APRIL 18, 2000
- NOT USED BECAUSE OF DEEP WELLS (WHICH HAVE SCREENED INTERVAL LOCATED IN A LOWER AQUIFER) MW18, 34, 36, 37, 38, 40, 43, 67
- MW21 NOT USED BECAUSE WATER MEASURED IS BELOW THE BOTTOM OF THE SCREEN AND CAUGHT IN 2.5 FT SUMP
- MW2, 5, 17 WERE DRY
- MW4, 48, 59, 60, 61, 64 AND PZ05, 06, 07 WERE NOT MEASURED

FIGURE 2-5
Water Table Elevations
in Fluvial Deposits
*Memphis Depot Main Installation ROD*

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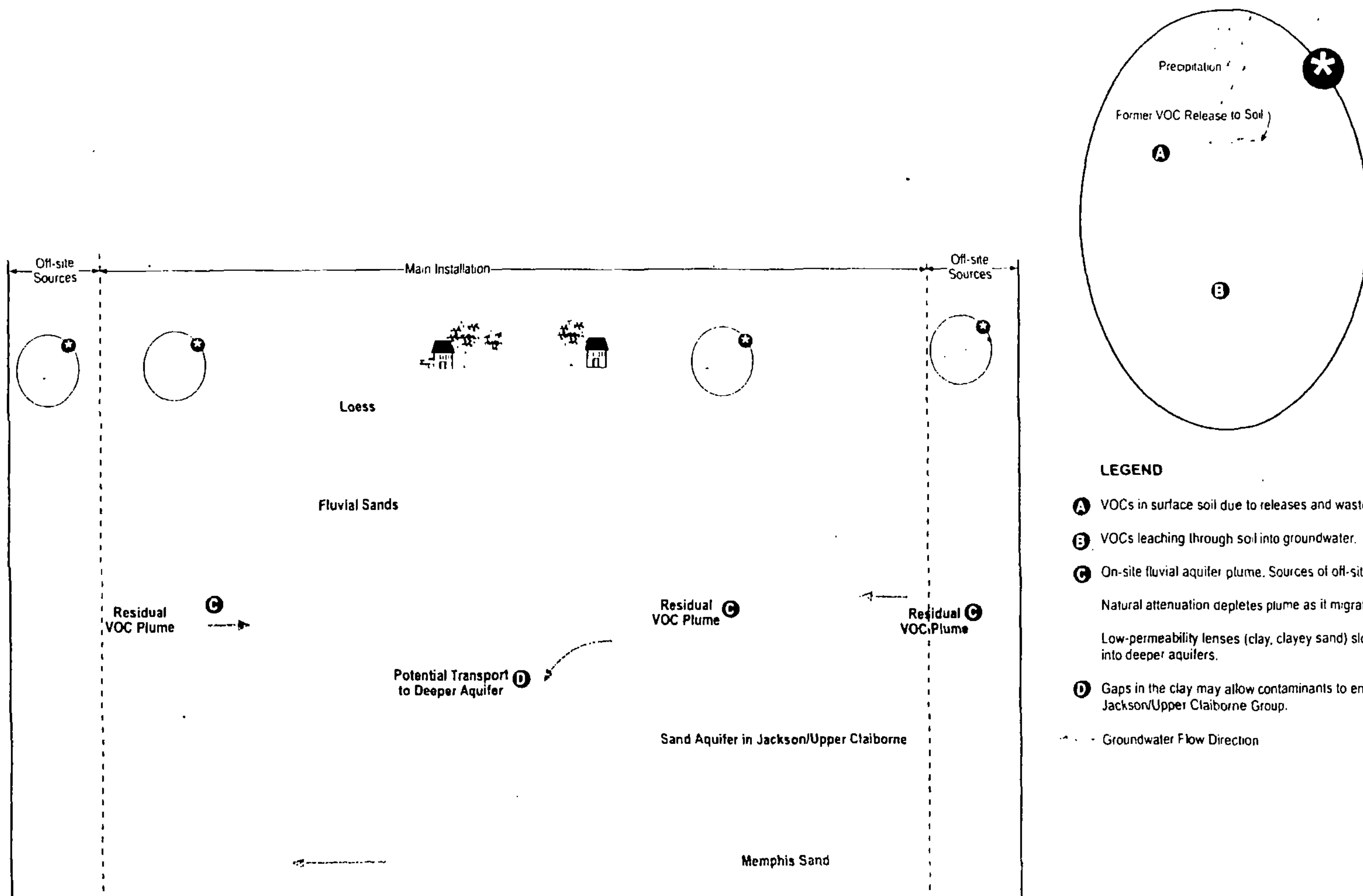


**LEGEND**

- **A** VOCs in surface soil due to releases and waste management activities.
- **B** VOCs leaching through soil into groundwater.
- **C** On-site fluvial aquifer plume. Sources of off-site plume currently unknown.

  Natural attenuation depletes plume as it migrates within the fluvial aquifer.

  Low-permeability lenses (clay, clayey sand) slow migration of contaminants into deeper aquifers.
- **D** Gaps in the clay may allow contaminants to enter sand aquifer in Jackson/Upper Claiborne Group.
- Groundwater Flow Direction

FIGURE 2-6
Conceptual Model of Contaminant Transport
*Memphis Depot Main Installation ROD*

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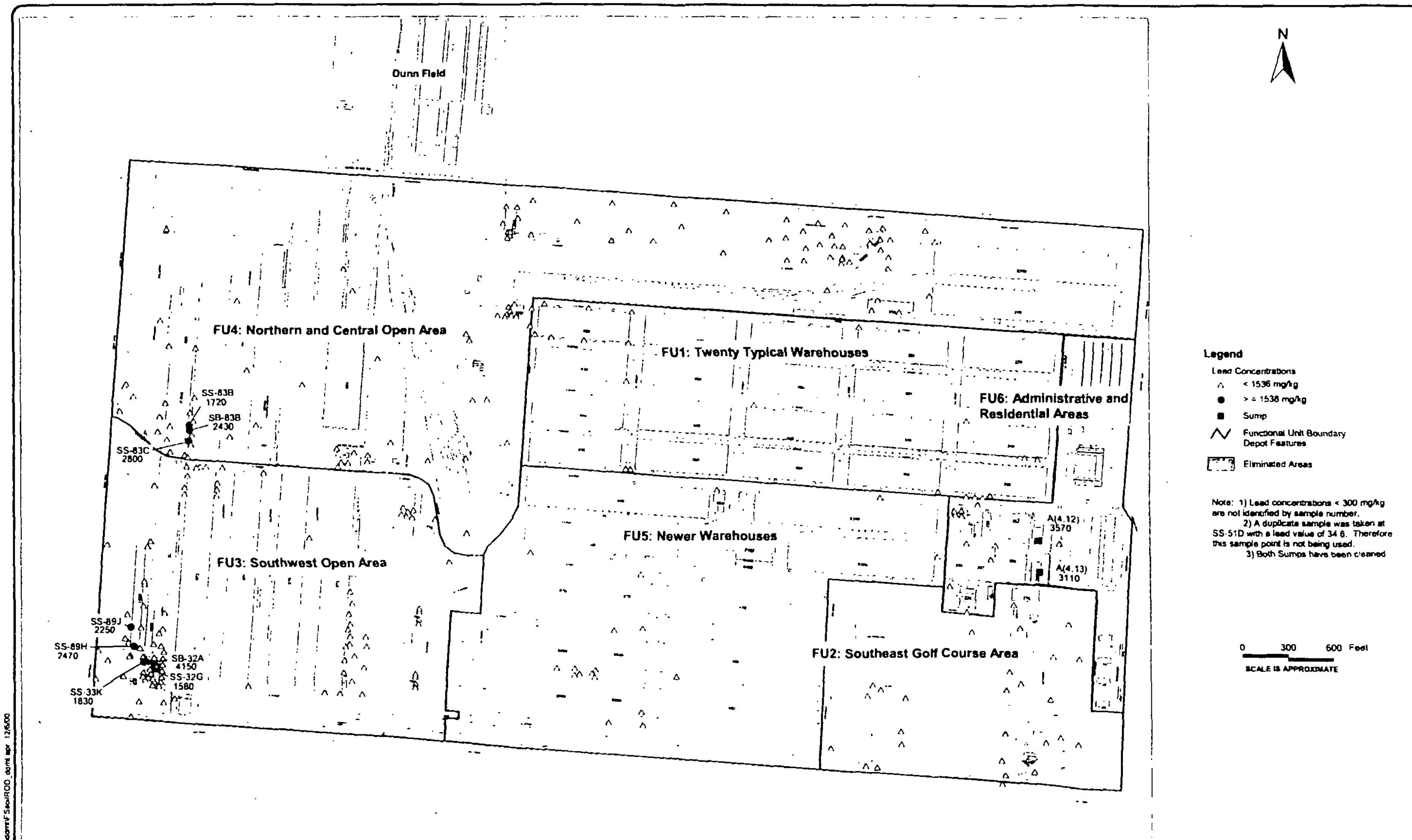


FIGURE 2-7
Distribution of Surface Soil Lead Across the Main Installation
*Memphis Depot Main Installation ROD*

CH2MHILL

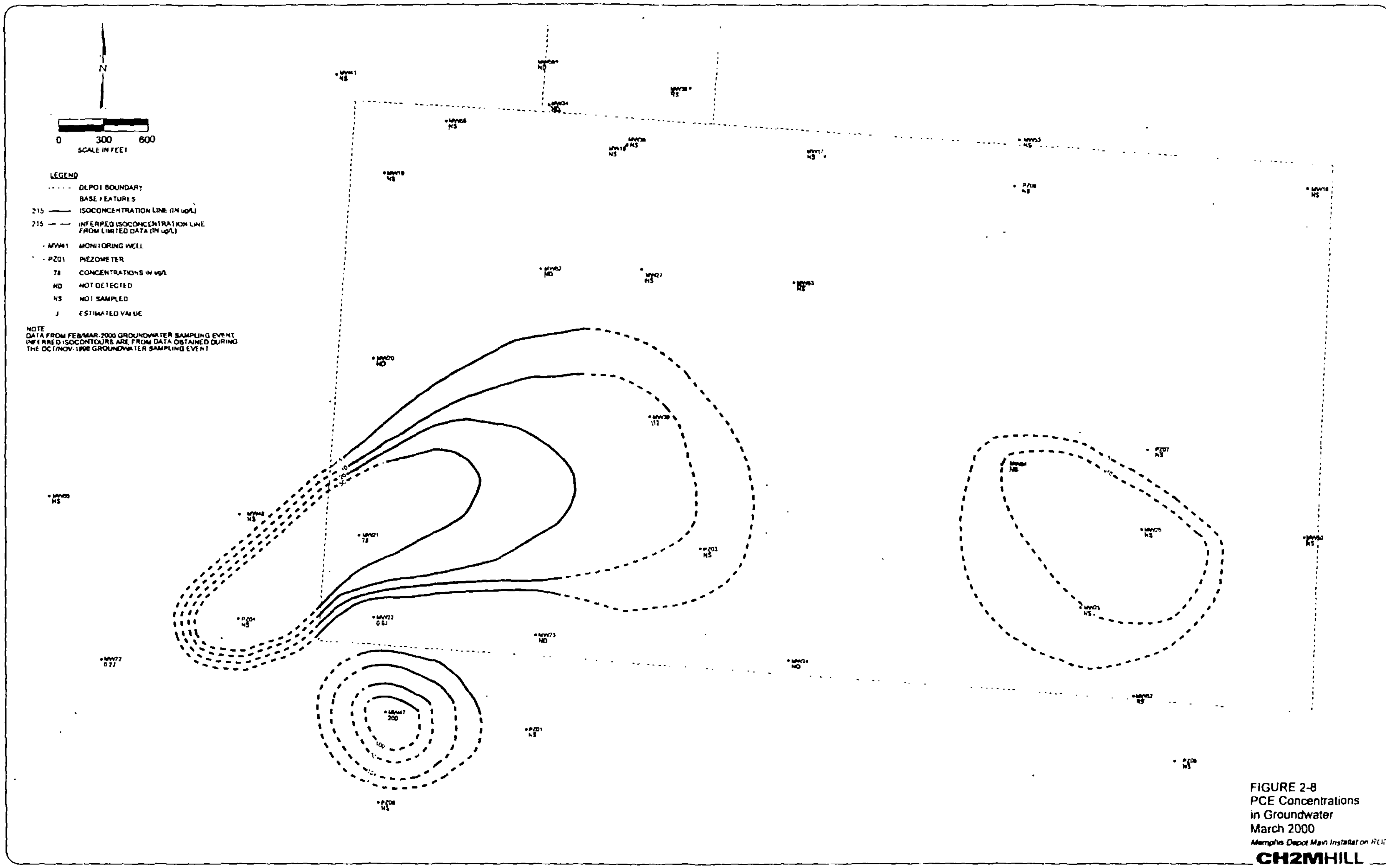


FIGURE 2-8
PCE Concentrations
in Groundwater
March 2000

*Memphis Depot Main Installation ROD*

**CH2MHILL**

ATLANTA/CAD/PROJECTS/147543 MemphisDepot 12-DEC-2000 75438g2-8.dgn

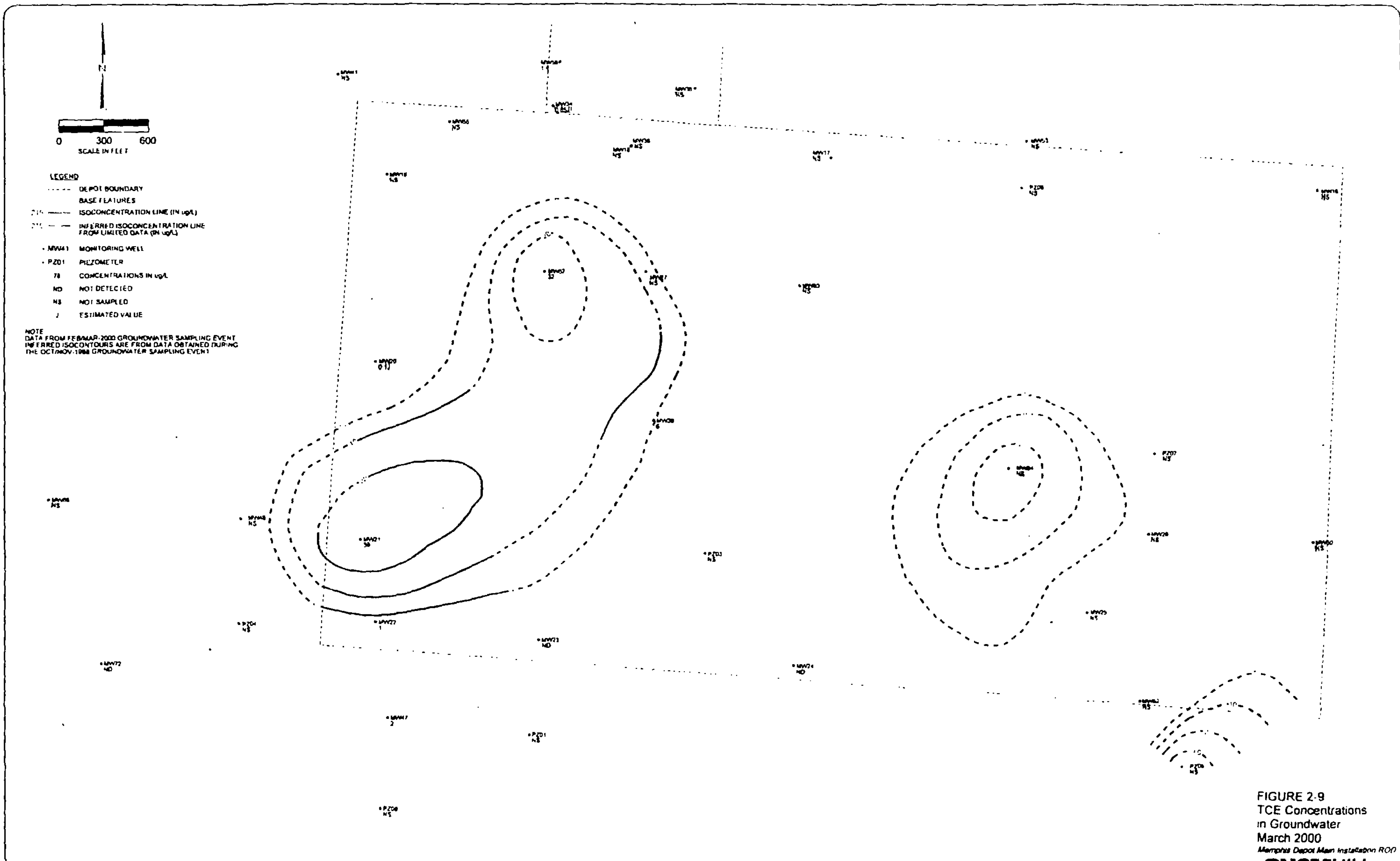


FIGURE 2-9
TCE Concentrations
in Groundwater
March 2000
*Memphis Depot Main Installation ROD*

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ATLANTA/CAD1/PROJECTS/147543 MemphisDepot 17-DEC-2000 75438g2-9.dgn

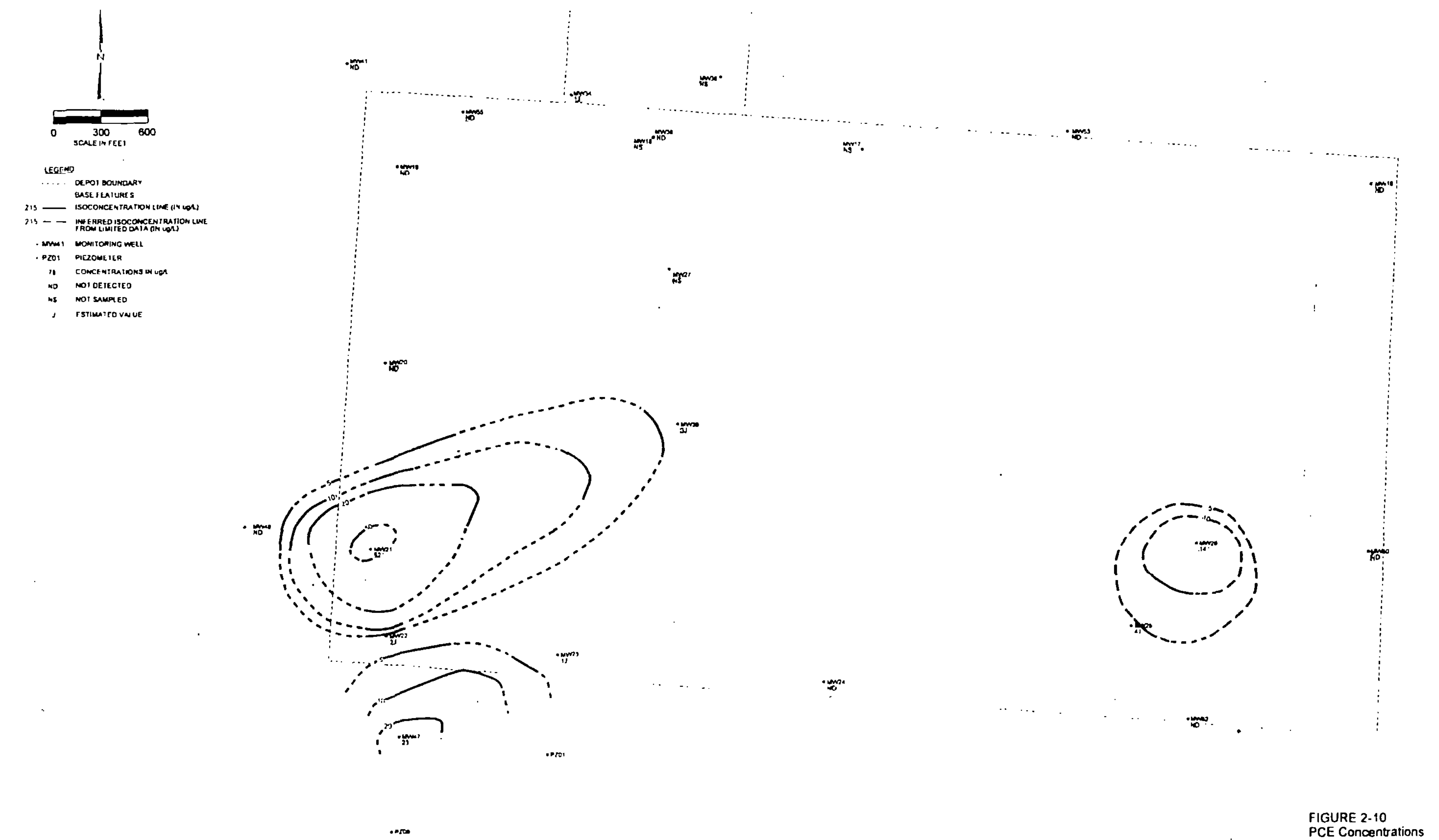


FIGURE 2-10
PCE Concentrations
in Groundwater
February 1996
*Memphis Depot Main Installation ROD*

**CH2MHILL**

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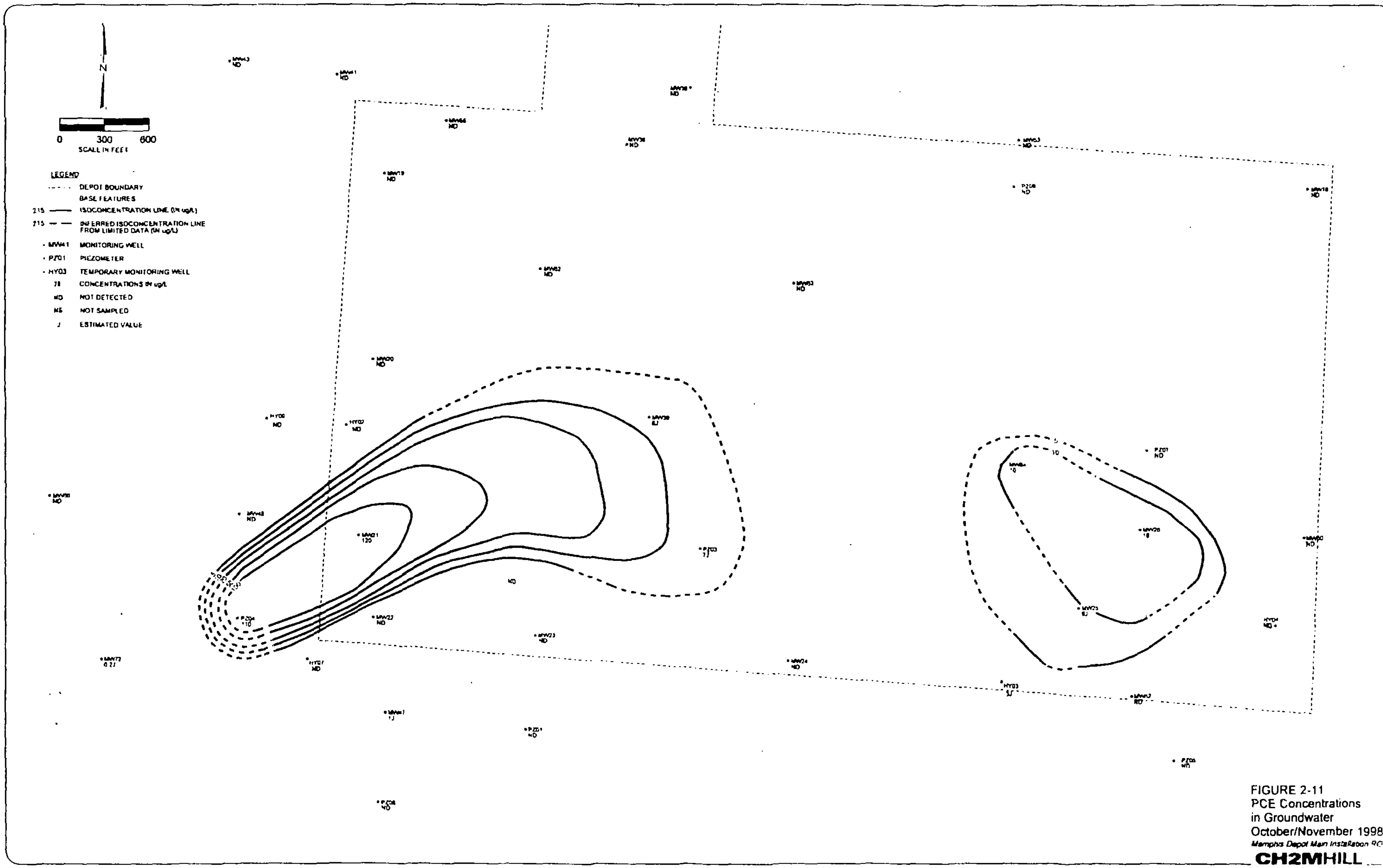


FIGURE 2-11
PCE Concentrations
in Groundwater
October/November 1998
*Memphis Depot Main Installation ROD*

**CH2MHILL**

ATLANTA/CAD1/PROJECTS/147543 MemphisDepot 13-SEP-2000

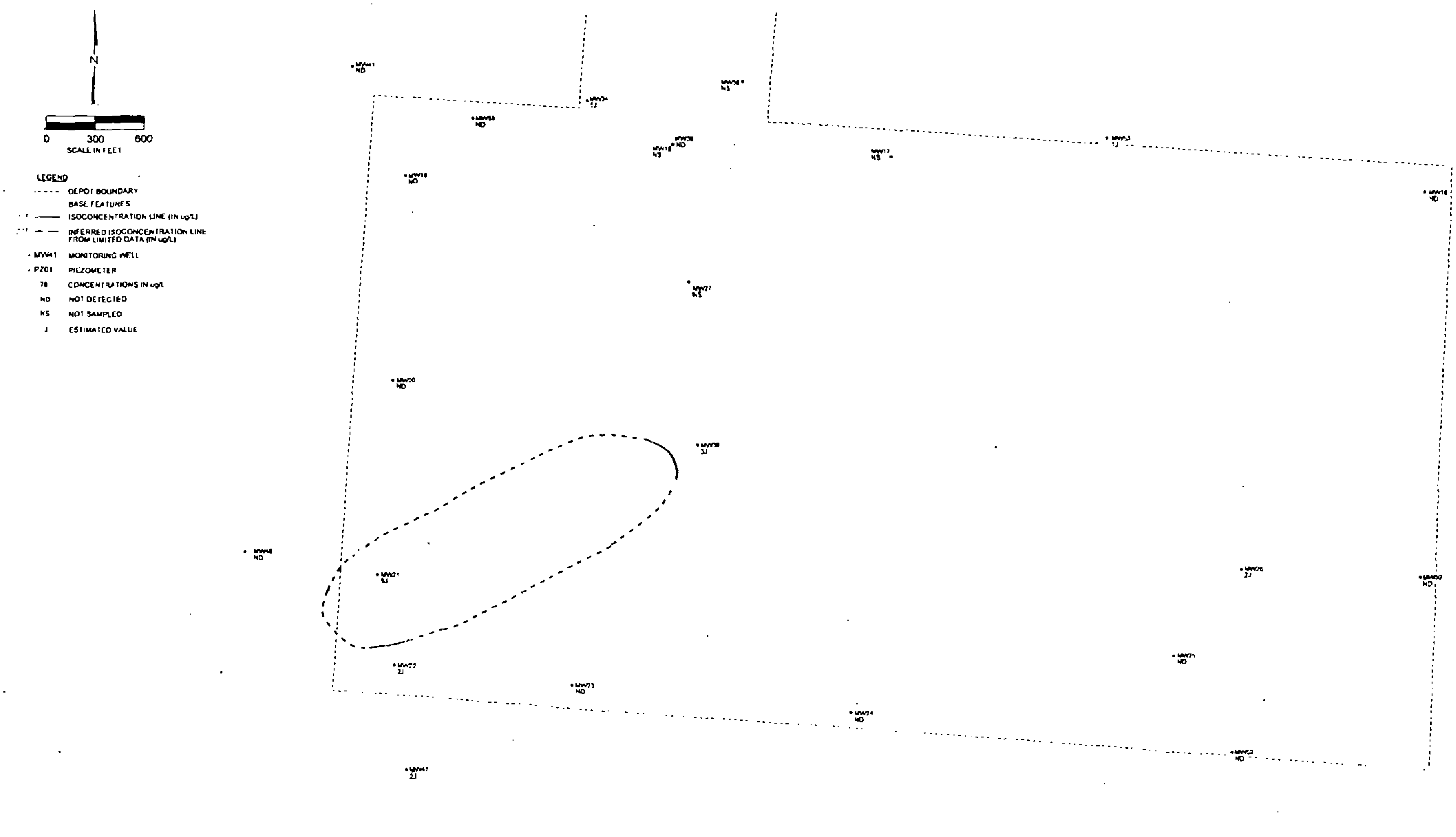


FIGURE 2-12
TCE Concentrations
in Groundwater
February 1996
*Memphis Depot Main Installation RCP*
**CH2MHILL**

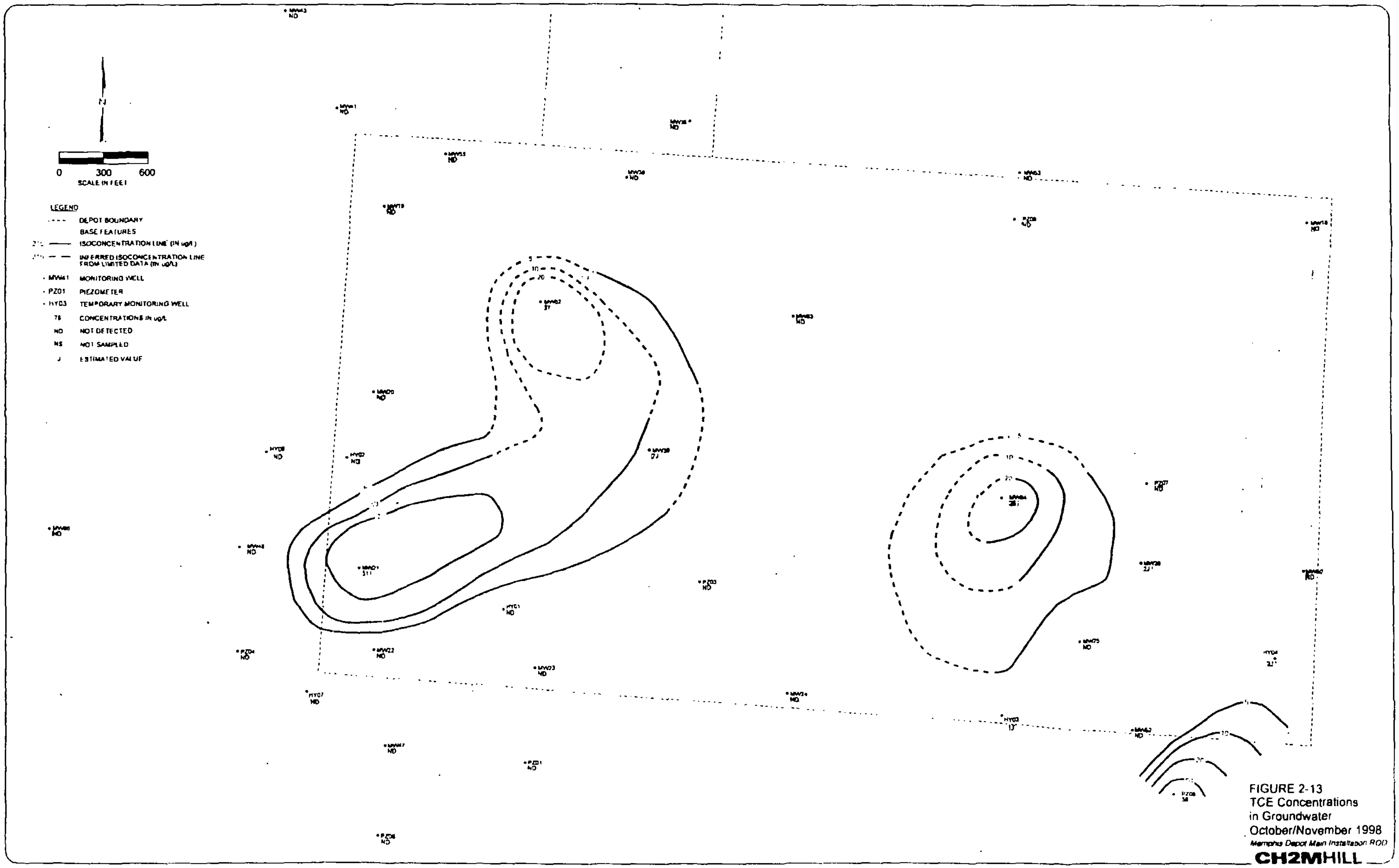


FIGURE 2-13
TCE Concentrations in Groundwater
October/November 1998

*Memphis Depot Main Installation ROD*

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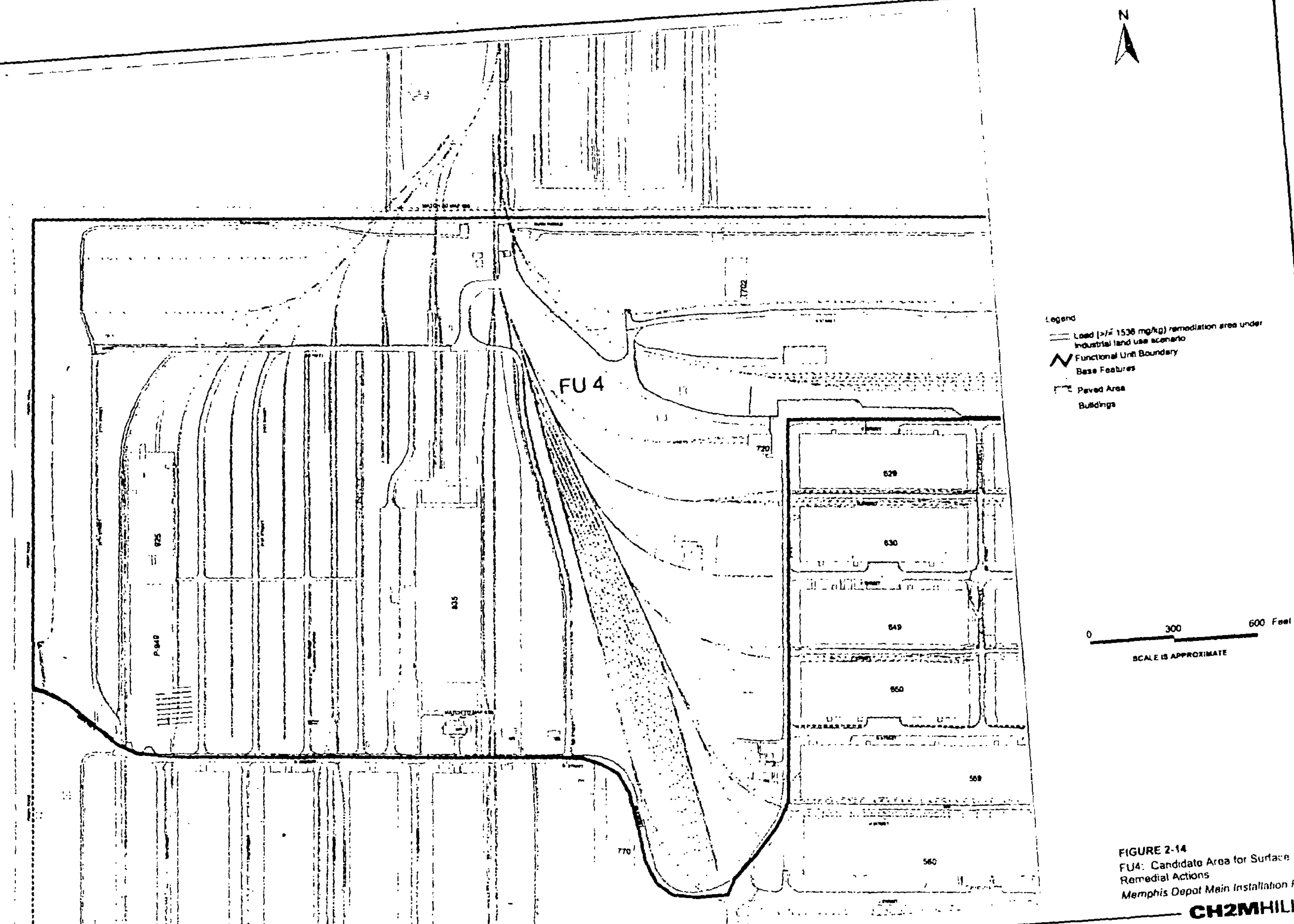


**FIGURE 2-14**
FU4: Candidate Area for Surface Soil Remedial Actions
*Memphis Depot Main Installation ROD*

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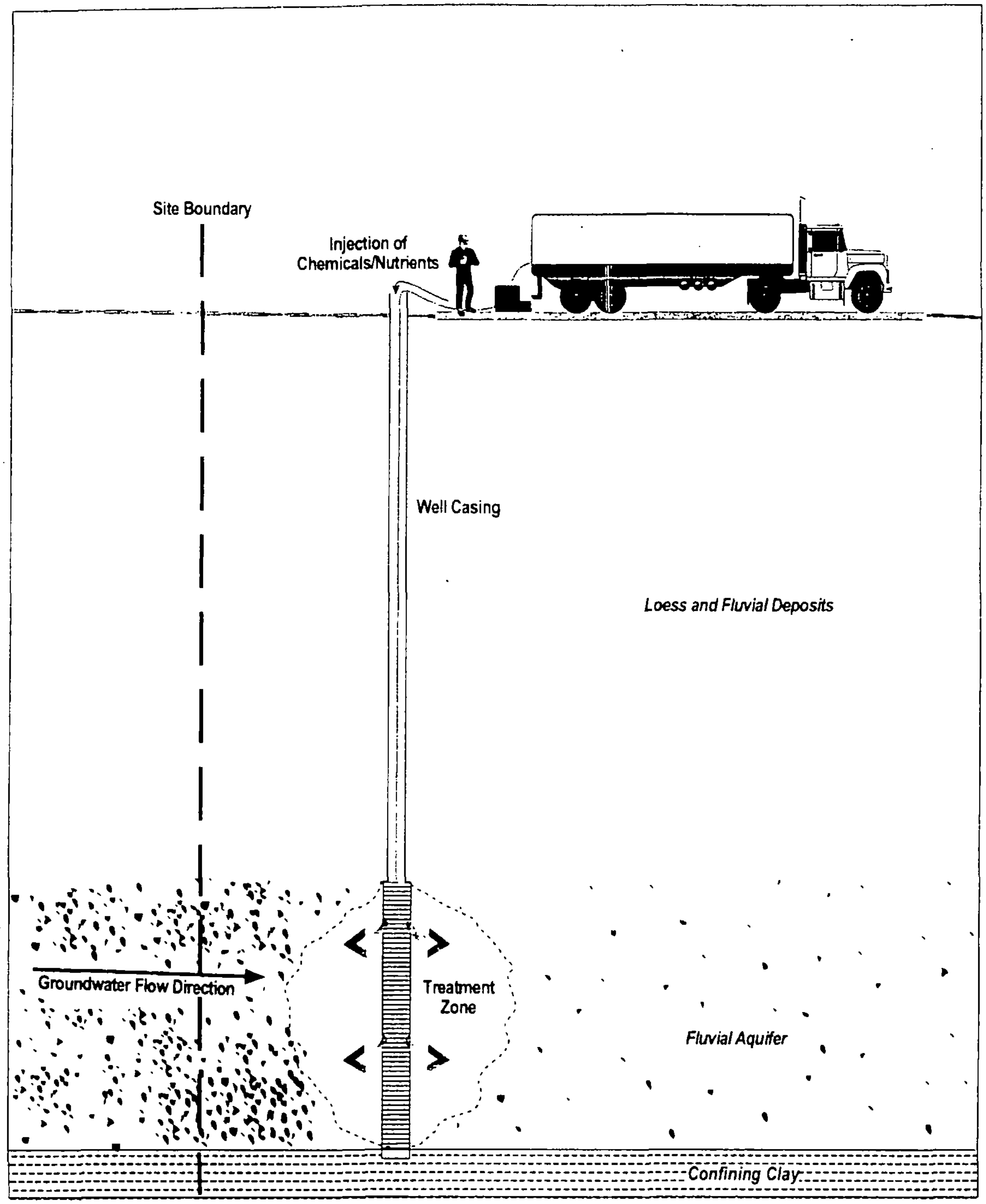


**FIGURE 2-15**
Injection of Chemicals/Nutrients to Enhance Bioremediation
*Memphis Depot Main Installation ROD*


FIGURE 2-16
Potential Injection Zone for
Enhanced Bioremediation
*Memphis Depot Main Installation ROD*

CH2MHILL

ATLANTA/CAD1/PROJECTS/147543 MemphisDepot 12 DEC 2000 7543fig2-16.dgn

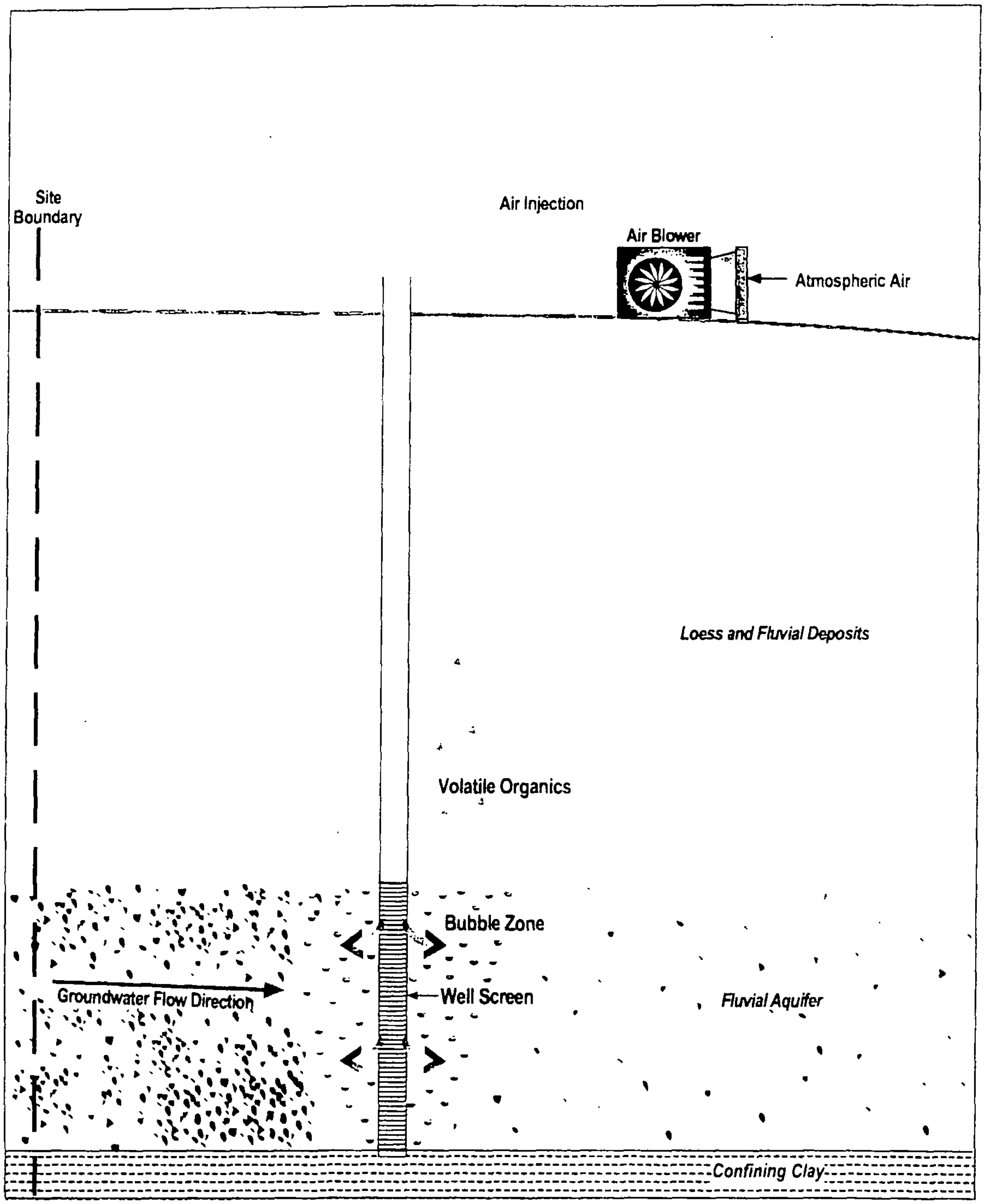


**FIGURE 2-17**
Air Sparging of Groundwater
*Memphis Depot Main Installation ROD*

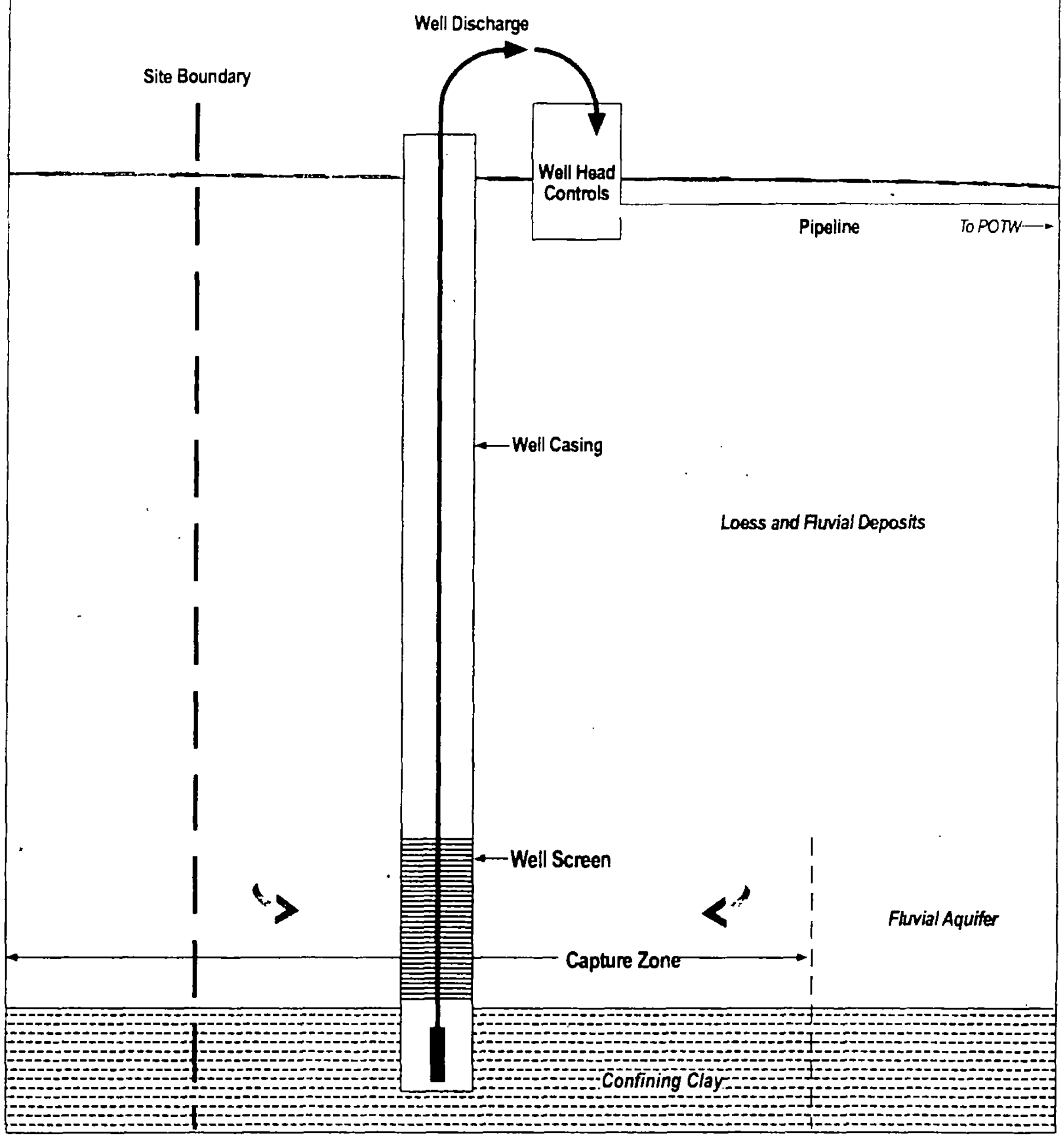


**FIGURE 2-19**
Groundwater Extraction and Discharge to POTW
*Memphis Depot Main Installation ROD*

CH2MHILL

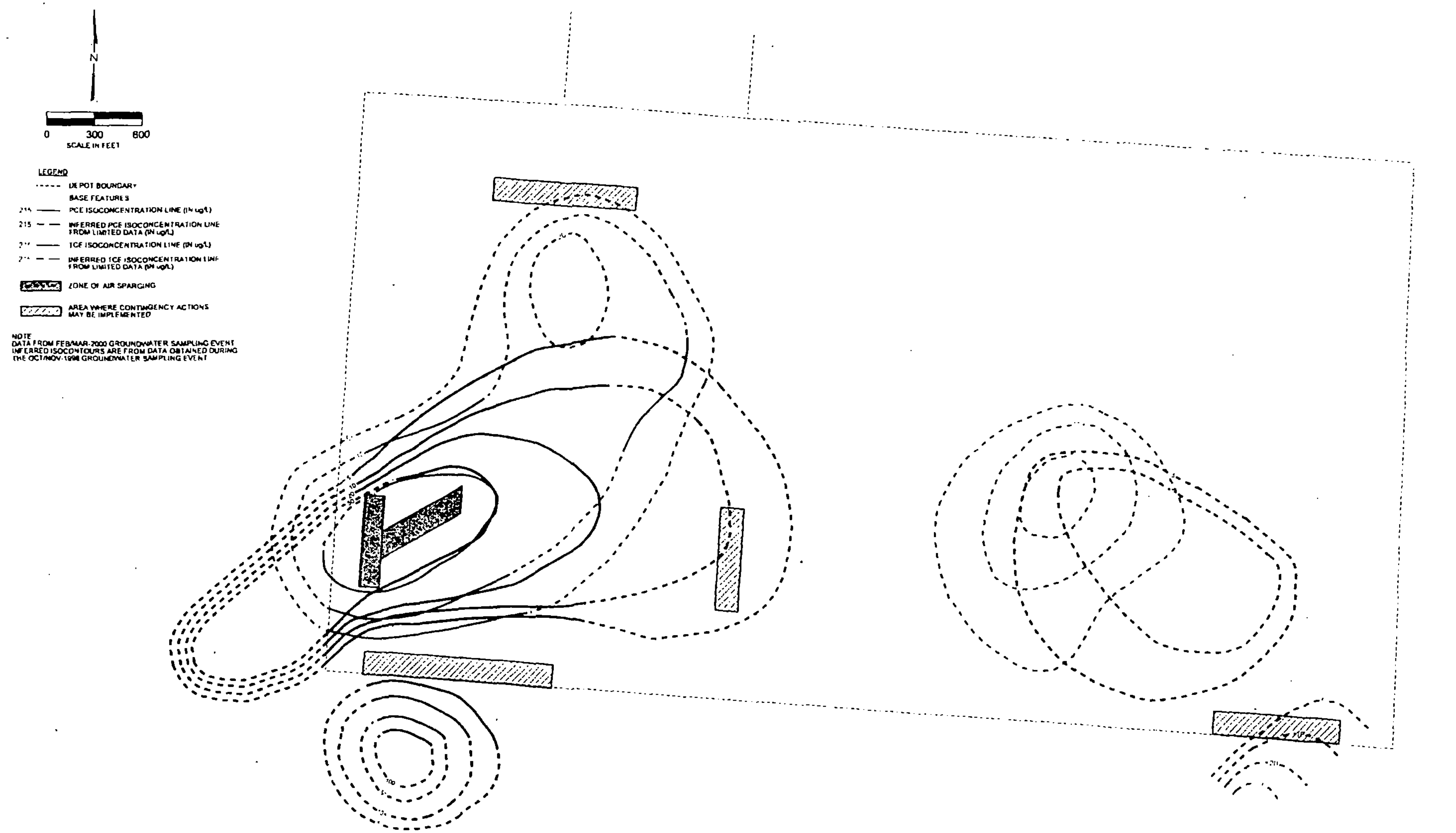


FIGURE 2-18
Potential Air Sparge Zones
*Memphis Depot Main Installation ROD*

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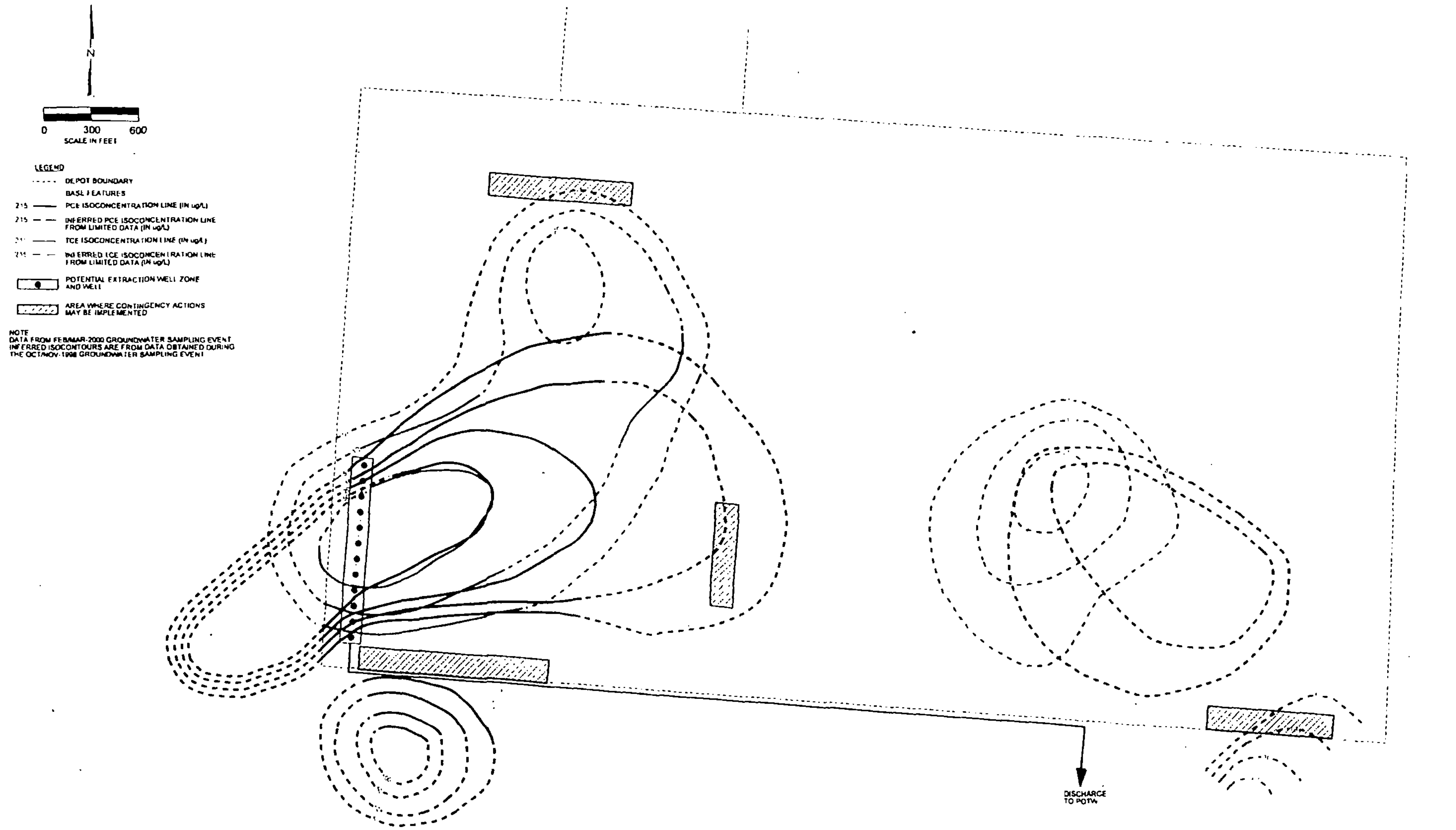
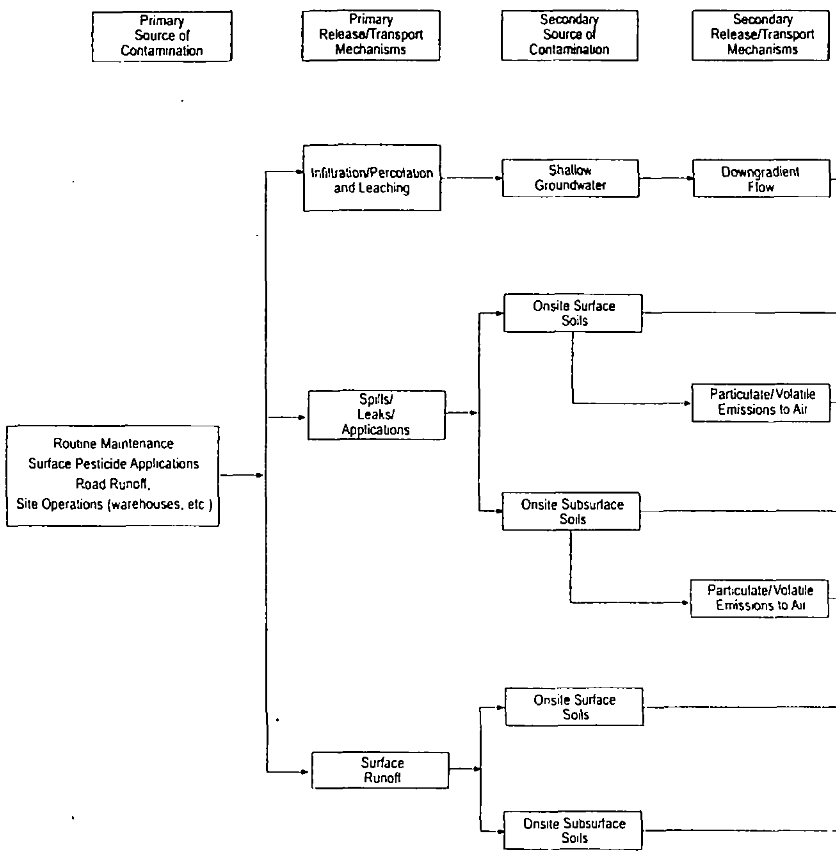



FIGURE 2-20
Potential Extraction Well Locations
*Memphis Depot Main Installation ROD*

CH2MHILL




| Potential Exposure Routes | HUMAN RECEPTORS: Maintenance Worker | Lumberyard/ Factory Workers | Office Workers | Future Utility Workers | Future Landscapers | Future Industrial Workers | Future Recreational | Future Residential | BIOTA: Terrestrial | Aquatic |
|---|---|---|---|---|---|---|---|---|---|---|
| Ingestion | | | | | | FU1, FU2, FU3 FU4, FU5, FU6 | FU1, FU2, FU3 FU4, FU5, FU6 | | | |
| Inhalation | | | | | | FU1, FU2, FU3 FU4, FU5, FU6 | FU1, FU2 FU3 FU4, FU5 FU6 | | | |
| Dermal | | | | | | FU1, FU2, FU3 FU4, FU5, FU6 | FU1, FU2 FU3 FU4, FU5 FU6 | | | |
| Ingestion | FU1, FU2, FU3 FU4, FU5, FU6 | FU3 | FU1 | FU1, FU2, FU3 FU4, FU5, FU6 | FU1, FU2, FU3 FU4, FU5, FU6 | FU1, FU2, FU3 FU4, FU5, FU6 | FU 2 | FU1, FU3 FU4, FU5, FU6 | FU1, FU2, FU4, FU5, FU6 | |
| Dermal | FU1, FU2, FU3 FU4, FU5, FU6 | FU 3 | FU1 | FU1, FU2, FU3 FU4, FU5, FU6 | FU1, FU2, FU3 FU4, FU5, FU6 | FU1, FU2, FU3 FU4, FU5, FU6 | FU2 | FU1, FU3 FU4, FU5, FU6 | FU1, FU2 FU4, FU5, FU6 | |
| Inhalation | FU1, FU2, FU3 FU4, FU6 | FU3 | FU1 | FU1, FU2, FU3 FU4, FU6 | FU1, FU2, FU3 FU4, FU6 | FU1, FU2 FU3 FU4, FU5, FU6 | FU 2 | FU1, FU2, FU3 FU4, FU5, FU6 | | |
| Ingestion | | | | FU1, FU2, FU3 FU4, FU5 | | FU 3 | | | | |
| Dermal | | | | FU1, FU2, FU3 FU4, FU5 | | FU 3 | | | | |
| Inhalation | | | | FU1, FU2, FU3 FU4, FU5 FU6 | | FU 3 | | | | |
| Ingestion | FU 2 | | | | | FU 2, FU3 | FU 2 | | | FU 2 |
| Dermal | FU 2 | | | | | FU 2, FU3 | FU2 | | | FU2 |
| Ingestion | FU 2, FU3 | | | | | FU 2, FU3 | FU 2 | | | FU 2 |
| Dermal | FU 2, FU3 | | | | | FU 2, FU3 | FU2 | | | FU2 |

LEGEND:

**FU1** = Primary exposure route

*FU2* = Minor exposure route

**FIGURE 2-21**
Conceptual Site Model for Potential Human and Ecological Exposures: Functional Units 1-6
*Memphis Depot Main Installation ROD*

# 3.0 Responsiveness Summary

Public comments on the environmental remedial action proposed at the Main Installation (MI) have been requested and received. The Defense Logistics Agency (DLA) placed the MI Proposed Plan, which documents and recommends a cleanup alternative, into the four Depot Information Repositories before August 14, 2000, when the 30-day public comment period began. A public meeting was held to describe the preferred alternative and solicit comment from the public on August 24, 2000. The comment period was extended for 30 days until October 13, 2000. During that 60-day period, 65 comments were received by DLA from the public. All comments were received either verbally during the public comment meeting or in writing. During the 60-day period, no comments were received from the public via the telephone answering system or via email.

Of the 65 comments, 12 are directly applicable to the proposed action (Comments 6, 9, 12, 32, 34, 50, 54, 59, 61, 62, 64, and 65). Although the remaining 53 comments are not directly applicable to the proposed action, responses are provided in the following documentation. Comments 1 through 30 are not applicable to the documentation within the Administrative Record, but rather to information provided at the June 20 and July 20, 2000, Restoration Advisory Board (RAB) meetings.

Please note that not all comments ask a question or require a response. Some comments are statements of opinion. Whenever this occurs, DLA will note the opinion and, if necessary, provide clarification or cite the legal requirement.

DLA, as the lead agency performing this remedial action, requested and received assistance in developing these responses from the U.S. Environmental Protection Agency (EPA) Region 4, the U.S. Army Corps of Engineers (USACE), and CH2M HILL.

## 3.1 Stakeholder Issues and Lead Agency Responses

**Comments 1 through 30 refer to the Main Installation Remedial Investigation (RI) Risk Assessment presentation provided by Dr. Ted Simon, EPA, and Dr. Vijaya Mylavarapu, CH2M HILL, at the July 20, 2000, RAB meeting. These comments are not specifically on the Administrative Record for this Record of Decision.**

1. *Do the Functional Units represent 100 percent coverage of the Depot? If not, what percentage of the Depot is not included?*

Functional units (FUs) represent 100 percent of the MI of the former Defense Distribution Depot, Memphis, Tennessee.

2. *One foot of surface soil was designated as the depth needed to determine chemical content. Why weren't additional samples taken at greater depths in suspected problem areas?*

Additional samples were taken at depths greater than 1 foot. The upper 1 foot of soil is defined as surface soil. The soil at depths greater than 1 foot is defined as subsurface soil.

Surface soil samples (580 samples) and subsurface soil samples (427 samples) were collected for laboratory analyses to determine chemical content in suspected problem areas.

3. *The report cited "off-site" pollution moving "on-site." What and where is the origin of the source or sources? In which direction is it flowing? What are the pollutants?*

Groundwater elevation data indicate that the degreasing solvents (tetrachloroethene and trichloroethene)found in the shallow groundwater on the southeast (near Ball Road and Airways Boulevard) and southwest (near the intersection of Ball and Perry Roads) portions of the MI are moving from off-site to on-site. In the southeast portion of the MI, groundwater flows toward the west-southwest. In the southwest portion of the MI, groundwater flows toward the northeast. The sources for these off-site groundwater contamination plumes are not known at this time; however, the Tennessee Department of Environment and Conservation (TDEC) plans to conduct a Site Assessment to identify potential off-site sources. Cleanup of off-site, non-federal sources would be the responsibility of the party that caused the solvents to be released into the environment, as determined by TDEC. Such a party is referred to as the "responsible party."

4. *In the FU-Specific conclusions section, some areas are cited safe for workers not safe for residents, and not safe for recreation. I realize an exposure factor is being figured in the safety factor of workers vs. residents. Are you factoring in the individual differences of workers, including genetic and physical resistance (or lack of) to the toxicity of the hazardous area, or are you relying on a statistical average that does not provide for individual differences?*

The exposure scenarios used in the human health Risk Assessment included the potential hypersensitivity of certain individuals in each of the groups (workers, residents, etc.). The toxicity criteria used in the Risk Assessment also factored in uncertainties associated with populations that might be more sensitive. The methods used in Risk Assessments are meant to protect individuals who might be more sensitive than the average population.

5. *Can the government insure the safety of residents who move in close proximity to polluted areas?*

The Agency for Toxic Substances and Disease Registry (ATSDR) conducted public health assessments for the Memphis Depot in 1995 and again in 2000. Both assessments concluded that Depot operations and environmental conditions found at the Depot are not impacting the surrounding, off-site areas. In addition, the Risk Assessment did not identify any unacceptable risks from environmental conditions at the MI to people living in the nearby residential areas.

The Preferred Cleanup Alternatives outlined in the Proposed Plan will ensure that the entire MI is safe for future industrial use. The selected remedies for cleaning up the MI to industrial reuse standards include provisions for federal and state regulators to monitor the effectiveness of the remedies over time. Residential dwellings will not be permitted on the MI property, now or in the future, with the exception of the former base Housing Area in the southeast.

6. *My interpretation of the comments in the report seems to indicate that some polluted areas will not be cleaned. Is this correct? If it is correct, as a representative of the Rozelle community, I strongly suggest that the decision makers clean up ALL areas that are polluted to residential and recreational living conditions!!*

All areas of the MI will be controlled and/or cleaned up to allow for the anticipated future land use, as determined by the Depot Redevelopment Corporation's (DRC's) *Memphis Depot Redevelopment Plan*. The public was involved in the process that led to this reuse plan, which concludes that only the golf course area will be used for recreation in the future. Only the former military Housing Area may be used for residential purposes. Light industrial uses are planned for all other areas of the MI.

This plan was used by DLA and the Base Realignment and Closure (BRAC) Cleanup Team (BCT) to establish the Preferred Cleanup Alternatives to meet or surpass the standards for the anticipated future use of the property.

EPA policy requires that cleanup and industrial controls be undertaken to meet or surpass the standards of the intended future land use. This policy is applied to all BRAC facilities across the country.

For more information on EPA policy concerning future land use, refer to: Land Use in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedy Selection Process, OSWER Directive 9355.7-04.

7. *What testing of the residential areas (e.g., one foot of soil samples to determine chemical content that you did on the depot property) was done to eliminate the fear [and ensure] that the residential areas are free of pollution?*

Based on the findings of the MI RI, there is no evidence that environmental effects from Depot operations have impacted the surrounding community. Samples of soil and stormwater sediments were taken outside the Depot property and throughout the Memphis area. The RI concluded that soil and surface-water sediments outside the Depot fence line do not pose an increased risk of health effects. In addition, the RI confirmed that substances detected in the soil on the MI are not moving off-site and do not present an exposure concern under the planned uses (with the exception of the small area containing lead, which will be removed).

8. *Please address air pollution as a possible transport of pollutants to the residential areas throughout the 40 year history of the Depot.*

Airborne contaminants are typically transported through the air in two ways:

- Fumes or vapors from volatile organic compounds (VOCs) such as solvents, which dissipate rapidly and have no long-term effects.
- Dust, which may carry particles of certain compounds such as metals and pesticides.

VOC fumes and vapors are short-lived in the environment and cannot be measured after a brief duration. Dust-borne contaminants can settle on the ground surface and remain for many years. Impact from dust that may have been carried off the Depot property through the wind was evaluated by sampling the surface soils. Samples were taken along the Depot fence line and in areas of the surrounding community. The RI Risk Assessment concluded that the risk to off-site residents from dust was well within the acceptable range. This indicates that the dust has presented no increased health risk to residents living near the Depot property. The ATSDR Public Health Assessment report (ATSDR, 2000) concluded that current environmental conditions at the Depot would not present unacceptable health risks to the surrounding community.

9. *Groundwater underneath the Depot is not fit for human consumption. The report stated the aquifer has an 80-foot buffer zone. Since the buffer zone is not uniformly 80-feet but is dangerously narrow at certain places [therefore closer to] to the drinking water, has this been taken under consideration and, if so, what is being done about it?*

The affected groundwater in the shallow aquifer under the Depot property has never been used for drinking. The selected remedy for groundwater includes restoring the shallow aquifer to drinking-water standards. In addition, throughout the remediation of the groundwater, which may require several years, both the shallow aquifer and the deeper Memphis Sand aquifer (drinking water) will be continually monitored to ensure that the drinking-water supply is protected.

This remedy also includes deed restrictions that prohibit the installation and use of groundwater production wells during the groundwater restoration.

The groundwater in the shallow aquifer is not expected to affect the deeper drinking-water aquifer. However, the Proposed Plan allows for more aggressive treatment to be implemented if monitoring indicates that an unacceptable risk may be present at any time during the remedy.

10. *Mentioning chemicals such as arsenic, dieldrin and PAHs [Polynuclear Aromatic Hydrocarbons] as residuals of routine pesticide application, asphalt and railroad tracks does not render them any less lethal especially in elevated toxic levels.*

Routinely applying or spilling a substance does not necessarily affect its toxicity. In a Risk Assessment, the potential health risks associated with a substance are affected by the availability of that substance to a person, as well as the level and frequency of exposures.

- For a health risk to be present, exposure must occur. While some substances may pose unacceptable risks at low levels, others require much higher levels of repeated, long-term exposures before any risks are indicated.
- To evaluate the need for corrective action based on potential risks, scientists must examine the origin of the substance, its concentrations, and changes in those concentrations over time. In addition, they must identify the exposure pathways, which are the methods through which humans become exposed to substances in their environments.
- Some substances (such as PAHs in asphalt or soil) are bound to solid matter, and are less available for exposure.
- Other substances (such as low-level pesticide residues in soil) may require direct, long-term, repeated exposures before any health effects are seen.

Based on the RI and Public Health Assessment conducted at the MI, the environmental conditions at the Depot do not present any unacceptable health risks to workers or to the surrounding community.

11. *How much evaluation is still ongoing? Do you have a timetable?*

The MI RI and Feasibility Studies (FSs) for Groundwater and Soil are completed. Before finalizing the Remedial Design for the MI, additional groundwater samples are being collected and analyzed. The results of these tests may affect the methods and locations within the MI where the remedy is applied and where monitoring is conducted. The Remedial Design for the MI groundwater remedy is scheduled for completion in late 2001.

12. *CERCLA and the RI evaluates the potential environmental effects on plants and animals as well as humans. The pollutants arsenic, lead, dieldrin, DDE and DDT detected in Lake Danielson, and the Golf Course Pond does not appear to be a good physical environment for fish, plants, animals or humans. Explain, considering the above, how BRAC could make a decision not to clean up Lake Danielson and the pond?*

The Human Health and Ecological Risk Assessments presented in the RI report concluded that the overall risks from surface water and sediments in Lake Danielson and the Golf Course Pond are within acceptable levels. Currently, fishing and swimming are prohibited in both areas for safety reasons related to their location in the golf course fairways. -Signs will continue to be posted restricting these activities.

13. *Dr. Simon's report on Risk Assessment is severely handicapped because his toxicity data are based on animal experiments. Until the experiments are performed on humans, the validity of experiments cannot be confirmed.*

While it is true that toxicity research on animals must be carefully interpreted when applying the results to humans, conducting similar research on humans is unethical.

According to EPA guidance, the procedures used in the Risk Assessment represent the most reasonable approach to quantifying risks to humans from chemical exposures, as recognized by the scientific community. The accepted approach to conducting a Risk Assessment for humans includes safety factors that increase the protectiveness of the risk estimates, thereby ensuring that conditions are 100 to 1,000 times safer (for humans) than animal data support.

Toxicity factors are developed using the results of extensive animal research performed under controlled conditions. However, there are exceptions to this. The Risk Assessment also takes into account dose-response information and other toxicity factors from available human evidence. This includes documented occupational exposures (for example: metal fume or benzene vapor exposures to workers) or environmental exposures (for example: high natural arsenic levels in drinking water in Taiwan). All conclusive information that is available and based on human evidence is taken into account in the risk data used for all Risk Assessments.

For more information on EPA guidance concerning Risk Assessments, please refer to: Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (RAGS).

14. *The Risk Assessment leads to the overcompensation of dividing the original dose that has no effect in animals by 3000 to arrive at what EPA considers a safe dose for humans. The toxicologist cannot be certain of the threshold when the chemicals become physiologically harmful until they are able to include humans in their experiments. They speculate based on formulas. Some with unit-less dimensions baffle me since they divide by zero and this cannot be done mathematically.*

For clarification in response to this comment, see Comment 13 (above).

15. *Screening values considered by EPA to be safe are calculated using the same risk-based methods valid for animals and not yet proven in humans. The Risk Assessment model of EPA and its major divisions: Hazard identification; exposure assessment; toxicity assessment; and risk characterization are all based on animal experiments.*

For clarification in response to this comment, see Comment 13 (above).

16. *Dr. Simon stated that "without doubt that some people are more susceptible to chemicals than others." Dr. Simon believes this without data from human experimentation but does not consider it when workers are allowed to enter the workplace of a contaminated area. Instead, he deals with a hypothetical worker. The model methodically follows a path to compensate for an obstacle that cannot be remedied until humans are tested.*

Those who are more sensitive than others when exposed to different chemicals and allergens are referred to as "hypersensitive individuals." The methods used in Risk Assessments are designed to protect these individuals who may be more sensitive than the average population. While the majority of the chemical dose-response information is from animal studies under controlled conditions, there are some chemical toxicity factors that are based on human evidence (see response to Comment 13 above).

17. *The hypothetical industrial worker that spends 250 days a year, five days a week, eight hours a day at work does not take under consideration that the ability of that worker's biological mechanisms to detoxify certain chemicals may not be functioning properly. So many variables in the human physiology and environment may render this worker at greater risk than the hypothetical worker. Do not forget that the threshold that overcomes the natural defenses are an educated guess but not certain because no human has been tested.*

Based on extensive animal research and available human evidence, the toxicity factors included in a Risk Assessment are designed to protect hypersensitive individuals. For further clarification, please refer to responses to Comments 13 through 16 (above).

18. *Dr. Simon states: "We zero out the background." I am curious to know what the data would look like if the background level was added. Did the study start with high, medium or low levels of background?*

The term 'background level' refers to the levels at which certain substances are naturally occurring in the environment or may be the result of common urban activities such as paving, traffic exhaust, or pesticide use. Samples were taken outside the Depot and throughout the Memphis area to determine these background levels.

Once a chemical is determined to be above the background level, the risks associated with the detected concentration are estimated. For example, if background levels showed arsenic at 13 milligrams per kilogram (mg/kg), and the site had 22 mg/kg, the risks were estimated for the total level of arsenic detected at the site. In this example, risks would be calculated for 22 mg/kg, not for the difference between background and detected levels (i.e., 22-13 = 9 mg/kg). Therefore, the background level it is not truly "zeroed out." This "zero out" statement refers to the fact that risks are not calculated for areas where the concentration of an identified substance is equal to or below the background level.

19. *Functional Unit 2: Industrial Worker = Acceptable; Residential = Unacceptable; Rated 200 million. Unacceptable due to arsenic and dieldrin. This data should be published.*

The data have been published in the MI RI report, which is available for public review at the four Information Repositories in the community.

20. *Functional Unit 3: Industrial Worker = Acceptable. "While the risk numbers did not include the lead because EPA assesses lead in a slightly different fashion. But the lead concentrations. . . were not within acceptable levels . . . around the paint shop area." Residential = Unacceptable due to Polynuclear Aromatic Hydrocarbons (PAHs). What about the lead levels?*

The concentrations of lead were above both the residential and industrial land-use scenario target levels around the paint shop area. The Engineering Evaluation/Cost Analysis (EE/CA) for the Old Paint Shop and Maintenance Area addressed this issue, and the Soils Feasibility Study (FS) for the MI also referenced the EE/CA. This soil was cleaned up as part of the removal action. The results of this removal action were presented to the public at the September 2000 RAB meeting and can also be found in the Remediation Report: *Remedial Action in Parcels 35 and 28 (September 15, 2000)*, available for public review in the four Information Repositories.

21. *Functional Unit 4: Residential = Acceptable; Industrial Worker = Acceptable. "Solvents levels are above screening levels, which means they are not within the acceptable concentrations." This to me is a contradiction.*

When the term "acceptable concentrations" was used during the July 2000 RAB presentation on Risk Assessment, it was in direct reference to screening values, which are not a measure of risk. When a substance exceeds the screening value, this does not necessarily indicate that an unacceptable risk is present. Screening values are within EPA's health-protective standards and are used in the Risk Assessment process to identify where further investigation is required for a specific substance.

When a substance is detected above the screening levels, it is considered to be a Chemical of Potential Concern (COPC) and continues through the Risk Assessment process. Each COPC is further investigated using risk factors that take into account exposure pathways and land-use scenarios. If the COPC is found to pose an unacceptable risk, it becomes a Chemical of Concern (COC) and a solution is required to reduce the risk of exposure to an acceptable level. Solvents detected in one soil sample at Functional Unit (FU) 4 were not identified as COCs since they were within the acceptable risk criteria.

FU4 does not present unacceptable risks to current and future industrial workers or hypothetical future residents.

22. *Functional Unit 5: Residential = Unacceptable; Industrial Worker = Acceptable. "They did find solvents in one sample higher than the screening values." No further investigation?*

See response to Comment 21 (above) for clarification of screening values in the Risk Assessment process.

Since the Risk Assessment concluded that the risks to current and future industrial workers are within acceptable levels in FU5, no further investigation is required. The selected remedy for this FU includes institutional controls to prohibit future residential land use, thus eliminating any unacceptable risk to hypothetical future residents.

23. *Functional Unit 6. "Solvents are found in subsurface soils at one location above the screening values, and the trichloroethylene (TCE) concentration . . TCE is one of the solvents. It was found at 18 to 20 feet depth . . . ." Why did this exploration go so deep and does the two feet explorations allow us to miss some undiscovered chemicals?*

The MI RI included soil samples from the upper 1 foot of soil (surface soil) and as deep as 18 to 20 feet below ground surface (subsurface soil). Deeper samples were also collected at 38 to 40 feet below ground surface at many locations to evaluate if any residual materials in the soil could impact the groundwater. This is a reasonable and accepted method to investigate environmental sites and is in accordance with EPA guidelines. The results confirmed that solvents in the subsurface soil showed no movement toward the groundwater.

Risks to current and future industrial workers in this FU are within acceptable levels.

24. *Functional Unit 6: Industrial Worker = Acceptable; Residential – "Housing area remediated – Acceptable. Parking lot – unacceptable. Future Hypothetical residents – unacceptable due to PAHs in the parking lots, railroad tracks etc. How can the housing area be acceptable and future residents unacceptable?*

FU6 consists of BRAC Parcels 1, 2, 4, and 5. The entire area of FU6 is safe for current and future workers. In 1998, surface soil in the Housing Area of FU6, BRAC Parcel 2, was removed because of the presence of dieldrin. The Housing Area is the only area of the MI that may be used for future residential purposes, according to the DRC's *Memphis Depot Redevelopment Plan*. As such, it has been restored to meet the risk criteria for both industrial and residential use. Results of soil samples collected in the open land area around Building 144 and the north and south paved parking lots within BRAC Parcel 1 also indicated levels that are not inconsistent with unrestricted use. The remainder of FU6 is safe for industrial use but not suitable for residential use due to the presence of PAHs in the paved areas and around railroad tracks in BRAC Parcels 4 and 5. Institutional controls will be placed on these areas to prevent future residential use.

25. *Functional Unit 7: Three plumes of contaminants of potential concern (COPCs) are PCE, TCE and PCA. Residential – Groundwater cannot be used for drinking – Unacceptable. Industrial Worker – Acceptable, no drinking of the water. Risk to the offsite residents are acceptable. Unacceptable levels must have been existing for long periods of time. Depot employees have been working under conditions Dr. Mylavarapu has outlined since the areas were contaminated. Has this ever been addressed?*

Since the Depot was established in the 1940s, there are no records showing that the groundwater in the shallow aquifer beneath the MI has been used by employees for drinking or showering. There is no evidence to suggest that exposures occurred in the past, and no exposures are occurring at the present time. Potable water at the Depot is drawn from the deeper aquifer, which supplies drinking water to the municipal water system.

26. *Please provide the RAB members with a copy of the data presented by Dr. Mylavarapu. The information should be published to the public at large and especially to new tenants.*

The complete Risk Assessment data have been published in the MI RI report, which is available for all community members to review at the four Information Repositories in the community, including the Community Outreach Room located in Building 144 at the Memphis Depot.

27. *The EPA representative stated on page 15 (of the meeting minutes transcript), "we clean up the source of which might be putting chemicals in the air." Dr. Simon stated on page 17, "These are specific ways chemicals get into your body . . . . It can be inhalation from soil. Again, you may get some dust, and you may breathe the dust and it gets into your lungs." Dr. Simon stated on page 40, "Also our major concern for the off-site individual is when dust is generated from the area of the Depot, which is then transported by the wind off-site." The above three statements are defined by me as air pollution. The chemicals, dust, etc. when transported by air can cause serious problems for people inhaling the contents. The years since 1940 are completely ignored because it's another unsolvable problem.*

The Risk Assessment process evaluates existing conditions and potential future health effects that may be associated with substances found in the environment. The Risk Assessment evaluated the current risk to off-site residents from dust coming from surface soils carried from the Depot through wind action. It was concluded that the dust presented no increased health risks to surrounding residents.

It is not within the scope of the CERCLA process to assign potential past risks from conditions that no longer exist, such as the fumes from solvents that dissipate rapidly in the air.

28. *On page 48, a former Depot administrator informed the RAB members of a PCB underground leak, which was put off-limits. A 12-inch cap of limestone was placed on it. ". . . and only then were the employees allowed to go in there." ". . . historically, until I left here in '92, there was not . . . threat to the employees." How long were the employees exposed to the PCBs before the leak was discovered? What was the concentration of the PCBs?*

There are no historical records of polychlorinated biphenyls (PCBs) stored in underground storage tanks at the Depot.

The statement by a former Depot employee at the July 20, 2000, RAB meeting was in reference to pentachlorophenol, also known as PCP, a chemical used as an industrial wood treatment. There was an underground tank that contained PCP for treating wood at Building 737. Wood treatment started in 1952 and ended in 1971. The underground tank was discovered to be leaking into the subsurface soil, which would limit direct exposure to workers. The PCP dip vat and affected soil were removed in 1985.

This removal is documented in the *Summary Report: On-Site Remedial Activities* (February 1986) and in the background information portion of the MI RI. These documents are available in the four Information Repositories.

29. *A former employee reminded the administrator of the removal of soil from the housing complex that occurred since the PCB incident. Have there been other incidents forgotten or conveniently ignored by administrators since the 1940 opening of the Depot? No records were kept or were poorly kept.*

All known or suspected areas of environmental impact from Depot operations, as well as all documented historical cleanup actions, were included in the MI RI, based on all available records. These records provided important information for developing the sampling plan. However, the field investigators did not rely solely on the historical data to develop the final sampling plan.

In addition to sampling those areas where known events have occurred in the past, samples were also collected from all areas where hazardous materials had been stored. To provide additional confidence in the overall findings, samples were also taken from areas where there were no known or suspected environmental concerns. These areas are discussed in the *BRAC Parcel Summary Reports* (October 1998) and the sampling data were also included in the MI RI.

For more information on historical records, refer to the following: *Installation Assessment of Defense Depot Memphis, Tennessee, Report No. 191* (March 1981); the *Environmental Baseline Survey* (November 1996); and the *Ordnance and Explosive Waste Chemical Warfare Materiels, Archives Search Report for Memphis Defense Depot* (January 1995).

All studies related to past events, which are known or suspected to have affected the environmental conditions at the Depot, are available in the four Information Repositories. Results from these studies were included in the MI RI.

30. *On page 45, a person from the community asked these questions and received some interesting answers from the Chairman of BRAC: ". . . is the complete area . . . that was considered the Depot, after you clean it up will that be acceptable?" Chairman, "Yes." Community person, "Everywhere." Chairman, "Yes." Community person, "The entire site." Chairman, "Yes, sir." I understood the answers by the chairman to mean that the entire site known formerly as the Memphis General Depot will be cleaned to the acceptable specifications of the community person that asked the questions. If this is not the case the chairman misled the community person and the community.*

The above exchange is documented in the RAB meeting minutes of July 20, 2000, in which the RAB Facility Co-Chair correctly stated that the MI would be restored to meet the environmental standards for its intended reuse. The Chair correctly stated that the entire MI would be cleaned as required to meet industrial reuse standards.

In addition to this, the Southeast Golf Course/Recreation Area (FU2) is also safe for recreational use. The Housing Area in FU6 has been restored to meet the standards for future residential reuse.

**Comments 31 through 55 were received during the MI Proposed Plan Public Comment Meeting conducted on August 24, 2000.**

31. *I would like to make a comment that we need to extend the public comment period another 30 days.*

The extension was approved. The closing date of the public comment period was extended from September 14 to October 13, 2000. The public comment period lasted a total of 60 days.

32. *About this golf course, I read somewhere in some of these documents that the dieldrin level on the golf course was high, but acceptable by EPA standards. Is there going to be a plan to remove the so-called high dieldrin levels on the golf course?*

As part of the MI RI, a Risk Assessment was performed on the Golf Course/Recreation Area. Since it was determined that this area is safe for unrestricted recreational reuse, the only action required is to prevent residential use through institutional controls.

33. *When we get ready to clean the Depot up, the residential standards are not going to be met all over the Depot. It's just going to be like industrial standards. What's going to stop someone from coming in and deciding, "Well, I've got an industrial site. I just want to dirty this place up again, provided I meet EPA standards." Is there any restrictive covenant about what can come in on the Depot? Because you've the paint shop. It was dirty once. Somebody might come and decide to have the same problems they had before.*

All businesses locating in Memphis must comply with existing federal and state environmental laws. Please contact the DRC at (901) 942-4939 for information relating to the leasing or selling of property in the Memphis Depot Business Park. The DRC is responsible for attracting businesses that comply with municipal zoning restrictions.

34. *Back to this recreational area, if you're going to make this a city park, we're going to have to do something about this dieldrin level.*

Please refer to the response provided for Comment 32 (above).

35. *One other thing I was concerned about is that we have a lot of technical manuals. Are we going to be able to get all these manuals on the Internet before September 14th, so I can download what I need?*

All administrative records relating to the Depot's environmental restoration program are available at four Information Repositories in the community. Some of these documents and technical report summaries are available on the Depot's website at www.ddc.dla.mil/memphis. DLA is working to make more documents available on the Internet. Unfortunately, at the time of the public comment period for the MI Proposed Plan, all documents were not available online.

36. *I'm one of the public people that feels like that this site should never be turned over to the city at all, ever, because I feel like that the Depot did not do an extensive enough research on all the chemicals that was found on this site.*

The methods used in the MI RI for assessing the environmental conditions and potential health risks at the Depot were approved by EPA and TDEC. These are the state and federal authorities assigned to oversee the environmental restoration program at the Depot. Based on the results of the RI Risk Assessment, these agencies are confident that the MI is safe for future industrial use.

For more information, please see responses provided for Comments 21 (above), 27 (above), 37 (below), and 41 (below).

37. *In going through documents in the early years when they first started, there were chemicals found on the site, and now those chemicals have disappeared some kind of way. You're showing only five chemicals of concern on one of these documents. There are only five chemicals of concern: arsenic, dieldrin, lead, PCE and TCE. But what happened to the other 249 chemicals that were found on this site?*

A USACE-approved laboratory, using EPA-approved methodologies, performed 99,264 different analyses of 300 different substances, which are listed in the MI RI report. Each of these substances was considered in the screening and evaluation process, which is also summarized in the report. Note that some substances, such as lead and arsenic, are naturally occurring in the soils of western Tennessee. Most of the remaining chemicals were either naturally occurring or were not detected at levels that required further investigation.

See the response provided for Comment 21 (above) for further clarification of the screening process for COCs, which is in accordance with EPA Superfund technical guidance.

38. *I feel like that you're still pushing stuff up under the table and trying not to give the community all the information that they need to know about this site. I feel like until you give us full disclosure of everything and all the activities that went along on this site, you're misleading the city.*

The community relations efforts at the Depot are beyond the requirements for National Priorities List (NPL) sites. The four Information Repositories in the Depot community contain the full Administrative Record of the environmental restoration program. This includes historical information on environmental conditions and past Depot operations, as well as technical documents dating back to 1981. All of these documents are available for public review. In addition, regular presentations are made to the public at RAB meetings and periodic Community Information Sessions, and through bi-monthly newsletters distributed in the community. A community relations office is also available to direct enquiries from the community to the appropriate source of information. The phone number and email address of this office are widely publicized, as is the Depot's website address.

39. *Institutional control means no clean up.*

Institutional controls and land-use controls identified in the Proposed Plan include prohibiting future residential use across most of the MI and preventing access to the shallow groundwater aquifer. These remedies comply with the National Oil and Hazardous Pollution Contingency Plan (NCP), which allows for *prevention of exposure* as a remedial alternative. By preventing exposure, these controls are protective of human health and the environment.

40. *If you bring in another company and something is found that is different from what you found on this site, then what are you going to do? Will the company have to prove that they did not pollute it and DLA walk away scott-free? How do we know that you're going to fulfill your responsibility to this community, with all the pollution that is here?*

According to CERCLA, the restoration program must ensure the protection of public health and the environment, now and in the future. To accomplish this, CERCLA requires that the remedy be reviewed periodically, at least every 5 years. The proposed cleanup alternative for groundwater includes a monitoring program to ensure that the groundwater remedy is working properly over time and continues to be protective of public health and the environment.

An organization that harms the environment is responsible for restoring it. If environmental impacts are discovered after the Depot property is transferred to the City of Memphis, then an investigation will take place to identify the responsible party. The responsible party must ensure that the health of the public is protected in accordance with CERCLA.

41. *I feel like you did not do enough testing. 70 sites. Out of 77 sites that were tested, 70 sites come out dirty that you found chemicals in, and I feel like that you didn't do enough. I think this place is actually too big to just do that few amount of testing.*

A total of 702 locations were sampled throughout the MI, resulting in 1,208 samples being collected. The USACE-approved laboratory, using EPA-approved methodologies, performed 99,264 different analyses of 300 different substances, which are listed in the MI RI report.

To ensure that no area was overlooked, sampling included three different types of investigation: RI sites, screening sites, and BRAC parcels. The results of these investigations are included in the RI report.

See the responses provided for Comments 21 and 37 (above) for further clarification of the screening process for COCs, which is in accordance with EPA Superfund technical guidance.

42. *You didn't do the broad spectrum testing. You told us you were going to do it. You told us you were going to bring in another laboratory, and these are things that you didn't do.*

See response to Comment 41 (above) for information on the scope of sampling conducted at the Depot.

About 40 percent of all samples were analyzed for every compound on the target analyte list and target compound list (TAL/TCL). This goes beyond EPA guidance, which suggests that at least 20 percent of all samples be analyzed for the TAL/TCL. According to this guidance, the remaining samples must be analyzed for what is reasonably expected on the basis of historical activities at the site.

The BCT, which includes EPA, TDEC, and DLA, determined sampling locations on the basis of their evaluation of historical documents. The results of EPA's initial evaluation of Depot activities (Resource Conservation and Recovery Act [RCRA] Facilities Assessment, 1990) were also considered. All sampling locations have been reviewed and approved by both EPA and TDEC.

43. *I think that this has been just a waste of time because I don't feel like DLA has come to us completely honest in the beginning, and I don't think that this place will ever be clean. But what I'm afraid of is a lot of workers being exposed to a contaminated site like the workers that worked at DLA, and I think that EPA hasn't done their job extensively enough and not pushing forward the agenda like they should.*

DLA, EPA, and TDEC, as members of the BCT are committed to ensuring that environmental conditions at the Depot site meet or exceed the requirements for the intended future land use.

DLA has not been informed of any documented evidence linking former employee health issues to environmental conditions at the Depot.

The United States Department of Labor is responsible for employee health issues. To begin the process for investigating a health claim, a former employee must complete a CA-2 form with assistance from a physician. This form is available at any federal office that has a personnel/human resource office, and on the Internet at www.dol.gov/dol/esa/pub;oc/regs/compliance/wocp/forms.htm.

44. *I think things are done backwards, that so many people have been suffering in the community and people who worked here. And, I don't think any great effort has ever been done to find out why*

*that is, and, therefore, how can we have any confidence that any remediation plan that's going to be considered will actually do anything about that?*

The MI RI Risk Assessment confirmed that the MI is safe for the intended future land –uses. The selected remedy set forth in the MI Proposed Plan is protective of human health and the environment, and complies with federal and state environmental requirements. Those areas that are not within the acceptable standards for health protection will be (or have been) restored.

The ATSDR has completed two Public Health Assessments for the Memphis Depot (1995 and 2000). Both reports concluded that Depot operations are not impacting the local community based on environmental conditions on the MI and at the boundaries of the property.

45. *If we look at the remediation plan, it's based on several premises, which I think are dubious. The first premise is that the toxic contaminants on this site have been correctly identified, all of them, and that the levels of them have been correctly measured, you know, precisely enough. And, as I think has been pointed out many times, not everything has been tested every place, and part of the determination of what to test for is made based on the file, which was the first thing that was cleaned out. That's dubious.*

For clarification, see responses provided for Comments 29, 37, 38, 41 and 42 (above).

46. *The second premise is that the effect on human health is negligible if the particular contaminant is below a certain level, which is specified, you know, at the action level or whatever. And I think that there have already been scientific studies that have questioned these levels.*

The MI RI Risk Assessment was based on all available toxicity data and best practices approved by EPA and TDEC and supported by the scientific community, including information from extensive animal research and documented human experience.

For further clarification, please refer to the responses provided for Comments 13, 16, 18, and 21 (above).

47. *The third premise is that someone who's exposed to multiple chemicals, all of them below the official level of concern, will still suffer a negligible health impact, and that's not really based on any science. It's just an assumption, and there's evidence that it's not true.*

The potential health effects identified in the Risk Assessment take into account possible exposure to multiple substances, assuming that the effects are additive. The scientific information available indicates that exposures below these levels are safe and have no adverse health effects.

For further clarification, please refer to the responses provided for Comments 13, 16, 18, 21, and 46 (above).

48. *And the fourth premise, of course, is that the amount that people are exposed to based on the pathways of exposure is known, which I doubt also that enough has been done to figure that out.*

Exposure pathways are the ways in which a substance moves from the environment into the body. Three specific exposure routes are: ingestion (eating or drinking), inhalation (breathing), and dermal (contact with skin). In the Risk Assessment process, conservative exposure assumptions are made using each of these possible routes of exposure for different types of activity. In addition, the exposure scenarios account for different types of activity performed by people of various ages, body weights, and habits (i.e., adult, child, worker, and recreational teenager). In all cases, estimates of risk are based on higher levels of exposure than a typical human activity might involve. In other words, the risk estimations are designed to be conservatively protective.

49. *Because if we accept all these premises and we accept the conclusions that the remediation plan is going to prevent significant health impact, then we're totally at odds with the actual situation. Why are people still suffering and dying in the community – people who have worked at this installation? It's a sham if we don't know why that's happening and we're not doing anything to stop that from happening other than hiding behind the laws and regulations and pretending that if we follow these procedures that that's going to solve the problem.*

For clarification, refer to the responses provided for Comments 5 and 43 (above).

50. *Who is going to do it (the cleanup), and when is it going to be decided who's going to do it and what input would the community have in making the actual decision as to what alternative is chosen?*

It is anticipated that the remedial action contractor (Jacobs Sverdrup, under contract with the Mobile District of the USACE) will perform the cleanup actions, with oversight and approval by EPA and TDEC. A 60-day public comment period for the MI Proposed Plan and Preferred Cleanup Alternatives was held from August 14 through October 13, 2000. All public comments relating to the MI Proposed Plan must be evaluated and may affect the selected remedy.

51. *Will there be a public meeting?*

The results of the MI RI were presented to the RAB and members of the community in attendance at the June 2000 and July 2000 RAB meetings. The public comment meeting for the MI Proposed Plan occurred on August 24, 2000. The community was informed of these meetings through advertisements in the *Tri-State Defender*, the *Silver Star News*, and the *Commercial Appeal*, and in newsletters distributed throughout the community encouraging participation. Local radio stations also announced the meeting and the dates of the public comment period. This document represents all responses received during the public comment period.

52. *Will the community be telephoned, newspaper, radio?*

For clarification of the methods used to encourage participation in the public comment period related to the MI Proposed Plan, please refer to the response provided for Comment 51 (above).

For further information on the Depot's community relations activities, please refer to the response provided for Comment 38 (above).

53. *How is the community going to have input as to what alternative is selected?*

For clarification of the methods used to encourage participation in the public comment period related to the MI Proposed Plan, please refer to the response provided for Comment 51 (above).

54. *How much money is going to be figured into it, and when is that decision going to be made?*

As presented in the MI Proposed Plan, the estimated cost of the selected remedy is $2,500,000. This Record of Decision presents the selected remedy for the MI, as well as all public comments and agency responses, and is considered the "decision document." It is anticipated that DLA will sign the MI Record of Decision in early 2001.

55. *We need to just try and be more inclusive of the public and of former workers, of people who worked here, about maybe getting the input, asking what went on and how things went on what would be good or just include everybody in what alternatives about cleaning up that you want to do.*

Interviews with current and former employees were an important aspect of the environmental investigations conducted at the Depot. Current and former employees are included on the Depot's community mailing list and receive copies of newsletters, bulletins, and other notices promoting public meetings and events associated with the environmental restoration program.

Any former employee or member of the community who is not receiving this information and would like to be placed on the mailing list is encouraged to contact the Depot's community relations office at 544-0613.

For clarification of the methods used to encourage participation in the public comment period related to the MI Proposed Plan, please refer to the response provided for Comment 51 (above).

For further information on the Depot's community relations activities, please refer to the response provided for Comment 38 (above).

56. *Why don't you have mini comment period throughout the community instead of just having it here on this site? There are people that don't want to come up here for nothing, and this is not community friendly, not at all.*

Opportunities for public comment are not limited to one public comment meeting. Members of the public are encouraged to provide comments via letter, email, or telephone during the public comment period. In addition, each RAB meeting includes a period for public comments to be recorded. The June 2000 RAB meeting, which included a presentation on the MI RI, was held at a local elementary school in the community.

**Comments 57 through 65 were received in writing during the public comment period.**

57. *I am concerned that you now state the necessity to have a major clean-up plan. When this was brought to the citizens that there was no reason for this to transpire. So today you say that there is a need, why the lies; why so much deception?*

Since placement of the Memphis Depot on the NPL in 1992, DLA has followed the cleanup process prescribed by federal environmental laws. DLA has informed the public about the need for and results of the environmental investigation. This communication has been through placement of documents in the four Information Repositories; presentations at regular RAB meetings and Community Information Sessions, and through fact sheets and the bi-monthly newsletter *EnviroNews*, which is mailed to approximately 4,900 people in the community.

Through these communications efforts, the public has learned about the groundwater pumping system at Dunn Field; the voluntary removal actions taken at the Housing Area, Cafeteria Area, and Old Paint Shop and Maintenance Area; and the CWM removal action at Dunn Field. The MI Proposed Plan, which will complete the cleanup of the MI, resulted from the MI RI, which was presented to the public at the June and July 2000 RAB meetings.

For further information on the Depot's community relations activities, please refer to the response provided for Comment 38 (above).

58. *So the chemicals that do exist -- can you say that it can not or has already caused major health risk to persons within this community?*

Public Health Assessments (1995 and 2000) conducted by ATSDR concluded that Depot operations have not impacted the local community. People living in nearby residential areas are not exposed to the environmental conditions at the Depot on an ongoing, long-term basis, so there are no unacceptable risks.

For further clarification, please refer to the response provided for Comment 44 (above).

59. *The work that you are proposing will completely solve the problems that was said never to exist?*

The MI RI identified areas where environmental conditions required a remedy, in order to restore the site and meet the health-protective standards for the intended future land use. The remedy outlined in the Proposed Plan will allow the safe transfer or lease of the MI property to the City of Memphis.

60. *How do you plan to ensure the residents in this community that our welfare is being looked after, after this long denial of a real problem; what liability do you hold to this community?*

The selected remedies proposed for the MI include provisions for monitoring the effectiveness of the remedies in protecting human health and the environment over time. If state and federal regulators determine that a remedy is not effectively protecting human health and the environment, action will be taken to correct the remedy.

For further clarification of long-term monitoring, see the responses provided for Comments 5 and 40 (above).

61. *My biggest concern, how can you truthfully replace soil that has been contaminated for over 50 years?*

After the excavation of affected soil is completed, samples are then collected from the edges of the excavation area and analyzed to confirm that any substances detected in the soil are at levels that are protective of human health and the environment. Once that is confirmed, clean soil or gravel is used to fill the excavation area. Before the excavation site is refilled, this fill material is analyzed by a laboratory to confirm that it is acceptable and meets or exceeds standards for health protection.

62. *I have been informed that you do not plan to clean up the Memphis Defense Depot to meet residential standards. I am formally requesting that you clean up the Memphis Defense Depot to meet residential standards. The water is not being cleaned up to adequate levels, and the soil contamination is not being cleaned up to meet residential standards. It is not fair for you to leave a polluted plot of 642 acres land in our community.*

The selected remedy for the MI was chosen in accordance with CERCLA, as amended by the Superfund Amendments and Reauthorization Act (SARA), and, to the extent applicable, by the NCP. This decision is based upon the Administrative Record for the MI, including EPA Policy, *Land Use in the CERCLA Remedy Selection Process (OSWER Directive No. 9355.7-04).* This policy allows for the consideration of the intended future land use of the site when selecting the remedy.

The selected groundwater remedy is designed to remediate the groundwater to the Maximum Contaminant Levels (MCLs) of trichloroethene (5 micrograms per liter [μg/L]) and tetrachloroethene (5 μg/L). These concentrations represent acceptable residential (drinking water) standards considered to be protective of human health.

For further clarification on intended future land uses, see the responses provided for Comments 6 and 24.

63. *I have been informed that you did not conduct a broad spectrum soil sampling as is required to properly identify all possible forms of carcinogens presently located on the Memphis Defense Depot property. I request that you conduct "Broad Spectrum Sampling Test" on the Memphis Defense Depot to direct your clean up of the Memphis Defense Depot to meet residential standards. I feel you are stopping short of what is legally and morally responsible for the clean up. You are taking short-cuts to rush a clean up that is not happening as it should. The property was farmland and residential land before you created the polluted land that is now the Memphis Defense Depot.*

All sampling locations and methods have been reviewed and approved by both EPA and TDEC.

For clarification of the soil sampling methods used in the MI RI, please refer to the responses provided for Comments 41 and 42 (above).

64. *I am formally requesting that you clean up the groundwater on the Memphis Depot Main Installation to meet residential standards.*

This request is addressed in the Proposed Plan. The remedial goal for the groundwater is for residential (drinking-water) standards.

For further clarification, see the response provided to Comment 62 (above).

65. *I request that a much larger area of soil be excavated and removed from Functional Unit 4. The soil should be excavated and removed to an off site location. The top 24" of soil should be excavated and removed from the entire FU4. If you were to conduct a broad spectrum soil sampling as I have requested, the results would show that is the only alternative to remediate this area. I request that you cleanup the Memphis Defense Depot to meet residential standards.*

The selected remedy for the MI includes excavation of the surface soil (defined as the top 12 inches of soil) that has been impacted by lead above the industrial health-protective level of 1,536 mg/kg in the area of Building 949. After the excavation has been completed, confirmation samples will be analyzed to confirm that the affected surface soil has been remediated. If confirmation samples indicate concentrations of lead above the industrial protective level, the excavation will be expanded to include additional surface soil.

According to the MI RI Risk Assessment, FU4 does not present unacceptable risks to current and future industrial workers or hypothetical future residents.

For further clarification on intended future land uses at the MI, see the responses provided for Comments 6 and 24 (above).

## 3.2 Remedy Selection Rationale

Responsiveness summaries, as provided by CERCLA guidance (CERCLA 117 and NCP 300.430[f][3][I][F] and 300.430 [f][5][iii][B]), must include an attempt to address citizens' concerns and explain why or why not or why not the selected remedies were or were not altered as a result of issues raised by stakeholders. Based upon review of the responsiveness summary for the MI, there are two major concerns expressed by the local community that potentially may affect the remedy selection: (1) treatment or remediation of the site soils to residential standards, and (2) treatment or remediation of the groundwater to residential standards. These concerns are addressed in the following paragraphs.

Several of the comments made by the local community express concern that soil within the MI will not be treated or remediated to residential standards. CERCLA law and BRAC guidance provide for remediation of a site to anticipated future land use. The DRC's *Memphis Depot Redevelopment Plan* and current land use zoning, as established by Memphis-Shelby County, call for the majority of the MI property to be reused for light industrial purposes and, at FU2 only, for recreational purposes. The Housing Area in FU6 will be reused for transitional housing and has been remediated to residential standards. The selected remedy for soil will remediate the property to provide adequate protection for the anticipated future land use; therefore, no change was made to the selected remedy.

Other important comments made by the community express concern over remediation of groundwater to residential standards. The remedial action objectives of the selected groundwater remedy at the MI are designed to remediate groundwater to MCLs as established by the Safe Drinking Water Act. This act authorizes EPA to set standards for maximum levels of contaminants in drinking water in order to be protective of human health and the environment. Therefore, as part of the selected remedy, contaminated groundwater beneath the MI will be remediated to levels protective of human health (i.e., residential standards). Subsequently, a change in the selected remedy is not necessary.

## 3.3 Technical and Legal Issues

The BCT requested additional confirmation of the groundwater conceptual site model (CSM) of the MI. There were significant differences between the CSM in the RI and the CSM in the Groundwater FS. The BCT members agreed to complete the confirmation prior to beginning the remedial design. The work will include drilling new wells at selected locations to determine the depth and base of the aquifer within the fluvial deposits under the MI. The results of the work are not expected to change the effectiveness of the remedy for groundwater, but may affect where groundwater monitoring occurs while the remedy is implemented.

TDEC requested additional confirmation that no dense non-aqueous phase liquid (DNAPL) sources occur beneath historic long-term operational areas on the MI. There is no evidence from the RI and groundwater FS that a DNAPL is present in the groundwater on the MI; however, the Depot and EPA agreed to complete this testing prior to beginning the remedial design. The pre-design tests will include drilling new soil borings and monitoring wells at selected locations within the MI and obtaining soil and groundwater samples for targeted laboratory analysis. The results of these pre-design tests are not expected to change the effectiveness of the selected remedy for groundwater; however if results of the pre-design tests indicate a significant or fundamental change to the remedy is warranted, then an Explanation of Significant Differences (ESD) or a ROD amendment would be required in accordance with CERCLA §117(c) and NCP §§300.435(c)(2)(i) and (ii).

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