THE MEMPHIS DEPOT
TENNESSEE

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Operable Unit 4
Field Sampling Plan

for

Defense Distribution Depot Memphis

September 1995

Prepared for

U.S. Army Corps of Engineers
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Executive Summary

Introduction

In October 1992, the Defense Depot Memphis, Tennessee, was placed on the National Priorities List by the U.S. Environmental Protection Agency. Therefore, Defense Depot Memphis, Tennessee, must fulfill requirements under the Comprehensive Environmental Response, Compensation, and Liability Act and National Oil and Hazardous Substances Pollution Contingency Plan. A Remedial Investigation/Feasibility Study will be conducted to evaluate the nature and extent of contamination, to evaluate the risk to human health and the environment, and to screen potential cleanup actions. The *Generic Remedial Investigation/Feasibility Study Work Plan* was prepared to show how the investigation and study will be accomplished. This Field Sampling Plan was prepared for Operable Unit 4 as a supplement to the *Generic Remedial Investigation/Feasibility Study Work Plan*. The *Operable Unit 4 Field Sampling Plan* has two objectives. The first is to present a detailed description of the proposed sampling and analysis activities that will be performed for the characterization of Operable Unit 4 at Defense Depot Memphis, Tennessee. The second is to provide a detailed description of proposed sampling and analysis activities as a part of the facilitywide groundwater investigation.

The ultimate goal of the Remedial Investigation/Feasibility Study is to select cost-effective cleanup actions that provide protection of public health and the environment. To accomplish this goal, the nature and extent of the release of hazardous substances must be identified, the source of release must be determined, and proposed cleanup actions must be evaluated. By implementing the field investigation strategies described in the Field Sampling Plans, the quantity and quality of data collected will aid in achieving the goal of the Remedial Investigation/Feasibility Study at Defense Depot Memphis, Tennessee.

Site Background and Location

Defense Depot Memphis, Tennessee, receives, warehouses, and distributes supplies common to all U.S. military services and some civil agencies located primarily in the southeastern United States, Puerto Rico, and Panama areas. The installation covers 642 acres of land in Memphis, Shelby County, Tennessee, in the extreme southwestern portion of the state. The installation contains approximately 110 buildings, 26 miles of railroad track, and 28 miles of paved streets. Approximately 5.5 million square feet of storage space is open. Stored items include food, clothing, electronic equipment, petroleum products, construction materials, and industrial, medical, and general supplies used by all military branches of the U.S. government.

Description of Operable Units

Defense Depot Memphis, Tennessee, is divided into four operable units for evaluation purposes. Operable Unit 1, north of the Main Installation, is called Dunn Field. The Main Installation is divided into three areas: the southwestern quadrant, Operable Unit 2; the southeastern quadrant including Lake Danielson and the golf course area, Operable Unit 3; and the north-central area, Operable Unit 4. Sites identified in Operable Unit 1 for investigation are a result of use of the area for landfill operations, mineral stockpiles, pistol range, and materials storage. Potential contamination of Operable Unit 2 may have resulted from spills or releases from the hazardous material storage and repouring area, sandblasting and painting activities, or both. Storage of polychlorinated biphenyls and the use of pesticides and herbicides are potential sources of contamination for Operable Unit 3. Principal contamination in Operable Unit 4 probably resulted from a wood treatment operation and hazardous materials storage.

Operable Unit 4 contains the former wood treatment dip vat area, which is now used for pesticide storage and hazardous materials storage. Extensive remediation of soils was conducted at this site during 1985 and 1986. Samples taken in 1990 revealed pesticides at quantitation levels. Soil samples were also taken where past spills have occurred. These samples indicated the presence of solvents, petroleum products, pesticides, and metals. Groundwater samples in Operable Unit 4 indicated the presence of solvents and metals.

Summary of Field Sampling Plan

This Field Sampling Plan describes the Defense Depot Memphis, Tennessee, facility and individual operable unit history and data gaps, locations, geography, surface water hydrology, geology, hydrogeology, land use, and Operable Unit 4 data needs. Additionally, this Field Sampling Plan describes the sampling strategy and sampling plan at Operable Unit 4. A facilitywide investigation of the Fluvial Aquifer, including onsite and offsite wells, also is presented in this Field Sampling Plan. The final section of the plan evaluates the option of installing a monitoring well in the Memphis Sand Aquifer. The purpose of this Field Sampling Plan is to characterize potential releases from the site, to delineate the nature and extent of soil and groundwater contamination attributable to past operations, and to gather data to evaluate the feasibility of remedial actions for this site.

Sampling Strategy

A cost-effective sampling strategy has been developed to perform a Remedial Investigation/Feasibility Study at Defense Depot Memphis, Tennessee. This Field Sampling Plan uses an observational approach to field data collection and making field-based decisions to achieve the goals of the facility. The approach presented is intended to support a recommendation of one of the following options for Operable Unit 4:

- Site upgrade (Feasibility Study activities, Remedial Designs, Remedial Actions)
- Site downgrade (support No Further Action)
- Interim Remedial Action or Early Removal

To support recommendations in a timely manner, soil and water samples will be collected at Operable Unit 4 and analyzed using a fixed-based laboratory. Data must be of sufficient quality to support the decision-making process. A tiered approach to sampling and analysis (including field screening) will be used so that the field team can adjust the sampling effort to accommodate site-specific conditions. Three categories of data will be collected as part of this field effort, with each category having a different level of supporting quality assurance/quality control documentation. The three categories, or levels, correspond to quality control levels 1, 2, and 3. Level 1 includes field monitoring activities such as pH, temperature, conductivity, and total organic vapor monitoring. Level 2 screening activities (such as using a field gas chromatograph for volatile organic compounds) are indicative of the nature of contamination, and Level 3 analysis provides confirmation by an analytical laboratory.

There is a potential for Level 4 data to be required in the future at this facility. Samples analyzed using Level 4 quality control are analyzed using the same analytical methods as Level 3 samples, but different data package deliverables are provided.

Ten percent of the Level 2 samples will be sent to an offsite laboratory for Level 3 confirmational analysis. On the basis of Level 2 and Level 3 data, a comparison of regulatory levels and calculated risk levels of contamination will aid in supporting the appropriate recommendation.

Proposed Sampling

Some surface and subsurface soil samples are planned for Operable Unit 4. Shallow soil borings will be installed surrounding and within Operable Unit 4. Soil samples will be collected at regular intervals from each boring to assess the vertical extent of contamination. Surface soil samples will be collected and analyzed to assess the horizontal extent of contamination.

The seven existing monitoring wells at Operable Unit 4 will be sampled according to procedures outlined in the *Generic Quality Assurance Project Plan*. Two additional monitoring wells will be installed to evaluate Fluvial Aquifer groundwater quality, to further characterize the configuration of the water table, and to assess the possibility of a contaminant release from Operable Unit 4. As a part of the overall groundwater quality assessment, 16 to 21 new Fluvial Aquifer wells will be installed to provide additional information concerning the estimation of the extent of the contaminant plume migrating to the west of Dunn Field, the extent of contaminants migrating under Defense Depot Memphis, Tennessee from offsite sources, the potentiometric surface of the Fluvial Aquifer, and the groundwater flow direction. Water level data from these wells and the other existing monitoring wells will be used to update the potentiometric surface map. Chemical analyses from these wells will be used to evaluate the nature and extent of contamination and to provide water quality data upgradient to the facility. The optional task of installing a well in the Memphis Sand Aquifer will be evaluated after discussion of groundwater sampling results from Fluvial Aquifer wells. The intent of this well will be to evaluate Memphis Sand Aquifer groundwater quality downgradient from the area of suspected hydraulic interconnection between the Fluvial Aquifer and the Memphis Sand Aquifer and further evaluate the nature of the potential hydraulic interconnection.

The ultimate goal of the Remedial Investigation/Feasibility Study is to select cost-effective cleanup actions that minimize threats and provide protection of public health and environment. To accomplish this, the nature and extent of the release of hazardous substances to the Fluvial Aquifer must be identified, the source of release must be determined, and proposed cleanup actions must be evaluated.

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Acronyms

ARARs	Applicable or relevant and appropriate requirements
ASTM	American Society for Testing and Materials
beta-BHC	Beta-hexachlorocyclohexane
bls	Below land surface
BOD	Biochemical oxygen demand
BRA	Baseline risk assessment
CEHND	Corps of Engineers/Huntsville
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Contaminant of concern
COD	Chemical oxygen demand
COE	U.S. Army Corps of Engineers
DDE	1,1,1-dichloro-2,2-bis(4-chlorophenyl)ethylene
DDMT	Defense Depot Memphis, Tennessee
DDT	Dichlorodiphenyltrichloroethane
DLA	Defense Logistics Agency
DNAPL	Dense non-aqueous phase liquid
DOI	Department of Interior
DQOs	Data quality objectives
DRMO	Defense Reutilization Marketing Office
EPA	U.S. Environmental Protection Agency
ER	Early removal
ESE	Environmental Science & Engineering, Inc.
FBL	Fixed-based laboratory
FFA	Federal Facilities Agreement
FR	*Federal Register*
FRL	Final remediation level
FSP	*Field Sampling Plan*
FTL	Field Team Leader
HASP	*Health and Safety Plan*
HQ/HI	Hazard quotient/hazard index
HRS	Hazard Ranking System
ID	Inside diameter
IRA	Interim Remedial Action
mL	Milliliter
MS/MSD	Matrix spike/matrix spike duplicate
MW	Monitoring well
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA	No further action
NPL	National Priorities List
OU	Operable unit

Acronyms (Continued)

PAH	Polynuclear aromatic hydrocarbon
PCOC	Potential contaminant of concern
PCP	Pentachlorophenol
PM	Project manager
POL	Petroleum, oil, and lubricants
PRG	Preliminary remediation goal
PVC	Polyvinyl chloride
QAPP	*Quality Assurance Project Plan*
QA	Quality assurance
QC	Quality control
RAGS	*Risk Assessment Guidance for Superfund*
RALS	Removal action levels
RCRA	Resource Conservation and Recovery Act
RGO	Remedial goal option
RI/FS	Remedial Investigation/Feasibility Study
RI/FS WP	*Generic RI/FS Work Plan*
ROD	Record of Decision
SMP	*Site Management Plan*
STB	Stratigraphic test boring
SVOC	Semivolatile organic compound
TCE	Trichloroethene
TCLP	Toxicity Characteristic Leachate Procedure
TCL/TAL	Target Compound List/Target Analyte List
TDEC	Tennessee Department of Environment and Conservation
THI	Target hazard index
TOC	Total organic carbon
TRL	Target risk level
UCL	Upper confidence limit
USGS	U.S. Geological Survey
VOC	Volatile organic compound
WWII	World War II

1.0 Introduction

1.1 Objectives

One objective of this Field Sampling Plan (FSP) for Operable Unit 4 (OU-4) is to present a detailed description of the proposed sampling and analysis activities that will be performed for characterization of the site (Site 57) in OU-4 at Defense Depot Memphis, Tennessee (DDMT). The purpose of this effort is to characterize potential releases from the site, to delineate the nature and extent of soil and groundwater contamination attributable to past operations, and to distinguish among remedial actions considered feasible for this site. Once the site has been characterized, data will be evaluated and used to screen remedial alternatives in accordance with preliminary remediation goals (PRGs) and the baseline risk assessment (BRA).

Another objective of the OU-4 FSP is to present a detailed groundwater quality assessment strategy. The purpose of this effort is to evaluate the nature and extent of contamination beneath and to the west of Dunn Field, to further characterize the potentiometric surface of the Fluvial Aquifer, and to provide water quality data upgradient of the facility. The north-central section of the Main Installation has been designated by the U.S. Environmental Protection Agency (EPA) and DDMT as OU-4. A list of references is provided as Appendix A.

1.2 Regulatory Requirements

DDMT was issued a Resource Conservation and Recovery Act (RCRA) Part B permit (No. TN4 210 020 570) by the EPA, Region IV, and the Tennessee Department of Environment and Conservation (TDEC) on September 28, 1990. Subsequently, in accordance with Section 120(d)(2) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9620(d)(2), EPA prepared a final Hazard Ranking System (HRS) Scoring Package for DDMT. On the basis of the final HRS score of 58.06, EPA added DDMT to the National Priorities List (NPL) by publication in the *Federal Register (FR)*, 57 FR 47180 No. 199, on October 14, 1992.

DDMT has entered into a Federal Facilities Agreement (FFA) between the Defense Logistics Agency (DLA), EPA, and TDEC. This agreement establishes a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions at DDMT in accordance with existing regulations and for achieving RCRA/CERCLA integration. In response to the FFA, sites at DDMT have been grouped into four OUs and a number of screening sites that must be addressed under the CERCLA process.

1.3 Facility and Site Status

As a result of DDMT's status as an NPL site, it was agreed that the investigation of all applicable sites would proceed under the CERCLA process for remediation (Remedial Investigation, Feasibility Study, Proposed Plan, Record of Decision, Remedial Design, and Remedial Action). OU-specific FSPs are being prepared for OUs-1, 2, 3, and 4 and for the screening sites, and will provide guidelines for conducting the Remedial Investigation/Feasibility Study (RI/FS) for each of the OUs. Schedules for completing specific tasks during the process have been submitted separately in the *Site Management Plan* (SMP).

DDMT is conducting RI/FS activities at OU-4 in conformance with the requirements of CERCLA and the FFA. In addition, elements of DDMT's RCRA permit dictate that DDMT undertake a study to confirm the absence or presence of contamination at locations where hazardous or toxic wastes were managed or disposed of. This FSP concurrently addresses the site within OU-4 that has been previously identified as requiring an RI. The remainder of the OU-4 sites identified as requiring confirmatory sampling will be addressed in the *Screening Sites FSP* (ref. 16). Table 1-1 presents a summary of the sites at OU-4, along with the document that addresses future work planned for the site. Drawing 1 (located at the end of this document) illustrates the location and status of each site identified in OU-4.

1.4 Elements of the Field Sampling Plan

This FSP is written as a supplement to the "generic" (facilitywide) RI/FS work plans for DDMT. Details not included in this plan can be found in the generic work plans. These work plans were provided as separate documents and are listed below:

- *Generic RI/FS Work Plan* (RI/FS WP)
- *Generic Quality Assurance Project Plan* (QAPP)
- *Generic Health and Safety Plan* (HASP)

The FSP defines in detail the sampling and data-gathering methods that will be used. The structure of the FSP includes known site conditions and history; proposed site-specific sampling, analysis, intended data use, and data quality level; and a discussion of non-site-specific field actions required.

Table 1-1
OU-4 (North Area of Main Installation)
CERCLA Site Status (February 21, 1995)
Defense Depot Memphis, Tennessee

RI/FS Site Number	Description	SWMU Number	RI Report Number[1]	RFA Status	Current Status	Document Addressing Future Work
41	Satellite Drum Accumulation Area (1 of 5 total - Bldg. 210)	41	-	NFA	NFA	Ref. 22
44	Former Wastewater Treatment Unit Area	44	56	NFA	NFA	Ref. 22
45	Former Contaminated Soil Staging Area	45	56	NFA	NFA	Ref. 22
53	X-25 Flammable Solvents Storage Area (near Bldg. 925)	AOC-D	61/62	NFA	NFA	Ref. 22
57	Building 629 Spill Area	AOC-H	49	RFI	RI	NA
28	Recoup Area Building	28	-	NFA	Screening	Ref. 21
35	DRMO Bldg. T-308 Hazardous Waste Storage	35	46	NFA	Screening	Ref. 21
36	DRMO Hazardous Waste Concrete Storage Pad	36	-	NFA	Screening	Ref. 21
37	DRMO Hazardous Waste Gravel Storage Pad	37	-	PRFI	Screening	Ref. 21
38	DRMO Damaged/Empty Hazardous Materials Drum Storage Area	38	-	PRFI	Screening	Ref. 21
39	DRMO Damaged/Empty Lubricant Container Area	39	-	PRFI	Screening	Ref. 21
42	Former PCP Dip Vat Area	42	56	PRFI	Screening	Ref. 21
43	Former Underground PCP Tank Area	43	56	PRFI	Screening	Ref. 21
46	Former PCP Pallet Drying Area	46	56	PRFI	Screening	Ref. 21
54	Main Installation-DRMO East Storm Water Runoff Canal	AOC-E	-	NFA	Screening	Ref. 21
55	Main Installation-DRMO North Storm Water Runoff Area	AOC-F	-	NFA	Screening	Ref. 21
56	Main Installation-West Storm Water Drainage Canal	AOC-G	-	NFA	Screening	Ref. 21
70	POL, Various Chemicals (RR tracks 1, 2, 3, 4, 5, 6)-Leaks	-	70	-	Screening	Ref. 21
71	Herbicide (All RR tracks) (used to clear tracks)	-	71	-	Screening	Ref. 21

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Table 1-1
OU-4 (North Area of Main Installation)
CERCLA Site Status (February 21, 1995)
Defense Depot Memphis, Tennessee

RI/FS Site Number	Description	SWMU Number	RI Report Number[1]	RFA Status	Current Status	Document Addressing Future Work
72	Waste Oil (PDO yard) (surf. appl. for dust control)	-	72	-	Screening	Ref. 21
73	2,4-Dichlorophenoxyacetic Acid (all grassed areas)	-	73	-	FS	Upcoming Feasibility Study
74	Flammables, toxics (West End-Bldg. 319)	-	45	-	Screening	Ref. 21
79	Fuels, Misc. Liquids, Wood, Paper (Vicinity of S702)	-	54	-	Screening	Ref. 21
80	Fuel and cleaners dispensing (Bldg. 720)	-	55	-	Screening	Ref. 21
81	Fuel Oil (Bldg. 765)	-	57	-	Screening	Ref. 21
83	POL (isoctane, toluene, actone, MEK, naptha) Areas X-13, 15, 25	-	69	-	Screening	Ref. 21

[1]RI Report = Ref. 5

Notes:

RFA = RCRA Facility Assessment
NFA = No Further Action
PA/SI = Preliminary Assessment/Site Inspection
PRFI = Preliminary RCRA Facility Investigation
RFI = RCRA Facility Investigation
Screening = Screening Sites Field Sampling Plan
ER = Early Removal Site
RI = Remedial Investigation Site
SWMU = Solid Waste Management Unit
CWMP = Chemical Warfare Management Plan
NA = Not Applicable

2.0 Site Description

2.1 Location

DDMT covers 642 acres of land in Shelby County, Memphis, Tennessee, in the extreme southwestern portion of the state. Approximately 5 miles east of the Mississippi River and just northeast of the Interstate 240–Interstate 55 junction, DDMT is in the south-central section of Memphis, approximately 4 miles southeast of the Central Business District and 1 mile northwest of Memphis International Airport. Airways Boulevard borders DDMT 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 to the Main Installation, respectively. Person Avenue, Kyle Street, and Hays Street serve as the northern, western, and eastern boundaries to Dunn Field, respectively. Figure 2-1 shows the installation's location within the Memphis area.

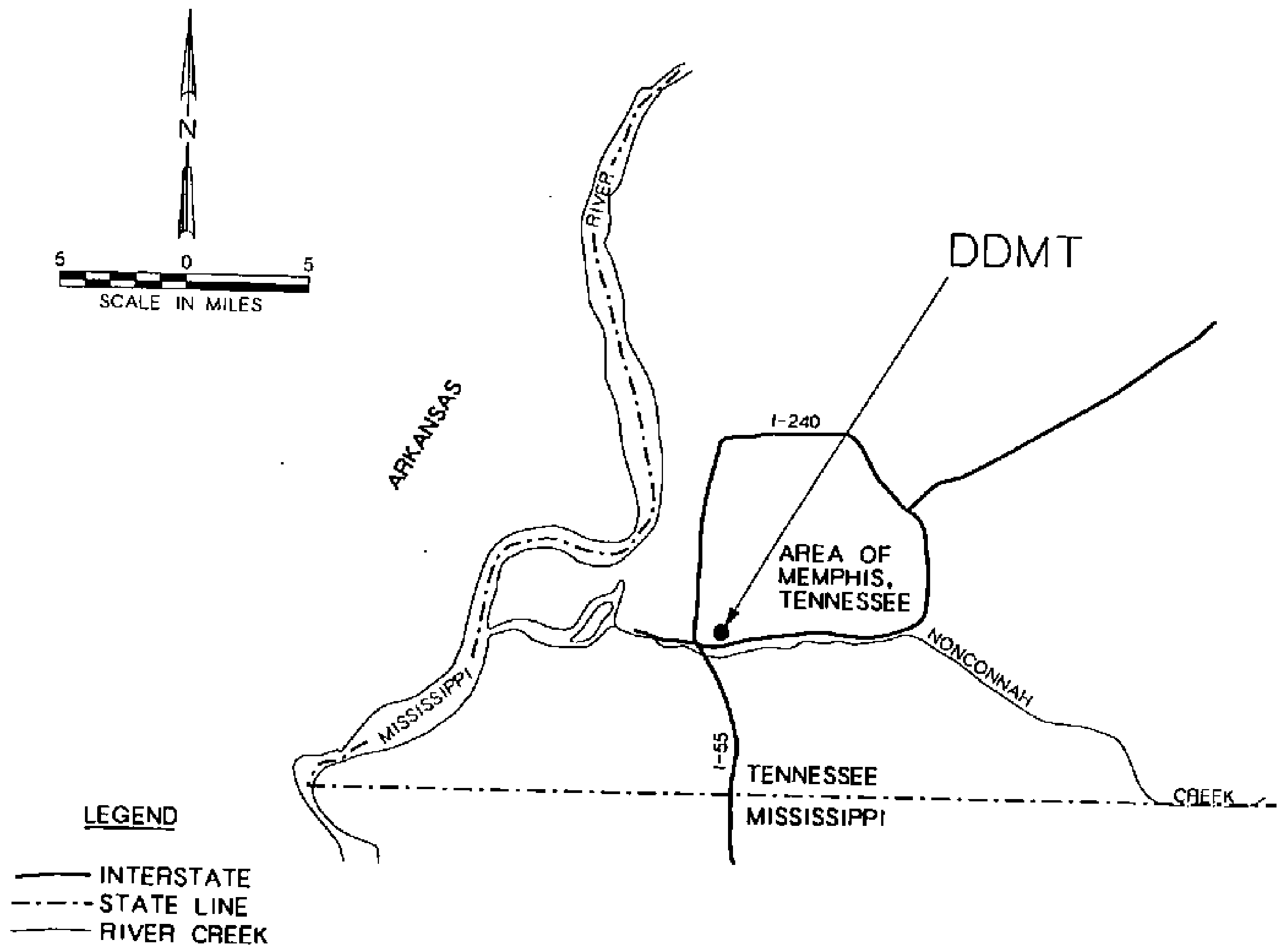
OU-4 consists of approximately 168 acres and is located in the north-central section of the Main Installation at DDMT. A site location map for DDMT is shown in Figure 2-1. The location of OU-4 in relation to the entire DDMT facility and other proposed OUs is shown in Figure 2-2.

2.2 Operable Unit Description

OU-4 includes former and current hazardous materials storage buildings—Buildings 319, 629, and 835—and the Defense Reutilization Marketing Office (DRMO) buildings and stock yards. The geographical area of OU-4 also contains the former Pentachlorophenol (PCP) Dip Vat area sites (all near Building 737), which will be addressed as part of the *Screening Sites FSP* (ref. 16). In addition, OU-4 is located in the general area of the installation where a data gap exists concerning the confining unit that separates the Fluvial Aquifer from the Memphis Sand Aquifer.

2.3 Physiography

Figure 2-3 shows the location of Site 57 within the boundaries of OU-4, as well as the current land use. No perennial surface water bodies are located within the geographic boundaries of OU-4. All geological, climatological, physical, and surface drainage information for the Main Installation is discussed in detail in Section 2.4 of the *Generic RI/FS WP* (ref. 1).



Source: Engineering-Science, 1993

FIGURE 2-1
DDMT LOCATION IN MEMPHIS METROPOLITAN AREA
Defense Depot Memphis, Tennessee

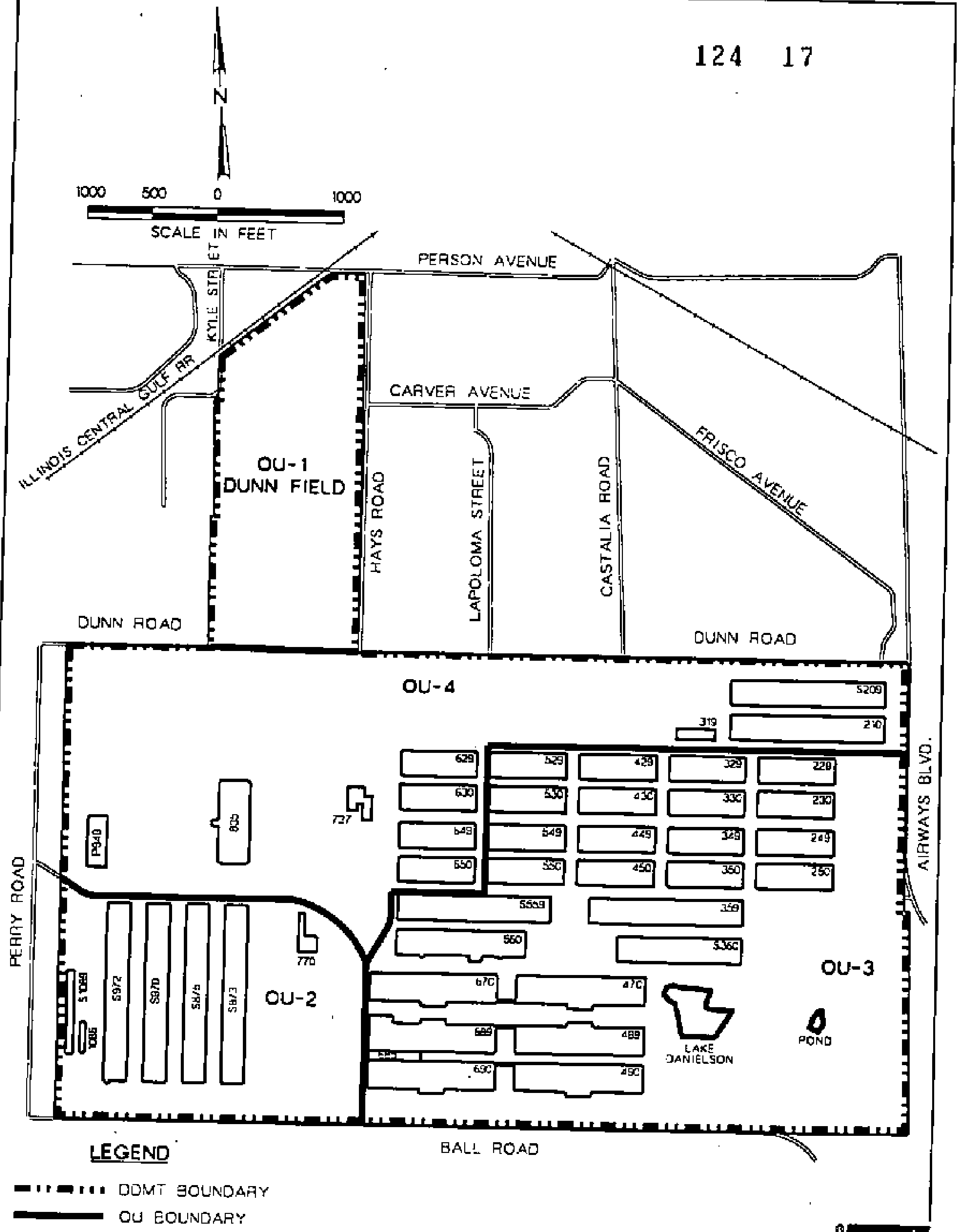


FIGURE 2-2
OPERABLE UNIT LOCATIONS
Defense Depot Memphis, Tennessee

Source: Engineering-Science, 1993

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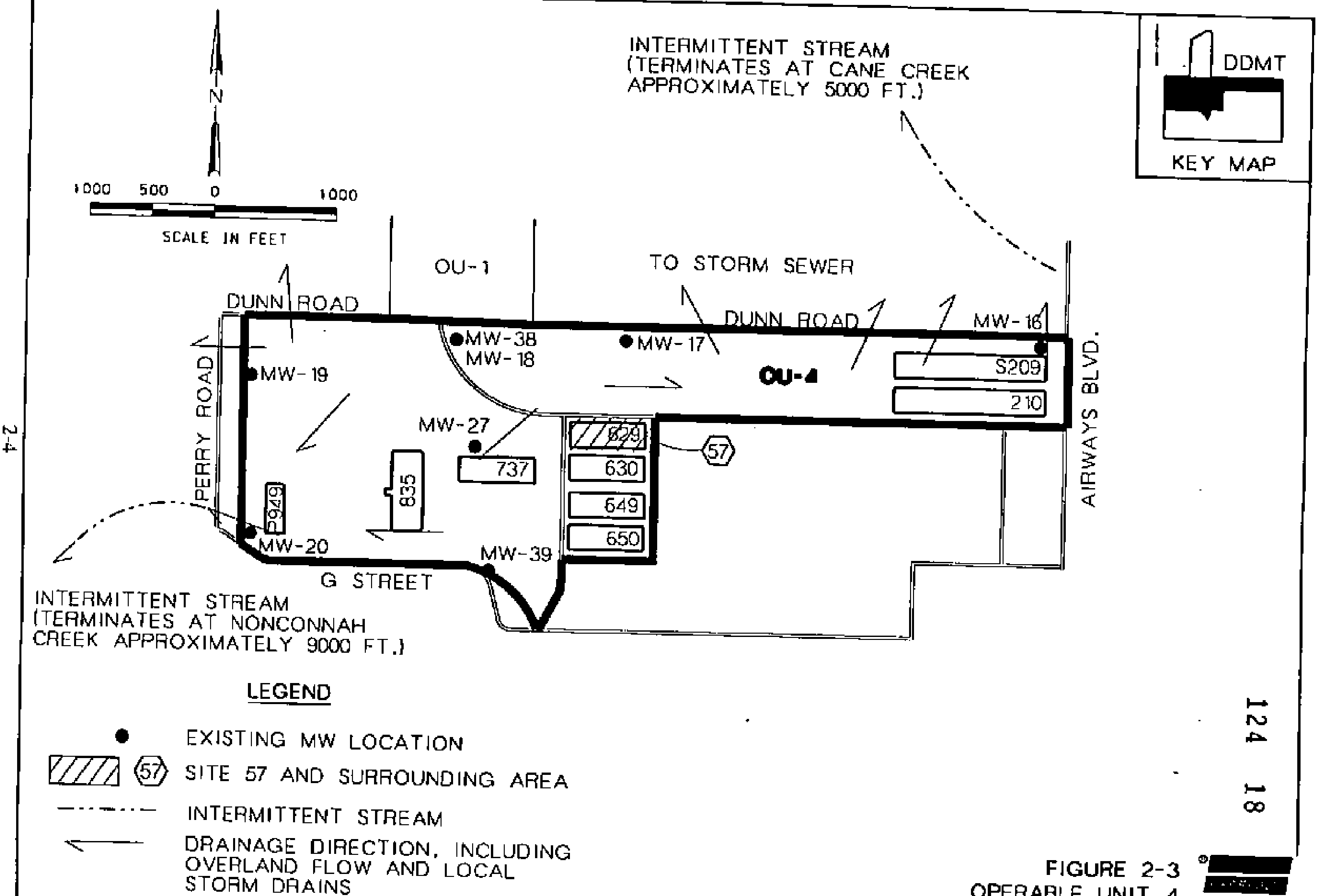

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FIGURE 2-3
OPERABLE UNIT 4
Defense Depot Memphis, Tennessee

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2.4 Hydrogeology

OU-4 is underlain by a layer of loess about 20- to 30-feet thick. Terrace deposits underlie the loess. The lower, saturated portion of the terrace deposits is referred to as the Fluvial Aquifer, which is the uppermost aquifer beneath DDMT. Perched groundwater also exists in the terrace deposits above small clay lenses at elevations above the Fluvial Aquifer. However, these perched water zones are temporal and are not considered part of the Fluvial Aquifer. The Fluvial Aquifer is not used as a drinking water source within the City of Memphis. The Memphis Sand Aquifer underlies the Fluvial Aquifer and is the primary source of drinking water for the City of Memphis.

The Fluvial and Memphis Sand Aquifers are separated by the Jackson Formation/Upper Claiborne Group, which generally consists of a high-plasticity clay of variable thickness. The depth to the top of the confining unit at OU-4 ranges from about 70 feet below land surface (bls) on the east and west sides of OU-4 to about 160 feet bls in the north-central portion of OU-4, where a depression in the top of the clay unit exists. The maximum thickness of this unit is estimated to be 85 feet at stratigraphic test boring (STB)-6, while the minimum thickness (at STB-8) is 5 feet of sandy, silty clay and 9 feet of interbedded silty clay and fine-grained sand.

Figure 2-4 presents the November 1993 potentiometric surface map of the Fluvial Aquifer at DDMT. The map was compiled by contouring water levels recorded by Environmental Science & Engineering, Inc., (ESE) in November 1993 (ref. 2). The groundwater flow direction in the Fluvial Aquifer within OU-4 is toward the depression in the top of the clay unit on the northern portion of OU-4. This portion of DDMT is a suspected area of hydraulic interconnection between the Fluvial Aquifer and the underlying Memphis Sand Aquifer. The extent of the suspected area of hydraulic interconnection is currently unknown. Depths to Fluvial Aquifer groundwater generally range from about 60 feet on the east side of OU-4 to about 140 feet in the depression in the north-central portion of OU-4. The groundwater flow direction in the Memphis Sand Aquifer is westward toward the Allen Well Field.

A more complete discussion of the geologic and hydrogeologic conditions at OU-4 is presented in Section 2.4 of the *Generic RI/FS WP* (ref. 1).

2.5 Land Use

OU-4 is characterized by light industrial activities, primarily warehousing. The most prominent features of OU-4 include four World War II (WWII) vintage (typical) warehouses used for bulk storage; Buildings 319 and 835, which are used for warehousing hazardous materials; a hazardous recoup facility (where damaged hazardous materials are reclaimed); and the DRMO facilities used for waste handling. Building 737, also located in OU-4, was historically the PCP Dip Tank building. The following activities either now occur or are reported to have occurred at Building 737 in the past: pesticide/herbicide storage, mixing, and application; and treatment of wood products with PCP preservatives. Most of the land area within OU-4 has been graded, paved, and heavily built-up. The topography of this OU is primarily flat.

2.6 Operable Unit 4 Data Gaps

Using the existing data, knowledge of the site operations, and DDMT records, a review was conducted to assess where data were insufficient to achieve the objectives of the RI/FS process. The review process resulted in the identification of data gaps that need to be addressed during the RI/FS. The primary objectives for conducting field sampling at the OU-4 sites are to evaluate the nature and extent of groundwater contamination in the Fluvial Aquifer with an emphasis on potential offsite receptors, to evaluate the potential interconnection between the Fluvial and Memphis Sand Aquifers, and to characterize soil contamination at Site 57. Table 2-1 provides a generalization of data needs, existing data, and future sampling requirements.

Table 2-1
Generalized OU-4 Data Gaps
Defense Depot Memphis, Tennessee

Data Need/Use	Existing Data	Future Data Collection
Groundwater Flow-Fluvial Aquifer	Dunn Field monitoring wells Main Installation monitoring wells	Additional offsite groundwater monitoring wells. Groundwater level measurements.
Background water quality (metals)	Limited data for upgradient wells	Additional wells upgradient and offsite
Background soil chemistry	None available	Soil sample from offsite locations
Meet RCRA Permit Requirements for Confirmatory Sampling/RFI	Available for the site	Sampling at site
Evaluate offsite exposures for baseline risk assessment (BRA)	Limited offsite data records	Additional sampling offsite
Characterize site	Installation records; actual sampling	Install/analyze soil borings, surface soil and groundwater samples at site
Evaluate presence/thickness of confining unit; aquifer interconnection	Boring and well logs; regional reports; water level information; draft seismic reflection study	Additional wells and borings water level information (site and local/regional)

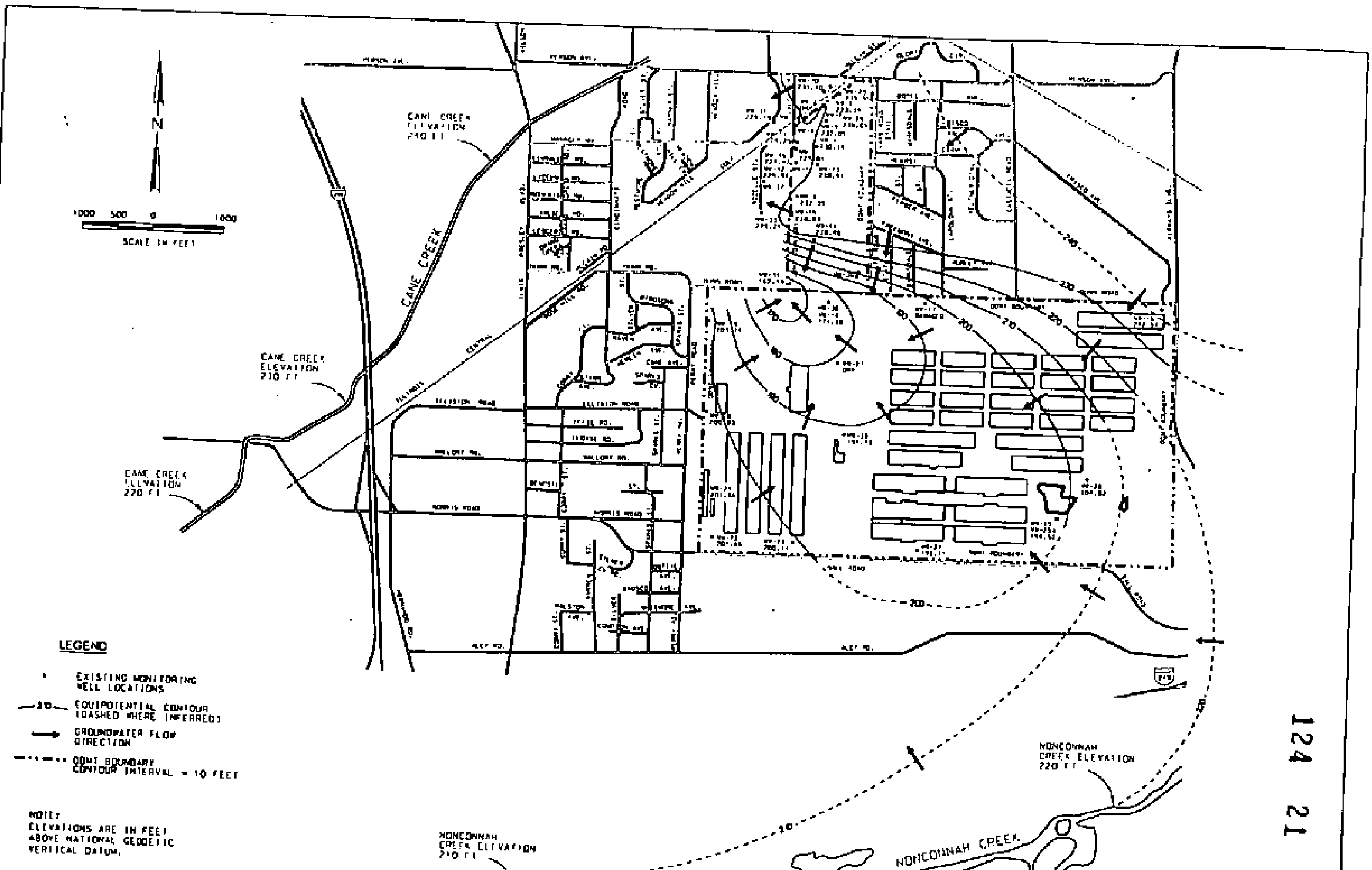

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FIGURE 2-4
NOVEMBER 1993 POTENTIOMETRIC SURFACE MAP OF THE FLUVIAL AQUIFER
Defense Depot Memphis, Tennessee

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3.0 Sampling Strategy for Operable Unit 4

3.1 Structure of Operable Unit 4 Investigation

This section presents a detailed description of the overall strategy for the investigation of OU-4. The approach presented is intended to support a remedial decision to recommend one of the following options for OU-4:

- Site upgrade (FS activities, Remedial Designs, and Remedial Actions)
- Site downgrade (support no further action [NFA])
- Interim Remedial Action (IRA) or Early Removal (ER)

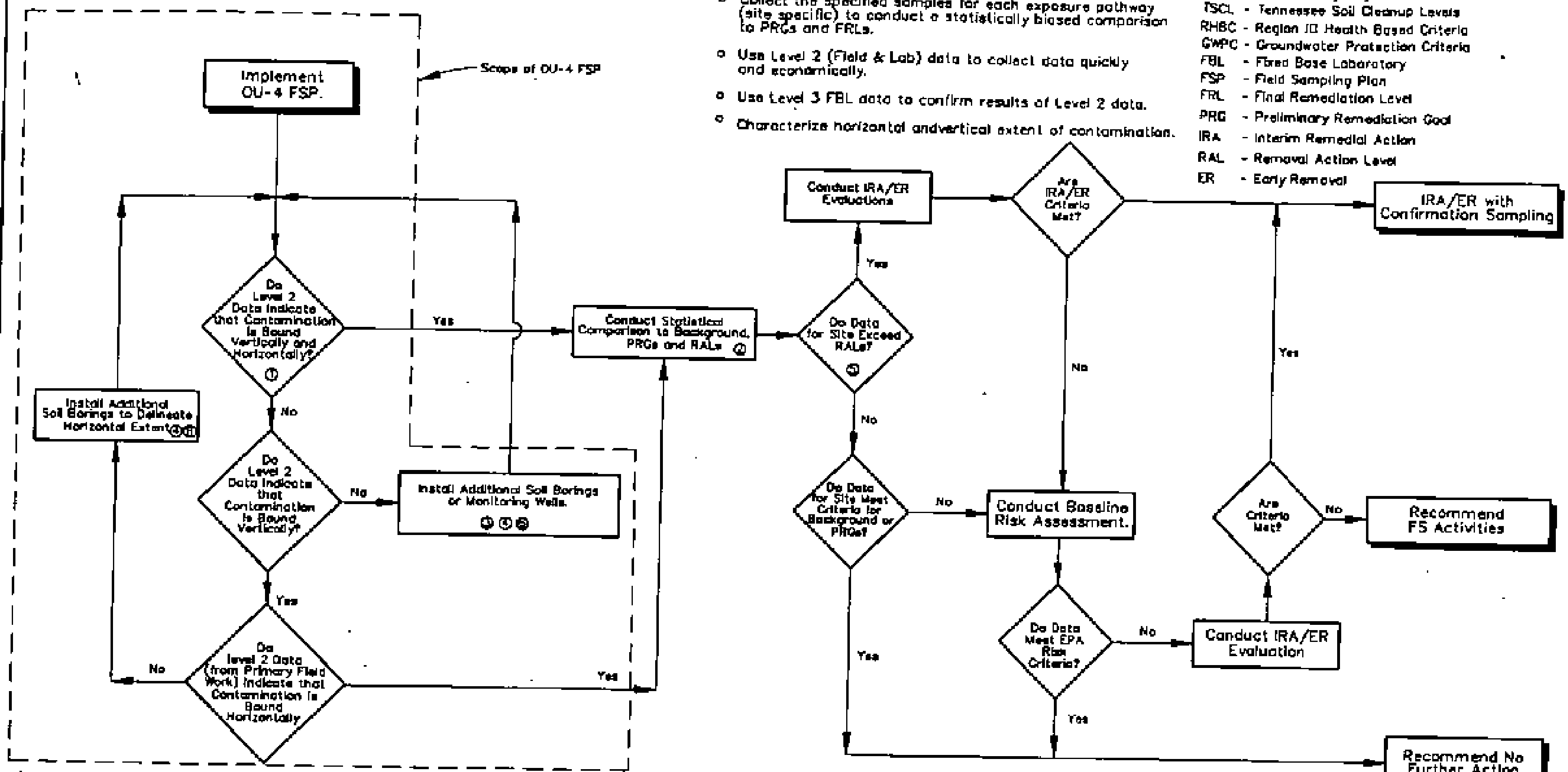
This work plan is intended to implement RI/FS activities on a cost- and time-effective basis. Field screening procedures and statistical evaluations will be used to facilitate decisionmaking, as defined by Figure 3-1.

3.1.1 Scope

In general, the soil investigation and groundwater investigation will be conducted in parallel. If soil contamination is present, the lateral and vertical extent will be delineated during the field effort.

Previous investigations at DDMT (ref. 2; ref. 5) have indicated the presence of organic and metal constituents in groundwater primarily in the vicinity of Site 57 and in the northwest portion of OU-1 (Dunn Field). To further evaluate the risk to potential offsite receptors and to develop the conceptual model of groundwater flow at the facility, the evaluation of groundwater contamination at OU-4 will be expanded to address groundwater flow and contaminant transport on a facilitywide basis, including the OU-1 groundwater plume. The initial groundwater investigation for OU-4 includes the installation of fluvial wells near Site 57 to further evaluate potential releases from past spills.

In addition, the investigation is designed to evaluate the suspected area of hydraulic interconnection between the Fluvial Aquifer and the Memphis Sand Aquifer. Upon completion of the evaluations, a determination will be made regarding the need for and feasibility of installing a deep well in the Memphis Sand Aquifer. This decision will require approval by state and federal agencies. If a decision is made to install the deep well, the procedures will follow the methods delineated in Section 4.6 of this document.



DQOs

- Collect the specified samples for each exposure pathway (site specific) to conduct a statistically biased comparison to PRGs and FRLs.
- Use Level 2 (Field & Lab) data to collect data quickly and economically.
- Use Level 3 FBL data to confirm results of Level 2 data.
- Characterize horizontal andvertical extent of contamination.

Acronyms

DQOs - Data Quality Objectives
TSCL - Tennessee Soil Cleanup Levels
RHBC - Region III Health Based Criteria
GWPC - Groundwater Protection Criteria
FBL - Fixed Base Laboratory
FSP - Field Sampling Plan
FRL - Final Remediation Level
PRG - Preliminary Remediation Goal
IRA - Interim Remedial Action
RAL - Removal Action Level
ER - Early Removal

NOTES:

① The bounds of contamination refer to the extent of contamination equal to or less than background and/or PRGs.

② Background data set will be established by using criteria identified in the Generic RI/FS WP. Comparison criteria are developed using TSCL, RHBC and GWPC, and other applicable regulatory criteria. These criteria are used as PRGs based on a conservative approach from the standpoint of risk (exposure and assessment criteria). Section 3 of this FSP discusses the comparison criteria. Statistical comparison will be limited by the amount of data collected during the field investigation.

③ One upgradient well is required to assess impacts to groundwater from a particular site.

④ Wells and borings installed adjacent to a group of sites may be used to fulfill DQOs for the group of sites if the data is collected useful in assessing a contaminant release. Factors considered in deciding to install wells include proximity to site data previously collected, and potential contaminants of concern.

⑤ The RALs will be established based on acute criteria of risks and economic factors.

⑥ Optional work (soil borings, sampling, or monitoring wells) will not be initiated without prior approval of CEHND. Optional samples will be collected only after a field change request form is signed by CEHND.

FIGURE 3-1
OU-4 SOIL REMEDIAL LOGIC DIAGRAM
Defense Depot Memphis, Tennessee

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3.2 Data Quality Objectives

Data quality objectives (DQOs) are qualitative and quantitative statements that specify the quality of the data required to support the decision-making process during the sampling activities. The intended final use of the data determines DQOs. Specific objectives of this sampling effort are as follows:

- Evaluate the lateral and vertical extent of contamination in the soil and groundwater associated with releases from Site 57 and within Dunn Field, using Level 2 screening analytical methods, Level 3 analytical data, or both.

- Collect data to support a decision for remediation, including but not limited to, the following:

    - NFA
    - ER
    - Institutional controls
    - Excavation and onsite treatment/replacement
    - Excavation and offsite treatment/disposal
    - Excavation and offsite disposal

- Compare the levels of contamination at Site 57 and within groundwater against applicable regulatory levels or calculated risk-based levels, so that the appropriate recommendations can be developed.

- Collect soil and groundwater samples that are representative of actual site conditions.

- Conduct sufficient Level 3 fixed-based laboratory (FBL) analyses to support confirmation of Level 2 data and to support risk-based decisions, where appropriate.

- Provide reliable data results supported by quality control measures implemented during sampling and analysis.

As a result of a phased field investigation process, specific DQOs for each phase are necessary. These phase-specific DQOs are presented in Table 3-1.

Table 3-1 Specific DQOs for OU-4 RI Sites Defense Depot Memphis, Tennessee	
Primary Fieldwork DQOs[1]	Optional Fieldwork DQOs[2]
Conduct proposed soil sampling at RI sites to evaluate the magnitude of a contaminant release as a result of historical site activities. Collect sufficient data to support a statistical-based data comparison and to support a baseline risk assessment. A minimum of nine samples are necessary at each site for each exposure pathway to define the mean concentration at 95 percent confidence. Collect data to support the IRA evaluation.	Collect groundwater data upgradient and downgradient of the site to assess whether a release to groundwater as a result of site activity has occurred. Install additional soil borings to collect additional data, if necessary, to characterize the horizontal and vertical extent of contamination.

[1]DQOs that are achieved using the primary sampling activities presented in Section 4 of this FSP.
[2]DQOs applicable if a potential contaminant release to groundwater has been identified or if contaminants in soil media are not evaluated during the primary field activities.

Notes:

DQOs = data quality objectives

RI = Remedial Investigation

IRA = Interim Remedial Action

3.3 Data Comparisons

The primary fieldwork of this investigation consists of monitoring well installation, groundwater sampling and analysis, measurement of aquifer characteristics, and surface and subsurface soil sampling and analysis. The data will be collected at locations identified in Section 4 of this report. Locations have been selected where current data show that the highest probability of contamination exists. Once the RI field investigation is under way, soil data will be collected through the use of the Level 2 data quality, which provides an expedited turnaround time. Four data comparisons will be conducted during the RI activities as part of the ongoing investigation, as follows:

- Individual data points for Level 2 data will be compared with the PRGs (Sections 3.5 and 3.6) for organic constituents. Contaminants that exceed the PRGs are considered to be representative of contamination for a site.

  For inorganic constituents, Level 2 data will be compared with the background data for each data point first, then with PRGs. (Background data are discussed in Section 3.4 of this document.) Therefore, when attempting to estimate the horizontal and vertical extent of contamination, additional soil borings may be necessary when organic constituents exceed PRGs or when inorganic constituents exceed background and PRGs.

- Level 2 data will be compared with Level 3 data to assess the data usability. This comparison will be conducted after the Level 3 data have been analyzed by the laboratory and validated. The *Generic QAPP* (ref. 15), Section 3.2.2.2, discusses the approach to assessing data quality and usability. The goal is to collect Level 2 data of sufficient quality to be used for statistics and for BRA.

- Level 2 data will be compared with removal action levels (RALs) for each data point. The RALs are discussed in Section 3.5.

- The final data comparison will be conducted after the field investigation is complete. This data comparison will use a statistical approach to compare the data for a site with PRGs and RALs. This approach is presented in Section 3.7.

3.4 Background Data

Background data for groundwater, surface water, soil (surface and subsurface), and sediment will be collected during the screening and RI fieldwork activities. The approach to collecting these data is presented in Section 5.3.2 of the *Generic RI/FS WP* (ref. 1). The background data set will be used to establish individual background data numerical criteria for each constituent of concern. The method for establishing these background data numerical criteria also is presented in Section 5.3.2 of the *Generic RI/FS WP* (ref. 1). Individual parameters for each biased sampling location will be compared with the background data set to evaluate whether a contaminant release has occurred. If the data do not exceed the background data, the site will be recommended for NFA. Only the parameters that exceed background data will be considered for further investigation using the optional field activities, surface soil samples, borings, wells, and ERs.

3.5 Preliminary Identification of Applicable or Relevant and Appropriate Requirements and Screening Preliminary Remediation Goals

3.5.1 Introduction

The purpose of this section is to summarize information used in the scoping phase of DDMT projects on issues relating to compliance with applicable or relevant and appropriate requirements (ARARs), including identification of PRGs. This information guides the development of appropriate sampling and analysis plans and removal actions or facilitates the development of a range of appropriate remedial alternatives and can focus selection on the most effective remedy. Terms used in this section are defined in Table 3-2.

Table 3-2
ARARs and PRGs Definitions
Defense Depot Memphis, Tennessee

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Term	Definition
Applicable or Relevant and Appropriate Requirements (ARARs)	"Applicable" requirements are those clean-up standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal, state, or local law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site. "Relevant and appropriate" requirements are those cleanup standards which, while not "applicable," address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. ARARs can be action-specific, location-specific, or chemical-specific.
Final Remediation Levels (FRLs)	Chemical-specific cleanup levels are documented in the Record of Decision (ROD). They may differ from preliminary remediation goals (PRGs) because of modifications resulting from consideration of various uncertainties, technical and exposure factors, as well as all nine selection-of-remedy criteria outlined in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).
Preliminary Remediation Goals (PRGs)	Initial cleanup goals that (1) are protective of human health and the environment, and (2) comply with ARARs. They are developed early in the process based on readily available information and are modified to reflect results of the baseline risk assessment. They also are used during analysis of remedial alternatives in the remedial investigation/feasibility study (RI/FS).
Risk-based PRGs	Concentration levels set at scoping for individual chemicals that correspond to a specific cancer risk level of 10^{-6} or a Hazard Quotient/Hazard Index (HQ/HI) of 1. They are generally selected when ARARs are not available.
Screening Risk-based PRGs	Conservative risk-based estimates and guidance concentrations to be used for site and pathway screening. Lower values than typically estimated after a baseline risk assessment are presented—values correspond to an HQ/HI of 0.1.
Remedial Goal Options (RGOs)	Remedial goal options are typically developed during the baseline risk assessment to present risk managers with a range of possible target FRLs.
Removal Action Levels (RALs)	Concentrations that trigger consideration of removal actions based on the potential for acute or long-term chronic effects.

The procedures for identification and evaluation of ARARs and PRGs are presented in several important sources, particularly the following:

- The National Oil and Hazardous Substances Pollution Contingency Plan (NCP), specifically 55 FR 8741-8766 for a description of ARARs, and 55 FR 8712-8715 for using ARARs as PRGs; also 53 FR 51394
- CERCLA Compliance Manuals (EPA, 1988 and 1989)
- *Risk Assessment Guidance for Superfund: Volume 1— Human Health Evaluation Manual* (Part B, Development of Risk-based Preliminary Remediation Goals) (RAGS Part B, EPA, 1991; ref. 9)

Three types of federal and state ARARs have been identified as described below:

- **Chemical-specific.** Health- or risk management-based numbers or methodologies that result in the establishment of numerical values for a given medium that would meet the NCP "threshold criteria" for overall protection of human health and the environment and compliance with ARARs. The development and presentation of these threshold criteria are a major focus during this initial phase because of their role in the development of the specific sampling plans and their use in initial data interpretation.
- **Location-specific.** Restrictions placed on the concentrations of hazardous substances or the conduct of activities solely because they are in special locations (such as wetlands)
- **Action-specific.** Usually technology- or activity-based requirements or limitations on actions taken with regard to hazardous waste

The detailed ARAR and PRG information, provided in the *Generic RI/FS WP* (ref. 1), Section 3.5, presents initial guidelines. This information does not establish that cleanup to meet these goals is warranted. As more information is obtained about all four OUs and as remedial alternatives are considered, federal and state requirements will be narrowed to those that are potential ARARs for each alternative.

3.5.2 Chemical-specific Threshold Concentrations

Threshold criteria were developed for each medium of potential concern, specifically groundwater, surface water, soil, and sediment. These criteria include ARARs-based PRGs, guidance values that are "to be considered," and screening risk-based PRGs.

The screening PRGs that were developed during this phase represent the most conservative approach to interpreting the site data. These data are intended for use in screening the sites to evaluate the appropriate disposition of the site.

The screening PRGs were developed from information provided in *RAGS Part B* (ref. 9) and guidance from EPA Region IV. Region III publishes screening PRGs, and the table is updated semiannually. Region III PRGs were used for guidance in developing the PRGs. However, the screening values for DDMT are more conservative than the Region III values. The following factors were considered and led to the development of these screening PRGs for DDMT:

- Presence of multiple contaminants
- Pathways not considered in the published values (soil-to-groundwater pathways)
- Potential ecological effects
- Appropriate land-use assumptions

Remedial goal options (RGOs), consistent with EPA Region IV guidance, will be developed during the RI process and will provide a more realistic basis for the development of final remediation levels (FRLs). A more detailed discussion of media-specific PRGs is presented in Section 3.6 of the *Generic RI/FS WP* (ref. 1).

3.5.3 Action-specific ARARs

Action-specific ARARs usually are technology- or activity-based requirements or limitations on actions taken with regard to hazardous wastes, or requirements to conduct certain actions to address particular circumstances at a site. Remedial alternatives that involve, for example, closure or discharge of dredged or fill material may be subject to ARARs under RCRA and the Clean Water Act, respectively. A detailed media-specific explanation of action-specific ARARs is presented in Section 3.5.3 of the *Generic RI/FS WP* (ref. 1).

3.5.4 Location-specific ARARs

Location-specific ARARs generally are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in special locations. Some examples of special locations include floodplains, wetlands, historic places, and sensitive ecosystems or habitats. Discussions with TDEC, Division of Solid Waste Management, have indicated that the state is not aware of any natural resources for which it acts as a trustee that are potentially threatened or damaged as a result of past or current waste disposal practices conducted at DDMT. Furthermore, a search for possible location-specific ARARs was conducted during the 1990 RI activities (ref. 5), and no federal, state, or local natural resources were found to be near the site. Before the completion of the final RI/FS report(s), a CERCLA 104B.2 Notification Form will be submitted to the Department of Interior (DOI) by DDMT to evaluate whether the DOI is a trustee of any natural resources that may be threatened by a release of hazardous substances from the site.

3.6 Risk-based Preliminary Remediation Goals

The PRGs developed for use in DDMT work plans are designed to be protective using conservative assumptions. In this way, they may be used for screening sites where a focused investigation is conducted to select locations that represent "worst-case conditions," and decisionmakers can be confident that chemicals reported below these concentrations would result in acceptable risks at the site after a BRA. For risk-based PRGs, the following general assumptions are used:

- Residential land use
- Target risk level (TRL) of 10^{-6}; target hazard index (THI) of 0.1

The current land use is industrial, and many areas of the facility are located where worker exposures would be relatively infrequent. Risk estimates based on the TRL of 10^{-6} or THI of 0.1 would be protective if several chemicals were present below the specified concentrations. However, under conditions where 10 or more chemicals were reported, additional review would be required. More detailed information regarding PRG development and calculations can be found in Section 3.6 of the *Generic RI/FS WP* (ref. 1).

3.7 Statistical Data Comparison

If a biased sample (assumed to represent a potential "hot spot" or high-concentration location) shows concentrations exceeding the conservative screening PRGs (but below the RAL), it is possible that the average concentration over the designated exposure area may not represent a potential for adverse effects. Statistical sampling and comparison of estimates of the average concentration would meet requirements to demonstrate acceptable risk-based levels.

The exposure concentrations used in risk assessments reflect the arithmetic average of the concentration that would be contacted over the exposure period. Although this concentration may not reflect the maximum concentration that could be contacted at any one time, it is regarded as a reasonable estimate of the concentration likely to be contacted over time, because it is not reasonable to assume long-term contact with the maximum concentration. Provided that no hot spots (areas of high concentration relative to other areas of the site or elevated above an RAL) are identified, risk estimates are based on the average concentration (EPA *RAGS*, 1989; ref. 19). However, because of the uncertainty associated with any estimate of soil concentration, the 95 percent upper confidence limit (UCL95) of the arithmetic average is used for this estimate. The PRGs are based on the average exposure below the estimated concentration; therefore, these would also be compared with a statistical estimate of the average.

This method is also documented in EPA guidance for statistical comparisons. For example, methods for testing whether soil chemical concentrations at a site are statistically below a cleanup standard or ARAR are presented in *Methods for Evaluating the Attainment of Cleanup Standards, Volume I: Soils and Solid Media* (ref. 20). Several approaches are identified, including comparison of a calculated UCL95 of the mean with the target concentrations.

3.7.1 Statistically Based Samples

Surface soil samples will be collected at each site. A total of nine is the recommended minimum because it is the smallest number of samples that can be used in an estimate of the average concentration to be used in a UCL95 calculation without defaulting to the maximum detected concentration. Nine samples provide information on the chemical distribution of the contamination. The average is used to calculate a UCL95, which gives the upper confidence limit of a data set a 95 percent confidence.

The objective of the sampling program is to allow a set of discrete samples collected from a site to be generalized to the entire site. This form of systematic (probabilistic) sampling is proposed to assist in reaching conclusions about a site as efficiently as possible, while maintaining a degree of confidence that the site has been effectively sampled.

4.0 Sampling Plan

4.1 Objectives

Samples will be collected from surface soils and soil borings to characterize the horizontal and vertical extent of soil contamination that may have been caused by a release from Site 57. Soil samples will be collected and analyzed in accordance with the procedures outlined in the *Generic QAPP* (ref. 15). Upon completion, soil borings will be grouted in accordance with the procedures outlined in the *Generic QAPP*.

The objectives of the groundwater investigation are to achieve a better understanding of the Fluvial Aquifer characteristics including the direction and velocity of groundwater flow, the horizontal and vertical extent of groundwater contamination, the distribution of contaminant concentrations, and the degree of interconnection between the Fluvial and Memphis Sand aquifers. To achieve these objectives, groundwater samples will be collected from new and existing monitoring wells to assess groundwater quality that meets the following criteria:

- Flows onto DDMT from offsite
- Indicated the presence of contaminants in the past
- Is upgradient of known contamination
- Is associated with Site 57

Samples will be collected and analyzed in accordance with the procedures outlined in the *Generic QAPP* (ref. 15). Water level measurements will be performed on all wells and data obtained will be used to characterize the potentiometric surface of the Fluvial Aquifer.

4.2 Site 57: Building 629

4.2.1 Site Description and History

Site 57 (Building 629 spill area) is the former hazardous materials storage building that has been used to store dichlorodiphenyltrichloroethane (DDT), herbicides, solvents, oxidizers, and other toxic and corrosive materials. Past spills may have occurred in this area, including a documented spill of an unknown amount of hydrofluoric acid. Site 57 contains a rail-loading dock approximately 125 feet long, located near the southwestern corner of Building 629, where pesticides, polynuclear aromatic hydrocarbons (PAHs), and volatile organic compounds (VOCs) were detected during the previous RI (ref. 5).

4.2.2 Existing Data

Sampling data for OU-4 were collected during 1990 (ref. 5) and during ESE's groundwater monitoring field effort (ref. 2). Details of the chemical analyses are provided in Appendix B. Four surface soil samples (less than 0.5 foot bls) were taken around Site 57 (Building 629) in areas where past spills may have occurred (see Figure 4-1). PAH contamination and pesticides (including 1,1,1-dichloro-2,2-bis(4-chlorophenyl)ethylene [DDE], DDT, dieldrin, methoxychlor, gamma-chlordane, and beta-hexachlorocyclohexane [beta-BHC]) were detected in all four samples. Toluene also was detected at low concentrations in all four samples, while 1,1,2-trichloroethane, tetrachloroethene, and trichloroethene (TCE) were detected in one of the samples. The metal contaminants—arsenic, lead, mercury, barium, cadmium, chromium, copper, and zinc—were present in at least three of the four surface soil samples. Soil sample results are summarized in Appendix B.

Groundwater samples were collected from monitoring wells MW-39, MW-38, MW-17, MW-19, and MW-20, which are screened in the Fluvial Aquifer (see Figure 2-3). Analytical results detected tetrachloroethene and TCE in MW-39. Acetone, a common laboratory contaminant and a degradation product of decontamination solvent, was detected in MW-17 and 20, as well as in the upgradient well (MW-16). Phthalates, which are common sampling contaminants, also were detected in all of the wells except MW-38. Groundwater sample results are summarized in Appendix B.

Subsequent sections of this FSP describe the sampling strategy and future sampling activities proposed for Site 57.

4.2.3 Soil Sample Location and Rationale

Sampling locations at Site 57 were evaluated and selected by the following methods:

- Loading and Unloading Area—The potential exists for releases as a result of spills at loading and unloading areas.

- Storage Locations—The potential exists for release from leaking and damaged containers at storage areas.

- Historical Information (e.g., recorded spills, results from previous investigations)—The potential exists for contamination at historical spill locations or is indicated using results from previous investigations.

- Site Topography and Drainage Pathways—Storm water contacting industrial activities can become contaminated. Also, contamination as a result of spills flows naturally through drainage pathways.

Sampling locations are subject to slight changes according to field screening results and field observations such as vegetative stress and noticeable staining. This approach is consistent with DDMT's overall approach to evaluating worst-case scenarios and to selecting "biased" sample locations at Site 57.

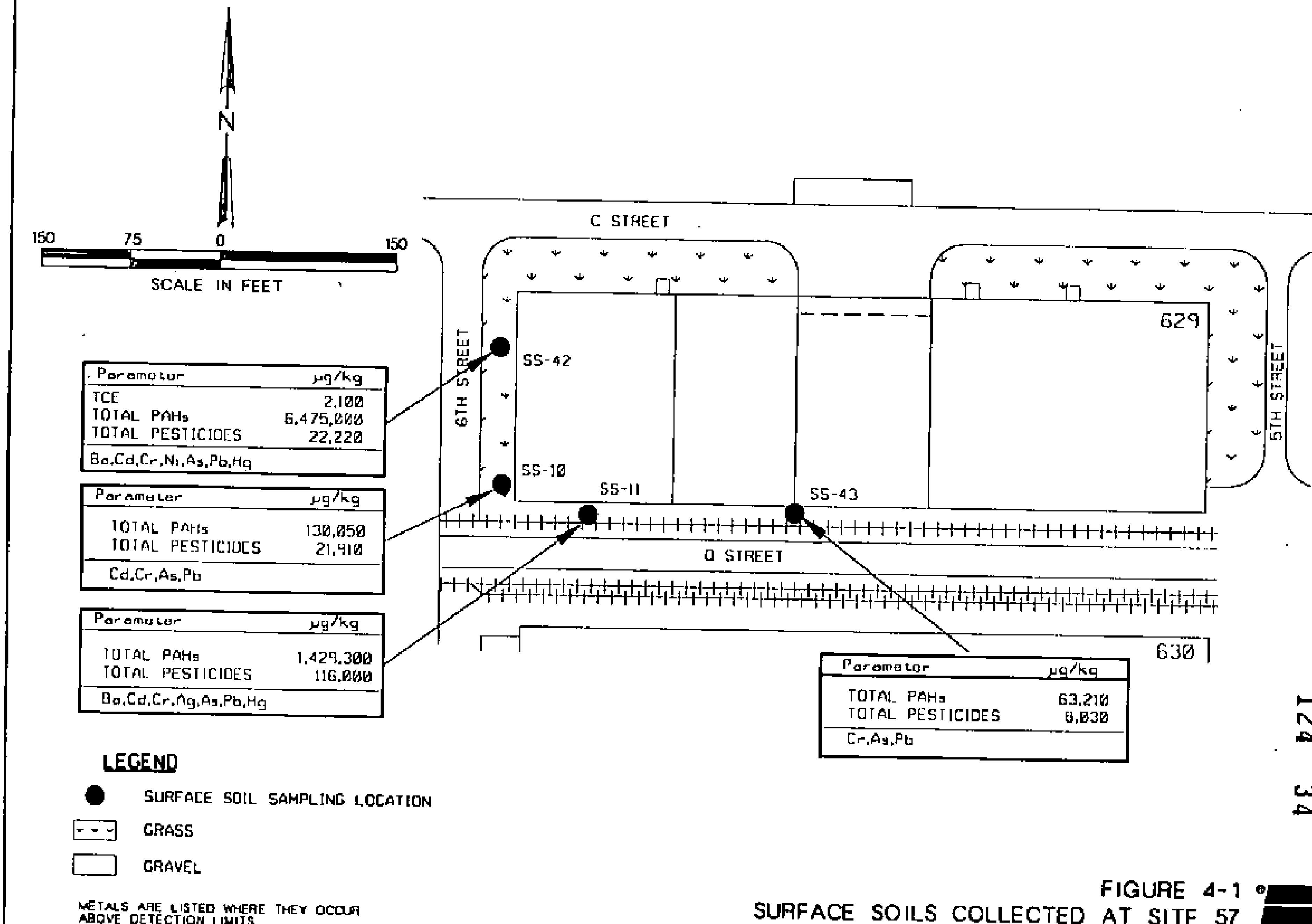

FIGURE 4-1
SURFACE SOILS COLLECTED AT SITE 57
WITH RESULTS EXCEEDING PRGs
Defense Depot Memphis, Tennessee

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4.2.4 Potential Contaminants of Concern

Review of the site history and the previous sampling analytical results indicates that the potential contaminants of concern (PCOCs) for Site 57 are VOCs, semivolatile organic compounds (SVOCs), PAHs, metals, and pesticides..

4.2.5 Soil Sampling and Analysis

Nine shallow boreholes are initially proposed along the perimeter of Site 57 to determine contaminant concentrations in shallow soil in a manner that satisfies the DQO identified in Table 3.1. Shallow boreholes are positioned in areas identified by the criteria provided in Section 4.2.3 (see Figure 4-2) and sampled at 2, 5, and 10 feet (or as otherwise directed by the field engineer or hydrogeologist) for field screening of PAHs, VOCs, SVOCs, metals, and pesticides (Level 2 analyses). Shallow borings are appropriate at this site because releases from Building 57 were at the surface. Up to six additional borings may be installed based on the results of the initial nine borings. The location and depth of these borings will be based on the results of the field screening analyses. Ten percent of the surface soil samples will also be analyzed for Level 3 data quality to conduct the data comparisons defined in Section 3.3 of this work plan.

4.2.6 Groundwater Sampling and Analysis

Two groundwater samples will be obtained from the Fluvial Aquifer to characterize groundwater contamination that may have been caused by a release from Site 57 and to further define the potentiometric surface. A monitoring well will be installed south of MW-34 to characterize Fluvial Aquifer groundwater quality from other potential sources in OU-4 (well U in Figure 4-4). From information collected to date, it appears that this well also will be used to evaluate groundwater downgradient of OUs-2 and 3. This monitoring well, along with other Fluvial Aquifer monitoring wells, will be used to characterize the extent of the suspected area of hydraulic interconnection between the two aquifers.

On the basis of the information obtained from the groundwater investigation, the feasibility of installing an additional deep well, screened in the Memphis Sand Aquifer, will be evaluated. This decision will take into account the following:

- Nature and extent of contamination at Site 57
- Nature and extent of contamination in the Fluvial Aquifer
- Potential hydraulic interconnection between the two aquifers
- Topography of the top of the confining clay bed
- Geotechnical properties of the confining clay bed

Existing monitoring wells MW-18, MW-19, MW-20, MW-27, MW-34, MW-38, and MW-39 will be sampled according to procedures outlined in the *Generic QAPP* (ref. 15), Section 5.4. Locations of the existing monitoring wells are shown in Figure 4-3. Groundwater samples will be screened for VOCs, SVOCs, unfiltered metals, and pesticides. The

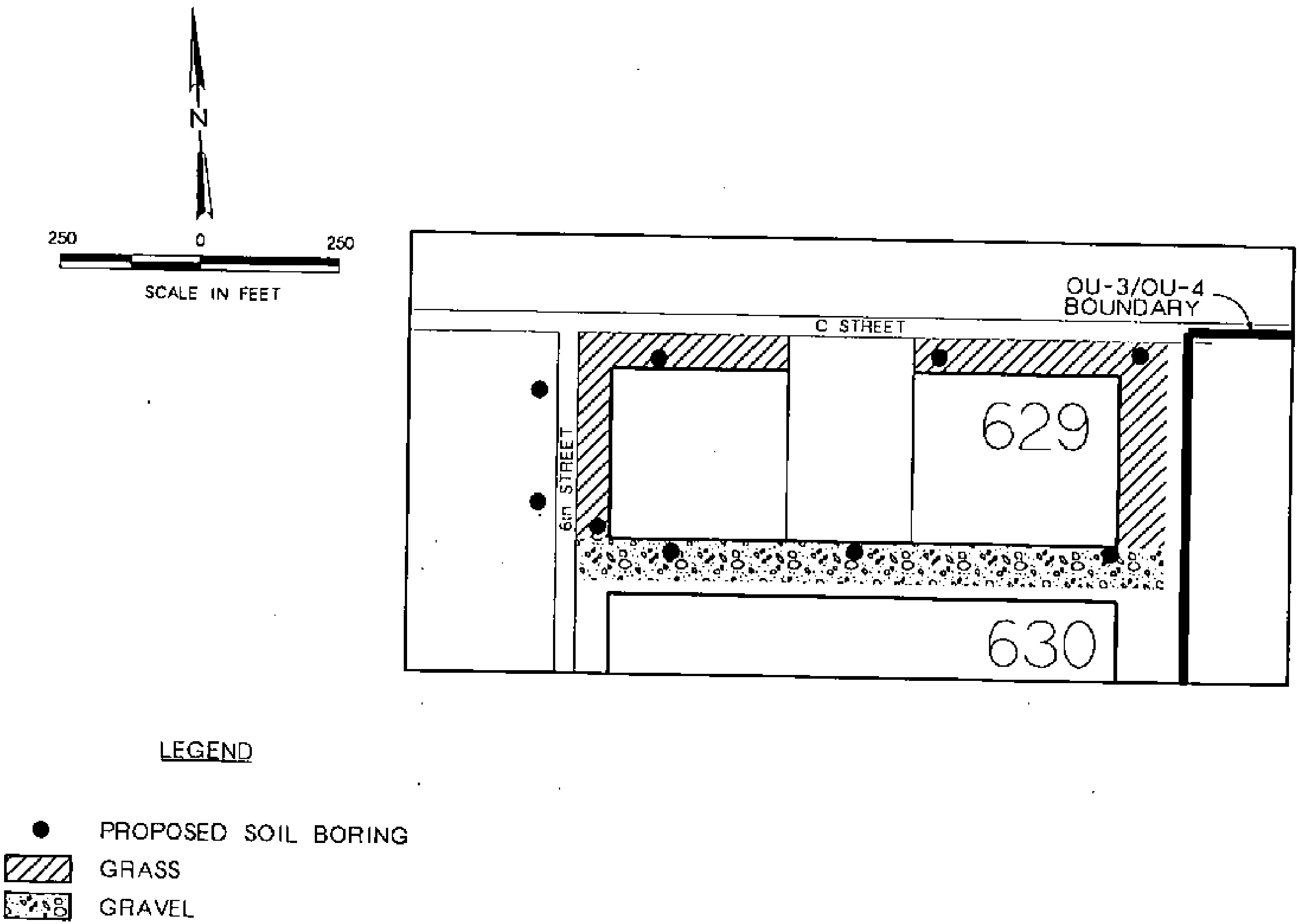

FIGURE 4-2
PROPOSED SAMPLING LOCATIONS OU-4, SITE 57
Defense Depot Memphis, Tennessee

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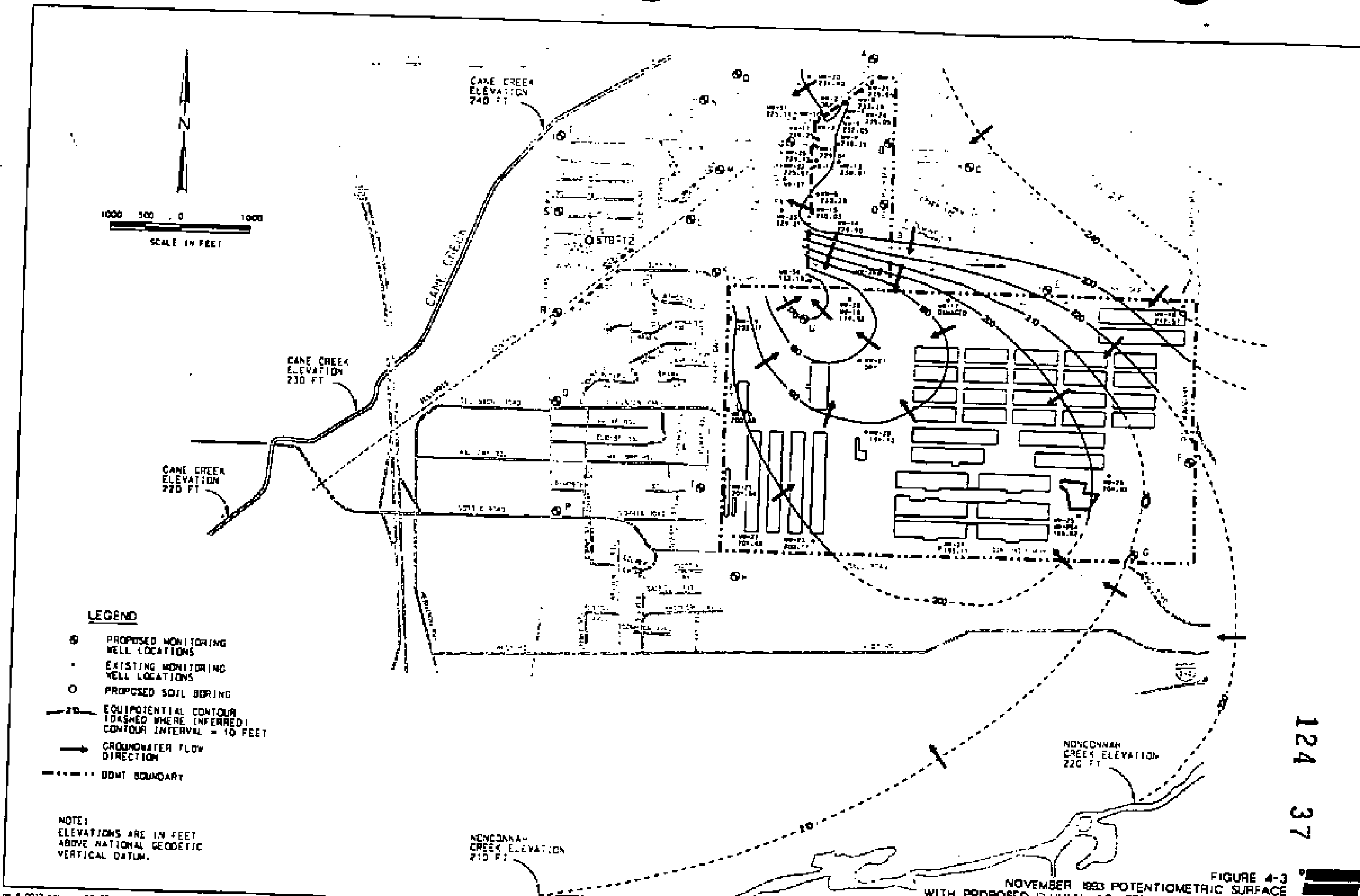

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FIGURE 4-3
NOVEMBER 1993 POTENTIOMETRIC SURFACE
WITH PROPOSED FLUVIAL AQUIFER MONITORING WELLS
Defense Depot Memphis, Tennessee

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groundwater samples collected will be analyzed and reported by the offsite laboratory using Level 3 QC requirements.

4.3 Facilitywide Groundwater Investigation

4.3.1 Strategy Summary

The goal of the groundwater investigation is to achieve a better understanding of the Fluvial Aquifer characteristics, the contamination within it, and the degree of interconnection between the Fluvial and Memphis Sand aquifers. The overall objectives to meet this goal include the following:

- Prepare a current potentiometric map for the Fluvial Aquifer, based on existing and additional monitoring well locations.
- Assess groundwater quality flowing onto the facility.
- Evaluate the nature and extent of the contamination plume beneath Dunn Field and offsite to the west.
- Assess the potential hydraulic interconnection between the Fluvial Aquifer and the deeper Memphis Sand Aquifer.

As part of the groundwater quality assessment at DDMT, this FSP includes the installation of as many as 21 new wells (A through U, see Figure 4-3) and the replacement of one existing well as described in Section 4.3.3. Nine of these wells will be placed around DDMT's perimeter, six will be placed outside of DDMT's property west of Dunn Field, five optional wells will be placed farther west (along Elvis Presley Boulevard or at other locations if appropriate), and a final well will be placed in the suspected area of hydraulic interconnection between the Fluvial Aquifer and the deeper Memphis Sand Aquifer.

Fluvial Aquifer wells will be screened just above the Jackson Formation/Upper Claiborne Group, which serves as the confining layer of the Memphis Sand Aquifer and the base of the Fluvial Aquifer. Groundwater near the base of the Fluvial Aquifer will be monitored because many of the detected organic compounds are characteristic of dissolved constituents of dense non-aqueous phase liquid (DNAPL), which are likely to accumulate at the top of the low permeability clay and present a source of dissolved organic compounds near the base of the Fluvial Aquifer. Drilling to the top of the Jackson Formation/Upper Claiborne Group also provides information on the elevation of the top of the confining layer as well as a lithologic description of the entire fluvial sequence.

For information about proposed monitoring wells associated with a specific site, refer to the OU-specific FSP for that site. Currently, known groundwater contamination at Dunn Field is being addressed through an IRA, which includes the proposed installation of a recovery well for testing purposes. A technical memorandum will be issued describing the drilling and testing of the recovery well, with interpretation of results, and providing recommendations for location, construction, spacing, and pumping rates for additional recovery wells.

4.3.2 Existing Data

MWs-3 through 15, MW-28, MW-29, and MWs-30 through 35 are located in Dunn Field and screened within the Fluvial Aquifer. VOCs and metals have been detected in the groundwater in MWs-3 through 13, MW-29, MW-35, MW-31, and MW-32 during the previous RI (ref. 5) and during investigations conducted by ESE (ref. 2). Table 4-1 presents the maximum concentration of contaminants found in Dunn Field groundwater samples. Previous sampling activities also indicate the presence of VOCs and metals in Main Installation wells MW-21, MW-22, MW-25, and MW-26. Refer to Appendix B for complete sampling data. Tables 4-2 and 4-3 show comparisons of existing data with ARARs and PRGs.

4.3.3 Monitoring Well Location and Rationale

Figure 4-3 illustrates the locations of proposed monitoring wells addressed in this FSP, as well as the potentiometric contours of the Fluvial Aquifer in November 1993. Proposed locations are in the general area of placement; the exact placement of wells depends on a field check to ensure accessibility and absence of overhead or underground barriers such as power lines, underground cables, water lines, or other obstructions. Proposed monitoring wells have not yet been numbered to allow for greater flexibility in placement, addition, or deletion of any wells. Proposed wells are lettered in Figure 4-3 for convenience in discussion. The proposed wells will be numbered by the field team leader (FTL) in a manner consistent with standard well numbering practices at DDMT.

Wells A through E, when used with existing wells, have been placed to aid in the revision of the potentiometric surface map and to assess groundwater quality flowing onto the facility. Their positions were chosen to fill voids in water quality and water level data. Wells F, G, H, and I are upgradient from MW-26, MW-25, MW-22, and MW-21, respectively. As discussed in Section 4.3.2, these existing wells have indicated the presence of VOCs and metals in the past. Wells F, G, H, and I will therefore be useful in characterizing contamination associated with the existing monitoring wells, assessing groundwater quality flowing onto the facility, and providing the water level data necessary to update the potentiometric surface map.

Wells J through T have been placed to aid in delineation of the nature and extent of the contamination plume west of Dunn Field and to provide water level data necessary to update the potentiometric surface map. Wells K, L, and M will be installed first, with wells A through H installed next. Chemical analyses from Wells K, L, and M will be evaluated during the installation of Wells A through H, and a round of water level readings will be taken from new and existing wells. The chemical data will be used to evaluate whether the contamination is bound on the western side of the plume. The water level data will be used to revise the potentiometric surface map. A critical component of this investigation is that the need for the next proposed well is constantly reevaluated as new data are obtained from the last well that was drilled.

Table 4-1
Maximum Concentration of Contaminants Found in Dunn Field Groundwater
Defense Depot Memphis, Tennessee

Constituent	MCL (µg/L)	Highest Level Detected During 1990 RI (µg/L)/(location)
Volatile Organic Compounds		
1,1-Dichloroethylene	7	160 (MW-10)
1,2-Dichloroethylene (total)	70	520 (MW-11)
tetrachloroethylene	5	240 (MW-10)
trichloroethylene	5	5,100 (MW-12)
carbon tetrachloride	5	77 (MW-6)
Metals		
arsenic	50	210 (MW-14)
barium	2,000	3,740 (MW-14)
chromium	100	1,240 (MW-7)
lead	15[a]	1,000 (MW-10)
nickel	100	602 (MW-7)

[a]Action Level

Notes:

MCL = Maximum Contaminant Level
µg/L = micrograms per liter
MW = monitoring well

Source: Engineering Science, 1994. *Focused Feasibility Study: Dunn Field*

Table 4-2
Comparison of Parameters Detected with ARARs and PRGs
OU-4, Site 57, Groundwater
Defense Depot Memphis, Tennessee

Parameter	Maximum Concentration Detected (mg/L)	MWs[a] w/Contaminants Detected	Risk based PRGs[b,c] (mg/L)	ARAR-based PRGs	
				MCLs[d] (mg/L)	TN Guidance Levels (mg/L)
Anthracene	0.00184	39	1.095	N/A	N/A
Benzo(a)anthracene	3.5E-05	39,38	1.17E-04	N/A	N/A
Benzo(a)pyrene	4.6E-05	39,38,20	1.17E-05	0.0002	N/A
Benzo(b)fluoranthene	6.3E-05	39,38,19,17	1.17E-04	N/A	N/A
Benzo(g,h,i)perylene	9.3E-05	39	N/A	N/A	N/A
Benzo(k)fluoranthene	2.9E-05	39,38,19	0.001	N/A	N/A
Chrysene	1.27E-04	39	0.012	N/A	N/A
Dibenzo(a,h)anthracene	5.0E-06	39	1.17E-05	N/A	N/A
Fluoranthene	7.5E-05	39,38,20,19,16	1.25E-04	N/A	N/A
Indeno(1,2,3-cd)pyrene	2.0E-05	39,16	1.17E-04	N/A	N/A
Naphthalene	0.0012	17,19	0.146	N/A	0.025
Phenanthrene	1.58E-04	39	N/A	N/A	N/A
Phenol	0.0059	38,39,20,16	2.19	N/A	3.50
Pyrene	1.66E-04	39	0.11	N/A	N/A
Tetrachloroethene	0.00239	39	0.001	0.005	0.008
Trichloroethene	0.00353	39,38,16	0.004	0.005	0.005
Aluminum	120.0	20,39,38,19,16	N/A	N/A	N/A
Arsenic	0.0062	16,20,39	4.87E-05	0.050	0.05
Barium	0.567	39,20,38,39,16	0.256	2.0	1.0
Soluble Barium	0.112	19,20,39,16	0.256	2.0	1.0
Cadmium	0.008	17,19	0.002	0.005	0.01
Chromium[d]	0.191	20,38,39,19,16	0.018	0.1	0.05
Cobalt	0.0632	19,17	N/A	N/A	N/A
Copper	0.314	20,38,39,19,16	0.135	1.30	1.0
Lead	0.0852	20,38,39,19,16	N/A	0.015	0.050
Soluble Lead	0.0023	39	N/A	0.015	0.050
Mercury	6.6E-04	19,17	0.001	0.002	0.002
Nickel	0.040	20,16	0.073	0.1	0.0134
Zinc	0.321	20,38,39,19,16	1.095	N/A	5.0

[a] For MW locations, refer to Figure 2-4. First MW location reported = MW location of maximum concentration.
[b] PRGs are based on standard exposure assumptions for ingestion, inhalation, and dermal contact, following RAGS Supplemental Guidance, OSWER Directive 9285.6-03. Values developed by U.S. EPA Region IX Technical Memorandum (August 6, 1993).
[c] A risk assessment will be performed before finalizing these PRGs.
[d] State of TN Guidance levels and maximum concentration detected values are for total chromium.
Note: N/A = not available

Table 4-3
Comparison of Parameters with PRGs
OU-4, Site 57, Soil
Defense Depot Memphis, Tennessee

Parameter	Maximum Concentration Detected (mg/L)	Surface Soil Samples[a] Detected	PRG[b] (mg/L)
Trichloroethene	2.1	42	2.77
Dibenzofuran	24	42,43,10,11	163
2-Methylnaphthalene	2	11,10	N/A
Acenapthene	64	42,43,10,11	2430
Anthracene	130	42,43,10,11	12200
Benzo(a)anthracene	970	42,43,10,11	0.13
Benzo(a)pyrene	450	42,43,10,11	0.013
Benzo(k)fluoranthene	450	42,43,10,11	5.55
Benzo(b)fluoranthene	540	42,43,10,11	0.13
Benzo(g,h,i)perylene	360	42,43,10,11	N/A
Chrysene	620	42,43,10,11	55.5
Dibenzo(a,h)anthracene	160	42,43,10,11	0.013
Fluoranthene	860	42,43,10,11	1630
Fluorene	47	42,43,10,11	1620
Indeno (1,2,3-cd) pyrene	310	42,43,10,11	0.555
Naphthalene	4.6	11,10,43	1610
Phenanthrene	620	42,43,10,11	N/A
Pyrene	870	42,43,10,11	1220
4,4'-DDD	3.6	11,10,42,43	0.395
4,4'-DDE	39	11,42,43,10	0.279
4,4'-DDT	5.9	11,42,43,10	0.279
Chlordane	4.4	10	0.0729
Methoxychlor	1.5	42	203
Heptachlor	0.12	10	0.0211
Heptachlor Epoxide	0.25	10	0.0104
Arsenic	26	43,42,11,10	0.231
Barium	343	11,42	12200
Cadmium	11.8	42,11,10	174
Chromium[c]	135	11,42,43,10	868
Lead	1680	11,42,43,10	N/A
Mercury	1.3	42,11	52.1
Nickel	367	42	3470
Silver	9.0	11	868

[a] For sample locations, refer to Figure 4-1.
[b] PRGs are based on standard exposure assumptions for ingestion, inhalation, and dermal contact following RAGS Supplemental Guidance, OSWER Directive 9285.6-03. Values developed by U.S. EPA Region IX Technical Memorandum (August 6, 1993).
[c] Maximum concentration detected values are for total chromium.

Note:
N/A = not available

A final well, Well U, will be placed in the area of suspected hydraulic interconnection (water table low) between the Fluvial Aquifer and the deeper Memphis Sand Aquifer. The purpose of Well U is to assess stratigraphy and groundwater quality in the immediate vicinity of the area of suspected hydraulic interconnection. The absence or presence and elevation of the Jackson Formation/Upper Claiborne Group at this location also will be evaluated. Evaluation of both water quality and stratigraphy at this location is intended to provide critical information concerning the probability of DDMT activities affecting the Memphis Sand Aquifer. Exact placement of this final well will depend on groundwater elevation data from the other wells. In general, the well is expected to be placed in OU-4 near the southwestern corner of OU-1.

The proposed deeper Memphis Sand Aquifer well, discussed in Section 4.6, may be installed if Well U does not encounter the Jackson Formation/Upper Claiborne Group or if the groundwater is found to be contaminated at Well U. Corps of Engineers/Huntsville (CEHND), DDMT, EPA, TDEC, and U.S. Geological Survey (USGS) are requested to be present when drilling Well U. Written permission must be provided by the Commander of DDMT prior to installation of this well.

4.3.4 Stratigraphic Test Borings

A stratigraphic test boring (STB-12, see Figure 4-3) will be completed through the Fluvial Aquifer to the top of the Jackson/Upper Claiborne confining unit prior to installation of the wells discussed in Section 4.3.3. The purpose of the boring is to assist in well installation by identifying stratigraphic features of the area and to characterize the offsite fluvial system for potential contamination and geotechnical parameters. Three samples will be taken and analyzed for screening Level 2 VOCs, SVOCs, TAL metals, and PCBs/pesticides: one from the surface, one within the saturated zone, and another based on the results of field screening and visual inspection of the core. A Shelby tube sample will also be taken from the Jackson/Upper Claiborne confining unit and analyzed for all geotechnical parameters identified in Section 5.4.2.5 of the *Generic QAPP* (Ref. 15), including triaxial permeability, as well as total organic carbon (TOC) (EPA Method 415.1), cation exchange capacity (SW-846 Method 9080), pH (SW-846 Method 9045), and alkalinity (EPA Method 310.1M).

4.3.5 Potential Contaminants of Concern

Previous investigations of the groundwater in the vicinity of or upgradient to the proposed wells indicate the presence of VOCs and metals. Therefore, the PCOCs for this portion of the investigation are VOCs, metals, and pesticides.

4.3.6 Groundwater Sampling and Analysis

The existing monitoring wells and analytical parameters selected for evaluation (see Figure 4-4) are presented in Table 4-4. Well-specific analytical parameters were based on a review of existing groundwater data (ref. 2; ref. 5). Additionally, eight of the wells (MW-3, MW-6, MW-8, MW-13, MW-14, MW-32, MW-34, and MW-36) will be analyzed to collect data for the evaluation of alternatives and to assess the risk of contamination associated with the facility. The additional analytical parameters include TOC, sulfate, nitrate/nitrite, chlorides, ammonia, and iron. The eight wells were selected because of their location around OU-1, which will allow for a systematic sampling approach. Proposed monitoring wells A through J will be analyzed for TCL/TAL constituents to provide a comprehensive analysis of potential contaminants coming on to the facility (i.e., upgradient, background locations). Monitoring wells K through U will be analyzed for VOCs and metals to determine the western extent of groundwater contamination.

4.3.7 Geotechnical Sampling and Analysis

At each proposed fluvial well, a sample will be selected from the saturated portion of the Fluvial Aquifer and analyzed for grain-size distribution, Atterberg limits, and moisture content following sampling and geotechnical methods presented in Section 5.4.2.5 of the *Generic QAPP* (ref. 15). The sampling interval will be selected by the geologist in the field. Proposed fluvial wells O, K, I, D, and B (see Figure 4-3) will be sampled and analyzed for additional transport parameters from the fluvial aquifer and additional geotechnical parameters from the Jackson/Upper Claiborne confining unit. At each of these five wells, the Fluvial Aquifer geotechnical samples will also be characterized for TOC (EPA Method 415.1), cation exchange capacity (SW-846 Method 9081), pH (SW-846 Method 9045), and alkalinity (EPA Method 310.1M) to support qualitative and quantitative assessments of contaminant fate and transport. A Shelby tube sample will also be taken from the Jackson/Upper Claiborne confining unit at each of the same five wells and analyzed for all geotechnical parameters identified in Section 5.4.2.5 of the *Generic QAPP* (ref. 15), including triaxial permeability, as well as TOC (EPA Method 415.1), cation exchange capacity (SW-846 method 9081), pH (SW-846 Method 9045), and alkalinity (EPA Method 310.1M). Permeability data will be used to evaluate the potential for groundwater flow from the Alluvial Aquifer to the Memphis Sand Aquifer through the clay confining unit. The open wellbore within the Jackson/Upper Claiborne confining unit will be plugged with high solids bentonite grout to the base of the silt trap.

4.3.8 Hydraulic Conductivity

The hydraulic conductivity of the water-bearing zone in which each monitoring well is screened will be estimated using a rising-head pneumatic slug test method. This slug test method will allow testing to be performed quickly, and the nearly instantaneous removal of the pneumatic slug will eliminate much of the noise in the very-early-time data that is often present in manual slug test methods performed in transmissive aquifers. It is anticipated that

Table 4-4
Monitoring Wells and Analytical Parameters Selected for Semi-Annual Assessment
Defense Depot Memphis, Tennessee

Location	Monitoring Well	VOCs	SVOCs	Total Metals
Dunn Field	2	-	-	X
Dunn Field	3	X	-	X
Dunn Field	4	X	-	X
Dunn Field	5	X	-	X
Dunn Field	6	X	X	X
Dunn Field	7	X	X	X
Dunn Field	8	X	-	X
Dunn Field	9	X	-	X
Dunn Field	10	X	-	X
Dunn Field	11	X	-	X
Dunn Field	12	X	-	X
Dunn Field	13	X	X	X
Dunn Field	14	-	X	X
Dunn Field	15	X	-	X
Dunn Field	28	-	-	X
Dunn Field	29	X	X	X
Dunn Field	30	-	X	X
Dunn Field	31	X	X	X
Dunn Field	32	X	-	X
Dunn Field	33	-	-	X
Dunn Field	34	-	-	X
Dunn Field	35	X	X	X
Dunn Field	36	-	-	X
Dunn Field	37	-	-	X
Main Installation	17	X	-	X
Main Installation	19	X	-	X
Main Installation	20	X	-	X
Main Installation	21	X	-	X
Main Installation	22	X	-	X

Table 4-4
Monitoring Wells and Analytical Parameters Selected for Semi-Annual Assessment
Defense Depot Memphis, Tennessee

Location	Monitoring Well	VOCs	SVOCs	Total Metals
Main Installation	23	X	-	X
Main Installation	24	X	X	X
Main Installation	25	X	-	X
Main Installation	26	X	-	X
Main Installation	38	X	X	X
Main Installation	39	X	-	X

Notes:
X = Sample will be collected for the listed parameter
- = No sample required

the data will be analyzed using the method of Bouwer and Rice (ref. 18); however, other methods may be applicable depending on the nature of the hydrogeologic system.

4.3.9 Monitoring Well Abandonment

Based on information provided by DDMT and CEHND, MW-17, located in the north central portion of OU-4 (see Figure 4-3). has been damaged and may no longer be usable. As part of the OU-4 field activities, this well will be inspected and, if necessary, plugged and abandoned in accordance with American Society for Testing and Materials (ASTM) D 5299 and TDEC requirements. A new well will be drilled to replace it.

4.4 Fluvial Aquifer Monitoring Well Installation

4.4.1 Soil Sampling

As discussed in Section 4.3.1, each monitoring well boring will be drilled to the top of the Jackson Formation/Upper Claiborne Group. Soil samples will be collected at 5-foot intervals from each soil boring for visual classification. The samples will be collected on the basis of field screening and at the discretion of the field geologist. Selected soil samples also will be submitted for geotechnical analysis as discussed in Section 4.3.6. Refer to the *Generic QAPP* (ref. 15), Section 5.4, for soil sample analyses.

4.4.2 Well Design

Well and screen placement depths will be developed according to site-specific field conditions and will be determined by the onsite field geologist. Refer to the *Generic QAPP* (ref. 15), Section 5.4.1, for Fluvial Aquifer monitoring well design and construction details.

The depth of these wells is approximately 100 to 150 feet, based on data from previous studies. A 10-foot polyvinyl chloride (PVC) screen will be placed at or near the base of the Fluvial Aquifer. Risers used in the construction of the wells will be PVC. However, if DNAPL or elevated concentrations of VOCs are observed, stainless steel will be considered as the well construction material. Figure 4-3 shows the general locations proposed for the installation of these wells. Monitoring wells will be numbered by the FTL during field operations to allow greater flexibility in placing wells as more information is obtained.

4.4.3 Monitoring Well Development

The new monitoring wells will be developed in accordance with the procedures outlined in the *Generic QAPP* (ref. 15), Section 5.1.2. In addition to the new wells installed at OU-4, all existing monitoring wells at DDMT will be purged in accordance with the procedures outlined in the *Generic QAPP* (ref. 15), Section 5.4.2.7.

4.5 Quarterly Monitoring of Groundwater Levels

Groundwater levels will be measured in all DDMT wells both onsite and offsite for the first year. The purpose of this quarterly monitoring will be to evaluate levels of groundwater fluctuation in the wells and to further define the direction of groundwater flow. Water levels will be measured using standard measuring techniques described in the *Generic QAPP* (ref. 15), Section 5.1.2. If the fluctuation is not significant, measurements may be conducted semi-annually after the first year.

4.6 Memphis Sand Aquifer Monitoring Well Installation and Sampling

The following task is tentatively described, but installation will depend on the evaluation of offsite and OU-4 investigations. The confining unit clay will be drilled through only after provision of a written directive from the regulatory agencies to the Commander of DDMT.

4.6.1 Purpose

The intent of a deep aquifer well will be to evaluate Memphis Sand Aquifer groundwater quality downgradient from the area of suspected hydraulic interconnection between the Fluvial Aquifer and the Memphis Sand Aquifer.

One of two criteria may be used to decide if the Memphis Sand Aquifer well is needed. It will be installed under the following conditions:

- If Well U is contaminated; or

- If no Jackson Formation/Upper Claiborne Group is encountered in drilling well U, it may be completed as a Memphis Sand Aquifer well.

The location of this monitoring well will be established after the extent of the suspected area of hydraulic interconnection between the Fluvial and Memphis Sand Aquifers has been evaluated by the installation of monitoring wells west of Dunn Field and at OU-4 (as outlined in this FSP). This well will be located next to a Fluvial Aquifer monitoring well, so that a nested well pair within the suspected area can be established between the two aquifers.

Two scenarios will develop when drilling begins, which are that the Jackson Formation/Upper Claiborne Group will be encountered or it will not. In the first instance, when the clay is encountered, the well will be completed as a Fluvial Aquifer well seated at the top of the clay. This Fluvial Aquifer well will be sampled. If the groundwater is contaminated in Well U, the Memphis Sand Aquifer well will be considered.

The second scenario occurs if the Jackson Formation/Upper Claiborne group is not encountered. Before drilling, a range of expected depths to the top and bottom of the Jackson Formation/Upper Claiborne Group will have been projected at the drilling site as based on existing data. As drilling progresses and no clay is encountered, and as long as the borehole is still within the expected range of the confining unit clay, drilling will continue. When the borehole is advanced to the bottom of the expected range, plus whatever contingency was previously agreed upon, the borehole will be in the Memphis Sand Aquifer, and therefore, it will be concluded that the clay bed is missing there. At this point, the most cost-effective solution would be to complete the well as a Memphis Sand Aquifer well. CH2M HILL recommends this approach, using a construction essentially as shown in Figure 5-3 of the *Generic QAPP* (ref. 15), only deeper. The second part of this scenario is that a Fluvial Aquifer well would be also necessary at this location, to provide the data to determine the potentiometric head differences between the aquifers at this potential point of interconnection.

4.6.2 Evaluation of Aquifer Interconnection

Nested pair monitoring wells MW-32/MW-37, located west of Dunn Field, and the new nested pair resulting from installation of the Memphis Sand Aquifer well will be sampled for water quality parameters to evaluate the degree of interconnection between the two aquifers.

Nested pair monitoring wells MW-32/MW-37 are installed outside of the suspected area of hydraulic interconnection between the two aquifers where the Jackson Formation/Upper Claiborne Group confining unit is 90-feet thick. The head difference between these two wells is about 70 feet. This head difference indicates minimal interconnection of the aquifers at this location. The new nested pair will be located inside the suspected area of hydraulic interconnection.

In addition to the PCOCs, the four monitoring wells and the deep well will be sampled for the following parameters:

- Aluminum
- Silica
- Iron
- Calcium
- Manganese
- Sodium
- Potassium
- Tritium
- Bicarbonate
- Sulfate
- Chloride
- Fluoride
- Nitrate
- Total dissolved solids
- Hardness, as $CaCO_3$

The concentrations of these parameters will be compared between the deep well and shallow well in each nested pair. If minimal interconnection exists between the two aquifers, there should be a significant contrast between the water quality parameters in each aquifer. If mixing of groundwater is occurring, then the concentrations of the parameters in the Memphis Sand Aquifer and the Fluvial Aquifer should be similar. This comparison of water quality parameters between both pairs of nested wells will provide a qualitative indication of the degree of interconnection between the Fluvial Aquifer and the Memphis Sand Aquifer inside the area of suspected hydraulic interconnection at DDMT.

4.6.3 Monitoring Well Installation

The Memphis Sand Well will be a double-cased monitoring well. The initial (surface) casing will be installed into the Jackson Formation/Upper Claiborne Group, which separates the Fluvial Aquifer from the underlying Memphis Sand Aquifer. The purpose of the surface casing is to prevent mixing of Fluvial Aquifer groundwater with Memphis Sand Aquifer groundwater inside the monitoring well borehole. The monitoring well (which is the second casing) will be installed inside the surface casing.

The surface casing will be steel and will be of sufficient inside diameter (ID) to allow drilling and installation of a 4-inch-diameter monitoring well. The surface casing will be installed a minimum of 3 feet into the top of the Jackson Formation/Upper Claiborne Group. The borehole to be drilled for the surface casing will be of sufficient diameter to allow a 2-inch annular space between the wall of the borehole and the outside of the surface casing. A drillable plug will be installed in the bottom of the surface casing before installation, thus providing a clean environment down to the top of the confining bed before drilling into the Memphis Sand Aquifer.

After drilling and placement of the surface casing to the target depth, the annular space between the borehole and outside of the surface casing will be pressure-grouted using a cement/bentonite slurry that conforms to ASTM D 5092-90. The grout will be placed using tremie methods. The grout will be allowed to cure for a minimum of 24 hours before well installation proceeds.

After installation of the minimum 8-inch-ID surface casing, a borehole will be advanced through the confining unit, to a minimum of 15 feet into the Memphis Sand Aquifer. Relatively undisturbed samples of the confining unit will be collected for laboratory permeability testing as specified in the *Generic QAPP* (ref. 15), Section 5.4.2.5.

After reaching the target depth, a 4-inch ID, schedule 80, PVC monitoring well will be installed in the Memphis Sand Aquifer in accordance with the procedures outlined in the *Generic QAPP* (ref. 15), Section 5.4. Except for the ID of the monitoring well screen and casing (which will be 4 inches), the well materials and completion will be the same as the materials specified in the *Generic QAPP*.

4.6.4 Monitoring Well Development

After installation, the monitoring well will be developed using the procedures outlined in the *Generic QAPP* (ref. 15), Section 5.4.2.7.

4.6.5 Monitoring Well Sampling and Laboratory Analysis

After the well has been developed, a full-scale chemical analytical scan will be run on the groundwater sample. Sampling methods will be in accordance with the procedures outlined in the *Generic QAPP* (ref. 15), Section 5.1.2.

4.7 Geophysical Logging

Geophysical logging will be performed on two wells currently installed in the Memphis Sand Aquifer (MW-36 and MW-37, see Figure 4-3) and four wells installed in the Alluvial Aquifer (MW-19, MW-34, MW-38, and MW-39). Natural gamma, caliper, and either dual density or acoustic velocity logging will be performed to confirm the integrity of the grout seals, to provide data on the configuration of the Jackson Formation/Upper Claiborne group confining layer, and to evaluate the distribution of clays within the Fluvial Aquifer.

5.0 Preliminary Data Needs for Remedial Alternatives

After the RI field work has been completed, the data can be assessed to evaluate the appropriate future disposition of a site (NFA, FS, or IRA). Sites that require an FS to meet the objectives of the program may require additional data collection. The additional collection may be used to support the alternatives evaluation, to refine selected alternatives, or to collect data to support remedial design activities.

5.1 Initial Alternatives

A cursory review of the RI sites at OU-4 has been conducted to develop a list of initial preliminary alternatives. These initial alternatives have been identified from existing data, from the PCOCs, and from knowledge about treatment technologies available. The initial alternatives do not represent a complete, detailed evaluation of alternatives or represent the final remedy. They do represent an initial attempt at identifying alternatives that are likely to be on the final list of developed alternatives for evaluating a site for remedial activities. Groundwater at Dunn Field currently is being addressed through an IRA because of the known contamination in the groundwater at Dunn Field. The list of initial alternatives for soil media at each site is presented in Table 5-1.

5.2 Data Collection

For each alternative listed in Table 5-1, a select group of parameters has been identified. These parameters must be considered when evaluating the identified alternative. A field decision for each site will be made to assess whether the identified data needs will be met during the RI field investigation. Factors affecting the decision to collect data include the following:

- Presence of contamination
- Spatial magnitude of contamination
- Concentrations of contaminants
- Character of contaminants (VOCs, SVOCs, metals, and so forth)

Future data collection should be identified using data collected during the RI field investigation and by completing a detailed identification of remedial alternatives for each site.

Existing data for groundwater in wells at Dunn Field indicate the presence of VOCs, SVOCs, and metals. The preliminary data needs for remediation of Dunn Field groundwater include potentiometric surface, concentration of contaminants, and geotechnical data such as grain size and vertical hydraulic conductivity.

Table 5-1
Preliminary Screening of Remedial Alternatives for RI Site 57, OU-4
Defense Depot Memphis, Tennessee

Site Numbers and Descriptions	Media	Analytical Data Available	Possible Parameters to be Remediated[a]	Remedial Options That May Be Evaluated[b]	Data Need for Initial Evaluation of Alternatives
No. 57 Building 629 Spill Area	Soil	Limited	VOCs, SVOCs, pesticides, metals	Land Disposal	TCLP, HW characteristics
				Incineration	Metals (TCLP and total), chlorine, Btu as higher heating value and ash content (can probably just use reference values)
				Cover	Adequate blow count information on boring logs (to 15' or so)
				Solidification/ Stabilization	pH, moisture content, grain size, porosity
No. 57 Building 629 Spill Area	Ground-water		VOCs, SVOCs	Containment	Slug and pump tests
				Treatment	COD, BOD, TDS, TSS, pH, conductivity, cations/anions, ammonia, nitrate/nitrite, total phosphorus, alkalinity, hardness
				In-Situ Bioreclamation	Nutrients, electron acceptors, moisture content, dissolved oxygen, T, pH

[a]Listed are general categories of contaminants. The list is not all inclusive nor a limitation on the analytical data to be collected, because current analytical data are not available for many sites and the listed COCs are based on reported activities. The "contaminants of concern" are for potential collection of data to support alternatives evaluation.

[b]This table is a generalized list of potential data needs for the RI to aid in scoping of field activities. It is not intended for use as the preliminary remedial alternatives screening for the FS, nor is it intended to collect data for all potential remedial alternatives to be evaluated. Alternatives that will not require data collection during the RI field activities are not included. Similar technologies would be grouped under a specific name; for example, incineration would generally also represent thermal desorption, cement kilns, incinerators, pyrolysis, or wet air oxidation as similar technologies.

Notes:
TCLP = Toxicity Characteristic Leaching Procedure
VOC = volatile organic compound
SVOC = semi volatile organic compound
TDS = total dissolved solids
TSS = total suspended solids
COD = chemical oxygen demand
BOD = biochemical oxygen demand

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Quarterly water level data and sampling data will be collected and analyzed for all monitoring wells in the Dunn Field area following procedures identified in Section 5.1.2 of the *Generic QAPP* (ref. 15). The data will allow the groundwater flow direction and contaminant levels to be evaluated for possible recovery well locations and proper design parameters for treatment systems. Pump and treat systems include but are not limited to the following:

- Airstripping
- Metals removal (ion exchange, flocculation, or sedimentation)
- Biological treatment
- Filtration (multimedia)

6.0 Quality Assurance for Field Sampling

The goal of quality assurance (QA) in the field is to provide data of known quality to the project team to support the project decision-making process. The implementation of QA goals is the responsibility of the FTL. The FTL reports to the project manager (PM) and is responsible for the coordination of field efforts, provides for the availability and maintenance of sampling equipment and materials, and provides shipping and packing materials. The FTL supervises the completion of all chain-of-custody records, supervises the proper handling and shipping of samples, and is responsible for accurate completion of the field notebook. As the lead field representative, the FTL is responsible for consistently implementing program QA/quality control (QC) measures at the site and for performing field activities in accordance with approved work plans, policies, and field procedures. The *Generic QAPP* (ref. 15), Section 3, provides details on meeting the goal of QA during the field investigation. This section summarizes some of the critical field QA procedures, as well as the QA/QC samples to be collected during the field investigation.

6.1 Field Documentation Summary

All field notes will be recorded in indelible ink on standard forms in bound notebooks. Section 4.3 of the *Generic QAPP* (ref. 15) contains all information that will be recorded in the field book. A daily field log will be completed by the FTL. This log will be signed and dated daily. Significant events occurring during the day will be recorded and reported to the PM. Daily communication is essential to evaluate whether timely corrective measures are necessary. The field notebooks must provide a place for the field team members to sign and date the entries. The FTL or designated representative will conduct weekly informal audits for completeness. The following items must be entered:

- Sample labels
- Chain-of-custody records
- Field notebooks
- Sampling operations
- Document control

6.2 Field Monitoring Summary

All field monitoring equipment will be calibrated according to the procedures outlined in Section 6.1 of the *Generic QAPP* (ref. 15); all field procedures concerning groundwater and soil sampling are described in Section 5. Additionally, Section 5 contains soil boring and monitoring well drilling procedures, geophysical survey and logging procedures, and all equipment decontamination procedures.

6.3 QA/QC Sampling Summary

Different types of QA/QC samples will be collected and analyzed during the RI/FS at DDMT. These samples include the following:

- Trip blanks
- Equipment blanks
- Field blanks
- Field duplicates
- Matrix spike/matrix spike duplicate (MS/MSD) samples
- Split samples

6.3.1 Trip Blanks

Trip blanks are to be analyzed for VOCs only. Three 40-milliliter (mL) VOC vials will accompany each ice chest that contains samples collected for VOC analyses. The trip blanks will be filled with ASTM Type II water when they are shipped to the site from the laboratory; the trip blanks will be shipped with sampling kits. One of the trip blanks will accompany split VOC samples to the U.S. Army Corps of Engineers (COE) QA laboratory.

6.3.2 Equipment Blanks

Equipment blanks are processed by rinsing decontaminated sampling equipment with ASTM Type II water obtained from the laboratory. The rinse water is collected in sample bottles, preserved, and handled in the same manner as the samples. Equipment blanks will be collected once a day for the equipment used during sampling procedures. Split equipment blank samples of the rinsate will be sent to the COE QA laboratory.

6.3.3 Field Blanks

Field blanks are samples of source water used for decontamination and are used to monitor the potential for contamination from the source water. One field blank will be collected from each source once a week.

6.3.4 Field Duplicates

The FTL will choose at least 10 percent of the Level 3 samples and 5 percent of the Level 2 samples from sample locations previously known to be contaminated, and will collect duplicate samples from those locations. The source information will be recorded in the field notes, but not on the chain-of-custody form. The identity of the duplicates will not be given to the analyst. The source of information will be forwarded to the QA reviewer to aid in the review and validation of the data. The source of the field duplicate will be clearly identified in the chain-of-custody form sent to the QA laboratory.

6.3.5 Matrix Spike/Matrix Spike Duplicate

MS/MSD samples will be collected and shipped to the laboratory for spike sample analyses. Five percent of the samples collected at OU-4 will be accompanied by spike samples. However, if an MS/MSD sample has not been collected in a 14-day time period, a spike sample will be collected and sent for sample analyses.

6.3.6 Split Samples

Split samples will be collected for 1 percent of the samples at OU-4. Tables 6-1 and 6-2 present the number of QA/QC samples to be collected at OU-4 as based on the assumption that the duration of the field effort will be 20 days.

Split samples will be submitted to the contractor's laboratory as QC samples and to the COE and EPA/TDEC laboratories as QA samples. The samples will be sent to the following address:

COE Laboratory
Missouri River Division
420 South 18th Street
Omaha, Nebraska 68102

Table 6-1
Summary of Field and QC Samples
OU-4, Site 57
Defense Depot Memphis, Tennessee

Sample Matrix	QC Level	Parameter	Method	Samples	Dup[3]	Trip Blank[4]	Equip Blank[5]	Field Blank[6]	MS/MSD[7]	Total
Soil[1]	2	VOCs/SVOCs	SW8010-8020/ SW8100	57	6	-	3	2	3	71
		Metals	SW6010	57	6	-	3	2	3	71
		Pesticides	SW8080M	57	6	-	3.	2	3	71
	3	VOCs/SVOCs	SW8240/8270	6	1	1	1	1	1	11
		Metals	SW6010	6	1	-	1	1	1	10
		Pesticides	SW8080M	6	1	-	1	1	1	10
Groundwater[2]	3	VOCs/SVOCs	SW8010-8020/ SW8100	9	1	-	1	1	1	13
		Metals	SW6010	9	1	-	1	1	1	13
		Pesticides	SW8080M	9	1	-	1	1	1	13

1 QC Level 2 soil samples assume three samples at each of nine boreholes and five samples at each of 6 locations. QC Level 3 samples include 10 percent of the Level 2 samples (six) and three samples from STB-12.
2 One groundwater sample will be collected from each of the 2 new and 7 existing MWs.
3 Duplicates will be collected at the rate of 10 percent per analyte/matrix.
4 Trip blanks will accompany every shipment of VOCs.
5 Equipment rinsates will be collected at the rate of 5 percent per analyte/matrix.
6 Field blanks will be analyzed as one per each water source each week of the field event.
7 MS/MSDs will be collected at the rate of 5 percent per analyte/matrix.

Notes:

QC = quality control
Dup = duplicate
MS/MSD = matrix spike/matrix spike duplicate

VOC = volatile organic compound
SVOC = semivolatile organic compound
PAH = polynuclear aromatic hydrocarbon

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Table 6-2
Summary of Field and QC Samples
Fluvial Aquifer Investigation
Defense Depot Memphis, Tennessee

Sample Matrix	Status	QC Level	Parameter	Method	Samples[1]	Dup[2]	Trip Blank[3]	Equip Blank[4]	Field Blank[5]	MS/MSD[6]	Total
Groundwater[1]		3	VOCs	SW8240	37	4	10	2	2	2	57
			SVOCs	SW8270	10	1	-	1	1	1	14
			Metals	SW6010	45	5	-	2	2	2	56
			TCL/TAL		10	1	2	1	1	1	16
Groundwater[7]	O	3	VOCs/SVOCs	SW8010-8020/ SW8100	4	1	1	1	1	1	9
			Metals	SW6010	4	1	-	1	1	1	8
			TCL/TAL		4	1	1	1	1	1	9

[1] Ten new monitoring wells (A-J) will be analyzed for TCL/TAL. Ten new monitoring wells (A-T) will be analyzed for VOCs and metals. Twenty seven VOCs, 10 SVOCs, and 35 unfiltered metals will be collected from existing monitoring wells.
[2] Duplicates will be collected at the rate of 10 percent per analyte/matrix.
[3] Trip blanks will accompany every shipment of VOCs and TCL samples and will be run for VOCs and TCL analysis, respectively.
[4] Equipment rinsates will be collected at the rate of 5 percent per analyte/matrix.
[5] Field blanks will be analyzed as one per each water source each week of the field event.
[6] MS/MSDs will be collected at the rate of 5 percent per analyte/matrix.
[7] Optional samples are for four additional Fluvial Aquifer wells (TCL/TAL) and resampling of four additional existing wells (VOC, SVOC, and unfiltered metals).

Notes:

P = Primary
O = Optional
Dup = Duplicate
MS/MSD = matrix spike/matrix spike duplicate
PAH = polynuclear aromatic hydrocarbon

VOC = volatile organic compound
SVOC = semivolatile organic compound
TCL = Target Compound List
TAL = Target Analyte List

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Appendix B – Table of Contents
Summary of Previous Investigations
Defense Depot Memphis, Tennessee

Study Title	Study Investigator	Date of Investigation	Purpose of Investigation	Appendix B Page Numbers
Groundwater Monitoring Results for DDMT	Environmental Science & Engineering, Inc. (ESE)	September 1993	Groundwater sampling	B-2
Remedial Investigation/ Feasibility Study	Law Environmental	August 1990	Groundwater, soil, surface water, and sediment sampling	B-10

Groundwater Monitoring Results for DDMT
Environmental Science & Engineering, Inc.
September 1993

TAB[illegible] 1 [illegible]

SAMPLE IDS PARAMETERS UNITS	STORET METHOD	MW1 COUNTY 1	MW4 COUNTY 4	MW5 COUNTY 5	MW6 COUNTY 6	MW7 COUNTY 7	MW8 COUNTY 8	MW9 COUNTY 9	MW10SP COUNTY 10	MW11 COUNTY 11	MW12SP COUNTY 12	MW13 COUNTY 13	MW14 COUNTY 14	MW15 COUNTY 15	State and Federal MCLs Tennessee MCL	Federal MCL
DATE TIME		11/12/93 15:00	11/15/93 15:00	11/16/93 17:00	11/18/93 09:00	11/15/93 10:50	11/17/93 12:20	11/15/93 17:11	11/11/93 16:00	11/11/93 09:30	11/11/93 15:30	11/15/93 15:10	11/17/93 15:45	11/18/93 12:00		
CARBON TETRACHLORIDE UG/L	32102 8010-G	--	--	--	83.7	--	--	3.07	1.13	--	--	--	--	18.8	5	5
CHLOROFORM UG/L	32106 8010-G	1.26	--	1.85	14.1	12.8	--	4.78	4.22	2.33	1.93	--	--	59.2	--	100
1,1-DICHLOROETHANE UG/L	34496 8010-G	1.06	--	--	--	1.49	1.83	--	3.16	--	--	--	--	--	--	--
1,2-DICHLOROETHANE UG/L	34531 8010-G	--	--	--	--	--	--	--	1.56	--	--	--	--	--	5	5
1,1-DICHLOROETHYLENE UG/L	34501 8010-G	38.3	--	--	--	46.3	34.4	7790	11.6	--	--	--			7	7
TRANS-1,2-DICHLOROETHENE UG/L	34546 8010-G		--	--	20.8	--	--	--	118	11.7	19.6	--	--	7.09	100	100
METHYLENE CHLORIDE UG/L	34423 8010-G	--	--	--	--	--	--	--	334	--	--	--	--	--	--	5
1,1,2,2-TETRACHLOROETHANE UG/L	34516 8010-G	--	--	--	335	--	--	--	32.1	3.58	263	--	--	7.71	--	--
TETRACHLOROETHYLENE UG/L	34475 8010-G	192	33.6	14.9	3.06	35.0	35.2	3213	145	11.1	34.0	3.01	--	4.39	5	5
1,1,1-TRICHLOROETHANE UG/L	34506 8010-G	1.06	--	--	--	1.61	1.96	--	5.06	--	--	--	--	--	200	200
1,1,2-TRICHLOROETHANE UG/L	34511 8010-G	--	--	--	9.16	--	--	--	4.14	--	--	--	--	--	--	5
TRICHLOROETHYLENE UG/L	39180 8010-G	55.8	--	3.11	111	1327	1573	8170	1020	4932	1500	--	--	46.4	5	5
TOLUENE UG/L	34010 8020-G	--	--	--	--	--	--	3.49	30.7	--	--	--	--	--	1000	1000
BIS(2-ETHYLHEXYL) PHTHALATE UG/L	39100 8270/1520-G	1.4	--	--	--	--	6.0	8.6	5.2	2.8	--	--	0.9	--	--	[illegible]
DI-N-BUTYLPHTHALATE UG/L	39110 8270/1520-G	--	--	--	--	--	1.7	--	--	--	--	--	--	--		
PENTACHLOROPHENOL UG/L	[illegible] 8270/1520-G	--	--	--	1.5	--	--	--	--	--	--	--	--	--		
PHENOL UG/L	34694 8270/1520-G	--	--	--	--	--	--	--	4.5	--	--	--	--	--	--	--
ACENAPHTHENE UG/L	34205 8310/1520-G	--	--	--	10.1	--	--	--	--	--	--	19.0	--	--	--	--
ANTHRACENE UG/L	34220 8310/1520-G	--	1.59	1.27	6.04	4.84	1.65	--	--	--	--	34.5	5.22	--	--	-
BENZO(A)ANTHRACENE UG/L	34526 8310/1520-G	0.023	0.042	0.034	0.786	0.136	0.043	0.004	0.015	0.010	--	1.01	0.131	0.004	-	0.1
BENZO(A)PYRENE UG/L	34247 8310/1520-G	0.025	0.048	0.037	0.826	0.165	0.052	0.008	0.023	0.037	--	1.37	0.116	0.001	--	0.2
BENZO(B)FLUORANTHENE UG/L	34230 8310/1520-G	0.026	0.057	0.041	0.888	0.144	0.055	0.010	0.021	--	--	1.47	0.119	0.005	--	0.2
BENZO(GHI)PERYLENE UG/L	34521 8310/1520-G	0.021	0.098	0.068	1.41	0.225	0.089	--	0.026	0.010	--	1.20	0.225	--	--	-
BENZO(K)FLUORANTHENE UG/L	34242 8310/1520-G	0.012	0.035	0.015	0.433	0.066	0.023	0.005	0.011	0.606	--	0.697	0.066	0.007	--	0.2
CHRYSENE UG/L	34320 8310/1520-G	--	--	--	3.44	0.175	1.58	--	--	--	--	1.49	3.83	--	--	0.2
DIBENZ(A,H)ANTHRACENE UG/L	34556 8310/1520-G	--	0.008	0.004	0.332	0.011	0.008	--	--	0.014	--	0.150	0.006	--	--	[illegible]
FLUORANTHENE UG/L	34376 8310/1520-G	0.057	0.105	0.089	2.31	0.134	0.113	0.015	0.050	--	--	2.70	0.173	0.018	-	-
INDENO(1,2,3-CD)PYRENE UG/L	34403 8310/1520-G	0.016	0.015	0.005	1.17	0.060	0.034	--	0.030	0.023	0.005	0.160	0.061	0.010	--	0.4
NAPHTHALENE UG/L	34696 8310/1520-G	--	--	--	3.88	--	--	--	--	--	--	1.90	--	--	--	
PHENANTHRENE UG/L	34461 8310/1520-G	--	0.150	0.146	3.01	0.939	0.165	--	--	--	--	4.53	0.784	--		
PYRENE UG/L	34469 8310/1520-G	0.110	0.287	0.204	6.91	1.54	0.235	--	-	1.15	--	11.7	3.15			
ALDRIN UG/L	39330 8080/1520-G		--	-	--	--	--	--	--	--	--	0.027	--	--	--	
DDD, PP' UG/L	39310 8080/1520-G	--	--	--	--	--	--	--	0.091	--	--	--	--	--	--	
DDE, PP' UG/L	39320 8080/1520-G	--	--	--	--	--	--	--	0.023	--	--	--	--	--	--	
DDT, PP' UG/L	39300 8080/1520-G	--	--	--	--	--	--	--	0.041	0.015	--	--	--	--		
DIELDRIN UG/L	39380 8080/1520-G	--	0.087	--	--	--	0.057	0.044	0.033	--	--	--	--	--		

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TABLE B-1

SAMPLE ID'S / PARAMETERS / UNITS	STORET METHOD	MW1 CDOMTW 1	MW4 CDOMTW 4	MW5 CDOMTW 5	MW6 CDOMTW 6	MW7 CDOMTW 7	MW8 CDOMTW 8	MW9 CDOMTW 9	MW10DP CDOMTW 10	MW11 CDOMTW 11	MW12SP CDOMTW 12	MW13 CDOMTW 13	MW14 CDOMTW 14	MW15 CDOMTW 15	State and Federal MCLs* Tennessee MCL	State and Federal MCLs* Federal MCL
DATE / TIME		11/12/93 15.00	11/15/93 15:00	11/16/93 17:00	11/18/93 09:00	11/15/93 10:50	11/17/93 12:20	11/15/93 13:11	11/13/93 18:00	11/11/93 09:30	11/11/93 15:30	11/15/93 15:30	11/17/93 15:45	11/16/93 12:00		
ALUMINUM, TOTAL UG/L	1105 6010-G	18700	13600	59400	62900	36900	167000	41100	139000	117000	51200	34100	101000	124000	--	--
ARSENIC, TOTAL UG/L	1002 7060-G	--	6.5	33.5	1.8	2.6	--	4.2	12.4	4.6	7.1	--	336	19.4	50	50
BARIUM, TOTAL UG/L	1007 6010-G	155	130	218	610	347	573	260	1024	1330	154	140	1570	508	2000	2000
CHROMIUM, TOTAL UG/L	1034 6010-G	59.1	122	338	21.9	76.7	384	304	365	305	11.9	66.6	304	108	100	100
COBALT, TOTAL UG/L	1037 6010-G	30.4	98.6	53.1	184	84.3	132	63.4	90.7	344	223	47.1	129	148	--	--
COPPER, TOTAL UG/L	1042 6010-G	31.3	17.1	41.8	38.5	43.8	276	138	391	352	81.4	115	189	187	--	1100
LEAD, TOTAL UG/L	1051 7421-G	18.3	137	30.8	44.3	18.7	69.0	81.2	477	303	53.4	57.5	109	83.3	5	15
MERCURY, TOTAL UG/L	71900 7470-G	--	0.87	0.43	0.65	--	0.75	--	0.73	0.74	0.31	0.31	1.53	1.00	2	2
ZINC, TOTAL UG/L	1092 6010-G	332	195	337	138	135	417	365	739	475	181	166	452	454	--	--
RESIDUE, DISS (TDS) MG/L	70300 160.1-G	370	189	177	760	268	405	333	303	260	202	186	350	771	-	-
ALUMINUM, DISS UG/L	1106 6010-G	--	--	--	--	--	--	--	43.3	--	--	--	297	-	--	--
BARIUM, DISS UG/L	1005 6010-G	97.0	45.4	30.0	177	65.2	58.1	54.9	16.9	63.6	47.4	16.0	45.2	19.4	-	
LEAD, DISS UG/L	1049 7421-G	--	--	--	--	--	--	--	--	--	--	--	--	10.1	--	
ZINC, DISS UG/L	1090 6010-G	--	--	--	24.1	--	--	--	--	--	--	--	--	--	-	-

*All units in micrograms per liter (ug/L)
+Proposed value

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TABL[illegible]-1

SAMPLE SITE / PARAMETERS / UNITS	STORET / METHOD	MW16 COUNTY 16	MW19 COUNTY 19	MW20 COUNTY 20	MW21 COUNTY 21	MW22SB COUNTY 22	MW23 COUNTY 23	MW24 COUNTY 24	MW25 COUNTY 25	MW26 COUNTY 26	MW28 COUNTY 28	MW29 COUNTY 29	MW30 COUNTY 30	MW31 COUNTY 31	State and Federal MCLs: Tennessee MCL	State and Federal MCLs: Federal MCL
DATE / TIME		11/09/93 14:05	11/12/93 18:00	11/19/93 14:20	11/18/93 17:00	11/17/93 15:00	11/15/93 03:30	11/14/93 17:00	11/13/93 08:20	11/09/93 15:30	11/19/93 18:30	11/17/93 09:45	11/15/93 15:45	11/21/93 12:30		
CARBON TETRACHLORIDE UG/L	32102 8010-G	--	--	--	--	--	--	--	--	1.16	--	--	--	4.81	5	5
CHLOROFORM UG/L	32106 8010-G	--	--	--	--	--	--	--	--	--	--	4.26	--	21.1	[illegible]	100
1,1-DICHLOROETHANE UG/L	34496 8010-G	--	--	--	--	--	--	--	--	--	--	2.69	--	1.66		
1,2-DICHLOROETHANE UG/L	34531 8010-G	--	--	--	--	--	--	--	--	--	--	--	--	1.90	5	5
1,1-DICHLOROETHYLENE UG/L	34501 8010-G	--	--	--	--	--	--	--	--	--	--	33.1	--	52.6	[illegible]	[illegible]
TRANS-1,2-DICHLOROETHENE UG/L	34546 8010-G	--	--	--	--	--	--	--	--	--	--	--	--	141	100	100
1,1,2,2-TETRACHLOROETHANE UG/L	34516 8010-G	--	--	--	--	--	--	--	--	--	--	--	--	96.0	--	
TETRACHLOROETHENE UG/L	34475 8010-G	--	--	--	49.1	--	--	--	31.3	6.80	--	43.1	--	31.6	5	5
1,1,1-TRICHLOROETHANE UG/L	34506 8010-G	--	--	--	--	--	--	--	--	--	--	--	--	2.77	200	200
1,1,2-TRICHLOROETHANE UG/L	34511 8010-G	--	--	--	--	--	--	--	--	--	--	--	--	6.46		5
TRICHLOROETHENE UG/L	39180 8010-G	1.10	--	--	4.47	1.24	--	--	--	1.29	--	14.9	--	3310	5	5
BIS(2-ETHYLHEXYL) PHTHALATE UG/L	39100 8270/3520-G	1.3	--	5.6	3.4	--	--	376	4.0	5.8	--	3.4	11	2.1	[illegible]	6
PHENOL UG/L	34694 8270/3520-G	2.8	--	1.5	--	--	--	--	--	--	--	--	--	--	[illegible]	[illegible]
ANTHRACENE UG/L	34220 8310/3520-G	--	--	--	--	--	--	--	--	--	--	0.261	--	--	--	--
BENZO(A)ANTHRACENE UG/L	34526 8310/3520-G	--	--	--	--	0.008	0.003	0.009	--	--	0.035	0.011	--	--	--	0.1
BENZO(A)PYRENE UG/L	34247 8310/3520-G	--	--	0.005	0.002	0.018	0.005	0.004	--	--	0.006	0.006	0.007	0.003	--	0.2
BENZO(B)FLUORANTHENE UG/L	34230 8310/3520-G	--	0.002	0.006	0.003	0.035	0.008	0.005	--	0.002	0.008	0.008	0.009	0.005	--	0.2
BENZO(K)FLUORANTHENE UG/L	34242 8310/3520-G	--	--	0.005	0.001	0.005	0.005	0.002	--	--	0.004	0.001	0.001	0.001	--	0.2
CHRYSENE UG/L	34320 8310/3520-G	--	--	--	--	--	--	--	--	--	--	1.61	0.181	--	[illegible]	0.2
DIBENZ(A,H)ANTHRACENE UG/L	34556 8310/3520-G	--	--	--	--	0.005	--	--	--	--	0.006	--	--	--	[illegible]	0.3
FLUORANTHENE UG/L	34376 8310/3520-G	0.007	0.005	0.012	0.009	0.023	0.013	0.009	--	0.007	0.017	0.019	0.018	0.019	--	--
INDENO(1,2,3-CD)PYRENE UG/L	34403 8310/3520-G	0.001	--	--	--	0.020	--	--	--	--	--	--	--	--	[illegible]	0.4
NAPHTHALENE UG/L	34696 8310/3520-G	--	1.20	1.33	--	--	--	--	--	--	1.28	--	--	--	--	--
ALUMINUM, TOTAL UG/L	1105 6010-G	17000	11300	120000	105000	198000	196000	89900	33400	23400	341000	135000	15500	76900	--	--
ARSENIC, TOTAL UG/L	1002 7060-G	6.3	--	3.0	4.9	6.0	67.5	--	--	--	98.5	44.5	8.4	12.0	50	50
BARIUM, TOTAL UG/L	1007 6010-G	163	567	411	299	462	566	358	599	160	3358	173	116	381	2000	2000
CADMIUM, TOTAL UG/L	1027 6010-G	--	--	--	--	--	33.8	--	--	--	--	--	--	--	10	5
CHROMIUM, TOTAL UG/L	1034 6010-G	27.4	49.8	191	272	824	438	323	303	49.1	270	709	332	163	100	100
COBALT, TOTAL UG/L	1037 6010-G	-	17.5	45.2	42.7	29.0	65.7	156	103	31.1	931	36.5	--	62.1		
COPPER, TOTAL UG/L	1042 6010-G	41.6	132	114	113	179	310	21.6	90.1	91.1	196	99.1	49.3	76.6		1300
LEAD, TOTAL UG/L	1051 7421-G	20.9	50.1	85.3	75.2	31.3	444	242	23.6	17.9	119	34.5	20.3	41.1	5	15
MERCURY, TOTAL UG/L	71900 7470-G	--	0.20	0.46	0.47	1.86	1.65	0.81	0.26	0.28	1.11	0.31	--	0.41	2	2
ZINC, TOTAL UG/L	1092 6010-G	11.6	136	371	389	845	1530	266	148	107	657	283	176	264	--	
RESIDUE, DISS (TDS) MG/L	70300 160.1-G	406	207	335	366	388	396	111	373	260	572	478	325	241	--	
ALUMINUM, DISS UG/L	1106 6010-G	--	--	--	--	--	--	--	--	454	--	--	--	--	--	
BARIUM, DISS UG/L	1005 6010-G	51.1	132	41.0	29.8	91.6	37.1	38.8	44.9	371	39.0	82.8	--	84.6	--	
COPPER, DISS UG/L	1040 6010-G	--	--	--	--	--	--	--	--	--	--	11.4	--	--	--	

*All units in micrograms per liter (ug/L)
**Proposed value

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TABLE [illegible]

SAMPLE ID'S PARAMETERS UNITS	STORET METHOD	MW32 COMPTN 32	MW33 COMPTN 33	MW34 COMPTN 34	MW35 COMPTN 35	MW36 COMPTN 36	MW37EP COMPTN 37	MW38 COMPTN 38	MW39 COMPTN 39	MW40DUP COMPTN 40	MW41DUP COMPTN 41	MW42DUP COMPTN 42	MW43DUP COMPTN 43	MW44EBLK COMPTN 44	State and Federal MCLs: Tennessee MCL	Federal MCL
DATE TIME		11/18/93 17:00	11/19/93 09:10	11/19/93 10:30	11/14/93 17:30	11/12/93 17:15	11/18/93 11:30	11/15/93 16:55	11/15/93 15:40	11/16/93	11/16/93	11/11/93	11/17/93	11/16/93 16:30		
CARBON TETRACHLORIDE UG/L	32102 8010-G	33.0	--	--	--	--	--	--	--	--	1.17	--	--	--	5	5
CHLOROBENZENE UG/L	34301 8010-G	--	--	--	1.18	--	--	--	--	--	--	--	--	--	--	100
CHLOROFORM UG/L	32106 8010-G	11.1	--	2.37	3.74	--	--	--	--	--	4.18	7.97	--	1.06	--	
1,1-DICHLOROETHANE UG/L	34496 8010-G	--	--	--	--	--	--	--	--	--	1.38	--	--	--	.	--
1,2-DICHLOROETHANE UG/L	34531 8010-G	--	--	--	0.49	--	--	--	--	--	3.73	1.13	--	--	5	5
1,1-DICHLOROETHYLENE UG/L	34501 8010-G	--	--	--	--	--	--	--	--	--	88.5	--	--	-	7	7
TRANS-1,2-DICHLOROETHENE UG/L	34546 8010-G	10.4	--	--	28.1	--	--	--	--	--	139	11.2	--	--	100	100
METHYLENE CHLORIDE UG/L	34423 8010-G	--	--	--	--	--	--	--	--	--	338	--	--	2.47	-	5
1,1,2,2-TETRACHLOROETHANE UG/L	34516 8010-G	142	2.28	--	63.8	--	--	--	--	--	41.6	311	--	--	--	
TETRACHLOROETHENE UG/L	34475 8010-G	2.00	--	--	44.3	--	--	--	2.10	--	161	55.4	--	--	5	5
1,1,1-TRICHLOROETHANE UG/L	34506 8010-G	--	--	--	--	--	--	--	--	--	6.03	--	--	--	200	200
1,1,2-TRICHLOROETHANE UG/L	34511 8010-G	7.68	--	--	--	--	--	--	--	--	4.66	1.64	--	--	--	5
TRICHLOROETHENE UG/L	39180 8010-G	337	--	--	161	--	--	8.55	1.51	--	3310	3110	.	--	5	5
TOLUENE UG/L	34010 8020-G	--	--	--	--	--	--	--	--	--	33.1	--	--	--	1000	1000
DI(2-ETHYLHEXYL) PHTHALATE UG/L	39100 8270/3520-G	46	4.3	3.5	--	3.2	15	7.8	3.9	12	7.4	1.9	2.5	--	.	6
PHENOL UG/L	34694 8270/3520-G	2.3	1.4	--	--	--	2.2	5.9	3.2	2.9	5.5	--	2.4	.	.	
ANTHRACENE UG/L	34220 8310/3520-G	--	--	--	0.462	--	--	--	1.84	--	0.105	--	0.738	--	-	.
BENZO(A)ANTHRACENE UG/L	34526 8310/3520-G	--	--	--	0.015	0.008	--	0.003	0.035	--	0.116	--	0.036	--	.	0.1
BENZO(A)PYRENE UG/L	34247 8310/3520-G	--	0.006	0.008	0.032	0.041	--	0.003	0.046	--	0.140	--	0.016	--	.	0.2
BENZO(B)FLUORANTHENE UG/L	34230 8310/3520-G	--	0.006	0.008	0.013	0.014	--	0.002	0.063	--	0.167	--	0.017	.	.	0.2
BENZO(GHI)PERYLENE UG/L	34521 8310/3520-G	--	--	--	0.018	--	--	--	0.053	--	0.134	--	0.075	--	--	
BENZO(K)FLUORANTHENE UG/L	34242 8310/3520-G	--	0.003	0.005	0.007	0.012	--	0.001	0.029	--	0.063	--	0.006	--	--	0.2
CHRYSENE UG/L	34320 8310/3520-G	--	--	--	--	0.170	0.189	--	0.127	0.219	0.238	--	--	--	--	0.2
DIBENZ(A,H)ANTHRACENE UG/L	34556 8310/3520-G	--	--	--	--	--	--	--	0.005	--	0.014	--	--	--	-	0.1
FLUORANTHENE UG/L	34376 8310/3520-G	0.004	0.070	0.025	0.027	0.035	--	0.003	0.015	0.004	0.248	--	0.034			
INDENO(1,2,3-CD)PYRENE UG/L	34403 8310/3520-G	--	--	--	--	0.013	0.007	--	0.020	--	0.114	0.005	.	-		0.4
PHENANTHRENE UG/L	34461 8310/3520-G	--	--	--	--	--	--	--	0.158	--	0.098	--	--			
PYRENE UG/L	34469 8310/3520-G	--	--	--	0.065	--	--	--	0.144	--	1.07	--		1.78		
DDD, PP' UG/L	39310 8080/3520-G	--	--	--	--	--	--	--	--	--	0.035	.	.	--		
DDT, PP' UG/L	39300 8080/3520-G	--	--	--	--	--	--	--	--	--	0.013	-	--	--	-	
DIELDRIN UG/L	39380 8080/3520-G	--	--	--	0.008	--	--	0.062	--	--	--	0.006	--	--	.	
HEPTACHLOR EPOXIDE UG/L	39420 8080/3520-G	--	--	--	--	--	--	--	--	--	--	0.005	-	--	0.2	0.2

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TABLE B-1

SAMPLE ID'S PARAMETERS UNITS	STORET METHOD	MW32 COUNTY 32	MW33 COUNTY 33	MW34 COUNTY 34	MW35 COUNTY 35	MW36 COUNTY 36	MW37DP COUNTY 37	MW38 COUNTY 38	MW39 COUNTY 39	MW40DUP COUNTY 40	MW41DUP COUNTY 41	MW42DUP COUNTY 42	MW43DUP COUNTY 43	MW44 COUNTY 44	State and Federal MCLs: [illegible] MCL	State and Federal MCLs: Federal MCL
DATE TIME		11/18/93 07:00	11/19/93 09:20	11/15/93 10:30	11/14/93 13:30	11/13/93 17:15	11/18/93 11:30	11/15/93 10:15	11/15/93 13:40	11/18/93	11/11/93	11/11/93	11/17/93	11/16/93 16:10		
ALUMINUM, TOTAL UG/L	1105 6010-G	177000	61300	3710	33800	765	3210	4990	3550	3480	174000	57100	175000	.		
ARSENIC, TOTAL UG/L	1002 7060-G	20.4	35.4	--	4.6	--	--	--	4.3	--	4.6	--	22.5	.	50	50
BARIUM, TOTAL UG/L	1007 6010-G	1450	435	142	387	376	588	95.7	133	574	1010	176	450	--	2000	2000
CHROMIUM, TOTAL UG/L	1034 6010-G	331	118	13.9	81.4	10.3	--	20.4	21.7	--	383	61.1	405	--	100	100
COBALT, TOTAL UG/L	1037 6010-G	117	37.5	--	72.7	--	--	--	--	--	80.3	188	57.9	--		
COPPER, TOTAL UG/L	1042 6010-G	101	44.9	7.6	65.7	6.4	6.5	16.5	33.3	5.4	372	59.4	186	--	--	1300
LEAD, TOTAL UG/L	1051 7421-G	38.1	46.1	6.7	36.8	6.3	2.8	6.9	37.5	--	421	18.5	54.0	--	5	15
MERCURY, TOTAL UG/L	71900 7470-G	1.94	0.26	--	--	--	--	--	--	--	0.74	0.36	1.94		2	2
ZINC, TOTAL UG/L	1092 6010-G	307	335	21.3	344	36.0	--	40.0	37.1	--	321	176	845	.	--	--
RESIDUE, DISS (TDS) MG/L	70300 160.1-G	822	303	127	356	336	316	366	198	314	579	393	279	0.0	--	--
ALUMINUM, DISS UG/L	1106 6010-G	--	--	--	325	--	--	--	--	--	44.0	--	--		.	--
BARIUM, DISS UG/L	1005 6010-G	262	51.2	47.8	12.6	344	464	--	40.5	456	72.1	41.8	10.7		--	--
LEAD, DISS UG/L	1049 7421-G	--	--	--	--	--	--	--	7.1	--	--	--	1.0			
ZINC, DISS UG/L	1090 6010-G	.	--	44.5	--	30.5	--	--	--	--	49.3	.	.		.	

*All units in micrograms per liter (ug/L)
*Proposed value.

TABLE B-1

SAMPLE IDS / PARAMETERS / UNITS	STORET METHOD	HW45FBLK CDNMTN 45	HW46EBLK CDNMTN 46	HW47EBLK CDNMTN 47	HW48TS CDNMTN 48	HW49TS CDNMTN 49	HW50TS CDNMTN 50	HW51TS CDNMTN 51	HW52TBLK CDNMTN 52	HW53TBLK CDNMTN 53	HW55TBLK CDNMTN 55	HW56TBLK CDNMTN 56	HW57TBLK CDNMTN 57	HW58TBLK CDNMTN 58	State and Federal MCLs: Tennessee MCL	Federal MCL
DATE / TIME		11/18/93 15:00	11/18/93 16:30	11/18/93 18:30	11/18/93 17:15	11/19/93 15:15	11/19/93 17:45	11/19/93 18:30	11/25/93 21:30	11/11/93 23:00	11/14/93 17:50	11/13/93 15:10	11/08/93 11:00	11/10/93 22:00		
CHLOROFORM UG/L	32106 8010-G	1.61	--	1.75	--	--	--	--	--	--	--	--	--	--	--	
PERCHLOROETHYLENE UG/L	34475 8010-G	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
1,1,2,2-TETRACHLOROETHANE UG/L	34516 8010-G	--	--	--	--	--	--	--	--	3.05	--	--	1.12	--		5
TRICHLOROETHYLENE UG/L	39180 8010-G	--	--	--	--	--	--	--	--	3.33	--	--	--			
BARIUM, TOTAL UG/L	1007 6010-G	--	--	--	38.4	31.6	35.4	56.1							5	5
LEAD, TOTAL UG/L	1051 7421-G	--	--	--	1.9	6.7	7.4	2.4							2000	2000
ZINC, TOTAL UG/L	1092 6010-G	--	--	--	305	2110	544	428							5	15
RESIDUE, DISS. (TDS) MG/L	70300 160.1-G	--	--	--	350	272	257	348							--	
BARIUM, DISS. UG/L	1005 6010-G				36.5	30.9	37.8	33.6							--	--
LEAD, DISS. UG/L	1049 7421-G				2.3	5.9	2.5	3.8							--	--
ZINC, DISS. UG/L	1090 6010-G				702	1190	344	631							--	

*All units in micrograms per liter (ug/L).
[illegible] value

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TABLE B-1

SAMPLE ID'S PARAMETERS UNITS	STORET METHOD	MW60TULK COUNTN 60	MW61TULK COUNTN 61	MW61TULK COUNTN 67	MW61TULK COUNTN 64	MW26 COUNTMD 1	MW27 COUNTMD 2	MW28 COUNTMD 1	State and Federal MCLs* Tennessee MCL	Federal MCL
DATE TIME		11/12/93 15:00	11/11/93 15:00	11/10/93 22:00	11/10/93 20:00	11/10/93 11:15	11/10/93 15:30	11/10/93 15:15		
BROMODICHLOROMETHANE UG/L	32101 8010-G	--	--	--	--	--	18.6		--	100
DIBROMOCHLOROMETHANE UG/L	32105 8010-G	--	--	--	--	--	15.5		--	100
1,2-DICHLOROETHANE UG/L	34531 8010-G	--	--	--	--	--	17.0		--	--
TRANS-1,2-DICHLOROETHENE UG/L	34546 8010-G	--	--	--	--	--	17.0		100	100
CIS-1,3-DICHLOROPROPENE UG/L	34704 8010-G	--	--	--	--	--	15.6		--	--
TRANS-1,3-DICHLOROPROPENE UG/L	34699 8010-G	--	--	--	--	--	14.6		--	5
METHYLENE CHLORIDE UG/L	34423 8010-G	--	15.4	--	--	--	16.9		--	--
1,1,2,2-TETRACHLOROETHANE UG/L	34516 8010-G	2.72	--	--	--	--	--		5	5
TETRACHLOROETHENE UG/L	34475 8010-G	--	--	--	--	--	15.3		200	200
1,1,1-TRICHLOROETHANE UG/L	34506 8010-G	--	--	--	--	--	15.1		5	5
TRICHLOROETHENE UG/L	39180 8010-G	1.75	--	--	--	--	--		2	2
VINYL CHLORIDE UG/L	39175 8010-G	--	--	--	--	--	20.0		--	--
ACENAPHTHENE UG/L	34205 8270/3520-G					--	39		--	0.2*
BENZO(B)FLUORANTHENE UG/L	34230 8270/3520-G					--	430		--	0.2*
BENZO(K)FLUORANTHENE UG/L	34242 8270/3520-G					--	4.1		--	--
DI-N-BUTYLPHTHALATE UG/L	39110 8270/3520-G					--	33		--	--
2,4-DIMETHYLPHENOL UG/L	34606 8270/3520-G					--	87		--	--
2,4-DINITROTOLUENE UG/L	34611 8270/3520-G					--	33		--	--
FLUORENE UG/L	34381 8270/3520-G					--	38		--	--
ISOPHORONE UG/L	34408 8270/3520-G					--	58		--	--
PENTACHLOROPHENOL UG/L	39032 8270/3520-G					--	77		--	1
PHENANTHRENE UG/L	34461 8270/3520-G					--	37		--	--
PHENOL UG/L	34694 8270/3520-G					--	72		--	--
PYRENE UG/L	34469 8270/3520-G					--	50		--	--
2,4,6-TRICHLOROPHENOL UG/L	34621 8270/3520-G					--	35		--	--
2,4,5-TRICHLOROPHENOL UG/L	77687 8270/3520-G					--	69		--	--
ALUMINUM, TOTAL UG/L	1105 6010-G					--	1910	91200	--	.
ARSENIC, TOTAL UG/L	1002 7060-G					--	15.8	--	50	50
BARIUM, TOTAL UG/L	1007 6010-G					.	458	.	2000	2000
CADMIUM, TOTAL UG/L	1027 6010-G					--	99.4	--	10	5
CHROMIUM, TOTAL UG/L	1034 6010-G					--	48.1	--	100	100
COBALT, TOTAL UG/L	1037 6010-G					--	181	--	--	--
COPPER, TOTAL UG/L	1042 6010-G					--	45.5		--	1300
LEAD, TOTAL UG/L	1051 7421-G					--	20.7	--	5	15
MERCURY, TOTAL UG/L	71900 7470-G					--	0.28	--	2	2
SELENIUM, TOTAL UG/L	1147 7740-G					--	17.3	--	.	--
ZINC, TOTAL UG/L	1092 6010-G					--	20.0	--	--	--

*All units in micrograms per liter (ug/L)
*Proposed value

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Remedial Investigation/Feasibility Study
Law Environmental
August 1990

POSITIVE RESULTS IN GROUND WATER
DUNN FIELD AREA
DEFENSE DEPOT MEMPHIS TENNESSEE

HALOGENATED VOLATILES (ug/l)

PARAMETER		Background Well MW18	MCL	MW3	MW4	MW5	MW6	MW7	MW8	MW9	MW10	MW11	MW12	MW13	MW14	MW15	MW28	MW29	MW34	MW35	MW30	MW31	MW32	MW33
1,1,1-Trichloroethane	PHASE I	--	200	3J	--	--	--	5J	5	--	0	--	--	--	--	--	--	--	--	--	--	--	--	--
	PHASE II	--		4J	--	--	--	4J	6	--	10	--	--	--	--	--	--	9	--	--	--	5	--	--
	AEHA-1987	--		4	--	--	--	9	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
1,1,2,2-Tetrachloroethane	PHASE I	--	--	--	--	--	150	--	--	--	10	73	340D	--	--	--	--	--	--	--	--	--	--	--
	PHASE II	--		--	--	--	66	--	--	--	8	11	1900D	2J	--	--	--	--	--	--	--	2600	110	--
	AEHA-1987	--		--	--	--	82	--	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
1,1,2-Trichloroethane	PHASE I	--	--	--	--	--	7	--	--	--	--	2J	1J	--	--	--	--	--	--	--	--	--	--	--
	PHASE II	--		--	--	--	4J	--	--	--	--	--	7	--	--	--	--	--	--	--	--	12	5	--
	AEHA-1987	--		--	--	--	4	--	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
1,1-Dichloroethane	PHASE I	--	--	--	--	--	--	3J	3J	--	3J	--	--	--	--	--	--	--	--	--	--	--	--	--
	PHASE II	--		--	--	--	--	2J	4J	--	4J	--	--	--	--	--	--	5	--	--	--	--	--	--
	AEHA-1987	--		--	--	--	--	3	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
1,1-Dichloroethylene	PHASE I	--	7	36	--	--	--	81	66	3J	130	--	--	--	--	--	--	--	--	--	--	--	--	--
	PHASE II	--		47	--	--	--	58	68	2J	160	--	--	--	--	--	--	58	--	--	--	61	--	--
	AEHA-1987	--		27	--	--	--	75	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
1,2-Dichloroethane	PHASE I	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	PHASE II	--		--	--	--	--	--	--	--	3J	--	--	--	--	--	--	--	--	--	--	--	--	--
	AEHA-1987	--		--	--	--	--	--	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
1,2-Dichloroethylene	PHASE I	--	100/70(c)	--	--	3J	270D	--	--	--	6J	520D	190D	--	--	--	--	--	--	--	--	--	--	--
	PHASE II	--		--	--	--	180	--	--	--	160	61	510D	--	--	2J	--	--	--	1J	--	1100D	110	--
	AEHA-1987	--		--	--	--	200	--	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Carbon Tetrachloride	PHASE I	--	5	--	5J	4J	77	--	--	7	--	4J	1J	--	1J	10J	--	--	--	--	--	--	--	--
	PHASE II	--		--	10	--	40	--	--	5	3J	5	3J	--	--	17	--	--	--	--	--	11	52	--
	AEHA-1987	--		--	4	--	78	--	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Chloroform	PHASE I	--	100(c)	3J	2J	11	15	0	--	3J	--	6	3J	--	--	4J	--	--	--	--	--	--	--	--
	PHASE II	--		--	7	2J	10	6	--	--	6	11	10	--	--	18	--	--	--	--	--	33	12	--
	AEHA-1987	--		--	8	--	10	3	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Methylene chloride	PHASE I	--	5	--	--	--	--	4BJ	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	PHASE II	--		2J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	AEHA-1987	--		--	--	--	--	--	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Tetrachloroethene	PHASE I	--	5	40	100	210	3	59	56	8	190	--	--	3J	--	--	--	--	--	--	--	--	--	--
	PHASE II	--		74	200D	46	2J	47	54	5	240D	18	33	9	--	--	--	67	--	--	--	96	2J	--
	AEHA-1987	--		29	81	27	3	39	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Trichloroethene	PHASE I	--	5	25	4J	28	190D	19	21	7	140	300D	1700D	--	--	2J	--	--	--	--	--	--	--	--
	PHASE II	--		35	9	5	120	18	21	4J	380D	81	5100D	--	--	6	--	24	--	61	--	1500D	110	--
	AEHA-1987	--		18	4	7	150	15	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

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POSITIVE RESULTS IN GROUND WATER
DUNN FIELD AREA
DEFENSE DEPOT MEMPHIS TENNESSEE

PARAMETER		Background Well MW18	MCL	MW3	MW4	MW5	MW6	MW7	MW8	MW9	MW10	MW11	MW12	MW13	MW14	MW15	MW28	MW29	MW34	MW35	MW30	MW31	MW32	MW33
NONHALOGENATED VOLATILES (ug/l)																								
Acetone	PHASE I	3J	--	--	--	--	34B	3J	--	--	--	1JB	1JB	1JB	2JB	--	--	--	--	--	--	--	--	--
	PHASE II	--		6J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NONHALOGENATED SEMIVOLATILES (ug/l)																								
Boric acid	PHASE I	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	PHASE II	--		3J	3J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	PHASE I	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	PHASE II	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	42	--	--	--	--
N-Nitrosodiphenylamine	PHASE I	2J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	PHASE II	--		4BJ	19B	6BJ	6BJ	3BJ	4BJ	3BJ	6BJ	4BJ	7BJ	6BJ	--	5BJ	3BJ	6BJ	--	3BJ	--	--	--	--
bis(2-Ethylhexyl) phthalate	PHASE I	5J	--	8J	7J	6J	5J	5J	5J	8J	13	--	5J	3J	5J	8J	--	--	--	--	--	--	--	--
	PHASE II	3J		7BJ	--	--	--	--	--	--	--	3BJ	--	--	--	--	--	--	--	11J	--	--	--	--
VOLATILE METALS (ug/l)																								
Arsenic	PHASE I	55	50	--	--	--	--	--	--	62	85	--	--	--	--	--	--	--	--	--	--	--	--	--
	PHASE II	40		--	--	--	--	--	--	--	150	--	--	--	210	--	--	50	--	--	50	180	--	80
	AEHA-1987			--	--	--	--	--	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Lead	PHASE I	79	50/15(f)	238N	257N	84N	395N	390N	165N	171N	653N	383N	417N	150N	507N	255N	--	--	--	--	--	--	--	--
	PHASE II	80		90	130	40	70	280	70	--	1000	140	70	40	200	120	80	80	--	--	50	200	120	100
	AEHA-1987			8	3	12	--	4	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Mercury	PHASE I	--	2	1.8	1.1	.6	3.6	1.4	1.7	.8	.7	1.4	.5	1.4	1.9	3.1	--	--	--	--	--	--	--	--
	PHASE II	--		--	--	--	1	--	1	--	1	--	--	--	2	1	--	--	--	--	--	1	1	--
	AEHA-1987			0.4	0.2	--	--	0.2	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

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POSITIVE RESULTS IN GROUND WATER
DUNN FIELD AREA
DEFENSE DEPOT MEMPHIS TENNESSEE

NONVOLATILE METALS (ug/l)

PARAMETER		Background Well MW18	MCL	MW3	MW4	MW5	MW6	MW7	MW8	MW9	MW10	MW11	MW12	MW13	MW14	MW15	MW28	MW29	MW34	MW35	MW30	MW31	MW32	MW33
Antimony	PHASE I	--	6	45BN	59BN	--	142N	170N	113N	81N	8IN	54BN	--	--	--	--	--	--	--	--	--	--	--	--
	PHASE II	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	AEHA-1987			NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Barium	PHASE I	218	2000	659N	695N	224N	117N	1030N	994N	416N	1310N	3390N	2010N	416N	3740N	899N	--	--	--	--	--	--	--	--
	PHASE II	410		310	280	200	830	540	350	130	1900	1200	560	220	1500	550	660	410	120	120	600	880	1000	460
	AEHA-1987	--		135	129	155	674	107	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Cadmium	PHASE I	--	5	--	--	--	8N	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	PHASE II	--		--	--	--	--	--	--	--	--	--	--	--	--	--	9	9	--	--	--	--	--	--
	AEHA-1987			--	--	--	--	--	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Chromium (d)	PHASE I	55	100	643N	823N	170N	386N	1240N	471N	182N	286N	530N	517N	184N	800N	393N	--	--	--	--	--	--	--	--
	PHASE II	50		60	120	50	40	340	100	10	310	120	40	20	100	110	130	170	--	--	50	280	140	100
	AEHA-1987			--	--	22	27	--	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Copper	PHASE I	190	1300(g)	345N	438N	78N	213N	856N	304N	138N	813N	843N	454N	190N	592N	400N	--	--	--	--	--	--	--	--
	PHASE II	180		50	80	40	40	210	180	20	910	520	80	50	180	110	80	80	--	--	50	100	50	70
	AEHA-1987			--	--	--	--	--	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Nickel	PHASE I	28	100	324N	301N	57N	145N	602N	170N	67N	142N	225N	350N	70N	421N	170N	--	--	--	--	--	--	--	--
	PHASE II	40		40	50	20	30	170	50	--	170	60	40	20	100	60	70	60	--	--	30	130	60	50
	AEHA-1987			--	--	--	--	--	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Silver	PHASE I	--	100(h)	--	--	--	20	--	--	--	--	--	42	11	13	6B	--	--	--	--	--	--	--	--
	PHASE II	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	AEHA-1987			--	--	--	--	--	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Zinc	PHASE I	116	5000(h)	114N	115N	311N	517N	1010N	745N	304N	1120N	872N	1300N	407N	1840N	662N	--	--	--	--	--	--	--	--
	PHASE II	180		160	170	81	63	450	160	14	1300	230	110	79	430	140	250	210	24	35	160	490	220	230
	AEHA-1987			46	74	79	79	43	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

(c) Trans Isomer/Cis Isomer
(d) No distinction between Chromium (III) and Chromium (VI)
(e) Total trihalomethanes
(f) MCL/ Action Level
(g) MCLG. Primary MCL is a Treatment Technique
(h) Secondary MCL
NT = Well not tested for this parameter due to one of following reasons:
(1) Well not constructed yet
(2) Well constructed but sample not analyzed for this parameter
AEHA 1987 – Groundwater samples analyzed using EPA Methods 624, 625, 608, 200.7, 245.2, 239.2, and 270.2

B (Inorganic) = Value less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL).
B (Organic) = Found in method blank.
D = Identified in an analysis at a secondary dilution factor.
J = Estimated value less than the sample quantitation limit but greater than zero.
N = Spiked sample recovery not within control limits.
-- = Not detected.
NA = Not Available

POSITIVE RESULTS IN GROUND WATER DUNN FIELD – PERCHED WATER TABLE DEFENSE DEPOT MEMPHIS TENNESSEE

PARAMETER	MCL	PHASE I MW2
NONHALOGENATED VOLATILES (ug/l)		
Acetone	--	3J
NONHALOGENATED SEMIVOLATILES (ug/l)		
bis(2-Ethylhexyl) phthalate	--	5J
VOLATILE METALS (ug/l)		
Arsenic	50	100
Lead	50/15 (b)	186N
Mercury	2	.5
Selenium	50	90
NONVOLATILE METALS (ug/l)		
Antimony	6	90N
Barium	2000	475N
Cadmium	5	12N
Chromium (c)	100	118N
Copper	1300 (d)	127N
Nickel	100	48N
Zinc	5000 (h)	299N

Reference – RI Report (1990)

(b) MCL/ Action Level

(c) No distinction between Chromium III and Chromium VI.

(d) MCLG. Primary MCL is Treatment Technique.

(h) Secondary MCL

J = Estimated value less than the sample quantitation limit, but greater than zero.

N = Spiked sample recovery not within control limits.

NA = Not Available

POSITIVE RESULTS IN GROUND WATER
MAIN INSTALLATION – FLUVIAL AQUIFER
DEFENSE DEPOT MEMPHIS TENNESSEE

PARAMETER (UG/L)	DATE	BACKGROUND WELL MW16	MCL	MW17	MW19	MW20	MW21	MW22	MW23	MW24	MW25	MW26	MW38	MW39
HALOGENATED VOLATILES (ug/l)														
Carbon Tetrachloride	PHASE I	--	5	--	--	--	--	--	--	--	2J	5J	--	--
	PHASE II	--		--	--	--	--	--	--	--	--	5	--	--
Chloroform	PHASE I	--	100(c)	--	--	--	--	--	--	--	--	1J	--	--
	PHASE II	--		--	--	--	--	--	--	--	--	2J	--	--
Methylene chloride	PHASE I	--	5	--	--	--	--	--	--	--	--	1BJ	--	--
	PHASE II	--		--	--	--	--	--	--	--	--	--	--	--
Tetrachloroethene	PHASE I	--	5	--	--	--	39	--	--	--	8	10	--	--
	PHASE II	--		--	--	--	15	2J	--	--	7	5	--	1J
Trichloroethene	PHASE I	--	5	--	--	--	--	5J	--	--	--	3J	--	--
	PHASE II	--		--	--	--	2J	11	--	--	--	3J	--	9
NONHALOGENATED VOLATILES (ug/l)														
Acetone	PHASE I	3J	--	3J	--	4J	2J	3J	3J	3J	2BJ	4J	--	--
	PHASE II	--		--	--	--	--	--	--	--	--	--	--	--
NONHALOGENATED SEMIVOLATILES (ug/l)														
Di-n-butyl phthalate	PHASE I	--	--	--	--	3J	--	--	--	--	--	--	--	--
	PHASE II	--		--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	PHASE I	2J	--	--	--	7J	--	--	4J	--	--	3J	--	--
N-Nitrosodiphenylamine	PHASE I	2J	--	--	--	--	3J	3J	--	2J	5J	--	--	--
Phenol	PHASE II	--	--	--	--	--	--	--	--	--	--	--	--	3J
bis(2-Ethylhexyl) phthalate	PHASE I	5J	--	3J	5J	12J	--	4J	8J	5J	--	9J	--	--
	PHASE II	3J		--	2J	--	--	--	--	--	--	--	--	54
VOLATILE METALS (ug/l)														
Arsenic	PHASE I	55	50	324	38	--	--	--	--	--	--	--	--	--
	PHASE II	40		--	--	70	60	200	120	--	--	50	--	--
Lead	PHASE I	79	50/15 (e)	205	42	79*	97*	201*	334*	152*	128	--	--	--
	PHASE II	80		--	--	50	110	220	140	--	70	50	--	70
Mercury	PHASE I	--	2	6.8	--	.9N	1N	1.4N	1.6N	.4N	1.7	.4N	--	--
	PHASE II	--		--	--	--	1	5	1	--	--	--	--	--

POSITIVE RESULTS IN GROUND WATER
MAIN INSTALLATION – FLUVIAL AQUIFER
DEFENSE DEPOT MEMPHIS TENNESSEE

PARAMETER (UG/L)	DATE	BACKGROUND WELL MW16	MCL	MW17	MW19	MW20	MW21	MW22	MW23	MW24	MW25	MW26	MW38	MW39
NONVOLATILE METALS (ug/l)														
Antimony	PHASE I	--	6	47B	--	--	--	--	--	--	--	--	--	--
	PHASE II	--		--	--	--	--	--	--	--	60	50	--	--
Barium	PHASE I	218	2000	603	296	247	229	343	567	167	1960	908	--	--
	PHASE II	410		190	310	290	240	380	390	81	410	380	80	130
Cadmium	PHASE I	--	5	8	6	11N*	7N*	14N*	15N*	18N*	--	--	--	--
	PHASE II	--		--	--	--	--	7	8	--	--	--	--	--
Chromium (d)	PHASE I	55	100	408	17	100	171	618	306	31	337	150	--	--
	PHASE II	50		10	20	90	110	560	150	--	40	30	--	20
Copper	PHASE I	198	1300 (f)	322	108	242	148	326	1570	88	209	268	--	--
	PHASE II	180		60	80	130	90	160	230	50	20	40	--	30
Nickel	PHASE I	29	100	238	--	35	49	110	73	26	125	58	--	--
	PHASE II	40		--	--	40	40	100	40	--	--	--	--	--
Zinc	PHASE I	116	5000 (h)	910	59	150	242	594	413	193	408	400	--	--
	PHASE II	180		180	53	140	190	750	290	170	120	120	23	86

Reference – RI Report (1990)
MCL – SDWA Maximum Containment Level
(c) Total trihalomethanes
(d) No distinction between Chromium III and Chromium VI.
(e) MCL/ Action Level
(f) MCLG. Primary MCL is Treatment Technique.
(h) Secondary MCL
B (Inorganic) = Value less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL).
B (Organic) = Found in method blank.
J = Estimated value less than the sample quantitation limit but greater than zero.
N = Spiked sample recovery not within control limits.
* = Duplicate analysis not within control limits.
-- = Not detected.
NA = Not Available.

POSITIVE RESULTS IN GROUNDWATER
MEMPHIS SAND AQUIFER
DEFENSE DEPOT MEMPHIS TENNESSEE

PARAMETER	DATE	MCL	MW36	MW37
NONHALOGENATED VOLATILES (ug/l)				
Acetone	PHASE II	--	--	3500D
2-Butanone	PHASE II		4J	--
4-Methyl-2-pentanone	PHASE II		--	8J
NONHALOGENATED SEMIVOLATILES (ug/l)				
N-Nitrosodiphenylamine	PHASE II	--	38J	--
NONVOLATILE METALS (ug/l)				
Barium	PHASE II	2000	410	380
Chromium (c)	PHASE II	100	--	20
Copper	PHASE II	1300 (d)	10	20
Nickel	PHASE II	100	--	20
Zinc	PHASE II	5000 (e)	73	150

Reference RI Reopr1 (1990)

MCL – SDWA Maximum Containment Level

(c) No distinction between Chromium III and Chromium VI.

(d) MCLG. Primary MCL is Treatment Technique.

(e) Secondary MCL

D = Identified in an analysis at a secondary dilution factor.

J = Estimated value less than the sample quantitation limit, but greater than zero.

-- = Not detected.

NA = Not Available.

POSITIVE RESULTS IN SURFACE SOILS
BUILDING 629
DEFENSE DEPOT MEMPHIS TENNESSEE

PARAMETER	PHASE I SS10	PHASE I SS11	PHASE II SS42	PHASE II SS43
HALOGENATED VOLATILES ug/kg				
1,1,2-Trichloroethane	--	--	11	--
Methylene chloride	18B	13B	8B	7B
Tetrachloroethene	--	--	3J	--
Trichloroethene	--	--	2100E	--
NONHALOGENATED VOLATILES ug/kg				
Acetone	67	95	24	21
Carbon disulfide	2J	5	--	--
Toluene	6J	18	4J	7
HALOGENATED SEMIVOLATILES ug/kg				
Pentachlorophenol	--	--	--	270J
NONHALOGENATED SEMIVOLATILES ug/kg				
bis(2-Ethylhexyl) phthalate	500J	--	--	1300BJ
Dibenzofuran	1300J	9700	24000J	340J
N-Nitrosodiphenylamine	510JB	1900JB	--	--
Polynuclear Aromatic Hydrocarbons (PAHs)				
2-Methylnaphthalene	500J	2000J	--	--
Acenaphthene	2300	20000	64000J	1100J
Acenaphthylene	550J	1900J	--	--
Anthracene	4400	26000	130000J	1800
Benzo(a)anthracene	9500	110000D	970000	5300
Benzo(a)pyrene	8300	100000D	450000	5200
Benzo(b)fluoranthene	9500	110000D	540000	9300
Benzo(g,h,i)perylene	5300	65000D	360000	2900
Benzo(k)fluoranthene	10000	92000D	450000	--
Chrysene	8900	120000D	620000	6600
Dibenzo(a,h)anthracene	1400J	9800	160000	1400
Fluoranthene	23000	260000D	860000	9300
Fluorene	2600	16000	47000J	880J
Indeno(1,2,3-cd)pyrene	4900	72000D	310000	2800
Naphthalene	1900	4600	--	130J
Phenanthrene	19000	200000D	620000	7000
Pyrene	18000	180000D	870000	9300
TOTAL PAHs	130,050	1,429,300	6,475,000	63,210

POSITIVE RESULTS IN SURFACE SOILS
BUILDING 629
DEFENSE DEPOT MEMPHIS TENNESSEE

PARAMETER	PHASE I		PHASE II	
	SS10	SS11	SS42	SS43
PESTICIDES ug/kg				
4,4'-DDD	2100X	3600	1400JX	320DJ
4,4'-DDE	4500D	39000D	9000DJ	2500DJ
4,4'-DDT	6700D	59000D	7900DJ	710DJ
alpha-Chlordane	4000D	--	--	--
beta-BHC	--	--	1800XZ	--
Dieldrin	240	--	--	4500D
Endrin ketone	--	12000D	--	--
gamma-Chlordane	4000D	2400J	820J	--
Heptachlor	120	--	--	--
Heptachlor epoxide	250	--	--	--
Methoxychlor	--	--	1500J	--
VOLATILE METALS mg/kg				
Arsenic	12	20	12	26
Lead	81	1680	1120	126
Mercury	0.080	0.84	1.3	--
NONVOLATILE METALS mg/kg				
Antimony	--	8B	--	--
Barium	57.6	343	108	70.8
Cadmium	1.1	6.0	11.8	--
Chromium **	24	135	39	15
Copper	16	135	705	15
Nickel	--	--	367	5.0
Silver	3.0	9.0	--	--
Zinc	63.4	960	10400	94.8

Reference – RI Report (1990)
na = Not Available
B (Inorganic) = Value less than the Contract Required Detection Limit (CRDL), but greater than the Instrument Detection Limit (IDL). B (Organic) = Found in method blank.
D = Identified in an analysis at a secondary dilution factor.
E = Concentration exceeded the calibration range of the GC/MS instrument.
J = Estimated value less than the sample quantitation limit, but greater than zero.
X = Estimated value due to a confirmed compound which is off-scale in both columns.
** = No distinction between Chromium (III) and Chromium (VI)
-- = Not detected.

POSITIVE RESULTS IN SUBSURFACE SOILS
DEFENSE DEPOT MEMPHIS TENNESSEE

PHASE I

PARAMETER	STB-1-1	STB-1-2	STB-1-3	STB-2-1	STB-2-2	STB-2-3	STB-3-1	STB-3-2	STB-3-3	STB-4-1	STB-4-2	STB-4-3	STB-5-1	STB-5-2	STB-5-3
Depth of Sample:	25.5	62.9	73.5	19.0	17.5	67.9	21.0	20.0	23.5	19.0	20.0	102.0	10.0	78.0	93.0
HALOGENATED VOLATILES ug/kg															
Chloroform	--	0	--	--	--	--	--	--	--	--	--	--	--	--	--
Methylene chloride	16B	19B	10B	7B	8B	12B	3J	3J	3J	2J	10B	10B	13B	21B	12B
NONHALOGENATED VOLATILES ug/kg															
2-Butanone	--	--	--	--	--	--	--	--	--	18	--	--	--	--	--
Acetone	57	43	29	24B	12B	13B	--	--	30	31	8J	17	18	14B	14
Toluene	--	--	--	--	--	--	--	--	--	1J	--	--	--	--	--
NONHALOGENATED SEMIVOLATILES ug/kg															
Benzoic acid	--	--	--	--	--	58J	--	--	--	--	--	--	--	--	--
bis(2-Ethylhexyl) phthalate	1200	1200	780J	1100	1000	1600	2000B	670B	910B	610B	1500B	560BJ	450B	440B	320BJ
Di-n-butyl phthalate	--	--	--	--	210BJ	100BJ	140BJ	170BJ	120BJ	--	--	--	--	--	--
N-Nitrosodiphenylamine	--	--	--	43JB	--	--	--	--	--	--	44J	--	--	--	--
Polynuclear Aromatic Hydrocarbons (PAHs)															
Fluoranthene	--	--	--	--	51J	47J	--	--	--	--	--	--	--	--	--
Pyrene	--	--	--	--	40J	40J	--	--	--	--	--	--	--	--	--
TOTAL PAHs	--	--	--	--	91	87	--	--	--	--	--	--	--	--	--
NONVOLATILE METALS															
Barium (EPTOX in ug/l)	15	25	58	--	--	--	10	18	40	--	--	25	--	10	--
Cadmium (EPTOX in ug/l)	--	12	5	20	6	--	7	--	--	--	--	--	--	--	--

B (Organic) = Found in method blank
J = Estimated value less than the sample quantitation limit, but greater than zero.
-- = Not detected

POSITIVE RESULTS IN SUBSURFACE SOILS
DEFENSE DEPOT MEMPHIS TENNESSEE

PARAMETER	Phase II											
	STB-6-1	STB-6-2	STB-6-3	STB-6-4	STB-7-1	STB-7-2	STB-7-3	STB-7-4	STB-8-1	STB-8-2	STB-8-3	STB-8-4
Depth of Sample:	71.5'	78.0'	88.0'	181.0'	71.0'	76.0'	91.0'	170.0'	92.0'	97.0'	127.0'	217.0'
HALOGENATED VOLATILES ug/kg												
1,1,2,2-Tetrachloroethane	240E	12	4J	13	--	--	--	--	--	--	--	--
1,2-Dichloroethane	--	--	--	--	--	--	--	--	--	--	--	11
1,2-Dichloroethylene	26	--	13	7	--	--	--	--	--	--	--	--
Methylene chloride	21B	18B	6BJ	54B	5BJ	11B	8B	8	10B	7B	5BJ	5BJ
Trichloroethane	4J	--	1J	--	--	--	--	--	--	--	--	--
NONHALOGENATED VOLATILES ug/kg												
2-Butanone	--	--	15	--	--	--	--	--	3BJ	2BJ	2J	--
Acetone	210	80	1100D	74	250	95	31	8J	60B	40B	45	28
Toluene	1J	1J	5J	--	--	5J	--	--	--	3J	--	2J
NONHALOGENATED SEMIVOLATILES ug/kg												
bis(2-Ethylhexyl) phthalate	500B	260BJ	6400D	500B	1600B	160BJ	1000B	230BJ	520B	250BJ	350BJ	270BJ
Di-n-butyl phthalate	--	--	--	--	--	--	76J	--	--	--	--	--
N-Nitrosodiphenylamine	--	--	--	--	--	--	--	--	65BJ	53BJ	39J	98BJ
PESTICIDES ug/kg												
beta-BHC	--	--	147	--	--	--	--	--	--	--	--	197
VOLATILE METALS mg/kg												
Lead	6	7	5	9	11	9	7	--	--	6	--	7
NONVOLATILE METALS mg/kg												
Barium	20.7	30.1	42.5	72.7	39.1	51.6	68.6	10.6	3.6	20.1	2.9	14.2
Cadmium	--	--	--	--	--	--	--	0.6	--	--	--	--
Chromium **	9	11	4	5	12	11	6	4	1	5	2	6
Copper	3	3	4	5	2	6	6	2	3	5	3	0
Nickel	2	--	5	3	3	3	7	3	--	8	--	4
Zinc	15.7	11.4	31.2	47.2	12.1	41.3	31	11.9	19	20.5	3.0	11.0

B (Organic) = Found in method blank.
D = Identified in an analysis at a secondary dilution factor.
J = Estimated value less than the sample quantitation limit, but greater than zero.
E = Concentration exceeds the calibration range of the GC/MS instrument for this specific analysis.
Z = Matrix interference, compound not positively identifiable.
** = No distinction between Chromium (III) and Chromium (VI).
-- = Not detected

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